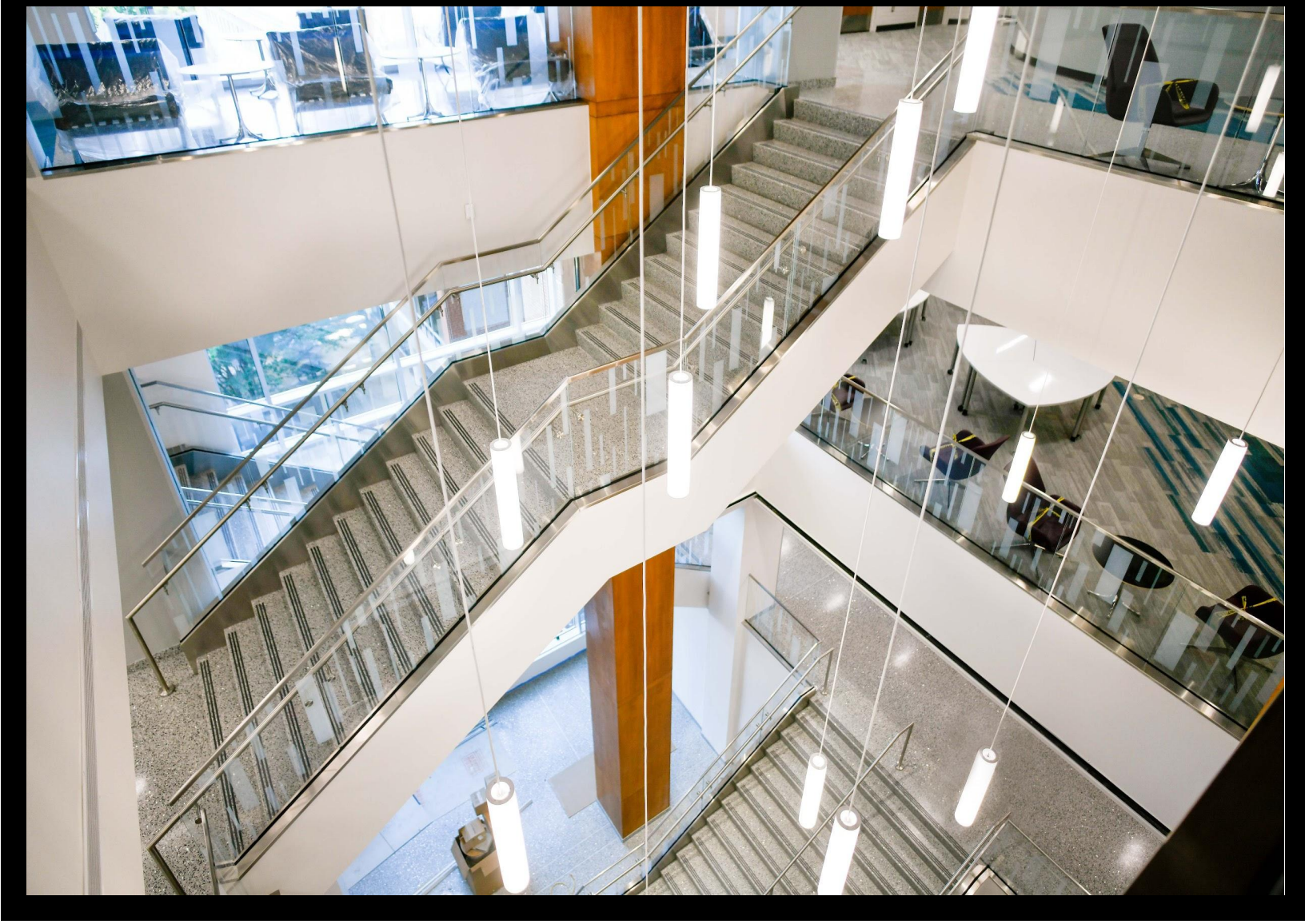

NC STATE UNIVERSITY

2022 Summer Undergraduate Research & Creativity Symposium

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Summer Symposium Schedule

TUESDAY | JULY 26	
9 a.m. - 9:30 a.m.	Check-in, Set up, Light refreshments
9:30 a.m. - 10:30 a.m.	Session 1
10:30 a.m. - 10:45 a.m.	Takedown/Set Up
10:45 a.m. - 11:45 a.m.	Session 2
11:45 a.m. - 12:15 p.m.	Lunch Break
12:15 p.m. - 12:30 p.m.	Set Up
12:30 p.m. - 1:30 p.m.	Session 3
1:30 p.m. - 1:45 p.m.	Takedown/Set Up
1:45 p.m. - 2:45 p.m.	Session 4

WEDNESDAY | JULY 27	
9 a.m. - 9:30 a.m.	Check-In, Set Up, Light Refreshments
9:30 a.m. - 10:30 a.m.	Session 5
10:30 a.m. - 10:45 a.m.	Takedown/Set Up
10:45 a.m. - 11:45 a.m.	Session 6
11:45 a.m. - 12:00 p.m.	Takedown/Set Up
12:00 p.m. - 1:00 p.m.	Session 7

REU Program Key

CMI SIRI - Summer Interdisciplinary Research Initiative
BIT SURE - Biotechnology Summer Undergraduate Research Experience
WMSRP - Women & Minority Summer Research Program
RISE - Research Internship Summer Experience
ASSURE - Animal Sciences Summer Undergraduate Research Experience
CEFS ASPIRE - Agroecology Scholars Program in Research and Extension
DRUMS - Directed Research for Undergraduates in Mathematics and Statistics
BeeMORE - Bees and Microbes in Organized Research and Extension
ASSIST - Advanced Self-Powered Systems of Integrated Sensors and Technologies
STEPS - Science and Technologies for Phosphorus Sustainability
RTNN - The Research Triangle Nanotechnology Network
GCSP - The Engineering Grand Challenges Scholars Program
IMPS - Integrative Microbial and Plant Systems
SPIA SURE - School of Public and International Affairs
BESST - Basic and Environmental Soil Science Training
SRCA - Socially Relevant Computing and Analytics Research Experience
MAT-DAT - Materials Engineering with Date Science
ICE - Integrated Computational and Experimental
TECS - Textile Engineering, Chemistry, and Science
MI - Mentoring Incubator

PRESENTER INDEX

Lead Presenter	Co-Presenters	Session	Primary Mentor	REU/Summer Research Program	Project Title
Abbey, Keith College of Engineering NC State University		6	Alon Greenbaum (College of Engineering)	OUR Award	Enhancing In-Vitro Drug Delivery to the Inner Ear Using Exosomes
Abello, Sofia College of Engineering NC State University		7	Januka Budhathoki-Uprety (Wilson College of Textiles)		Development of optical nano-biosensors for detection of electrolytes
Ahmed, Taha College of Engineering NC State University		7	Venkat Narayanaswamy (College of Engineering)	MAE	Characterizing Fluid-Structure Interactions and Energy Transfer in a Thin-Walled Plate Through Simultaneous Imaging of Pressure Field and Measurement of Displacement
Alcantara Ocampo, Xiomara College of Agriculture & Life Sciences NC State University		4	Alejandra Huerta (College of Agriculture & Life Sciences)	Kelman Scholars	Rhs-toxins Diversity, Abundance, and Function in the bacterial pathogen Xanthomonas
Aligwekwe, Adrian College of Engineering NC State University		6	Ashley Brown (College of Engineering)	CMI SIRI	Fibrin Based drug delivery system for Staphylococcus
Almazo Rosendo, Mark College of Agriculture & Life Sciences Robeson Community College		4	Alejandra Huerta (College of Agriculture & Life Sciences)	CEFS ASPIRE	Exploring the phenotypic and genetic diversity of Xanthomonas arboricola pv. Pruni, a bacterial pathogen of peach, to develop alternative treatment to copper tolerance in pathogen population
Alvarez Valverde, Victor Wilson College of Textiles NC State University		7	Jenna Decandio (Wilson College of Textiles)		Integration of thermoset and thermoplastic yarns in knitted shoe uppers
Anderson, Sydney College of Sciences NC State University		4	James Martin (College of Sciences)	OUR Award	Exploring Crystal Growth Theory to Understand the Mechanism(s) of Crystal Growth from Saturated Solutions
Ard, Tiffany College of Engineering NC State University		1	Okan Pala (College of Natural Resources)	SRCA	Validating Electric Power Flow Simulation that Predicts Regional U.S. Water Footprints

PRESENTER INDEX

Lead Presenter	Co-Presenters	Session	Primary Mentor	REU/Summer Research Program	Project Title
Arline, Jarin College of Agriculture & Life Sciences		4	Hannah Levenson (College of Agriculture and Life Sciences)	CEFS ASPIRE	Pest Management Practices in Blackberries and their Impacts on Pollination
Armour, Sean College of Agriculture & Life Sciences		3	David Tarpy (College of Agriculture & Life Sciences)	BeeMORE	Colonization dynamics of the microbial community in stored Western Honey Bee pollen
Asadchykh, Sofia College of Engineering NC State University		7	Melissa Srougi (College of Vet Med)	BITSURE	Identification and Analysis of Potential NQO1 bioactivatable Drugs for the Treatment of Triple Negative Breast Cancer
Aslam, Muskan College of Engineering NC State University		6	Zachary Davis (College of Engineering)	CMI SIRI	Verification of fluid shear stress to develop an organ-on-a-chip model for tendon injury
Baird, Thomas College of Sciences Belmont Abbey College		4	Linda Hanley-Bowdoin (College of Sciences)	IMPS	SEGS-1 Activity in CMD Resistant Cassava Cultivars
Baker, Parker Wilson College of Textiles NC State University		7	Warren Jasper (Wilson College of Textiles)	TECS	An open-source driver to measure particle concentrations
Barfield, Andrew College of Natural Resources NC State University	Heather Moeller College of Sciences NC State University	4	Carol Price (College of Sciences)	OUR Award	Crystal Skipper Conservation
Barker-Edwards, Tiffany College of Agriculture & Life Sciences University of Texas at San Antonio		3	Brina Montoya (College of Engineering)	BESST	Comparing the Mineralogy of Microbially Induced Calcium Carbonate Precipitation to Naturally Cemented Sandstone
Barlow, Olivia College of Engineering NC State University		5	Matthew Fisher (College of Engineering)	GCSP	Degenerative Effects of Partial and Complete ACL Tears

PRESENTER INDEX

Lead Presenter	Co-Presenters	Session	Primary Mentor	REU/Summer Research Program	Project Title
Barrera, Kimberly College of Humanities & Social Sciences NC State University		2	Qiana Cryer-Coupet (College of Humanities & Social Sciences)		Examining Trauma-Informed Social Work Practice and Education
Barth, Chris College of Engineering Reedy Creek Middle School Teacher		1	Tiffany Barnes (College of Engineering)	SRCA	Interweaving Snap! Into Earth Science Instruction
Bayat, Aurian College of Humanities & Social Sciences NC State University		6	Steven Greene (College of Humanities & Social Sciences)	SPIA SURE	Impacts of Money in Politics on Political Efficacy and Democracy in the United States
Bevans, Zachary College of Engineering NC State University		6	Scott Palmtag (College of Engineering)	OUR Award	Modeling B&W Nuclear Reactors using Nodal Core Simulator
Bhandari, Indira College of Engineering Reedy Creek Middle School Teacher		1	Tiffany Barnes (College of Engineering)	SRCA	Computer Science: Creating activities for the classroom and contributing to research
Bhatia, Karina Wilson College of Textiles NC State University		7	Xiaomeng Fang (Wilson College of Textiles)	TECS	Converting electrospun webs into traditional textiles
Blackwell, Brooklyn College of Engineering Howard University		1	Alexey Gulyuk (College of Engineering)	STEPS	Molecular Simulations of Removal and Recovery of Phosphate from Wastewater using Temperature Swing Solvent Extraction (TSSE) Method
Blythe, Caroline College of Agriculture & Life Sciences Stanford University		3	Becky Irwin (College of Agriculture & Life Sciences)	BeeMORE	Variation in bumblebee and floral visitor abundance across two microhabitats of the threatened Smooth Purple Coneflower
Brewer, Bruce College of Sciences Utah State University		2	Nghiem Nguyen (College of Sciences)		Explicit synchronized solitary waves for some models for the interaction of long and short waves in dispersive media

PRESENTER INDEX

Lead Presenter	Co-Presenters	Session	Primary Mentor	REU/Summer Research Program	Project Title
Brewer, Blake College of Engineering NC State University		6	Krisstina Burgess (College of Engineering)	BTEC	Purification of Green Fluorescent Protein with the Millipore XM012 Single-Use Column Chromatography Platform and the Sartorius CIMultus Monolith
Broderick, Meghan College of Sciences NC State University		2	Caroline Proulx (College of Sciences)		Development of a SNAr Reaction on Resin-bound Peptides for Scope Expansion in Ketoxime Ligations
Brown, Ana College of Engineering NC State University		3	Javon Adams (College of Engineering)	WMSRP	Fit 4 Purpose Handbook form UMM Sector
Brown, Nia College of Sciences NC State University		4	Catherine Hoyo (College of Sciences)	BeeMORE	AHRR Hypomethylation Mediated the Effect of Maternal Smoking on Child Metabolic Profiles
Brown, Nia College of Agriculture & Life Sciences NC State University		5	Hannah Levenson (College of Agriculture & Life Sciences)	BeeMORE	Does adding pollinator conservation habitat increase mite abundance on bees?
Brown, Jackson College of Engineering NC State University		3	Tarek Aziz College of Engineering	RISE CCEE	Investigating Woodchip Fungal Bioreactor Dissolved Organic Matter as a Surrogate for Fungal Biomass
Bruxellas, Brynna College of Agriculture & Life Sciences Concordia University Nebraska		4	Robert Austin (College of Agriculture & Life Sciences)	BESST	UAV-Based Characterization of Micro-Topographic Features for Use in Estimating Soil Moisture and Nitrous Oxide Emissions in Agriculture Fields
Buggs, Julianne College of Sciences NC State University		1	Douglas Call (College of Engineering)	STEPS	Chemical and Biological Factors Affecting Phosphorus Uptake/Release by Phosphorus Accumulating Organisms

PRESENTER INDEX

Lead Presenter	Co-Presenters	Session	Primary Mentor	REU/Summer Research Program	Project Title
Burden, Jeremiah College of Sciences Juniata College	Nina De La Torre College of Sciences The University of San Antonio Nicole Lacey College of Arts & Sciences Drake University Taylor Cobb College of Sciences Truman State University	2	Sharon Lubkin (College of Sciences)	DRUMS	Modeling Developing Tissues as a Foam
Burroughs, Mason College of Agriculture & Life Sciences NC State University		4	William Thompson (College of Agriculture & Life Sciences)		A dual labeling procedure to analyze cell cycle progression
Cada, Drew College of Engineering NC State University		1	Tiffany Barnes (College of Engineering)	SRCA	A Novel Approach to Discover the Number of Solutions to the Strong Goldbach's Conjecture
Carr, Jesse College of Engineering NC State University		5	Amirreza Naseri (College of Engineering)	BME	Comparing the Efficacy of Using Different Balance Metrics to Detect Significant Gait Disturbances and Predict Falls
Carter, Shan College of Sciences Syracuse University		1	James Kneller (College of Sciences)	CDSA	Multi Angle NSI with Neutrinos
Carter, Caleb College of Sciences NC State University		6	Carlos Goller (College of Sciences)	GCSP	Grand Challenges Equal Grand Opportunities: Developing Comprehensive Protocols and Tutorials for Discovery, Sequencing, and Identification of Microbial Organisms
Cartrette, Katelyn College of Sciences NC State University		2	Caroline Proulx (College of Sciences)	ICE	Late-Stage N-Alkylation Reactions Various Amino Acid Protected Side-Chains on Azapeptides

PRESENTER INDEX

Lead Presenter	Co-Presenters	Session	Primary Mentor	REU/Summer Research Program	Project Title
Cecchini, Emily College of Sciences NC State University		1	Karen Daniels (College of Sciences)		The Effect of Boundary Roughness on Granular Flow in a Hopper
Cernoch, Chloe College of Engineering NC State University		7	Sophie Noel (Collage of Agriculture & Life Sciences)	BITSURE	CHIPS Taste Test via ELISA Assay
Chabeda, Mika College of Agriculture & Life Sciences NC State University		4	James Holland (College of Agriculture & Life Sciences)	CEFS ASPIRE	The Effect of Selection for Early Flowering on Tassel Length and Branch Numbers in Tropical Maize Populations
Chandarana, Lauren College of Agriculture & Life Sciences NC State University	Jasmine Peace College of Agriculture & Life Sciences NC State University	1	Lisa Van den Broeck (College of Agriculture & Life Sciences)	STEPS	Analyzing Phosphorus Uptake in 3-D Bioprinted Arabidopsis thaliana Cells
Cheng, Nicholas College of Agriculture & Life Sciences NC State University		4	Haotian Zheng (College of Agriculture & Life Sciences)	Food Science Summer Scholars	Heat Stability of Colloidal Dispersions Containing Assemblies of Pulse Proteins
Chilton, Lillian College of Engineering NC State University		5	Javon Adams (College of Engineering)	WMSRP	The Effects of Walking-Related Fatigue on Vulnerability to Later Waist-Pull Perturbations
Chong, Hannah College of Engineering Emory University	Eileen Malick College of Engineering Governor's School	1	Collin Lynch (College of Engineering)	SRCA	The Road to CS Mastery is Paved with Bugs
Cipriano, Benjamin College of Sciences NC State University		2	Joshua Pierce (College of Sciences)	OUR Award	Palladium-Catalyzed Cleavage of Bicyclo [4.1.0] Derivatives

PRESENTER INDEX

Lead Presenter	Co-Presenters	Session	Primary Mentor	REU/Summer Research Program	Project Title
Condo, Bella College of Agriculture & Life Sciences NC State University		7	Lina Quesada (College of Agriculture & Life Sciences)		Monitoring populations in Pseudoperonospora cubensis using biosurveillance and molecular markers
Cook, Caleb College of Vet Med NC State University		2	Laurianne Van Landeghem (College of Vet Med)	OUR Award	Development of a method to grow primary culture of enteric glial cells from the porcine colon
Council, Erica College of Sciences NC State University		2	Mansoor Haider (College of Sciences)		Mathematical models of interactions between platelet-like particles and hydrogels during ultrasound stimulation
Cox, Alaina College of Agriculture & Life Sciences Michigan State University		4	Hui Li (College of Agriculture & Life Sciences)	BESST	Effects of temperature and moisture conditions on the stability and bioavailability of soil nutrients
Crow, Arin College of Engineering NC State University	Alaina Smith College of Engineering NC State University	5	Javon Adams (College of Engineering)	WMSRP	Design, Development, and Testing of a Multi-Terrain Amphibious Rover
Crowe, Declan College of Sciences NC State University		3	Luke Allen (College of Natural Resources)		Examining Differences in Ice Growth Processes for Different Modes of Storm Formation
Crunkleton, Tori College of Engineering NC State University		2	Ramon Collazo (College of Engineering)	MSE REU	Qualifying an RF Sputter System for the Fabrication of Distributed Bragg Reflector Mirrors
Cutler, Addyson College of Sciences Eastern New Mexico University		4	Oliver Baars (College of Agriculture & Life Sciences)	IMPS	Culturing a Maize Root Bacterium for Isolation of Novel Siderophore
Da Silva, Gabriel College of Engineering NC State University		5	Javon Adams (College of Engineering)	WMSRP	Analyzing Instantaneous Water Quality Variability During Sunny Day Flooding

PRESENTER INDEX

Lead Presenter	Co-Presenters	Session	Primary Mentor	REU/Summer Research Program	Project Title
Daddone, Andrew College of Engineering NC State University		3	Angela Harris (College of Engineering)	RISE CCEE	Tracking the emergence of SARS-CoV-2 Omicron variant of concern in Raleigh, NC through clinical and municipal wastewater genomic sequencing
Dasilva, Cameron College of Sciences Reed College		2	Elon Ison (College of Sciences)	ICE	Computational Comparison of the Protonolysis of Pt-Me Bond by TFAH
Davila, Maria College of Engineering University of Puerto Rico-Mayaguez		3	Sara Shashaani (College of Engineering)	RISE ISE	Data Structuring of Additive Manufacturing Machine Outputs
De La Cerda, Adamari College of Sciences Texas A&M University		7	Jennie Fagen (College of Sciences)	Kelman Scholars	Determining the cause of PhiPhi bacteriophage resistance and susceptibility in Xanthomonas campestris strain Wilson
Deany, Ryan College of Agriculture & Life Sciences Beloit College		4	Stephanie Kulesza (College of Agriculture & Life Sciences)	BESST	Impact on Long-Term Manure Application on Potentially Mineralizable Nitrogen in Soil
Deaton, Taylor College of Sciences NC State University		7	Lina Quesada (College of Agriculture & Life Sciences)	Kelman Scholars	Crop varieties assessment of susceptibility to downy mildew in North Carolina
Delgado, Leo WIlson College of Textiles NC State University		7	Wei Gao (Wilson College of Textiles)	TECS	Textiles for Extreme Environments and High Oxygen Atmospheres
DiGiovanni, Maria College of Agriculture & Life Sciences Cornell University		4	Michael Schulman (College of Agriculture & Life Sciences)	CEFS ASPIRE	Pasture and Perseverance: How Niche Meat Farms in North Carolina Maintain Sustainable Livelihoods During COVID-19

PRESENTER INDEX

Lead Presenter	Co-Presenters	Session	Primary Mentor	REU/Summer Research Program	Project Title
Do, Anh College of Sciences Colorado College		4	Vincent Lindsay (College of Sciences)	ICE	Effect of the acidity of 1-sulfonylcyclopropanols on their equilibrium to cyclopropanes and computational study of their trapping reaction with pyrazole as nucleophile
Doak, Samuel College of Engineering NC State University		7	Stefanie Chen (College of Agriculture & Life Sciences)	BIT SURE	Visualization and characterization repair protein RadD brinding and function on ssDNA
Dominguez-Leach, James College of Engineering NC State University		5	Javon Adams (College of Engineering)	WMSRP	Application of Game Technology as an Educational Tool for Management Students
Donnellan, Ashley College of Sciences NC State University		3	Matthew Breen (College of Vet Med)		Association of Disinfection Byproducts and Heavy Metals Contaminants in Drinking Water and Canine Bladder Cancer
Draghici, Alex College of Engineering NC State University		3	Thom LaBean (College of Engineering)	MSE REU	Novel Device for Electronics Printing using Contact Dispensing Methods
Drum, Rachel Wilson College of Textiles NC State University		7	Emiel DenHartog (WIlson College of Textiles)	TECS	Strength Loss Indicator for Textile Webbing
Dudley, Madeline College of Engineering NC State University		5	Javon Adams (College of Engineering)	WMSRP	Application of an Optical Sensor System for Wrist Rotation Control
Eamiguel, Bea Marie Louise College of Sciences St. Edward's University		2	Elon Ison (College of Sciences)	ICE	Study of Mechanism of a Family Biomimetic Models of Manganese Catalase

PRESENTER INDEX

Lead Presenter	Co-Presenters	Session	Primary Mentor	REU/Summer Research Program	Project Title
Edds, Eli College of Engineering NC State University		2	Nathan Woodward (College of Engineering)	MSE REU	Modernization of RoboMapper Control Software
Esmailian, Tara College of Agriculture & Life Science NC State University	Megan Rossi College of Agriculture & Life Sciences NC State University	4	Fernanda Santos (College of Agriculture & Life Sciences)	Food Science Summer Scholars	Microbial Inhibition Using Peanut Skins
Fabian Plascencia, Fabiola College of Engineering NC State University		6	Franky So (College of Engineering)	MI	Optimization of perovskite for superfluorescence applications
Fawcett, Kriby College of Sciences NC State University		1	Alex Wall (College of Sciences)		Expression, purification and characterization of recombinant, histidine tagged Pycr3
Ferrell, Ayden College of Engineering NC State University		4	Luciano Gatiboni (College of Agriculture & Life Sciences)		Availability of Soil Legacy Phosphorus for Corn and White Lupin
Fetsko, Bethany College of Sciences Penn State	Henry Shugart College of Arts & Sciences University of North Carolina at Chapel Hill Quinn Aiken College of Arts & Sciences Ohio Northern University Bruce Brewer College of Science Utah University	2	Ryan Murray (College of Sciences)	DRUMS	A primal method for topological changed in optimal adversarial classification
Fijen, Sean Wilson College of Textiles NC State University		7	Walaa Enab (Wilson College of Textiles)	TECS	Improving Transverse and Interlaminate Properties of Carbon Fiber Reinforced Plastic Using Microfiber Veils

PRESENTER INDEX

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Finley, Maeve College of Agriculture & Life Sciences University of Michigan	Estefany Valdez Barnard College	3	Aram Mikaelyna (College of Agriculture & Life Sciences)	BeeMORE	Changes in microbiome composition through bee bread maturation in the nests of the eastern large carpenter bee, Xylocopa virginica
Fiorito, Teresa Wilson College of Textiles NC State University		7	Januka Budhathoki-Uprety (Wilson College of Textiles)	TECS	Development of Carbon Nanotube-based Optical pH Sensors
Fortunato, Anna College of Sciences University of Richmond	Matthew Caird College of Sciences Virginia Tech Sara Helmer College of Natural Science University of Texas at Austin Gabe McClinton NC State University College of Sciences	2	Mette Olufsen (College of Sciences)	DRUMS	Understanding heart rate variability using modeling and data analysis
Fox, Aiden College of Agriculture & Life Sciences Duke University		4	Ramon Leon (College of Agriculture & Life Sciences)	CEFS ASPIRE	Exploring Interactive Responses Between Cover Cropping and Preemergence Herbicides
Fraser, Rebecca College of Engineering North Carolina Agricultural & Technical State University		2	Bongmook Lee (College of Engineering)	ASSIST	Fabrication of nanofibers by electrospinning for energy harvesting application
Frazier, McKenzie College of Agriculture & Life Sciences Pacific Lutheran University		3	April Sharp (College of Agriculture & Life Sciences)	BeeMORE	How the pollination efficiency of the common eastern bumblebee (B. impatiens) foraging on tomato (S. lycopersicum) is impacted by diet and parasitism
French, Katie College of Natural Resources NC State University		4	Oliver Baars (College of Agriculture & Life Sciences)	BESST	Enzymatic Degradation of Siderophores by Fungi
Fritz, Jordan College of Sciences NC State University		1	Sandra Yuter (College of Sciences)	SRCA	Evaluating Weather Forecasts of Precipitation Start and End Times

PRESENTER INDEX

Lead Presenter	Co-Presenters	Session	Primary Mentor	REU/Summer Research Program	Project Title
Froneberger, Anna College of Agriculture & Life Sciences NC State University		6	Lauren Schnabel (College of Vet Med)	CMI SIRI	Examining the effects of natural products on the interactions between macrophages and methicillin-
Gaddy, Lakeah Wilson College of Textiles NC State University		7	Jessica Gluck (Wilson College of Textiles)	TECS	Tissue Engineering
Gamble, Carter College of Engineering NC State University		5	Jacque Cole (College of Engineering)	BME	Identifying differences between stroke and healthy bone metabolites using mass spectral analysis
Garcia, Emely College of Sciences Texas A&M University		7	Sara Villani (College of Agriculture & Life Sciences)	Kelman Scholars	Effect of ethanol on relative growth on Ambrosia, plant pathogen, and endophytic fungi
Garcia Corona, Fatima Wilson College of Textiles NC State University		7	Bryan Ormond (Wilson College of Textiles)	TECS	Impact of Fit on Total Filtration Efficiency of Face Masks on Different Headform Sizes
Gebeaux, Quinn College of Engineering NC State University		2	Tarek Aziz (College of Engineering)	RISE CCEE	A Fungal Bioremediation Game for K-12 Science Education using Agent-Based Modeling
Genne, Sierra College of Sciences University of Colorado-Boulder		1	John Blondin (College of Sciences)	CDSA	Simulating Cas A Jets with Asymmetric Circumstellar Medium
George, Raymond College of Agriculture & Life Sciences Bowdoin College		4	Alex Woodley (College of Agriculture & LIfe Sciences)	BESST	Study of Nitrous Oxide Flux along Microtopsequences
Ghosh, Ishan College of Engineering Clemson University		2	Wenpei Gao (College of Engineering)	MAT-DAT	Materials Research Data Analysis for Coastal Science

PRESENTER INDEX

Lead Presenter	Co-Presenters	Session	Primary Mentor	REU/Summer Research Program	Project Title
Ghosh, Oishi College of Sciences Purdue University		1	Collin F. Lynch (College of Engineering)	SRCA	Analyzing office hours interaction strategies using instructor feedback
Gillan, Lydia College of Engineering NC State University		4	Imani Madison (College of Agriculture & Life Sciences)	IMPS	Understanding How Phosphate Deficiency Affects The Root Architecture of Arabidopsis to Optimize Nutrient Uptake In Plants
Gillikin, Elizabeth College of Engineering NC State University		6	Praveen Kolar (College of Engineering)	MI	Developing Modified Biochar for Nitrate Adsorption
Giman, Annie College of Sciences Yale University		1	Rongmon Bordoloi (College of Sciences)	CDSA	Modeling Cool Gas Kinematics of the Fermi Bubbles
Gomez, Mariel College of Natural Resources Virginia Polytechnic Institute & State University		2	Hannah Dedmon (Wilson College of Textiles)	MAT DAT	Computational design of green bioplastics from cellulose derivatives
Gongireddy, Megha College of Engineering NC State University		6	Kurt Selle (College of Engineering)	BTEC	Cell-Line Development of Lactococcus Lactis
Good, Christopher College of Engineering Lafayette College		1	Douglas Call (College of Engineering)	STEPS	Enhancing Phosphorus Release from Food Waste using Freeze-Thaw Cycles
Gorman, Parker College of Sciences NC State University		7	Stefanie Chen (College of Sciences)	BIT SURE	Investigating RpoN control of RadD Expression
Gould, Grace College of Engineering NC State University		5	Javon Adams (College of Engineering)	WMSRP	The implications of adopting modern household cooking fuels

PRESENTER INDEX

Lead Presenter	Co-Presenters	Session	Primary Mentor	REU/Summer Research Program	Project Title
Graves, Gabriel College of Engineering Georgia Institute of Technology		2	Aram Amassian (College of Engineering)	MAT-DAT	Machine Learning-Driven Image Classification of Perovskite Film Quality for Closed-Loop Experimentation
Guercio, Leah College of Agriculture & Life Sciences NC State University		4	Mark Hoffmann (College of Agriculture & Life Sciences)	CEFS ASPIRE	Preliminary Substrate and Root Evaluation for Grapevine Plants
Hackman, Natalie College of Engineering NC State University		3	Jessi Thanjitham (College of Engineering)	RISE CCEE	Geometric Optimization and 3D Printing Reinforcing Steel
Hancock, Asher College of Engineering NC State University		6	Hisham El-Shaffey (College of Sciences)	CMI SIRI	Localized delivery of immunotherapeutics utilizing self-assembling associative chitosan systems with tunable, controlled release kinetics
Hande, Anand College of Sciences University of North Carolina at Chapel Hill	Mason Lu School of Science Murray State University Ta'Destiny Geiger School of Mathematics Georgia Institution of Technology Casey Lang School of Mathematics Virginia Wesleyan University	2	Ana-Maria Staicu (College of Sciences)	DRUMS	Statistical Methods for Histopathology Images of Cancer Tissues
Hansen, Rose College of Engineering NC State University		5	Jacque Cole (College of Engineering)	BME	Finite Element Analysis of Scapular Bone Mechanics Following Brachial Plexus Birth Injury
Harris, Jacob College of Engineering NC State University		3	Brina Montoya (College of Engineering)	RISE CCEE	The Effects of Acid Rain on Sand Treated with Microbially Induced Calcium Carbonate Precipitation
Hatcher, Michael College of Sciences NC State University		2	Christopher Gorman (College of Sciences)	OUR Award	Organic Synthesis of Acene Derivatives for Use in Organic Semiconducting Electronics

PRESENTER INDEX

Lead Presenter	Co-Presenters	Session	Primary Mentor	REU/Summer Research Program	Project Title
Hatton, Ayanna College of Agriculture & Life Sciences Bowdoin College		4	Shuijin Hu (College of Agriculture & Life Sciences)	Kelman Scholars	Impact of endophytic bacteria on mycorrhizal root colonization of switchgrass [Panicum virgatum]
Hayden-Lowe, Jasmine College of Engineering NC State University		5	Javon Adams (College of Engineering)	WMSRP	Monitoring Coastal Flooding with Sunny Day Flood Sensors
Helms, Cassie College of Agriculture & Life Sciences University of North Carolina at Pembroke		4	David Suchoff (College of Agriculture & Life Sciences)	CEFS ASPIRE	Investigating no-till fiber hemp production utilizing cover crop mulch for weed management
Henderson, Malcolm College of Sciences Ohio Wesleyan University		1	John Blondin (College of Sciences)	CDSA	Variation in Mass Accretion Rate in a Massive X-Ray Binary System
Herrup, Jacob College of Agriculture & Life Sciences Cornell University		7	Andres Velazquez (College of Agriculture & Life Sciences)	Kelman Scholars	Assessing Wastes from North Carolina Industries as Carbon Sources for Anaerobic Soil Disinfestation
Hewett, Krystyn College of Engineering NC State University		3	Amay Bandodkar (College of Engineering)	ASSIST	Unconventional methods of fabrication for carbon nanotube based printed electronics
Hinkle, Emma College of Engineering NC State University		5	Jacqueline Cole (College of Engineering)	WMSRP	Effects of Brachial Plexus Birth Injury on Muscle Spindle Morphology
Hoff, Meredith College of Sciences Wofford College		2	Jun Ohata (College of Sciences)	ICE	Chemical Reactions on Peptides/Proteins in Nonaqueous Medium Using Furan and Thiophene Derivatives

PRESENTER INDEX

Lead Presenter	Co-Presenters	Session	Primary Mentor	REU/Summer Research Program	Project Title
Hollett, Andrew College of Engineering Tufts University		5	Rajeev Gupta (College of Engineering)	MAT-DAT	Improving the Corrosion Properties of Multi-Principal Element Alloys using Data Science
Holman, Olivia College of Sciences Arizona State University	Kathy Uyen-Nguyen College of Sciences NC State University	2	Jonathan Lindsey (College of Sciences)	Computational Chemistry	Pigments of LIfe from Liver to Leaves - A Demo of Molecular Unity
Holt, Aaron College of Sciences NC State University	Alexandra Klipfel College of Sciences The California Institute of Technology	1	Karen Daniels (College of Sciences)		Stick-Slip Events in a Low Gravity Granular System
Hon, Mason College of Engineering NC State University		6	Ashley Brown (College of Engineering)	BME	Neonatal Derived Fibrin Nanoparticles to Promote Wound Healing
Hosseini, Iman College of Engineering NC State University	Chris Foley College of Engineering NC State University Krish Patel College of Engineering NC State University	1	Steffen Herber (College of Engineering)	SRCA	Teaching Whales to Extractive Summarize Scientific Papers
Hussain, Misk College of Engineering NC State University		5	Javon Adams (College of Engineering)	WMSRP	Health and Environmental Tracker 2
Hutchins, Emily College of Agriculture & Life Sciences University of Arkansas		3	Lisa Dean (College of Agriculture & Life Sciences)	Food Science Summer Scholars Program	Peanut Seed Maturity as a Factor in Free Amino Acid Content
Ibarra-Mendoza, Victor College of Engineering NC State University		6	Venkateswaran Narayanaswamy (College of Engineering)	TRIO Ronald E. McNair Scholars	Eliminating pathogenic viruses in air: a quantitative study of UV radiation among the pathogenic viruses
Ikekhua, Jeanine College of Humanities & Social Sciences		5	Javon Adams (College of Engineering)	WMSRP	Appeasing African Americans

PRESENTER INDEX

Lead Presenter	Co-Presenters	Session	Primary Mentor	REU/Summer Research Program	Project Title
Jacobs, Howard College of Agriculture & Life Sciences NC State University		4	Katherine William (College of Agriculture & Life Sciences)	CEFS ASPIRE	Interactions between the peach pathogen Xanthomonas arboricola pv. Pruni and bacteriophage
James, Myla College of Engineering NC State University		6	Kenitta Johnson (College of Engineering)	GCSP	The Design and Implementation of a Custom MUSE (Microscopy with UV Surface Excitation) Imaging System for the Investigation of Diabetic Kidney Disease
Jessup, Jillian College of Engineering NC State University	Taylor Hildreth College of Engineering NC State University Nicolas Jimenez College of Engineering Durham Technical Community College	5	Katherine Saul (College of Engineering)	WMSRP GCSP	Developing a Standard Operating Procedure and Data Collection Protocol of Key Military Functional Tasks
Jiang, Yueyue College of Agriculture & Life Sciences NC State University		4	Haotian Zheng (College of Agriculture & L:ife Sciences)		Oil-water interfacial characteristics of assemblies of pulse proteins and polyphenol compounds
Johnson, Meghan College of Sciences NC State University		7	Audrey Fikes (College of Sciences)	BIT SURE	Synthesis and characterization of nitrophenyl-containing endoperoxides for nitroreductase-mediated release of singlet oxygen in hypoxic cancer cells
Jugan, Alina College of Engineering NC State University		6	Alexander Bataller (College of Engineering)	OUR Award GCSP	Investigating the Fundamental Mechanisms of Electric Discharges in Ionic Liquids
Kauffman, Skyler College of Engineering Worcester Polytechnic Institute		2	Sam Daigle (College of Engineering)	MAT-DAT	Investigation of order-disorder phenomena for a high entropy carbide
Kays, Eli College of Engineering NC State University		2	Morton Barlaz (College of Engineering)	RISE CCEE	Abiotic Cellulose Hydrolysis Under Elevated Temperature Landfill Conditions

PRESENTER INDEX

Lead Presenter	Co-Presenters	Session	Primary Mentor	REU/Summer Research Program	Project Title
Kebede, Caleb College of Engineering NC State University		5	Tiegang Fang (College of Engineering)	WMSRP	Gel Propellant Stability
Kelly, Brooke College of Agriculture & Life Sciences NC State University		7	Andres Salcedo (College of Agriculture & Life Sciences)	Kelman Scholars	Does a Pseudoperonospora cubensis cryptospecies population caused a cucurbit downy mildew epidemic in the U.S.?
Kennedy, Jacob College of Engineering NC State University		3	Lilian Hsiao (College of Engineering)	OUR Award CBE REU	The Effect of Surface Morphology of Colloidal PMMA Particles in Capillary Suspensions for 3D Printing
Kerrigan, Malachy College of Engineering NC State University		1	Cranos Williams (College of Engineering)	Sweet-APPS	Statistical Analysis of Sweet-APPS Imagery Sensors
Ketzes, Katie Rose College of Humanities & Social Sciences NC State University		7	Lina Quesada (College of Agriculture & Life Sciences)	Kelman Scholars	Cataloging NLRs to get closer pathogen-resistant sweet potatoes
Kiel, Grace College of Engineering NC State University		5	Javon Adams (College of Engineering)	WMSRP	Self Assembly of PEDOT:PSS from Solution to Solid Phase
Kimble Laney College of Agriculture & Life Sciences NC State University		1	Leslie Sombers (College of Sciences)	Beckman Scholars	Real Time Measurements of Dopamine and Glutamate in Rat Striatum Using Fast-Scan Cyclic Voltammetry
Kodikara, Seth College of Engineering NC State University		6	Albert Keung (College of Engineering)	OUR Award Beckman Scholars	Differential Acetylation of Histone Tail Variants
Kohn, Jackson College of Sciences Colorado College		1	Owen Duckworth (College of Agriculture & Life Sciences)	BESST	Investigation binding affinities of a synthetic siderophore PDMA with various trace metal nutrients
Kirshna Kumar, Pranav College of Engineering NC State University		5	Javon Adams (College of Engineering)	WMSRP	Algorithms for Geometric Multi-Matching

PRESENTER INDEX

Lead Presenter	Co-Presenters	Session	Primary Mentor	REU/Summer Research Program	Project Title
Kumara, Pranav College of Engineering NC State University		1	Leslie Sombers (College of Sciences)		Manipulation of Striatal Dopamine Dynamics through Ventral Tegmental Area Mu Opioid Receptor Activation
Kumaran, Utkarsh College of Engineering NC State University		1	Nitin Sharma (College of Engineering)		Validation of Acoustically Actuated Microswimmer
Kuppler, Abigail College of Engineering NC State University		6	Ashley Brown (College of Engineering)	GCSP	Effects of Molecular Size on Loading Efficiency and Drug Release of Fibrin Based Nanoparticles
Lamsal, Aysush College of Engineering NC State University		5	Olgha Qaqish (College of Engineering)	GCSP	Digital Branding and the Community of Practice
Lasdin, Christina College of Engineering NC State University		5	Javon Adams (College of Engineering)	WMSRP	Effect of Nerve Injury on Shoulder Muscles in Brachial Plexus Birth Injury Rat Model
Lee, Angela College of Engineering NC State University		6	Brendan O'Connor (College of Engineering)	GCSP	Stability of Thermocleveable Polymers for Organic Semiconductors
Lee, Andrea Wilson College of Textiles NC State University		7	Amanda Mills (Wilson College of Textiles)	TECS	Development of screen-printable ferromagnetic inks for material handling
Lewis, Jimmy College of Engineering NC State University		3	Andrew Grieshop (College of Engineering)	RISE CCEE	NOx Removal using Photocatalytic Pavement Rejuvenator

PRESENTER INDEX

Lead Presenter	Co-Presenters	Session	Primary Mentor	REU/Summer Research Program	Project Title
Lin, Maggie College of Engineering NC State University	Sana Mahmou College of Engineering NC State University	1	Tiffany Barnes (College of Engineering)	GCSP	Participatory Design on Block Based Learning Management Tool
Lin, Josephine College of Sciences NC State University		2	Liana Gouveia (College of Sciences)	ICE	Investigation of NN Re and Mn Complexes: Synthesis, Characterization, and Catalysis
Lingerflet, Drew Wilson College of Textiles NC State University		7	Amanda Mills (Wilson College of Textiles)	TECS	Eliminating PFAS from Firefighters Skin before Bloodstream Exposure
Lohia, Siddharth College of Engineering NC State University		6	Chris Dobek (College of Sciences)	OUR Award	Quantifying the Impact of Reflective Roads
Lopez Jimenez, Sebastian College of Engineering Morgan State University		3	Angela Harris (College of Engineering)	RISE CCEE	Monitoring Cefotaxime resistant E. coli surface water and wastewater on Coharie Native American Land
Lopez-Alfonzo, Joshua College of Agriculture & Life Sciences University of Puerto Rico - Mayaguez Campus		4	Stephanie Ward (College of Agriculture & Life Sciences)	CEFS ASPIRE	Impact of heat stress on lactating dairy cow performance
Lowry, Mya College of Humanities & Social Sciences NC State University		6	Steven Greene (College of Humanities & Social Sciences)	SPIA SURE	The Impact of the Native American Vote on the 2020 United States Presidential Election
Lucas, Ta'Kia College of Agriculture & Life Sciences NC State University		4	Jon Kizer (College of Agriculture & Life Sciences)	IMPS	Plasma Activated Water (PAW) effects on Arabidopsis stress responses
Lucas, Sydney WIlson College of Textiles NC State University	Olivia Hartung Needham B. Broughton Magnet High School	7	Tova Williams (Wilson College of Textiles)	TECS	Metal-complexable monoazo dyes containing sulfonamide auxochromes: synthesis, analysis, and application

PRESENTER INDEX

Lead Presenter	Co-Presenters	Session	Primary Mentor	REU/Summer Research Program	Project Title
Lyons, Ian College of Engineering University of Washington		2	Nina Balke (College of Engineering)	MAT-DAT	Machine learning optimization of strain sensors based on piezoelectric properties of 2D layered materials
Mahmoud, Sana College of Engineering NC State University	Maggie Lin College of Engineering NC State University	5	Javon Adams (College of Engineering)	WMSRP	Participatory Design
Mann, Hayden College of Sciences NC State University		2	Yi Xiamo (College of Sciences)	OUR Award	RP-HPLC Method for Separation and Analysis of phytocannabinoids commonly found in Plant Material
Mao, Wendy College of Engineering NC State University		1	Okan Pala (College of Natural Resources)	SRCA	Defining the Knowledge Gap Between Subject Matter Experts and Students in First/Last Mile and Cross Commodity Connections
Marks, Brian College of Sciences Carleton College		4	Ruben Rellan Alvarez (College of Sciences)	IMPS	Heterologous Expression of Maize HPC1 Variants and their Functionality Assays
Martinez-Mata, Cristina College of Engineering NC State University		3	Jennifer Pancorbo (College of Engineering)	BTEC	Optimizing the Plasmid Purification Process in Support of mRNA Synthesis for Vaccine Production
Mastrovito, Nicolas COllege of Agriculture & Life Sciences NC State University		7	Jacob Dums (College of Agriculture & Life Sciences)	BIT SURE	In vitro Generation of WT and Mutant T7 Phage for Viral Phenotype Comparisons
Matusko, Brooke College of Agriculture & Life Sciences NC State University		4	Shuijin HU (College of Agriculture & Life Sciences)	CEFS ASPIRE	The Relationship between AMF Colonization and N:P Ratios in Maize

PRESENTER INDEX

Lead Presenter	Co-Presenters	Session	Primary Mentor	REU/Summer Research Program	Project Title
Mayer, Alexandra College of Agriculture & Life Sciences Embry-Riddle Aeronautical University-Prescott		4	Colleen Doherty (College of Agriculture & Life Sciences)	IMPS	The Identification of Rare Earth Element-Binding Peptides/Proteins from Plants to create REE Biomining Systems
McCleod, Zhane College of Engineering University of Florida		2	Joshua Harris (College of Engineering)	MAT-DAT	PhosFORUS: Predicting Reusable Candidate Phosphorous Removing Materials using Machine Learning
McCrary, Chase College of Natural Resources NC State University	Emma Mullins College of Natural Resources NC State University Mindy Dunn College of Natural Resources NC State University	3	Angela Allen (College of Natural Resources)		Continuous Field Monitoring and Evaluation to Assess Water Quality
McDaniel, Hanna College of Engineering NC State University		5	Javon Adams (College of Engineering)	WMSRP	Drag Decomposition of a Flexible Kite Airborne Wind System
McLaurin, Logan College of Sciences NC State University		1	Kevin Burris (College of Sciences)	SRCA	48- Year Temperature Trends Based Upon Observed Hourly Weather Station Data
Meis, Brittani College of Agriculture & Life Sciences Colorado State University		4	Stephanie Kulesza (College of Agriculture & Life Sciences)	CEFS ASPIRE	Poultry Litter Impacts on Imbibition and Radicle Length
Mercer, Ian College of Engineering NC State University	Andrew Liao College of Engineering NC State University	6	Kaveh Ahadi (College of Engineering)	OUR Award	Liquid Phase Epitaxy for Narrowband Semiconductors
Mereddy, Raghu College of Engineering NC State University		6	Aryssa Simpson (College of Engineering)	GCSP	Analysis of Dual-Delivery Microgels for Treating Cardiac Fibrosis

PRESENTER INDEX

Lead Presenter	Co-Presenters	Session	Primary Mentor	REU/Summer Research Program	Project Title
Merkel, Amanda College of Sciences NC State University		4	Hao Chen (College of Agriculture & Life Sciences)	IMPS	Quantifying the Effects of uORFs on Auxin Signaling in Arabidopsis thaliana
Mesecar, Paige College of Agriculture & Life Sciences NC State University		3	Rebecca Irwin (College of Agriculture & Life Sciences)	OUR Award	Effect of parasitism and diet on pollination efficiency of the common eastern bumblebee (*Bombus impatiens*) visiting snapdragon (Angelonia)
Meyerhoffer, Alissa College of Sciences NC State University		3	Manuel Kleiner (College of Agriculture & Life Sciences)	OUR Award	Assessing the growth of *Bacteroides thetaiotaomicron* on different sources of dietary protein.
Micheli, Gabriella College of Engineering NC State University		5	Javon Adams (College of Engineering)	WMSRP	Human-Readable (and Editable) Intermediate Representation for a Compiler
Mirajkar, Ashlesha College of Engineering NC State University		1	Nitin Sharma (College of Engineering)		LMPC method for FES control of antagonistic muscles in elbow model
Moeller, Heather College of Sciences NC State University	Andrew Barfield College of Natural Resources NC State University	4	Carol Price (College of Sciences)	OUR Award	Surveying for Adult Gopher Frogs in the Croatan National Forest
Morgan, Thomas College of Agriculture & Life Sciences NC State University		7	Caroline Sjogren (College of Agriculture & Life Sciences)	BIT SURE	A De Novo Gene Sequence of a North Carolina Native Plant Species
Murray, Cameron College of Sciences Pennsylvania State University		3	David Tarpy (College of Sciences)	BeeMORE	Describing the interactions between pathogens and parasites within honey bee colonies

PRESENTER INDEX

Lead Presenter	Co-Presenters	Session	Primary Mentor	REU/Summer Research Program	Project Title
Myer-Medina, Emma WIlson College of Textiles NC State University		7	Januka Budhathoki-Uprety (Wilson College of Textiles)	TECS	Understanding Structure-Property Relationship between Polymer and Dye
Nandwani, Janvi College of Engineering University of North Carolina at Charlotte		1	Tiffany Barnes (College of Engineering)	SRCA	The Creation, Use, and Impact of Block-Based Programming Curriculum: An Experience Report
Nash, Matt College of Engineering NC State University		6	Scott Palmtag (College of Engineering)	OUR Award	Validation of multicycle core optimization code using the F6 computer program
Nash, Jordan Wilson College of Textiles NC State University		7	Ericka Ford (Wilson College of Textiles)	TECS	Characterizing Bio-renewable Fibers Spun from Polymers Found in Seaweed
Ndey-Bongo, Nyssa College of Agriculture & Life Sciences NC State University		4	Kevin Garcia (College of Agriculture & Life Sciences)	IMPS	The Impact of Salinity and Potassium on Legume Nodulation
Neri-Otero, Areli College of Engineering NC State University		5	Javon Adams (College of Engineering)	WMSRP	Understanding how biochar co-compost application rate impacts decomposition of biomolecule classes
Newman, Elliott College of Sciences Millersville University of Pennsylvania		2	Elon Ison (College of Engineering)	ICE	New CNS Re Complexes for Hydrogenation of Carbonyl Compounds
Nguyen, Amy College of Engineering NC State University		5	Javon Adams (College of Engineering)	WMSRP BTEC	Developing a Versatile LC/MS-compatible Sample Preparation Protocol for Proteomic Analysis using Single-Chain Fragment Variables Produced in *E.coli* and *Pichia pastoris*

PRESENTER INDEX

Lead Presenter	Co-Presenters	Session	Primary Mentor	REU/Summer Research Program	Project Title
Nguyen, Cindy College of Engineering NC State University		2	Mansoor Haider (College of Sciences)	GCSP	A Tailored k-Means Algorithm for Efficient Geographic Clustering Applied to County-Level Data for Type 2 Diabetes Incidence in North Carolina
Nguyen, Chriselda College of Sciences Reed College		2	Elon Ison (College of Sciences)		Investigation of A Large Kinetic Isotope Effect On Iridium-Ruthenium Complex
Nieves Baez, Joaquin College of Engineering University of Puerto Rico-Mayaguez		3	Maria Mayorga (College of Engineering)	RISE ISE	Identifying and Operationalizing Indicators of Illicit Massage Business using NLP
Norwood, Emilie College of Engineering NC State University		1	Leslie Sombers (College of Sciences)		Real-time Detection of Glucose and Lactate Fluctuations During Hypoxia in Rat Dorsal Striatum
Nus, Jonah Wilson College of Textiles NC State University		7	Xiaomeng Fang (Wilson College of Textiles)	OUR Award TECS	Designing a Pneumatically Actuated Origami Robot
Nyambega, Zacharia College of Engineering NC State University		6	Michael Dickey (College of Engineering)	MI	Re-polymerization of double-network hydrogels by liquid metal particles
O'Neill, Jennifer College of Agriculture & Life Sciences NC State University		6	Albert Keung (College of Engineering)	OUR Award	Choroid Plexus Organoids as Novel Drug Screening Platform
Obrero, Caitlyn College of Engineering NC State University		1	Christpher Rock (College of Engineering)	RISE ISE	Designing and Testing 3D-Printed Hyperuniform Networks

PRESENTER INDEX

Lead Presenter	Co-Presenters	Session	Primary Mentor	REU/Summer Research Program	Project Title
Ogboi, Chiemerigo College of Engineering North Carolina A&T State University		1	Qicheng Tang (College of Agriculture & Life Sciences)	STEPS	Analyzing relationships among P, other elements and type of land cover per US state
Pacheco, Emely College of Natural Resources NC State University		3	Elizabeth Nichols (College of Natural Resources)	OUR Award	Screening hybrid poplar clones for resistance to Phytophthora
Pacheco-Cay, Cristian College of Engineering NC State University		6	Andrew Mazzoleni (College of Engineering)	MI-REU	Fabrication, assembly, and operation of a lab-scale experimental setup to analyze locomotion dynamics of helical drives
Parker, Taylor College of Sciences NC State University		7	Sophie Noel (College of Agriculture & LIfe Sciences)	BIT SURE	Assay Development: An ELISA for Fibrinogen
Parker, Auston College of Engineering North Carolina Central University		3	Chang Nam (College of Engineering)	ISE	Brain-Controlled Wheelchair: The effectiveness and inclusiveness of Motor Imagery based Brain-Computer Interfaces in disabled populations.
Parker, Sophia College of Engineering NC State University		1	Collin Lynch (College of Engineering)	SRCA	Using Participatory Design to Help Teachers Understand Student Writing Processes and Apply Personalized Learning Solutions

PRESENTER INDEX

Lead Presenter	Co-Presenters	Session	Primary Mentor	REU/Summer Research Program	Project Title
Pashnyak, Tatyana College of Engineering Wiregrass Ranch High School		1	Tiffany Barnes (College of Engineering)	SRCA	The Effects of Storyboarding Approach on the Design Quality of AP Create Performance
Patel, Dharmin College of Engineering NC State University	Carter Wang College of Engineering NC State University	4	Katherine Saul (College of Engineering)	MAE	Conversion of Electromyogram and Joint Angle Data into Personalized Musculoskeletal Models
Patterson, Bailey College of Engineering NC State University	Carlos Banegas College of Engineering NC State University	5	Seth Hollar (College of Engineering)	WMSRP	Ride height of a Lightweight Autonomous Vehicle
Paul, Jonathan College of Engineering University of Virgiania		2	Douglas Irving (College of Engineering)	MAT-DAT	Neural Network Approach to Inverse Design of High-Entropy Alloys
Perez, Richie College of Sciences NC State University	Riley Morgan College of Sciences NC State University	6	Carlos Goller (College of Sciences)	BIT SURE	Characterization of metabolic activity in Delftia acidovorans' isolates and expression of NRP in the presence and absence of gold
Perrott, Ayil College of Agriculture & Life Sciences NC State University		3	Robert Rose (College of Agriculture & Life Sciences)		Engineering a Thermophilic Biotin Carboxylase to Increase CO2 Fixation in Plants
Phung, Megan College of Agriculture & Life Sciences Methodist University		3	Bradley Metz (College of Agriculture & Life Sciences)	BeeMORE	Impact of Oxytetracycline treatment on mite and pathogen levels in honey colonies
Pickering, Tabitha College of Engineering NC State University		1	Douglas Call (College of Engineering)	RISE CCEE	Enzymatic treatment of textile waste to enable recovery of valuable fibers and methane-rich biogas
Pirro, Jalissa College of Agriculture & Life Sciences Binghamton University		4	Luciano Gatiboni (College of Agriculture & LIfe Sciences)	BESST	Effect of long-term phosphorus and potassium fertilization on soil permanganate oxidizable carbon

PRESENTER INDEX

Lead Presenter	Co-Presenters	Session	Primary Mentor	REU/Summer Research Program	Project Title
Polishook, Mira College of Agriculture & Life Sciences Duke University		4	Kevin Garcia (College of Agriculture & Life Sciences)	BESST	Impact of potassium availability on symbiotic ectomycorrhiza formation between the fungus *Paxillus ammoniavirescens* and the loblolly pine roots under salt stress
Pottle, Kate College of Agriculture & Life Sciences Davidson College		4	Linnea Andersen (College of Agriculture & Life Sciences)	CEFS ASPIRE	Striped Bass Breeding Program: StriperHub
Prestemon, Fiona College of Humanities & Social Sciences NC State University		2	Kelly Lynn Mulvey (College of Humanities & Social Sciences)	OUR Award	The Role of School Racial Climate on Adolescents' Sense of Belonging and Academic Coping Skills
Prockter, Aly College of Sciences NC State University	Jess Schinsky College of Sciences NC State University	6	Cassidy Hubbard (College of Sciences)	OUR Award	Creating a 24 Hour Understanding of Activity and Behavior Patterns in Zoo-Housed African Elephants (*Loxodonta africana*)
Profit, Kasar College of Sciences Colgate University		1	Rongmon Bordoloi (College of Sciences)	CDSA	Understanding Our Galactic Center Through Spectroscopic Observation of the Fermi Bubbles
Qualls, Rachel College of Engineering University of Alabama		1	Tiffany Barnes (College of Engineering)	SRCA	How to Catch Novice Programmers' Struggles: Detecting Moments of Struggle in Open-Ended Block-Based Programming Projects using Trace Log Data
Rastogi, Srishti College of Engineering NC State University		5	Javon Adams (College of Engineering)	WMSRP	Usage of Ultratrack to improve accuracy of FES and Exoskeleton movement
Reagan, Cynthia College of Agriculture & Life Sciences Durham Technical Community College		6	Carlos Goller (College of Sciences)	BeeMORE	The effect of antibiotics on the microbial colonization of bee bread

PRESENTER INDEX

Lead Presenter	Co-Presenters	Session	Primary Mentor	REU/Summer Research Program	Project Title
Reyes, Daniel College of Engineering NC State University		1	Kirill Efmenko (College of Engineering)	STEPS	Degradation of Organophospates using Hydroxamic Acid Functional Groups
Rogers, Hanna College of Sciences Goucher College		2	Yi Xiao (College of Sciences)	ICE	Predicting the excitation energies of polymethine dyes using DFT for use in dye- displacement assays
Rose, Julia College of Agriculture & Life Sciences Boston College		7	Adrienne Gorny (College of Agriculture & Life Sciences)	Kelman Scholars	Survey of the occurrence of plant-parasitic nematode population at different soil profile depths in a North Carolina soybean field
Rosenberg, Zoe College of Sciences Rutgers University- New Brunswick		1	John Blondin (College of Sciences)	CDSA	Modeling Pair Instability Supernovae: from Explosion to Remnant
Rossi, Megan College of Agriculture & Life Sciences NC State University	Tara Esmailian College of Agriculture & Life Sciences NC State University	3	Lynette Johnson (College of Agriculture & Life Sciences)	Food Science Summer Scholars Program	Raw Milk Lab Optimization
Roy, Nikhil College of Engineering NC State University		5	Javon Adams (College of Engineering)	WMSRP	Tensile Testing of Resin Additive Materials
Rudman, Peyton College of Agriculture & Life Sciences NC State University		3	Elsa Youngsteadt (College of Agriculture & Life Sciences)	BeeMORE	Analyzing Honey-Bee Behavior and Effectiveness in Pollination Services
Rushing, Elijah College of Engineering NC State University		5	Javon Adams (College of Engineering)	WMSRP	Safety of Nuclear Reactors
Ruslander, Carly College of Sciences NC State University		3	Matthew Breen (College of Vet Med)		Connections Between Disinfectant Byproducts in Water and Canine Cancer

PRESENTER INDEX

Lead Presenter	Co-Presenters	Session	Primary Mentor	REU/Summer Research Program	Project Title
Saberi Bosari, Azin College of Engineering NC State University		5	Javon Adams (College of Engineering)	WMSRP	SrxBa1-xFeyCo1-yO3 phase transition sorbents for the high-temperature isothermal sorption-enhanced gasification process
Sadhu, Dhruv College of Engineering NC State University		6	Michael Daniele (College of Engineering)	OUR Award	Investigating Performance of Potential Recognition Schemes for IL-6 detection
Sall, Aby College of Engineering NC State University		5	Javon Adams (College of Engineering)		Ischemia-Reperfusion Injury Model
Sauers, Nora College of Agriculture & Life Sciences NC State University		1	Natalie Nelson (College of Agriculture & Life Sciences)		Determining effects of sunny-day floods on water quality using multiparameter sonde data
Schiltz, Luke College of Engineering NC State University		1	Okan Pala (College of Engineering)	SRCA	Using Synthetic Rasterization to Predict Urban Development According To Road Infrastructure
Schmidt, Kalyan College of Agriculture & Life Sciences Oberlin COllege		4	Ying-Yu Liao (College of Agriculture & Life Sciences)	IMPS	TagM and its effects on T6SS as well as the plants we hold dear
Schroedl, Joe College of Engineering NC State University		2	Nathan Woodward (College of Engineering)	MSE	RoboMIxer
Schuh, Gabrielle College of Sciences NC State University		7	Jacob Dums (College of Agriculture & Life Sciences)	BIT SURE	Genetic Engineering of the Giant Algae Virus Host Chlorella variabilis
Selleseth, Zander College of Engineering NC State University		6	Michael Dickey (College of Engineering)	MI-REU	Characterization of the Temperature-Dependent Resistivity of Eutectic Gallium-Indium

PRESENTER INDEX

Lead Presenter	Co-Presenters	Session	Primary Mentor	REU/Summer Research Program	Project Title
Sen, Amit College of Agriculture & Life Sciences NC State University		5	Raquel Hernandez (College of Agriculture & LIfe Sciences)		Experimental Protocol for Automated Viral Infectivity Assay (AVIA)
Sewell, Bea College of Agriculture & Life Sciences NC State University		3	Michael Goshe (College of Agriculture & Life Sciences)	OUR Award	Site Directed Mutagenesis of Bovine Serum Albumin to Characterize the Redox Mechanism of Amyloid Formation
Sharkey, Chris College of Engineering NC State University		6	Michael Daniele (College of Engineering)	OUR Award GCSP	Reversing Biorecognition Events and Recycling Biosensors by Electronically Modulating pH
Shete, Tvisha College of Engineering NC State University		3	Mehmet Ozturk (College of Engineering)	ASSIST	Fiber Reinforced Low Thermal Conductivity Silicone Elastomers
Shipp, Elena College of Agriculture & Life Sciences NC State University		7	Lina Quesada (College of Agriculture & Life Sciences)	Kelman Scholars	Evaluation of Efficacy of Fungicides on Sweet potatoes for control of Ceratocystis fimbriata
Sides, Rachel College of Engineering NC State University		6	Nidhi Diwakar (College of Engineering)		Exploring osmotically propelled particles for use in super-diffusive paste against infection
Silvernail, Irene College of Engineering Agnes Scott College		1	Jim Kneller (College of Sciences)	CDSA	Multi-angle Neutrino Flavor Transformation in Supernovae
Simon, Charlotte College of Engineering NC State University		5	Javon Adams (College of Engineering)	WMSRP	Assessment of Computational Requirements for Computer Vision Models Implemented in High-Throughput Agricultural Packing Systems

PRESENTER INDEX

Lead Presenter	Co-Presenters	Session	Primary Mentor	REU/Summer Research Program	Project Title
Smith, Madeline College of Engineering NC State University		5	James Dieffenderfer (College of Engineering)	WMSRP	Continuous, Non-invasive, Optical Measurement of Total Hemoglobin via Bluetooth Enabled Ring
Soliman, Salma College of Engineering The American University in Cairo		3	Daryoosh Vashee (College of Engineering)	ASSIST	Nanocomposite-based Rigid TEG for Wearable Devices
Sow, Alassane College of Agriculture & Life Sciences Michigan State University		3	Elsa Youngsteadt (College of Agriculture & Life Sciences)	BeeMORE	A Study of the Luxury Effect and Bee Populations in Raleigh N.C.
Sow, Penda College of Humanities & Social Sciences NC State University		6	Lori Foster (College of Humanities & Social Sciences)	TRIO Ronald E. McNair scholars	Reactions to Automated Job Interviews
Spake, Kailee College of Natural Resources NC State University		1	Duarte Morais (College of Natural Resources)	OUR Award	Bigger is Not Always Better : Analysis of the Link Between Agritourism Microentreprenurs and an Increased Adoption of Sustainable Agriculture Practices
Sridharan, Smriti College of Engineering NC State University		6	Ashley Brown (College of Engineering)	BME	Analysis of Cardiac Cell Phenotypes on Viscoelastic Substrates
Steffens, Helen College of Engineering NC State University		3	Morton Barlaz (College of Engineering)	RISE CCEE	Measuring Heat Release from Ash under Landfill Relevant Conditions
Sterna, Christina College of Agriculture & Life Sciences NC State University		4	Matthew Ricker (College of Agriculture & Life Sciences)	BESST	Utilizing Soil Electrical Conductivity and Halinity to Quantify Salinization in Coupled Wetland-Farm Systems
Sumner, Joshua College of Engineering NC State University		6	Ryan Barton (College of Engineering)	BTEC	Large-scale centrifuge turbidity probe calibration and new measurement standard development

PRESENTER INDEX

Lead Presenter	Co-Presenters	Session	Primary Mentor	REU/Summer Research Program	Project Title
Suresh, Neha College of Agriculture & Life Sciences NC State University	Seeva Cherukuri College of Engineering NC State University Daniel Spang College of Engineering NC State University Saarim Ahmed College of Sciences NC State University	3	Adriana San Miguel (College of Engineering)	OUR Award	NCSU iGEM 2022-ForgetMeNot
Thomas, Madison College of Engineering NC State University		1	Tiffany Barnes (College of Engineering)		Natural Language Processing, Artificial Intelligence and the Integration of Computer Science Frameworks into Secondary English Language Arts Curriculum
Thompson, Steven College of Engineering NC State University		5	Jacqueline Cole (College of Engineering)	OUR Award BME	Forepaw Usage Preference following Brachial Plexus Birth Injury
Tran, Stefanie College of Sciences NC State University		3	Detlef Knappe (College of Engineering)	RISE	Method development for determination of extractable organic fluorine in environmental and biological samples
Trapier, Tajah College of Engineering NC State University		2	Mahesh Shinde (College of Engineering)	OUR Award	Evaluating Electrochromic Performance of Electrochromic Devices Via Spectroelectrochemsitry Techniques
Truett, Preston College of Natural Resources NC State University		2	Robert Jetton (College of Natural Resources)	OUR Award	Response of mushroom fruiting bodies and associated mycophagous fly communities to selected forest disturbances
Turner, Raiford Poole College of Management NC State University	Lily Palmer College of Humanities & Social Sciences NC State University Alexa Kostopoulos College of Humanities & Social Sciences NC State University	6	Samantha Rich (University College)		The Pack Proficiencies: Undergraduate perspectives on the relevance and importance of personal and professional learning outcomes

PRESENTER INDEX

Lead Presenter	Co-Presenters	Session	Primary Mentor	REU/Summer Research Program	Project Title
Urbina, Jessie College of Engineering NC State University		6	Jacob Jones (College of Engineering)	MI-REU	Ferroelectric and Polarization
Valdez, Estefany College of Agriculture & Life Sciences Barnard College	Maeve Finley University of Michigan	3	Aram Mikaelyna (College of Agriculture & Life Sciences)	BeeMORE	Changes in Microbial Abundance and Nutritional Content through Bee Bread Maturation in the Nests of the Eastern Large Carpenter Bee Xylocopa Virginica
Van Zele, Elise College of Sciences NC State University	Danielle Smith College of Sciences NC State University	7	Andrew Hasley (College of Agriculture & Life Sciences)	BIT SURE	Environmental DNA metabarcoding techniques reveal prokaryotic and metazoan community profiles of two freshwater sites at NC State
Vasselli, Angelina College of Engineering NC State University		5	Matthew Fisher (College of Engineering)	OUR Award BME	Effect of Sex Hormones on Mechanical Properties of the Anterior Cruciate Ligament Via Cellular and Non-Cellular Pathways
Velasco, Max College of Engineering NC State University		6	Scott Palmtag (College of Engineering)		Generating Multi-Group Cross Sections For Fast and Microreactors
Villalobos, Luis College of Engineering NC State University		5	Javon Adams (College of Engineering)	WMSRP	Control of fin induced shock separation using steady micro jets
Walker, Leilani College of Engineering NC State University		5	Jacqueline Cole (College of Engineering)	BME	Musculoskeletal Modeling of Rat Shoulders Affected by Brachial Plexus Birth Injury
Walker, Haley Wilson College of Textiles NC State University		7	Xiaomeng Fang (Wilson College of Textiles)	OUR Award	Development of fabric robots using ultrafine fiber shaped pneumatic artificial muscles

PRESENTER INDEX

Lead Presenter	Co-Presenters	Session	Primary Mentor	REU/Summer Research Program	Project Title
Wang, Andong College of Sciences NC State University	Kelly Wentzlof College of Arts & Sciences Indiana University Bloomington Miontranese Green College of Natural Sciences & Mathematics California State University Johnny Rajala College of Computational, Mathematical and Natural Sciences	2	Shu Yang (College of Sciences)	DRUMS	Transfer Learning Methods for Individual Treatment Rules
Watson, Samantha College of Engineering NC State University		5	Matthew Fisher (College of Engineering)	OUR Award WMSRP	Comparison of AFM and Tensile Testing Methods on Equine Superficial Digital Flexor Tendon
Webb, Leslie College of Engineering University of Delaware		1	Owen Duckworth (College of Agriculture & Life Sciences)	STEPS	Biogeochemistry of Phosphite in Soil and its Interactions with Iron and Aluminum Oxides
Wettig, Heidi College of Agriculture & Life Sciences Hollins University		7	Katherine D'Amico-Willman (College of Agriculture & Life Sciences)	Kelman Scholars	Genomic Diversity of Bacteriophages Lytic on Xanthomonas spp. Pathogenic on Pepper
Whilden, Mckaela Elizabeth College of Agriculture & Life Sciences Texas A&M University		3		BeeMORE	Effects of Nectar Yeast in Pollinator Foraging Preference
Whimpenny, Kaitlynn College of Engineering NC State University		5	Helen Huang (College of Engineering)	WMSRP	The Effects of Powered Knee Prosthetics on Trans-femoral Amputees
Wilcox, Galen College of Sciences NC State University		2	Ryan Murray (College of Sciences)	OUR Award	Birkhoff-Rott CIrcles

PRESENTER INDEX

Lead Presenter	Co-Presenters	Session	Primary Mentor	REU/Summer Research Program	Project Title
Wilds, Emma College of Agriculture & Life Sciences NC State University		7	Lina Quesada-Ocampo (College of Agriculture & LIfe Sciences)	Kelman Scholars	Differential expression of two effector-encoding genes in Clade 1 and Clade 2 of the cucurbit downy mildew pathogen Pseudoperonospora cubensis
Wilkinson, Victoria College of Sciences Norfolk State University		2	Elena Jajubikova (College of Sciences)	ICE	Computational Studies of a Series of Metal-based Graphite-conjugated Electrocatalysts for Nitrate Reduction
Williams, Audrey College of Agriculture & Life Sciences UC Berkeley		4	Alex Woodley (College of Agriculture & Life Sciences)	CEFS ASPIRE	Kelp as a Soil Amendment - Nutrient Release and Greenhouse Gas Mitigation Potential
Williams, Niamh WIlson College of Textiles NC State University		7	Amanda Mills (Wilson College of Textiles)	TECS	Fabrication of Stretchable Knit Antenna
Wilson, Bryan College of Engineering NC State University		5	Javon Adams (College of Engineering)	WMSRP	Al Generated Music using Tension
Wilson, Brandon College of Natural Resources NC State University		5	Javon Adams (College of Engineering)	WMSRP	The Development of Renewables on Abandoned Oil & Gas Wells (Literature Review)
Witt, Caroline College of Sciences Missouri State University		1	Carla Frohlich (College of Sciences)	CDSA	Light curves from core-collapse supernovae with circumstellar material
Wood, Elyse College of Sciences NC State University		2	Laurianne Van Landeghem (College of Vet Med)	OUR Award	Involvement of glial cells of the gallbladder wall in gallbladder mucocele
Wood, Sam College of Engineering NC State University	Shaan Stephen College of Engineering NC State University	6	Venkateswaran Narayanaswamy (College of Engineering)	MAE	Development and Testing of High-Temperature Fast Response Pressure Sensitive Paint

PRESENTER INDEX

Lead Presenter	Co-Presenters	Session	Primary Mentor	REU/Summer Research Program	Project Title
Wright, Bryan College of Engineering Colorado School of Mines		2	Ramon Collazo (College of Engineering)	MAT-DAT	Using data to design LEDs emitting in the ultraviolet for disinfection applications
Wunch, Carter College of Engineering University of Rhode Island		2	Veronica Augustyn (College of Engineering)	MAT-DAT	Data-Driven Synthesis of Metastable Hydrated Transition Metal Oxides
Zauscher, Elias College of Engineering NC State University		3	Emily Berglund (College of Engineering)	RISE CCEE	Modeling Energy and Water Use Changes in a Hybrid Water System in Perth, Australia
Zheng, Jeffrey College of Engineering University of Pittsburgh	Neil Bennett College of Engineering NC State University	1	Thomas Price (College of Engineering)	SRCA	Qualitative Analysis of Novices' Programming Behaviors during Web Help-Seeking
Zhu, Jocelyn Wilson College of Textiles NC State University		7	Jessica Gluck (Wilson College of Textiles)	TECS	Guiding cardiac differentiation via decellularized ECM electrospun scaffolds
Zizzo, Kieryn College of Agriculture & LIfe Sciences University of Arizona		7	Christina Cowger (College of Agriculture & Life Sciences)	Kelman Scholars	Diversity of Fusarium sp. In Pennsylvania Wheat Fields
Zwennes, Nicole College of Sciences NC State University		6	Ashley Brown (College of Engineering)	CMI SIRI U-Team T34	Development of a Dual-Loaded Drug Delivery Patch Made Using Fibrin-Based Nanoparticles

ABSTRACTS | SESSION 1

Title: Validating Electric Power Flow Simulation that Predicts Regional U.S. Water Footprints

Presenter(s): Tiffany Ard

Mentor(s): Okan Pala

REU/Summer Research Program: SRCA

The presence of microbes, such as bacteria and yeasts, has been widely documented in stored pollen that enzymatically alters it in the honeycomb of Apis mellifera colonies to form "bee bread." However, the role of microbes in the conversion of pollen to bee bread is still a subject of uncertainty. We hypothesize that microbial growth will be rapid with a quick asymptote, thus we expect to see these colonizing bacteria and yeasts as the main causes for fermentation within the samples. In this study, we investigate the progression of microbial community composition and abundance with periodic sampling periods over the course of eight days, generating data on the relation of colonization periods and bee bread composition. Sample preservation and DNA extraction were optimized to accurately quantify DNA for sequencing with the Oxford Nanopore Technologies (ONT) MinION. Samples were pre-treated with Zymo DNA/RNA Shield and disrupted, then subjected to the ZymoBiomics Quick-DNA Tissue/Insect Mini-Prep Kit. DNA yields were high but not sufficient for extraction, thus we used Zymo Select-a-size DNA MagBead kit to concentrate 4 samples into 1 (4:1). This improved library preparation will enable us to sequence samples from specific timepoints and identify microbial and plant DNA in the samples using non-PCR reliant methods. Our bioinformatic analyses using the EPI2ME "What's in my pot" (WIMP) and EDGE Bioinformatics cloud-based tools will further enable us to identify the microbes that are present in our bee bread samples.

Title: Interweaving Snap! Into Earth Science Instruction

Presenter(s): Chris Barth

Mentor(s):Tiffany Barnes

REU/Summer Research Program: Socially Relevant Computing Analytics Research Experience for Teachers

This summer, we embarked on a journey to learn about research and create materials for our classroom. To start off the experience, we contributed to a participatory design project for a new learning management system for Snap!. We also trialed a workshop for grading and assessing in computer science, contributing to its improvement. Finally, we collaborated with high school interns to create activities for our classrooms. We focused on three different projects: 1. Creating science lessons for students in Snap!. 2. Improving current assignments in Snap! and 3. Incorporating storyboarding into an existing AP CSP project.

Title: Molecular Simulations of Removal and Recovery of Phosphate from Wastewater using Temperature Swing Solvent Extraction (TSSE) Method

Presenter(s): Brooklyn Blackwell

Mentor(s): Alexey Gulyuk

REU/Summer Research Program: STEPS

Phosphorus is a non-renewable resource that is polluting our environment and decreasing in accessibility at a rapid rate. All in all, phosphorus plays an important part in maintaining the world's population due to its role in global food production. Due to the world market and the war in Ukraine, there is a rise in prices of fertilizer that contains the element, which makes it more crucial that we find cost effective solutions to recover phosphorus. In this research, we investigated recovery of phosphorus from wastewater by modeling experiments using molecular dynamics. Software like Visual Molecular Dynamics (VMD), Assisted Model Building with Energy Refinement (AMBER), and Chemistry at Harvard Macromolecular Mechanics (CHARMM) have aided us in setting up ideal environments to successfully carry out the phosphate removal using the temperature swing solvent extraction method (TSSE). Unlike more traditional methods, utilizing molecular dynamic simulations is a more cost effective way to carry out experiments on a molecular scale to see results free from human error. To start, we modeled the experiment using .5M of NaCl solution to selectively extract water at an ambient pressure with low grade heat. We expect to be able to successfully demonstrate the removal of phosphates from the water using an NaCl solution. By utilizing the molecular dynamics software mentioned above, we can adjust the type and concentration of varied solutions to determine which one will be the most effective at removing phosphorus from wastewater using the TSSE method.

ABSTRACTS | SESSION 1

Title: Chemical and Biological Factors Affecting Phosphorus Uptake/Release by Phosphorus Accumulating Organisms

Presenter(s): Julianne Buggs

Mentor(s): Douglas Call

REU/Summer Research Program: STEPS

Phosphorus accumulating organisms (PAOs) store inorganic phosphate as polyphosphate granules, and accumulate volatile fatty acids (VFAs) to store as polyhydroxyalkanoates (PHAs). They are present in wastewater streams and used in biological nutrient removal processes at water reclamation facilities. Phosphorus removal by PAOs involves anoxic, anaerobic, and aerobic phases, coordinated with phosphorus uptake and release. In some wastewater facilities, phosphorus removal can become unstable. Reasons for these instabilities remain unclear, but emerging evidence points to possible roles of metals and presence of particular microorganisms. Toward addressing these knowledge gaps, our work focuses on two key aspects: (1) the role of the metal aluminum (often added as alum in wastewater facilities), and (2) microbial community composition differences between a stable and unstable full-scale phosphorus removal system, using chemical and biological techniques to understand phosphorus uptake and release. Chemical techniques involve the addition of alum to wastewater streams and analyzing PAO uptake of phosphorus through electron microscopy-based imaging and measuring soluble orto-phosphate concentrations. Biological techniques include completing DNA extraction and Nanopore sequencing to determine the bacterial and archaeal species present in the wastewater streams. Chemically, we expect that effective phosphorus removal will be shown in waste streams that are treated with alum to allow for polyphosphate storage by PAOs. Biologically, we expect effective phosphorus uptake will occur in microbial communities that have a symbiotic relationship instead of a competitive one. Applications of this research include environmental health; wastewater treatment and phosphorus removal are critical for preventing eutrophication and degrading water quality.

Title: A Novel Approach to Discover the Number of Solutions to the Strong Goldbach's Conjecture

Presenter(s): Drew Cada

Mentor(s): Tiffany Barnes

REU/Summer Research Program: SRCA

The strong Goldbach conjecture, proposed by Christian Goldbach in 1742, states that every even integer greater than two can be expressed as the sum of two prime numbers (Goldbach, 1742). Other work has confirmed the conjecture up to 4*1018 (Silva et al., 2013), and attempted to prove it absolutely through a variety of methods (Aouessare et al., 2016; Bado, 2019). While the most recent publication in 2019 by Bado claims to have proven the conjecture, we are unable to find widespread acceptance of their work and thus consider the conjecture yet unproven. We propose a novel approach to visualize patterns between key known even integers—which we dub "sweet points"—using computer-generated charts. First, we constructed these sweet points such that the number of prime pairs, which are solutions to the conjecture, is known at those points. Second, we defined prime pairs and non-prime pairs as the pairs of numbers which sum to the sweet point. Using these sweet points, we may extrapolate the number of solutions for even numbers in between said sweet points by determining the ratio of prime pairs to non-prime pairs. Our research attempts to further future work toward a more rigorous proof of the strong Goldbach conjecture which would also explore the number of prime pairs, rather than just determining that a pair exists at each even integer. Future work may consist of attempting a formal mathematical proof of our proposed solution to the conjecture, or use of our approach to work toward other solutions.

Title: Multi Angle NSI with Neutrinos

Presenter(s): Shan Carter

Mentor(s): James Kneller

REU/Summer Research Program: CDSA

Nonstandard interactions (NSI) of neutrinos will alter how they change flavor in a supernova. A change in the flavor transformations will alter the amount of energy deposition by the neutrinos and therefore alter the dynamics of the supernova explosion. The goal of this project is to study neutrino transformation within the supernova when the neutrinos are given NSI with matter. We will calculate the flavor transformation probabilities using a multi-angle version of a code known as SQA. The results from the calculations will be processed with the SNEWPY software to help us simulate the ability of neutrino detectors to detect NSI Neutrino features from the next Galactic Supernova.

ABSTRACTS | SESSION 1

Title: The Effect of Boundary Roughness on Granular Flow in a Hopper

Presenter(s): Emily Cecchini

Mentor(s): Karen Daniels

Granular flows are affected by the properties of the particles, the environment they are in, and the geometry of the flow. Experiments have shown that boundary conditions impact the flow of particles, specifically the flow speed and pressure, and its force fluctuations. In this experiment we designed and built a flat hopper filled with photoelastic particles, which allow visualization of internal forces, to test the effect of five different boundary roughness' on a vertical flow. We tested how changing the boundary roughness affects specific flow characteristics by calculating the internal forces and speed of each particle, and averaging them over multiple runs. After performing data analysis of the flow data, we determined that changing the boundary roughness does affect the particle speed, pressure, and force fluctuations, particularly in the regions closest to the walls. In the future, we will use these results to find a model that represents the dependence granular flows have on boundary roughness vs other characteristics and conditions.

Title: Analyzing Phosphorus Uptake in 3-D Bioprinted Arabidopsis thaliana Cells

Presenter(s): Lauren Chandarana, Jasmine Peace

Mentor(s): Lisa Van den Broeck

REU/Summer Research Program: STEPS

Phosphorus is an essential element for plants to efficiently photosynthesize, grow, and reproduce. Soil contains a large amount of organic phosphorus that is unavailable to plants, and is therefore applied through fertilization. However, applying phosphorus as fertilizer is unsustainable as around 60% is lost due to inefficiency. In addition, run-off causes phosphorus to leach into our waterways, which is harmful to our environments. Plants intake phosphate through their roots, making roots an essential organ in determining a plant's phosphate use efficiency. This research project aims to identify efficient ways that plants can use applied phosphate. To study phosphate uptake in plants, we isolated and 3D bioprinted cells from Arabidopsis thaliana roots. The use of 3D bioprinting allowed us to control the cells' microenvironments and track single cells. To map the cellular response to changing phosphate concentrations, we analyzed viability under phosphate deficient conditions and variable phosphate concentrations of our bioprinted constructs. Moreover, we quantified the amount of phosphate taken up by the cells. Additionally, to investigate the potential underlying molecular response to phosphate deficiency, we evaluated root cells from multiple loss-of-function lines of genes that are involved in phosphate uptake. Furthermore, to determine if we could improve phosphate uptake, we added sodium silicate to the bioprinted constructs, a compound shown to increase phosphate uptake. By precisely controlling the phosphate availability in the microenvironment of root cells and subsequently studying their uptake of phosphate, we will be able to identify methods to increase phosphate use efficiency in plants.

Title: The Road to CS Mastery is Paved with Bugs

Presenter(s): Hannah Chong, Eileen Malick

Mentor(s): Collin Lynch

REU/Summer Research Program: Socially Relevant Computing Analytics Research Experience for Teachers

Issues surrounding K-12 computer science education have appeared at unprecedented rates in the last decade as scholars and policymakers' debate over the best methods, languages, and timelines for CS curriculums. Broadly, our research focuses on pedagogical methods for syntax in K-12 CS education. The current research in this sphere shows that various methods can be utilized to teach syntax but should be based on a constructivist- approach rather than the traditional one-size-fits-all approach. For our research, we aim to gauge the efficacy of an iterative interactive game model (SNAP) for fundamentals in code implementation in place of brute syntax. We will use SNAP, a beginner-friendly programming platform. First, we will administer a pre-test to gauge students' current levels. Then students will complete the challenges, followed by a post-test to gauge retention and efficacy of the curriculum. We intend for the results of our project to shed light on alternative methods and improvement of CS education for K-12 students.

ABSTRACTS | SESSION 1

Title: Expression, purification and characterization of recombinant, histidine tagged Pycr3

Presenter(s): Kirby Fawcett

Mentor(s): Alex Wall

Pyrroline-5-carboxylate reductase 3 (Pycr3) catalyzes the final step in proline biosynthesis. There are two other members of the Pycr family, which are responsible for genetic diseases, such as cutis laxa. Whereas Pycr1 and Pycr2 are highly similar with respect to sequence, cofactor preference, and intracellular location, Pycr3 is only 45% similar to the other Pycrs, prefers a different cofactor (NADPH), and localizes to the cytosol rather than mitochondria. Although the structures and kinetics of Pycr1 and Pycr2 have been revealed, no such findings exist yet for Pycr3. This leaves a gap in the understanding of proline biosynthesis. BL21(DE3) and NiCo21 E. coli strains were transformed using a pET24b-pycr3 plasmid, which encodes Pycr3 under the control of T7 RNA Polymerase in addition to a kanamycin resistance gene (KanR). Following transformation, we graphed growth curves and used this information to induce Pycr3 expression, after which we assessed localization of Pycr3 within the bacteria. Growth on an LB agar plate containing kanamycin indicated successful transformation. Growth curves showed that the transformed cells reached ideal optical density for IPTG induction at roughly 4 hours post-inoculation. SDS-PAGE performed post-induction showed expression of recombinant Pycr3 in intracellular soluble and intracellular insoluble proteinaceous fractions (i.e. inclusion bodies). IMAC spin column purification of our soluble and insoluble proteinaceous fractions confirmed the presence of His-tagged Pycr3 in those samples. Moving forward, we will scale up our affinity purification of Pycr3 from our samples using FPLC, determine Pycr3's kinetic properties, and crystallize it in preparation for X-ray crystallography.

Title: Evaluating Weather Forecasts of Precipitation Start and End Times

Presenter(s): Jordan Fritz

Mentor(s): Sandra Yuter

REU/Summer Research Program: Undergraduate Research at Environment Analytics

Weather forecast models often struggle to correctly predict the timing of precipitation events. Even an error of an hour or two on when snow will start to fall can have large impacts on airline schedules or on the timing of school closures. In order to evaluate the weather model error, we compare the forecasted storm start and end times from the National Oceanographic and Atmospheric Administration (NOAA) Global Forecast System (GFS) weather model to the observed start and end times, obtained from NOAA's Integrated Surface Dataset. We use three precipitation rate thresholds to define precipitation events, > 0 mm/hr, >=0.3 mm/hr and >=0.5 mm/hr. If there is more than six hours between the end of one event and the start of the next event, we consider them to be separate storms. For a given date, we use three different GFS forecasts that are initialized 24 hours, 48 hours, and 72 hours prior to the time of interest. Our analysis will determine if the storm timing forecast errors have a typical bias. For example, if the weather model usually predicts the start of precipitation too early or too late, or if the timing errors are more random.

Title: Simulating Cas A Jets with Asymmetric Circumstellar Medium

Presenter(s): Sierra Geene

Mentor(s): John Blondin

REU/Summer Research Program: CDSA

In 2004 the Chandra X-Ray Observatory captured a one-million-second view of Cassiopeia A (Cas A), the supernova remnant (SNR) of a Type IIb supernova. It revealed a jet of ejecta in the Northeast and a counter jet in the Southwest direction. Both were rich in silicon with evidence of iron, sulfur, argon, calcium, and potassium. Since this observation, there has been speculation that the jets resulted from an asymmetrical explosion rather than variation in the circumstellar medium (CSM) density. We used VH-1 hydrodynamic modeling to create 2D and 3D simulations of supernovae to explore the hypothesis that it is actually interaction with the CSM, with a symmetrical explosion, which could produce jets. In the models, CSM density was dependent on the azimuthal angle, with higher density regions near the equatorial plane and lower density regions near the poles. Tracers in the simulations tracked the elements from the progenitor star through the explosion. The resulting element distribution was compared to the Cas A observations. Additionally, velocity profiles of the ejecta were used to illustrate that the ejecta had been decelerated by the reverse shock and then re-accelerated in the area between the shock waves where there is both high temperature and pressure. We also briefly explored the relationship between the density profile and the likelihood of jets.

ABSTRACTS | SESSION 1

Title: Analyzing office hours interaction strategies using instructor feedback

Presenter(s): Oishi Ghosh

Mentor(s): Collin Lynch

REU/Summer Research Program: SRCA

In Computer Science education, understanding office hours interaction using instructor feedback is essential for analyzing students' progress. Office hours allow students to seek help and get feedback from instructors on their assignments and course progress. In this research, we analyze office hour interactions from a CS2 course during the Spring 2022 semester at NCSU. Prior work focuses on categorizing the type of questions students ask, what format of office hours is best utilized by students, and help-seeking behaviors. Our focus in this work is on gaining insights on which strategies employed by instructional staff took the most time. We collected request time, start time, and end time of the student interaction to analyze how long students waited and how long their interaction lasted. Then, using feedback provided by instructors and students during each office hours interaction, we explore the strategies they use and the effectiveness of how well the interaction went. The outcome of this study would tell instructors how to provide help more efficiently and thus improve the office hours experience for students.

Title: Modeling Cool Gas Kinematics of the Fermi Bubbles

Presenter(s): Annie Giman

Mentor(s): Rongmon Bordoloi

REU/Summer Research Program: CDSA

In 2010, the Fermi Gamma-ray Space Telescope detected large gamma-ray emitting lobes on either side of our galactic center (GC). These lobes, named Fermi Bubbles (FBs), are the result of high-energy particle interactions corresponding to hot plasma, and eject gas in high-velocity outflows. Imaging surveys are not enough to constrain gas kinematics. However, using background quasar sightlines allows the detection of cool entrained gas in the bubbles. Because these observations are in projection, a model is needed to constrain the gas kinematics further. In this work, we develop a kinematic model of the Milky Way nuclear outflow to constrain the FB observed velocity profiles, which are used to constrain the age and velocity of the Milky Way's nuclear outflow.

Title: Enhancing Phosphorus Release from Food Waste using Freeze-Thaw Cycles

Presenter(s): Christopher Good

Mentor(s): Douglas Call

REU/Summer Research Program: STEPS

Phosphorus is a key ingredient in agricultural fertilizers, but mineable sources are becoming increasingly scarce. Phosphorus recovery techniques are becoming more important as alternative methods for meeting demand for this resource. Food waste is a waste stream that is very rich in phosphorus, but largely ends up in landfills, thus removing the resources in food waste from the nutrient cycle. Studies have shown that freeze-thaw cycles facilitate the release of nutrients from physical substrates, specifically soil and manure. However, studies on phosphorus recovery from food waste using freeze-thaw cycles are scarce. Here, we examine phosphorus release from food waste subjected to freeze-thaw under different conditions (e.g. moisture content). We are specifically interested in the release of orthophosphates, as this reactive phosphorus is most readily available to plant life. Our study tested the effects of the moisture content of food waste on phosphorus and nitrogen release after a 24 hour freezing period when compared to unfrozen control samples. We expect that a freeze-thaw cycle will break down the structure of the food waste substrate and damage cellular structure sufficiently to release the nutrients trapped inside. Although this research is unfinished, we expect that freeze-thaw cycles will increase the nutrient release of the food waste substrate, and that this process will be enhanced as moisture content increases. We will use a scanning electron microscope to compare substrate structure before and after freezing. This study offers a simple strategy to advance nutrient recovery from food waste, eliminating the resources lost to landfills.

ABSTRACTS | SESSION 1

Title: Variations in Mass Accretion Rate in a Massive X-Ray Binary System

Presenter(s): Malcolm Henderson

Mentor(s): John Blondin

REU/Summer Research Program: CDSA

Binary systems consisting of an OB supergiant star and a compact companion can produce X-ray emissions when mass from the stellar wind of the supergiant is accreted onto the compact companion. In these systems, the X-ray emissions from the compact object can both heat and ionize the stellar wind from the OB supergiant, slowing the stellar wind and causing increased mass accretion rate due to the lower relative velocity. This causes increased X-ray luminosity until the ionization completely stops the stellar wind, stopping the mass accretion and X-ray luminosity until the wind resumes. This creates a variable X-ray luminosity and mass accretion rate in the system I will be using hydrodynamic simulations to model the massive X-ray binary system Vela X-1 in 2d and 3d to observe the rate at which mass is accreted onto the neutron star in the system over a period of time. I will be using the hydrodynamic models to see if there are any stable states in the luminosity of the system and under what conditions those stable states might occur.

Title: Stick-Slip Events in a Low Gravity Granular System

Presenter(s): Aaron Holt, Alexandra Klipfel

Mentor(s): Karen Daniels

As human activity in space becomes more common, an understanding of the surfaces of celestial bodies will be increasingly relevant. Many rocky bodies, such as the moon and rubble pile asteroids, have surfaces composed of granular materials: groups of small, solid particles which can collectively behave like a fluid. Currently, our understanding of how these materials behave in low gravity environments is limited. Consider a craft of some kind landing on this sort of terrain: how does the material react as an object intrudes through it? Does its behavior depend on the strength of gravity? To help answer these questions, we designed an experiment to simulate an approximately two-dimensional granular material in low gravity. This was accomplished by having the system lie flat atop a titlable surface; the more the surface was tilted away from the horizontal, the stronger the effective gravity. The granular material itself consisted of disks made of photoelastic material, which distorts light passing through it when force is applied. This allowed us to measure the contact forces between particles in the system as a small intruder moved through and around them. A common trend across all trials is the prevalence of stick-slip events, characterized by the driver being brought to a temporary stop before resuming movement. We investigate how the effective gravity, driver size, and mass used influence properties of these events, such as their duration, magnitude, and the interval between them.

Title: Teaching Whales to Extractively Summarize Scientific Papers

Presenter(s): Iman Hosseini, Chris Foley, Krish Patel

Mentor(s): Steffen Heber

REU/Summer Research Program: SRCA

Roughly 1.8 million research papers are published annually, spread across multiple scientific disciplines and fields of study. To cope with this publication deluge, we adapted the Whale Optimization Algorithm (WOA) to generate extractive paper summaries. We used the Recall-Oriented Understudy for Gisting Evaluation (ROUGE) metric to evaluate the quality of the generated summaries and compare our WOA summarizer with greedy and variable neighborhood search-based approaches. We benchmark our adapted algorithm against an arXiv dataset of 17,038 preprocessed documents. Our preliminary results are promising, and we hope that we can achieve significantly improved ROUGE scores with only a slight increase in runtime. This study also explores the maximum ROUGE score that an extractive summary can achieve.

ABSTRACTS | SESSION 1

Title: Statistical Analysis of Sweet-APPS Imagery Sensors

Presenter(s): Malachy Kerrigan

Mentor(s): Cranos Williams

REU/Summer Research Program: Sweet-APPS

North Carolina is the largest producer of sweet potatoes in the United States. Over the past few years, the sweet potato industry has invested in and tested different automated processes using optical sensors to quickly sort sweet potatoes based on value-driven metrics (e.g., size, shape). The Sweet potato Analytics for Produce Provenance and Scanning project (Sweet-APPS) is a research project at NC State with two overall goals: 1) reduce food waste, 2) maximize value for sweet potato producers, growers, and packers. At the processing facility, there are two different sensors scanning sweet potatoes as they run down a conveyor belt. The two sensors return different outputs since each sensor scans a varying percentage of the sweet potatoes as they run down the belt. A MATLAB program was written to analyze datasets created from the sensors. The analysis consists of connecting each sweet potato to its respective field where it was harvested and then sorting the sweet potatoes from each field based on its weight. This study evaluated how these two sensors and computer vision models differ in estimating the sweet potato value for every field harvested by statistical analysis. The results of this assessment will affect how packers use the sensors for decision-making.

Title: Real Time Measurements of Dopamine and Glutamate in Rat Striatum Using Fast-Scan Cyclic Voltammetry

Presenter(s): Laney Kimble

Mentor(s): Leslie Sombers

REU/Summer Research Program: Beckman Scholars Program

Glutamatergic and dopaminergic transmission within the striatum is interrelated and linked to several psychiatric, neurodevelopmental, and neurodegenerative pathologies. The release and removal of neurotransmitters from the synapse occurs within milliseconds; thus, analytical techniques capable of monitoring rapid neurochemical fluctuations on this timescale are required in order to directly quantify these processes. Fast-scan cyclic voltammetry (FSCV) is an electroanalytical technique with superb temporal resolution that is commonly used to monitor rapid DA fluctuations, even in the presence of interferents. FSCV is typically coupled with carbon-fiber microelectrodes. These can be modified with a chitosan matrix containing an oxidase enzyme to allow for the simultaneous detection of non-electroactive analytes. In this work we have modified the carbon-fiber microelectrodes with glutamate oxidase (GlutOx) to allow for the detection of glutamate in live rat brain tissue. The GlutOx-modified electrodes have been characterized for their stability, selectivity, oxygen dependency, and sensitivity to glutamate and DA. Additionally, glutamate has been detected in rat striatal tissue upon electrical stimulation using an ex-vivo brain slice preparation. The signal was verified using the pharmacological agent, DL-TBOA, a potent and selective inhibitor of the excitatory amino acid transporter that is responsible for glutamate reuptake. Future work will entail characterization of the DA and glutamate kinetics in intact, anesthetized animals via stereotaxic surgery. The ability to simultaneously record rapid fluctuations of glutamate and DA at one electrode promises to inform improved therapeutic strategies for a wide range of disorders in which both dopaminergic and glutamatergic signaling are altered.

Title: Investigating binding affinities of a synthetic siderophore PDMA with various trace metal nutrients

Presenter(s): Jackson Kohn

Mentor(s): Owen Duckworth

REU/Summer Research Program: BESST

Trace metal limitation is a widespread agricultural issue with far-reaching implications for managing healthy and productive soils worldwide (Kraemer et al., 2006). Several essential metal nutrients primarily exist outside of the bioavailable pool due to their slow dissolution kinetics or low solubilities (Kraemer et al., 2015). To overcome this problem, organisms have developed the ability to exude metal-chelating compounds called siderophores that promote biologic uptake of essential metal nutrients (Harrington et al., 2015). These exudates display widely variable binding affinities for specific metals, contributing to large discrepancies in nutrient uptake rates in competitive soil ecosystems, (Treeby et al., 1989). Our study seeks to quantify the binding affinities and stability constants of Cu, Co, Zn, Ni, Mn, and Fe with PDMA, a recently developed analog of the well-studied but notoriously expensive 2'- deoxymugineic acid (DMA) (Suzuki et al., 2021). We will determine the stability constants of each metal-siderophore complex via spectrophotometric titration of 1 mM of metal and 1 mM of siderophore in a 0.1 M electrolyte background using a standardized 0.1 M NaOH titrant. A UV-VIS-NIR Deuterium-Halogen Light Source (OceanOptics, FL, USA) will be used to collect our spectral measurements following each dose of titrant. We will fit our data in hyperquad to determine stability constants and relative binding affinities for specific

metal-siderophore combinations. Our results are critical for furthering our understanding of PDMA's effectiveness at mobilizing trace metals, particularly in nutrient-poor, alkaline soils that comprise approximately one-third of Earth's land area (Kraemer et al., 2006).

Title: Manipulation of Striatal Dopamine Dynamics through Ventral Tegmental Area Mu Opioid Receptor Activation

Presenter(s): Pranav Kumara

Mentor(s): Leslie Sombers

Endogenous opioid peptide signaling in the ventral tegmental area (VTA) is imperative to dopamine (DA) function. However, not much is known about the subtleties underlying opioid peptide modulation of dopamine cells in the VTA. Endogenous opioid peptides acting on receptors in this region modulate DA signaling in striatum, which is heavily implicated in drug addiction. Unfortunately, this is a disorder for which few pharmacological interventions are available. In this study, we aim to better understand neurochemical interactions by coupling fast-scan cyclic voltammetry (FSCV) with carbon-fiber microelectrodes for recordings of DA release in the nucleus accumbens of awake rats before and after microinfusion of mu-opioid receptor (MOR) drugs directly into the VTA. Survival surgery was performed to install a head cap with two recording electrodes, two microinfusion ports, and one reference electrode. Awake rats were tethered in a behavioral chamber for voltammetric recordings. Microinfusions of saline were followed by similar infusions of either CTOP, a MOR antagonist, or DAMGO, a MOR agonist. The resultant transient DA signals in rat striatum were recorded in real-time. Preliminary results suggest that manipulation of DA cell bodies in the VTA with MOR-selective drugs - both agonists and antagonists - results in an increase in striatal DA transients. This is important because the striatum is involved in complex behaviors like action selection, habit formation, and locomotion. Overall, this work advances our understanding of complex mesolimbic circuitry and the role opioid peptides play in the VTA, which will undoubtedly inform new therapeutic strategies for addiction recovery.

Title: Validation of Acoustically Actuated Microswimmer

Presenter(s): Utkarsh Kumaran

Mentor(s): Nitin Sharma

This project aims to demonstrate the validity of acoustically actuated bubble-based microswimmers and an ultrasound tracking strategy for trajectory. Methods: Bench top testing was conducted to verify motion at two different resonance frequencies, validating the swimmer's bubble-based mechanism. Experiments will be performed to capture the motion of the microswimmers by synchronized ultrasound and camera systems. A laboratory-developed tracking algorithm will be utilized to estimate the trajectory for both tracking methods. Results: The microswimmers can perform two different moving trajectories at separate resonance frequencies. An ultrasound setup was developed to evaluate the comparison between camera tracking and ultrasound. Conclusion: This project validated the motion of acoustically powered bubble-based microswimmers. Future Work: Future work will be required to fulfill all the project's objectives. Further bench top testing will need to be conducted to validate ultrasound tracking. Additionally, applications of real-time control systems, such as closed-loop control, will open up additional applications for this device. Significance: Validating the motion of acoustically powered micro-swimmers can further the applications of these swimmers. If ultrasound tracking is validated in future work, non-invasive tracking of motion will allow for in vivo testing for this device.

Title: Computer Science: Creating activities for the classroom and contributing to research

Presenter(s): Indira Bhandari

Mentor(s): Tiffany Barnes

REU/Summer Research Program: SRCA

The goal of my work this summer is to create a framework in my 6th-grade science classroom where I can integrate Snap! and Computational Thinking into my daily lessons. In the past, I have taught my science curriculum, and then have reserved other days to do coding lessons, usually with members of the Friday Institute coming into my classroom. I would like to break down this divide between only teaching science and teaching coding. The focus of these lessons will be on earth's structure and is divided into three parts, all in Snap! The first is an interactive informational section on the layers of the earth, including the inner core, outer core, mantle, and crust. The second is a series of simulations modeling different plate boundaries and what landforms occur at these boundaries (mountains, volcanoes, etc.) The third is an interactive simulation of the asthenosphere, lithosphere, and convection currents. All three lessons will be used as either a complement or substitute to internet research or direct instruction, which is often provided through guided notes and a slideshow. Snap! Lessons will be differentiated to accommodate students with different programming backgrounds. Students who are less familiar with Snap! will read code and eventually solve Parsons Problems. More advanced students will solve more difficult Parsons problems, implement a change in code, and write their own code.I will start the year off with a

coding pre-assessment and will have used Snap! in other units before I begin the Earth Science Lesson.

Title: Participatory Design on Block-Based Learning Management Tool

Presenter(s): Maggie Lin, Sana Mahmou

Mentor(s): Tiffany Barnes

REU/Summer Research Program: GCSP

Most software designed for educational use presently does not involve teachers in the design process. This is an issue because teachers have valuable expertise, needs, and desires that might be neglected. As learning technologies are increasingly used in classrooms, the involvement of teachers in the design process gains greater importance. Using participatory design techniques, we incorporate teachers' voices in the improvement of SnapClass, a block-based programming learning management system. A future workshop, a common participatory design technique, was conducted with 3 teachers who use block-based programming in their classrooms followed by live prototyping and enactment. The workshops enabled teachers to visualize functionality they would value in the software through evaluating teaching practices, imagining solutions, and collaborative prototyping. We found that within the SnapClass environment, there is a need for a real-time hand-raising feature, level differentiation within assignments, and a feature for assigning student self-reflection. The teachers' concerns will be addressed through implementation of new functionalities into the software. Teacher feedback for our design will be discussed.

Title: Defining the Knowledge Gap Between Subject Matter Experts and Students in First/Last Mile and Cross Commodity Connections

Presenter(s): Wendy Mao

Mentor(s): Okan Pala

REU/Summer Research Program: SRCA

Understanding the structures of the US Food Energy Water (FEW) Supply Chain (SC) system and the impact of disruptions in said systems is a key part of decision-making in response and recovery efforts. It is essential for policymakers, business owners, and other stakeholders to understand FEW networks in order to make more educated and informed decisions to increase sustainability and resiliency within the system. Therefore we conducted a think-aloud user study examining the knowledge gap between Subject Matter Experts (SMEs) and the general population, represented by college students and future stakeholders. Both student and expert participants were given commodity flow diagrams in an interactive digital environment. They then were directed to draw (a) in-network and (b) cross-network commodity source-sink relationships. Expert participants were also given hypothetical supply-chain disruption scenarios on an interactive map, including mesoscale, first/last-mile, and both combined with loss of human resources. They then were asked open-ended questions and completed a survey. The outcomes of this study would help define disparities between the two groups' knowledge regarding SC flows and dependencies. This will allow us to gain new insights into human perception of SC systems. Preliminary results show that SMEs and students' knowledge diverges overall, especially regarding cross-commodity connections; most students also reported to struggle more on defining commodity flows within the water SC, as well as understanding SC interdependence. These findings can be used in bridging the knowledge gap between SMEs and stakeholders, such as designing, and implementing, educational resources emphasizing cross-commodity connections and SC interdependencies.

Title: 43-Year Temperature Trends Based Upon Observed Hourly Weather Station Data

Presenter(s): Logan McLaurin

Mentor(s): Kevin Burris

REU/Summer Research Program: Undergraduate Research at Environment Analytics

Many analyzes of climate change, such as the US Global Change Research Program's National Climate Assessment, rely heavily on daily meteorological datasets. Changes to average and extreme values of daily temperatures are important for understanding the climate change that has already occurred. However, many relevant aspects are left unquantified by daily metrics. For example, the impacts to people, plants, and buildings are substantially different for a day with five consecutive hours with an air temperature of 95 degrees Fahrenheit as compared to only one hour at 95 degrees Fahrenheit. The daily high temperature would be the same for both scenarios. Long term records of the number of hours at a given temperature provide additional information not captured by daily values. We analyze hourly air temperatures and wet bulb temperatures for over 200 US and Canadian weather stations from 1978-2021. The wet bulb temperature includes information on air temperature and humidity and is a method to measure the ability of the human

body to effectively cool itself. For each weather station, the 10th, 50th, and 90th percentiles are computed for each year and the average change per decade is estimated. Variations in temperature trends among geographic regions and seasons clarify differences in regional warming.

Title: LMPC method for FES control of antagonistic muscles in elbow model

Presenter(s): Ashlesha Mirajkar

Mentor(s): Nitin Sharma

Functional electrical stimulation (FES) control techniques could help to restore limb movements in people with stroke, spinal cord injury or other musculoskeletal disorders caused by neurological injuries. Existing FES control methods for limb movement/regulation are unable to properly prevent overstimulation, which can lead to muscle fatigue. For example, antagonistic muscles such as the biceps and triceps are required for several functional tasks like elbow control. Some established control methods use muscle co-contraction, which is the simultaneous activation of muscles on opposite sides of a joint. Co-contraction is useful for achieving desired joint impedance through FES; however, it can lead to early onset of muscle fatigue. There is therefore a need to develop FES control techniques which prevent or avoid overstimulation and offer a more stable performance. Lyapunov-based nonlinear model predictive control (LMPC) methods for bi-directional FES control of antagonistic muscles could be used to avoid overstimulation and offer greater stability. We employ an LMPC on the antagonistic muscles of the arm and assess its control performance.

Title: The Creation, Use, and Impact of Block-Based Programming Curriculum: An Experience Report

Presenter(s): Janvi Nandwani

Mentor(s): Tiffany Barnes

REU/Summer Research Program: SRCA

The use of block-based programming languages has become common when teaching novice programmers basic concepts due to its ease of use and lack of complex syntax. For the students who attended the Art, Coding, Action! summer camp, curriculum was developed in the Snap! programming interface with an emphasis on coding activities related to art. To ensure that there was clear understanding during the camp, the lessons were created to build on each other. Each activity was designed carefully; the lessons had to cater to beginner programmers, yet had to maintain a level of rigor that would be enjoyable to the demographic. In this way, students not only learned core programming fundamentals but also understood the process of logic and algorithm construction. One of the activities the students completed, entitled “Fireworks in the City Sky,” combined mini-lessons on drawing various shapes, loops, multiple sprites, and randomization. Throughout the camp, students were gradually introduced to the traditional Driver-Navigator pair programming method, where one student controls the computer, while the other assists with logic creation. The first day consisted of individual efforts to solidify the concepts with each student, while the following days included pair programming. In order to investigate the perceptions of the students on the curriculum and the pair programming pedagogy, observation of the students took place as they completed each of the activities, in addition to conversation with the programmers to understand their thought processes, successes, and struggles.

Title: Real-time Detection of Glucose and Lactate Fluctuations During Hypoxia in Rat Dorsal Striatum

Presenter(s): Emilie Norwood

Mentor(s): Leslie Sombers

The brain expends about 20% of the body’s total glucose while comprising only around 2% of the body’s total mass. Research has correlated a wide range of neurological disorders, including traumatic brain injury and sleep apnea, to dysregulation in brain metabolism. One common thread among these disorders is hypoxia, a condition in which insufficient oxygen reaches the brain. As a result, the brain cells cannot undergo enough aerobic respiration to meet the huge metabolic demand of neurotransmission. In this work, the little known second-by-second dynamics of glucose and lactate were examined in normoxic and hypoxic conditions in the rat striatum while dopamine signaling was simultaneously recorded at the same site. Neurochemical dynamics were measured by pairing fast-scan cyclic voltammetry with novel enzyme microbiosensors. Electrical stimulation of the dopaminergic midbrain was used to drive striatal dopamine release, eliciting a metabolic demand that was immediately met by glucose and lactate. These concentrations rose then fell, quickly followed by a return to baseline. Upon induction of hypoxia, local decreases in both glucose and lactate were measured. The concentrations of these substrates fell on a similar time scale. Stimulation of dopamine release under these hypoxic conditions again elicited glucose and lactate again fluctuations to meet the metabolic demand.

Finally glucose and lactate concentrations increased when returning to normoxia. The data shed new light on the kinetics of specific energetic metabolites with respect to the time course of neuronal signaling under normoxic and hypoxic conditions, which is important in the development of potential therapeutic strategies.

Title: Designing and Testing 3D-Printed Hyperuniform Networks

Presenter(s): Caitlyn Obrero

Mentor(s): Christopher Rock

REU/Summer Research Program: RISE ISE

Hyperuniformity refers to a characteristic of networks that fall between ordered and disordered. While ordered networks have a consistent edge length and disordered networks have a variety of edge lengths, hyperuniform networks have characteristics of both. We aim to find which properties of a hyperuniform or nearly-hyperuniform network have practical applications such as transport properties or mechanical response. To make a network from a randomly-generated point cloud become iteratively more hyperuniform, we used Lloyd's Algorithm. The algorithm works by calculating the centroid of each cell in a Voronoi diagram based on the initial point cloud and moving the point to the centroid's position. It generates a new diagram, and the process repeats for N iterations, where each one is more hyperuniform than the previous. For each iteration, we then connect every point to its nearest neighbor using a method called Delaunay's triangulation. We have created MATLAB scripts that bring each dataset from its initial point cloud to an STL file ready for 3D printing. For our printed samples, we selected a copper-filled PLA to provide good thermal and electrical conductivity for transport properties testing. In our initial thermal conductivity tests, we noticed that in more disordered, nearly-hyperuniform structures, heat centralized in areas where the edges were more tightly-packed, matching the predictions from calculating a network property known as betweenness centrality. From these initial results, we are now motivated to quantify these results and extend our studies to include electrical and photoelastic measurements.

Title: Analyzing relationships among P, other elements and type of land cover per US state

Presenter(s): Chiemerigo Ogboi

Mentor(s): Qicheng Tang

REU/Summer Research Program: STEPS

The USGS (United States Geological Survey) compiled a database of soil samples from different states across the US. The samples contained various elements and types of land covers. The relationship between the elements specifically P, other elements and the type of soil per state has yet to be examined. For this project, we wanted to determine how the relationship between phosphorus and other elements in the soil like, aluminum, carbon and iron, changed in the different states. We analyzed the USGS soil data and determined the coefficient of determination values between soil elements and also compared these values geographically. A hierarchical model was used to further investigate the relationships.My project will help to better understand spatial variation in P and other elements, and the interactions among with land cover. The results will show what elements had most significant relationships with P and provide information for modeling on a more national scale.

Title: Designing a Teacher Dashboard to Support the Student Writing Process - A Participatory Design Approach

Presenter(s): Sophia Parker

Mentor(s): Collin Lynch

REU/Summer Research Program: SRCA

Teachers have limited time and resources to provide students comprehensive feedback and personalized help in writing tasks, while still covering the necessary materials for their course. Using participatory design, we are working with teachers to design a dashboard for them to better understand the student writing process and to supply students with useful learning resources. Widespread technology use has made collecting and using data about the process of writing more attainable. Our collaborators have recruited a select group of writing instructors from middle schools in the United States who participated in multiple workshops, providing feedback about how they taught and what they believed would be useful in a dashboard setting. After carefully reviewing the initial ideas from the teachers, we created multiple prototypes to present to them, and got feedback on the inadequacies of the system to create a new prototype. We aim to create an intuitive dashboard that helps teachers supplement their teaching by providing more individualized feedback about students and an overview of the problems faced in their classrooms.

ABSTRACTS | SESSION 1

Title: The Effects of Storyboarding Approach on the Design Quality of AP Create Performance

Presenter(s): Tatyana Pashnyak

Mentor(s): Tiffany Barnes

REU/Summer Research Program: Socially Relevant Computing Analytics Research Experience for Teachers

The purpose of this study is to determine the effects of a storyboarding approach on the design quality of student projects created using a block-based programming language, such as Snap or Scratch. Many high school students in the AP Computer Science Principles (CSP) course are struggling with incorporating required abstractions, lists, and functions, into their Create Performance Task projects. The main reason appears to be focusing on the overall program design first and attempting to meet rubric requirements last. While there are some preliminary studies, such as Çakıroğlu et al. (2021) that suggested providing aids for abstractions, research is limited on this topic, possibly because AP CSP has been offered for only a few years and is language-agnostic, thus many students choose to complete their projects in non-block-based programming languages. One very promising study (Limke et al., 2022) suggested that using storyboarding to design the program before attempting to write any code may impact the design quality of student projects. The participants will be two AP CSP courses taught by the same instructor. The control group will be given the rubric and asked to create a project. The intervention group will be given the rubric and asked to create the design storyboard before creating the project. It is expected that storyboarding will result in the improvement of project design quality, thus an expected impact of this research study will be higher quality AP projects and, consequently, higher AP scores.

Title: Enzymatic treatment of textile waste to enable recovery of valuable fibers and methane-rich biogas

Presenter(s): Tabitha Pickering

Mentor(s): Douglas Call

REU/Summer Research Program: RISE CCEE

There is an urgent need to find sustainable ways to manage growing quantities of textile waste. In 2018 the EPA reported over 11 million tons of textile waste being received by landfills. An alternative option to landfilling is to convert textiles into biogas through anaerobic digestion (AD). Anaerobic digestion is the breaking down of organic materials by microorganisms in the absence of oxygen, resulting in the production of methane-rich biogas which can be used as an energy source. Textiles can consist of one or multiple fiber types, or have dyes and chemical finishes present which makes the textile biodegradability uncertain. Moreover, recovering valuable components (e.g., polyester) could improve circularity and reuse of textiles. Our goal is to evaluate a strategy wherein enzymes convert low-value fibers into sugars and high-value fibers are separated. The sugar-rich slurry is then sent to AD for conversion into biogas. Preliminary results show that enzymatic treatments are highly effective at converting cotton into sugar-rich solutions. We are currently testing a suite of textile slurries in lab-scale anaerobic digesters to determine the volume of biogas that they can produce. So far we have seen significant gas production from untreated cotton slurries. Next we are looking at dyed and finished fabrics as well as polyester blends. Detailed COD balances as well as total and suspended solids balances are being conducted to understand the fate of the textile materials. The results of this work will provide knowledge on the potential of AD to help improve management of textile wastes.

Title: Understanding Our Galactic Center Through Spectroscopic Observation of the Fermi Bubbles

Presenter(s): Kasar Profit

Mentor(s): Rongmon Bordoloi

REU/Summer Research Program: CDSA

There is a supermassive black hole at the center of our Milky Way Galaxy, and this black hole breeds activity that requires further study. One of the curious activities surrounding the galactic center are Fermi Bubbles, which are huge clouds of plasma and cosmic rays that extend 55,000 light years above and below the galactic plane. Currently, it is not understood exactly how these bubbles were formed. A poignant question we are trying to answer is whether these bubbles formed from one specific event all at once, or if it occurred over a much longer period of time. In an attempt to answer some of the questions surrounding these Fermi Bubbles, I will perform UV spectroscopic observations of the Fermi Bubbles to study the kinematics of the gas at the edge of the northern Bubble. These observations will constrain the velocity and column density of the cool entrained gas in the Milky Way's nuclear outflow. Combined with a kinematic model, these observations will constrain the true radial velocity profile of the galaxy's nuclear outflow. These steps will ultimately help reveal the recent history of the supermassive black hole at the center of our Milky Way Galaxy.

ABSTRACTS | SESSION 1

Title: How to Catch Novice Programmers' Struggles: Detecting Moments of Struggle in Open-Ended Block-Based Programming Projects using Trace Log Data

Presenter(s): Rachel Qualls

Mentor(s): Tiffany Barnes

REU/Summer Research Program: SRCA

While interest in programming has increased in the past couple of years, the number of instructors to support this increase has failed to keep pace. Larger class sizes limit the support students might receive, especially in introductory programming courses where students may need the most help. Detectors that identify when a student is struggling enable us to provide students with a quality intervention like automated help or support from teaching staff. While other studies have created detectors to identify struggling programming moments, none to our knowledge has created detectors in a block-based language for open-ended projects, i.e., projects that can be completed in multiple ways. We collected code traces from students of a non-major introductory programming class working on their midterm project. After each coding session, students filled out a survey about how they felt about potentially negative self-assessment moments. Based on experts' hypotheses and two prior studies, we created detectors to identify struggle moments in student code traces. We identified how closely these detectors correlated with students' moments of negative self-assessments based on their survey responses. Our results show some significant correlation between detectable patterns in student code traces and their self-identified struggle moments. These correlations suggest that students who show low amounts of coding especially later in the programming may have more frequent negative self-assessments.

Title: Degradation of Organophospates using Hydroxamic Acid Functional Groups

Presenter(s): Daniel Reyes

Mentor(s): Kirill Efimenko

REU/Summer Research Program: STEPS

Organophosphates are often used in pesticides and warfare chemicals which can lead to contaminated runoff, soil, and drinking water. Organophosphates degrade very slowly to inorganic phosphate, and this process can often be complicated by other minerals and compounds binding to the organophosphate. It's been shown that functional gels containing hydroxamic acid can easily degrade organophosphates in liquid environments. We will be testing a similar compound called Desferal, which is normally used for removing iron, but it has the same functional groups as our hydroxamic acid gel.

Title: Modeling Pair Instability Supernovae: from Explosion to Remnant

Presenter(s): Zoe Rosenberg

Mentor(s): John Blondin

REU/Summer Research Program: CDSA

Pair-instability supernovae (PISNe) are a type of supernova theorized to occur at the end of the life of very massive stars (VMS) at low metallicities. Although no PISN have been observed to date, their existence is strongly suggested through simulations and theory. Additionally, several VMS that are potential PISN progenitors are known, and there are observations of unusual superluminous supernovae that are hypothesized to have originated from the PISN mechanism. Using the VH-1 hydrodynamics code, we evolve PISN simulations in one and three dimensions from explosion well into its supernova remnant stage. With these simulations we aim to obtain an understanding of what the supernova remnant (SNR) of a PISN might look like, and to compare our results with observations of potential SNRs of PISNe.

ABSTRACTS | SESSION 1

Title: Using Synthetic Rasterization to Predict Urban Development According To Road Infrastructure

Presenter(s): Luke Schiltz

Mentor(s): Okan Pala

REU/Summer Research Program: SRCA

Land-use change has been shown to have a solid connection to road networks. Potential growth in urban infrastructure can be predicted by relating the road network proximity to the likelihood of development. Although there has been previous research regarding this relationship, a cohesive future development model has not been applied to predictive methodologies. The problem tackled in this research is predicting this change by creating a synthetic raster in Geographical Information Systems (GIS). This model classifies road networks based on given types and locations. Using geometry to construct the road networks and calculate the station and offset from every segment of the road network to every point on the map. It then correlates the proximity to road networks to the probability of urban development in a given area. We used GIS and roadway feature classes from North Carolina's NCOneMap digital roads database and constructed a built-in interface. Using this interface, an analyst can read the road files, create raster files based on a rational equation, and populates the raster with a parametric surface of probabilities. With this software, innovations toward predicting and identifying developmental patterns in modern infrastructure could be possible. This will allow for urban planning to be more efficient, effective, equitable, and timely in utilizing resources to account for projected growth. Lastly, though the focus of this work relates to land use development, synthetic rasters can be applied to many parametric surfaces, such as temperature and rainfall. Thus the work has wider applicability than the ones featured here.

Title: Multi-angle Neutrino Flavor Transformation in Supernovae

Presenter(s): Irene Silvernail

Mentor(s): Jim Kneller

REU/Summer Research Program: CDSA

Neutrinos are an integral part of supernova explosions and their properties impact the explosion itself and the remnants created in their aftermath. By exploiting this dependence upon the neutrino, we can explore the possibility that Beyond the Standard Model neutrino physics might alter the explosion and the signal we receive. Using the multi-angle code SQA, we study the sensitivity of supernovae to Non-Standard Interactions (NSI) of neutrinos with matter. Previous studies of NSI effects have adopted the single-angle approximation. As part of this project we will compare the multi-angle calculations to the single-angle calculations to evaluate the validity of those previous studies. The flavor-transformed neutrino spectra will be processed using SNEWPY to examine whether current or near-future neutrino detectors may be sensitive to (or constrain) the NSI.

Title: Bigger is Not Always Better : Analysis of the Link Between Agritourism Microentreprenurs and an Increased Adoption of Sustainable Agriculture Practices

Presenter(s): Kailee Spake

Mentor(s): Duarte Morais

REU/Summer Research Program: OUR Award

The ever-growing human population is placing an increasing strain on the food systems in place and in turn the environment to provide nutrient-rich foods for the global population. Small-scale farming is often considered a model capable of supporting local food systems sustainably and resiliently. Likewise, there is evidence of a link between involvement in agricultural tourism microentrepreneurship and the adoption of sustainable agriculture practices as well as stewardship of working lands on small-scale farms. Minimal research on this link has been completed in the United States, where agriculture revenues have been in the tens of billions to hundreds of billions for decades. This study aims to understand the link between agricultural tourism and sustainable farming techniques used on small-scale farms in the USA. Through the in-depth analysis of both quantitative and qualitative data collected from the NC Agribusiness and Tourism Survey (NCATS) (March 2022) as well as the consideration of responses from in-person member checks following P1T labs interview protocol with qualifying participants, the following questions will be addressed: What kind of sustainable agriculture practices are used by farmers involved in tourism microentrepreneurship? RQ2) In what ways are farmers sharing their environmentally sustainable agriculture practices with visitors? RQ3) To what extent is farmers' involvement in agritourism microentrepreneurship influencing their adoption of sustainable agriculture practices? Contrary to what conventional agricultural practices may suggest, my findings indicate that a link between land stewardship, involvement in agricultural tourism microentrepreneurship, and the adoption of sustainable agriculture practices is supported.

ABSTRACTS | SESSION 1

Title: Natural Language Processing, Artificial Intelligence and the Integration of Computer Science Frameworks into Secondary English Language Arts Curriculum

Presenter(s): Madison Thomas

Mentor(s): Tiffany Barnes

Introductory Artificial Intelligence courses at the 9-12th grade level often include curriculum standards that require learning about machine learning, natural language processing, and computer vision. Core subjects, such as science, mathematics, social, and physical sciences require learning about their domain specific content. Making the connection to artificial intelligence standards is easier to integrate into a math or science course due to the nature of the content. Achieving this same goal is a challenge for the educators who teach in the ELA and Social Science domains. A majority of public high schools across the United States lack full integration of artificial intelligence concepts into core courses including how natural language processing (NLP) and sentiment analysis function in their subject domain. As reliance on NLP to perform everyday tasks increases, the need for the general student population to understand these concepts increases. Scholars in the domain have published research on the benefits of instruction on AI concepts in the K-12 space, but there is insufficient literature that specifically concentrates on bridging the gap between instruction on linguistics, grammar, text classification, sentence structure, and parsing the parts of speech required for natural language processing to function effectively. This research addresses solutions and activities using the NetsBlox block based programming tool to provide English language arts 9th-12th grade students an introduction in NLP and sentiment analysis with computers and coding.

Title: Biogeochemistry of Phosphite in Soil and its Interactions with Iron and Aluminum Oxides

Presenter(s): Leslie Webb

Mentor(s): Owen Duckworth

REU/Summer Research Program: STEPS

Phosphorus is imperative for plant growth yet current fertilizers which utilize phosphate are not always the most efficient due to quick immobilization of phosphate in soil and the potential for phosphorus in surface water runoff. Although it is commonly known that phosphorus occurs in the environment mainly as phosphate, there is evidence suggesting that reduced phosphorus compounds (at an oxidation state lower than (+5)) also exist naturally and synthetically. When phosphate is used as a fertilizer, it is quickly immobilized and poorly soluble once sorbed onto the surface of soil minerals. There is little research studying the extent to which phosphite, an inorganic phosphate compound in the +3 oxidation state, reacts with these soil minerals. This project aims to evaluate the nature and kinetics of phosphite sorption to synthetic analogs of certain minerals in soil. Batch sorption isotherm experiments were performed on the following minerals: hematite, alumina, and ferrihydrite. The samples were analyzed for total dissolved phosphorus using and inductively coupled plasma – optical emission spectrometry (ICP-OES). Based on literature review, we expect to find that phosphite has a lower affinity for being sorbed onto mineral surfaces than phosphate, making it potentially more available to plants. This project will lead to a better understanding of phosphite biogeochemistry in soils, shedding light on its potential as a fertilizer that could reduce the amount of phosphorus in runoff and surface waters.

Title: Light curves from core-collapse supernovae with circumstellar material

Presenter(s): Caroline Witt

Mentor(s): Carla Frohlich

REU/Summer Research Program: CDSA

Core-collapse supernovae are the magnificent death of massive stars. The light curves of these supernovae are diverse and their shapes can reveal properties of the star that exploded. The modeling of supernova light curves has been well-developed and the general features are well understood. However, massive stars are known to experience mass loss throughout their lifetimes, and the resulting circumstellar material is typically not considered in light curve models. Here, we build upon a previous light curve study and include the presence of circumstellar material. We will use pre-existing SNEC code to compute bolometric light curves. By using the same supernova explosion models as in the previous study, we will be able to directly compare our results and determine the effect that circumstellar material has on supernova light curves.

ABSTRACTS | SESSION 1

Title: Qualitative Analysis of Novices' Programming Behaviors during Web Help-Seeking

Presenter(s): Jeffrey Zheng, Neil Bennett

Mentor(s): Thomas Price

REU/Summer Research Program: SRCA

Effective Web help-seeking behavior (i.e. using the Web to search and resolve challenges while coding) is a critical skill that is expected in both professional and non-professional programming settings; however, it's a skill rarely explicitly taught in university Computer Science courses, and may lead to students having disparate search behaviors. This study identifies, categorizes, and discusses some of the behaviors that novice programmers exhibit, the struggles they face, and the perceptions students have on using Web search during programming. Previous studies have focused on the Web help-seeking behaviors of expert programmers, not novices. Additionally, research on novice programmers tends to focus more on their debugging practices rather than help-seeking behaviors. To understand novice programmers' perceptions of web search and directly observe their help-seeking behaviors, we conducted user studies on 19 university students enrolled in a CS2 course, consisting of both an interview and a think-aloud programming portion with Web access. During the programming portion, we collected their search logs as well as snapshots of their code state. We then examined and categorized key Web help-seeking behaviors and struggles in relation to their current stage in the help-seeking process. Behaviors we observed included students focusing on their specific approach rather than their general problem, using image search to look for code examples, and expressing reliance on previous code they have written. We then suggest how these defined behaviors can be used for the creation of tools and other interventions that will improve the instruction of novice programmers.

ABSTRACTS | SESSION 2

Title: Examining Trauma-Informed Social Work Practice and Education

Presenter(s): Kimberly Barrera

Mentor(s): Qiana Cryer-Coupet

In the field of social work, there has been an increasing demand for trauma-informed practice approaches to address the needs of clients seeking care. More individuals have sought professional help with individual, family-based, and community-based trauma, indicating the importance of training and education for social work practitioners. Among practicing social workers, many have noted the need for increased trauma-informed practice training particularly within their workplace. Although most social workers can define 'family trauma' and 'trauma-informed practice' whether from direct education or personal experience, several feel uncertainty in properly being able to work within the field of trauma. This study examines qualitative data from 20 social work practitioners from various educational backgrounds and practice settings within the State of North Carolina. Data was collected as a part of the Trauma Informed Practice Support Project. Each participant was interviewed about their personal and professional experiences with trauma, professional preparation to address trauma, and ongoing trauma-informed practice training needs. The data suggests that social workers have received general training from their educational experience, but lack specific training on trauma-informed practice and require more adequate training from their workplace. These interviews provide insight into the types of trainings social workers believe would be beneficial, as well as how they can be incorporated. These results have implications for social work practice, education and future research.

Title: Explicit synchronized solitary waves for some models for the interaction of long and short waves in dispersive media.

Presenter(s): Bruce Brewer

Mentor(s): Nghiem Nguyen

REU/Summer Research Program: DRUMS

Some systems were previously proposed for studying the interactions of long and short waves in dispersive media. In this presentation, these systems are shown to possess synchronized solitary waves via direct computation of the associated systems of ODEs. These synchronized solitary waves have the hyperbolic sech^2-profile typical of dispersive equations.

Title: Development of a SNAr Reaction on Resin-bound Peptides for Scope Expansion in Ketoxime Ligations

Presenter(s): Meghan Broderick

Mentor(s): Caroline Proulx

Nucleophilic aromatic substitution (SNAr) reactions have been reported on free amino acid residues; however, reaction conditions have not been translated to resin-bound peptides. We previously developed a method for ketoxime ligation that utilizes mild aqueous conditions and electron-rich N-aryl peptides. Methods such as the submonomer peptoid synthesis and Buchwald N-arylation chemistry have been used to expand the side chain diversity at the site of ligation, but we still do not have access to all twenty natural amino acids at that linkage. Here, we report conditions to perform a SNAr reaction on a variety of resin-bound peptides. Additionally, conditions for the on-resin reduction of the N-aryl ring are screened.

Title: Modeling Developing Tissues as a Foam

Presenter(s): Jeremiah Burden, Nina De La Torre, Nicole Lacey, Taylor Cobb

Mentor(s): Sharon Lubkin

REU/Summer Research Program: DRUMS

Epithelial cells packed in tissues share many qualities with foam. The evolution and geometry of foams and cells are dominated by physical properties such as surface tension and pressure. To understand morphogenesis, the generation and alteration of biological form, knowing how cells pack and rearrange in tissues is important. Foam models can be used to study morphogenetic processes. Often, biologists use 2D "vertex models" for cell packing, where they are limited to a plane and the cell edges are straight. However, cells exist in three dimensions where they have curved edges and surfaces, so 2D vertex models have limitations. In this paper, we use

ABSTRACTS | SESSION 2

3D foam models with curved edges and surfaces to represent how cells pack inside of tissues. By using finite element methods, we find minimal energy configurations with volume and tension constraints. Using these results, we aim to create useful 3D models of epithelial tissue structure.

Title: Late-Stage N-Alkylation Reactions with Various Amino Acid Protected Side-Chains on Azapeptides

Presenter(s): Katelyn Cartrette

Mentor(s): Caronline Proulx

REU/Summer Research Program: ICE

Azapeptides are peptidomimetic that contain one or more aza-amino acids, where the a-carbon is replaced by a nitrogen atom. We recently demonstrated that azapeptides can undergo late-stage N-alkylation reactions to chemoselectively install side-chains on the hydrazide nitrogen atoms, using Leu-enkephalin as a model peptide. Here, a library of aza-glycine containing tripeptides was alkylated to determine which functional groups can be present during late-stage alkylation as to not compete with the chemoselectivity of the aza-amino acid. Using computational methods, the pKa values of the aza-glycine nitrogen atoms was calculated to validate the alkylation selectivity of the N1 vs N2 atoms. Computational analyses of un-, mono-, and di-alkylated aza-glycine with different alkyl groups was also used to measure the energy barriers for rotation about the N-N bond.

Title: Palladium-Catalyzed Cleavage of Bicyclo [4.1.0] Derivatives

Presenter(s): Benjamin Cirpriano

Mentor(s): Joshua Pierce

REU/Summer Research Program: OUR Award

Certain α,β-unsaturated ketones have been shown to undergo 1,4-hydrosilylation reactions with alkyl silanes in the presence of a palladium catalyst to form silyl enol ethers. (1) Our hypothesis was to expand this chemistry to α-keto cyclopropanes, which is a key intermediate in the total synthesis of abyssomicin C within the Pierce Group.The current synthetic strategy relies on the fragmentation of an α-keto cyclopropane with SmI2 (2). Despite appreciable yields, this reagent is tedious to prepare, air-sensitive, and has been on backorder until recently. Hoping to apply palladium catalysis to achieve similar chemistry, our goal was to chemoselectively cleave one of the strained cyclopropyl bonds, which would result in a silyl enol ether bearing a methyl group at the beta position. Our current results show that upon ligand exchange, a palladium(0) source is generated in situ and readily undergoes oxidative addition into the desired cyclopropyl carbon-carbon bond. However, we believe that the resulting palladium(II) intermediate undergoes a β-hydride elimination resulting in a methylated α,β-unsaturated ketone. While this is undesirable as it results in a deletion of a chiral center, we have been able to demonstrate initial insertion of palladium(0) into the cyclopropane carbon-carbon bond. Current research focuses on optimization of reaction conditions, including temperature, time, ligands, concentrations, solvent, and order of addition of reagents in an attempt to avoid β-hydride elimination and favor our desired product.

(1) J. Org. Chem. 2009, 74 (20), 7986–7989.

(2) Tetrahedron 2010, 66 (46), 9049-9060.

Title: Development of a method to grow primary cultures of enteric glial cells from the porcine colon

Presenter(s): Caleb Cook

Mentor(s): Laurianne Van Landeghem

REU/Summer Research Program: OUR Award

A functional enteric nervous system (ENS) is essential to maintain gut health. The ENS is comprised of enteric neurons that are outnumbered by an expansive network of enteric glial cells (EGCs). EGCs contribute to nearly all gut functions, including barrier integrity, blood flow, immunological modulation, and motility. As such, the development of in vitro procedures that allow primary cultures of EGC to grow robustly is highly desirable to allow the field to better understand EGC biology.Here, we have developed a method to establish EGC primary cultures from the porcine colon. Briefly, colon specimens have been microdissected, and the two layers of the colon wall containing the enteric nervous system ganglionic networks, or plexus, have been isolated. More specifically the

submucosa containing the submucosal plexus and the longitudinal muscle indissociable from the myenteric plexus (LMMP) have been collected. Subsequently, the LMMP and submucosa have been cut into 1mm2 pieces and enzymatically digested. Samples have been next mechanically dissociated to obtain single-cell preparations. Cells have been grown in medium containing N2, B27, and G5 supplements on poly-L-lysine coated wells. Using a 3 cm2 porcine spiral colon specimen, we obtained 1.3 million EGCs from the submucosa and 700,000 EGCs from the LMMP. Once adequate confluency was reached, cells were either frozen, fixed for purity assessment via immunofluorescence, or passaged to monitor P1 progression. While human tissue is often ideal for researchers, a porcine alternative to studying EGC in vitro provides a powerful tool for performing relevant translational studies.

Title: Mathematical models of interactions between platelet-like particles and hydrogels during ultrasound stimulation

Presenter(s): Erica Council

Mentor(s): Mansoor Haider

Data-driven mathematical and computational models are developed for mechanical interactions between synthetic platelet-like particles (PLPs) and hydrogel materials under ultrasound stimulation. PLPs are microgels with a design that is tailored to mimic the action of platelets during wound healing, including aiding in fibrin polymerization and clot retraction. Ultrasound stimulation has been shown to increase interactions between the PLPs and the surrounding biomaterial (within its pores) and to enhance clot retraction. Yet, the detailed mechanisms governing such interactions are not well understood. This problem is studied using differential equation models that account for inertia, internal stiffness and damping, and viscoelastic effects in both the particles and background medium. Models of increasing complexity are formulated, evaluated and compared in the context of data from experiments [1] for dynamic ultrasound stimulation (MHz range) of gel materials seeded with PLP-like microgel particles. An overall aim is to develop mathematical models that help identify an optimal combination of tunable system properties for enhancing wound healing outcomes. References: [1] A Joshi, S Nandi, D Chester, AC Brown and M Muller (2018) Study of Poly(N-isopropylacrylamide-co-acrylic acid) (pNIPAM) Microgel Particle Induced Deformations of Tissue-Mimicking Phantom by Ultrasound Stimulation, Langmuir 34(4):1457-1465.

Title: Qualifying an RF Sputter System for the Fabrication of Distributed Bragg Reflector Mirrors

Presenter(s): Tori Crunkleton

Mentor(s): Ramon Collazo

REU/Summer Research Program: Materials Science and Engineering

This research aimed to qualify a new RF sputter system and use the sputter chamber to deposit a distributed Bragg reflector (DBR) mirror. Alternating oxide layers create the DBR mirror, which will be used to reflect ultraviolet (UV) light in the 260 to 280 nm range on optoelectronic devices such as UV lasers and LEDs. To achieve high reflectivity at the wavelengths of interest, the oxides used in the RF sputter system were SiO2 and HfO2. Different operating conditions were explored to qualify the sputter system to determine the rate of oxide deposition, with the goal of finding appropriate operating conditions and deposition rates that create thin films on the scale of 35 nanometers. The deposited films were studied for composition using energy dispersive spectroscopy and for thickness with scanning electron microscopy (SEM) and profilometry. Film thicknesses displayed trends of a linear increase as the distance from oxide targets to substrates decreased and as power increased. Additionally, the rate of deposition was found to be constant when operating at the same conditions over different run times.

Title: Computational Comparison of the Protonolysis of Pt-Me Bond by TFAH

Presenter(s): Cameron Dasilva

Mentor(s): Elon Ison

REU/Summer Research Program: ICE

The protonolysis of (cod)PtMe2 (1) by trifluoroacetic acid (TFAH) is of interest in studying C-H bond activation because it produces methane, which is the microscopic reverse of methane activation. The two proposed reaction mechanisms for protonolysis of 1 are the concerted, single-step pathway (SE2) and the multi-step oxidative pathway (SE(ox)). Previous literature has suggested that the SE2 mechanism is favored for 1, in part due to its large kinetic isotope effect (KIE). However, recent experimental work done by our group points to a multi-step mechanism involving two equiv TFAH. Thus this study carries out a computational comparison between the SE2 and the SE(ox) pathways for the protonolysis of 1. This was accomplished by computationally identifying intermediates and transition states of a multi-step protonolysis that included the 2:1 TFAH to 1 ratio observed experimentally. Structures were optimized using the B3LYP level of theory with a split basis set (def2tzvpp for Pt; def2svpp for all other atoms). All optimization, frequency, PES scans, and

ABSTRACTS | SESSION 2

SPE calculations were carried out with dichloromethane solvation (IEFPCM) to better match lab experiments. Using the identified transition states and intermediates, each pathway was compared to determine the more favorable mechanism.

Title: Effect of the acidity of 1-sulfonylcyclopropanols on their equilibrium to cyclopropanones and computational study of their trapping reaction with pyrazole as nucleophile

Presenter(s): Anh Do

Mentor(s): Vincent Lindsay

REU/Summer Research Program: ICE

1-Sulfonylcyclopropanols derivatives constitute readily accessible substrates that can equilibrate to highly electrophilic cyclopropanone in mild basic conditions. Previous research in our group determined that the rate of equilibration to cyclopropanone depends on the electronic and steric profile of the sulfonyl group on these substrates. The mechanism of the sulfinate elimination process and equilibration to cyclopropanone with respect to the overall reaction rate is of interest in order to design more efficient substrates for future synthetic applications. The energy profile and pKa of previously synthesized 1-sulfonylcyclopropanols are calculated using DFT functional M06/6-311G++(d,p) with solvation method PCM. Transition state energy is calculated for the elimination of the sulfinate salt to form a cyclopropanone, and for the pyrazole addition step to form a stable adduct. The calculated pKa values for each derivative, when compared to our previous kinetic data, indicates that the deprotonation of the hydroxyl proton does not greatly affect the rate of equilibration to cyclopropanone and thus is not rate-limiting of the overall process.

Title: Study of the Mechanism of a Family of Biomimetic Models of Manganese Catalase

Presenter(s): Bea Marie Louise Eamiguel

Mentor(s): Elon Ison

REU/Summer Research Program: ICE

Catalase is an enzyme that acts as an antioxidant for organisms. There are two types of catalases which includes the heme form for mammals and the non-heme form, manganese catalase (MnCAT), for bacteria. These bacteria play a role in human health by protecting and restoring cells, mainly in the stomach. Furthermore, MnCAT has been proposed to be the molecular ancestor for photosystem II. There are several biomimetic models of MnCAT, however, the overall mechanism is a topic of debate. To understand the metalloenzyme's mechanism, we have synthesized a family of biomimetic manganese model complexes analogues of MnCAT. The complexes were synthesized with the intention to probe how systematic structural modifications might impact catalytic activity and to uncover the possible mechanisms of MnCAT. The synthesis and preliminary mechanistic studies will be discussed.

Title: Modernization of RoboMapper Control Software

Presenter(s): Eli Edds

Mentor(s): Nathan Woodward

REU/Summer Research Program: Materials Science and Engineering

Metal-halide perovskites are an up-and-coming class of semiconductors material for PV, LED, and other optoelectronic devices. Material discovery of these materials requires exploration over a vast chemical space. We have integrated an automated liquid handler and microplotter to explore this wide material composition space; we call this the RoboMapper. However, the existing control software for the RoboMapper platform had multiple problems; it was inconsistent when plotting patterns and had a confusing interface. My work has been to completely rewrite the control software from the ground up to use modern programming practices. The project source code was restructured to use a more scalable and sustainable structure to allow future expansion. The user interface enables a simple-to-use user interaction and uses native controls to better integrate with other tools. A new process management tool was added that ensured dependencies were always up-to-date during the tool's runtime and automatically updates the program when newer versions are pushed to the source control server. This project showed the effectiveness of high-quality control software, and the same methodology will be applied to other projects in the lab. The new control software has increased researcher productivity and decreased frustration. By eliminating common roadblocks with the previous software, researchers are able to focus on their experiments.

ABSTRACTS | SESSION 2

Title: A primal dual method for topological changes in optimal adversarial classification

Presenter(s): Bethany Fetsko, Henry Shugart, Quinn Aiken, Bruce Brewer

Mentor(s): Ryan Murray

REU/Summer Research Program: DRUMS

Recently proposed machine learning algorithms have utilized a hypothetical adversary during training to improve performance and robustness on classification. However, a rigorous understanding of the mechanisms during this performance remains incomplete. In this work, we study a non-parametric variational framework for classification in the presence of an adversary where the power of the adversary is defined by a positive ϵ. We describe an algorithm to construct an optimal classifier for any adversarial power. Prior work has shown that a set of uncoupled ordinary differential equations govern the evolution of the geometry of optimal adversarial classifiers in one dimension for small enough ϵ. We prove that optimal classifiers are governed by the same differential equations except for a finite number of instantaneous changes in topology and discontinuous movements in the endpoints of classification intervals. We rely on a novel primal dual method stemming from optimal transport theory to prove the optimality of our algorithm.

Title: Understanding heart rate variability using modeling and data analysis

Presenter(s): Anna Fortunato, Matthew Caird, Sara Helmer, Gabe McClinton

Mentor(s): Mette Olufsen

REU/Summer Research Program: DRUMS

Heart rate variability (HRV), measuring how heart rate changes over time, is induced by the autonomic and respiratory control systems. A high HRV indicates healthy cardiovascular activity, while a low HRV is associated with disease or aging. To eliminate extraneous factors caused by disease, we examine changes in HRV in 18 healthy patients before and after blood donation. Heart rate is determined from electrocardiogram (ECG) measurements as the difference between the largest peaks (the R-wave) of the ECG, the RR interval. To capture multiple time-scales of the autonomic nervous system, we characterize three types of variation: beat-to-beat, baroreflex, and respiratory sinus arrhythmia (RSA) variation using time domain, complexity, and frequency analysis methods. Time domain methods average beat-to-beat variation over the entire series of RR intervals. Distribution entropy (DistEn) also measures irregularity over the full series, but instead of explicitly quantifying HRV, this method analyzes the complexity and self-similarity of the signal. Frequency domain methods separate the signal into frequency bands, which allows analysis of variability in terms of our three variation types. For this analysis, we use wavelet transforms and uniform phase empirical mode decomposition (UPEMD) to extract the respective powers of the baroreflex and RSA. Results show a significant decrease ($p < 0.05$) in both heart rate and the impact of RSA on the RR intervals after blood donation. Additionally, DistEn decreases after donation, indicating a decline in overall variability. We conclude, from the observations of our metrics, that blood donation primarily affects RSA variability.

Title: Fabrication of nanofibers by electrospinning for energy harvesting application

Presenter(s): Rebecca Fraser

Mentor(s): Bongmook Lee

REU/Summer Research Program: ASSIST

Electrospinning is one of the methods to produce nanostructures by applying an electrostatic field to a polymer solution. Nanofibers made by electrospinning have a nanoscale diameter and high specific surface area. Many materials can be utilized through this method such as biopolymers, nanocomposite materials, and medical materials. As there can be specific methods of applications the process is versatile and has the ability to interchange product fibers based on a change in functional and/or morphological properties.Using this method nanofibers of differing surface areas can be achieved.This study focused on the preparation of electrospun polyvinylidene difluoride (PVDF) nanofibers for energy harvesting application.Under small forces impacts like bending, pressure, mechanical impact, and mechanical vibration PVDF is an electroactive polymer with the ability to change form. It is regarded as having high functional strength and high non conductivity.Meaning PVDF can withstand high electric fields in comparison to other polymers. In this work, the impact of various process parameters is shown. The effects of applied voltage on the surface areas,morphology and size of nanofiber are measured. Moreover, the effect of solvent on viscosity, size of nanofiber, and other specific effects is explored. The resulting nanofibers are characterized by scanning electron microscopy(SEM) to investigate the surface morphology as well as the size of the fibers.

ABSTRACTS | SESSION 2

Title: A Fungal Bioremediation Game for K-12 Science Education using Agent-Based Modeling

Presenter(s): Quinn Gebeaux

Mentor(s): Tarek Aziz

REU/Summer Research Program: RISE CCEE

Educational games have the potential to engage students in cutting-edge research, where lab access and steep learning curves are a barrier. This work develops a game to introduce students to fungal bioremediation: the removal of contaminants from the environment by fungi. In this game, students play the role of researchers working to remove an emerging contaminant by optimizing the growth of fungi species and their extracellular enzyme production.The fungal bioremediation game was developed in Netlogo, an open source, agent-based modeling platform. In Agent Based Modeling (ABM) we model the behavior of individuals given specific rules. The result of this type of modeling approach is a virtual experiment wherein students change experimental parameters and watch as the fungus responds. The two key objectives of the game are to provide students with the ability to observe the bioremediation process as it occurs in real-time and to engage in experimental design as they hunt for optimum parameters. An initial demo given to high school students showed a strong engagement with the game and many students indicated an interest in learning more about the Fungi. Here we present some features of our game, the course materials we're developing for K-12 STEM applications, and a preview of our next steps.

Title: Materials Research Data Analysis for Coastal Science

Presenter(s): Ishan Ghosh

Mentor(s): Wenpei Gao

REU/Summer Research Program: MAT-DAT

The oceans cover about 71% of the world, and they not only regulate the global climate, but also hold diverse resources both in materials and biology. Regardless, the increase in human activity constantly changes coastal environments, which has led to an uptick in chemical pollution, especially microplastics, which pose a significant threat to marine ecosystems, water quality, and human health. Through the use of data analysis, the goal of this project is to geographically find the correlation between the location of water samples and the concentration of organic and inorganic material (i.e. types of pollution). There are also the questions of how the inorganic material can be collected and how the solution can be properly engineered. In order to answer those questions, samples from around the state, country, and even globe have to be analyzed, as well as learning about high-tech characterization tools, including SEM, XRD, and TEM in order to understand the structure and processes of all of the organic and inorganic materials found in the ocean across different length scales. Once the correlation is found, high-risk areas can be further identified and solutions can be made in order to both purify the water and recycle/upcycle the microplastics and other types of pollution found in the water.

Title: Computational design of green bioplastics from cellulose derivatives.

Presenter(s): Mariel Gomez

Mentor(s): Hannah Dedmon

REU/Summer Research Program: MAT-DAT

Cellulose acetate (CA), a biodegradable derivative of cellulose, is the most prolific cellulose ester, found in industrial and consumer products like films, cosmetics, and screens. Its diverse applications are credited to its superior characteristics that are dependent on a variety of factors, including the degree of substitution of the CA acetyl groups. Since CA is not a thermoplastic, and has a melting temperature close to its decomposition temperature, it is difficult to thermally process without the inclusion of plasticizers. The majority of plasticizers on the market are petrol-based with phthalates contributing to 10%–60% (by weight) of plastic products. However, phthalates have been found to be weak endocrine disruptors and androgen blocking chemicals. Alternatively, phosphate based plasticizers derived from vegetable oils, like castor oil, have been extensively studied in other polymer systems and are potential candidates for plasticizing CA. The focus of this work is to use molecular modeling to elucidate interactions between CA and common phosphate based plasticizers as a function of their weight percentage and predict their influence on thermal, structural, and rheological properties. We will discuss a variety of molecular-level features in these composite systems that could lead to green alternatives for CA plasticization.

ABSTRACTS | SESSION 2

Title: Machine Learning-Driven Image Classification of Perovskite Film Quality for Closed-Loop Experimentation

Presenter(s): Gabriel Graves

Mentor(s): Aram Amssaian

REU/Summer Research Program: MAT-DAT

Perovskite photovoltaics offer a pathway to high efficiency solar cells at a drastically reduced cost. However, synthesizing high performing perovskite solar cells requires multi-parameter optimization to achieve optimal device characteristics and the one-variable-at-a-time experimental method is time and resource intensive. Bayesian Optimization offers one approach to drastically cut down on the number of experimental iterations. Nevertheless, developing the acquisition function solely based on measured optical properties often fails to encapsulate the overall film quality gained by visual inspection. Herein, machine learning (ML) models are trained and tested on images gained from an in-situ camera on a high-throughput, robotic spin-coater to classify film quality. The models are benchmarked on both real and synthetically augmented images to improve generalizability, with some reporting an accuracy > 90%. Perovskite visual film quality is classified in a novel hierarchical approach by segmenting the images into five categories based on a combination of phase color, defects, reflectivity, and uniformity. The approach given here demonstrates a further closing of the loop of design of experiment (DOE) to experimentation and thus offers a pathway to fully autonomous experimentation in the domain of perovskite synthesis.

Title: Statistical Methods for Histopathology Images of Cancer Tissues

Presenter(s): Anand Hande, Mason Lu, Ta'Destiny Geiger, Casey Lang

Mentor(s): Ana-Maria Ataicu

REU/Summer Research Program: DRUMS

Histopathological imaging is the main tool in the diagnosis of prostate cancer. Examination and interpretation of the histopathology images of prostate tissue are generally performed by highly trained anatomic pathologists, and the conclusions may vary across pathologists. To decrease the human effort and also remove the pathologists diagnosis variation we propose to develop an automatic procedure for identification of the presence of cancer in such histopathology images. The methodology relies on three key parts. The first one is the segmentation of epithelial cells using the intensity of the stain color. Then is the filtering of the cytoplasm epithelial cells, which are known to be mostly affected by cancer, from the stroma epithelial cells using the epithelial cell spatial pattern. Finally, the spatial configuration of the cytoplasm epithelial cells is summarized using standard methods from point processes. The classification of the histopathological images relies on these summaries. We compare the approach to several existing competitive methods based on various features of the images.

Title: Organic Synthesis of Acene Derivatives for Use in Organic Semi-conducting Electronics.

Presenter(s): Michael Hatcher

Mentor(s): Christopher Gorman

REU/Summer Research Program: OUR Award

Acenes are molecules made up of a linear chain of benzene rings. Acene chains lose stability with each addition of a benzene ring to the chain. 1–3 This loss in stability often leads to the breaking down of the molecule into shorter segments, which renders the materials less effective as organic semiconductors. Achieving longer acene compounds is desirable because the band gap properties shorten between the conduction and valence band.2,4 One solution to the problem is to synthesize acenes with heteroatoms incorporated in the conjugated backbone.1,3 The task of this project is to stabilize a seven ring acene chain by adding a nitrogen-based backbone. The electronegativity of nitrogen lowers the HOMO-LUMO levels making these compounds more stable. This electronegativity stabilizes longer acene chains to produce better semi-conductors while preventing break down. Along with nitrogen, different carbon-hydrogen based chains (R-groups) will also be added through Grignard and Kumada synthesis to help make the target product more soluble. the solubilizing groups will help with characterization of the materials. It is useful for NMR, but also other characterizations. Several R-group derivatives will also be tested to further compare potential different semi-conductor properties. The addition of these R-groups will first be synthesized onto four ring acene chains before attempting the seven ring acene chains. This synthesis aims to produce acenes using less extreme and less hazardous methods, and the group I am working with has already established a method of synthesis to employ.5 The target product would have potential for improving upon organic-based electronics.

ABSTRACTS | SESSION 2

Title: Chemical Reactions on Peptides/Proteins in Nonaqueous Medium Using Furan and Thiophene Derivatives

Presenter(s): Meredith Hoff

Mentor(s): Jun Ohata

REU/Summer Research Program: ICE

Completing selective chemical reactions on biomolecules (such as peptides and proteins) poses many challenges. The Ohata lab is tackling the challenge of the reactivity and selectivity of complex biomolecules using nonaqueous media. Under the guidance of my mentors, I have studied reactions of hydroxyethyl-furan and hydroxyethyl-thiophene on peptides using hexafluoroisopropanol (HFIP) as a nonaqueous solvent. These experiments required the synthesis of the thiophene reagent and hydrolysis of a peptide. Results were analyzed using liquid chromatography (LC), mass spectroscopy (MS), and nuclear magnetic resonance (NMR). Additionally, I have employed computational methods to determine the most preferable nucleophiles (such as indole, phenol, and ethylamine) and the preferred mechanistic pathway for the furan/thiophene reaction. I have likewise studied the effect of additives, including the use of Lewis acids. This process has been accomplished by calculating the activation energy and the change in Gibbs Free Energy of overall reactions, and the results will be compared to experimental trends. The effects of structural changes on the furan/thiophene ring may also be studied computationally.

Title: Pigments of Life from Liver to Leaves – A Demo of Molecular Unity Olivia P. Holman, Kathy Uyen-Nguyen, and Jonathan S. Lindsey Department of Chemistry, NC State University

Presenter(s): Olivia Holman

Mentor(s): Jonathan Lindsey

REU/Summer Research Program: Computational Chemistry

Who cannot give a true reason for the grass under his feet, why it should be green rather than red? – Sir Walter Raleigh (early 1600s) Chlorophyll is the green pigment in plants responsible for photosynthesis. Heme is the red pigment in blood that carries oxygen. Both are members of the same molecular family. To illustrate the unity of the molecular world to pre-college students, we developed a simple experiment that uses readily available substances. For the green substance, spinach leaves were ground up, treated with toluene, and filtered to give chlorophyll in a green solution that glows red under a flashlight. Treatment with acid (removal of one atom of magnesium) and then an oxidant (formation of one double bond) gave a red solution that glows red. Additional treatment with an iron salt gave a red solution without a red glow. For the red substance, beef liver was cut up, heated in salt water, and filtered to give heme in a reddish-brown solution without a red glow. Chlorophyll and heme are disk-shaped molecules containing a central metal (magnesium or iron). Replacing magnesium with iron causes loss of fluorescence (red glow) and forming one double bond changes the color from green to red. The ability to convert chlorophyll (green color, red glow) to a derivative that resembles heme (red color, no glow) illustrates the unity of these majestic pigments of life. We now can answer Sir Walter Raleigh some 400 years later. This work is supported by the NSF (CHE-2054497).

Title: Investigation of order-disorder phenomena for a high entropy carbide

Presenter(s): Skyler Kauffman

Mentor(s): Sam Daigle

REU/Summer Research Program: MAT-DAT

High-entropy ceramics (HECs) are a novel class of materials that exhibit appealing mechanical and electrical properties. However, the development of these materials is relatively recent, so their properties are not fully understood. Density functional theory (DFT) may be used to accurately predict properties of HECs, but is complex and computationally expensive. Therefore, a method to predict the properties of HECs without DFT will hasten the advancement of our understanding of these materials. Over the course of this project, we use machine learning to construct a model to effectively predict the energy of a carbide containing equivalent molar concentrations of Hafnium, Niobium, Tantalum, Titanium, and Zirconium using pair interactions as model features. We evaluated and compared the performance of multiple algorithms for this task. Initially, DFT energy data for high-energy random structures were used to train and test the model. Monte-Carlo simulation was employed to generate structures with comparatively low energy. This simulation generates new structures by randomly switching cation positions in the ceramic, and accepting or rejecting the new structure according to the simulation temperature. Repeating this method iteratively yields an annealed final configuration. DFT energy data for these simulation-generated structures was used to further improve the model. The order-disorder phenomena of the ceramic was investigated

using the Warren-Cowley short range order parameters, which converge to zero for a random structure. These parameters were evaluated over a range of temperatures to evaluate the temperature-dependence of the order-disorder transition for the ceramic.

Title: Abiotic Cellulose Hydrolysis Under Elevated Temperature Landfill Conditions

Presenter(s): Eli Kays

Mentor(s): Morton Barlaz

REU/Summer Research Program: RISE CCEE

In recent years, some US landfills have been reaching temperatures of 80-100 °C for unknown reasons. These elevated temperature landfills (ETLFs) are a problem because the higher temperatures change the chemistry of the landfill, which impacts the safety and stability of the landfill. Cellulose is the largest component of municipal solid waste in landfills, making up 30-50% by weight, so understanding what happens to cellulose under ETLF conditions will help us understand thelarger problem of excess heat generation and accumulation in ETLFs. The objective of this study is to evaluate environmental factors that impact cellulose hydrolysis including temperature, pH, and cellulose form (mechanical vs chemical pulp) in the presence of leachate from 3 distinct landfills. In addition, we are researching the end products of abiotic cellulose hydrolysis to quantify the thermodynamics of abiotic cellulose hydrolysis. Tests are being conducted in 160 mL serum bottles filled with filter-sterilized leachate sourced from a landfill. Calculation of the percent cellulose hydrolysis based on increases in soluble chemical oxygen demand (COD) over time. Preliminary work has been done to ensure that changes in COD will not be impacted by factors other than cellulose hydrolysis. The end products of cellulose hydrolysis will be identified by GC mass spec. Ultimately, the data from this research will be used to parameterize a model of landfill heat generation and accumulation, and the model will be used to evaluate the contribution of abiotic cellulose hydrolysis to landfill heat accumulation.

Title: Investigation of NN Re and Mn Complexes: Synthesis, Characterization, and Catalysis

Presenter(s): Josephine Lin

Mentor(s): Liana Gouveia

REU/Summer Research Program: ICE

A family of ENENES complexes, consisting of a rhenium or manganese metal center and a bidentate NNS ligand, has been previously explored as successful catalysts in the hydrogenation of aldehydes. The mechanism proposed for this reaction is metal-ligand cooperation, where the metal and the ligand act together to recognize, activate, and transform the bond of the substrate. Herein, the importance of the sulfur arm in the ENENES complexes was explored by omitting the sulfur arm and forming Re(I) and Mn(I) complexes using morpholine and piperidine-based NN ligands. Their catalytic activity with benzaldehyde was tested, and the free energies for the transition states and the minima structures were obtained using DFT (B3PW91-D3).

Title: Machine learning optimization of strain sensors based on piezoelectric properties of 2D layered materials

Presenter(s): Ian Lyons

Mentor(s): Nina Balke

REU/Summer Research Program: MAT-DAT

The field of layer thio- and seleno-phosphates has been growing rapidly in recent years for the use in 2D and quasi-2D electronic materials. One such material that has been garnering recent attention is $CuInP_2S_6$ (CIPS) for its wide range of unique properties that make it especially promising for implementation in ultra-thin few layer control dielectrics. Among these properties is negative electrostriction, a uniaxial quadruple potential well for Cu displacements enabled by the van-der-Waals (vdW) gap, and the existence of multiple polar states with dissimilar properties. The piezoelectric qualities of CIPS are of interest as they are linked to bias-dependent strain response. CIPS can be strained utilizing phase decomposition which is regulated by the Cu/In stoichiometry, giving a strained CIPS phase in a non-piezoelectric matrix. CIPS is a material that was discovered in the 1980's; however, it is recent developments in piezoelectric force microscopy (PFM) and data science that have allowed for direct quantifications of the useful material characteristics of CIPS. PFM is used to probe the local piezoelectric properties and extract relevant phase data, which is then processed through computational analysis. The computational approach is used as it can deal with a high volume of data and accurately capture material properties with high statistical significance. This allows for efficient analysis of PFM data to extrapolate the Cu/In ratios to determine the strain of the material as well as other relevant characteristics.

ABSTRACTS | SESSION 2

Title: RP-HPLC Method for Separation and Analysis of phytocannabinoids commonly found in Plant Material

Presenter(s): Hayden Mann

Mentor(s): Yi Xiao

REU/Summer Research Program: OUR Award

The Xiao lab has recently developed an aptamer-based sensor for the selective quantification of THC in plant and human biosamples. To evaluate aptamer sensor performance, a gold standard method such as reversed-phase high-performance liquid chromatography (RP-HPLC) are first used to separate and determine for the quantification of seven phytocannabinoids commonly found in Cannabis sativa via UV-Vis spectroscopic detection. Phytocannaboids include THC, THCA, CBD, CBDA, CBG, CBGA, and CBN were analyzed with both standard addition and external calibration methods; achieving consistently $R2 \geq 0.990$ for each analysis. A total THCA content in plant extracts was determined as 1.48 w/w% , while CBDA was determined as 1.47 w/w%, both with 95% confidence. Further work is needed to determine plant sample content and associated errors for the remaining five cannabinoids and to compare analytical performance between RP-HPLC and aptamer-based sensors.

Title: PhosFORUS: Predicting Reusable Candidate Phosphorous Removing Materials using Machine Learning

Presenter(s): Zhane McCleod

Mentor(s): Joshua Harris

REU/Summer Research Program: MAT-DAT

Phosphorus (P) is important to DNA and processes like energy transfer in biological cells, and it also improves the productivity and sustainability of global food systems. However, the way in which humans use P is unsustainable and has a negative impact on the environment. An important area of research is the design of materials for recovering and reusing P. Maximum phosphate uptake capacity, qm, is a material's ability to remove P (in the form of phosphates) from its surrounding environment. Materials with high qm are good candidates for P recovery applications. In this study, data from measurements of qm for many different materials were found in the literature and collected into a single dataset along with other properties. This dataset was used to train several machine learning models to predict qm from widely available measured parameters. These models include Linear Regression, Decision Trees, Random Forests, and K-Nearest Neighbors. The trained machine learning models were validated and compared to one other, then used to predict qm for materials for which it has not yet been measured. These predictions pave the way for future studies by identifying potential candidate materials for P recovery applications.

Title: New CNS Re Complexes for Hydrogenation of Carbonyl Compounds

Presenter(s): Elliott Newman

Mentor(s): Elon Ison

REU/Summer Research Program: ICE

A new CNS ligand has been synthesized, with promising characteristics for coordination with the known Re(I) complex $Re(CO)5Cl$. This potential new CNS-Re complex along with 3 other CNS-based Re complexes were investigated via DFT (B3PW91-D3) as catalysts for the hydrogenation of carbonyl compounds. The mechanism for this catalytic reaction is proposed to take place via metal-ligand cooperation, where Re and the ligand are acting together to recognize, activate, and transform the substrate. The first transition state involves the activation of the $H2$ molecule, which is the rate-determining step, and the second transition state involves the hydrogen transfer to the substrate. The free energies for the transition states and for the minima structures were obtained, and they indicated that these reactions can happen at mild temperatures. The differences in energies between Re complexes highlighted that a bulkier CNS ligand contributed to lower transition state energies

ABSTRACTS | SESSION 2

Title: Investigation of A Large Kinetic Isotope Effect On Iridium-Ruthenium Complex

Presenter(s): Chriselda Nguyen

Mentor(s): Elon Ison

Kinetic Isotope Effects (KIE) is the modification of a chemical reaction's rate caused by the substitution of an isotope for one of the reactant's atoms. It plays a crucial role in determining reaction mechanisms. The heterobimetallic iridium-ruthenium hydride complex [Cp*Ir(OH2)(μ-bpm)Ru(bpy)2](OTf)4 ([1-OH2](OTf)4) has been used to express kinetic isotope effects and sparked an interest for our group. For this experiment, we investigate the Iridium-Ruthenium complex's dehydrogenation of formic acid into H2 and CO2. A proposed mechanism included 3 steps: Beta-Hydride Elimination, Formic Acid Association and Hydrogen Generation. And the study carries out the computational calculation by optimizing the minima and transition state. Structures were optimized using the B3LYP level of theory with a split basis set (def2TZVPP for Ir, Ru and Zn; def2SVPP for all other atoms). All optimizations were conducted in acetonitrile (MeCN). Then identify the transition state and intermediates and use it to investigate the proposed mechanism.

Title: A Tailored k-Means Algorithm for Efficient Geographic Clustering Applied to County-Level Data for Type 2 Diabetes Incidence in North Carolina

Presenter(s): Cindy Nguyen

Mentor(s): Mansoor Haider

REU/Summer Research Program: GCSP

We extend the unsupervised learning data clustering algorithm developed in [1] to integrate k-means clustering (k++ initialization) with a tailored objective function. This approach is then used to analyze dual-domain data sets for incidence of Type 2 Diabetes at the county-level in North Carolina. A dual-domain data set is a collection of data components, assembled into vectors, with one subspace containing geographic location information and the complementary subspace containing attribute information. Our tailored approach integrates a clustering algorithm with optimization of a few hyperparameters in a non-Euclidean distance function to identify geographically cohesive clusters of counties. Attributes considered in our analysis include disease incidence rates, disease risk factors and demographic variables such as race, gender, age and household income in each of North Carolina's 100 counties. Clusters determined via this approach aid in identifying disease patterns and disparities in regions of the state via automated and less-biased algorithms that are well-suited to public health applications requiring coordination between county-level and state-level policymakers. References: [1] ME McMahon, L Doroshenko, J Roostaei, H Cho and MA Haider (2022), Unsupervised learning methods for efficient geographic clustering and identification of disease disparities with applications to county-level colorectal cancer incidence in California, Health Care Management Science, published online 6/23/22, https://doi.org/10.1007/s10729-022-09604-5

Title: Neural Network Approach to Inverse Design of High-Entropy Alloys

Presenter(s): Jonathan Paul

Mentor(s): Douglas Irving

REU/Summer Research Program: MAT-DAT

Neural networks are an extremely useful device for computational research as they are able to accurately learn and predict trends in data sets of many dimensions. We are developing a system to predict the atomic compositions which can be used to obtain desirable properties in high-entropy alloys. The neural network is trained with large datasets of randomly generated compositions and their respective analytically calculated properties. Our system then creates a highly-complex multi-dimensional design space in which the network "searches" for the optimal alloy composition that can be used to achieve the properties it was given. These can include Young's modulus, Pugh's ratio, mass density, and any other property that is pertinent to the purpose of the material. The design space is created within the neural network by applying the proper activation functions and parameters to each of the neurons in the network. This work is useful with regard to experimental research as experimentalists often need materials with certain properties in order to conduct their research; therefore, providing a framework by which they can easily design materials with desirable properties will remove a large amount of estimation from their work.

ABSTRACTS | SESSION 2

Title: The Role of School Racial Climate on Adolescents' Sense of Belonging and Academic Coping Skills

Presenter(s): Fiona Presetemon

Mentor(s): Kelly Lynn Mulvey

REU/Summer Research Program: OUR Award

School racial climate (SRC) plays a role in students' school performance (Byrd, 2015; Byrd, 2019; Byrd & Chavous, 2011) yet no prior research explores its relation to academic coping (AC), a tool that can support school success (Skinner et al., in press; Skinner & Saxton, 2019). The present study investigates how SRC shapes a student's AC strategies, and if belonging mediates the relationship. 686 students in 9th and 10th grade (Mage= 15.13, SD = 0.86) of diverse racial makeup were recruited from five low-to-middle income public schools in the southeastern United States to complete a survey with likert scales for SRC (Byrd, 2015), an adapted Institutional Belonging Scale (London et al., 2011), and an AC (Skinner & Saxton, 2019) likert scale. After data collection, a mediation analysis was run with Hayes' SPSS process macro with the Sobel test (Z) and 95% confidence intervals. From these processes, we found interaction between SRC and AC, as well as a relationship between SRC, a sense of belonging, and academic coping. These results suggest a student's sense of belonging could behave as a mediator between SRC and AC. Belonging also a) has the potential to help or harm a student's AC and success, and b) has different levels of influence based on the student's level of belonging within academic work. Based on these findings, schools and researchers can acknowledge the need for a positive SRC, and work to foster belonging and explore early interventions that promote a positive racial climate in the school setting.

Title: Predicting the excitation energies of polymethine dyes using DFT for use in dye- displacement assays

Presenter(s): Hanna Rogers

Mentor(s): Yi Xiao

REU/Summer Research Program: ICE

Selecting optimal dyes for analyte detection using predicted excitation energies from density functional theory
Aptamers, oligonucleotide-based biorecognition elements, have emerged as promising receptors for the development of biosensors for analytical applications. Aptamer-based dye-displacement assays allow for rapid, simple, and instrument-free detection of analytes in field settings. Here, an organic dye molecule is initially complexed with an aptamer, and the addition of target induces displacement of the dye from the aptamer into aqueous solution, resulting in a change in dye absorbance. However, most dyes employed thus far produce only minor color changes, making result interpretation with the naked eye challenging. Herein, I employ density functional theory (DFT) to predict suitable dye candidates for subsequent synthesis and testing in the dye-displacement assay. I first compare the accuracy of several functionals to predict the excitation energies of three commonly employed polymethine dyes and compare these values to experimental spectra in organic and aqueous solution. Based on these results I determine that ωB97X-D was able to predict relative changes in excitation energy between these different dyes. I then utilize this functional to predict the shift in excitation energy caused by modifying various substituent sites on these polymethine dyes with different functional groups (*e.g.* halogen). Based on these results, I was able to create a library of dye monomers that can span virtually any color in the visible spectrum. Since color changes in the dye-displacement assay are produced via changes in dye aggregation state, my next plan is to use the current DFT method to predict the wavelength shifts of these candidate dyes in their dimeric and trimeric form.

Title: Determining effects of sunny-day floods on water quality using multiparameter sonde data

Presenter(s): Nora Sauers

Mentor(s): Natalie Nelson

Sea-level rise contributes to increased flooding among coastal communities through sunny-day flooding. Sunny-day flooding typically occurs regardless of rainfall during full or new moon phases that coincide with the moon at its closest position to the earth on its elliptical path, resulting in exceptionally high "king tides" that cause floods. These king tides inundate municipal separate storm sewer systems (MS4), flood onto roadways, and drain back into the natural waterway. The impacts of this flooding on water quality remain unknown. In this study, we hypothesize that sunny-day flooding events cause changes in the water quality and chemical signatures of receiving coastal waters when compared to baseline conditions. A multiparameter sonde was deployed from a dock in downtown Beaufort, NC, in Taylor's Creek starting on June 6, 2022 to measure chlorophyll, conductivity, depth, fluorescent dissolved organic matter, water depth, turbidity, pH, and temperature during baseline and flood conditions. Baseline and flood data were taken by the sonde in fifteen-minute and five-minute intervals, respectively. Results will compare differences between baseline and flood data to determine if water quality is impacted by sunny-day flood events. Findings from this study will provide insights as to whether public officials should monitor and address water quality impacts of sunny-day floods, if sondes are effective tools for monitoring flood-driven

water quality impacts, and whether new solutions are required to redirect tidal waters to avoid flushing pollutants into waterways. Impacts of this study include developing preventative methods by redirecting water from flushing pollutants into coastal waters.

Title: RoboMixer

Presenter(s): Joe Schroedl

Mentor(s): Nathan Woodward

REU/Summer Research Program: MSE

Metal-halide perovskites are an up-and-coming class of semiconductors material for PV, LED, and other optoelectronic devices. Discovery of these materials requires exploration over a vast chemical space. This design of experiments quickly reaches over a thousand experiments. In addition, there are many process variables that play a role in the experiment outcome. This is not feasible for a single student to complete, so we are turning to automation to assist in solving these problems. My summer project has focused on developing code to perform solution preparation of differing ratios from stock solutions, along with integrating the Opentron automated pipette with an in-house built spin coater, hot plate, and robotic arm. Moving towards an automated process alleviates human error and enables more precise, repeatable experimentation and logging of experiments, in addition to huge time savings. While my summer project has focused on 2D hybrid perovskite material, this automated platform can be used in the future for a wide range of solution processes and thin-film fabrication experiments.

Title: Evaluating Electrochromic Performance of Electrochromic Devices Via Spectroelectrochemsitry Techniques

Presenter(s): Tajah Trapier

Mentor(s): Mahesh Shinde

REU/Summer Research Program: OUR Award and MSE

Electrochromic devices are a popular technology that enables modulation of light via said devices' ability to change their transparency and color. Such devices are vital to the economy because they allow for the reduction of heating and cooling loads in buildings, therefore, reducing energy consumption and our carbon footprint once integrated as windows. Integration of electrochromic devices in buildings, or their commercial viability, is dependent on their ability to meet industry standards. To verify electrochromic devices developed in-house meet electrochromic performance and coloration requirements specified by industry standards, a spectroelectrochemistry platform was designed. The spectrochemistry platform incorporates a light source, potentiostat, spectrometer, battery testing protocols, and computing technologies to measure transient transmittance profiles, color, coloration efficiency, and switching speeds of electrochromic devices.

Title: Response of mushroom fruiting bodies and associated mycophagous fly communities to selected forest disturbances

Presenter(s): Preston Truett

Mentor(s): Robert Jetton

REU/Summer Research Program: OUR Award

The goal of this project can be divided into two parts. First, we want to observe the fruiting response of fungi in selected forest disturbances. Mushroom formation relies on many factors, and it is known that forest disturbances influence mushroom production, especially mycorrhiza species. Mycorrhiza mushroom fruiting depends upon photosynthetically fixed carbon produced by its host tree, so the health of the tree may drive the production of mushrooms. Disruption of the flow of these carbohydrates to the mycelium has been proven to decrease and, in some cases, completely stop mushroom fructification. On the other hand, parasitic mushrooms may increase when forest disturbances arise. The rise of parasitic fungi leads to an increase in forest decline and its ability to rebound from disturbances. Saprophytic fungi play a key role in nutrient recycling and humus formation in forest ecosystems. These three categories of fungi are critical in the overall inference about a forest's health. Second, we want to observe the mycophagous fly communities that feed on these fungi. Mushroom production influences these fly communities, so a consequence of decreased mushroom production is a decrease in these fly communities. This highlights the varying trophic levels that are affected by a disturbance in a forest. The mycophagous insect communities rely on these mushrooms and further research needs to be conducted to evaluate the importance of this subset of insects. That is why in this study we want to measure the species richness and abundance of these communities and observe the effect of disturbances.

ABSTRACTS | SESSION 2

Title: Transfer Learning Methods for Individual Treatment Rules

Presenter(s): Andong Wang, Kelly Wentzlof, Miontranese Green, Johnny Rajala

Mentor(s): Shu Yang

REU/Summer Research Program: DRUMS

Modern precision medicine aims to utilize real-world data to provide the best treatment for an individual patient. An individualized treatment rule (ITR) maps individual characteristics to a recommended treatment that maximizes the expected outcome of each patient. A problem facing modern medicine is that studies on the effect of treatment are conducted for a source population that may be different from the population of interest. Our research goal is to investigate a transfer learning algorithm to obtain targeted, optimal, and interpretable ITRs. We will develop a calibrated augmented inverse probability weighting (CAIPW) estimator by maximizing the value function for the target population to estimate an optimal ITR. Additionally, we will investigate transfer learning methods based on two large medical databases, eICU-CRD and MIMIC-III, identifying the important covariates, treatment options, and outcomes of interest to estimate the optimal ITRs for patients with sepsis. This project will introduce new techniques for data merging to provide data-driven optimal ITRs, catering to each patient's individual medical needs. These techniques extend beyond medicine, applying to a wide range of areas such as marketing, technology, social services, education, etc.

Title: Brikhoff-Rott Circles

Presenter(s): Galen WIlcox

Mentor(s): Ryan Murray

REU/Summer Research Program: OUR Award

Sharp discontinuities in fluid velocity or density often present themselves in natural fluid flows, and can be modeled mathematically as vortex sheets. Beautiful examples can be found in the meandering spirals on the surfaces of Jupiter and Saturn, or when pouring milk into coffee. Our project studies the stability of a circular vortex sheet, generalized to two-dimensional, inviscid, and incompressible flow. From an analytic standpoint, we use the Birkhoff-Rott equation to show that major differences exist between our circular case and the well-studied planar Kelvin-Helmholtz instability. The linear evolution problem for Kelvin-Helmholtz develops violent instability in a short time. By contrast, our linear analysis yields a closed-form traveling wave solution, showing that the circular contour is stable under small perturbations. An expansion to second order produces a term reminiscent of Burgers' equation, which models wave breaking. Simulation in MATLAB by the point-vortex method reveals wave-breaking instability, strongly suggesting that the Burgers' term is the mechanism of instability. Meanwhile, we develop an experimental setup involving a circular rotating tank with differentially rotating disks submerged in water. Viewed from above, this setup will induce and stabilize a circular vortex sheet, allowing us to qualitatively observe the development of instability and adding physical significance to our analytic and computational work.

Title: Computational Studies of a Series of Metal-based Graphite-conjugated Electrocatalysts for Nitrate Reduction

Presenter(s): Victoria Wilkinson

Mentor(s): Elana Jakubikova

REU/Summer Research Program: ICE

Nitrate pollution from agricultural runoff is a growing ecological concern as excess nitrate is capable of triggering health and breathing problems in humans. Nitrate pollution is especially harmful to aquatic ecosystems since nitrogen encourages algae overgrowth and reduces the amount of dissolved oxygen available for other aquatic life. A potential way to mitigate this problem is through extraction of nitrates and their electrocatalytic reduction back to ammonia. In this work, we employ density functional theory (DFT) to study a series of metal-based graphite conjugated electrocatalysts (GCC-MDIM, M = Co, Cr, Mn, Ni, Cu) active toward nitrite reduction. Redox potentials as well as ligand binding and dissociation energies were calculated for each of the GCC-MDIM complexes in order to determine the electronic structure and coordination environment of active catalysts.

ABSTRACTS | SESSION 2

Title: Involvement of glial cells of the gallbladder wall in gallbladder mucocele

Presenter(s): Elyse Wood

Mentor(s): Laurianne Van Landeghem

REU/Summer Research Program: OUR Award

Gallbladder mucocele is a disease unique to dogs characterized by excessive production of viscous mucus, which can lead to infarction of portions of the gallbladder, loss of gallbladder function, or rupture. Glial cells are an important component of the nervous system within the wall of the gallbladder and are known to influence the behavior of neurons and epithelial cells - including mucus-producing cells - in other organs. The mycotoxin Zearalenone (ZEN) is commonly found in dog food and dogs with mucoceles present with high concentrations of ZEN in their abdominal fat. Current literature suggests that ZEN causes defects in neurons and glial cells in the central nervous system. Therefore, our overall hypothesis is that high levels of ZEN induce alterations in glial cell functions, leading to unregulated mucus production and mucocele formation. This project aims to (1) characterize the glial cell network in gallbladder mucocele using 3D imaging and (2) test if ZEN affects glial cell phenotype. 3D light sheet microscopy was used to visualize differences in the glial cell network of mucocele-affected gallbladders versus healthy specimens. Glial cells isolated from the gallbladders of healthy dogs were exposed to ZEN and their calcium response was quantified to assess if ZEN affected glial cell activity. Additionally, the calcium activity in response to ATP of glial cells incubated with ZEN was observed. ATP is a neurotransmitter known to induce calcium transients in glial cells under normal conditions.

Title: Using data to design LEDs emitting in the ultraviolet for disinfection applications

Presenter(s): Bryan Wright

Mentor(s): Ramon Collazo

REU/Summer Research Program: MAT-DAT

While extracting the components of an LEDs external quantum efficiency (EQE) is a non trivial task, it is possible to do by measuring the LEDs electro luminescence spectra over a wide range of temperatures and currents. It is expected that the AlN substrates will produce better performing LEDs than sapphire substrates because they have a smaller lattice misfit with the epitaxial layers and hence a smaller threading dislocation density. By separating the EQE components we can gain insight into the underlying mechanics affected by the threading dislocations. It would also be possible to tune specific structures to optimize efficiencies. Using home built python scripts we are able to analyze the data from temperature dependent electroluminescence measurements and display it in a format that is easier to interpret.

Title: Data-Driven Synthesis of Metastable Hydrated Transition Metal Oxides

Presenter(s): Carter Wunch

Mentor(s): Veronica Augustyn

REU/Summer Research Program: Materials Engineering

Acid etching is a topochemical method that replaces soluble cations with hydrogen ions to form a semi-stable material while preserving the original material's structure. These metastable materials can exhibit more promising electrochemical properties than their precursors. In this project, we utilized a materials informatics approach to search for etchable layered transition metal oxides (LTMOs) with the Materials Project database, data analysis techniques, and Python. Utilizing data analysis methods can be faster and more cost effective for materials discovery than experimental trial and error approaches. Using previously collected data on etched LTMOs, we analyzed the trends in etchable cation, transition metal, and crystal structure. We found that oxides containing small alkali cations like lithium and sodium, and transition metals like niobium and tungsten are good candidates for acid etching. These materials also tended to have monoclinic or orthorhombic unit cells. The trends in elemental occurrences, structure, and acid stability were applied to over 130 layered materials to identify new suitable candidates for acid etching. Some of these materials will be synthesized, characterized to confirm the identity of the product using X-ray diffraction and thermogravimetric analysis, and acid etched. Successful acid etched materials will undergo electrochemical characterization to determine charge storage capabilities in relation to their unetched precursor.

ABSTRACTS | SESSION 3

Title: Colonization dynamics of the microbial community in stored Western Honey Bee pollen

Presenter(s): Sean Armour

Mentor(s): David Tarpy

REU/Summer Research Program: BeeMORE

The presence of microbes, such as bacteria and yeasts, has been widely documented in stored pollen that enzymatically alters it in the honeycomb of Apis mellifera colonies to form "bee bread." However, the role of microbes in the conversion of pollen to bee bread is still a subject of uncertainty. We hypothesize that microbial growth will be rapid with a quick asymptote, thus we expect to see these colonizing bacteria and yeasts as the main causes for fermentation within the samples. In this study, we investigate the progression of microbial community composition and abundance with periodic sampling periods over the course of eight days, generating data on the relation of colonization periods and bee bread composition. Sample preservation and DNA extraction were optimized to accurately quantify DNA for sequencing with the Oxford Nanopore Technologies (ONT) MinION. Samples were pre-treated with Zymo DNA/RNA Shield and disrupted, then subjected to the ZymoBiomics Quick-DNA Tissue/Insect Mini-Prep Kit. DNA yields were high but not sufficient for extraction, thus we used Zymo Select-a-size DNA MagBead kit to concentrate 4 samples into 1 (4:1). This improved library preparation will enable us to sequence samples from specific timepoints and identify microbial and plant DNA in the samples using non-PCR reliant methods. Our bioinformatic analyses using the EPI2ME "What's in my pot" (WIMP) and EDGE Bioinformatics cloud-based tools will further enable us to identify the microbes that are present in our bee bread samples.

Title: Comparing the Mineralogy of Microbially Induced Calcium Carbonate Precipitation to Naturally Cemented Sandstone

Presenter(s): Tiffany Barker-Edwards

Mentor(s): Brina Montoya

REU/Summer Research Program: BESST

In the past years, the efforts to move toward a more sustainable way of life have resulted in new techniques and improvements in many industries. Society now has electric cars, and personal solar panels, but the engineering industry has had to adapt to sustainability in a different way. The introduction of a technique known as Microbially Induced Calcium Carbonate Precipitation has proved to be useful in the fields of geotechnical engineering. The ability to create artificially cemented sandstone allows for an environmentally conscious way to strengthen the soil, manufacture bricks, and even treat concrete. The process of creating these cemented sandstones abbreviated to MICP has been studied extensively, however not much research has gone into comparing the aspects of MICP's to naturally occurring sandstones. Using data from various techniques such as a scanning electron microscope and energy dispersive x-ray spectrometer the differences and similarities between the MICP sandstone and naturally occurring sandstone were identified. Using this information, adjustments can be made to the treatment of MICP's to their naturally occurring counterparts to get more accurate data for research and experimental purposes.

Title: Variation in bumblebee and floral visitor abundance across two microhabitats of the threatened Smooth Purple Coneflower

Presenter(s): Caroline Blythe

Mentor(s): Becky Irwin

REU/Summer Research Program: BeeMORE

Echinacea laevigata is a federally threatened plant endemic to the Piedmont Savanna ecosystem of the Southeast, which has been nearly totally extirpated due to widespread habitat loss. The flora of the Piedmont Savanna persist mostly in high-light environments, such as rights-of-way and land managed through prescribed thinning and burning. Populations living in undermanaged areas are at risk for being shaded out. Pollination of E. laevigata is insect-mediated, and the global trend of pollinator decline could pose serious risk to E. laevigata, especially for populations living in lower-light microhabitats where insect visitation may be decreased. Bumblebees are likely the most important pollinators of E. laevigata, but the most frequent Bombus floral visitors have not been described. This project investigates three questions: 1) What species of Bombus are common visitors of E. laevigata in high- and low-light microhabitats? 2) Does Bombus abundance differ between microhabitats? 3) Does floral visitor abundance vary between microhabitats? To address these questions, researchers netted floral visitors to E. laevigata in five open and five forested plots at Picture Creek Diabase Barrens in Granville County, NC. I sorted floral visitors and identified Bombus specimens to species, and subsequently compared the rate of capture of Bombus and all

floral visitors between the two microhabitats. Understanding the most common visitors to E. laevigata and how microhabitat affects visitation will elucidate how global pollinator decline and land management strategies might affect reproduction of this threatened plant.

Title: Investigating Woodchip Fungal Bioreactor Dissolved Organic Matter as a Surrogate for Fungal Biomass

Presenter(s): Jackson Brown

Mentor(s): Tarek Aziz

REU/Summer Research Program: RISE CCEE

Fungal bioremediation is a novel, compelling treatment method for contaminants of emerging concern in stormwater. Through complex enzymatic systems, fungi are able to degrade contaminants that are resistant to conventional treatment. Though the success of fungal bioremediation is well documented on the lab scale, the measurement of fungal biomass on woodchip bioreactors is a cumbersome and time-consuming process. This inability to rapidly measure fungal biomass in a reactor is a major barrier to utilizing fungus in environmental process design. We hypothesize that readily measurable dissolved organic matter (DOM) characteristics can be used to approximate fungal biomass when fungus is grown on wood chips. In order to analyze and formulate the relationship between fungal biomass and DOM, we inoculated poplar wood chip batch reactors with varying amounts of the fungus Phanerodontia chrysosporium, and submerged the substrate in synthetic stormwater. Samples were collected in triplicate at four time points to ensure that there were varying levels of fungal biomass throughout the experiment. Absorbance and fluorescence characteristics of the DOM as well as dissolved organic carbon (DOC) concentrations of the supernatant were analyzed, and ergosterol was extracted from the remaining fungal-woodchip mass in order to estimate the fungal biomass. Statistical analysis of pertinent DOM characteristics will be used to demonstrate the relationship between fungal biomass and DOM.

Title: AHRR Hypomethylation Mediates the Effects of Maternal Smoking on Child Metabolic Profiles

Presenter(s): Nia Brown

Mentor(s): Catherine Hoyo

REU/Summer Research Program: BeeMORE

In the United States, 12.3% of pregnant women smoke, and adverse health outcomes increase among children aged 0-15 years. These outcomes include respiratory illness, sudden infant death syndrome, and metabolic dysfunction including obesity and liver dysfunction. However, data on the effects of cigarette smoking during pregnancy on these childhood outcomes, and mechanistic insights for these associations, are limited. Several studies have identified the connection between prenatal tobacco smoke exposure and DNA hypomethylation at regulatory regions of the aryl hydrocarbon receptor repressor (AHRR) gene CpG site cg05575921. We tested the hypothesis that hypomethylation of the AHRR gene cg05575921 derived from umbilical cord blood leukocytes mediates the association between maternal smoking and metabolic dysfunction that has not been described. We used regression models and mediation analyses to analyze the association between maternal smoking during pregnancy and n=90 children's metabolic parameters at age 7-10 years, the multiethnic Newborn Epigenetics Study (NEST) cohort. Pyrosequencing was used to measure CpG methylation of the cg05575921 site. After adjusting for the sex of the child, the child's age, maternal education, maternal pre-pregnancy BMI, and breastfeeding, we found that there was an association between hypomethylation and metabolic parameters of children born to smoking mothers at birth, which includes liver fat fraction (p=0.01), triglycerides (p=0.01), and ALT levels (p=0.03). The association between hypomethylation and metabolic outcomes was not sustained in childhood between the ages of 7-10. These data support that cigarette smoking during pregnancy contributes to hypomethylation of the AHRR gene.

Title: Examining Differences in Ice Growth Processes for Different Modes of Storm Formation

Presenter(s): Declan Crowe

Mentor(s): Luke Allen

REU/Summer Research Program: Undergraduate Research at Environment Analytics

Most precipitation that falls to the ground starts as ice in clouds. In summer thunderstorms, unstable air rises from near the ground and ice grows fastest within strong updrafts. In winter snowstorms, ice often initially forms near cloud top and then drifts downward in air with weak to negligible vertical motions. Ice grows when relative humidities exceed 100% (supersaturated) and shrinks when relative humidities are below 100% (subsaturated). Any given ice particle often experiences multiple growth and shrinkage periods along its

path from initial formation to the ground. We examine measurements of air temperature, humidity, air motions, and ice particles made by research aircraft in clouds during field studies in environments that range from the tropical ocean to the Arctic. Our goal is to better understand the differences and similarities between conditions that increase and decrease ice particle mass in summer versus winter season storms.

Title: Tracking the emergence of SARS-CoV-2 Omicron variant of concern in Raleigh, North Carolina Through clinical and municipal wastewater genomic sequencing

Presenter(s): Andrew Daddone

Mentor(s): Angela Harris

REU/Summer Research Program: RISE CCEE

Throughout the COVID-19 pandemic, tracking the virus and the emergence of novel variants of concern (VOC) has been important for creating a plan of action for responding to the pandemic. Typically, this has been done by testing symptomatic patients. Due to this, asymptomatic cases are often missed, making it difficult to understand the full scope of the pandemic. Wastewater-based epidemiology (WBE) has proven to be helpful in tracking the pandemic trends more broadly. This study uses WBE to track the emergence of Omicron VOC in Wake County, North Carolina. Wastewater and clinical samples around these dates were sequenced in order to track the Delta-to-Omicron transition. The first Omicron case in the United States was reported on December 1, 2021 and accounted for the majority of cases by December 25, 2021 quickly overtaking the Delta VOC as the most prevalent. Our preliminary analysis shows that we first detected Omicron in our clinical sample set on December 17, and by December 25 it accounted for approximately 60% of cases. For our wastewater samples, we took a different analytical approach. Wastewater samples are often difficult to analyze due to the quality of the sequence data and the lineage abundance within a sample. Therefore, we are focusing on comparing results from our North Cary and Raleigh wastewater sites with recently developed pipelines.

Title: Data Structuring of Additive Manufacturing Machine Outputs

Presenter(s): Maria Davila

Mentor(s): Sara Shashaani

REU/Summer Research Program: RISE ISE

Additive Manufacturing (AM) is a process in which a build is designed in a computer-based program and later created by adding layers of material with a laser or electron beam. For each build, an AM machine produces log data. In addition, Programmable Logic Controller (PLC) data, images from each layer of the build, and 3-D scans of the build can be separately produced. Since the physical process in an Electron-Beam Machine (EBM) is too complicated, using these data can help create a prediction model via data analysis. Previous studies identified the defects and their locations by characterizing and aggregating various recordings in one layer. However, as multiple defects may occur in one layer, analyzing the data in smaller spatial scales is necessary to have a more reliable prediction model. This research synchronizes log files, PLC data, and images at each layer that can inform about labeling data points as defective to predict AM machine outputs at user-specified spatial units. This tool ultimately can monitor additive manufacturing near-real-time, which in turn enables the prevention of plausible imperfections by identifying the causes and appropriate interventions. Synchronization and reducing the large-scale data to build the dataset is challenging. Additionally, the proper spatial scale is an open question in response to the trade-off of more data that leads to more zero-inflation but more targeted predictions.

Title: Association of Disinfection Byproducts and Heavy Metals Contaminants in Drinking Water and Canine Bladder Cancer

Presenter(s): Ashley Donnellan

Mentor(s): Matthew Breen

Interest in the relationship between exposure to environmental toxicants and dogs with pre-clinical signs of bladder cancer has become increasingly relevant regarding early detection of the BRAF mutation. The BRAF genetic mutation is identified in an overwhelming number of dogs with transitional cell carcinoma in the bladder with possible connection to high levels of toxicants in the canines drinking water. Continued research of exposure to disinfectant byproducts and heavy metals may help to identify predominant risk factors of occurrence and recurrence in these species. Assessing this relationship would determine whether dogs could serve as a model for treatment in human bladder cancer and association of such exposures due to the same level of toxicants in both the human and canine drinking water. Using candidate gene Methylenetetrahydrofolate Reductase (MTHFR), we look to identify the mechanism of carcinogenesis and how heavy metals, such as copper and lead, and disinfection additives, such as chlorine, are metabolized in the

body. The geometric mean of levels of total trihalomethanes, haloacetic acid 5, and chlorine from the canines' resident cities will be found and used to run statistical analysis for comparison of cases, dogs which tested positive for BRAF, and controls, BRAF negative. Functional variants C667T and A1298C will be used for whole genome DNA to run methods of PCR, gel electrophoresis, and Sanger sequencing.

Title: Novel Device for Electronics Printing using Contact Dispensing Methods

Presenter(s): Alex Draghici

Mentor(s): Thom LaBean

REU/Summer Research Program: Materials Sciences and Engineering

Direct printing methods have been used to print functional inks and electronic components because of their decreased cost and time requirements when compared to other manufacturing methods, such as photolithography. However, current printing devices carry costs in the range of hundreds of thousands of dollars, limiting their use to only well funded departments and institutions. This study presents a contact-type dispensing device as a less expensive alternative to industry devices. The market for lower-cost electronics printing devices is discussed, and the feasibility and characteristics of contact-type printing is demonstrated. Designs for a full printing system, including gantry, nozzle, and electronics, are presented. Finally, the opportunities and costs for the continued development of this contact-type printing device are discussed.

Title: Changes in microbiome composition through bee bread maturation in the nests of the eastern large carpenter bee, Xylocopa virginica

Presenter(s): Maeve Finley, Estefany Valdez

Mentor(s): Aram Mikaelyan

REU/Summer Research Program: BeeMORE

Xylocopa virginica, the eastern large carpenter bee, is a native pollinator found throughout North America. It drills tunnels in dead wood to make its nest, in which multiple independent brood chambers house one egg. Each egg is provisioned with a mix of pollen, nectar, and the mother's saliva. This "pollen provision" is the sole food source for the developing larva, and is crucial in influencing its microbiome and overall health. Their linear nest structure allows us to analyze the temporal changes in the assembly of pollen provision microbiomes. We aimed to examine the temporal changes in the microbiome of pollen provisions, in the context of larval development, as well as how diverse pollen sources influence X. virginica. Using Illumina sequencing of the V3–V4 region of the 16S rRNA gene in bacteria and the internal transcribed spacer (ITS) sequence in plants, we analyzed pollen provisions and adult bees from multiple locations. We also swabbed Magnolia anthers and petals, a common visitation site for X. virginica, to assess the presence of co-occurring bacteria between Magnolia pollen and X. virginica microbiomes. Preliminary results from 16S rRNA gene analysis show clear differences in the composition of bacterial communities and pollen origin among nests and between individual brood cells, suggesting that the selection of pollen could be influencing the quality of pollen provision in X. virginica.

Title: How the pollination efficiency of the common eastern bumblebee (B. impatiens) foraging on tomato (S. lycopersicum) is impacted by diet and parasitism

Presenter(s): McKenzie Frazier

Mentor(s): April Sharp

REU/Summer Research Program: BeeMORE

Bombus impatiens is widely distributed across eastern North America and the species plays an essential role in the preservation of ecosystems. This species is also used as a managed pollinator for agricultural production. A threat to the health of B. impatiens populations could have a detrimental impact on the agricultural industry, making the conservation of this species a priority. One threat to B. impatiens is the spread of parasites like Crithidia bombi. In B. impatiens, this parasite reduces colony growth and increases worker mortality. It is recognized that C. bombi infection diminishes flower navigating abilities, however, there is a lack of research concerning the impact C. bombi has on the pollination services of B. impatiens. Previous research on differing diets has shown a reduction in C. bombi loads when sunflower, H. annuus, pollen is the primary food source. However, H. annus pollen is less nutritious and may have adverse effects on individuals consuming it. This project seeks to discover how the interaction of infection with C. bombi and an H. annuus diet will influence pollination. The colonies of B. impatiens involved were either inoculated with C. bombi in sucrose solution or

given a sham. Colonies from both groups were fed a diet of H. annuus pollen or the wildflower control diet and set to perform pollination trials with S. lycopersicum to compare foraging behavior. Afterward, the bees were dissected to count C. bombi load and each visited flower's stigma was analyzed to determine pollination efficiency.

Title: Geometric Optimization and 3D Printing Reinforcing Steel

Presenter(s): Natalie Hackman

Mentor(s): Jessi Thanjitham

REU/Summer Research Program: RISE CCEE

Using high-strength reinforcing steel in high seismic areas could improve bridge designs by reducing congestion, construction time, and environmental impact. It has been found from material tests and large-scale experimental tests of columns reinforced with high strength steel that rebar geometry influences the seismic behavior. The relationship between the rib geometry of reinforcing steel and resulting strain concentrations from buckling will help define an optimal rebar geometry to improve the seismic performance of reinforced concrete bridge columns. This study examines rebar geometries and strives to create a database of these rebar geometries and their correlating strains under a prescribed loading. First, a method of 3D scanning and then 3D printing the rebar with flexible resin was performed to analyze the relationship between rebar geometry and strain. Next, the rebar was tested by buckling the 3D printed rebar to a prescribed displacement. This summer, we focused on meshing the 3D scanned and extruded rebar to be used in finite element analysis. The number of nodes, elements, and levels of mesh coarseness were recorded and used to select the level of detail for the FEA. Several FEAs have been conducted on rebar with different geometries. Additionally, the rebar properties of rib height, rib radius, and distance between ribs were measured by taking ten measurements from each side of the rebar and averaging the results. The final results at the end of this research will be the recommendation of optimal rebar geometry properties to improve the seismic performance of RC bridge columns.

Title: The Effects of Acid Rain on Sand Treated with Microbially Induced Calcium Carbonate Precipitation

Presenter(s): Jacob Harris

Mentor(s): Brina Montoya

REU/Summer Research Program: RISE CCEE

Sandy soil that is treated with Microbially Induced Calcium Carbonate Precipitation (MICP) has the potential to be a safeguard for infrastructure in areas with poor soil conditions. In the natural environment, however rain with different levels of acidity often occurs, washing over the nearby sand and causing potential erosion. It is unclear how much erosion occurs to MICP-treated sands from acid rain and if MICP can be a realistic solution to withstand acidity from rain over a sustained period of time. With the possible implementation of this treatment in the sandy soil of communities, it is of the utmost importance that we know the level of degradation and erosion of MICP-treated sand caused by acid rain This paper focuses on the effects of acid rain with varying pH levels on the permanence of MICP-treated sand samples. The effects of acid rain with different acidity (i.e. varying pH levels) on mass loss, shear strength, and stiffness reduction of the MICP-treated sand samples were considered. To simulate acid rain the sand samples were placed in beakers of different acidity for a period of time. The mass of the beakers was measured, and the samples were removed to be examined once the mass loss of the beaker plateaued. All experiments demonstrated a correlation between cementation degradation and the acidity of acid rain. Results indicated that increased acidity has a greater effect on the dissolution of the cementation.

Title: Unconventional methods of fabrication for carbon nanotube based printed electronics.

Presenter(s): Krystyn Hewett

Mentor(s): Amay Bandokar

REU/Summer Research Program: ASSIST

Stretchable and conductive inks have a range of applications in the field of electronic devices, particularly in wearable systems that require flexibility. The fabrication of stretchable electronics typically relies on processing techniques that are expensive or unsuited to scalable production. We investigate unconventional fabrication techniques for carbon nanotube inks in conjunction with a stretchable substrate to realize a low-cost, scalable alternative to traditional printed circuit boards for use in wearable electronics. Utilizing a self-assembling nanotube platform, the carbon nanotubes are mechanically isolated to allow a conductive layer that is strain-insensitive and screen printable. As such, a fabrication process is sought after that will perform on par with traditional printed circuit boards, both

economically and in practical use. The fabrication approaches discussed have the potential to increase the performance of a device, are generally low cost, and are a scalable alternative to traditional fabrication methods of wearable electronics which have broad applications in many industries where electronic devices are necessary.

Title: Peanut Seed Maturity as a Factor in Free Amino Acid Content

Presenter(s): Emily Hutchins

Mentor(s): Lisa Dean

REU/Summer Research Program: Food Science Summer Scholars Program

The peanut plant produces new seeds over the whole growth cycle from about 30 days after planting up until harvest time. As a result, the peanuts harvested will have a range of seed maturities. As part of a larger on-going study, this research examined the changes in free amino acid content in peanut seeds over the whole range of seed maturity stages. Virginia type peanuts (variety Sullivan) were harvested on 3 dates close to the time of optimum harvest date. The pods were sorted using the "Hull Scrape" methods into the individual maturity classes based on pod mesocarp color. The pods were dried and the seeds were shelled. The seeds were analyzed for free amino acid content. It was found that total free amino acid content decreased with increasing maturity, although certain individual amino acids such as phenylalanine and glutamic acid increased. Free ammonia content also decreased with maturity. This data will be used to determine if the formation of certain flavor compounds are affected by seed maturity.

Title: The Effect of Surface Morphology of Colloidal PMMA Particles in Capillary Suspensions for 3D Printing

Presenter(s): Jacob Kennedy

Mentor(s): Hsiao Lilian

REU/Summer Research Program: OUR Award and CBE

One of the primary challenges in modern 3D printing applications lies in the conjugation of materials which can be utilized as a filament of adequate tensile strength and composition. In addition to strength detriments, many colloidal and ceramic based inks result in a non-homogenous printed structure with poorly defined edges. Incorporating capillary suspensions here is of particular interest due to their cohesive nature in combination with their relatively high viscosity and tensile strength while maintaining a homogenous composition. Rheological properties such as suspension viscosity, yield stress and microstructural parameters (i.e. storage and loss modulus) have been measured using rheometry and a physical description of the system is provided based on models suggested by Bindgen, Allard, and Koos. Exact control over the synthesis of anisotropic colloidal particles and their morphology was the precursor to capillary suspension preparation and characterization. In addition to my experience with dispersion polymerization for colloidal synthesis, I have worked closely with a graduate student trained in confocal microscopy in order to determine the structures of colloidal particles and to understand the effect of their particle morphology on capillary attractive forces present within suspension. The implementation of a thermal crosslinking agent is now understood to be vital in materializing a capillary suspension that is of particular use in 3D printing applications. Investigation into the effects of surface morphology on the rheological properties of capillary suspensions is being conducted in Hsiao laboratory.

Title: NOx Removal using Photocatalytic Pavement Rejuvenator

Presenter(s): Jimmy Lewis

Mentor(s): Andrew Grieshop

REU/Summer Research Program: RISE CCEE

Excess atmospheric nitrogen oxides (NOx) poses human health and environmental issues. The manufacturers of an asphalt rejuvenator product including titanium dioxide (TiO2) nanoparticles claim the product decreases the net NOx released to the atmosphere from vehicle emissions through an on-road photocatalytic reaction. In this project, a novel Field On-slab Photocatalysis Experimental Apparatus (FOPE) is developed to measure NOx reactions with treated and untreated in-use pavement in Cary, NC. Conditions such as humidity, temperature, and solar radiation affect the oxidation power of TiO2. Previous research assessed these photocatalytic coatings in lab settings or simulation slabs placed in the environment while our method will achieve real world conditions by using in-service roads. An airtight chamber that seals to the pavement was constructed with Teflon walls transparent to UV light. Diluted engine exhaust is injected into the chamber and NOx measured in 'treatment' and 'control' chambers to measure removal over time. This apparatus method addresses intermittent vehicle traffic, measures CO2 as an engine exhaust tracer, and maintains environmental factors such as

humidity, temperature, and solar radiation. The chamber is kept under positive pressure with a leak rate of 35%. Residence time inside the chamber will be an important factor for NOx removal. NOx removal in the treatment chamber is expected to increase with higher solar radiation and relative humidity. Higher humidity is expected to increase NOx removal. An areal NOx removal rate (e.g. ppm NOx/m2-min) will be estimated to provide a peak removal efficiency estimate.

Title: Monitoring Cefotaxime resistant E. coli in surface water and wastewater on Coharie Native American land.

Presenter(s): Sebastian Lopez Jimenez

Mentor(s): Angela Harris

REU/Summer Research Program: RISE CCEE

In recent years, the Coharie Native Americans of Clinton, North Carolina have been increasingly concerned with the surface water quality of their river, The Great Coharie Creek. Environmental racism is a tale all too common in this country and the Coharie Tribe is not exempt. Hog farming is one of the biggest industries in North Carolina, but it is also responsible for health issues of people living near these farms which are focused on counties with extreme poverty; Sampson County being one of these counties. The watershed of concern is in the heart of hog farming culture in the state, which is likely a primary source of fecal contamination to the river. In accordance with current monitoring efforts this study seeks to identify the presence of Cefotaxime resistant Escherichia coli (E. coli) in surface water on the Great Coharie Creek and from the influent of the Clinton wastewater treatment facility as antimicrobial resistance (AMR) is a growing concern in today's world. Wastewater is known to be a hotspot for AMR due to the vast use of antibiotics across many sectors. Both wastewater and agriculture enhance the interaction between AMR organisms promoting a mix of mobile genetic elements. To identify Cefotaxime resistant E. coli, water samples were spiked with Cefotaxime and analyzed using the IDEXX Colilert-18 assay. Positive samples were then archived in preparation for metagenomic sequencing.

Title: Optimizing the Plasmid Purification Process in Support of mRNA Synthesis for Vaccine Production

Presenter(s): Cristina Martinez-Mata

Mentor(s): Jennifer Pancorbo

REU/Summer Research Program: BTEC

The emergence of pathogenic viruses is threatening human health, and subsequently human lives. To combat this, scientists are studying different types of treatments and vaccines such as mRNA vaccines. With the first FDA-approved mRNA vaccine being the COVID-19 vaccine, they are relatively new in public application, but they have been studied for decades. Research will continue to be done on mRNA vaccines for other viruses. A crucial step in mRNA research is the purification of plasmids. A plasmid is a small, circular, double-stranded DNA molecule that is commonly found in bacteria. They replicate independently and serve as vectors, or delivery vehicles for genetic material. Today, most researchers use kits made by large manufacturing companies for purification. The kits are reliable but they are very expensive. This project details a new and optimized process of plasmid purification. The process consists of five main steps: fermentation, centrifugation, cell lysis, clarification, and chromatography. Through these steps, the plasmid is batch produced in E.coli, the E. coli cells are spun down to form a pellet, the cells are broken open to release the plasmid, and the plasmid is concentrated and purified using liquid chromatography. The liquid chromatography system uses a HiTrap column packed with Capto PlasmidSelect purification resin. The resin allows the liquid to pass through while removing all the unwanted material. Once it is purified, the plasmids are ready for use in the next step of mRNA production, with the ultimate goal of creating mRNA vaccines.

Title: Continuous Field Monitoring and Evaluation to Assess Water Quality

Presenter(s): Chase McCrary, Emma Mullins, Mindy Dunn

Mentor(s): Angela Allen

Water samples were tested from two locations in Raleigh: the Richland Creek at Schenck Forest and the Walnut Creek in the Wetland Center vicinity. These samples were analyzed in an effort to begin a long-term water quality system to evaluate and determine the source of alteration as the surrounding environment changes with time. The data collection allows us to make observations about the quality of the water as changes in urbanization and local sewage pipelines can lead to an effective impact on society.

ABSTRACTS | SESSION 3

Title: Effect of parasitism and diet on pollination efficiency of the common eastern bumblebee (Bombus impatiens) visiting snapdragon (Angelonia)

Presenter(s): Paige Mesecar

Mentor(s): Rebecca Irwin

REU/Summer Research Program: OUR Award

This applied ecology research project analyzed the foraging behavior of the common eastern bumblebee (Bombus impatiens) when infected with one of their most common pathogens (Crithidia bombi). This native bee has been studied extensively in an effort to determine and mitigate causes for their decline. Previous research shows that a sunflower pollen diet significantly reduces the Crithidia load in bee intestines; however, this beneficial effect is paired with a nutritional tradeoff due to a relatively low protein content. This project aims to measure the degree that Crithidia infection and diet interact to impact bees' pollination services by investigating how crossing Crithidia infection and sunflower pollen diet affect the pollination efficiency of bees. Bees were either inoculated with Crithidia cells or a sham mixture of 50% sucrose and DI water. At these two levels of inoculation treatment, half of the bees were fed a sunflower pollen diet and half were fed a control wildflower pollen diet beginning one week after inoculation. Then after seven to ten days of the sunflower or control diet, bees were introduced to a square mesh cage with a snapdragon plant inside. The data collected analyzed both the amount of time that bees in every treatment group spent foraging on snapdragon flower as well as the amount of pollination that occurred, measured by the number of pollen grains deposited on the stamens of foraged flowers. This project is ongoing, so the data and analysis available will be limited for the poster presentation.

Title: Assessing the growth of Bacteroides thetaiotaomicron on different sources of dietary protein.

Presenter(s): Alissa Meyerhoffer

Mentor(s): Manuel Kleiner

REU/Summer Research Program: OUR Award

The gut microbiota is composed of complex and varying groups of microorganisms. The composition of the gut microbiota plays a major role in the metabolism and, consequently, the health of the individual. One of the things that alters the composition of the gut microbiota is diet. In a recent study using mice, we found that providing yeast or egg protein as the sole protein source in a mouse's diet led to an increase in the abundance of Bacteroides thetaiotaomicron at the expense of the rest of the microbiota. Proteomic analysis under these conditions revealed abundant B. thetaiotaomicron proteins that are involved in the hydrolysis of polysaccharides, and the import and metabolism of acetylglucosamine in the case of egg protein and mannose in the case of yeast protein. Since mannose is a component of yeast glycoproteins and acetylglucosamine is a component of egg white glycoproteins, this suggests that egg and yeast protein diets promote the abundance of B. thetaiotaomicron through the metabolism of these glycoproteins. In this study, we are seeking to confirm that B. thetaiotaomicron grows on yeast and egg protein through the consumption of these specific sugars from glycoproteins. This is accomplished through optimizing anaerobic growth in hungate tubes through a variety of anaerobic methods. Findings from this research provides a better understanding of one of the many bacterial species that make up the gastrointestinal tract and will hopefully lead to future research investigating the effect of diet on intestinal bacteria.

Title: Describing the interactions between pathogens and parasites within honey bee colonies

Presenter(s): Cameron Murray

Mentor(s): David Tarpy

REU/Summer Research Program: BeeMORE

Viral pathogens transmitted by the Varroa mite parasite, Varroa destructor, pose a high burden on the health and productivity of managed honey bee populations. Many of these diseases are asymptomatic and thus difficult to diagnose in the hive without use of genetic testing, making it difficult to identify and address unhealthy colonies. Finding predictive links among virus prevalence, the presence of Varroa destructor, and the time of year may help beekeepers prevent the spread of disease within and among hives and may enable them to more effectively reduce colony losses. In this experiment, the prevalence of eight common honey bee viruses were recorded every other week in 20 colonies over a period of 30 weeks. Samples have been taken for Varroa mites, honey bee nurses, worker pupae, mature drones, and entire colonies to elucidate a pattern of where viral pathogens are located within colonies. These samples were screened for Acute Bee Paralysis Virus, Black Queen Cell Virus, Chronic Bee Paralysis Virus, Deformed Wing Viruses A and B, Israeli Acute Paralysis Virus, Lake Sinai Virus, Trypanosomes, and Nosema spp. using qPCR. It is expected that colonies later in the season and those with more Varroa mites will have higher viral prevalence. Preliminary analysis suggests that worker pupae samples have higher prevalence and intensity of viruses and thus may be a better predictor of viral load and colony health than an indiscriminate

colony sample, although additional statistical analysis is required to fully determine the pathogen webs within honey bees.

Title: Identifying and Operationalizing Indicators of Illicit Massage Business using NLP

Presenter(s): Joaquin Nieves Baez

Mentor(s): Maria Mayorga

REU/Summer Research Program: RISE ISE

An estimated 9,000 illicit massage businesses (IMBs) are operating today in the United States. IMBs have been found to participate in human trafficking, including labor and sex trafficking, and to aid in covering up money laundering organizations. Despite the many efforts that exist today to help shut down these businesses, it is not an easy task. Therefore, the purpose of this project is to identify and operationalize indicators of illicit massage businesses by analyzing stakeholder interviews using text preprocessing and natural language processing for topic modeling techniques. Topic modeling's main task is to discover abstract topics in a collection of documents, which in our case will help to identify key topics to look for when identifying illicit massage businesses. We interviewed 24 stakeholders from multiple sectors including nonprofit organizations, law enforcement agencies, and various federal and state agencies. This work will help such stakeholders identify illicit massage businesses more easily, therefore helping them shut these down.

Title: Screening hybrid poplar clones for resistance to Phytophthora

Presenter(s): Emely Pacheco

Mentor(s): Elizabeth Nichols

REU/Summer Research Program: OUR Award

Warming climate and continued spread of Phytophthora in the mountains of western North Carolina poses a significant threat to the Christmas Tree industry. Phytophthora is a soil pathogen that exerts total mortality for Fraser fir. In order to determine which clones have the highest tolerance, different clones of poplar whips were collected and planted. The next steps were to monitor their growth and soil moisture and then expose the clones to P. cinnamomi (the most virulent Phytophthora species). The poplars were inoculated with P. cinnamomi through the soil using P. cinnamomi-soaked rice grains. The growth and survival differences between treated and non-treated poplar clones will be recorded. Mortality will be assessed weekly for 16 weeks. This study hopes to give insight since poplar offers opportunities to restore prior Fraser fir acreage infested with Phytophthora to high-value veneer poplar production with marketable products in 10 to 12 years.

Title: Brain-Controlled Wheelchair: The effectiveness and inclusiveness of Motor Imagery based Brain-Computer Interfaces in disabled populations.

Presenter(s): Auston Parker

Mentor(s): Change Nam

REU/Summer Research Program: RISE

Brain-Controlled Wheelchair: The effectiveness and inclusiveness of Motor Imagery based Brain-Computer Interfaces in disabled populations.Brain-Computer Interface (BCI) controlled systems will be an important tool in the aid of disabled and differently abled peoples. Using electroencephalography (EEG) technology and motor imagery, humans can control and manipulate systems such as wheelchairs with just the power of thought. It is known that by analyzing resting state sensorimotor rhythms predictions can be made about the compatibility of subjects with motor imagery BCIs'. Yet, there is a scarcity of information regarding the usability of such BCI systems with disabled patients, despite their importance as the primary consumer. The aim of this study is to compare the performance of motor imagery (MI) based BCI systems with able-bodied and disabled participants and the predictive abilities of certain brain-wave frequencies as biomarkers for wheelchair control. Participants are asked to navigate a course and avoid obstacles with a wheelchair driven by motor imagery signals and a three-class Support Vector Machine (SVM) classifier. In both populations, this study will analyze the correlation of sensorimotor rhythm biomarkers with user success in course completion, while also evaluating user experience, satisfaction, and levels of comfort.

ABSTRACTS | SESSION 3

Title: Engineering a Thermophilic Biotin Carboxylase to Increase CO2 Fixation in Plants

Presenter(s): Ayil Perrott

Mentor(s): Robert Rose

Carbon dioxide is the most abundant greenhouse gas. Researchers at NCState have proposed to reduce atmospheric CO2 by adapting an alternative carbon fixation pathway, the reductive TCA (rTCA) cycle, to plants. Our research focuses on modifying an enzyme 2-oxoglutarate carboxylase (OGC), part of the rTCA cycle utilized of the chemoautotrophic bacteria Hydrogenobacter thermophilus, to optimize this pathway in plants. This thermophilic enzyme functions at temperatures greater than 70oC, but is inactive at the lower temperatures in which plants reside. OGC belongs to the biotin-dependent carboxylase family homologous to pyruvate carboxylase, which possess three common domains. The first, the biotin carboxylase (BC) domain, uses ATP to capture bicarbonate and transfer it to the biotin cofactor, and also contains a flexible "lid" structure that closes over the bound substrates. Our goal is to identify mutations that will increase activity at 25oC. Previous studies in the Rose lab proposed that the lid domain contributed to the high temperature activity of OGC BC. To test this hypothesis, an OGC chimera was cloned in which the wild type BC lid subunit was switched with the lid from the pyruvate carboxylase of mesophilic Rhizobium etli. This chimera was expressed in E. coli and purified by Nickel affinity and size-exclusion chromatography. The BC reaction rate was measured by formation of ADP followed by NADH oxidation with a secondary reaction catalyzed by pyruvate kinase and lactate dehydrogenase. Our preliminary studies indicate that this chimera is active, but is not more active at lower temperatures than the wild type.

Title: Impact of Oxytetracycline treatment on mite and pathogen levels in honey colonies

Presenter(s): Megan Phung

Mentor(s): Bradley Metz

REU/Summer Research Program: BeeMORE

The importance of honey bees has been known, recognized, and researched throughout history. When humans began to actively manage bees, various methods were developed to improve their health and productivity. The infestation of Varroa destructor mites has become particularly devastating to honey bee populations, affecting the physical condition of the bees making them more susceptible to pathogens. Currently, there are antibiotic treatments for certain bacterial pathogens, such as Oxytetracycline. The purpose of this experiment is to investigate the effects of Oxytetracycline and its effectiveness in the treatment of pathogens, mites, and impacts on reproductive health, as well as their interactions. Forty honey bee colonies, initially treated for Varroa mites with formic acid, were placed into one of two treatment groups: antibiotic or control. Antibiotic colonies were treated with a formulation of antibiotic and sugar formulation every 5 days for 15 days; control colonies were not manipulated. Following the antibiotic treatment period, mite and virus samples were collected. Bees and mites were hand-counted to ensure accuracy on the overall percentage of infestation, which was done blindly to prevent any bias from occurring. The results varied with some colonies increasing in mites through the treatment period and others decreasing. Colonies were then subjected to qPCR analyses of several viral and bacterial pathogens to determine if they differentially harbored various infections. Understanding the full impact of antibiotic treatment on colony health will help improve management of the honey bee population.

Title: Raw Milk Lab Optimization

Presenter(s): Megan Rossi, Tara Esmailian

Mentor(s): Lynette Johnston

REU/Summer Research Program: Food Science Summer Scholars

Approximately 48 million cases of foodborne illness occur annually in the United States. Unpasteurized milk and milk products have a high potential to increase cases of disease; however, misinformation surrounding nutritive values and health claims have caused individuals to believe they are choosing healthier options when in reality they are putting themselves at risk. The overall goal of this project was to develop a food microbiology lab module focused on food safety risks and preventive controls of raw milk. The first objective was to develop material to educate students and consumers on the risks associated with consumption of unpasteurized milk. A powerpoint presentation was developed as a teaching tool to provide background information on various topics associated with raw milk, including foodborne outbreaks, common nutrition misconceptions and health claims, state and federal regulations, and treatments used to process raw milk. A fact sheet was also developed as a way to communicate with the general public and will be distributed through NC State food safety extension programs. The second objective optimized the procedure of an existing teaching lab on heat inactivation of vegetative cells and spores in milk. Using a previously developed procedure for the thermal inactivation lab in the food microbiology course, we optimized the lab to include a comparison of non-flavored to chocolate milk to better understand heat resistance in spore-forming bacteria. The project provides an opportunity for increased awareness of risks associated with raw milk, as

well as factors impacting effective heat inactivation of milk and milk products.

Title: Analyzing Honey-Bee Behavior and Effectiveness in Pollination Services

Presenter(s): Peyton Rudman

Mentor(s): Elsa Youngsteadt

REU/Summer Research Program: BeeMORE

Pollination is essential to agricultural production, and insect communities that provide this service are expected to decline or shift due to environmental change. The degree of impact on pollination depends on the efficiency of the individual species. For example, the amount of pollen a single bee deposits determines its effectiveness as a pollinator, but the behaviors that contribute to pollen deposition are undetermined. Here I raise the question, does single visit duration determine the species' effectiveness in pollination? I predict honey bees that visit the longest and earlier in the morning will be more effective pollinators than other bee species. To test this, I will record the duration a single honey bee spends visiting a virgin female cucumber flower. I will observe their behavior at different times throughout the morning to assess their pollination habits. Once the honey bee has visited the virgin female flower, I will allow pollen grains to adhere overnight, and count the pollen grains deposited. As a control, I will observe the honey bee's natural pollination patterns on the cucumber plants and record the duration honey bees spend on previously visited cucumber flowers (non-virgin flowers). To compare to other non-honey-bee species, I will observe and record the duration of pollination for the top three most visited species in a five-minute period during the same morning time frames. These results will determine what specific behaviors make an effective pollinator. This information will be useful in understanding pollination services in insect-dependent crops within agricultural production.

Title: Connections Between Disinfectant Byproducts in Water and Canine Cancer

Presenter(s): Carly Ruslander

Mentor(s): Matthew Breen

Urothelial carcinoma is a commonly diagnosed malignancy in canines and humans. A positive BRAF mutation has been implicated in causing the cancer, as well as exposure to environmental toxins such as disinfectant byproducts. Two genetic variants have been associated with the metabolism of disinfectant byproducts and the onset of bladder cancer, CYP1A1 and LSP1. It has been previously determined that dogs and owners experience the same chemicals at the same levels in their daily lives. The goal of this study is to determine the relationship between the metabolism of disinfectant byproducts and the onset of urothelial carcinoma in canines to help improve outcomes for both dogs and humans. We will compare the levels of disinfectant byproducts in the water that is drank by both dogs that are BRAF positive and negative. We will also be testing our cases and controls to determine if they have the genetic variants that have been associated with exposure to disinfectant byproducts and bladder cancer. We will use whole genome DNA collected from cheek swabs to run a PCR. After running a gel electrophoresis to ensure the DNA has been properly amplified, we will send the samples off for sanger sequencing.

Title: Site Directed Mutagenesis of Bovine Serum Albumin to Characterize the Redox Mechanism of Amyloid Formation

Presenter(s): Bea Sewell

Mentor(s): Michael Goshe

REU/Summer Research Program: OUR Award

Amyloid aggregation is commonly associated with pathogenic diseases such as Alzheimer's and Parkinson's. These aggregations are known to seed fibril formation which causes degenerative plaques in tissues. In order to combat these degenerative diseases, the root cause of amyloid aggregation must be investigated, therefore our lab is developing methods to better understand these mechanisms. Using one of our approaches, we revealed a role for disulfide bond shuffling in amyloid formation. Disulfide bonds are post-translational modifications that are crucial for protein folding and stability. Assays developed by our lab showed that bovine serum albumin (BSA) underwent amyloid fibrillation when the disulfide bonds were disrupted by dithiothreitol. This amyloid fibrillation was theorized to be initiated by exposing buried disulfide bonds to a redox environment to trigger a chain reaction of spontaneous non-native pairings. To probe this hypothesis with BSA, our next step is to create in vitro mutants using site-directed mutagenesis and serine scanning of cysteinyl residues. The first step for this approach is to establish a recombinant system to overexpress BSA. This summer we have proposed a protocol for overexpressing wild-type BSA, identified and developed primers for our first set of mutants, and plan to conduct the site directed mutagenesis in the fall.

ABSTRACTS | SESSION 3

Title: Fiber Reinforced Low Thermal Conductivity Silicone Elastomers

Presenter(s): Tvisha Shete

Mentor(s): Mehmet Ozturk

REU/Summer Research Program: ASSIST

There is a growing interest in flexible thermoelectric generators (TEGs) for harvesting body heat to power wearable health monitoring electronics. TEGs produce an output voltage proportional to the temperature differential that develops across them. For optimal heat transfer, flexible TEGs require both low and high thermal conductivity elastomers in their structures. The thermal conductivity of a silicone elastomer can be reduced by incorporating air filled pores in the material. Unfortunately, the pores degrade the mechanical integrity of the elastomer. In this work, we have added a fibrous filler to improve the mechanical stability of silicone elastomers. The tensile strength and heat transfer of non-porous Ecoflex® reinforced with 0.4 w/w%, 0.6 w/w%, and 0.8 w/w% of polypropylene (PP) fiber were compared. The fiber homogeneity in the reinforced elastomeric lattices was studied microscopically, and the quality of heat transfer between the two sides of the non-reinforced elastomers were compared via IR thermal imaging.

Title: Nanocomposite-based Rigid TEG for Wearable Devices

Presenter(s): Salma Soliman

Mentor(s): Daryoosh Vashaee

REU/Summer Research Program: ASSIST

The human body dissipates heat through the skin all the time. Harvesting this thermal energy is a research hotspot for wearable devices and bioelectronics, particularly with the increasing global demand for batteryless wearable devices. Thermal energy can be harvested and converted into electricity through transducers such as thermoelectric generators (TEGs), to produce electric power for small devices. However, the harvested power density from the body using TEGs is limited to a few ten micro-watts per square centimeter, which is insufficient to turn on many wearables. To date, the highest power density of 44.2 μW/cm2 under no airflow conditions, and 156.5 μW/cm2 under airflow is achieved by the ASSIST Center, NCSU in 2020. The device consisted of a nanocomposite- p-type with commercial n-type legs (unmatched legs). Compared to commercial TEGs tested under similar conditions, the nanocomposite-based TEGs exhibited 4–7 times higher power density on the human body depending on the convective cooling conditions. However, this previous study proved theoretically that a TEG with both p- and n-type nanocomposites could produce 55% higher output power, increasing the system efficiency. This summer, we are working on fabricating a rigid TEG based on matched nanocomposite legs to prove that practically. The process involves metalizing the nanocomposite disks, dicing them into 0.6mm x 0.6mm x 3mm TE legs using a diamond wire saw, bonding legs with headers, and finally testing the rigid TEG on a wrist-mounted low-power sensor platform.

Title: A Study of the Luxury Effect and Bee Populations in Raleigh N.C.

Presenter(s): Alassane Sow

Mentor(s): Elsa Youngsteadt

REU/Summer Research Program: BeeMORE

A phenomenon called the luxury effect describes the positive correlation between affluence and biodiversity in cities.The luxury effect has been studied extensively with plants and birds, but insects remain relatively unstudied, despite their contribution to major ecosystem services and disservices.Bees are an economically and environmentally important group of insects that pollinate many of our crops and wild plants. In this study we aim to find the mechanisms that explain the luxury effect in urban bee populations. Because 70% of wild bee species nest in the ground, we hypothesize that the ground cover and soil characteristics will correlate with both socioeconomic class and bee biodiversity. In this study we sampled from 30 homes in Raleigh, NC. We selected sites representing census block groups with median household incomes between $10,000 - $200,000 according to the 2014 census. Over several sampling periods we visited each house and recorded soil characteristics like drainage, slope, soil texture and compaction.We also marked potential bee nests, placed traps over them, and netted bees for 40 minutes of search effort to get a representative sample of the bee population on each site. The results of this ongoing work will describe the correlations between socioeconomic class, available soil-nesting resources, and bee diversity. By understanding how the luxury effect works in bee populations we can take more effective measures to reduce their population decline.

ABSTRACTS | SESSION 3

Title: Measuring Heat Release from Ash under Landfill Relevant Conditions

Presenter(s): Helen Steffens

Mentor(s): Morton Barlaz

REU/Summer Research Program: RISE CCEE

In recent years, a few municipal solid waste (MSW) landfills have experienced temperatures as high as 80 - 100°C. These landfills are characterized as elevated temperature landfills (ETLFs) and have caused damage to landfill gas and leachate collection systems that can be expensive to repair and make landfills harder to maintain. Currently, there are no methods to effectively measure heat release from heat generating wastes under landfill relevant conditions. This study aims to develop a reactor system that can be used to measure heat release from carbonation and hydration reactions as applied to ash buried in MSW landfills. The proposed reactor system utilizes a well-insulated, semi adiabatic flow system where heat can be measured from a carbonation or hydration reaction using a temperature sensor. The study includes characterizing reactor heat loss, measuring heat release from the carbonation and hydration of calcium oxide and hydroxide, and comparing the measured to theoretical values. To simulate landfill conditions, both moisture and carbon dioxide will be added to the reactor. The development of the reactor is ongoing, and the results will lead to a method for measuring heat release from landfills. Information on the heat release potential of a waste will then be used in a model of heat accumulation in landfills to estimate the mass of waste that can be disposed of without unacceptable heat accumulation.

Title: NCSU iGEM 2022-ForgetMeNot

Presenter(s): Neha Suresh, Seeva Cherukuri, Daniel Spang, Saarim Ahmed

Mentor(s): Adriana San Miguel

REU/Summer Research Program: OUR Award

iGEM is an annual, international synthetic biology competition. This project represents the first undergraduate team from NCSU at this competition. Dementia is an age related, late onset neurodegenerative disease characterized by the failure of recent memory and essential brain functions such as visual-spatial orientation and attention. Alzheimer's Disease(AD) is the most common form of dementia,it affects 5-10% of the U.S population over 45 years, it's incidence is said to threefold in 50 years from now. The total number of people with AD dementia is projected to be 13.8 million in 2050. Our project titled,'ForgetMeNot,'consists of a dry lab project that is using quantum-classical hybrid machine learning(QML) to classify MRIs of patients into AD, Mild Cognitive Impairment (MCI) and Cognitively Normal (CN). The wetlab project is looking to intervene at the MCI stage-studying and reengineering the microbiome-microglial circuit along the gut-brain axis to confer neuroprotection at the MCI stage, and prevent neurotoxicity from high GABA levels. A neuroethical report will accompany the wet lab experiment to educate undergraduate researchers and the general public on the ethics of gene editing and synthetic biology. Finally, we create a drug discovery platform for AD using QML. After surveying the relevant stakeholders, we are developing a user centric HIPAA compliant app that allows caregivers and patients to house all relevant medical information and milestones from a patient's life in one compact Near-Field-Communication (NFC) card.

Title: Method development for determination of extractable organic fluorine in environmental and biological samples

Presenter(s): Stefanie Tran

Mentor(s): Detlef Knappe

REU/Summer Research Program: RISE

Per- and polyfluoroalkyl substances(PFAS)are highly fluorinated aliphatic substances that are widely found in water, air, soil, fish, numerous food products,and human blood. Previous studies have discussed the harmful effects of PFAS on the environment, our drinking water, and human health. However,there is limited research on determining concentrations of unidentified organic fluorine compounds in blood and water. Therefore, the purpose of this study is to develop an analytical method to measure the concentration of organic fluorine as a way to assess total PFAS in environmental and biological samples. Before testing the blood samples for PFAS,the method was first tested and optimized using ultrapure water. First, the use of a mix of PFAS for calibration was chosen instead of an individual compound to better simulate the combustion efficiencies of unknown fluorinated chemicals. Second, the necessity to account for interferences like inorganic fluoride, which is naturally present in environmental samples, was assessed by measuring a known amount of inorganic fluoride in the mixture and comparing the results to the organic fluorine curve that is used in quantification. This study contributes to the body of knowledge of the field by developing new strategies for a more accurate organic fluorine measurement in complex systems, as well as better accounting for the impact inorganic fluoride has on CIC measurements.Future directions for the method will be to apply it to blood serum samples of more than 1,000 people, who are living in the Cape Fear River basin(Wilmington, Fayetteville, Pittsboro- NC) and participating in the GenX exposure study.

ABSTRACTS | SESSION 3

Title: Changes in Microbial Abundance and Nutritional Content through Bee Bread Maturation in the Nests of the Eastern Large Carpenter Bee Xylocopa Virginica

Presenter(s): Estefany Valdez, Maeve Finley

Mentor(s): Aram Mikaelyan

REU/Summer Research Program: BeeMORE

Xylocopa virginica, the eastern large carpenter bee, are facultatively social bees that nest in decaying and dead wood. These important pollinators construct their nest by creating individual brood cells. In each of these cells, the mother bee deposits pollen provisions, or "bee bread", for her larvae. This mixture of pollen, nectar, and saliva is crucial for the development of a young carpenter bee. Microbes in the pollen provision are essential for developing larvae, since axenic diets have been shown to negatively affect growth rates, biomass, and survivorship in bees. However, the precise contributions of the pollen provision microbiome of X. virginica remains undescribed. In addition, the impact of microbial abundance on the nutritional quality of the pollen provision is still unknown. In this project, we quantified the microbial DNA in the pollen provisions using primers specific to the V3–V4 region of the 16S rRNA gene to estimate the absolute abundance of the bacterial community present on pollen provisions. We also determined the nutritional quality of the provisions using the Bradford assay to quantify protein content. By estimating larval mass, length, and development, we related pollen nutritional quality to larval health.

Title: Effects of Nectar Yeast in Pollinator Foraging Preference

Presenter(s): Mickaela Elizabeth Whilden

Mentor(s): Elizabeth Moore

REU/Summer Research Program: BeeMORE

Microbes play important and complex roles in ecological systems, yet their interactions with multicellular organisms are understudied and poorly understood. Symbiotic relationships between yeasts and insects have evolved multiple times across diverse taxa of both organisms, and appears to be an ancient association. Yeast is highly present in nature and a multitude of species colonize flower nectar. Evidence suggests that these yeast have mutualistic relationships with pollinating insects, especially bees. We believe that pollinators have a preference for nectars containing yeast, because floral yeast requires nectar to grow, therefore, where yeast is present, food is present. The yeast within nectar releases volatiles that have been shown to be attractive to bumblebees, but remains to be investigated in other species. We conducted an observational field experiment to investigate the effect of nectar yeast on bee pollinator foraging preference. To assess bee preference, live flowers from 3 plant species were inoculated with one of two treatments: artificial nectar that contained native yeast strains, or sterile artificial nectar. Pollinators were observed foraging among the plants, and the number, order, and length of flower visits were recorded for each visitor. Primarily honey bee, bumble bee, and carpenter bees were recorded, but several lepidoptera, coleoptera and hemiptera were found on these plants as well. Based on the preliminary analysis of our data, we believe that pollinators have a preference for nectars with yeast present, but further analysis is necessary.

Title: Modeling Energy and Water Use Changes in a Hybrid Water System in Perth, Australia

Presenter(s): Elias Zauscher

Mentor(s): Emily Berglund

REU/Summer Research Program: RISE CCEE

As the climate warms, urban water systems will need to adjust to a future with increased water demand and constrained resources to make a shift toward climate independent sources. Novel water management strategies, such as water trading, connected to an Agent-based Model (ABM), can show the expected conservation of municipal and groundwater resources. Unlike past studies which use simulated water flow data, this research will use an existing dataset that describes real-world water demands for households in Perth, Australia. Municipal water in Perth comes from surface water dams, desalination, and groundwater. The ABM couples the Perth dataset with MODFLOW, which is a modeling tool for simulating natural water systems, especially groundwater aquifers. Households act as agents and can microtrade water, or sell and purchase water from other household agents. Micro-trading requires no pipe network as surplus water is traded via the underground aquifer. The Perth dataset reports demand data alone, and surplus rainwater is estimated based on rainwater demands and precipitation. Surplus rainwater can be sold by household agents that act as prosumers, and households that purchase rainwater can pump the bought water from a backyard bore. We expect to see that through the use of water trading, households will reduce freshwater demands, consume less energy in pumping water from wells, and save costs. As a result of decreased demand from houses, water suppliers will consume less energy to pump water to households and will reduce demands on a sensitive groundwater aquifer.

ABSTRACTS | SESSION 4

Title: Rhs-toxin Diversity, Abundance, and Function in the bacterial pathogen Xanthomonas.

Presenter(s): Xiomara Alcantara Ocampo

Mentor(s): Alejandra Huerta

REU/Summer Research Program: Kelman Scholars

Phytopathogenic bacteria cause plant diseases and yield loss in many crops worldwide. Within microbial communities, intra- and interspecies interactions can influence bacterial survival, resilience, and persistence. To compete for resources and space, phytobacterial pathogens have evolved a variety of molecular mechanisms that impact the growth of competitor bacterial cells in their environment. Rearrangement hot spot toxins (Rhs-toxins), is one mechanism that bacteria use for cell-to-cell competition. These toxins are ubiquitous in bacteria, including species in the genus *Xanthomonas*. Intra- and interspecies competition is an attractive mechanism to study for the development of targeted biological disease management tools due to the difficulty in managing phytobacterial pathogens in field settings. Toward this end, we characterized Rhs-toxins diversity and abundance in gram-negative bacteria in the genus *Xanthomonas*. We used a Hidden Markov Model to mine the proteomes of 1,844 *Xanthomonas* strains. The in-silico analysis identified 5,283 putative Rhs-toxins for this bacterial *Xanthomonas*. Among the 16 species in the genus *X. vesicatoria* showed the least number of Rhs-toxins per genome at zero, whereas, *Xanthomonas spp* had the largest with 17 putative toxins per genome. We hypothesize that the large abundance of Rhs-toxins found among species contributes to this pathogen's ability to occupy different ecological niches and infect different hosts.
Keywords: rhs, toxins, competition, molecular mechanisms, lifestyle, host, Hidden Markov Model.

Title: Exploring the phenotypic and genetic diversity of Xanthomonas arboricola pv. pruni, a bacterial pathogen of peach, to develop alternative treatment to copper tolerance in pathogen populations.

Presenter(s): Mark Almazo Rosendo

Mentor(s): Alejandra Huerta

REU/Summer Research Program: CEFS ASPIRE

North Carolina (N.C.) peach farmers experience hardship on their peach orchards due to the bacterial pathogen, Xanthomonas arboricola pv. pruni (Xap). Characteristic symptoms of the disease include water soaking, and chlorotic spots, then followed by dark necrotic spots on the surface of peach leaves. Current practices to manage the disease include spraying copper based chemicals; this has caused copper tolerance to build in the Xap pathogen population. Understanding the genetic diversity of Xap in peach orchards is a significant step to understand this bacterial pathogen and to identify corrective treatments.The study examines genetic diversity of Xap strains across spatial and temporal scales using bacterial stains isolated from symptomatic leaves. To test our hypothesis, we collected 190 symptomatic leaf samples from peach trees at the Sandhill Research Station during the 2020 and 2021 summer season. Next, we used a sterile metal pick to pick at the border of bacterial spots on symptomatic tissue. The same pick was used to streak across Nutrient Agar plates and incubated at 28C for 24 hrs. Single colonies that were yellow, a characteristic of Xap, were selected for restreaking and strain purification and storage until further characterization. Putative Xap isolates were genotyped using Xap specific primers. Of 44 bacterial isolates screened, 31 amplified the correct band sizes for FTSX, QUMA, and 16s. The confirmed Xap strains will be sent for whole genome sequencing to allow for comparative genomic studies that provide an explicit overview of the genetic diversity of Xap strains in peach orchards.

Title: Exploring Crystal Growth Theory to Understand the Mechanism(s) of Crystal Growth from Saturated Solutions

Presenter(s): Sydney Andersen

Mentor(s): James Martin

REU/Summer Research Program: OUR Award

Crystal growth is one of the most important processes in the world, from synthetic crystal formation and thermal energy storage to explaining natural processes such as cloud formation and geologic phenomena. Crystal growth models in the literature are largely extended from gas phase condensation reactions. Thus, they do not accurately reflect crystal growth out of condensed systems (i.e., melts or saturated solutions). Previous work in the Martin group proposed Transition Zone Theory (TZT), which is the condensed matter analog to Eyring's transition state theory. This uniquely condensed phase theory results in a superior fit of experimental crystal growth

rate data. We are working to extend this theory to describe crystallization out of saturated solutions. Crystal growth rate data will be presented for the $ZnCl_2$: R H_2O hydrate system between the congruently melting R = 3 hydrate, and its eutectic at R = 4.1, and for temperatures between the system's liquidus to -75 °C (about 40 ° below the eutectic temperature). Crystal growth rates are measured by polarized optical video microscopy and by DSC. Analysis of this concentration and temperature dependent data shows evidence of melt-like growth when first quenched to the crystallization isotherm which is followed by diffusion limited growth as equilibrium concentrations are achieved. It will be demonstrated that this data is consistent with a solution-modification to TZT. The initial growth phase is shown to proceed via an associative mechanism whereas the latter diffusion limited regime proceeds via a dissociative mechanism.

Title: Pest Management Practices in Blackberries and their Impacts on Pollination

Presenter(s): Jarin Arline

Mentor(s): Hannah Levenson

REU/Summer Research Program: CEFS ASPIRE

One of the biggest challenges in agriculture is to manage insect pests that jeopardize crop production. However, many crops also rely on pollination by bees and other insects creating a struggle to balance protecting pollinator populations and minimizing pest damage. To investigate this interaction we documented pollinator populations on North Carolina blackberry farms and how the management of an invasive fruit fly pest - Spotted Wing Drosophila (SWD) - may impact crop pollination. Pollinator surveys were conducted for three weeks in April and May - during blackberry bloom - at four sites across North Carolina. Once ripe, berries were collected, measured for symmetry and weight, and screened for SWD larval infestation. We will compare the documented pollinator communities to the berry symmetry to evaluate pollination services provided. We will also compare SWD infestation levels to see how grower management impacts pest and pollinator populations. The results from this research will be shared with berry growers and researchers across the US and will provide critical information on sustainable management in berry crops. As pollinator communities in blackberry crops is an understudied topic, this work will act as the baseline for future research.

Title: SEGS-1 Activity in CMD Resistant Cassava Cultivars

Presenter(s): Thomas Baird

Mentor(s): Linda Hanely-Bowdoin

REU/Summer Research Program: Integrative Microbial and Plant Sciences

African agriculture has been devastated by geminiviruses that cause the Cassava Mosaic Disease (CMD). The African Cassava Mosaic Virus (ACMV) and the East African Cassava Mosaic Virus Kenyan Isolate (EACMV-K-401) both have bipartite ssDNA genomes and are transmitted by a whitefly vector (B. tabaci). They contain an A component that codes for proteins involved in viral replication, encapsidation, and countering host defenses and a B component that facilitates movement. Researchers (Ndunguru et al, 2016) discovered SEGS-1 (Sequences Enhancing Geminivirus Symptoms), which occurs in the cassava genome and is released as an episome during viral infection. SEGS-1 episomes are associated with breaking CMD resistance in some cultivars and enhancing mosaic symptoms. This study seeks to understand the relationship between the geminiviruses, SEGS-1, and the severity of infection over a 28-day period. Two lines of resistant cultivars, TME7 with the CMD-2 locus and Mkombozi with uncharacterized resistance, were infected with various combinations of ACMV, EACMV-K-401, and SEGS-2, a satellite that enhances viral symptoms (Aimone, et al (2021). Symptom scores have been taken every week, and tissue samples have been taken every 14 days for viral titer analysis (qPCR) and episome detection.

Title: Crystal Skipper Conservation

Presenter(s): Andrew Barfield, Heather Moeller

Mentor(s): Carol Price

REU/Summer Research Program: OUR Award

The Crystal skipper is a small brown butterfly endemic to a 30-mile stretch of barrier islands on the North Carolina Crystal Coast. Scientists first collected data on the insect in 1978, but it was not declared a new species until 2015. Crystal skippers get their name from the small white "crystals" that can be seen on its brown wings, and for its location along the NC Crystal Coast. The population range of this species is from Bear Island in Hammocks Beach State Park through Bogue Banks to Fort Macon State Park in Atlantic Beach. Smaller populations have also been previously detected on Radio Island and the Rachel Carson Reserve. During the months of

ABSTRACTS | SESSION 4

April-May and July-August, the Crystal skipper has two adult flight periods where butterflies can be seen flying around the dunes of the NC Crystal Coast. Individual adults live an estimated 9-14 days and are highly mobile, regularly moving hundreds of meters up to several kilometers. My work will consist of monitoring skipper populations throughout their habitat range during their second flight period, as well as documenting what nectar plants skippers are seen feeding on.

Title: Does adding pollinator conservation habitat increase mite abundance on bees?

Presenter(s): Nia Brown

Mentor(s): Hannah Levenson

REU/Summer Research Program: BeeMORE

Bees visit flowers to actively collect pollen and nectar - their sources of protein and carbohydrates. However, they may sometimes unintentionally pick up tiny mites and bring them back to their nests. But, little is known about what dictates the presence of these mites or the health impacts - if any - to the bees. Since bees are critical pollinators worldwide, pollinating over 85 percent of our natural areas and agricultural systems, their health is of high concern. To investigate the presence of mites on bees, we utilized samples collected in 2019 from six NCDA&CS Experimental Agricultural Research Stations across North Carolina. Samples were collected either from pollinator habitat - planted for pollinator conservation - or from crop fields - soybean. We then inspected each specimen under the microscope and documented the location on the bees' bodies and how many mites were found. For this study we are comparing the data to habitat characteristics - such as location, field type, flower type, and amount of pollen on each specimen - to better understand what factors are important in mite abundance on bees. The results from this research will provide important information for pollinator conservation. Pollinator conservation is essential to our global ecosystems, without them crops and human health could be jeopardized. As adding habitat to support pollinators is a popular conservation tool, we need to investigate the impacts of such habitat. Future pollinator habitat establishment should be designed to not just support bees, but to support healthy bees and crops.

Title: UAV-Based Characterization of Micro-Topographic Features for Use in Estimating Soil Moisture and Nitrous Oxide Emissions in Agriculture Fields.

Presenter(s): Brynna Bruxellas

Mentor(s): Robert Austin

REU/Summer Research Program: BESST

Yields are extremely important to farmers and highly related to the efficient use of nitrogen. Not all of the nitrogen makes it to the crop. Two reasons for this involve leaching and loss to the atmosphere as nitrous oxide. This loss is highly variable and often related to the underlying soil and topographic properties. For the purpose of this research, we looked at five factors that are uniquely related: soil moisture, micro-topographic features, long-wave infrared (LWIR) emissions, soil properties, and nitrous oxide emissions. Soil moisture is often controlled by soil texture and landscape position. It is difficult to assess because it can change quickly over time and space, which makes on-ground assessment via direct measurement difficult at the field scale. To overcome this, we used both true-color and multi-spectral images captured from drones to determine elevation, topographic characteristics, plant growth, and heat distribution. Unmanned aircraft are a new and emerging technology that allow for the rapid collection of data that can be used to help assess soil moisture and subsequently nitrous oxide emissions. We also used a soil moisture sensor in the corn field. We set up fifteen nitrous oxide gas chambers along two perpendicular transects 160 feet in length and measured the emissions. We used an auger to collect the soil samples. We determined the location of the chambers and the soil samples by using maps created by the UAV flights, Metashape, and GIS software. By conducting this research, we better understand nitrogen losses and crop yields.

Title: A dual labeling procedure to analyze cell cycle progression

Presenter(s): Mason Burroughs

Mentor(s): William Thompson

Labeling of nascent DNA with nucleotide analogs is a method that has long been used to enable analysis of the processes that occur during S-phase in the cell cycle. Several thymidine analogs have been used to accomplish this goal including 5-bromo-2'-deoxyuridine (BrdU) and more recently 5-ethynyl-2'-deoxyuridine (EdU). It is typical for a single analog to be used in experiments aimed at gathering data on which areas of the genome replicate at what times during S-phase. Data from some of these single-analog experiments in Zea mays have shown examples of cells in the very early stage of S-phase that display certain characteristics typical of cells in late S-phase. This has spurred the question of whether these data are due to some cells going extremely rapidly through the cell cycle during the

labeling period. To answer this question, this research project aims to optimize a procedure for using dual-pulse labeling with EdU and BrdU in plant cells to provide a method for determining whether this rapid progression through the cell cycle could be occurring. In these experiments the root cells of Z. mays seedlings are first labeled with EdU followed by BrdU labeling. The tips of the roots (0-1mm) are collected and the nuclei from the cells of those root tips are isolated, stained, and analyzed using flow cytometry and fluorescence imaging.

Title: The Effect of Selection for Early Flowering on Tassel Length and Branch Numbers in Tropical Maize Populations

Presenter(s): Mika Chabeda

Mentor(s): James Holland

REU/Summer Research Program: CEFS ASPIRE

Tropical maize provides unique and important genetic diversity that is not found in commercial US hybrids, which are grown across millions of acres by farmers in America. Tropical corn can provide genes for resistance to various pests, diseases, and changing climates. However, tropical maize is not adapted to the US environment, making it difficult for breeders to incorporate their unique genetics in their programs. Reducing flowering time is the most important trait to improve adaptation of tropical maize to the US. Selection for earlier flowering can affect other traits, and in this study I will measure the effects of selection for early flowering on tassel size in several tropical maize populations. Tassels are important for producing pollen for seed production, but tropical populations tend to have larger than optimal tassels that divert energy from the ears and seeds. In order to measure the response of tassel size to early flowering selection, a randomized and replicated experiment containing 729 unique lines sampled from original and selected generations of five different tropical maize populations was planted. Tassel length and branch number will be measured on the 1458 plots and the mean values will be compared between the original and early-selected generations to understand the effect of selecting for early flowering on tassel size.

Title: Heat Stability of Colloidal Dispersions Containing Assemblies of Pulse Proteins

Presenter(s): Nicholas Cheng

Mentor(s): Haotian Zheng

REU/Summer Research Program: Food Science Summer Scholars

Proteins are vital macronutrients in human growth and development, and serve key roles in nutritional and physical properties of food product applications. With growing demand for protein sources due to the growing global population new ingredients have been developed to feed the world and to improve health conditions. Pulse crops such as dry peas, and chickpeas are valuable natural sources for manufacturing functional protein ingredients, which may be applied to diversified processed foods/beverages. Thermal processes often used in food processing can cause protein denaturation and aggregation which not only affect sensory attributes but also impact on phase stability of the processed food matrices. Literature showed that aggregation/pre-denaturation of proteins may improve thermal stability of protein dispersion systems. Moreover, protein aggregates also have a capacity to form complexes with polyphenols through hydrogen bonding and hydrophobic interactions (Diaz, J. T., 2022). These protein-polyphenol aggregates have been shown to improve colloidal strength as well as provide additional anti-inflammatory properties (Diaz, J. T., 2022). However, the heat stability of dispersions of protein-polyphenol aggregates under different physicochemical conditions (e.g. ionic strength) has yet to be elucidated. This ingredient functionality information is essential to food manufacturers who use these protein ingredients in different foods/beverages products. In this work, we aim to characterize heat stability of dispersions formed by protein aggregates and protein-polyphenol complexed aggregates under a range of ionic strength (0-60 mM NaCl). The characteristics to be evaluated are turbidity dynamics (as a function of time), particle size distribution and ζ-potential of protein particles.

Title: Effects of temperature and moisture conditions on the stability and bioavailability of soil nutrients

Presenter(s): Alaina Cox

Mentor(s): Hui Li

REU/Summer Research Program: BESST

Soil nutrients are a vital aspect of a soil's general character and greatly impact its fertility. Of particular note are the nutrients carbon and phosphorus. Measuring soil carbon is an important way of approximating organic matter levels, which can substantially alter soil structure and bulk density. Those properties in turn affect water penetration and retention. Phosphorus is required for successful plant

growth, but its bioavailability depends on the pools of phosphorus present as well as soil texture and pH. Bioavailable forms (extracted by H2O and NaHCO3) and refractory forms (extracted by NaOH and HCl) are phosphate pools of interest. In this study, soil samples from two locations in Raleigh, North Carolina, were incubated at different temperatures and with varying levels of moisture saturation. Soils were incubated at 4 °C, 20 °C, or 50 °C. Those soils were saturated, at 30% water content, or dry. Periodically, samples were collected and their nutrient levels were analyzed to determine the effects of the temperature and moisture conditions. It is predicted that higher temperatures and higher levels of saturation will facilitate nutrient destabilization and possibly mineralization, thereby decreasing the amount of nutrients remaining in the soils. The anticipated outcome of this study is that moisture conditions will have a larger impact on nutrient loss than temperature will.

Title: Culturing a Maize Root Bacterium for Isolation of Novel Siderophore

Presenter(s): Addyson Cutler

Mentor(s): Oliver Baars

REU/Summer Research Program: Integrative Microbial and Plant Systems

Iron is a scarce micronutrient for bacteria and plants because it is poorly bioavailable in soil at circumneutral pH. Bacteria have a special way of chelating iron using secreted extracellular siderophores so the iron can be brought into the cell. These secreted metabolites also affect other microbiome members and plants but the nature of these siderophore interactions is poorly understood and depends on the specific siderophore structure. Using the model of a 7-member bacterial synthetic community for maize roots, we previously found that Chryseobacterium indologenes produces a family of novel siderophores. The goal of this project is to optimize C. indologenes growth media for isolation and chemical characterization of the new siderophore. We found that conventional complex media (King's B and Tryptone Soy Broth) yielded low or variable siderophore production dependent on reagent batch, even after depleting iron with a chelating resin (Chelex 100) and adding increasing amounts of EDTA. This was likely due to the complexity of the media and undefined trace-metal availability. A minimal defined media was then designed allowing control of trace-metal concentrations and providing a simple matrix for analysis. The iron-limited defined media showed robust and strong siderophore production. We are currently using this medium to grow large volume cultures for isolation and characterization of the siderophore. The outcomes of this study will improve the knowledge of siderophore structures that are important in the rhizosphere microbiome which have the potential to improve plant nutrition and health.

Title: Impact of Long-Term Manure Application on Potentially Mineralizable Nitrogen in Soil

Presenter(s): Ryan Deany

Mentor(s): Stephanie Kulesza

REU/Summer Research Program: BESST

Over application of nitrogen can lead to leaching and eutrophication in runoff waters, which can result in negative human health and environmental impacts. Manure, as a sustainable source of nitrogen fertilizer, is readily available in North Carolina due to large numbers of swine and poultry farms. The goal of this study is to determine if corn growers can reduce inorganic nitrogen applied to corn in fields with a history of manure application and to determine if potentially mineralizable nitrogen could be an indicator of nitrogen needs in manured soils of North Carolina. The research conducted analyzed the amount of potentially mineralizable nitrogen in soils collected from fields across North Carolina with long manure application histories (minimum of 5 years). The research was conducted as an incubation study over the course of 28 days at 21℃, with soils held at 70% field capacity. Extractions were completed at 0, 1, 2, 7, 14, and 28 days after project initiation. Soil samples (3 g) were extracted with 30 ml of 1M KCl by shaking for one hour before filtering for analysis. Samples were analyzed using a Lachat flow injected colorimeter for concentrations of ammonium and nitrate. Results of this work will be discussed.

Title: Pasture and Perseverance: How Niche Meat Farms in North Carolina Maintain Sustainable Livelihoods During COVID-19

Presenter(s): Maria DiGiovanni

Mentor(s): Michael Shulman

REU/Summer Research Program: CEFS ASPIRE

Niche meat leverages pasture-based practices to produce specialty commodities with a price premium. Small-scale farms participate in niche meat to accrue more of the value they produce via direct sales or wholesale, rather than conventional markets. Maintaining the

farm during and after pandemic-induced lockdowns has depended on their capacity to adapt to unstable conditions, making it important to understand how small-scale niche meat farmers responded to the COVID-19 pandemic. This qualitative panel study thus inquires into what assets and motivations support small-scale niche meat farmers to continue farming in the face of pandemic-related challenges.In 2021 and 2022, five small-scale niche meat farmers recruited with the support of NC Choices participated in semi-structured interviews about their farm operations and households. A thematic content analysis of interview transcripts was then conducted utilizing a community capitals framework. The primary theme concerned values-based agricultural branding, which indicated that respondents engage in actions that make use of their farmer identity to curate a brand that distinguishes their farm and its products from commodity meats. A secondary theme emphasized respondents' drive to manage a balance between farming as a business and lifestyle in order to coordinate their farming practices with their values. Moreover, access to environmental, social, financial and human capitals facilitates farmers' use of values-based agricultural branding. Altogether, the small-scale niche meat farmers interviewed in this study navigated the pandemic-related uncertainties using sustainable livelihood strategies supported by available assets and grounded in their motivations regarding what practices and systems should comprise American agriculture.

Title: Microbial Inhibition Using Peanut Skins

Presenter(s): Tara Esmailian, Megan Rossi

Mentor(s): Fernanda Santos

REU/Summer Research Program: Food Science Summer Scholars

The CDC estimates that 48 million people get sick, 128,000 are hospitalized, and 3,000 die from foodborne diseases each year in the United States. A common source of foodborne pathogens are poultry meat and eggs. Therefore, prevention of infection at the farm level is crucial and can significantly affect the burden of foodborne illnesses. Peanut skins are a waste product of the peanut industry and have been shown to have antioxidant and antimicrobial properties when used in poultry feed. The current project aimed to test the effectiveness of peanut skins against four common foodborne pathogens; Escherichia coli, Salmonella, Listeria, and Staphylococcus aureus. As a preliminary study, E. coli was grown in nutrient broth supplemented with different concentrations of peanut skins (1, 2.5, and 5%), and bacterial populations were estimated at predetermined intervals to create a growth curve over the course of 12 hours. For the main study, a bacterial lawn of each of the four previously mentioned pathogens was created and an agar diffusion assay was performed at varying concentrations of peanut skin agar (0, 5, 10, and 20%). The plates were then incubated for 24 hours and yielded observable zones of inhibition against the gram positive pathogens (Listeria, S. aureus) and no observable zones against the gram negative pathogens (E. coli, Salmonella). Future studies are needed to determine an effective way of controlling pathogen growth using peanut skins.

Title: Availability of Soil Legacy Phosphorus for Corn and White Lupin

Presenter(s): Ayden Ferrell

Mentor(s): Luciano Gatiboni

Legacy Phosphorus (P) is when fertilizer accumulates in the soil by cause of successive fertilizations. According to McDowell et al. (2022), one definition of legacy P is, "P accumulated in soil above the agronomic recommended level, assuming that this is the minimum to maintain crop yield close to the maximum." Due to chemical interactions with the soil particles, P availability is dependent on a plant's capability to take up that nutrient. The objective of this experiment was to study how some crop plants explore legacy P in the soil. We used soil samples taken from a long-term field trial at Tidewater Research Station in Plymouth, NC. Three fertilization regimes were sampled: 1) Low P, with no P fertilization; 2) Medium P, with annual fertilization utilizing agronomic P rates; 3) High P, with annual fertilizer rates 3 to 4 times the agronomic needs. Soil samples were added to pots with 2 stacked compartments, separated by a 0.25 µm nylon mesh. Corn and white lupin were sown in the upper compartment and grown for 37 days (May 16 – June 21), after which plants were harvested and plant biomass was determined. Soil from the rhizosphere was separated into 5 layers, one in the upper compartment and four below the rhizoplane (0-5 cm, 5.0-5.5, 5.5-6.0 cm, 6.0-7.0 and 7.0 -10.0 cm). To determine how much P was taken up from the soil and what P forms were available, soil P fractionation was performed. Conductivity and pH levels were also measured.

ABSTRACTS | SESSION 4

Title: Exploring Interactive Responses Between Cover Cropping and Preemergence Herbicides

Presenter(s): Aiden Fox

Mentor(s): Ramon Leon

REU/Summer Research Program: CEFS ASPIRE

Weeds cause major yield losses and increased in-season costs for growers, making it necessary to develop innovative and effective strategies for weed management. In the face of growing herbicide resistance, cover cropping has become an increasingly important tool to suppress weeds. However, it is not yet understood how cover cropping could interact with current weed management practices, such as preemergence herbicides, for weed control. Therefore, a field study was conducted to compare weed emergence under different cover crop treatments (standing cereal rye, rolled cereal rye, and no cereal rye) and preemergence herbicide s-metolachlor rates (0X, 0.5X, 1X, 1.5X, and 3X) in a factorial design. The results indicated that there were no interactions between the cover crop and s-metolachlor for weed suppression. There was a constant inverse relationship between s-metolachlor rate and weed emergence and establishment. Also, standing cereal rye contained two times more weeds compared to no cereal rye and rolled cereal rye treatments. The data suggest that cover crops and preemergence herbicides are not interfering with each other. However, further evaluation on standing cereal rye is needed to understand its lack of weed suppression compared to other treatments.

Title: Enzymatic Degradation of Siderophores by Fungi

Presenter(s): Katie French

Mentor(s): Oliver Baars

REU/Summer Research Program: BESST

Iron is an insoluble and poorly bioavailable nutrient in soil at circumneutral pH values. Iron deficiency can limit plant growth in agricultural soils and is a driver of microbial activity (Morrissey and Guerinot, 2009). Siderophores are a group of small molecules secreted by bacteria, fungi, and graminaceous plants that chelate iron and make it biologically available. To better understand the fate of siderophores in soil, we will examine the ability of two fungi to produce extracellular enzymes that degrade three different structural classes of siderophores in a liquid growth medium-based laboratory system. Our hypothesis is that siderophore degradation will be dependent on siderophore structure and metal chelation properties. For the proposed experiments, two soil and plant associated fungi will be examined: the 'white-rot' fungus Phanerodontia chrysosporium and a wheat seed/root endophyte Drechslera biseptata. Each fungus will be grown in liquid medium(s) and filtered to obtain the culture filtrate (supernatant). Chemical assays will be used to test the filtrate for extracellular enzyme production. The siderophores: 1) hydroxamate desferioxamine B, 2) catecholate protochelin, or 3) synthetic carboxylate proline-2'-deoxymugineic acid will be added to the fungal supernatant in the unbound or iron-bound form. Siderophore degradation will be analyzed by UV-visible spectroscopy and liquid chromatography - mass spectrometry. The results generated in these experiments will provide information that will potentially be useful for further studies on changing iron availability due to the degradation of siderophores by enzymes.

Title: Study of Nitrous Oxide Flux along Microtoposequences

Presenter(s): Raymond George

Mentor(s): Alex Woodley

REU/Summer Research Program: BESST

The agricultural sector accounts for 80% of nitrous oxide (N2O) emissions in the United States, a greenhouse gas with almost 300 times the warming potential of carbon dioxide. Nearly all of these N2O emissions within agriculture come directly from the soil. It is understood that these emissions are neither uniform across regions nor across a single acre of farmland. Through a partnership between NC State University and the USDA Center for Environmental Farming Systems (CEFS), we seek to identify geospatial and hydrological patterns of N2O emissions within a conventionally gown corn field in Goldsboro, NC. Working under the hypothesis that these N2O emission "hot spots" are driven by microbial denitrification, we stationed gas collection chambers along 2 transects ranging in elevation and hydrology. Transects are chosen to include both upland sites and lower-elevation sites where ponding is predicted to occur through an ArcGIS-generated hydrology model using LiDAR elevation data of the study area. Gas samples and soil moisture content will be taken at each site both during local dry spells and between 24 and 48 hours in the aftermath of significant rain events. Gas samples are taken at 5 minute intervals over 30 minutes following the sealing of collection chambers to generate N2O flux values.

ABSTRACTS | SESSION 4

Title: Understanding How Phosphate Deficiency Affects The Root Architecture of Arabidopsis to Optimize Nutrient Uptake In Plants

Presenter(s): Lydia Gillan

Mentor(s): Imani Madison

REU/Summer Research Program: Integrative Microbial and Plant Sciences

Phosphate deficiency limits crop yield in approximately 70% of the world's arable land. Phosphate fertilizers are a finite resource and are not taken up efficiently by plants, so finding new ways to enhance the ability of plants to tolerate harsher growing conditions is paramount to meet the needs of our world, especially as crops continue to be adversely affected by climate change. Because the root tip is in direct contact with soil, it often is the first part of the plant to sense environmental cues and undergoes phenotypic changes to compensate for nutritional deficiencies. Arabidopsis, a useful model system for plant development, exhibits a short primary root and increased lateral roots in response to phosphate starvation, thus optimizing the soil exploration capabilities of the plant. The root apical meristem also becomes disorganized, and root stem cells differentiate prematurely, causing meristematic exhaustion and severely stunting plant development. We aim to analyze the changes in the meristematic structure resulting from phosphate deficiency by imaging Arabidopsis roots and evaluating how cells in the root tip organize differently to those grown in phosphate sufficient conditions. These results will be compared with those of mutant lines in order to characterize key genes involved in the phosphate starvation response. Understanding the roles of these genes under phosphate starvation will aid the development of exogenous miRNA or compound treatments to influence the regulation of phosphate uptake in plants and thus is a promising alternative for quickly depleting phosphate fertilizers.

Title: Preliminary Substrate and Root Evaluation for Grapevine Plants

Presenter(s): Leah Guercio

Mentor(s): Mark Hoffmann

REU/Summer Research Program: Integrative Microbial and Plant Sciences

Soilless substrates are a critical component to potted plant production, and their importance continues to grow as controlled environment agriculture becomes more widespread. Young grapevines are commonly grown in pots during their first year and shipped to vineyards for transplanting, yet minimal research exists on the ideal pot size and substrate for growing grapevines. The objective of this supplemental study for ongoing grapevine controlled environment research is to investigate the impact of pot size and substrate composition on root development of grapevines grown in a controlled environment. For this study, 18 one-year-old bareroot Vitis labruscana 'Concord' grapevines were grown using 3 pot sizes and 3 substrates for 28 days in a controlled environment greenhouse. The three pot sizes used in this study were categorized as Small (68.25 in^3), Medium (111 in^3), or Large (271 in^3). This study additionally compares three different soilless substrate mixes; an industry standard consisting of 60% coconut coir, 30% sphagnum peat moss, and 10% perlite by volume, a fine aged pine bark, and a 50-50 fine and coarse aged pine bark. Coconut coir, peat moss and perlite are frequently used in potted substrate mixes while pine bark represents a growing alternative that is locally available in the Eastern United States. In order to evaluate the influence of pot size and substrate on the growth of 18 Concord grapevines, plant and root dry mass were assessed, and root analysis will be conducted utilizing WinRhizo software to assess root morphology, including length, diameter, and area.

Title: Impact of endophytic bacteria on mycorrhizal root colonization of switchgrass [Panicum virgatum]

Presenter(s): Ayanna Hatton

Mentor(s): Shuijin Hu

REU/Summer Research Program: Kelman Scholars

As the conditions and stresses presented to plants have changed due to climate change, the importance of microbes and research to understand their interactions have become more important. Arbuscular mycorrhizal fungi (AMF) form a symbiotic relationship with the roots of most terrestrial plants helping with plant nutrient acquisition, and resistance to environmental stresses. Endophytes and AMF occupy a similar niche in roots. Endophytic bacteria can aid plants in their growth as well as help them react to stresses. Endophytic bacteria may help AMF through promoting root growth and working together to respond to stresses. In other cases, endophytes may suppress AMF if they out-compete AMF for photosynthates from plants. To better understand how AMF and endophytic bacteria interact, switchgrass [*Panicum virgatum*] was planted in a sandy field soil of six different treatments with eight replicates each. The six treatments were formed with three conditions (no endophyte control, one treated with strain *Pantoea vagans,* and another with *Pantoea agglomerans*) and two AMF treatments (field soil with natural AMF, or natural soil inoculated with a mixture of eight AMF species).

ABSTRACTS | SESSION 4

Mycorrhizal colonization of the switchgrass roots was analyzed microscopically for AMF colonization. A modified grid-line intersect method (Giovannetti and Mosse, 1980) was used for the preparation and examination of root samples. The findings that AMF colonization and plant growth are dependent on the species of endophyte aids in creating conditions for more successful switchgrass growth and more to utilize as a biomass energy source.

Title: Investigating no-till fiber hemp production utilizing cover crop mulch for weed management

Presenter(s): Cassie Helms

Mentor(s): David Suchoff

REU/Summer Research Program: CEFS ASPIRE

Fiber hemp is an up-and-coming field crop used for textiles with a market demand larger than what can currently be supplied. In North Carolina one of the major production challenges faced by fiber hemp farmers is weed management; there are currently no available herbicides labeled for use on fiber hemp. No-till systems have numerous agronomic benefits and ecosystem services such as in-season moisture conservation and minimizing erosion. These systems tend to utilize herbicides to manage weeds pre- and post-planting of cash crops. No-till in organic systems utilize cover crop residues as a means to reduce weed emergence in the absence of herbicides. We investigated the feasibility of utilizing a terminated cereal rye cover crop mulch as a weed management strategy for no-till planted fiber hemp. Studies were conducted at the Piedmont Research Station (Salisbury) and Horticultural Crops Research Station (Clinton). We compared two no-till treatments (with cover crop rolling and without) to two bare ground controls (weedy and weed-free). Cereal Rye biomass production in both locations exceed 10,000 lb/ac, which made planting challenging. Stand counts were taken mid-season and in both locations the bare ground controls had significantly higher fiber hemp populations than the no-till treatments. Results from this trial indicate that fiber hemp does not have the same seed vigor as corn or soybean necessary to emerge through a thick cereal rye residue. Cover crops that produce lower amounts of biomass should be further investigated.

Title: Interactions between the peach pathogen Xanthomonas arboricola pv. pruni and bacteriophage

Presenter(s): Howard Jacobs

Mentor(s): Katherine William

REU/Summer Research Program: CEFS ASPIRE

Xanthomonas arboricola pv. pruni (Xap) is a bacterial pathogen that causes bacterial spot on peach. Xap was first described in 1903 in Japan on plum trees. Xap has a global distribution, and there are limited management practices available for control. In recent years bacteriophage (phage), viruses that lyse bacteria, have shown promise for disease management of bacterial pathogens with inconclusive results. In this study, we investigate the ecology of phage in a Xap-peach pathosystem;specifically, the prevalence and diversity of phage in peach orchards to assess the feasibility of using phage for disease management of the bacterial spot of peach. Towards this goal, a total of 49 phage isolates were collected in June and October of 2021 from bacterial spot symptomatic leaflets collected from a peach orchard in the Sandhill Research Station in North Carolina. These phages were isolated and purified using (write the technique) and stored for long-term storage. The phages were quantified and their host range was determined using an overly inhibition assay on a panel of 10 Xap strains, representative. The 10 Xap strains represent diverse Xap populations collected from bacterial spot symptomatic tissue from different geographic locations and collection dates. 14 phage isolates have been sequenced and are being used for host range assayes. Results of the host range assay suggest that all 10 bacterial strains are susceptible to phage infection. It also suggests that the phage lysis all bacteria differently.

Title: Oil-water interfacial characteristics of assemblies of pulse proteins and polyphenol compounds

Presenter(s): Yueyue Jiang

Mentor(s): Haotian Zheng

Literature has shown that protein aggregation is able to improve the functionality of protein ingredients in diversified food matrices, such as gels, emulsions, and foams. Both proteins and polyphenol compounds as important nutrients may provide health benefits to the human body. A review article has discussed the opportunities for the application of protein-polyphenol complexed assemblies as effective building blocks of food structures while delivering beneficial bio-functionalities. In this work, the oil-water interfacial (OWI) characteristics of different protein-polyphenol aggregate particles are studied. Five different protein and protein aggregate ingredients are chickpea protein (CH), pea protein (PP), blueberry-chickpea protein aggregate (BB-CH), blueberry-pea protein aggregate (BB-PP), and blueberry chickpea-pea protein blend aggregate (BB-CP), are used to investigate the OWI behaviors. Samples are to be prepared

using 10mM phosphate buffer to obtain 0.01% w/w protein content, and each sample is to be analyzed in duplicate. Interfacial tension and surface pressure as a function of time are going to be plotted using an interfacial tensiometer based on the pendant drop method. The diffusion (Kdiff) and penetration (Kp) adsorption coefficients may be computed based on the obtained interfacial behavior results. The obtained data from this work will help food technologists to better understand the ingredient functionality at the OWI layer for a rational design of o/w emulsion systems for food applications.

Title: Impact of heat stress on lactating dairy cow performance

Presenter(s): Joshua Lopez-Alfonzo

Mentor(s): Stephanie Ward

REU/Summer Research Program: CEFS ASPIRE

The objective of this project was to compare animal performance during different seasons of the year using milk yield, rumination, and activity. New wearable technology makes it easier to collect data biological data and use that information to make management decisions on the farm, for example, when cows are heat stressed. Data from 124 lactating Holstein and Jersey dairy cows was used. Cows were housed at the Lake Wheeler Field Lab Dairy Unit and were fitted with collars with neck sensors to monitor activity (rest, lying time), eating time, and rumination time (CowScout, GEA). Milk yield data was obtained from the milking parlor (DairyPlan Software, GEA Ind.) and summed to a daily value per cow. Weather data (air temperature and relative humidity) was obtained from the NC State Climate office from June 20, 2021 to June 1, 2022, which matches the activity and milk yield data. That data was used to calculate temperature humidity index (THI) using the following equation: 0.8*Temperature + Relative Humidity*(Temperature-14.4) + 46.4. Activity and weather data were collated by hour from June 20, 2021 to June 1, 2022 and milk yields were recorded daily for the same period. Data will be analyzed using the regression procedure in SAS, to determine the relationship between THI, cow activity responses, and impact on milk yield. We anticipate that cows will decrease rumination and milk production as temperature increases.

Title: Plasma Activated Water (PAW) effects on Arabidopsis stress responses

Presenter(s): Ta'Kia Lucas

Mentor(s): Jon Kizer

REU/Summer Research Program: Integrative Microbial and Plant Systems

Plasma Activated Water (PAW) is a fairly new technology that can be used in agriculture as a liquid fertilizer. It's been shown to enhance germination and promote plant growth. Our experiment tested PAW effects on arabidopsis stress response in relation to nitrate fertilizers which are typically used. Three experiments were conducted. Experiment 1 tests productivity of plants in the treatments PAW 4, PAW 5, NO3, hydrogen peroxide, and low nitrate. Plants are grown in soil and watered with treatment. Productivity was checked by measuring chlorophyll using a chlorophyll meter. In Experiment 2, arabidopsis was grown on gridded plates and transferred to individual stresses of heat, cold, salt, and mannitol for each treatment. Roots were measured in the priming, stress, and recovery stages then the plants were weighed for biomass before and after being dried in an oven. For Experiment 3, arabidopsis plants were grown on gridded plates in the five treatments then stained with ROS markers NBD, DAB, and NO. Using a microscope, ROS presence was recorded. We expect to find that PAW 4 has greater overall productivity in plants through a greater average root length in the presence of stresses and it's expected to perform similarly to nitrate in soil and have similar ROS accumulation to nitrate since it contains the same amount of nitrate in its chemistry as the nitrate treatment. PAW may have the potential to improve the quality of crops and replace nitrogen fertilizers which have a negative effect on the environment and can be costly.

Title: Heterologous Expression of Maize HPC1 Variants and their Functionality Assays

Presenter(s): Brian Marks

Mentor(s): Ruben Rellan Alvarez

REU/Summer Research Program: Integrative Microbial and Plant Systems Research Experience

Maize maintains great cultural and agricultural significance. Maize was domesticated from the tall grass teosinte and moved to highland regions by human migration. There, maize adapted to the low temperature conditions via introgression with teosinte mexicana (Zea mays ssp. mexicana). Critically, highland maize gained the nonfunctional highland variant of the gene HPC1 (highland genotype PT:

lowland genotype B73), a phospholipase A1 enzyme that converts phosphatidylcholine (PC) into lyso-phosphatidylcholine (LPC). Membrane dynamics suggest that a greater PC/LPC ratio improves membrane stability due to the rectangular structure of PC as opposed to the detergent forming triangular structure of LPC. Here we conduct functional assays on the variants of the HPC1 gene by heterologous protein expression using yeast (Saccharomyces cerevisiae) to verify the PC to LPC conversion. We use an EnzChek kit to conduct a PLA1 test on the protein variants, in which fluorescent dye is encapsulated within a PC micelle and should be released when exposed to the functional HPC1 B73 genotype.

Title: The Relationship between AMF Colonization and N:P Ratios in Maize

Presenter(s): Brooke Matusko

Mentor(s): Shuijin Hu

REU/Summer Research Program: CEFS ASPIRE

AMF (arbuscular mycorrhizal fungi) are soil microorganisms with the ability to form a mutualistic symbiosis with 70-90% of terrestrial plants in soil environments. Arbuscular fungi are able to penetrate host plants, colonize root cells, and acquire nutrients for their host through the spreading of hyphal structures, effectively increasing the host plant nutrient zone. In return, the host plant will provide carbon and other essential nutrients. It is currently understood that AMF enhances the acquisition of immobile nutrients such as phosphorus for host plants under low-nutrient conditions. However, research has been inconclusive on the impact of differing nitrogen:phosphorus (N:P) ratios on the symbiosis between AMF and host plants. This study aims to better understand the relationship between AMF colonization and N:P ratios by exploring whether the association between AMF and their host plants is mediated by nutrient composition and taxonomy. Maize was germinated under a controlled environment in conventionally-managed soil from Western NC. Prior to germination, the soil was prepared by inoculation of 8 different AMF species and addition of three nitrogen treatments: 45 kg/ha, 90 kg/ha, and 180 kg/ha with 8 replicates each. Soil P levels were determined via routine analysis to be optimum for maize production. At the end of the growing period, mycorrhizal root staining and gene sequencing will be performed to determine the presence and abundance of the AMF species in relation to nitrogen treatment. The roots of the maize plants will also be examined for phenotypic differences across nitrogen treatments.

Title: The Identification of Rare Earth Element-Binding Peptides/Proteins from Plants to create REE Biomining Systems

Presenter(s): Alexandra Mayer

Mentor(s): Colleen Doherty

REU/Summer Research Program: Integrative Microbial and Plant Systems

Rare Earth elements are increasing in demand because of their important role in electronics, green technology, and defense systems. However, mining these elements is expensive and is detrimental for the environment. Because of this, the United States has to rely heavily on foreign nations to meet this demand. In order to continue fighting climate change by switching over to an electronic world, REEs must be mined in a much safer and more profitable way. Biomining is being used for other elements, and it could be used for REE-uptake through REE-uptake proteins. The main goal of my research is to identify REE-binding peptides and proteins from plants to work toward creating REE-bioming systems. The 26 candidate proteins and peptides were chosen, mainly from Phytolacca americana, based on their ability to uptake calcium and other metals, as well as their similarity to Lanmodulin, the gold-standard in REE-uptake. The genes for these candidate proteins were transformed into Escherichia coli using an entry vector, then the plasmid was isolated and cloned into a destination vector using gateway cloning methods. Then, it was transformed into the final expression E. coli. Now, it will be determined whether the candidate protein genes can be expressed in bacteria, identify optimal conditions for expression using expression assays, and if those proteins can uptake REEs through different in-vivo metal-binding assays. Through the discovery of these proteins, bioming for REEs is a possibility in the shift to an electronic world and the fight against climate change.

Title: Poultry Litter Impacts on Imbibition and Radicle Length

Presenter(s): Brittani Meis

Mentor(s): Stephanie Kulesza

REU/Summer Research Program: CEFS ASPIRE

Poultry litter (PL) is a byproduct of the poultry industry and is primarily used as fertilizer through land application to row crops, such as corn, cotton, and soybean. Due to increasing costs of inorganic fertilizers, quality nitrogen sources are in high demand, and PL is one of

the highest-value manure-based fertilizers due to its high nitrogen content compared to other manures. It has been found that applying PL decreases germination rate, but the extent to which PL inhibits germination has not been widely studied. Therefore, germination tests were conducted to further explore the impact of PL on germination. A stock solution was first generated using a 1:4 PL:deionized water mixture that was shaken and filtered. There were 5 PL solution treatments of varying concentrations, with 1, 5, 10, 20, or 40% stock solution in deionized water. Three seed types were selected to represent a variety of seed sizes and seed coat thicknesses: Brassica alba (mustard seed), Triticum aestivum (wheat), and Lolium Perenne (ryegrass). Furthermore, the issue of salinity was also studied by reducing the salts and ion concentration using a mixed bed ion removing resin. Seeds (50) of each species were placed in Petri dishes with varying PL solution concentrations and kept in a germinator chamber alternating between 24C and 18C every 12 hours for one week. At the conclusion of the study, percent germination, viability of remaining seeds, radicle length, and abnormal radicles were determined. The results of this study will be discussed.

Title: Quantifying the Effects of uORFs on Auxin Signaling in Arabidopsis thaliana

Presenter(s): Amanda Merkel

Mentor(s): Hao Chen

REU/Summer Research Program: IMPS

uORFs (upstream open reading frames), located in the 5’ UTR of eukaryotic mRNAs, translationally control ARFs (auxin response factors) in Arabidopsis thaliana. This experiment was conducted to quantify the impact of the uORFs on mRNA and protein levels by looking at the uORFs of the auxin response factor MP/ARF5, as it regulates auxin-mediated stem cell differentiation, organogenesis, and morphogenesis (Shi and Teva, 2022). To quantify the effects of the uORFs in the 5'UTR of MP (MP5'), MP5' was fused to the Firefly luciferase and used the MP5'mut version lacking the uORF fused to Renilla luciferase as a control. Firefly and Renilla luciferase activities were measured using qRT-PCR to rule out any effect of these uORFs on transcript levels. By studying these uORFs of auxin response factor genes, any tissue-type or developmental stage effect on the regulatory role of these uORFs can be determined. The role of MCT-1, a key translation factor required for the translation of uORF-containing genes and previously characterized in humans as an oncogene, will also be investigated as it has been transferred to an Arabidopsis mutant line. This study will provide an accurate quantitative measurement of uORF effects on the translation of a key hormone response gene and the potential role of MCT-1 in regulating the plant response to auxin. By quantifying the effect of uORFs on the translation of auxin response factor genes, it can be better understood how uORFs regulate various processes in plant growth and development by directly affecting protein levels.

Title: Surveying for Adult Gopher Frogs in the Croatan National Forest

Presenter(s): Heather Moeller, Andrew Barfield

Mentor(s): Carol Price

REU/Summer Research Program: OUR Award

Since there was no gopher frog breeding this past spring research efforts for the summer were focused on surveying for burrows. Their burrows are found around their breeding ponds. The primary focus of the project was to look for stumpholes that had pads outside that are indicative of gopher frogs living there and place wildlife cameras at potential sites to observe behavior. Also, this project is used to determine an estimate of the number of adult gopher frogs present within the Croatan National forest.

Title: Conversion of Electromyogram and Joint Angle Data into Personalized Musculoskeletal Models

Presenter(s): Dharmin Patel, Carter Wang

Mentor(s): Katherine Saul

REU/Summer Research Program: MAE

Injury due to stroke can result in weakness or paralysis in the arms and hands, which inhibits dexterity that is essential to most daily activities. Key to the study of rehabilitation in cases of disability is an in-depth understanding of the underlying musculoskeletal mechanics involved for each patient. Musculoskeletal modeling has been an effective technique to understand these mechanics, but as of yet has not been implemented on a subject specific level for the arms and hands. We aim to develop personalized musculoskeletal models of the forearm, wrist and hand using OpenSim, a musculoskeletal mechanics simulation software, to better model these mechanics. We will develop these models using MATLAB to convert previously collected electromyography (EMG) and joint kinematics data from an online database, into muscle activations and motion information that can be used with OpenSim. These will be used to

simulate the experimental movements in a musculoskeletal model as well as to perform inverse dynamics to determine joint moments and reaction forces present in the model, and to tune the muscle parameters to match a hypothetical patient. To test both the MATLAB code and OpenSim model, we will collect experimental hand motion and EMG data in the fall to create a calibrated model to individual subjects.

Title: The Impact of Salinity and Potassium on Legume Nodulation

Presenter(s): Nyssa Ndey-Bongo

Mentor(s): Kevin Garcia

REU/Summer Research Program: IMPS

Soil salinity is currently a major concern within the agricultural field. Due to climate change and poor irrigation practices, salinity levels have been increasing in recent years. This poses an adverse impact on the yield and quality of legume crops, as the high salinity levels interfere with the legume-rhizobia symbiotic relationship that enables legumes to uptake nitrogen for growth and development via biological nitrogen fixation from rhizobial bacteria residing in the root nodules. That alone prompted investigation of the impact of sodium on nodulation and how potassium availability in the rhizosphere intercepts the adverse effects of salinity. To address this question, we grew 100 Medicago truncatula plants for 14 days after inoculation of Sinorhizobium meliloti in turface. To evaluate the functionality of nodules, rhizobial bacteria nitrogen fixing gene (nifH) was fused with GUS to visually quantify nodules fixing atmospheric nitrogen gas. During the growth period, plants were treated with five sodium concentrations: 0mM, 25 mM, 50 mM, 100 mM, and 200 mM along with four potassium concentrations: 0 mM, 0.05 mM, 3.75 mM, and 10 mM. During the harvesting, we visualized the stunted growth of roots with fewer lateral root branching in increasing salinity. We also quantified the functionality of nodule nitrogen fixation in gradients of salinity and potassium availability, shoot and root biomass. This study will provide a basic understanding of how potassium availability minimizes the salinity effect on legume crops which are ecologically and economically viable crops.

Title: Effect of long-term phosphorus and potassium fertilization on soil permanganate oxidizable carbon

Presenter(s): Jalissa Pirro

Mentor(s): Luciano Gatiboni

REU/Summer Research Program: BESST

Permanganate oxidizable carbon (POXC), also known as soil active carbon, is a metric by which soil scientists access the soil health status of agricultural fields. POXC is an increasingly popular indicator to evaluate soil health due to its low costs and ease of use in comparison to other laboratory methods. Our research aims to evaluate the effect of phosphorus and potassium rates on the POXC in three long-term field trials located in the Tidewater, Coastal Plain and Piedmont regions of North Carolina. Using molecular absorption spectrophotometry, we will determine the POXC concentrations in 135 soil samples from these long-term field trials. These results will allow us to understand the relationship between soil health and the use of inorganic fertilizers.

Title: Impact of potassium availability on symbiotic ectomycorrhiza formation between the fungus Paxillus ammoniavirescens and the loblolly pine roots under salt stress

Presenter(s): Mira Polishook

Mentor(s): Keivn Garcia

REU/Summer Research Program: BESST

With rising sea levels causing coastal saltwater intrusion, increasing soil salinity is negatively affecting the health of coastal forest trees, including loblolly pines. Ectomycorrhizal fungi associated with the roots of pine trees are known to improve potassium (K+) uptake, a mechanism that may improve tolerance of the host pines to salt stress induced by sodium (Na+) ions. One such fungus, Paxillus ammoniavirescens, can enhance K+ uptake in the loblolly pine, Pinus taeda. However, it is unknown if K+ availability impacts initial colonization of P. taeda roots by P. ammoniavirescens at various Na+ concentrations. To examine this question, P. taeda seedlings were inoculated with P. ammoniavirescens under each of 10 treatment conditions: sufficient (1 mM) or limited (0.05 mM) K+ supply with increasing NaCl concentrations (0.2, 25, 50, 100, or 200 mM). After 4 weeks of co-culture under sterile conditions, with additions of corresponding treatment solution every 3 days, P. taeda seedlings will be harvested. The shoot and root biomass will be measured, and percent root colonization quantified and compared among treatments.

ABSTRACTS | SESSION 4

Results from this experiment will contribute to a broader series of studies providing insight into the dynamic influences of soil salinity and K+ availability on the symbiotic relationship between ectomycorrhizal fungi and pines.

Title: Striped Bass Breeding Program: StriperHub

Presenter(s): Kate Pottle

Mentor(s): Linnea Andersen

REU/Summer Research Program: CEFS ASPIRE

The expansion of American aquaculture is critical to address the ~$17 billion seafood trade deficit caused in part by our importation of over 80% of seafood products. Striped bass (Morone saxatilis) is a prime candidate to help expand the aquaculture industry in America as it has been captive-bred for decades. This effort was initially in response to the wild population collapse in the 1980s and now supports the fourth largest aquaculture industry in America, hybrid striped bass, with striped bass gaining traction as a standalone industry. Breeding and domestication have resulted in better dress-out yield, improved growth rate, and greater stress tolerance in these seven-generation (F7) domesticated fish compared to earlier generations and their wild counterparts. The reduced time to reach market size is a key outcome, as striped bass can now reach market size (1.36 kg or 3 lbs.) in under two years, and the F8 generation are anticipated to require even less time, which supports economic feasibility for producers. Further, the use of exogenous hormones to induce captive spawning has been eliminated, and instead, spawning behavior of domestic fish is prompted by modifying water salinity and temperature to mimic natural conditions. In addition to the qualities that make striped bass a culture-ready product, these fish are a popular product among consumers with a slightly sweet flavor and firm texture once cooked. The presentation of these domestication efforts is in part to address challenges stemming from producer and consumer education with the ultimate goal of advancing aquaculture nationally.

Title: TagM and its effects on T6SS as well as the plants we hold dear

Presenter(s): Kalyan Schmidt

Mentor(s): Ying-Yu Liao

REU/Summer Research Program: IMPS

Ralstonia spp.(Rs), the causative agents of bacterial wilt disease on tomato, are plant pathogenic bacteria that are widespread around the world. Three species in the genus infect a variety of plant hosts, including high-value crops like potatoes and peppers. The Type VI Secretion System(T6SS) is a bacterial system that releases toxic proteins from a producing cell to a target cell in a contact-dependent manner. The toxins are translocated from one cell to the other via a hemolysin-coregulated protein(Hcp) tube with a spike complex made of Valine-Glycine repeat protein G(VgrG) and Proline-Alanine-Alanine-Arginine(PAAR) proteins, piercing the target cell membrane. The toxic protein is used for interbacterial competitive interactions and contributes to virulence in some bacterial pathogens. These toxic proteins may give Rs a competitive advantage over other Rs or closely related strains by killing neighboring cells. The T6SS in Rs K60 has the gene of interest tagM who's function remains unknown. The tagM and hcp genes were knocked out using double homologous recombination to generate K60ΔtagM and K60Δhcp. The effects of these mutations will be compared to the wild type strain using overlay inhibition and bacterial competition assays. We hypothesize that both mutants will be unable to release toxic proteins through T6SS, disrupting K60's ability to successfully compete against other Rs and closely related strains. Understanding the role of tagM and hcp in T6SS can enable the development of alternative management practices for Ralstonia, whose virulence of agricultural crops has led to a need for action.

Title: Utilizing Soil Electrical Conductivity and Halinity to Quantify Salinization in Coupled Wetland-Farm Systems

Presenter(s): Christina Sterna

Mentor(s): Matthew Ricker

REU/Summer Research Program: BESST

Agricultural fields on the Albemarle-Pamlico Peninsula of North Carolina are undergoing saltwater intrusion due to numerous artificial drainage systems allowing storm surges and wind currents to carry saltwater inland. Although salt-tolerant tidal marshes act as a buffer between farmland and the estuary shore, they do not fully prevent drained organic-rich soils from experiencing salinization in the region. One way of quickly testing the concentration of ocean-derived salts (halinity) is through electrical conductivity (EC) measurements. Soil halinity studies have been widely conducted in tidal wetlands and subaqueous environments, but little research has

been applied to farmlands. Coastal farmers urgently need field studies and mapping of soil halinity gradients in North Carolina as farm systems continue to experience significant loss of crop production. Soil halinity conversions can be made from EC measurements by using 1:1 and 1:5 water solutions (soil to water by volume). A dilution factor was determined for soil porewater EC ranges and multiplied by the EC value to convert to practical porewater halinity in parts per thousand (ppt). Based on our initial data, organic horizons had a significantly ($p = 0.02$) higher average 1:5 EC (3.74 dS/m) than mineral horizons (2.98 dS/m) located in the same estuary area. With further study, soil halinity and EC values can be used to establish thresholds for crop management as well as classify and map coastal wetland areas.

Title: Kelp as a Soil Amendment - Nutrient Release and Greenhouse Gas Mitigation Potential

Presenter(s): Audrey Williams

Mentor(s): Alex Woodley

REU/Summer Research Program: CEFS Agroecology

Regenerative ocean agriculture is a type of input-free ocean farming that sequesters carbon and produces seafood at limited environmental cost. Sugar Kelp (Saccharina latissima) is a key part of this system, but only a portion is used for human consumption and there are few commercial uses of the remaining biomass. This research evaluates a potential use of kelp as an organic soil amendment in land-based agriculture. Preliminary research indicated that when added with other fertilizers, kelp may reduce emissions of the greenhouse gas nitrous oxide (N_2O), but literature is limited. This research aims to evaluate this mitigation hypothesis and understand kelp's nutrient release patterns relative to other soil amendments. We carried out a 100-day incubation period using soils collected from the Mountain Research Station. The treatments used were kelp, kelp and urea, urea nitrogen fertilizer, beef compost, poultry fertilizer and a control. Application rates were applied at 400 kg N ha^{-1} equivalent per jar. We did repeated KCl extractions to determine ammonium and nitrate levels at different time points, calculated Permanganate Oxidizable carbon and measured N_2O fluxes through wetting and drying cycles. Preliminary results show that when compared with the urea alone treatment, the soil with both kelp and urea fertilizer released more nitrogen in the ammonium form rather than the leaching-prone nitrate form. This combination also reduced N_2O emissions. Kelp alone released less nitrogen than poultry fertilizer but more than compost, suggesting a role as a soil conditioner that likely needs to be paired with another nitrogen source.

ABSTRACTS | SESSION 5

Title: Degenerative Effects of Partial and Complete ACL Tears

Presenter(s): Olivia Barlow

Mentor(s): Matthew Fisher

REU/Summer Research Program: GCSP

Pediatric anterior cruciate ligament (ACL) injuries are becoming more frequent, and the effects that these injuries have can be degenerative and long-term. The ACL is composed of an anteromedial (AM) bundle and a posterolateral (PL) bundle, and injuries can extend through just one bundle as a partial tear or both as a complete tear. However, there is currently not much information on the degenerative effects associated with each of these injury types, especially in younger patients. Our goal is to determine the risk of long-term cartilage degeneration after partial and complete ACL tears in skeletally immature subjects using a porcine model. To represent the different injury types, juvenile (3 month) pigs underwent transection of the AM bundle, the PL bundle, or both bundles in one leg, and a sham operation was performed on the contralateral leg. Sections of cartilage were taken from the medial and lateral femoral and tibial condyles in both legs and were examined using histological methods to quantify the extent of degeneration for each injury type. When comparing average total scores for each injury type from a preliminary set of samples, complete ACL tears had higher scores, followed by PL tears and then AM tears. Cartilage structure and chondrocyte density scores were higher for complete ACL tears, while cell cloning and Safranin-O staining distribution scores were higher in PL- transected specimens. It should be noted that these scores may change as more data is collected, and PL tear scores could be skewed due to an outlier specimen.

Title: Fit 4 Purpose Handbook for UMM Sector

Presenter(s): Ana Brown

Mentor(s): Javon Adams

REU/Summer Research Program: WMSRP

Coupled with increasing resource costs and the threat of competitive companies, the construction industry is being pushed to find more efficient and sustainable project management practices. By performing in such a manner, companies will be able to keep up with the economic changes and increase project success. In order to attain this, companies need to stay up to date on CII Research to promote quality project performance. The problem, however, is that the vast amount of data collected by CII resulting in the 300+ page book companies are often provided but rarely used. This paper will present findings on what CII tools are needed within the Upstream, Midstream, and Mining (UMM) sectors and how to select project delivery methods (PDM) based on project complexity and associated characteristics. This is completed by implementing data from CII research, reference to existing PDM programs, interviews, use of focus groups, and literate reviews by a team of researchers consisting of NCSU faculty and both graduate and undergraduate students. This team has designed a fit-for-4-purpose handbook that will help companies assess the complexity of their projects, thereby increasing the visibility and use of CII research through easily assessable tools. This product has the potential to lessen project failure and promote an increase in the rate of return for companies in the long run.

Title: Comparing the Efficacy of Using Different Balance Metrics to Detect Significant Gait Disturbances and Predict Falls

Presenter(s): Jesse Carr

Mentor(s): Amirreza Naseri

REU/Summer Research Program: BME

Individuals worldwide with lower limb amputations are at a higher risk of experiencing harmful falls when compared to able-bodied individuals. This elevated incidence of harmful falls can lower amputees' quality of life both mentally and physically. This research project aims to compare various balance metrics (e.g. center of mass, step length, step width, etc.) to determine the most useful in anticipating falls and mitigating the harmfulness of these events. Steady-state walking data was collected from transfemoral (TF) amputees and able-bodied (AB) persons using a set-up comprised of twenty-three different IMU sensors fixed at various points on the participants' bodies. The walking data of the AB participants were then processed in MATLAB to extract all the metrics of interest, then, that same algorithm was used as a starting point to begin processing the TF walking data. At this time, there are few results from this study as data processing is ongoing and concrete conclusions have yet to be drawn; However, conclusions are expected in the coming weeks.

ABSTRACTS | SESSION 5

Title: The Effects of Walking-Related Fatigue on Vulnerability to Lateral Waist-Pull Perturbations

Presenter(s): Lillian Chilton

Mentor(s): Javon Adams

REU/Summer Research Program: WMSRP

Fatigue contributes to instability during walking and risk of falls, especially for older adults. However, little is known about how walking-related fatigue affects the vulnerability to balance challenges, even among younger adults. In this study, we examine the effects of a 30-min walk on the response to instability elicited by lateral waist-pull perturbations. Eighteen healthy young adults (24.5 ± 4.7 years) walked on a treadmill at their preferred walking speed for 30 minutes. Before (pre) and after (post) the 30-minute walk, subjects responded to five unanticipated lateral waist pulls (5% body weight) applied toward the swing limb at the instant of right toe-off. During the perturbed-step, a three-dimensional motion capture system tracked a reflective marker placed on the subject's sacrum to analyze the displacement of the participant's center of mass (CoM). The mediolateral displacement of the S2 maker was calculated between the instants of heel strike prior to and following the perturbation, and compared between the pre and post trials using a paired t-test. CoM displacement in response to lateral waist-pulls increased following the 30-minute walking task (pre: 42.3 ± 16.3mm, post: 51.5 ± 17.7 mm; p=0.028). The average percentage increase in CoM displacement was 41.8%. The results suggest that fatigue after prolonged walking might increase vulnerability to balance challenges. Our future work will investigate changes in the neuromuscular mechanisms responsible for these differences and effects of age. Our ultimate goal is the personalized prescription of interventions to mitigate fatigue, as well as fatigue-based control systems for assistive technologies.

Title: Design, Development, and Testing of a Multi-Terrain Amphibious Rover

Presenter(s): Arin Crow, Alaina Smith

Mentor(s): Javon Adams

REU/Summer Research Program: WMSRP

Helical drives are screw-like rotating cylinders with helical blades that can be used as a unique propulsion mechanism for locomotion of multi-terrain vehicles. The goal of this project is to study helical drives as a method of propulsion for multi-terrain vehicles built to explore arctic environments. Three main objectives of this project are to design a helical drive propulsion system, develop a testing rig to collect data, and to test the helical drive through different mediums. To design a helical drive, programs such as SolidWorks and 3D printers were used and could confirm that the assembly would properly fit together. SolidWorks was used to design a testing rig for the assembly and ensured everything would fit into the size constraints. This project is entering the data collection stage where data will be collected from sensors on the testing rig and used to validate the dynamic model. Researchers have assembled a testing rig that consists of low-friction linear rails, a large trough, and a wooden box that will hold various substrates for testing. Many electrical components such as Arduinos, motor drivers, and a large DC motor are also being used. The motor will be suitable for testing many different helical drive designs, RPMs, and substrates and is capable of producing a large amount of torque to fit all testing requirements. The motor needs to be used to actuate many tests with varying parameters as testing progresses.

Title: Analyzing Instantaneous Water Quality Variability During Sunny Day Flooding

Presenter(s): Gabriel Da Silva

Mentor(s): Javon Adams

REU/Summer Research Program: WMSRP

Sunny day flooding is a new phenomenon that occurs when coastal areas are inundated due to increased high tide water levels from sea-level rise. This flooding is especially common during king tides. King tide is the non-scientific name to describe the phenomenon of a perigean spring tide, when the moon is closest to the Earth in orbit whilst also being in the new/full moon phase. As the tidal water floods the streets through stormwater drainage systems, the water is potentially exposed to various pollutants. The objective of this study is to determine whether and to what extent the receding tidal water contaminates coastal waters.
In this study fecal bacteria levels were measured along the Taylor's Creek waterway adjacent to Front Street in Beaufort, NC. This location was chosen as it has previously documented sunny day floods and is located near various water level sensors. Enterococcus, a fecal indicator bacteria, was measured by taking tidal flood water samples at three different sites during the king tide period.
Tidal flood samples were collected at high tide, mid tide, and low tide after sunny day flooding inundated the Front Street roadway. Baseline sampling occurred daily at each site to document ambient conditions and compare against tidal flood sampling. Preliminary results suggest that there is a significant increase in enterococcus levels during king tides, especially during the transition from high tide

to low. Investigating this relationship could help determine if swimming advisories should be put into effect following sunny day flooding.

Title: Application of Game Technology as an Educational Tool for Management Students

Presenter(s): James Dominguez-Leach

Mentor(s): Javon Adams

REU/Summer Research Program: WMSRP

The goal of the research is the development of an Unreal Engine based, city building, tower defense game to be used to help improve the contract reading skills of the students in the Poole College of Management. This research involves innovative applications of game technologies to help make the incredibly dry task of learning to read contracts more interesting for the students. The game will task the player with building and protecting a city in a war stricken valley. To build the city and its defenses, the player will have to contract various companies for materials, resources, and manpower. The player will also be required to complete tasks they are assigned in a given time frame. By giving them a more interesting medium to interact with, the players will be more inclined to learn how to read the contracts closely and discern important details from them. This will help the Poole College of Management develop students who are better equipped to work with contracts in the future.

Title: Application of an Optical Sensor System for Wrist Rotation Control

Presenter(s): Madeline Dudley

Mentor(s): Javon Adams

REU/Summer Research Program: WMSRP

Interpreting a user's intent is the main challenge of robotic prosthetics and today’s researchers often use electromyography (EMG) signals as a method of reading the electrical activity produced by the muscles in order to control robotic prostheses. This method allows for the separate control of three degrees of freedom which include finger flexion and extension, wrist flexion and extension, and wrist pronation and supination. However, not all degrees can be controlled simultaneously using EMG due to deep rotational wrist muscles that risk potential crosstalk between signals. Because of this, a different method of control for wrist rotation is preferred. The question is, is this new potential solution an optical sensor system? An optical sensor works by capturing and comparing images to measure displacement. In this study, the possible issue of sensor drift was tested using bench tests that collected the sensor values over time. Correlational analysis was then used to compare these values’ standard deviations to provide a threshold for motor control. Potential control voltage was plotted live through MATLAB as the sensor measured pronation and supination to confirm that any drift the sensor may have did not greatly affect the accuracy of the sensor readouts. This test also showed how much proportional control the sensor could achieve. Real time implementation, that used able bodied individuals and a test of moving clothespins, was used to compare the control of the optical sensor against other methods of control to affirm the hypothesis that an optical sensor can work for wrist rotation.

Title: Identifying differences between stroke and healthy bone metabolites using mass spectral analysis

Presenter(s): Carter Gamble

Mentor(s): Jacque Cole

REU/Summer Research Program: BME

Ischemic stroke is a common condition causing substantial sensorimotor disability. Stroke also leads to significant bone loss, although the primary cause remains unknown. Matrix-assisted laser desorption electrospray ionization mass spectrometry imaging (MALDESI-MSI) is an innovative technology that can detect biological molecules with high spatial resolution and may provide insight into stroke-related bone loss. In a murine model of ischemic stroke, we collected bone samples from stroke and sham groups (n=3/group) and collected MALDESI-MSI data. Using MATLAB ® , these data were reorganized to isolate molecule IDs, which were evaluated using MetaboAnalyst, an open-source database, to identify active metabolic pathways. Up- and downregulation of pathways were compared between stroke and sham bones to identify potential biomarkers of pathway dysregulation (1.5x change or higher between groups). Further literature review was conducted to understand each metabolite’s role in osteogenesis and bone health, providing context and evidence for varying pathway activity between stroke and sham groups. Increased beta-alanine pathway activity (spermine) in stroke compared to sham bones suggest detriments to bone health, as spermine is implicated in Snyder-Robinson Syndrome, which impacts bone. Subtle changes were observed in retinol (1.3x change) and tryptophan (1.2x change) pathway

intermediates with lower intensities in stroke, suggesting loss of osteo-protective properties, as these pathways maintain bone mass. These data suggest multiple pathway dysregulations with stroke that impair bone health and maintenance. Further MALDESI research may identify additional metabolites that provide insight into mechanistic causes of stroke-related bone loss, which will inform clinical interventions.

Title: The implications of adopting modern household cooking fuels

Presenter(s): Grace Gould

Mentor(s): Javon Adams

REU/Summer Research Program: WMSRP

Approximately 2.8 billion people in the developing world use solid fuels for home cooking and heating practices with massive impacts on human health and the climate. The best way to address this problem is to use cleaner cooking alternatives to biomass, such as liquified petroleum gas (LPG) and electricity. A global model was developed to predict future fuel use and corresponding climate impacts for 77 countries with over 1 million solid fuel users until 2040. 5 different scenarios were considered, including a business as usual (BAU) scenario which takes current trends of fuel use and projects them forward. A full transition scenario (FT) considers all polluting solid fuel use to be rapidly transitioned to LPG and electricity. In this global model, the same approach predicts fuel use in all countries (using country-specific historical fuel adoption rates), only 6 fuel categories are included, and the use of multiple fuels in a household is not considered. Five of these countries (Ghana, Haiti, Rwanda, Nigeria, and Kenya) were selected as focus countries for a transition to LPG. For these countries, more detailed scenarios were calculated using country survey data, multiple fuels used within households, a wider set of fuels, and additional transition scenarios. This project used fuel use predictions based on country survey data for each of these countries to calculate emissions until 2040, and used a reduced form climate model to calculate temperature and forcing impacts. These results were compared with the global model for accuracy and compared between the countries.

Title: Finite Element Analysis of Scapular Bone Mechanics Following Brachial Plexus Birth Injury

Presenter(s): Rose Hansen

Mentor(s): Jacque Cole

REU/Summer Research Program: BME

Brachial plexus birth injury (BPBI) is one of the most common nerve injuries in children, caused by excessive tissue stretching during childbirth. Muscle and bone morbidities follow the initial injury, and depend on injury location. Postganglionic injury presents as limb disuse, joint contracture, and bone deformity. Preganglionic injury presents as greater limb disuse with less joint contracture and bone deformity. The mechanism underlying bone deformity is not fully understood, but developing bone is highly sensitive to mechanostimulation. Therefore, examining the mechanical response of bone to injury-specific loading conditions may deepen our understanding of why bone deformity occurs, facilitating development of treatments that target it. To model these interactions, contact finite element analysis (FEA, Abaqus) will be performed to simulate glenohumeral contact using joint reaction forces from a parallel study in rat musculoskeletal models as boundary conditions. FE models will be created from micro-computed tomography (micro-CT, 10μm voxels) images of rat humeri and scapulae from cohorts with surgically-induced BPBI phenotypes. A 0.2mm-thick shell will be created around each bone image and cropped to the articulating surface in 3DSlicer to model articular cartilage. Bone element moduli will be assigned based on micro-CT voxel density, and cartilage elements will be assigned a modulus of 1.1MPa. Element stress and strain outputs will be analyzed throughout the scapula, and for a trabecular bone volume of interest in the scapular neck to evaluate spatial distributions of mechanical stimuli. This approach may explain differences in bone deformity between preganglionic and postganglionic injury which remain unexplained.

Title: Monitoring Coastal Flooding with Sunny Day Flood Sensors

Presenter(s): Jasmine Hayden-Lowe

Mentor(s): Javon Adams

REU/Summer Research Program: WMSRP

As sea-level rises, urban areas along the coastline have an increased risk to flooding. Currently, records from the U.S. tide gauge records are being used as proxies to predict coastal flooding. However, these predictions underestimate flood frequency as they do not account for “sunny-day” flood events, or when rainfall along with high tides causes the stormwater network to be overloaded. Thus, the

ABSTRACTS | SESSION 5

Sunny Day Flood Sensors (SuDs) attempts to predict the coastal flood frequency more accurately. This open-source, low-cost sensor includes a pressure logger installed in a storm drain and a gateway box mounted on a pole next to the installation site. The pressure logger will collect the water depth in the storm drain in real time while the gateway box will send the data to the cloud and also take pictures of the street to visually see the flood. The current cost to build the SuDS is approximately $650 which is comparable to other sensor units that use a pressure transducer to log data in real time. SuDs have currently been installed in three cities along the North Carolina coast. For the SuDs installed in Beaufort, the sensors have found that 25% of floods at that location over a five month deployment period were caused by a sunny-day flood and were not predicted by tide gauge proxies. The hope for the SuDs is for this sensor framework to be open-source and allow coastal areas across the world to better monitor their local floods.

Title: Developing a Standard Operating Procedure and Data Collection Protocol of Key Military Functional Tasks

Presenter(s): Taylor Hildreth, Nicholas Jimenez, Jillian Jessup

Mentor(s): Katherine Saul

REU/Summer Research Program: GCSP and WMSRP

Military personnel can sustain injuries that affect their ability to complete tasks in the field or evacuate. However, limited data exists surrounding military functional task evaluation, especially in relation to the impact of injury. Due to this lack of data, collection of motion capture and EMG data to inform scaling of musculoskeletal models and simulations of key service member functional tasks can fill a gap in knowledge. We created a standard operating procedure for the Cortex motion capture system and EMG data collection. A data collection protocol for a set of military functional tasks based upon the Army Fitness Test exercises was also created. Next, the subject population and the inclusion and exclusion criteria surrounding recruitment of the subjects was determined. In addition, the associated risks for the research were identified. Our work will be used for data collection in the Fall, which will inform a previously developed injury model created via OpenSim, a software system used for biomechanical modeling, simulation, and analysis. This model will allow the military to better assess the impact of injury on key functional tasks service members need to execute in the field.

Title: Effects of Brachial Plexus Birth Injury on Muscle Spindle Morphology

Presenter(s): Emma Hinkle

Mentor(s): Jacqueline Cole

REU/Summer Research Program: Women and Minorities in Engineering Research Program

Brachial plexus birth injury (BPBI), one of the most common nerve injuries in children, occurs with excessive stretching of the head and neck during childbirth, causing significant deficits in upper limb musculoskeletal development. Of the children affected, 30-40% are left with lifelong impairment in the arm and shoulder. Little is known about how muscle spindles, which detect stretch in skeletal muscles and aid in proprioception, contribute to healthy growth and development, or how their structure and function is altered during a nerve injury like BPBI. On postnatal days 3-6, Sprague Dawley rat pups underwent one of four surgeries on one forelimb (preganglionic neurectomy, postganglionic neurectomy, forelimb disarticulation, or sham surgery) and were sacrificed at five different timepoints (2, 3, 4, 8, or 16 weeks post-injury). Three muscles per forelimb were harvested for analysis of muscle spindle number and morphology: subscapularis, biceps brachii, and supraspinatus. After dissection, muscles were immediately embedded in Optimal Cutting Temperature compound, snap-frozen, and stored at -80℃ until ready for cryo-sectioning. Muscles were cut longitudinally into 10-μm thick sections using a cryotome, with three sections taken from each muscle and placed on a silanized slide. Sectioned muscles were stained using Hematoxylin and Eosin, imaged at 20x, and analyzed for spindle number and morphology. Understanding when muscle spindle morphology is altered following BPBI can provide a greater understanding of the microstructural damage that occurs, how that leads to shoulder deformity, and can inform clinicians for enhanced treatment strategies for these patients.

Title: Improving the Corrosion Properties of Multi-Principal Element Alloys using Data Science

Presenter(s): Andrew Hollett

Mentor(s): Rajeev Gupta

REU/Summer Research Program: MAT-DAT

Multi-principal element alloys (MPEAs) are alloys consisting of several primary elements in concentrations from 5% to 35%. MPEAs are valued for their high yield strength, thermal stability, and corrosion resistance. Future research aims to optimize these properties and minimize elemental cost. In this work, theoretical MPEAs will be designed using shallow neural networks and produced by arc-melting.

ABSTRACTS | SESSION 5

These MPEAs will be tested for their corrosion resistance using electrochemical testing, specifically corrosion potential, corrosion rate, and pitting potential. The data for the models was gathered from recent in-house testing and literature focused on MPEAs undergoing electrochemical tests in 0.6M NaCl solutions. The neural networks were designed using the Keras API with a single hidden layer. The atomic fractions and corrosion properties of MPEAs were used for training and testing the models. The neural networks were used to predict the corrosion properties of over 100,000 potential MPEAs, which were filtered for desired performances. Several alloys with desirable properties will be selected for testing. Selected alloys will undergo potentiodynamic polarization testing to determine corrosion performance. Further characterization, such as scanning electron microscopy and electron dispersion x-ray spectroscopy, may be utilized to identify the microstructure and to gain insight into the corrosion behavior. The results will be fed back to the neural network for further training and validation to improve the accuracy of the model.

Title: Health and Environmental Tracker 2

Presenter(s): Misk Hussain

Mentor(s): Javon Adams

REU/Summer Research Program: WMSRP

Wearable devices are promising alternatives for expensive and invasive health tracking systems. Patients and physicians need an inexpensive system to monitor metabolic biomarkers such as blood pH levels, body temperature, and blood sugar levels in real time. Wearables can be used to provide continuous monitoring for chronic illnesses such as diabetes, allowing for a faster response time to avoid emergency situations. The wearable system integrates a flexible sensor that detects pH, lactate and body temperature through noninvasive methods. In order to have a working sensor, a functionalization process must take place. This process, in order involves: cleaning the sensor, electrodeposition of polyaniline (PANI) onto the pH electrode, MWCNT dispersion onto the lactate electrode, electrodeposition of Prussian blue, adding Ag/AgCl to the reference electrode, adding enzyme solution, adding PEI and PEGDGE solution onto the enzyme layer, and lastly adding the cellulose acetate solution. Historically, one disadvantage in wearable devices is that they provide accurate measurements for a limited skin tone range. This issue was highlighted during the COVID-19 pandemic, where Black and Latino people were disproportionately affected by the virus. The wearable pulse oximeters used to measure oxygen levels were providing inaccurate measurements. The HET2 (Health and Environmental Tracker 2) devices have been calibrated to create optimal settings for all skin tones.

Title: Appeasing African Americans

Presenter(s): Jeanine Ikekhua

Mentor(s): Javon Adams

REU/Summer Research Program: WMSRP

The first part of this study examines whether streets named after Martin Luther King, Jr., and the Ida B. Wells housing project, were only named after these Black figures to appease the Black community. The second part of this study examines why Ida B. Wells was important enough for a Chicago housing project named after her, but not enough to be taught about in Chicago schools. Information on the policies, power structure, and legal process behind street and building re/naming in Chicago was collected. Specific documents from Chicago newspapers that mention why and who renamed the Ida B. Wells housing developments were also collected. Using this method confirmed that the first MLK building was created to mollify the black community in Chicago post the 1968 riots. Furthermore, the Ida B. Wells housing project was created to maintain segregation in Chicago, which did not honor Ida B. Wells because she was against segregation. It can be concluded that the naming of public structures after MLK and Ida B. Wells, was enacted by the white Chicago power structure to appease the black community and not to honor the lives of MLK and Ida B. Wells. Lastly, it was found that specific Black figures such as Ida B. Wells are not being taught in Chicago schools because Chicago's Black History requirements are extremely vague. If the Chicago power structure were not trying to merely appease the black community, they would ensure that Ida B Wells's legacy is being taught in schools.

ABSTRACTS | SESSION 5

Title: Gel Propellant Stability

Presenter(s): Caleb Kebede

Mentor(s): Tiegang Fang

REU/Summer Research Program: WMSRP

These experiments study the stability of gel propellants, specifically Jet A1 fuel. The fuel is gelled through the inclusion of Thixcin R, an organic derivative of castor oil, which accounts for 5% of the mixture's total volume. The two additives are then encased and at first spun at 1000 rpm in a mixing device at 50°C for 30 min before finally being spun with no set temperature for 90 min. A common issue in the use of gel propellants is the maintenance of the structure prior to combustion and in storage. To test the stability of the Jet A1 gel the substance was tested in various temperatures, at different rates of vibration, and combinations of both to determine the boundaries of stability. Along with finding the limitations of this substance, this project leads into the strengthening of the substance. This is done through adjustments of initial conditions and possible the addition of additives or other gellants. Gel exhibits the pros of both solid and liquid propellants and is cleaner than both. With the benefits being acknowledged this experiment aims to focus on gel propellants weakness and potentially strengthen the substance in the process. The work is expected to demonstrate that gel, although it is sensitive to its environment, is a reliable and stable option within the future of fuel.

Title: Self Assembly of PEDOT:PSS from Solution to Solid Phase

Presenter(s): Grace Kiel

Mentor(s): Javon Adams

REU/Summer Research Program: WMSRP

Poly(3,4-ethylenedioxythiophene):polystyrene sulfonate (PEDOT:PSS), a highly conductive polymer, is commonly used in organic devices due to its facile processing and tunable properties, namely electronic conductivity. Extensive research has been performed to understand the polymer's electronic conductivity in thin films; however, the polymer dispersion is yet to be fully understood. Various physical and chemical alterations can lead to the increase of conductivity in PEDOT:PSS. In this research, dynamic light scattering is used to study particle morphology and size to better understand self assembly of the polymer components when ionic salt is added. PEDOT:PSS was determined to form a network in solution, affecting particle size. With the addition of lithium, the network formation is enhanced and, in turn, affects the electronic conductivity of thin films. The trend in particle size is in agreement with additional experimentation in this study including transmission electron microscopy (TEM). The fundamental understanding of the solution phase of PEDOT:PSS can provide further information to the field of organic electronics.

Title: Algorithms for Geometric Multi-Matching

Presenter(s): Pranav Krishna Kumar

Mentor(s): Javon Adams

REU/Summer Research Program: WMSRP

This research involves an exploration of algorithms and their optimizations for solving the Max-Flow problem to work towards a faster method of solving maximum matching problems of sets. Using Python, we work through the complexity and run times of famous algorithms already created for solving the problem, such as the Ford-Fulkerson and Dinitz algorithms and work to understand how they work and ways to optimize them. Varying the methods of graph search and path finding, decreasing the number of times the main portion of the algorithm has to run, and ways to best store the flow of which you are looking to maximize, among other areas to optimize. We aim to take what has already been studied and find what can be improved on from a fresher look at the problem and its existent solutions.

ABSTRACTS | SESSION 5

Title: Digital Branding and the Community of Practice

Presenter(s): Ayush Lamsal

Mentor(s): Olgha Qaqish

REU/Summer Research Program: GCSP

The GCSP-REU is a high-impact engineering program that the NCSU College of Engineering offers to current Grand Challenges Scholars; however, the image of the GCSP required a redesign and digital branding improvements. For my summer REU, I worked on redesigning the GCSP website utilizing WordPress and HTML coding and established the GCSP Community of Practice. Learning how to use WordPress software as well as improving my HTML programing skills took a bit of an initial learning curve, but was smooth sailing afterwards. I learned how to hide hyperlinks so that they would remain on the website but not be visible, restructure tags for all of the pages, and redesign the website to showcase the GCSP. The work I have done showcases the GCSP and its opportunities in a much better light by drawing in visitors to the website with a clean and streamlined interface instead of driving away users with cumbersome textual data and complex visual design. In addition to restructuring the website, I established a GCSP Community of Practice with the REU by serving as a liaison for the Associate Director with the rest of the group. I created a GroupMe for the 17 group members to communicate with each other and ask questions that I answered or forwarded to the Associate Director and sent announcements to the group. Additionally, I managed the Learning Management System (LMS) Moodle site for the group by uploading helpful documents and uploading the recorded weekly hybrid hangout meetings for the group to watch.

Title: Effect of Nerve Injury on Shoulder Muscles in Brachial Plexus Birth Injury Rat Model

Presenter(s): Christina Lasdin

Mentor(s): Javon Adams

REU/Summer Research Program: WMSRP

The brachial plexus birth injury (BPBI) occurs in about 1 to 3 out of every 1000 human births and often results in muscle contracture, glenohumeral bone deformity, and paralysis of the upper limb. Previous murine studies have shown at 4- and 8-weeks post-injury, optimal fiber length and muscle mass of the muscles of the shoulder decrease in injured limbs due to BPBI. In this study, preganglionic and postganglionic neurectomies, forelimb disarticulations, and sham surgeries were administered to postnatal rats at postnatal days 3-6 to mimic BPBI. Eleven muscles surrounding the shoulder joint were harvested from both injured and uninjured limbs: Pectoralis major, Acromiodeltoid, Spinodeltoid, Supraspinatus, Infraspinatus, Teres major, Teres minor, Subscapularis, Triceps, Bicep long head, and Bicep short head. Muscle collection occurred at 2, 3, 4, 8, and 16 weeks after injury to evaluate the progression of muscle deformity. Mass and length measurements were collected of each muscle and compared to uninjured counterparts and other surgery groups, while sarcomere lengths were measured via laser diffraction through muscle fibers to determine optimal fiber length and physiological cross-sectional area (PCSA) for each muscle. Muscle mass, optimal fiber length, and PCSA are markedly decreased in the muscles on the injured limb at 3 weeks post-surgery, with the greatest decrease in the preganglionic neurectomy group. Analysis for remaining time points is ongoing.

Title: Participatory Design

Presenter(s): Sana Mahmoud, Maggie Lin

Mentor(s): Javon Adams

REU/Summer Research Program: WMSRP

Software designed for educational use presently does not involve teachers in the design process. This is an issue because teachers have valuable expertise, needs, and desires that are being neglected. As learning technologies gain increasing use in classrooms, the involvement of teachers in the design process gains greater importance. Using participatory design techniques, we investigate integrating teachers' voices in the improvement of a block-based programming learning management system, SnapClass. A future workshop, a common participatory design process, was conducted with 3 teachers who use block-based programming in their classrooms followed by live prototyping and enactment. The workshops enabled teachers to visualize functionality they would value in the software through evaluating teaching practices, imagining solutions, and collaborative prototyping. We found that within the SnapClass environment, there is a need for a real-time hand raising feature, level differentiation within assignments, and a feature for assigning student self-reflection. The teachers' concerns will be addressed through implementation of new functionalities into the software.Keywords: CS education, block-based programming, participatory design, HCI.

ABSTRACTS | SESSION 5

Title: Drag Decomposition of a Flexible Kite Airborne Wind System

Presenter(s): Hanna McDaniel

Mentor(s): Javon Adams

REU/Summer Research Program: WMSRP

Airborne wind energy (AWE) systems involve the use of kites or small aircraft attached to a tether to generate electricity instead of a fixed wind turbine. One of the benefits of AWE systems is their access to high velocity winds that are present at higher altitudes. Much research has gone into the analysis and development of AWE systems, but their design/optimization is typically performed by considering the aerodynamic effects as integrated quantities for an entire cycle. In this research, a drag decomposition will be conducted on a kite model AWE system to determine which parts of the system contribute to which types of drag and to determine which types of drag are most prevalent at certain points along the system's flight path. By focusing on the different types of drag generated by the system, it can be determined where to focus energies during segments of the system's flight path to reduce the drag therefore increasing the system's energy generation efficiency. The work so far has focused on studying a drag decomposition method for aircraft. This method will now be extended for the AWE kite system. Keywords: aerodynamics, airborne wind energy

Title: Human-Readable (and Editable) Intermediate Representation for a Compiler

Presenter(s): Gabriella Micheli

Mentor(s): Javon Adams

REU/Summer Research Program: WMSRP

Software is embedded in everything we do and almost every program requires some sort of text processing tool. Currently, every text processing tool utilizes Regular Expressions, regex, which is a 50-year old technique that was designed for computers much slower than the ones we have now. Even though regex is embedded in every programming language, it is known for its susceptibility to user errors and other bugs given the clunkiness of its syntax. Parsing Expression Grammars, PEGs, and other grammar-based systems are an alternative to regex. There are many benefits to PEGs, but the most important are its user-friendliness and its focus on integrating with software engineering workflows . Rosie is a PEG that was created in 2015 and is structured like a traditional compiler. This research is centered around modifying the structure of the compiler's output for Rosie 2.0, PEXL. Currently, Rosie outputs machine-readable text; then, if specified, it converts that into human-readable text. This research is switching that process; PEXL will output human-readable text – similar to assembly bytecode. In other words, PEXL will return a program that other researchers can reasonably understand and modify to their liking. PEXL will then read it back through an assembler and create the new modified program. This change should help optimize the highly iterative process of future research and development of PEXL. In the future, this redesign of Rosie will start to replace regex as a reliable way to handle text processing or inspire another solution that achieves this goal.

Title: Understanding how biochar co-compost application rate impacts decomposition of biomolecule classes

Presenter(s): Areli Neri-Otero

Mentor(s): Javon Adams

REU/Summer Research Program: WMSRP

Biochar co-compost in soil has been shown in previous studies to reduce the amount of greenhouse emissions during the process of composting. How this specifically functions and whether or not this applies to a variety of soil types and conditions is still unclear. In this experiment, we seek to understand if biochar co-compost is involved in the microbial acquisition of C (carbon) and N (Nitrogen) during decomposition of the compost process. We chose to measure specific enzyme classes found in composted material. We measured enzymes involved in cellulose degradation (β-glucosidase and exoglucanase), N-acetyl glucoside degradation (β-glucosaminidase), and non-specific oxidation (peroxidase and phenol oxidase). This would allow us to see C and N mineralization, and microbial degradation of the compost through time. By adding the levels of linked substrates such as pNP and L-Dopa so that it is saturated, we are able to measure absorbance using the colorimetric method. We have used three texture classes, which are sand, silt loam, and clay, while also using three biochar addition rates. Through the experiment, we used enzyme assays to analyze and measure the composition of these three texture classes, while also including two controls (substrate and soil sample). By also creating a standard curve for pNP in acetate buffer and another for DSQC, we can also use this to determine enzyme activity of the test samples and production. Our data demonstrates how the addition of biochar impacts decomposition of different biomolecule classes in compost material.

ABSTRACTS | SESSION 5

Title: Developing a Universal Sample Preparation Method for Total Protein Purification: An Investigation into Spectrophotometric Assays using Small Chain Antibody Fragments Produced in E.coli and Pichia pastoris

Presenter(s): Amy Nguyen

Mentor(s): Javon Adams

REU/Summer Research Program: WMSRP and BTEC

Product characterization is a key component of many downstream applications within biomanufacturing processes. While scientists may find the application of numerous diverse analytical techniques ideal for a more comprehensive analysis, the process can become time-consuming. Product variability is inevitable, and therefore, sample preparation methods need to be adjusted to appropriately address distinct concerns, including compatibility with more advanced tools (e.g., mass spectrometry). Consequently, it is important to consider these aspects when developing a protocol. BTEC-Analytical is developing an efficient and versatile protocol to extract and purify total protein without significantly compromising product recovery and integrity. The protocol first begins with a "cleanup" to extract the protein and remove unwanted cell debris. However, to assess any protein loss that occurs, a total protein quantification assay is also needed. Choosing the correct quantification assay is imperative. Spectrophotometric assays are usually used to quantify proteins because they are rapid and easy. However, the sample matrix can skew the results depending on different sample composition. To determine the most universal assay to pair with our versatile cleanup protocol, we also investigated common assays (e.g., BCA, Pierce-660, Bradford) for matrix effects, interference tolerance, and protein-protein variability. To conduct this study, small chain antibody fragments (scFv) produced in E.coli and Pichia pastoris were extracted with solvent (e.g., acetone, ammonium sulfate) precipitation and/or ultrafiltration protocols, using immunoglobulin G and bovine serum albumin as controls. The various quantification methods were compared between various proteins, and the best-performing one was subsequently used to assess the developed cleanup protocol.

Title: Ride height of a Lightweight Autonomous Vehicle

Presenter(s): Bailey Patterson, Carlos Banegas

Mentor(s): Seth Hollar

REU/Summer Research Program: WMSRP

This research seeks to establish a lightweight electric autonomous vehicle that will operate as personal rapid transit across NC State Campus. The riding height of the vehicle is determined by the shocks of the suspension system and should allow for both upward and downward motion of the wheels over the road, to maintain constant contact between the wheels and the ground to maximize control of the vehicle. In the lightweight autonomous vehicle, the springs in the suspension system compressed too much when the vehicle was loaded, so the body of the vehicle rubbed against the top of the wheels. The goal of this research is to determine how to raise the ride height of the car without changing the springs. The methods used for this research include extensive research and discussions about how suspension systems work, and how changing different parts will change the ride height or oscillations of the springs differently. The solution used was to install a half-inch shim around the piston above the spring to increase the preload of the spring. The shim increases the amount of load needed in the vehicle to compress the springs but still allows for compression and extension of the spring as the vehicle travels over uneven roads. The biggest challenge of this solution is installing the shims without the proper tools to compress the spring. Ultimately, this solution is a simple and cost-effective way to increase the ride height of the loaded vehicle.
Keywords: suspension, springs

Title: Usage of Ultratrack to improve accuracy of FES and Exoskeleton movement

Presenter(s): Srishti Rastogi

Mentor(s): Javon Adams

REU/Summer Research Program: WMSRP

Tremor causes an involuntary oscillation of one or more body parts and is often prevalent in persons with Essential Tremor (ET) and Parkinson's disease (PD). These involuntary oscillations can negatively impact the person's quality of life when performing everyday tasks. While current treatments for suppressing tremors have restrictive effectiveness, emerging solutions such as electrical stimulation have been developed. In order to further investigate and develop the potential for electrical stimulation-based tremor suppression, the goal of this research is to develop a novel tremor model based on ultrasound (US) imaging. While, current tremor modeling and detection is performed by sensors such as electromyography (EMG) and inertial measurement units (IMU), it is hypothesized that US imaging can be a novel sensing modality as it can provide a direct visualization of the tremor-causing muscles without cross-talk present in EMG signals. To test this hypothesis, US, IMU, and EMG signals were taken from three participant groups consisting of PD, ET, and a healthy control as

they performed a grasping motion. To model the tremor, fascicle position and velocity are extracted from the ultrasound images based on a speckle tracking algorithm which can be benchmarked with a state of the art UltraTrack software which measures fascicle length and velocity based on an optical flow algorithm. The tremor frequency detected in each of these methods will be compared to that of the measurements taken by the IMU and EMG to validate the finding that a novel speckle tracking based ultrasound fascicle length measurement can help model and detect tremor.

Title: Safety of Nuclear Reactors

Presenter(s): Elijah Rushing

Mentor(s): Javon Adams

REU/Summer Research Program: WMSRP

With concerns of how the energy industry is impacting the environment, nuclear energy comes as a potential solution. Nuclear energy provides a way for energy to be harnessed with low carbon emissions, low water pollution, and low to moderate land disruption. Nuclear energy accounted for 20 percent of the electricity in the United States as of November 2020 and about 10 percent as of June 2022. One of the concerns around nuclear energy is the safety associated with nuclear reactors due to radiation. It is believed that non-light water reactors (examples include reactors in which the coolants are helium, liquid metal, or molten salt) can be as safe as or safer than previous generation light water reactors since they rely on passive safety systems for all emergency conditions. The aim of this research is to examine and compare the safety levels of non-light water reactors and light water reactors. To do this, the frequency and dose of event sequences of several reactors were graphed against the Frequency-Consequence Target graph described by the United States Nuclear Regulatory Commission (may also be referred to as U.S.NRC.) At the time of this writing, the study has not finished; however, with data that has been analyzed through probabilistic risk assessment and from current understanding of nuclear reactors, it is expected that the results will show that non-light water reactors can be as safe as or safer than light water reactors.

Title: SrxBa1-xFeyCo1-yO3 phase transition sorbents for the high-temperature isothermal sorption-enhanced gasification process

Presenter(s): Azin Saberi Bosari

Mentor(s): Javon Adams

REU/Summer Research Program: WMSRP

The sorption-enhanced gasification (SEG) process is a promising approach for producing high-purity hydrogen from carbonaceous fuels by in-situ capturing CO2 using sorbents. Compared to the conventional method, SEG can save significant amounts of energy in the syngas conditioning and separation steps. Sorbents play a key role in the process performance, while the prevailing CaO-based sorbents will have deactivation issues during cyclic operation. Recently, a novel phase transition sorbent (PTS) was proposed to successfully address the deactivation issues at higher temperatures. In this study, we developed 28 different Ba and Co-doped SrFeO3 materials, which dramatically expanded the family of PTSs. The ball-milling method was used to synthesize the sorbents, and then the Thermogravimetric Analyzer (TGA) was used to test the performance of the sorbents and to obtain their corresponding sorption capacity. The variation in the A-site and B-site compositions of SrBaFeCo-based perovskite led to the sorption capacities ranging from 2% to 52% at 850°C, which was also the first time to achieve both the CO2 uptake and release at 850°C. The results also found that higher Co or Ba-doping samples led to a higher sorption capacity, but the variation in Ba had a greater impact on the sorption capacity in high-Co-doping materials. Specifically, Sr0.25Ba0.75Fe0.375Co0.625O3 demonstrated 52% sorption capacity at 850°C with a very stable performance over 15 cycles. In the future, more detailed characterization methods will be conducted to explain the tendencies.

Title: Ischemia-Reperfusion Injury Model

Presenter(s): Aby Sall

Mentor(s): Javon Adams

Ischemia-Reperfusion Injuries (IRI) are widely spread worldwide, can lead to severe multi-system organ failure and other injuries, and are the leading cause of death in several countries. In this study, the minimal time that leads to maximum of damage in the organism is observed by replicating an Ischemia-Reperfusion Injury model in vitro. This data will help in the development of therapies for these injuries. In order to do so, adult rat cardiomyocytes were isolated and cultured. Then, ischemia was stimulated followed by an induced reperfusion. Lastly, the ischemic assault time was optimized, and the cells were characterized. As a result, the minimal time causing the most damage to the tissues was 3.5 hours. In addition, many cardiomyocytes, hardly regenerated, were outnumbered by fibroblasts and went through apoptosis, eventually resulting in organ failure. Keywords: Ischemia, reperfusion, cardiomyocytes, fibroblasts

ABSTRACTS | SESSION 5

Title: Experimental Protocol for Automated Viral Infectivity Assay (AVIA)

Presenter(s): Amit Sen

Mentor(s): Raquel Hernandez

Viruses induce changes in infected cells that can be evaluated using Artificial intelligence (AI) by comparing images of structural changes between infected and non-infected cells. AI is "trained" to recognize structures induced by the infection and ignore structures formed by cell division or death. To train the algorithm, uninfected and cells infected with serial dilutions of lytic viruses are imaged multiple times post-infection to view cytopathic progression. Our analysis is based on training ML on structural differences of cell images and creating plots of validated "trained" data predictive of the number of infectious particles. The machine learning (ML) algorithms improve predictive analytic performance with increased training. This Automated Virus Infectivity Assay (AVIA; AI/ML) is adaptable to cytolytic viruses through comparison cell imaging. Currently, virus infectivity is determined by plaque assay. It involves serial dilutions of the virus sample that are inoculated onto plated cells to determine plaque-forming (pfu/mL). Infected cells lyse and spread the infection to adjacent cells. As the lytic cycle is repeated, the infected cell area will form a visible plaque. The pfu/mL result represents the sample's number of infectious particles. Compared to this traditional methodology, AVIA is a streamlined assay that can be theoretically configured for high throughput, thus saving preparatory work, starting material, and time. For flaviviruses, it takes two weeks to perform the basic tasks for the plaque assay, compared to 3 to 5 days with AVIA. We aim to compare the two assays and determine if AVIA is a suitable alternative.

Title: Assessment of Computational Requirements for Computer Vision Models Implemented in High-Throughput Agricultural Packing Systems

Presenter(s): Charlotte Simon

Mentor(s): Javon Adams

REU/Summer Research Program: WMSRP

For decades, it has been the vision of AI model developers that machine learning techniques be implemented to improve functionality, efficacy, and efficiency across a broad spectrum of processes. High-throughput, industrial scale applications have benefited from the incorporation of Computer Vision (CV) within the production process. Recently, researchers at North Carolina State University have developed machine learning based CV models intended to improve outcomes for sweet potatoes, a crop with high variability in the visual shape features that consumers use to assess quality when purchasing. The greatest challenge in implementing a CV model of this design at the required industrial scale is portability. CV models are typically developed in a very specific computational context, relying heavily upon a particular combination of software and architectural specifications to be directly available on the machines utilizing the models. Often these system requirements are not available with existing infrastructure, and thus may not be economically feasible to implement at larger scales. The use of virtual containers in a cloud environment for deploying these CV models eliminates the necessity to run a very specific software environment on existing computational infrastructure and allows the CV model to be accessed on any machine through the container by an Application Programming Interface (API). This study evaluated the computational requirements such as CPU, memory, and bandwidth required for a portable CV model in a high-throughput agricultural packing system. These results will provide stakeholders with a more precise assessment of computational costs when scaling the CV models for industry implementation.

Title: Continuous, Non-invasive, Optical Measurement of Total Hemoglobin via Bluetooth Enabled Ring

Presenter(s): Madeline Smith

Mentor(s): James Dieffenderfer

REU/Summer Research Program: WMSRP

The objective of this research is to develop a wearable Bluetooth enabled ring device that non-invasively and continuously measures total hemoglobin. Developing this system required testing and verifying a new battery protection circuit and fabricating a physical enclosure using resin printed molds. This device implements a continuous wave near-infrared spectroscopy setup to measure the attenuation of twelve distinct wavelengths from 485nm to 910nm. Modified Beer-Lambert Law is applied to determine delta oxy and deoxyhemoglobin features, which are inputted into a random forest algorithm (RFA) along with features derived from the raw optical signals to obtain a total hemoglobin measurement. The truth values for this algorithm are collected using a clinical measurement device (Masimo Pronto Pulse Co-Oximeter) that measures total hemoglobin optically using an empirically derived formula. Training data for the RFA is generated by taking measurements of each finger using both the ring and the Co-Oximeter. Additionally, a methodology is being explored that would eliminate scatter from attenuation measurements.

ABSTRACTS | SESSION 5

Recent literature has shown that measuring at a particular location on the finger relative to the emitter will result in a geometric phenomenon where path length remains constant despite varying scatter coefficients. To test this methodology, silicon phantoms of varying scatter coefficient were fabricated. If successful, the effect of scatter could be accurately accounted for and changes in attenuation could be assumed synonymous with changes in absorption.

Title: Forepaw Usage Preference following Brachial Plexus Birth Injury

Presenter(s): Steven Thompson

Mentor(s): Jacqueline Cole

REU/Summer Research Program: OUR Award and BME

Brachial plexus birth injury (BPBI) is a perinatal neuromuscular injury that can cause permanent arm defects. Spontaneous limb usage has not been studied with this animal model, and previous animal studies of post-injury limb use only employed adventitious motions that do not provide insight to intrinsic limb usage. Clinically, extrinsic motor and sensory assessments of the upper limb are utilized to examine the extent of arm impairment. Intrinsic limb usage is an important component of assessing BPBI, as it provides insight to how the injured limb will be used for completion of functional tasks including crawling, reaching, and grabbing. On postnatal day 3-6, Sprague Dawley rat pups underwent surgical neurectomy (postganglionic, preganglionic, or sham) excising the C5-C6 roots. At 3, 4, 6, 8, 12, and 16 weeks post injury, functional forepaw usage was examined using the cylinder test, in which limb preference (injured limb, uninjured limb, or both limbs) was quantified for push-off, resting against the cylinder wall, and landing motions during vertical exploration of the cylinder. Preliminary results of this ongoing study show that while the preganglionic injury group favors use of their uninjured limb (36-80% usage), injured limb use (5-17% usage) is greater than injured limb use in the postganglionic group. Both injury groups use their injured limb most during landing motions and least during vertical rest. This study is the first to determine spontaneous forelimb usage and functionality following BPBI and may provide insight to early functional limb impairments in clinical patients.

Title: Effect of Sex Hormones on Mechanical Properties of the Anterior Cruciate Ligament Via Cellular and Non-Cellular Pathways

Presenter(s): Angelina Vasselli

Mentor(s): Matthew Fisher

REU/Summer Research Program: OUR Award and BME

Anterior cruciate ligament (ACL) injuries are extremely common, and are increasingly so in highly active adolescent females in comparison to their male counterparts. Sex hormones unique to females have been studied to relate knee joint laxity to increased incidence of ACL injury in female atheletes. Studies in response to hormones use frozen animal tissues, and do not entirely account for mechanisms by which live cells interact with hormones. Our aim is to expose living ligament explants and thawed frozen ligaments to varying concentrations of female sex hormones and test their mechanics to elucidate the extent to which female sex hormones influence tissue mechanics. It is hypothesized that these effects will demonstrate an increase in tendon creep particularly in live explants, which would be indicative of an increase in anterior knee laxity contributing to ACL injuries. As a preliminary experimental group, frozen rat tails were obtained and rat tail tendon fascicles were extracted. The fascicles were hung in tension in concentrations of estradiol, relaxin, and collagenase. Across the measured time points, distances between stain markings demonstrated an overall increase in length in PBS control and hormone experimental groups of similar magnitudes. In an additional experiment, fascicles were soaked overnight in concentrations of hormones and mechanically tested until failure. The average ultimate stress was highest in experimental groups, however, the average associated strain was higher in the individual relaxin and estradiol groups. Further experimentation is needed in both experiments to eliminate sources of error, including measurement precision and uniform testing protocols.

Title: Control of fin induced shock separation using steady micro jets

Presenter(s): Luis Villalobos

Mentor(s): Javon Adams

REU/Summer Research Program: WMSRP

Control of hypersonic vehicles in near space where dynamic pressures begin to become significant entails the use of both a reaction control system (RCS) and aerodynamic control surfaces. The goal of this study was to experimentally determine the interactions between a cold gas nitrogen thruster used in an RCS and a fin mounted on an axisymmetric body. To do this, a fin was mounted on a

nose cone geometry in incident Mach 2.5 with a single cross flow nitrogen gas jet placed at various distances in front of the fin. The external flow field was quantified through the use of particle image velocimetry (PIV), with the surface pressure field being found using pressure sensitive paint (PSP). Surface steak-line visualization (SSV) was conducted through the use of mineral oil with pigment to qualitatively examine separation characteristics. The injected jet generates a vortex pair which travels streamwise down the length of the body. It was found that an optimal injection pressure exists where the separation vortex caused by the fin induced shock is greatly minimized. In addition, it was found that decreasing the streamwise distance between the microjet and fin demonstrated a stronger interaction between the jet vortex and separation vortex, leading to a large reduction in separation vortex size and vorticity.

Title: Musculoskeletal Modeling of Rat Shoulders Affected by Brachial Plexus Birth Injury

Presenter(s): Leilani Walker

Mentor(s): Jacqueline Cole

REU/Summer Research Program: BME

Brachial plexus birth injury (BPBI) occurs during strenuous childbirth, causing paralysis of the infant upper extremity. Injury presentation depends on location– preganglionic injury results in greater paralysis while postganglionic injury causes passive muscle contracture and greater bone deformity. To mimic BPBI, a surgical intervention in neonatal rats is employed, inducing forelimb paralysis, impaired muscle growth, altered gait, and bone deformity in the glenohumeral joint. Bone development is strongly mechanically controlled, so such bone deformities may result from altered joint loading. Musculoskeletal models created in OpenSim render relationships between bone and muscle properties, gait, and joint reaction forces (JRFs). Previously-measured properties including muscle and bone architecture, ground reaction forces (GRFs), and joint angles over a gait cycle will be incorporated into models for healthy and injured rat shoulders. Glenohumeral JRFs will be obtained through a two-stage analysis. First, the computed Computed Muscle Control tool will determine muscle activations needed to track measured joint kinematics and support measured GRFs. Then, muscle activations will be fed into the Forward Dynamics tool to determine net glenohumeral JRFs. By modeling glenohumeral JRFs in (1) passive and active loading, and (2) postganglionic and preganglionic injuries, biomechanical mechanisms linking muscle and bone changes following BPBI can be better understood. Musculoskeletal analyses using GRFs have never been used to study rat models of BPBI, but may be essential for understanding bone development for individuals in stages of partial nerve recovery, where the limb can still be used to support body weight, but with abnormal posture and muscle imbalance.

Title: Comparison of AFM and Tensile Testing Methods on Equine Superficial Digital Flexor Tendon

Presenter(s): Samantha Watson

Mentor(s): Matthew Fisher

REU/Summer Research Program: OUR Award and WMSRP

Tendon injuries account for ~50% of all musculoskeletal injuries in humans, and is one of the most frequent injury sites for horses. Tendon undergoes a healing process that is unable to restore full tendon function; however, little is known about the cell-matrix interactions during this process. To study these interactions, a tendon-on-chip model is needed that replicates all aspects of the native tendon environment. The current methodology to study mechanical properties of a tendon, Instron tensile testing, does not scale down enough to apply to these models; however, atomic force microscopy (AFM) allows for micron level mechanical analysis. This project used the contact force tapping mode on AFM to study modulus of equine SDFT tendon. Mechanical testing on an Instron was also performed using dog-bone sections of tendon in the longitudinal and transverse directions to obtain the ultimate stress and Young's Modulus to compare with the results obtained from AFM. Statistical differences between these groups were determined via a one-way ANOVA and Tukey's post hoc analysis. It was found that the average modulus obtained from AFM was ~0.015 MPa, while the modulus from Instron was ~170 MPa. This magnitude of difference may be due to the difference in size between the measurement scale testing methods, 2μm or 10mm for AFM or Instron, respectively. Further analysis of tissues from healthy versus diseased samples as well as tissue orientation need to be considered to better understand the mechanical changes within a tissue structure on the fibril level.

ABSTRACTS | SESSION 5

Title: The Effects of Powered Knee Prosthetics on Trans-femoral Amputees

Presenter(s): Kaitlynn Whimpenny

Mentor(s): Helen Huang

REU/Summer Research Program: WMSRP

In the investigation of how a powered prosthesis might benefit a trans-femoral amputee, there were several guidelines found which the research team has hoped to find some significance in. The subjects in this investigation have all used a powered prosthetic knee which is tuned among 3 different profiles, each of which have an individual set of parameters to see how the mechanics of walking may change as a result of the different profiles. Each of these profiles has been tested twice at random to prevent learned behavior, and there is an added neurocognitive task performed. The task is performed in addition to the walking because it is important to note the neurocognitive load that the subject is using to walk. Throughout this investigation, in addition to cognitive load, there have been several biomechanical factors which seem to pique interest. The factors studied thus far have been the stance time, step length and stride time of the prosthetic leg, found via calculations in MatLab and Vicon Nexus. These are the most notable due to the implications that these factors might be affected by the prosthetic. As this study continues, these factors will be evaluated and will be compared within the profiles of each subject, and between the subjects in search of statistical significances in these biomechanical factors.

Title: The Development of Renewables on Abandoned Oil & Gas Wells (Literature Review)

Presenter(s): Brandon Wilson

Mentor(s): Javon Adams

REU/Summer Research Program: WMSRP

The motive of this literature review is to provide the solar energy developers' in-depth perception on the value of installing renewable energy on abandoned oil and gas wells. The substantial amount of abandoned oil and gas wells across the country provides a unique opportunity for renewable energy sources to have land to operate on. The quality care and topographical capacity factor of these deserted lands will ultimately determine if the benefit of installing renewable energy sources outweighs the cost. Considering that the immensity of these aspects is subjective to each respective section of abandoned land, how these lands are regulated and used matters to renewable energy developers. To start, cleaning up these lands is necessary before the installation process. Various peer reviewed journal articles, newspaper articles, eBooks, and governmental documents have been reviewed. The recent literature confirms that hydraulic fracturing is a primary determinant for renewable energy developers, unemployment hurts rural areas the most once these oil and gas wells become abandoned, and the U.S. government prioritizes renewable energy development on these lands without consideration of private developers. The development of solar power on these abandoned oil and gas fields will create great opportunities for a multitude of U.S. regions; however, these renewable energy developers are working first-hand on the risk analysis.

Title: AI Generated Music using Tension Curves

Presenter(s): Bryan Wilson

Mentor(s): Javon Adams

REU/Summer Research Program: WMSRP

In the field of AI generated music compositions, it has become common practice to train a supervised learning model on a large corpus of already existing music, usually all within a similar music style. Neural machine learning approaches trained on these large corpuses have shown to produce novel aesthetically similar compositions to the corpus, which is the goal in some cases. However, this approach limits the originality of produced compositions. Traditional supervised learning methods learn surface level musical patterns and note structures before generating its own. There have been efforts to augment supervised learning with models from music theory (such as functional harmony) in order to increase composition originality. However this pushes the originality problem further, as the ML model still learns a human-generated framework. This study seeks to heighten the complexity and originality of AI generated music by training two machine learning models on a much more abstract musical framework - frequency based harmonic consonance and dissonance. I quantified and represented both the vertical and horizontal dissonance of a chord progression through tension curves. To generate original music using machine learning, I trained both a variational auto-encoder (VAE) and a supervised learning model (SL) to generate original tension curves and transform tension curves into chord progressions respectively.

ABSTRACTS | SESSION 6

Title: Enhancing In-Vitro Drug Delivery to the Inner Ear Using Exosomes

Presenter(s): Keith Abbey

Mentor(s): Alon Greenbaum

REU/Summer Research Program: OUR Award

Hearing loss is the third most common chronic physical condition in the US. To treat and prevent hearing loss, non-destructive drug delivery methods to the inner ear are required. Nanocarriers, such as extracellular vesicles (EVs) and exosomes, have the potential to address this need, as they were previously utilized to pass biological barriers such as the blood brain barrier. However, it is not yet known if these nanocarriers will be effective in delivering therapeutics to the inner ear by penetrating the round window membrane (RWM), a barrier that separates the middle ear space from the inner ear. To assess the potential of nanocarriers to pass through the RWM, we established an in-vitro RWM model, and we examined the RWM uptake of the following nanocarriers: RWM-derived epithelial cell EVs, fibroblast cell EVs, bone-marrow mesenchymal stem cell (MSC) EVs, and FDA-approved liposomes. Identifying cellular uptake allows us to investigate and isolate the potential interactions between RWM cells and EVs in their passage across the RWM. To determine effective cellular uptake, these vehicles were loaded with either red fluorescent protein (RFP) or green fluorescent protein (GFP)-coding mRNA. The RWM model was created by seeding and co-culturing epithelial and fibroblast RWM cells. Immunohistochemistry techniques were used to fix and stain the cells to be imaged by a confocal microscope to capture cellular expression of the RFP and GFP-coding mRNA following nanocarrier uptake. Image analysis procedures using ImageJ are currently being performed to quantify the uptake of the nanocarriers.

Title: Fibrin Based drug delivery system for Staphylococcus Aureus biofilm treatment

Presenter(s): Adrian Aligwekwe

Mentor(s): Ashley Brown

REU/Summer Research Program: Summer Interdisciplinary

Biofilms protect bacteria against antibiotics and the host immune response, and are commonly associated with nosocomial infections, occurring in 65-80% of all chronic infections. Staphylococcus Aureus, the leading pathogen of these infections, establishes a microbial community in vivo by attaching to host tissue and forming a dense extracellular polymeric substance composed of materials such as fibrin, polysaccharide, and extracellular DNA. The Advanced Wound Healing Lab has previously developed Fibrin Based Nanoparticles (FBNs) that can be integrated into biofilms by S. aureus, and used in tandem with antibiotic therapeutics due to drug encapsulation capabilities. The Pierce Lab has previously developed a 2,3-pyrrolidinedione-based technology capable of inducing antibiofilm properties in synergy with last-resort antimicrobials such as vancomycin. Using this technology, next-generation conjugates have been synthesized from vancomycin and displayed potent biofilm eradication properties. We hypothesize that conjugate-loaded FBNs (cFBN-273) can penetrate the bacterial biofilms and eradicate the bacterial infection more efficiently than free drugs. We first loaded FBNs with commercial vancomycin to determine the bactericidal potential of FBN technology, and the results have shown a response at concentrations of 2048, 1024, and 512 μg/mL. We have also developed a fluorescent plate-based assay that shows that our drug conjugate has a sustained release profile at a concentration of 0.412 pg/particle over a one-week period. Future studies will incorporate this data for use with an in vitro bacterial kill assay, seeking to achieve a clinically significant 99.9% killing efficiency.

Title: Verification of fluid shear stress to develop an organ-on-a-chip model for tendon injury

Presenter(s): Muskan Aslam

Mentor(s): Zachary Davis

REU/Summer Research Program: CMI SIRI

Tendon injuries result in chronic pain and disability and are characterized by alterations to the tendon's biochemical composition and biomechanical properties. Existing studies have analyzed tenocyte response to tensile strain and loading, but less is known about their reaction to fluid shear stress and its role in recreating physiologic loads. The objective of this study was to create an organ-on-a-chip model of tendon to investigate the role of fluid shear on tenocyte orientation, viability, and gene expression. We hypothesized that fluid shear would result in tenocytes aligned along gelatin fibers and enhanced expression of tendon-specific gene expression. A computational model of a microfluidics system with fluid shear across an array of fibers was constructed in COMSOL. Thereafter, the fluid shear system was fabricated via direct-writing tendon ECM-gelatin fibers on glass slides with various treatments applied to promote cell adhesion to the fibers and discourage growth on glass. Scaffolds were printed following treatment with bovine serum albumin (BSA), pluronic F-127, PDMS coating with corona wand treatment, parylene coatings with and without corona wand treatment, and compared to untreated slides. A polydimethylsiloxane (PDMS) chamber was bonded to the glass surrounding the

scaffolds after printing. Cell adhesion to the scaffolds and glass was assessed through live/dead and Actin/DAPI staining. Continued work will examine fluid shear within the system and its effect on tendon-specific gene expression in tenocytes. The results of these studies will establish an in vitro model of tendon tissue for testing novel therapies to treat tendon injury.

Title: Impacts of Money in Politics on Political Efficacy and Democracy in the United States

Presenter(s): Aurian Bayat

Mentor(s): Steven Greene

REU/Summer Research Program: SPIA SURE

The role of money in American politics has been an ongoing topic of political discourse in the United States. Money in politics can cloud perceptions of legitimacy regarding American institutions and democracy. A healthy democracy is one where people possess the ability to bring about social and political change. If Americans believe money in the political system has subdued their ability to bring about such change, there is a reason for concern. Given that previous research shows that most Americans believe wealthy individuals can buy political candidates or favorable policy outcomes, I search for how these attitudes relate to political efficacy in the United States. I examine the relationship between cynicism regarding money in politics and its impact on political efficacy nationally. Utilizing data from the Pew 2018 American Trends Panel wave 31, I analyze crosstabulations to construct my analysis. Although much work is available concerning money in politics and political efficacy, little research connects these factors. I investigate how demographic variables of sex, age, income, and education, along with internal and external efficacy political variables, affect attitudes concerning political financial cynicism. Across all variables, Americans take a generally cynical position regarding money in politics. However, variation exists depending on the observed variable. These findings provide an understanding of correlations between such variables and political financial cynicism that has yet to be analyzed in-depth. Since a healthy democracy is representative, trustworthy, and efficacious, identifying aspects within the American political system that pose a threat to such a democracy is pivotal.

Title: Modeling B&W Nuclear Reactors using Nodal Core Simulator

Presenter(s): Zachary Bevans

Mentor(s): Scott Palmtag

REU/Summer Research Program: OUR Award

High-fidelity core simulators used to model nuclear reactor cores provide deep insight into core physics but in general, are extremely computationally expensive. Because of this, nodal core simulators are used to solve these results in a fraction of the time: minutes versus thousands of hours for a single depletion cycle. Five cycles of a generic Babcock & Wilcox (B&W) reactor core have been modeled using VERA, a new high-fidelity simulator. The purpose of this project is to create this benchmark B&W case in CASMO4/SIMULATE3, an industry standard nodal core simulator, and use the VERA model to validate the nodal simulator's results. To achieve this, multi-group cross sections for each type of fuel assembly are generated in CASMO4 to be used in SIMULATE3 to model and deplete the core across each cycle. B&W cores use fuel assemblies that employ gadolinia and B4C inserts as burnable poisons to reach a goal of a 24-month, fifth cycle which add to the difficulty in modeling. With the cross sections generated, the core is depleted over each cycle with the burned assemblies shuffled and/or removed and fresh assemblies inserted. The boron concentration, pin power peaking, and pin exposures calculated are compared between the VERA and CASMO4/SIMULATE3 results to find any deficiencies between the two simulators. The created CASMO4/SIMULATE3 model can then be further used to develop an optimum core loading pattern using the F6 code, which utilizes simulated annealing to optimize core loading patterns to reduce costs.

Title: Purification of Green Fluorescent Protein with the Millipore XMO12 Single-Use Column Chromatography Platform and the Sartorius CIMmultus Monolith

Presenter(s): Blake Brewer

Mentor(s): Krisstina Burgess

REU/Summer Research Program: BTEC

A method based on AEX (anion exchange chromatography) was used to purify Green Fluorescent Protein (GFP) on Millipore's XMO12 Single-Use Chromatography Platform, using a 14 cm x 25 cm Q-Sepharose Fast Flow packed resin column (7.5 Liter BPG 140). The purification method was initially transferred from the AKTA Process large-scale stainless skid using the same type of resin column. The column's suitability for use was first determined by putting together a method for, and measuring, HETP and Asymmetry on the

single-use system. Then, equilibration, load, wash, and elution steps (purification conditions) were transferred from the large-scale stainless system, and optimization began. A load volume of about 3 Liters of GFP Clarified Lysate was determined to be appropriate for this single-use system. Additionally, a CIMmultus Monolithic Column by Sartorius was used to develop a method for the purification of GFP on a smaller, intermediate scale (also AEX). The purification using this monolith will be compared to that using a traditional AEX resin-based column, the Q-Sepharose resin. The load volume of GFP on the monolith was determined by finding the Dynamic Binding Capacity of the monolith for GFP (92 mg/mL). A method for anion exchange was then written for the UNICORN software system and applied. Purification success and yield were compared to that obtained using a resin-packed column. The goal of the work is to scale up the monolith purification so it can be used with the Millipore XMO12 Single-Use Chromatography skid for an overall "single-use" approach to GFP purification.

Title: Grand Challenges Equal Grand Opportunities: Developing Comprehensive Protocols and Tutorials for Discovery, Sequencing, and Identification of Microbial Organisms

Presenter(s): Caleb Carter

Mentor(s): Carlos Goller

REU/Summer Research Program: GCSP

In 1928 after returning to his lab from vacation, Alexander Fleming accidentally discovered what is now the most widely used bacterial antibiotic in the world growing on one of his petri dishes: penicillin. This discovery spurred a new era of scientific discovery where bacteria could be wielded as a tool for the betterment of medicine, the environment, and numerous facets of life. Today, it is known that there are a myriad of microbial organisms, and many more yet to be identified. With so many unknown microbes and even more problems needing to be solved, the ability to quickly identify and generate uses for microbes is becoming increasingly important. The process of identifying a microbe from a field sample involves a minimum of eight complex, meticulous physical and technological procedures and careful use of a variety of sensitive lab equipment. The focus of this research has been to create streamlined, accessible, and thorough protocols that future researchers can follow to obtain and analyze DNA from microbial samples. With minimal lab experience, the researcher learned and executed each of the procedures for several different bacterial samples. Furthermore, the researcher established and tested protocols in a way that other novice researchers can confidently execute each step, identifying previously unknown microbes, as well as finding specific and desirable genes in known microbes. Such a system will set a strong foundation for future new researchers to make their contributions to the ever-growing study of how to utilize microbes to solve scientific, environmental, and humanitarian problems.

Title: Optimization of perovskite for superfluorescence applications

Presenter(s): Fabiola Fabian Plascencia

Mentor(s): Franky So

When an electron emits its excess energy as a photon, it is called fluorescence. In some materials, like perovskites, a phenomenon called spontaneous synchronization occurs in which excited electrons synchronize to the same phase, creating a macroscopic dipole. The atoms in the macroscopic dipole produce coherent spontaneous emission, known as superfluorescence. Perovskite is the first material to show superfluorescence at room temperature, making it potential competition for devices using a laser mechanism as a source of coherent light. The superfluorescence of perovskites is affected by several steps in sample processing. Producing a thin film sample of BACsPbBr3 perovskite includes spin coating perovskite precursor solution on a substrate, dripping an antisolvent on the sample once during spin coating, then annealing the sample on a hot plate. The primary variables investigated during this processing technique were the antisolvent chemical and antisolvent drip time, and the secondary variables may include perovskite precursor concentration. To characterize each sample, a photoluminescence (PL) study with angle-resolved emission spectroscopy (ARES) as well as an X-ray diffraction (XRD) study were conducted. The PL study was used to measure the intensity of light emitted from perovskite samples at normal incidence, and the XRD study was used to analyze the uniformity of the crystal structure of each sample.

ABSTRACTS | SESSION 6

Title: Examining the effects of natural products on the interactions between macrophages and methicillin-resistant Staphylococcus aureus biofilms

Presenter(s): Anna Froneberger

Mentor(s): Lauren Schnabel

REU/Summer Research Program: CMI SIRI

Methicillin-resistant Staphylococcus aureus (MRSA) biofilms place a serious burden on healthcare due to their increasing antimicrobial resistance and ability to create recurrent biofilm wound and implant infections. MRSA biofilms exhibit mechanisms of immune evasion, limiting the body's ability to clear these infections. For that reason, there is a growing need for the development of novel antimicrobial therapeutics to eradicate biofilms and support immune cell function to aid in the clearance of these infections. Currently, there are no methods of high-throughput screening for treatment activity of an individual's recurrent biofilm infection that accounts for the variation in a patient's infection and immune response. In this project, we are standardizing an ex-vivo model to assess the interactions between macrophage function, MRSA biofilms, and their treatment with natural products. Additionally, we are using minimum biofilm eradication concentrations (MBEC) and minimum inhibitory concentrations (MIC) to examine the activity of novel 2,3-pyrrolidinediones monomers and dimers on bacterial biofilms. We will characterize the effects of both biofilms and compounds on macrophages through the examination of their viability, generation of reactive oxygen species (ROS), and changes in cytokine gene expression. Upon completion, this will create an accessible ex vivo model for the assessment of natural product therapeutics on recurrent MRSA biofilms and primary immune cell function.

Title: Developing Modified Biochar for Nitrate Adsorption

Presenter(s): Elizabeth Gillikin

Mentor(s): Praveen Kolar

REU/Summer Research Program: MI-REU

Removing contaminants from commercial wastewater is necessary to maintain the health and stability of aquatic resources and ecosystems. Nitrogen-doped biochar has shown promising adsorptive qualities towards common wastewater contaminants such as heavy metals, organic dyes, and pharmaceuticals. This project seeks to develop N-doped biochar as an efficient, sustainable, low-cost material for nitrate removal from aquaculture wastewater. The research focuses on synthesizing and analyzing biochar from urea and melamine-treated Loblolly pine bark, an inexpensive and readily available biomass. Previous research has demonstrated that biochar doped with N-containing urea or melamine enhances contaminant adsorption by incorporating heteroatoms, such as nitrogen, into the electronic structure of the biochar and creating localized regions of imbalanced charge. Current characterization data of the urea and melamine-treated pine bark biochars reflect the acid values and point of zero charges. Further characterization will utilize scanning electron microscopy, x-ray photoelectron spectroscopic analysis, and BET surface area analysis. Data from batch adsorption experiments will be modeled with the Langmuir and Freundlich isotherms. There is an additional focus on determining mass transfer kinetics to better understand the diffusion of the contaminants into the biochar structure during adsorption. Subsequent experiments will focus on synthesizing N-doped biochar into chitosan-based hydrogels to optimize the removal of adsorbent media from treated wastewater.

Title: Cell-Line Development of Lactococcus Lactis

Presenter(s): Megha Gongireddy

Mentor(s): Kurt Selle

REU/Summer Research Program: BTEC

My project is on the cell-line development of Lactococcus lactis, specifically as a host for lactate ester synthesis. Lactate esters are useful for many different industrial applications, such as fermentation and pharmaceuticals. Lactate esters are also considered "green solvents" because they are relatively safe for the environment. In this project, L. lactis will be used to become a suitable host for the production of lactate esters, through the recombination of proteins and conjugation of lactate with alcohols to produce esters. This will be done through screening wild type strains of L. lactis, cloning and characterization of the strains to determine the highest activity, recombination of L. lactis strains, and by determining the metabolic activity of L. lactis strains. Currently, I focused on the growth parameter modeling of L. lactis, especially within a small scale experiment. Using a statistical analysis of various strains, I was able to determine the productivity of each of the strains and how it ranks relative to each other. Using this information, I can test these L. lactis strains in a larger scale setting, such as a bioreactor to test the predictability of these strains with more parameters. This data will help me gather information on the most efficient strains that would be most beneficial for the production of lactate esters.

ABSTRACTS | SESSION 6

Title: Localized delivery of immunotherapeutics utilizing self-assembling associative chitosan systems with tunable, controlled release kinetics

Presenter(s): Asher Hancock

Mentor(s): Hisham El-Shaffey

REU/Summer Research Program: CMI SIRI

According to the WHO, in 2020, cancer caused nearly one in six deaths worldwide. Current cancer treatments consist of chemotherapy regimens, targeted drug therapies, and immunotherapies, and they often have significant toxicity concerns and side effects. Localized delivery at the site of the tumor may afford a solution, but due to the highly pressurized tumor environment, therapeutic injections in saline-based solutions at the site often are excluded post-injection. To solve this problem, we developed a novel drug delivery system that can withstand high intratumoral pressures and has controllable and tunable release kinetics. First, we synthesized and characterized a self-assembling associative chitosan system for hydrogel formation. We used an aza-Wittig reaction to modify chitosan, the product of which was verified with 1H NMR spectroscopy. We measured the viscosity and strength of the modified chitosan with frequency and amplitude rheological sweeps. Ongoing work includes tuning the hydrogel by measuring its physical properties via rheology and optimizing it with synthetic modification. In a second aim of the project, we are developing drug-polymer conjugates with tunable diffusivities and are examining the influence of the environmental material mechanics on drug release. We are verifying the activity of the modified drug, which is the toll-like receptor 7/8 agonist resiquimod, in vitro with the RAW-Blue™ reporter cell line. Additionally, we are verifying therapeutic retention and release via an agar tumor phantom.

Title: Neonatal Derived Fibrin Nanoparticles to Promote Wound Healing

Presenter(s): Mason Hon

Mentor(s): Ashley Brown

REU/Summer Research Program: BME

Non-healing wounds represent a significant clinical problem in both human and veterinary medicine. Current technologies for closing dermal wounds include fibrin sealants. They primarily consist of plasma-derived fibrinogen and thrombin and act to mimic the final stages of the coagulation cascade; the formation of a stable fibrin network that facilitates wound healing. Fibrin sealants are an attractive class of biomaterials due to their biodegradable and biocompatible nature. However, their formulations require reagent concentrations (i.e. fibrinogen and thrombin) well above physiological ranges and result in fibrin matrices that are much denser than native clots. Our novel treatment improves on this design as it is formulated with neonatal porcine fibrinogen into nanoparticles and utilizes physiologically relevant concentrations of reagents that augment, rather than hinder, proper cell activity to boost wound healing responses. In this work, we optimized the formulation of neonatal fibrin based nanoparticles (nFBNs) and characterized the particles with nanosight and atomic force microscopy analysis. Additionally, preliminary in vitro efficacy data analyzing fibrin clots in the presense/absense of fibrin clots was gathered.

Title: Eliminating pathogenic viruses in air: a quantitative study of UV radiation among the pathogenic viruses

Presenter(s): Victor Ibarra-Mendoza

Mentor(s): Venkateswaran Narayanaswamy

REU/Summer Research Program: TRIO Ronald E. McNair Summer Research Experience

The ongoing pandemic of coronavirus disease (COVID-19) has severely impacted the world socially and economically, unlike any previous pandemic. The COVID-19 pandemic has increased the awareness of the sanitization practice among pathogenic viruses. Failure to properly disinfect or sterilize nearby air carries the risk associated with person-to-person transmission of pathogenic viruses. There has been previous research on defecting pathogenic viruses with UV lights in a water setting. However, there is no research done on defecting pathogenic viruses with UV lights in an air setting. We examined the use of high dosages of ultraviolet radiation (390 nm) to deal with various pathogenic viruses' representatives. For safety concerns, the pathogenic viruses' representatives will be photochromic pigment powder, which reacts the same as pathogenic viruses when exposed to UV light. To closely imitate the person-to-person transmission of these pathogenic viruses, there will be a 3-D model, the seeder, which will mix the photochromic pigment into an air jet stream and disperse the mixture out of the seeder; this will simulate a cough. We observed the effectiveness of ultraviolet radiation on these UV-sensitive pigments with various intensities, exposure time, and lamp placement. To measure the UV light intensity, duration, and dosages, we will use various photodiodes and a camera that uses a sensitive-colored lens to capture air mixture in time integration. The efficacy of ultraviolet radiation on the UV-sensitive pigment in the person-to-person transmission provides a suitable sanitization practice varying in commercial, household, and military use.

ABSTRACTS | SESSION 6

Title: The Design and Implementation of a Custom MUSE (Microscopy with UV Surface Excitation) Imaging System for the Investigation of Diabetic Kidney Disease

Presenter(s): Myla James

Mentor(s): Kenitta Johnson

REU/Summer Research Program: GCSP

The goal of this research is to construct a microscope that uses ultraviolet (UV) light to examine tissue specimens for MUSE (Microscopy with UV Surface Excitation) Imaging, in order to examine tissues more quickly than routine histology, which is used in standard microscopy. MUSE imaging has a shorter preparation time (15 minutes), a shorter imaging time allowing for evaluation of fresh tissue, and the ability to create clearer images of each layer of the tissue. The reason for using UV light instead of histology is to observe the tissue in more depth, to see more layers of the tissue as well as prominent features like blood vessels. Aim 1 is to supply a safe UV light source for the microscope. The UV LED must be assembled with a power source and requires the necessary safety precautions to protect the users' eyesight from UV light. Aim 2 is constructing an image capture system to magnify tissue images for more cellular detail. Finally, Aim 3 is to independently control the position of the sample by constructing and remotely controlling the motion stage that will hold sample. Comparisons of healthy and diseased kidney tissues with MUSE imaging in the investigation of progressive diabetic kidney disease (DKD) will reveal information about the adaptations in the substructures of the kidney. This will inform changes seen in ultrasound images of progressive DKD.

Title: Investigating the Fundamental Mechanisms of Electric Discharges in Ionic Liquids

Presenter(s): Alina Jugan

Mentor(s): Alexander Bataller

REU/Summer Research Program: OUR Award and GCSP.

Molten salts are an important class of ionic liquids that have found applications across energy and manufacturing industries. Molten salts are being actively pursued for an advanced nuclear reactor called molten salt reactors (MSRs). Unlike water-cooled reactors, MSRs use molten salts as a coolant because of their high-temperature operation, thus enabling higher thermal-to-electric conversion efficiency and atmospheric pressure operation. One of the main challenges of MSRs is real-time monitoring of the nuclear material within the molten salts. MSRs could be quantified in real-time using plasma-bubble spectroscopy (PBS). This method uses electrical discharges to create localized low-density bubbles, from which a tenuous plasma can be generated, which is then quantified with optical emission spectroscopy. Due to their facile room-temperature operation, PBS will be benchmarked and optimized in saturated saline solutions. Experimentation of the saline solution has produced observations of constant current. Additionally, COMSOL multiphysics simulations have resulted in constant resistance, supporting experimental findings. However, when induced bubbles bridge the gap between the electrodes, an intense spark discharge is created from the plasma and current briefly increases. At larger electrode gaps, a spark is not created and instead a glow discharge forms. Further analysis will be performed spectroscopically. Determining the fundamental mechanisms of electric discharges in saturated saline solutions would improve our general understanding of electrical discharges and could lead to an effective method of real-time material quantification in molten salts.

Title: Differential Acetylation of Histone Tail Variants

Presenter(s): Seth Kodikara

Mentor(s): Albert Keung

REU/Summer Research Program: OUR Award and Beckman Scholars

Acetylation of residues on histone tails helps regulate chromatin structure and gene expression. Small variations in the sequences of these tails are found across cell types, stages, and species though little is known about the residue specificity of acetyltransferases to these variants. A library of histone H3 and H4 variants was assembled to study interaction with the p300 acetyltransferase. *Saccharomyces cerevisiae* were prompted to express histone tail variants that were displayed on the surface via the Aga1-Aga2 binding complex following sequestered interaction with the p300 acetyltransferase. These cells were labeled to identify potential acetylation, sorted via flow cytometry, and analyzed with next-gen sequencing to determine the lysine residues on each tail variant that served as a substrate for p300-mediated acetylation.

ABSTRACTS | SESSION 6

Title: Effects of Molecular Size on Loading Efficiency and Drug Release of Fibrin Based Nanoparticles

Presenter(s): Abigail Kuppler

Mentor(s): Ashley Brown

REU/Summer Research Program: GCSP

Wound dressings are central to the treatment of complicated traumas and chronic wounds. Current wound treatment protocols rely on basic bandages in conjunction with the administration of systemic antibiotic medications or local bulk-release mechanisms. The Brown lab has developed a wound dressing fabricated using fibrin based nanoparticles (FBNs); the colloidal properties that it provides has demonstrated improved healing as a result of physiologically-relevant porosity for cellular infiltration and healing. Furthermore, FBNs may be drug-loaded for the fine-tuned local administration of medication directly to a wound site. In this research, we investigated the effect of molecular weight on the loading efficiency, drug load per particle, and drug release kinetics of FBNs through the loading of FBNs with fluorescent dextran of varying molecular weights (MW), and the fluorescent reading of aliquots of releasate from specific timepoints. We found that across all MWs, the majority of drug mass was released within the first 24 hours. Smaller molecules (3 kDa MW) were found to have a higher total release, improved loading efficiency, and more drug mass per particle than larger molecules (40 kDa MW) with comparable loading solution concentrations. For 3 kDa MW dextran, release kinetics were found to be relatively unchanged between different loading solution concentrations, while for 40 kDa MW dextran, only 5 mg/mL and 10 mg/mL demonstrated a significant difference in release from unloaded FBNs. From these experiments, we may conclude that FBNs are most suited to loading with small molecule therapeutics.

Title: Stability of Thermocleveable Polymers for Organic Semiconductors

Presenter(s): Angela Lee

Mentor(s): Brendan O'Connor

REU/Summer Research Program: GCSP

Within previous studies of organic semiconductors and their applications, thermocleavable polymers have been of particular interest. In devices that use them, there appears to be a positive correlation between higher percentages of cleaved polymer chains and increased device performance. However, the consequences of increasing the amount of cleaved chains has been known to in turn decrease the stability of the polymer. The objective of the work was to explore the strength of thermocleavable polymers in order to establish the threshold at which the polymer is most effective while still maintaining its stability. During the course of the research, stability was measured by the polymer's elastic modulus when subjected to film on elastomer (Wrinkle) tests and film on water (FOW) tests.The results of the tests were then examined through the amount of wrinkles that appeared during the test which would correlate to the elastic modulus of the sample. The current results gathered in the course of the research are inconclusive and incomplete due to user error when conducting the film on water tests which caused measuring errors and the scarcity of materials involved in the project. When resumed, further research will be conducted that will include reconducting the film on water tests, as well as using a different compression to examine the results.

Title: Quantifying the Impact of Reflective Roads

Presenter(s): Siddharth Lohia

Mentor(s): Chris Dobek

REU/Summer Research Program: OUR Award

The purpose of this funded experiment was to measure the effect of a reflective road covering on one of the parking lots on University Campus. The impacts of the reflective covering were measured through temperature readings taken daily using an infrared thermometer. The expected results are that the parts of the road with a reflective covering will yield lower average temperatures than the uncovered road since many of the sun's rays will be reflected rather than absorbed in the experimental group. These temperature readings will be accompanied by quantitative measure of the reflectance for Coolseal, the specific road coating used in this experiment. These reflective readings will be taken using a spectrophotometer in order to quantify how much more reflective the coatings are compared to standard roads. The data taken from this experiment can be used to support or refute the idea of increased sustainability and decreased environmental impact of reflective roads.

ABSTRACTS | SESSION 6

Title: The Impact of the Native American Vote on the 2020 United States Presidential Election

Presenter(s): Mya Lowry

Mentor(s): Steven Greene

REU/Summer Research Program: SPIA SURE

Native American political behavior has historically been understudied in the discipline of political science, primarily because Native Americans only make up around two to three percent of the total United States population. Due to their small numbers, Native American electoral behavior and voting patterns have been difficult to analyze. Native American voters are frequently overlooked by the major political parties and the media. In surveys and exit polls, they are often excluded or grouped into the "other" category. However, there is reason to suspect that Native American voters could have played an important role in the 2020 presidential election, especially in key battleground states. Arizona, Wisconsin, and North Carolina were key battleground states in the election and all have sizable Native American populations. I explore data from existing research on historical Native American electoral behavior and voting patterns to tie my findings into the larger context of the 2020 presidential election. I discuss the impact of the Native American vote in the battleground states that were crucial to the outcome of the election, focusing on counties and precincts with high Native American populations. Additionally, I provide insight on what we might expect from Native American voters in upcoming elections.

Title: Liquid Phase Epitaxy for Narrowband Semiconductors

Presenter(s): Ian Mercer, Andrew Liao

Mentor(s): Kaveh Ahadi

REU/Summer Research Program: OUR Award

Liquid Phase Epitaxy (LPE) is a high temperature deposition technique used for growing cost-efficient 2D heterostructures; that are generally thicker but still of high crystalline quality and low dislocation density. The idea is that when a material is brought to a temperature just below its liquid phase, it is able to grow an epitaxial thin film on a substrate. Of these, locally epitaxial islands have been observed, but a globally metallic deposition has yet to be achieved. Custom graphite crucible and a quartz tube furnace are used for the high temperatures with the employment of Nitrogen gas to avoid surface oxidation on source material. Varying parameters is the main influence on growth, as well as avoiding oxidation, both of which are currently being tested. The source material deposited has primarily been Tin Telluride (SnTe), and substrates such as (111) Silicon, Sapphire, and Barium Fluoride (BaF2), with the most success on BaF2. BaF2 and IV-VI semiconductors lattice-match, wet easily on the BaF2, and have similar thermal-expansion coefficients, leading to higher observed quality semiconductor-on-insulator heterostructures. LPE has been common for growth of IV-VI narrow bandgap semiconductors, like that of group IV chalcogenides, for novel electronic and optoelectronic applications. Interesting characteristics have been observed in SnTe and other chalcogenides, like Bi2Te3 as a topological insulator; which if done with LPE, is an attractive cost-effective technique to further research electrical transport and novel quantum phenomena of many semiconductors.

Title: Analysis of Dual-Delivery Microgels For Treating Cardiac Fibrosis

Presenter(s): Raghu Mereddy

Mentor(s): Aryssa Simpson

REU/Summer Research Program: GCSP

Cardiac fibrosis is the scarring of cardiac tissue which can occur after a myocardial infraction (MI). Dual delivery nanogels containing Y-27632, which inhibits the Rho Rock pathway, have shown potential to treat complications associated with MI. Drug-loaded nanogels can reduce fibrotic marker expression when cardiac cells are cultured on stiff substrates (representative of fibrotic tissue) to levels seen when cells are cultured on soft substrates (representative of healthy tissue). These prior results with cells cultured on linear elastic materials suggest treatment with a Rho Rock inhibitor can reduce the onset of cardiac fibrosis. In this project, we are analyzing the cellular response of cardiac cell lines to Y-27632 loaded particles on viscoelastic substrates, which better mimic tissue properties in vitro compared to linear elastic materials. This project primarily focused on particle and material characterization. Nanogel cores are synthesized using precipitation polymerization of a 90% NIPAM and 10% BIS solution in ultrapure water. After a 6-hour reaction, nanogels are purified with dialysis using 1000 kDa MWCO cellulose ester dialysis tubing against Deionized water. The water is then changed after 1 hour, 24 hours, 38 hours, and 72 hours. After analyzing the particles in the nanosight at a concentration of 1: 3000 is 439.5 nm, and for 1:2000 the mean is 430.5nm. Ongoing work is evaluating the influence of Y-27632 loaded particles on the expression of fibrotic markers.

ABSTRACTS | SESSION 6

Title: Validation of multicycle core optimization code using the F6 computer program

Presenter(s): Matt Nash

Mentor(s): Scott Palmtag

REU/Summer Research Program: OUR Award

The goal of this project is to show that using Simulated Annealing optimization to determine a fuel loading pattern and cycle are more effective than an intuition-based fuel cycle optimizing process. The first step in this process is to develop the base model for a generic two-loop Westinghouse PWR with the CASMO lattice burn-up code, producing various cross sections to be used in SIMULATE. The basis of the CASMO scripts were generated from a sample two-loop PARCS input from the NRC. The NRC uses the Standard fuel assembly specifications that can be found in plants like Ginna, Point Beach and Prairie Island. The CASMO's included 7 IFBA patterns from 0 to 108 pins, across 8 different fuel enrichments, from 4.25% to 4.95% in increments of 0.1%. After obtaining cross sections, CMSLINK links them to SIMULATE based on their intended use (fuel management, reload analysis, etc.). SIMULATE is then used to run full-core depletions, with various user orientated features based on use. For this project we are concerned with generating the equilibrium cycle through the use of restart files given a map of a 3-cycle loop. Meaning that the equilibrium cycle will contain once burned, twice burned and three-times burned fuels. Lastly after generating the equilibrium cycle, the F6 optimization code will use a Simulated Annealing algorithm to determine which combinations of the 56 different fuel assemblies result in the best cost-power ratio.

Title: Re-polymerization of double-network hydrogels by liquid metal particles

Presenter(s): Zacharia Nyambega

Mentor(s): Michael Dickey

REU/Summer Research Program: Mentoring Incubator

Hydrogels are soft substances made from 3-D networks of crosslinked polymers. They can absorb water while maintaining their structure. This unique property comes with many applications, such as soft electronics and drug delivery. Radical activation is often an important initiation step for generating the polymers needed for hydrogels; this step can be dangerous and energy-intensive (e.g., UV-light, high-heat). Our group discovered that liquid metal particles composed of eutectic gallium indium (EGaIn) can be used to create polymers by initiating radicalization easily with minimal safety hazards because it is non-toxic at room temperature and forms radicals through a simple sonication process. Furthermore, hydrogels made using EGaIn can be easily fine-tuned for strength and hardness using sodium hydroxide (NaOH). This research investigated the impact of NaOH concentration on hydrogel stretchability and toughness. Two samples of the EGaIn hydrogels were reacted with 0.1 M NaOH and 1.0 M NaOH respectively and another third sample used as a control experiment was not reacted with NaOH. An Instron extensometer was used to test their strength. Preliminary results obtained showed that the 1.0 M gel had a low strain at break but was tough followed by the 0.1 M gel and the sample with no NaOH had a strain at break with decreased toughness. Ongoing research seeks to determine the suitable condition to make the gels more stretchable and tough.

Title: Choroid Plexus Organoids as Novel Drug Screening Platform

Presenter(s): Jennifer O'Neill

Mentor(s): Albert Keung

REU/Summer Research Program: OUR Award

Cerebral organoids are three-dimensional microtissues generated from human embryonic or induced pluripotent stem cells that resemble fetal brains in developmental timing. They are useful models for studying human neurodevelopment due to their ability to create organized structures and cell types from specific brain regions. The choroid plexus (ChP) is a specific region of the brain located adjacent to the ventricles and plays a significant role in brain development, function, and homeostasis by secreting cerebrospinal fluid (CSF) and forming the blood-CSF barrier. The blood-CSF barrier prevents toxic substances from reaching the brain, and directly contacts the CSF. Characterization of the choroid plexus and the effect of natural and environmental factors on its permeability has been difficult due to its location in the brain. Previous work in our group showed cerebral organoids differentiate strongly towards a choroid plexus (ChP) specific fate, with large fluid-filled sacs hypothesized to contain cerebrospinal-like fluid, when exposed to high concentrations of solubilized Matrigel. At typical levels, Matrigel, a gelatinous mixture of extracellular matrix proteins and growth factors secreted by Engelbreth-Holm-Swarm mouse sarcoma cells, is integral to many protocols for cerebral organoid generation.

Its critical role in cerebral organoid development is hypothesized to be promoting neural progenitor polarization and provision of growth and morphogenic factors. The CSF-like fluid produced from this new ChP organoid protocol allows us to study CSF secretion and barrier formation. We propose to investigate and characterize the barrier ability of these recently developed ChP organoids for use as a novel drug screening platform.

Title: Fabrication, assembly, and operation of a lab-scale experimental setup to analyze locomotion dynamics of helical drives

Presenter(s): Cristian Pacheco-Cay

Mentor(s): Andre Mazzoleni

REU/Summer Research Program: Mentoring Incubator

This research project involves designing and prototyping a helical drives-based multi-terrain and amphibious vehicle capable of traveling on ice, snow, mud, gravel, and on and under water in the Arctic. A helical drive is a cylinder with helical blades running along it like a screw thread. While helical drives have been used in the past to propel vehicles either on land or water, this multi-terrain vehicle is the first designed to travel under water. The tools that have been used to design, fabricate, and operate the experimental setup include SOLIDWORKS, LabView, MATLAB, ANSYS Fluent, Drill Press machine, 3D Printers, and Arduinos. The current phase of this project involves lab-scale testing of the helical drives over different land substrates by using an experimental rig that consists of a trough with 80x20 rods running perpendicular to it with a guide rail running over the middle of the trough which the helical drive system will mount onto. This motor driven helical drive system will be evaluated for its performance on soils of different densities and moisture contents. Three sensors will be used to measure the location, rotational speed, and forces/torques acting on the helical drive as it travels along an x-rail. The linear position and rotational speed of the helical drive will be compared between the experimental data and the results of the dynamic model. The experimental tests will be run over several months to collect as much data as possible to validate the dynamic model before designing a full-scale prototype.

Title: Characterization of metabolic activity in Delftia acidovorans' isolates and expression of NRP in the presence and absence of gold

Presenter(s): Richie Perez, Riley Morgan

Mentor(s): Carlos Goller

REU/Summer Research Program: BIT SURE

Delftia acidovorans is a gram-negative, aerobic, non-fermentative, rod-shaped bacillus. D. acidovorans is an environmental bacterium that can be found in soil and water. It has been identified as an opportunistic pathogen found in hospital settings reportedly in immunocompromised patients.. Furthermore, it is also found in places yielding high concentrations of heavy metals, such as cadmium and copper. This is significant because gold, another heavy metal, makes up a very large portion of total e-waste, or electronic waste. The economic value of discarded precious metals around the globe, largely made up by gold, amounts to tens of billions of dollars that are being thrown away (Forti 2020). Not only is it economically wasteful, the significant levels of gold toxicity could adversely affect the environment. However, D. acidovorans has the potential to make a significant impact in mitigating gold waste. Delftia spp. secrete a nonribosomal peptide (NRP) that is crucial to this project. Due to this metabolite, delftibactin, D. acidovorans has the ability to reduce gold ions, convert them to solid form, and biomineralize gold. During the BITSURE program, the focus was placed on understanding patterns of metabolic activity and biofilm formation and viability, in both the presence and absence of gold, and the correlation to Delftia spp. that were most effective at biomineralizing gold. This could prove to be a vital approach to further developing sustainable processes of biomineralization of e-waste and bioremediation.

Title: Creating a 24 Hour Understanding of Activity and Behavior Patterns in Zoo-Housed African Elephants (Loxodonta africana)

Presenter(s): Aly Prockter, Jess Schinsky

Mentor(s): Cassidy Hubbard

REU/Summer Research Program: OUR Award

The subjects of this study are seven African elephants housed at the North Carolina Zoo. Evidence of how much time zoo-housed elephants spend foraging, sleeping, socializing, or engaging in stereotypic behaviors can inform key management decisions, feeding enrichment, and habitat design - all of which could have a direct impact on elephant welfare. During winter, when temperatures are too low for the elephants to remain in their daytime habitat, the herd is housed in a temperature regulated barn. At night, the social groupings may vary with some individuals only having protected contact with one another versus full contact. A new male was

introduced to the herd earlier this year. With his arrival, monitoring social interactions among members of the established herd, especially in the close quarters of the barn, is even more critical and will provide valuable information about developing group dynamics to the zoo management team. In summer, elephants can remain in their outdoor habitat in varying social groupings. The project will examine the effect that daytime activity levels have on nighttime behavior patterns in two scenarios - in winter with majority barn access, and in summer when elephants have 24 hour access to their outdoor habitat. Thus, this study assesses behavior and activity in winter and summer housing and how it affects the elephants.

Title: The effect of antibiotics on the microbial colonization of bee bread

Presenter(s): Cynthia Reagan

Mentor(s): Carlos Goller

REU/Summer Research Program: BeeMORE

Bee bread, fermented pollen stored in the wax combs of a honey bee colony, is the main protein source for honey bees. Bee bread is essential to the developing bees, yet we do not know much about which microbes live in and shape this stored food. The aim of this project is to sequence microbes from bee bread and determine the effect antibiotics have on its production. 51 samples from four hives were collected over a period of eight days, with two of the hives treated with oxytetracycline (a common antibiotic used by beekeepers for certain brood diseases). DNA was extracted and prepared for sequencing using the Zymo Quick-DNA Tissue/Insect Microprep Kit. The DNA was then concentrated using the Zymo Select-a-size DNA MagBead kit. The average DNA concentration using the Zymo insect kit was 31.6, with an average 260/280 ratio of 1.79, which were then concentrated into a range of 120-130 ng/µl. Sequencing was then completed using the Oxford Nanopore Technologies (ONT) Rapid Sequencing gDNA kit with the Flongle Nanopore adaptor and R9.4 flow cells. Results were analyzed using EPI2ME "What's in my pot" (WIMP). Preliminary sequencing results showed high amounts of the bacterial genus Escherichia, also known as E. coli. Salmonella enterica and 178 other reads with less abundant microorganisms?. Additional analyses will be completed as necessary. Knowledge of the microbes within bee bread will give beekeepers a better understanding of the effects of antibiotic treatment on the nutrients offered by the bees' food.

Title: Investigating Performance of Potential Recognition Schemes for IL-6 detection

Presenter(s): Dhruv Sadhu

Mentor(s): Michael Daniele

REU/Summer Research Program: OUR Award

Sepsis is a life-threatening disease clinically defined by an improperly regulated systemic response to infection that can culminate in life-threatening organ dysfunction. Worldwide, there were approximately 47 million cases of sepsis in 2017. About 11 million of those cases resulted in death, accounting for nearly 20% of global deaths for the year. Sepsis, or the root infection that leads to sepsis, starts outside of the hospital in about 87% of cases across the US in a given year. Early diagnosis of sepsis drastically improves patient outcomes. Currently, sepsis is primarily diagnosed by monitoring the physical state of patients, and a definitive diagnosis cannot be made until symptoms are already prevalent. Biochemically, sepsis is preceded by an inflammatory response from the body for defense against injury. Inflammation involves the release of signaling molecules such as cytokines6. Interleukin (IL-6) is a cytokine involved in a wide range of biological activities, including inflammatory responses. IL-6 has been shown to offer moderate success in differentiating sepsis from non-infectious systemic inflammatory response syndrome (SIRS). Here, we present data gathered from surface plasmon resonance experiments indicating the IL-6 binding properties of different recognition schemes functionalized upon an electrode surface, which can be used to engineer sensors.

Title: Characterization of the Temperature-Dependent Resistivity of Eutectic Gallium-Indium

Presenter(s): Zander Selleseth

Mentor(s): Michael Dickey

REU/Summer Research Program: Mentoring Incubator

The rigidity of materials in conventional electronic circuits presents challenges and limitations in applications involving mechanical deformation. The field of flexible electronics aims to overcome these constraints through the development of novel devices that can be bent, twisted, or stretched without sacrificing functionality. Eutectic gallium-indium (EGaIn), a conductive liquid metal at room temperature, has been explored as a material of interest in the development of these devices. However, to rationalize the applications

of EGaIn in flexible electronic devices, its electrical transport under a wide variety of thermal environments must be understood. Although EGaIn was previously determined to have a resistivity of 29.4±1.3x10-6 ohm-cm at 22°C, there are few results published at other temperatures. This study aims to characterize the resistivity of EGaIn using the 4-point probe method over a broad temperature range so it may be used as a reference value in future materials research. Furthermore, it may provide a better understanding of structural changes within the material as a function of temperature. As a part of the study, temperature-dependent electrical contact resistance at the EGaIn-electrode interface will also be measured experimentally using the transmission line method. In the future, the methods developed to obtain these measurements could be adapted to study the effect of other variables on resistivity and contact resistance, such as intermetallic formation, electrode material, sample geometry, or the inclusion of metal nanoparticles. With the reference data gathered through this study, EGaIn could be more reliably implemented in flexible electronics under a wide range of temperature conditions.

Title: Reversing Biorecognition Events and Recycling Biosensors by Electronically Modulating pH

Presenter(s): Chris Sharkey

Mentor(s): Michael Daniele

REU/Summer Research Program: OUR Award and GCSP

While electrochemical biosensors continue to improve the efficacy and efficiency of medical diagnostics, many remain economically impractical due to the expensive cost of fabricating such devices for just one medical test. Much research has been conducted to find ways to make biosensors reusable, but very little to none has taken advantage of the pH dependence of molecular binding in many biosensors. In this work, a method for reversing binding between a sensor's recognition element and target analyte by electronically adjusting the pH of electrochemical cells was developed. Initial investigation confirmed the viability of palladium as the system's working electrode material, taking advantage of the highly reversible and voltage-dependent palladium/palladium hydride chemical reaction. The magnitude and sign of the electrical potential applied to the palladium electrode was found to determine the rate of the cell's change in pH. The system was then used to selectively control and reverse binding between a biotinylated glass substrate and fluorescently labeled streptavidin. The extremely high-affinity complex formed between biotin and streptavidin makes this interaction popular in biorecognition applications and thus an ideal model for investigating the viability of pH modulation in revitalizing biosensors for multiple diagnostic tests. It is predicted that the results will demonstrate this system's utility in selectively reversing biorecognition events and thus decreasing the costs associated with deploying biosensors in clinical settings by extending the number of diagnostic tests such devices are able accurately perform.

Title: Exploring osmotically propelled particles for use in super-diffusive paste against infection

Presenter(s): Rachel Sides

Mentor(s): Nidhi Diwakar

REU/Summer Research Program: Velev Research Group

Active particles can "self-propel" on the microscale by drawing energy from their environment to power their motion. These particles offer innovative solutions to many current challenges in the biomedical field, such as targeted drug delivery and selective micro-scale surgeries. We are introducing here a new superdiffusive paste that demonstrates the collective dispersal of rapidly dissolving particles. The radial dispersion is driven by osmotic pressure due to the solute concentration gradients formed by the dissolution of salt particles. We hypothesize that this paste could be highly effective in microbial disinfection of the branched networks in dermal wounds, a challenging problem due to the limited penetration of the present disinfectants. In this work, we present an analysis of the critical parameters governing the system and preliminary results on the loading and visualization of 5-aminolevulinic acid (5-ALA), a promising cytotoxic disinfecting agent. A systematic concentration sweep was conducted on hydrochloric acid (HCl) and sodium dodecyl sulfate (SDS) as bulk components with an ammonium bicarbonate (NH5CO3) bolus. Analysis of the bolus radius over time revealed an accelerated dispersion under low HCl molarity-high SDS conditions. Phase composition was modified to dispense combined 5-ALA and NH5CO3 in phosphate-buffered saline (PBS) to mimic the target in-vivo environment. In contrast to previous experiments, a qualitative analysis revealed slower radial dispersion with added SDS. Future work will involve implementing the paste in model skin and assessing disinfection capacity, propulsion speed, and penetration depth of 5-ALA upon dispersion.

ABSTRACTS | SESSION 6

Title: Reactions to Automated Job Interviews

Presenter(s): Penda Sow

Mentor(s): Lori Foster

REU/Summer Research Program: TRIO Ronald E. McNair Summer Research Experience

Automation, which is becoming increasingly widespread, has led to many fields implementing new innovations (Hunkenschroer & Luetge, 2022). This includes the use of automated video interviews (AVIs), whereby technology such as artificial intelligence is used to administer job interviews as well as score them and determine who will move to the next phase of a hiring process. While such practices can improve efficiency and reduce costs, there is a lack of research on the perspective of applicants regarding the shift from human to automated interviewing. Some people may be more receptive to AVIs than others. Scientific processes are needed to pinpoint the factors that could affect that receptivity, such as age and locus of control (LOC). LOC refers to an individual's perception of having control over life's events (Galvin et al., 2018). An applicant's perceived control over the interview's outcome may influence their attitudes toward automation. Research has shown a link between LOC and receptivity to automation in other contexts (Innocenti & Golin, 2022), yet the extent to which LOC affects attitudes toward automating job interviews remains unexplored. In addition, job seekers' age could play a role, as suggested by prior research on age and technology adoption (Hauk et al., 2018). Using a sample of N = 298 individuals, this study empirically examines the influence of LOC and age on attitudes toward automating job interviews. In doing so, we aim to develop a more comprehensive understanding of the shift toward AVIs and basis for future research.

Title: Analysis of Cardiac Cell Phenotypes on Viscoelastic Substrates

Presenter(s): Smriti Sridharan

Mentor(s): Ashley Brown

REU/Summer Research Program: BME

Myocardial Infarction (MI) is an obstruction of an artery supplying the heart, causing cardiac ischemia. One of the most common causes of MI is fibrin-rich clot formation in the coronary arteries. Previous studies have demonstrated the capacity of a dual drug-loaded nanogel therapeutic to reduce fibrotic markers on linear substrates. To further understand cellular response to this therapeutic, a current study is investigating fibrotic marker expression in cardiac cells seeded on viscoelastic materials. Varying degrees of viscoelasticity were used to mimic healthy and fibrotic cardiac tissue. To expand our understanding of cellular response on microgel thin films, we examined the expression of fibrotic markers at timepoints t=16hrs (overnight), 24hrs, and 48hrs. Human umbilical vein epithelial cells (HUVEC), neonatal rat cardiac fibroblasts (NRCF), and human aortic smooth muscle cells (HASMC) were seeded on 1%, 2%, and 7% BIS-crosslinked microgel thin films and incubated for the respective time points. We then proceeded with immunofluorescent staining for alpha-smooth muscle actin (αSMA) and connective tissue growth factor (CTGF), which are key fibrotic markers. Results demonstrated a decrease in fibrotic marker expression in HUVECs and HASMCs at t=24hr as microgel thin-film cross-linking increased. Conversely, NRCFs experienced an increase in αSMA expression and a decrease in CTGF expression with increased cross-linking. We hypothesize a similar trend at t=16hr and t=48hr for each cardiac cell line. HUVECs, HASMC, and NRCF display fibrotic phenotypes on high intraparticle cross-linking. Future studies will focus on employing a drug-loaded nanogel to reduce fibrotic markers in vitro.

Title: Large-scale centrifuge turbidity probe calibration and new measurement standard development

Presenter(s): Joshua Sumner

Mentor(s): Ryan Barton

REU/Summer Research Program: BTEC

This research assignment is developing a new standard curve and unit of measure (NTU) for the Optek C4000 TF16-N Scattered-Light Sensor Turbidity Probe currently placed in the large-scale centrifuge, within BTEC's downstream process area. This centrifuge is used to separate product containing cells from the spent media, and for a successful recovery, the clarified liquid should remain clear, indicating minimal loss of cells/product. The turbidity probe sensor feeds data into the DeltaV distributed control system (DCS) allowing monitoring of turbidity/particulates in the centrifuge's clarified liquid stream (spent media) measured in NTU's. The sensor needed calibration, but the measurement was also known to have issues due to air bubbles resulting from bowl discharges rendering the turbidity probe measurements ineffective. Using varying levels of NTU standards (.5, 10, 50, 100 NTU), multiple trial datasets were combined in Excel to develop and implement a linearization table into the turbidity probe sensor. To address the issue of air bubbles, the DeltaV turbidity monitoring program will be adjusted by setting the measurement window active only during feeding stages of the centrifuge process, preventing the probe from seeing bubbles in the clarified liquid stream.

ABSTRACTS | SESSION 6

The final objective is to have a working turbidity monitor which can be used to determine when the bowl should be discharged allowing for a more efficient and automated centrifuging process. Results of this project's assignment are shown through visual aids such as trendlines and graphs produced by the centrifuge and DeltaV software while product is being run on the centrifuge.

Title: The Pack Proficiencies: Undergraduate perspectives on the relevance and importance of personal and professional learning outcomes

Presenter(s): Raiford Turner, Lily Palmer, Alexa Kostopoulos

Mentor(s): Samantha Rich

The Pack Proficiencies are five important skill sets that NC State wants every undergraduate student to develop before they graduate including written communication, oral communication, quantitative literacy, critical thinking, and creative thinking. Working with the Division of Academic and Student Affairs, the Pack Assessment Ambassadors at NC State have conducted a series of five focus groups, in which a total of 23 students across grade levels were asked about their experiences with the Pack Proficiencies at NC State. Ambassadors also asked participants questions regarding their awareness of the Pack Proficiencies and their usefulness, as well as how they have specifically developed written communication, oral communication, and quantitative literacy skills within their coursework and extracurricular activities. Audio recordings of the focus groups were transcribed from which Ambassadors analyzed patterns among focus groups using qualitative coding techniques. Based on the stories shared, several common themes emerged among the participants. STEM students struggle in finding a connection or benefit to communication and creative thinking competencies; generally, participants were unaware of the Pack Proficiencies. Findings and recommendations were shared with NC State faculty and staff in order to promote awareness and understanding of common learning outcomes among NC State students.

Title: Ferroelectric and Polarization

Presenter(s): Jessie Urbina

Mentor(s): Jacob Jones

REU/Summer Research Program: Mentoring Incubator

Ferroelectric materials reorient their spontaneous internal polarization when exposed to an electric field. Ferroelectrics are useful in a wide range of applications, such as ferroelectric random access memory (FeRAM) used in PlayStation as a memory card. Researchers aim to reduce toxicity of ferroelectrics by utilizing tin over lead since this element is inherently less toxic. In many industrial ferroelectric materials, the desirable properties arise from lead's cationic distortion in the crystal structure. However, the high toxicity of lead has generated interest in developing lead-free ferroelectric materials. Ongoing research involves substituting lead with tin in materials for ferroelectric applications. However, tin containing materials cannot be conventionally processed without facing instability issues; conventional sintering processes utilize temperature far in excess of 300 °C required to degrade the metastable tin-containing compounds. In order to benchmark the properties of novel tin-containing ferroelectrics against their lead-containing counterparts, consolidated samples must be fabricated, while avoiding the high temperature that promote degradation. The present work outlines a consolidation process that avoids high temperatures by suspending the tin-containing powder particles in an acrylic resin matrix, enabling electrical property testing of highly metastable material without complications of degradation. Testing requires a densified material in order to measure the electrical properties. Initial electrical testing on stable ferroelectric materials demonstrates the feasibility of this consolidation method, and testing on the novel metastable materials will be conducted to evaluate their ferroelectric behavior.

Title: Generating Multi-Group Cross Sections For Fast and Microreactors

Presenter(s): Max Velasco

Mentor(s): Scott Palmtag

Fast and microreactors are part of the next generation of reactors, which have advantages like minimal size, use of natural uranium, genesis of fissile material in fuel cycles, etc. There are current codes to model these types of reactors, but they need accurate material cross sections for optimal modeling. The purpose of this project is to attain multigroup cross sections from Monte Carlo code Serpent. Models of fast reactor assemblies and microreactors are being created to look at different methods of generating multigroup cross sections for each respective reactor type. Monte Carlo codes are being used because they use exact geometry representation and, continuous energy cross sections. Monte Carlo codes will be used to generate reference solutions and homogeneous geometry.

Multigroup cross sections will then be used in deterministic solvers and the accuracy will be determined. Cross sections will be generated at different energy group structures and temperatures. The end goal of this project is to use the generated cross sections in LUPINE, which is another code written at NC State to model next generation reactors. This code can solve coupled neutronics models, with other reactor physics, such as thermal hydraulics and thermal expansion models like in current Multiphysics codes meant for thermal systems.

Title: Development and Testing of High-Temperature Fast Response Pressure Sensitive Paint

Presenter(s): Sam Wood, Shaan Stephen

Mentor(s): Venkateswaran Narayanaswamy

REU/Summer Research Program: MAE

Dynamic pressure-sensitive paint has quickly become an indispensable tool for researchers studying high-speed flows. It provides unparalleled data sets on flow evolution and time-dependent features. However, a current limitation for this paint is that it quickly degrades when exposed to temperatures above 60C, making it impossible to use this technique for experiments involving high-temperature flows. This work addresses this issue by combining novel techniques to develop a polymer/ceramic pressure-sensitive paint that can operate in a high temperature environment. This is made possible by using a water-soluble basecoat in conjunction with a urethane resin doped topcoat. Early static calibrations demonstrated that this paint is capable of withstanding temperatures as high as 140C and we hope dynamic tests will show that the paint can detect pressure fluctuations at a high frequency. With a high temperature resistance and a decent pressure fluctuation frequency, this paint can prove to be a strong tool for atmosphere-like conditions and heated test conditions in supersonic test environments.

Title: Development of a Dual-Loaded Drug Delivery Patch Made Using Fibrin-Based Nanoparticles

Presenter(s): Nicole Zwennes

Mentor(s): Ashley Brown

REU/Summer Research Program: U-Team T34

While end-stage renal disease affected 80,000 Americans in 2018, the only forms of treatment remain long-term hemodialysis or kidney transplant. Arteriovenous (AV) fistulas are the gold standard of vascular access for long-term hemodialysis, but their formation is a complicated surgical procedure that requires a months-long post-operative waiting period before they are ready for use. This maturation process can be hindered by intimal hyperplasia, the buildup of extracellular matrix and myofibroblast cells that prevents adequate blood flow through the fistula. We aim to provide support for this maturation process through the use of biomaterials with localized drug delivery capabilities. Our goal is the development of a dual-loaded drug delivery system, utilizing fibrin-based nanoparticles (FBNs) and polycaprolactone (PCL)-gelatin blend scaffolds. This model allows for delivery of two drugs on separate time scales – rapid release of drug by the FBNs to promote healing and delayed release of an antihyperplastic by the scaffold to prevent neointimal hyperplasia. We conducted tests of loading efficiency and drug release studies of the PCL-gelatin blend scaffold and the FBNs independently. Then, we characterized methods of seeding drug-loaded FBNs onto a drug-loaded scaffold. Through the results of this study, we have observed the time scales of drug delivery of both components, and the capability to integrate the two platforms together into one drug delivery system. These results support the conclusion that the loading and release efficiency is tunable based on characteristics of each component.

ABSTRACTS | SESSION 7

Title: Development of optical nano-biosensors for detection of electrolytes

Presenter(s): Sofia Abello

Mentor(s): Januka Budhathoki-Uprety

REU/Summer Research Program: Mentoring Incubator

Electrolytes such as sodium, potassium, calcium, and magnesium ions help regulate body functions. Among them, potassium ion plays a major role in biological processes such as activating nerve impulses and regulating heart, muscle, and kidney functions. However, elevated potassium ion levels, known as hyperkalemia, can cause neurological, muscular, and cardiovascular dysfunctions. Mild cases exhibit nausea and muscle weakness, while severe cases include muscle paralysis and cardiac arrythmia. Thus, monitoring potassium ion levels is crucial for mitigating life-threatening effects and could be considered as disease biomarker. Currently, potassium ion level is determined by collecting blood samples. However, this can be inconvenient and could delay treatment for at-risk patients. While recent technologies such as ion-selective electrodes and optodes provide point-of-care detection of potassium ion in sweat and interstitial fluid, wired systems are not suitable for continuous monitoring with implantable devices. Thus, a real-time, selective, sensitive, monitoring system that can detect potassium ion while implanted in the body could allow for timely interventions in facilitating treatment.Single-walled carbon nanotubes (SWCNTs) are a class of nanomaterials with unique photophysical properties. Their non-photobleaching near-infrared fluorescence, high sensitivity and stability is ideal for use in implantable and wearable sensors. Here, we use a polymer to functionalize SWCNTs to develop an optical nanosensor for detection of potassium ion. The polymer is a known potassium ion chelator used for hyperkalemia treatment and likely facilitates the ion recognition by the sensor. Our project investigates the use of this optical nanosensor to detect a range of potassium ion concentrations

Title: Integration of thermoset and thermoplastic yarns in knitted shoe uppers

Presenter(s): Victor Alvarez Valverde

Mentor(s): Jenna Decandio

REU/Summer Research Program: TECS

With the evolution and overall increase in use of knitted shoe uppers, there has been little research done concerning the use of thermoset and thermoplastic yarns in shoe based applications. A common issue that shoe manufacturers have come across is the cut and sow operations related to non-fashioned shoe uppers. Coming off the knitting bed, non-fashioned shoe uppers are steamed and then cut, however problems arise due to the precision required to cut the shoe uppers out of the backing as well as the curling edges and frayed yarns that develop shortly after cutting. Curling edges and frayed yarns make proper cut and sow operations more time consuming for workers at plants. The incorporation of either thermoset or thermoplastic yarns can lead to more defined edges in shoe uppers, facilitating cut and sow operations once the upper is produced by the knitting bed. Another aspect in which the incorporation of specialty yarns could increase the use of shoe uppers is through increasing the overall tear strength of the upper, thus making it suitable for heavy use application such as football cleats, hiking shoes, and skateboard shoes. This presentation thus shows the viability of the implementation of thermoset yarns and thermoplastic yarns in knitted shoe uppers to expedite cut and sow operations as well as acheiving high performance levels.

Title: An open-source driver to measure particle concentrations

Presenter(s): Parker Baker

Mentor(s): Warren Jasper

REU/Summer Research Program: TECS

An open-source driver, written in python, was developed for a particulate sensor, the PM2008 from Cubic, in order to analyze the filtration efficiency for different materials. We utilized a Raspberry Pi to allow for a virtual computing environment that was both robust enough to manage multiple sensors, as well as portable to be utilized outside of the university setting. Writing our own driver for the sensor allowed for complete control over the data collection process, or data provenance. This approach allowed for enhanced functionality such as the ability to sample multiple sensors simultaneously and manage the data into data frames, something the proprietary software lacked. Currently, we have almost completed the driver for the sensors. Moving forward, we hope to begin integrating many of these sensors onto a mannequin for testing under different particulate loads.

ABSTRACTS | SESSION 7

By sampling from multiple sensors across the body, both above and under a garment, we will be able to determine the percent penetration at seams and various stress points in a garment ensemble. With the use of other sensors in tandem with the PM2008 we will be able to create a particle size data acquisition system and begin testing under many different scenarios. This research will be applied to determine how different materials may protect firefighters against particulates as well as to determine the efficacy of masks, which have become increasingly important during the pandemic.

Title: Converting electrospun webs into traditional textiles

Presenter(s): Katrina Bhatia

Mentor(s): Xiaomeng Fang

REU/Summer Research Program: TECS

Electrospun ultrafine fibers possess many unique advantages, especially the high surface areas, which have great potential to be used in filtration, biomedical devices and soft batteries, etc. However, the electrospun webs are in a mat configuration in that fibers are attached to each other, which results in a weak mechanical strength, low compliance and conformity, and very low breathability. Hence, electrospun webs are not suitable for wearable device applications regardless of their intriguing properties. To address this challenge, this work aims to convert electrospun webs into woven fabrics. First, non-uniform electrospun sheets are cut into thin strips and then twisted to make yarns. A Servo motor controlled with a microcontroller ensured uniform yarn density while twisting. It was observed that the untwisting percentage of electrospun stripes is disproportional to its resting period; therefore, to maintain the yarn twist, yarns were taped in the twisted position on a flat surface for 24 - 48 hours. Subsequently, the yarns were hand-woven into fabrics utilizing a needle and tweezer, as the yarns were too delicate at this point to be woven with industrial-grade machinery. The findings of this work demonstrate the possibility of converting electrospun webs into traditional textiles. Future works on improving twisted yarn's strength and stability will be necessary to accelerate the scale-up of this technique.

Title: CHIPS Taste Test via ELISA Assay

Presenter(s): Chloe Cernoch

Mentor(s): Sophie Noel

REU/Summer Research Program: BIT SURE

Methicillin-resistant Staphylococcus aureus (MRSA) is a group of highly antibiotic resistant bacterial strains. MRSA infections often pose a serious threat in hospital settings as a result of high transmission rates and limited treatment options due to tolerance to common antibiotics. Chemotaxis inhibitory protein of Staphylococcus aureus (CHIPS) is a protein secreted by S. aureus that impairs leukocyte migration upon infection, a key event in the body's immune response against pathogens. CHIPS specifically works by blocking calcium mobilization of neutrophils and monocytes induced by the chemoattractants fMLP and C5a. CHIPS was chosen as the target protein for the development of an enzyme-linked immunosorbent assay (ELISA) due to its role as a protein driver of an immune escape mechanism used by S. aureus. We plan to develop a sandwich ELISA to detect CHIPS using primary antibodies raised against the CHIPS N-terminus and C-terminus. Results from a dot blot indicate that the selected antibodies are capable of detecting CHIPS protein. We will use the Abcam SimpleStep ELISA® kit to develop and optimize an assay to quantify CHIPS levels in different S. aureus samples and determine whether CHIPS expression differs between MRSA and non-antibiotic resistant S. aureus. This assay could then be used to more quickly detect MRSA infections in hospitalized patients, leading to reduced transmission rates and earlier treatment, improving patient outcomes.

Title: Monitoring populations in Pseudoperonospora cubensis using biosurveillance and molecular markers.

Presenter(s):Bella Condo

Mentor(s): Lina Quesada

REU/Summer Research Program: Kelman Scholars

Pseudoperonospora cubensis is the causative agent of cucurbit downy mildew (CDM), an obligate oomycete pathogen responsible for severe foliar disease in cucurbits. Annual infections start in the southern portion of the United States and move north as temperatures increase. Two clades have been identified, Clade 1 primarily infecting squash, pumpkin, and watermelon, and Clade 2, which targets cucumbers and cantaloupes. Current chemical controls are preventative, relying on reports of infection in neighboring counties to time fungicide applications. This can result in improper timing of treatments, resulting in financial losses from disease or excess fungicide

usage. Our aim was to utilize rotorod spore traps to detect the presence of P. cubensis spores before symptoms are present, allowing for timely intervention. Weekly samples are taken from traps 0.5 meters from the ground. These traps are placed around Arabian Cucumbers and Butternut Squash as these are both susceptible varieties to CDM. Rods are then taken to the lab and undergo DNA extraction. Quantitative PCR performed on the samples then allows for detection of the pathogen and the clade from unique molecular markers. Results indicate that P. cubensis can be detected using spore traps. Findings of this study will be helpful in allowing for recommendations on which crops should be sprayed based on clade. Additionally, preventing unnecessary spraying aids in preserving fungicide efficacy. This becomes important in preventing loss of control of CDM as it has already gained resistance to previous chemical controls, resulting in reduced crop yield and heavy economic losses.

Title: Determining the cause of PhiPhi bacteriophage resistance and susceptibility in Xanthomonas campestris strain Wilson

Presenter(s): Adamari De La Cerda

Mentor(s): Jennie Fagen

REU/Summer Research Program: Kelman Scholars

Bacteriophages are viruses that infect bacteria in a process that involves either killing (lytic) or genomic integration (lysogenic). These viruses are potent biological tools capable of controlling pathogenic bacteria. A major part of bacteriophage genes are not well characterized, impeding our understanding of their capacity for effective infections and medical therapeutic use. *Xanthomonas campestris* is a Gram-negative plant bacterium that causes black-rot in Brassica vegetation and is considered a bacterial disease that infects many commercial crops (Vicente et al, 2012). In this investigation, two undescribed regions of *Xanthomonas campestris* 'PhiPhi' phage DNA were isolated and sequenced. One of these regions, designated Target 2, was cloned into a bacterial plasmid and transformed into *Xanthomonas campestris Wilson*. Initially, these transformed cells demonstrated resistance against phage infection. However, the repetition of this trial showed susceptibility with the formation of plaques, indicating that bacterial cells were still being attacked by the phage. This observation brought the mechanism of resistance into question and suggested that a spontaneous mutation in the bacterial genome may potentially be the cause of phage resistance. The remainder of this study focused on determining the source of bacterial resistance and vulnerability in this system. After the same bacterial species was confirmed, the plasmid and entire chromosome of the resistant and susceptible strains were compared to understand the cause of inconsistent phage infection. Understanding the reasons for these observations is crucial for the controlling of pathogenic bacterias and the ultimate use of phage therapeutics.

Title: Crop varieties assessment for susceptibility to downy mildew in North Carolina

Presenter(s):Taylor Deaton

Mentor(s): Lina Quesada

REU/Summer Research Program: Kelman Scholars

Downy mildew is caused by oomycete or water mold pathogens that collectively infect many flowers, fruits, and vegetables. This disease affects the foliage of infected plants, causing small water-soaked spots on the tops of leaves that eventually become lesions of the foliage and result in leaf loss. These lesions first appear as a yellow color before turning brown and angular, while the bottom of the leaves have white, gray, or brown sporulation depending on the pathogen and host. Once a plant is infected with downy mildew, it cannot be cured, making downy mildew an economically important pathogen because it causes damage and death to many crops. The goal of this study was to confirm the resistance levels for resistant and susceptible varieties of basil, parsley, chives, cucumber, and zucchini squash, as well identify the type of downy mildew that affects the susceptible varieties of these crops. These plants were grown in a greenhouse before being transplanted to a sentinel plot where a randomized complete block design was performed using four replicates of the five crops, each with a resistant and non-resistant variety. Data was collected each week by carefully examining the foliage of each plant for symptoms of downy mildew, and leaves with disease symptoms were taken to the lab to undergo DNA extraction and PCR to determine the type of downy mildew present. Findings of this research may help to understand the levels of resistance for these crops and how to carefully select the right varieties for the future.

ABSTRACTS | SESSION 7

Title: Textiles for Extreme Environments and High Oxygen Atmospheres

Presenter(s): Leo Delgado

Mentor(s): Wei Gao

REU/Summer Research Program: TECS

Spacesuits are a type of suit meant to protect a person from the harsh environment of outer space. Currently, our main spacesuits are mainly designed for spacewalks and traversal on the International space station (ISS), however, we want to design spacesuits for exploring the moon and operations in extreme environments. The current fabric used in most spacesuits is 'Beta fabric', which only covers high flammability risks but not other environmental risks. We propose using a fiber commercially called 'ZYLON', which is supposed to have a high flame resistance, tensile strength, and tensile modulus. What we will do is weave a cloth completely made of ZYLON, a cloth with cotton as the warp yarn and ZYLON as the weft, and cloth with cotton as the warp yarn and Nomex as the weft. Once we have all three cloths we will perform a flammability test on all of them and compare which has the highest flame resistance. Assuming the 100% ZYLON cloth has the highest flame resistance, we will send our results to NASA, letting them proceed with the design of the new spacesuits.

Title: Visualization and characterization of repair protein RadD binding and function on ssDNA

Presenter(s): Samuel Doak

Mentor(s): Sefanie Chen

REU/Summer Research Program: BIT SURE

RadD is a DNA repair protein in E. coli involved in repairing genomic damage due to radiation. Of the known DNA repair proteins in E. coli, it is one of the least studied. However, it is known to be recruited by the single-stranded DNA binding protein (SSB), which plays a vital role in DNA replication, recombination, and repair. SSB binds to RadD via its C-terminal peptide (SSB-Ct), although the location where it binds to RadD is unknown. RadD contains the conserved motifs from the RecQ family of helicases, and also has the characteristic ATPase activity. The DNA- and SSB-Ct-binding capability of K37R, a RadD mutant with an inactivated ATPase site, were investigated using biolayer interferometry. Fluorescence microscopy was used to analyze cellular localization of RadD and SSB under damage conditions, and atomic force microscopy was used to visualize individual protein localization on a DNA substrate. This will lead to a better characterization of RadD's radiation repair pathway and provide insight on how to reduce radiation damage to humans and their microbiomes from sources ranging from chemotherapy to space travel.

Title: Strength Loss Indicator for Textile Webbing

Presenter(s): Rachel Drum

Mentor(s): Emiel DenHartog

REU/Summer Research Program: TECS

The main goal of this project is to perform controlled degradation of textile webbings used in tactile gear, both abrasion and UV degradation, and analyze the loss of mechanical properties at different levels of degradation in order to develop a strength loss indicator for the webbings. It is important for us to test these variables as this knowledge will lower the likelihood of accidents and/or complications when using these textile webbings. This was completed through the use of the Wyyzenbeek oscillatory abrasion tester, and the Atlas Ci 4000 weatherometer. Through testing, we were able to determine that a certain one of our webbing samples showed a more gradual decrease in strength with increasing abrasion cycles. We also were able to see there is a significant reduction in tensile strength of the webbings as we increase the exposure time to UV light at higher irradiance for all except the white webbings. Our FTIR results showed higher peaks with increased UV exposure, as well as higher carboxyl peaks. These peaks helped show us what was happening as the polymer backbone. An increase of -COOH and -NH peaks could be an indicator of hydrolysis in our Nylon 6 webbings. Overall, this insight helped us to construct a data base of strength properties of these textile webbings after a series of degradation.

ABSTRACTS | SESSION 7

Title: Improving Transverse and Interlaminate Properties of Carbon Fiber Reinforced Plastic Using Microfiber Veils

Presenter(s): Sean Fijen

Mentor(s): Walaa Enab

REU/Summer Research Program: TECS

Carbon fiber reinforced plastic laminate structures are a rapidly growing class of material. Providing greater specific strength and stiffness compared to traditional engineering materials. These structures have two series drawbacks, their transverse strength and interlaminate strength. This study focuses on improving the transference strength of unidirectional laminates using microfiber veils laminated between pre-impregnated carbon fiber epoxy plies. Examining both flat laminates in 3-point bending and tubes in compression. The main focus of the study on flat laminates is their transverse tensile strength. With veils being added at the part of the laminate in tension and the max tensile strength calculated through bending stress equations. The examination of the composite tubes was focused on the maximum stress before the onset of delamination of a tube under compressive load.

Title: Development of Carbon Nanotube-based Optical pH Sensors

Presenter(s): Teresa Fiorito

Mentor(s): Januka Budhathoki-Uprety

REU/Summer Research Program: TECS

Measuring pH is the process of quantitatively observing the acidity or alkalinity of aqueous solutions. pH plays an important role in biological, environmental, and industrial processes. In biology, irregular acidity or alkalinity levels in the body can indicate impaired cell function, microbial infection, wound healing processes, or various diseases. Precision pH measurements could aid in disease diagnosis and treatment. Single-Walled Carbon Nanotubes (SWCNTs) exhibit favorable properties to create a pH sensor. Significant properties include high photostability, sensitivity, and fluorescence in the near-infrared region at which interference from biological tissues and fluid is minimal. In this project, we are developing nanotube-based optical pH sensors. Initializing the process of creating a biocompatible optical nanosensor begins with the functionalization of the nanotubes with biocompatible polymers. The functionalized polymer-SWCNT sensor will be integrated into a crosslinked polymer network to form an insoluble sensor for implantation, topical use, or wearable applications. We found that the sensor responded to various pH in aqueous solution. Future experiments include testing these sensors in complex biofluids to observe the sensing responses in various pH environments.

Title: Tissue Engineering

Presenter(s): Kaleah Gaddy

Mentor(s): Jessica Gluck

REU/Summer Research Program: TECS

Fabrication of electrospun Polycaprolactone(PCL) with immobilization of collagen for skin tissue regeneration. The purpose of this project is to develop a way to heal chronic wounds through skin regeneration methods using tissue engineering. Electrospinning is one of the most popular experimental methods used to fabricate scaffolds. There are two ways, conventional and using a rotating funnel. Conventional has a flat metal collector that the samples need to be peeled from. A rotating funnel uses a two syringe pump system and a metal funnel that collects the fibers onto a mesh to later be peeled from the surface. For this project, electrospun PCL (Polycaprolactone) on the rotating funnel which was then immobilized with collagen solution was used. The experiments are separated based on two parameters: time soaked in the collagen solution and the concentration of the collagen. The first will be tested using 24 hours and 48 hours. The second will be tested using 1.5mg/mL and 3.0mg/mL. Cells will be placed on these scaffolds. The live/dead staining and alamarBlue Assays for cell viability will be conducted for both sets of samples as well. Over the course of one, three, and six days the human dermal fibroblast cells will be given time to grow. Following the cell growth, SEM imaging will be conducted to collect pictures of the samples. In the results the hope is to get cells to grow on these fabricated PCL scaffolds to mimic the extracellular matrix and aid in skin regeneration.

ABSTRACTS | SESSION 7

Title: Effect of ethanol on relative growth on Ambrosia, plant pathogen, and endophytic fungi

Presenter(s): Emely Garcia

Mentor(s): Sara Villani

REU/Summer Research Program: Kelman Scholars

Ambrosia beetles from the genus Xylosandrus, are attracted to ethanol stressed and dying trees. The beetles cultivate and feed upon Ambrosiella fungi. It is unclear how Ambrosiella interacts with fungal phytopathogens that are commonly found on stressed trees close to beetle galleries. Additionally, little research has been conducted on the potential impact of ethanol on the growth of phytopathogens such Botryosphaeria and Fusarium. The objectives of this study were to i) observe the effects of ethanol on growth of fungi that are commonly co-isolated with Ambrosiella and ii) characterize the type of competitive relationship, between these fungi and Ambrosiella fungi with and without ethanol. The growth response of 8 fungi commonly isolated from beetle galleries, and 6 Ambrosiella isolates was measured on malt extract agar (MEA) for seven different ethanol concentrations (0, 0.5, 1, 2, 3, 4, and 5 percent) and the effective concentration at which 50% of mycelial growth was inhibited (EC 50) was calculated. For each competition assay, 5 mm plugs were excised from a 7 day old culture of each isolate and placed mycelial side down, 1 cm from the edge of a Petri dish (80 mm) containing MEA amended with either 0% or 2.5% ethanol. A 5 mm mycelial plug of the competing fungus was placed on the opposite side of the plate, for the control no competing fungus was added. Competition assay was incubated at 25°C for 5 to 7 days in the dark. The inhibition was assessed as a relative measure of colony growth rate compared with single colony growth on the non-competitive plates.

Title: Impact of Fit on Total Filtration Efficiency of Face Masks on Different Headform Sizes

Presenter(s): Fatima Garcia Corona

Mentor(s): Bryan Ormond

REU/Summer Research Program: TECS

The purpose of this experiment was to determine the impact of fit of a face mask on the performance through examining the total filtration efficiency on three different size headforms. Gaps around the edges of the face masks cause leakages where the air inhaled and exhaled is not filtered through the material, decreasing the total filtration efficiency. A new testing method was developed with reference to current barrier face coving standards. The experiment was conducted using the small, medium, and large ISO 16900 RPD headforms from I-bodi. The External Breathing System from Thermetrics was attached to the headforms to achieve the required breathing parameters. The respiration rate was 16.3 bpm, volume was 1.0 L, and the flow rate was 56.3 lpm. A NaCl aerosol was generated within a closed environment along with an air purifier to control the amount of particles. Particle counters recorded the measurements of particles inside and outside the face mask to calculate the filtration efficiency. The ambient particle count was recorded before each test. Due to the production of low filtration efficiency on certified N95 respirators, tests were performed to eliminate possible sources of error within the set up. Possible limitations from the particle counters were considered due to the difference with the calibration. Five face masks were tested per headform size. Each test consisted of 5 trials, each 5 minutes long. The filtration efficiency was compared among the headform size to determine the impact of fit on the performance of the face mask.

Title: Investigating RpoN control of RadD Expression

Presenter(s): Parker Gorman

Mentor(s): Stefanie Chen

REU/Summer Research Program: BIT SURE

In prokaryotes, genetic expression starts with transcription. RNA polymerase binds to a DNA sequence called the promoter, the transcription start site, to begin producing mRNA. As an enzyme, RNA polymerase is made of several protein subunits, including the sigma factor. This subunit is required to recognize and bind to the promoter for transcription to begin. In the E. coli genome, sigma factor 70, the “housekeeping” sigma factor, interacts with most of the promoters to promote gene expression. The E. coli gene, radD, however, has been predicted to use the stress response sigma factor 54 (Zhao et al, 2010). In previous studies, analyzing mRNA levels from qPCR results has provided insufficient data quality. As an alternative approach, we used a biochemical method to investigate sigma factor 54 and radD promoter DNA binding in vitro. The sigma factor 70 protein, also called RpoN, was first cloned, overexpressed, and purified. Next, the promoter region on the E. coli genome upstream from radD was amplified using PCR. Electrophoretic mobility shift assay (EMSA) was then used to observe an interaction between the promoter and sigma factor. Finally, to detect transcriptional upregulation in vivo, digital droplet PCR was used on stressed and control samples.

ABSTRACTS | SESSION 7

Title: Assessing Wastes from North Carolina Industries as Carbon Sources for Anaerobic Soil Disinfestation

Presenter(s): Jacob Herrup

Mentor(s): Andres Velazquez

REU/Summer Research Program: Kelman Scholars

Anaerobic soil disinfestation (ASD) is a promising treatment for managing soilborne pathogens of field crops. Among these, Verticillium dahliae causes chlorosis and necrosis, and wilting of tomatoes in North Carolina has struggled to adopt to the use of ASD due to the lack of cheap carbon sources required for this process. The main objective of this project was to explore the potential efficacy of local industry wastes as carbon sources for ASD. For screening trials of ASD, four organic amendments: spent brewery grain, composted and fresh mycelia, tobacco waste, and sweet potato waste from local industries were tested. To determine the effects of volatile compounds during ASD on mycelial growth and microsclerotia production completely randomized block design experiments with ten replication per carbon source were carried out. Amended, saturated soils were placed in the bottom of Petri dishes and covered with another Petri dish bottom with potato dextrose agar (PDA) medium and an inoculum plug of V. dahliae. Petri dishes were sealed with two layers of electrical tape and incubated for 4 weeks at 28°C. Significant reductions in the mycelia of V. dahliae were observed for all carbon sources compared to the controls. Our further work is in progress.

Title: Synthesis and characterization of nitrophenyl-containing endoperoxides for nitroreductase-mediated release of singlet oxygen in hypoxic cancer cells

Presenter(s): Meghan Johnson

Mentor(s): Audrey Fikes

REU/Summer Research Program: BIT SURE

Hypoxia (low oxygen) is a known factor that increases drug resistance in cancer cells due to the reliance of chemotherapeutic drugs to generate reactive oxygen species to cause cell damage and death. We report the current progress on the synthesis and characterization of nitrophenyl pyridone endoperoxides that will selectively and rapidly release $^1O_2$ through a retro Diels-Alder reaction triggered by the reduction of the nitrophenyl group by nitroreductase, an enzyme that is overexpressed in hypoxic tumor cells. The presence of the electron-withdrawing nitro moiety decreases the rate of $^1O_2$. Nitroreductase-mediated reduction to an electron-donating amine group destabilizes the endoperoxide and increases the rate of $^1O_2$ release. The $^1O_2$ can then cause direct damage to the cancer cell or be converted to $^3O_2$ which would relieve the low oxygen conditions and decrease the cancer's drug resistance. Initial synthetic efforts indicate that substitution at the bridgehead position of the endoperoxide is not well tolerated. However, we have confirmed that electron-donating amines do destabilize endoperoxides, although decomposition pathways other than the desired retro Diels-Alder pathway can occur. Current efforts are focused on pyridone endoperoxides with the nitrophenyl group at the N1, C4, and C5 positions. The synthesis and initial characterizations of these compounds, 1-p-NP, 4-p-NP, and 5-p-NP, respectively, are presented here.

Title: Does a Pseudoperonospora cubensis cryptospecies population caused a cucurbit downy mildew epidemic in the U.S.?

Presenter(s): Brooke Kelly

Mentor(s): Andres Salcedo

REU/Summer Research Program: Kelman Scholars

The biotrophic pathogen Pseudoperonospora cubensis causes cucurbit downy mildew (CDM) on several economically important Cucurbitaceae hosts. CDM re-emerged as a major foliar disease on cucurbit crops in the United States (US) in 2004 as a result of the combination of host resistance and fungicide efficacy failure. Diverse P. cubensis population studies have pointed to the existence of two genetically distinct host-specific clades (clade1 and clade 2). Clade 1 isolates preferentially infect squash, pumpkin, and watermelon, while clade 2 isolates more frequently infect cucumber and cantaloupe and appear early in the growing season. These studies also found recombination in clade 1 isolates but not clade 2 isolates, suggesting a clade reproductive isolation and differential reproductive strategies may have resulted from a speciation event or single clonal lineage expansion in P. cubensis. Our objective was to demonstrate that the 2004 CDM epidemic was caused by the introduction of a cryptic Pseudoperonospora species adapted to cucumber. We performed a multilocus phylogenetic analysis and genotyping for clade and fungicide susceptibility using more than 850 pre- and post-epidemic historical isolates collected in the US and overseas. Representative isolates of each clade were used to evaluate morphological differences, cucurbit host specificity, and reproductive isolation by performing intra and interclade crosses to evaluate offspring oospore viability and genetic identity under laboratory conditions. Our findings trace possible determinants for the 2004 epidemics, supporting the hypothesis of a P. cubensis cryptospecies as the major driver. Our conclusions will influence the adoption of cucurbit-specific management practices, the timing of fungicide applications, and phenotyping for host resistance breeding efforts.

ABSTRACTS | SESSION 7

Title: Cataloging NLRs to get closer to pathogen-resistant sweetpotatoes

Presenter(s): Katie Rose Ketzes

Mentor(s): Lina Quesada

REU/Summer Research Program: Kelman Scholars

Sweetpotatoes (*Ipomoea batatas*) are often the chosen health food for many consumers due to their sweet taste and rich source of vitamins. However, sweetpotato production is often susceptible to many soil-borne pathogens. Chemical management restrictions make it important to look at the root of the problem and consider host resistance as a sustainable management tool. There is limited knowledge on the genetics of sweetpotatoes which makes it difficult for breeders to create more pathogen-resistant sweetpotatoes. Thus our goal is to identify, classify, and compare Nod-like receptor (NLRs) proteins in twenty-six diverse cultivars with different levels of resistance to several important pathogens. NLRs are key components of the plant immune response. We used resistance gene enrichment sequencing (RenSeq) to capture and sequence full NLR genes. Sweetpotato NLR genes were captured and sequenced at a 77% success rate. NLR contig assemblies yielded between 3,048 to 4,554 contigs with coverage averaging around 39.47X. We identified between 2,230 to 3,062 complete NLRs for each cultivar. These analyses revealed variation in overall NLR abundance and frequency of the different types of NLRs in cultivated sweetpotato. NB-ARC domains found were either TNLs or CNLs, with the majority being CNLs. The outcomes of this research aid in developing tools to assist sweetpotato breeding and move away from the short-term solution of using crop protection products to a more long-term solution of breeding pathogen-resistant sweetpotatoes.

Title: Development of screen-printable ferromagnetic inks for material handling

Presenter(s): Andrea Lee

Mentor(s): Amanda Mills

REU/Summer Research Program: TECS

This research explored the optimal magnetic ink composition and its performance on textiles, which can have potential use in manufacturing, security, and product accessibility. The magnetic inks were composed of magnetite and a polymer solution. Three different polymer solutions, Poly(vinyl alcohol) (PAA) powder and two Poly(acrylic acid) (PAA) solutions with different molecular weights, were used to find the ideal stabilizer for the magnetite. The 50 wt% low molecular weight PAA concentration 10 wt% high molecular weight PAA concentration, and 10 wt% PVA concentration were determined to be the optimal concentrations based on the viscosity for screen-printing. Then magnetic inks were prepared with different loading of magnetite from 5% to 20%. The magnetic inks were dispersed onto Evolon® nonwoven fabric (30 wt% of polyamide and 70 wt% polyester) samples through screenprinting. Various levels of magnetic attraction were found by using a magnet, where the sample with the highest loading weight was the ink composed of a PVA solution and 20% magnetite loading. This can potentially be used in automated textile manufacturing where robots equipped with electromagnets can be potentially used to pick up textiles without permanently deforming them. Further research can further expand the possible application of magnetic inks for security and authentication purposes. Magnetic inks can potentially be used to print unique magnetic patterns and barcodes that would be challenging to recreate, which makes it optimal for security keys and barcodes.

Title: Eliminating PFAS from Firefighters Skin before Bloodstream Exposure

Presenter(s): Drew Lingerfelt

Mentor(s): Amanda Mills

REU/Summer Research Program: TECS

Firefighter turnout gear is essential for reducing exposure to hazardous chemicals during training or a fire event. Per-and polyfluoroalkyl substances (PFAS) are exposed to firefighters during training or a fire event caused by fluoride within their suits. Exposure of PFAS can cause health problems like cancer, liver damage, decreased fertility, and increased risk of asthma and thyroid disease. Ways that per-and polyfluoroalkyl are exposed to firefighters are either through breathing, ingesting, or through the bloodstream. Many studies suggest that the exposure of PFAS is exposed through the bloodstream. In order for this to happen PFAS is going from the suit through the skin and entering the bloodstream. One way to help eliminate PFAS is wiping the chemical off the skin before it enters through the bloodstream. There are many wipes on the textile market that are used for this purpose. In order to find if these wipes are effective, we conducted a wipe test testing of all six wipes that were recently used by firefighters. During this test we will imitate human skin with synthetic skin as well as pig skin. We will expose the skins with different pHs chemicals and PFAS. We will test the wipes using different whipping techniques. This test will allow us to find how much PFAS is being cleaned off the skin and how much is still left on the skin before the chemical enters the bloodstream.

ABSTRACTS | SESSION 7

Title: Metal-complexable monoazo dyes containing sulfonamide auxochromes: synthesis, analysis, and application

Presenter(s): Sydney Lucas, Olivia Hartung

Mentor(s): Tova Williams

REU/Summer Research Program: TECS

Colorants are widely used to impart color on a variety of everyday products including cosmetics, textiles, paints, foods, and plastics. However, application of some synthetic dyes on human hair involves the use of potent skin sensitizers/allergens like p-phenylenediamine (PPD) and p-toluenediamine (PTD). These ingredients are often found in the many commercial permanent hair dyes that are consumed by billions of individuals. As a result, we were keen to continue exploring metal complexable monoazo dyes containing sulfonamide (-SO2NH2) auxochromes as potential permanent hair dye alternatives, specifically those based on monoarylide, arylazopyrazolone, and arylazonaphthol dye chemistries. These dyes have shown promise as potential alternatives. As an example, they exhibit a lower environmental hazard than PPD, PTD, and other largely consumed ingredients found in permanent hair dyes. We hypothesize that they will continue to show promise with additional testing. In our study, four dyes belonging to these dye chemistries were synthesized, and their structure, purity, and color were analyzed. In addition, the dyes were applied under mild conditions (e.g., a mild temperature of 40oC) with and without environmentally benign metal ions (e.g., Al3+) to different substrates including human hair fibers to assess their uptake. Lastly, the photostability of the dyes in human hair was evaluated. Our presentation will focus on key findings including color effects observed when complexing the dyes with different metal ions and exposing them to UV-light.

Title: In vitro Generation of WT and Mutant T7 Phage for Viral Phenotype Comparisons

Presenter(s): Nicolas Mastrovito

Mentor(s): Jacob Dums

REU/Summer Research Program: BIT SURE

Bacteriophage T7 is a virus that lytically infects the bacterium E. coli and carries a Family A DNA polymerase enzyme (PolA) to facilitate genome replication. Previous biochemical studies show that the activity of PolA varies significantly based on the identity of the amino acid present at its position corresponding to position 762 of E. coli PolA. Depending on whether the amino acid at this position is a tyrosine, leucine, or phenylalanine, PolA can have increased or decreased activity, efficiency, or accuracy. The long-term objective of this study is to characterize the differences in the T7 infection phenotype when the native 762 tyrosine residue is replaced with leucine or phenylalanine. This will be accomplished by synthetically assembling the full-length T7 genome before viral generation using in vitro transcription-translation (TXTL). PCR was used to amplify overlapping fragments of the T7 genome to be assembled into the full-length genome by Gibson Assembly. The resulting synthetic T7 genome was then used as the template for production of T7 virions by TXTL in comparison to production from extracted full-length T7 genomic DNA. Plaque assays were then performed to confirm the ability and efficiency of the synthetic population of T7 to infect E. coli. Future research will perform the same synthetic T7 production and testing of mutants containing leucine or phenylalanine instead of tyrosine for phenotype comparisons against the WT. The results from this study could hold significant implications for understanding the importance of phage DNA polymerase diversity.

Title: A De Novo Gene Sequence of a North Carolina Native Plant Species

Presenter(s): Thomas Morgan

Mentor(s): Caroline Sjogren

REU/Summer Research Program: BIT SURE

Intimate knowledge of diverse plant genomes has become a crucial tool in guiding breeding and gene modification efforts in the realm of modern plant breeding and will only become more important as time progresses. Currently only a fraction of all known plant species have genomic data available through repositories. With such a small percentage of plant species sequenced, there are undoubtedly unknown genes and genetic networks which could confer beneficial traits in important crop or horticultural species should they be introduced. Of particular interest are native species related to the main crops in North Carolina, as these species are already adapted to the environment of the state and could harbor especially beneficial traits for North Carolina crop production. As such, I set out to generate a de novo genome sequence of a North Carolina native plant species within either the Asterid or Rosid clades, as many of the most important crop species in the state fall within these groupings. Sequencing was completed using an Oxford Nanopore Technologies MinION Mk1B sequencer, and the quality of the assembly was assessed using QUAST and BUSCO.

ABSTRACTS | SESSION 7

Title: Understanding Structure-Property Relationship between Polymer and Dye

Presenter(s): Emma Myer-Medina

Mentor(s): Januka Budhathoki-Uprety

REU/Summer Research Program:

Dyes are used in nearly all industries including textile, cosmetic, medical, and food industries as valuable biological markers and to bring products to life by giving them unique, memorable colors that appeal to consumers. While these colors are attractive to the consumer, when dyes end up in wastewater, due to inefficient dyeing and finishing operations, they become the source of environmental problems such as interfering with photosynthesis of aquatic plants and causing toxic effects in animals and humans. Acid dyes are anionic dyes which are commonly used in textiles, food and beverages, cosmetics, and cleaning supplies. In textiles, acid dyes are used in dyeing fibers that contain nitrogenous polymers such as wool, silk, and nylon. Under acidic conditions, anionic dyes are attracted to the fibers through electrostatic interaction between negatively charged groups in the dye and partially positive polymer. However, the specific interaction between dyes and polymers could be influenced by molecular characteristics such as topological polar surface area, and steric hindrance (bulkiness) that affect hydrophobic, aromatic and electrostatic interactions. In this project, we synthesized nitrogen-rich synthetic polymers to absorb acid dyes from aqueous solution. Polymers with different pendant groups were tested to determine how steric hindrance on the polymer side chain can affect their absorption of acid dyes. UV-Vis spectrophotometry analysis indicated that the polymer side groups can influence the relationship between the dye and absorbent.

Title: Characterizing Bio-renewable Fibers Spun from Polymers Found in Seaweed

Presenter(s): Jordan Nash

Mentor(s): Ericka Ford

REU/Summer Research Program: TECS

This poster will illustrate the solution spinning process and fiber characterization of sodium alginate fibers. It will also discuss and display the effects of certain additives (without going into detail on what they were) on the process-ability, viscosity, and other potential parameters of the alginate fibers. Additional information will be provided on the sodium alginate polymer and its current uses, how it's bio-renewable, and how the solution spinning process works.

Title: Designing a Pneumatically Actuated Origami Robot

Presenter(s): Jonah Nus

Mentor(s): Xiaomeng Fang

REU/Summer Research Program: OUR Award and TECS

Origami, an art that creates three dimensional structures from two dimensional sheets, has often been used to design a wide range of robots with many applications. Many of the different mechanisms used to move the robot are either bulky, heavy, or slow. By integrating pneumatic artificial muscles (PAM) into the design of an origami robot, a higher rate of actuation is hoped to be achieved. The PAM fibers were developed by the host lab. They are created from a cylindrical elastomeric bladder wrapped in a braided sleeve. When the PAM is actuated, the length of the fiber contracts and expands in the circumference, similar to organic muscles. These fibers were integrated into several different fundamental styles of origami structures, such as the Kresling, Yoshimura, and Waterbomb pattens, as well as a couple more complex patterns, including oriceps and an origami spring. At this moment, only basic testing has occurred, and each of the pattern’s reaction to the PAM actuation has been noted. Several of the patterns, such as the oriceps, spring, and Kresling patterns, have produced forward locomotion or significant structural change when actuated with an artificial muscle. Moving forward, optimization of each folding pattern and improvements to the PAM fibers will be conducted, intending to decrease slippage and increase the severity of motion.

ABSTRACTS | SESSION 7

Title: Assay Development: An ELISA for Fibrinogen

Presenter(s): Taylor Parker

Mentor(s): Sophie Noel

REU/Summer Research Program: BIT SURE

Multiple sclerosis (MS) is an autoinflammatory disease involving nerve degeneration that is typically diagnosed using brain MRI images showing white matter lesions. However, research shows that the breakdown of the blood-brain barrier can be indicative of MS earlier than MRI detection. Fibrinogen is a vertebrate clotting protein that circulates in the blood. Once the immune system starts attacking the neuron-protecting myelin, elevated levels of fibrinogen can be detected. We aim to create an enzyme-linked immunosorbent assay (ELISA) to detect the elevated blood fibrinogen levels that accompany MS onset and progression. Invitrogen has numerous anti-fibrinogen antibodies available, from which we selected a capture antibody (mouse anti-fibrinogen, monoclonal) and a detection antibody (sheep anti-fibrinogen, polyclonal) to utilize with Abcam SimpleStep ELISA® Custom ELISA kits. We performed dot blots to ensure the chosen antibodies could form an ELISA "sandwich". Our next steps are to determine upper and lower limits of quantitation and test fibrinogen levels in simulated samples. Fibrinogen is not considered an official biomarker of MS due to its role in other inflammatory processes, including Rheumatoid arthritis, thrombotic disease, and even Alzheimer's disease. Accessible testing using ELISAs would ensure that patients can get both an earlier look at their susceptibility to inflammatory diseases, as well as continued monitoring for changes in disease progression.

Title: Survey of the occurrence of plant-parasitic nematode population at different soil profile depths in a North Carolina soybean field

Presenter(s): Julia Rose

Mentor(s): Adrienne Gorny

REU/Summer Research Program: Kelman Scholars

Plant parasitic nematodes have a devastating economic impact throughout the world. In North Carolina, the yield and quality of sweet potatoes, soybean, tobacco, and cotton are greatly impacted by several nematode genera, including root-knot nematodes. Yet knowledge of how deep nematodes can live and where are the greatest density of plant parasitic nematodes found in the soil profile is lacking. To explore the answer to this question, soil samples (n = 8) were collected from a field at three different depths: 0-6, 6-12, 12-18 inches. Live nematodes were isolated from the soil using a modified Whitehead tray extraction technique. Vermiform nematodes were identified under an inverted microscope based on morphological characteristics: cuticle annulations, esophageal overlap, movement, size, and stylet and tail shape. Nematodes were categorized in the following groupings: soybean cyst, free-living, lesion, root-knot, other, spiral, stubby root, stunt, and unknown – Plant Parasitic. Using ANOVA and a mean separation test, data were evaluated. It is hypothesized that fewer nematodes are found in deeper soil (12-18 inches), yet that a high proportion of the population will be found at a depth of 6-12 inches. Outcomes of this work will inform management tactics, such as nematicides and fumigants applications. If there is equal distribution of nematodes in the soil, management tactics that can target nematodes deeper in the soil might be preferred. Data were also be used to visualize the nematode 'hotspots' in the field.

Title: Tensile Testing of Resin Additive Materials

Presenter(s): Nikhil Roy

Mentor(s): Javon Adams

REU/Summer Research Program: WMSRP

The field of additive manufacturing has blossomed over the last few decades. Methods of printing different materials are constantly being improved on for use in the home, education, and industry. At the Center of Additive Manufacturing and Logistics (CAMAL) there are an array of materials ranging from different plastics to resins that the lab uses on its 3D printers. The goal of this research is to create a practical database of additive material properties for the lab by printing tensile bars on all the printers and testing the tensile bars for ultimate tensile strength (UTS). The database would aid in properly evaluating the best material for the item being manufactured. This is a continuation of previous summer research, the focus being on the different types of resins used for Formlabs printers. There are five different resin materials being printed in three different orientations on the build plate. Some materials such as Flexible 80A have higher ductile but have a lower UTS. On the other hand, materials such as Rigid 10k are extremely brittle and have a high UTS value.

ABSTRACTS | SESSION 7

Title: Genetic Engineering of the Giant Algae Virus Host Chlorella variabilis

Presenter(s): Gabrielle Schuh

Mentor(s): Jacob Dums

REU/Summer Research Program: BIT SURE

Chlorella variabilis NC64A is a unicellular, nonmotile green algae that may have acquired components of its genome from horizontal gene transfer from viruses. Chloroviruses are giant, double stranded DNA, plaque-forming viruses that infect and use Chlorella as a host for replication. Significant effort and progress has been made to isolate chloroviruses and characterize their interactions with Chlorella. However, an efficient and stable genetic engineering system for Chlorella is missing from the toolkit for studying virus algae interactions. Recent work has shown that Agrobacterium, bacteria containing tumor-inducing T-DNA commonly used to engineer multicellular plants, can genetically engineer Chlorella, although the engineered lines were plagued by transgene silencing. To refine this transformation system, four endogenous Chlorella promoters were selected based on high and stable gene expression in transcriptome datasets. Putative promoters were PCR amplified from the Chlorella genome and inserted into a pCambia1302 backbone by Gibson Assembly. The endogenous promoters will drive expression of Enhanced Green Fluorescent Protein (EGFP) and will be compared against the 35S promoter in the native pCambia1302 vector. Future optimization would include comparing additional Chlorella promoters or Agrobacterium strains for efficiency, as well as exploring inducible promoters and chlorovirus promoters. Applications of genetic engineering of algae allow exploration of the Chlorella genome to better study the molecular processes and overall biology of green algae and their viruses.

Title: Evaluation of Efficacy of Fungicides on Sweetpotatoes for control of Ceratocystis fimbriata

Presenter(s): Elena Shipp

Mentor(s): Lina Quesada

REU/Summer Research Program: Kelman Scholars Program

Ceratocystis fimbriata, causal agent of black rot, is known to be one of the most destructive pathogens of sweetpotato. Disease symptoms are typically observed postharvest as circular dark lesions on the surface of the sweetpotato, sometimes with black centers that harbor pathogenic reproductive structures. Even though the disease is observed postharvest, infections occur in the field. The pathogen may enter a field on infected seed, be present in the soil, volunteer plants, or weeds closely-related to sweetpotato such as morning glories. Because infections begin in the field, management strategies should also be implemented in the field to prevent postharvest losses. A greenhouse study was conducted using three fungicides as well as an uninoculated and inoculated control to determine the efficacy of managing C. fimbriata in the field. The fungicides evaluated were Inspire, Mertect, and Quadris. Sweetpotato seed roots were inoculated using a liquid black rot inoculum. The plants were rated once weekly for 13 weeks for signs of symptoms. Slips generated from seed roots were then harvested and evaluated using PCR to check for the presence of C. fimbriata after growth and treatment. The findings of this study will aid in identifying the most useful fungicides for the management of Ceratocystis fimbriata during sweetpotato slip propagation to prevent pathogen spread and postharvest losses.

Title: Environmental DNA metabarcoding techniques reveal prokaryotic and metazoan community profiles of two freshwater sites at NC State

Presenter(s): Elise Van Zele, Danielle Smith

Mentor(s): Andrew Hasley

REU/Summer Research Program: BIT SURE

Environmental DNA (eDNA) is DNA found within cells or found unprotected in ecosystems. eDNA is used to determine ecological diversity and community composition based on air, soil, or water samples from an environment. Studies have highlighted the importance of characterizing ecological communities to protect environments against invasive species (Dejean et al., 2012) and monitor ecosystems threatened by climate change (Dugal et al., 2021). We show how eDNA collection and analysis can be used to characterize prokaryotic and metazoan communities at two freshwater environments on NC State's campus. Both sites are along the Rocky Branch Trail; one site characterized by running water near a bridge and one site characterized by stagnant pond water. We show that use of larger pre-filters and 0.22 μM filters successfully collects eDNA at these sites. We targeted the 16S and CO1 genomic regions using a DNA metabarcoding approach. Sequencing 16S and CO1 regions allowed us to characterize bacterial and metazoan communities. Metabarcoding techniques make comparisons between the sequence data and known sequences from existing reference databases.

ABSTRACTS | SESSION 7

We compared our 16S results from this summer with spring 16S results to see how seasonal factors might affect these site communities. CO1 data adds metazoan information to our understanding of these communities. Results of this study reveal community composition at the two sites with multiple seasons of data. This will contribute to knowledge about bacterial and metazoan freshwater communities and could inform conservation efforts.

Title: Development of fabric robots using ultrafine fiber shaped pneumatic artificial muscles

Presenter(s): Haley Walker

Mentor(s): Xiaomeng Fang

REU/Summer Research Program: OUR Award

Pneumatic artificial muscles (PAM) are high-efficiency, safe-operation, and quick-response devices that have become prevalent in our daily lives. The McKibben robot (MR) is a cylindrical PAM, which consists of a cylindrical elastomeric bladder wrapped by a braided sleeve. Ultrathin fiber shaped MR can be integrated into textile structures, e.g., woven fabrics. In this project, we developed a very thin and flexible fiber-shaped MR with an outside diameter of around 1 mm. Using them and normal textile yarns, we fabricated a wide range of fabric robots that can generate bending motions and will be suitable for wearable assistive devices. By controlling the weave pattern and air pressure applied, a wide range of motions generated by the fabric robots can be achieved. Integrating these textiles into wearable apparel will open the door for many new applications in the healthcare industry.

Title: Genomic Diversity of Bacteriophages Lytic on Xanthomonas spp. Pathogenic on Pepper

Presenter(s): Heidi Wettig

Mentor(s): Katherine D'Amico-Willman

REU/Summer Research Program: Kelman Scholars Program

Bacteriophage (phage) meaning "bacteria eater," are viruses that have a predatory relationship with bacteria. Four species in the genus *Xanthomonas* are pathogenic on pepper plants and can cause bacterial spot disease. On a pepper leaf, *Xanthomonas* infection is characterized by water soaking, followed by chlorotic spots that culminate in brown spots that can be located along the leaf's veins or at the leaf edge. Bacterial spot is most likely to occur in times of continuous, heavy rainfall, and high temperatures, which are favorable to pathogen multiplication and dissemination. The ability of phage to lyse bacteria suggest that they can be used to manage populations of *Xanthomonas* on pepper. To test this hypothesis, we isolated phage from pepper leaves that were collected in the summer of 2020 and 2021. We isolated a total of four phage from leaves collected from various pepper varieties in 2020 and 2021. Using overlay inhibition studies, two purified phage were screened on thirty-five different *Xanthomonas* strains that were originally isolated from pepper leaves to test each phage host range. Both phage tested were able to lyse the same or very similar strains of *Xanthomonas.* Overall it was difficult to isolate phage from pepper leaves collected in 2020 compared to more recently collected leaf samples from 2021, however, two potential filamentous phage have been isolated that require additional characterization. Additional phage and *Xanthomonas* genomes will be sequenced and phenotyped which will enable the identification of mechanisms involved in *Xanthomonas*-phage-pepper interactions.Keywords: bacteriophage, *Xanthomonas*, pepper, pathogenic

Title: Differential expression of two effector-encoding genes in Clade 1 and Clade 2 of the cucurbit downy mildew pathogen Pseudoperonospora cubensis

Presenter(s): Emma Wilds

Mentor(s): Lina Quesada

REU/Summer Research Program: Kelman Scholars Program

Cucurbit downy mildew, caused by the obligate oomycete pathogen Pseudoperonospora cubensis, is one of the most devastating diseases of cucurbits. Population studies have revealed the presence of two host adapted clades of P. cubensis, Clade 1 and Clade 2. Prior to an epidemic in 2004, downy mildew in cucumbers was managed in the U.S. for 50 years by host resistance. Preliminary studies have indicated that Clade 2 was introduced to the United States in 2004 and likely caused the epidemic. Plant pathogens secrete proteins called effectors into the host cell and change the host cell processes to further spread infection. Previous studies in the lab have identified two paralogs of an effector-encoding gene: PcuREC221-A and PcuREC221-B. To analyze the expression patterns of the two paralogs in Clade 1 and Clade 2, cucumber leaves were infected with SC1982 and MSU1, representative Clade 1 and Clade 2

isolates, respectively and samples were collected at 1, 2, 3, 4, and 7 days post infection (DPI). RNA was isolated, complementary DNA was generated, and an RT-qPCR expression analysis was performed. PcuREC221-A showed elevated expression in MSU1 as compared to SC1982, with the highest expression occurring 1 DPI. On the other hand, PcuREC221-B was expressed exclusively in MSU1, with peak expression at 3 DPI. Expression levels indicate that PcuREC221-A and PcuREC221-B are important for the infection of MSU1 on cucumbers and that these genes can be potentially used to identify new sources of resistance to cucumber downy mildew.

Title: Fabrication of Stretchable Knit Antenna

Presenter(s): Niamh Williams

Mentor(s): Amanda Mills

REU/Summer Research Program: TECS

A textile antenna has been fabricated on a knit textile substrate using screen printing technology. Textile antennas are used in wearable healthcare applications and are advantageous due to their flexibility, breathability, and conformability. However, the conductive property of the antenna suffers when the fabric of the antenna is deformed. In this study, we would like to see how the mechanical properties are going to affect the antenna properties. The mechanical properties being measured will also be simulated on the CLO program and will be compared to the tested results. In order to test these properties and get measurements for the simulations, four layer and six layer samples of the textile antennas were made. The multilayer structure was fabricated to see how additional layers of fabric would help the durability of the antenna and how thickness affects the properties of the antenna. The textile antenna was fabricated using a knit textile substrate. The samples were tested to determine how the mechanical properties of the fabric affect the antenna properties. The mechanical testing was done on the four and six layer samples to get stress and strain data and different fabric directions were tested to see how direction affects the mechanical properties. Dielectric testing was done on the fabric before and during stretching to see how stretch would affect the dielectric properties of the antenna. The results of this study will impact how textile antenna are used as there will be a way to predict the mechanical properties and antenna performance.

Title: Guiding cardiac differentiation via decellularized ECM electrospun scaffolds

Presenter(s): Jocelyn Zhu

Mentor(s): Jessica Gluck

REU/Summer Research Program: TECS

The microenvironment within the heart provides structure and support, enabling the heart to function properly. Cardiac cell therapy is promising for improving heart function especially for the chronically failing myocardium. However, some of the mechanisms through which the microenvironment influences are still unknown, including both the microenvironment influences the developing heart and its subsequent function. The main objective is to develop an electrospun nanofibrous scaffold, which is derived from the native extracellular matrix（ECM) proteins found in the heart. ECM is a complex network of structural and regulatory proteins, secreted from the tissue's resident cells, responsible for regulating many cellular functions, and playing a major role in tissue homeostasis. In this project, our objective is to recapitulate the cardiac microenvironment by using the native tissue. This scaffold will be used for guiding the differentiation of human induced pluripotent stem cells (hiPSCs), and our aims are to fabricate and characterize a nanofibrous scaffold from decellularized cardiac tissue, and to characterize guided cardiovascular differentiation of hiPSCs. Optimization of the electrospinning process includes analysis of the following parameters: material selection, humidity, temperature, needle gauge, distance between the needle and collector, flow rate and applied electrical field. Conclusively, the purpose of this proof-of-concept project is to demonstrate the ability to fabricate the microenvironment of the heart and develop the electrospun nanofibrous scaffold, and focused on understanding the contribution of the microenvironment to terminal differentiation and elucidating the mechanisms.

ABSTRACTS | SESSION 7

Title: Diversity of Fusarium sp. In Pennsylvania Wheat Fields

Presenter(s): Kieryn Zizzo

Mentor(s): Christina Cowger

REU/Summer Research Program: Kelman Scholars Program

Fusarium head blight (FHB) is a disease in small grain cereals worldwide that is primarily caused by members of the Fusarium genus. Fusarium infects wheat spikes, causing shriveled kernels and contaminating the grain with mycotoxins. Overall, F. graminearum is the most commonly occurring FHB-causing Fusarium species, and produces the mycotoxin deoxynivalenol or DON, which is toxic to humans and animals. DON is the mycotoxin that is most tested for in wheat and barley. However, emerging mycotoxins such as moniliformin—a toxic animal feed contaminant—are produced by other FHB-causing Fusarium species that were recently identified as important or even a majority in some North Carolina wheat fields. *Purpose.* This project aimed to identify which species of Fusarium were present in wheat spikes from Pennsylvania fields and how prevalent each species is. We investigated whether FHB-causing species other than F. graminearum were present at sufficient frequencies that mycotoxins besides deoxynivalenol should be tested for in wheat crops in Pennsylvania. The secondary goal of this project is to determine how often the wheat spikes were naturally co-infected by multiple Fusarium species.