VIRGINIA TECH'S OFFICE of

UNDERGRADUATE RESEARCH SUMMER SYMPOSIUM

July 28, 2022 | 9am-4pm

ABSTRACTS

www.research.undergraduate.vt.edu

Contents

Jill C. Sible, Ph.D.
Associate Vice Provost for
Undergraduate Education,
Professor of Biological Sciences

Welcome

Welcome all to the 2022 Summer Undergraduate Research Conference at Virginia Tech. It is wonderful to return to an in-person event this year.

The students presenting today have spent weeks to months immersed in a research project. Summer affords undergraduates the opportunities to dedicate significant time and effort to the planning, execution and analysis of a research project. They have also had the chance to become authentic members of research teams by working with faculty, graduate students, postdoctoral fellows and research staff. Many thanks to all who have mentored undergraduates this summer. Your commitment to undergraduate research provides the hands-on, minds-on learning that we aspire to providing all students who spend time at Virginia Tech.

Virginia Tech is pleased to offer these summer experiences not only to our own students, but also to undergraduates from all over the country. We hope that you have enjoyed your time working with Virginia Tech research teams, and we appreciate the diversity of ideas and cultures that you have brought to our research programs. Congratulations to all our presenters!

A very special thank you to Keri Swaby, Nicole Bottass, Shu Pan, Sophie DeSimone and our peer mentors for their tremendous work in making this summer symposium happen.

I am looking forward to my time learning from our summer research students!

My best,
Jill C. Sible, Ph.D.
Associate Vice Provost for Undergraduate Education

Office of Undergraduate Research

Keri Swaby
Director, Office of Undergraduate Research

Welcome to the 11th annual Summer Research Conference at Virginia Tech! After moving our symposium online for the past two summers, we were sooo excited to be back in person this year.

Today we welcome 240 presenters from 24 organized funded programs and many independent labs, who will give a record breaking 206 poster presentations. Over the course of the past 10 weeks, these undergraduate students from Virginia Tech and across the country have been engaged in a wide variety of projects tackling real world problems in many disciplines. I am humbled by the quality of work on show today and invite you to enjoy and marvel at the wealth of research that took place this summer.

Throughout the summer, we offered comprehensive professional development programming that would not have been possible without the expertise and time of many folks. I would like to thank: Dr. Nikki Lewis (Honors College), Dr. Donald Conner (VT Environmental Health and Safety), and Kory Trott (Research Integrity), Regina Allen, Stephanie trout, and Lacey Mize (Virginia Tech Training and Compliance) for setting the stage and providing students with critical information during our summer orientation session; Amanda MacDonald (University Libraries) for providing students with valuable training through the online Advanced Research Skills Program as well as a seminar on proposals, title and creating an effective poster; and a number of faculty and students who offered a variety of seminars and workshops throughout the summer including Dr. Shernita Lee (VT Graduate School), Kory Trott (Research Integrity); Daniel Bird Tobin (Ctr for Comm Sci), Kelsey Reed (PhD candidate in Translational Plant Sciences), Alyssa Rametta (Career and Professional Development), Dr. Paul Heilker (Honors College), and Monica Hunter (MAOP) who moderated a graduate school panel. Thank you all for sharing your expertise and insights with our summer students.

This summer was not only about research and professional growth, but also about having fun! A special thank you to our energetic peer mentors – Hana, Hannah Jane, and Seth - who offered activities throughout the summer and were instrumental in building a vibrant research community. Without these dedicated mentors, this summer would not have been as fun and engaging for everyone.

An especially big thank you to Nicole Bottass, Shu Pan, and Sophie DeSimone, who were instrumental in supporting all OUR activities throughout the summer!

We would not have been able to offer programming and events throughout the summer, including today's symposium, without the generous financial support of the Fralin Life Sciences Institute, the Institute for Critical Technology and Applied Science, and Drs. David Schmale and Shane Ross who wrote the Office into their REU grant. Thank you!

Researchers, congratulate yourselves on a productive summer! I hope you have been inspired to continue exploring and growing. Good luck next year!

Sincerely,
Keri Swaby
Director, Office of Undergraduate Research

Dr. Dennis Dean

University Distinguished Professor
Fralin Hall Principle Scientist

Dennis R. Dean is a professor of Biochemistry in the College of Agricultural and Life Sciences and has been a member of the Virginia Tech faculty for 38 years. He attended Wabash College (B.A. 1973) and is a Purdue University College of Science Distinguished alumnus (Ph.D. 1979). He was an NIH Post-Doctoral Fellow at the University of Wisconsin and a Staff Scientist at the Kettering Research Laboratory before joining the Virginia Tech faculty in 1985. He was the founding director of the Fralin Life Sciences Institute and holds the title of University Distinguished Professor. He served as the term director for both the Virginia Tech Carilion Research Institute, recently renamed the Fralin Biomedical Research Institute, the Virginia Bioinformatics Institute and as the Virginia Tech Vice President for Research and Innovation. He has served on the editorial board of the Journal of Biological Chemistry, the publications board of the American Society for Biochemistry and Molecular Biology and the editorial board of the Journal of Bacteriology and is currently a member of the ethics committee for the American Society for Microbiology. He is a fellow of the American Academy of Microbiology, the American Academy for the Advancement of Science, the American Society for Biochemistry & Molecular Biology and the Virginia Academy of Science, Engineering & Medicine. Dr. Dean's research interests involve the role of metals in health and disease and his laboratory group has published over 200 articles on that topic.

SUMMER RESEARCH PROGRAMS AT VT
PROGRAM DIRECTORS

BECKMAN SCHOLARS AT VIRGINIA TECH
Amanda Morris (Director)
The Beckman Scholars Program, supported by the Arnold and Mabel Beckman Foundation, is a 15-month mentored research experience for exceptionally talented, full-time undergraduate students in chemistry, biological sciences, or biochemistry at Virginia Tech. In 2021, Virginia Tech was selected as one of 12 institutions nationwide to host a Beckman Scholars Program. The program leveraged the funding provided by the Beckman Foundation to form a partnership with the Fralin Life Sciences Institute to provide a fully-funded research experience like no other on the Virginia Tech campus. Through unique programming in communication, leadership, grantsmanship, and diversity and inclusion awareness, our goal is to create the next generation of scientific leaders.
Applicants select from 12 principal investigators from across multiple degree programs. The program provides a generous stipend and research support. More information can be found here - https://www.research.undergraduate.vt.edu/ugr-opportunities/vt-programs/beckman-scholars.html.

DATA SCIENCE FOR THE PUBLIC GOOD REU PROGRAM
Research and Extension Experiential Learning Program
Susan Chen, Ph.D. (Director)
Data Science for the Public Good brings teams of undergraduate and graduate students together to collaborate with faculty to address current local and national social issues. During the summer at Virginia Tech, the teams conduct research at the intersection of statistics, computation, and social sciences to determine how to leverage information to improve quality of life and inform public policy. Our team-based experiential learning approach develops the problem-solving, leadership, and technical skills necessary for a new generation of leaders in food, agriculture, and community development. The project-focused program exposes students to how data science tools are applied to meaningful research problems confronting agriculture and rural communities, and how to interact and present their reports to Virginia Cooperative Extension and external stakeholders.

FBRI- MOLECULAR VISUALIZATION SURF
Director: Dr. Jamie Smyth (FBRI + VT Biological Sciences)
Coordinator: Dr. Alexandria Pilot-Chambers (FBRI)
The FBRI Molecular Visualization SURF program gives students the opportunity to participate in hypothesis-driven independent research at Fralin Biomedical Research Institute at VTC in Roanoke, Virginia. In addition to completing a ten-week research project within a laboratory at FBRI, students will participate in a weekly workshop series to provide hands-on experience in the cutting-edge imaging technologies housed within FBRI to understand appropriate application of each technology in understanding biological processes. From functional magnetic resonance imaging of their own brains to single-molecule imaging techniques, we provide a multi-disciplinary experience for students to understand appropriate implementation of imaging techniques in answering critical biological questions.

FBRI NEUROSURF

Dr. Michael Fox (FBRI + VT Biological Sciences)

Dr. Alexandria Pilot (Fralin Biomedical Research Institute at VTC)

The FBRI neuroSURF program is a 10-week long program that gives VT and non-VT undergraduate students the opportunity to participate in independent translational neurobiology research at Fralin Biomedical Research Institute at VTC in Roanoke, VA. This year, program participants also included three high school students from Roanoke Valley Governor's School, Cave Spring High School, and Patrick Henry High School. In addition to independent research, the program includes coursework in translational neurobiology, seminars from VT and Carilion faculty whose research focuses on translational neurobiology, and professional development activities. The 2022 FBRI neuroSURF fellows came from Virginia Tech, Spelman College, University of Maryland - Baltimore County, Juniata College, College of William and Mary, Mary Baldwin University, Smith College, Roanoke College, and Virginia State University. The neuroSURF program is funded by the National Institutes of Health.

FRALIN SUMMER UNDERGRADUATE RESEARCH FELLOWSHIP (SURF)

Keri Swaby (Office of Undergraduate Research)

The Fralin SURF program is a 10-week training program designed to give motivated Virginia Tech undergraduates the opportunity to engage in full time research in the life sciences and related professional development activities that mirror graduate training. The goal is to offer students experiences that will help them determine if they want to pursue a career in research while they develop skills for graduate school. For over ten years, 15 to 30 exceptional students from a variety of majors have been selected each year to participate in this competitive program. This program is funded by the Fralin Life Sciences Institute.

GLYCOMIP SUMMER UNDERGRADUATE RESEARCH

Dr. Richard Helm (Department of Biochemistry and GlycoMIP Director of User Facility)

Linda Caudill (GlycoMIP Managing Director)

The National Science Foundation, NSF, funded molecular foundry entitled GlycoMIP (glycomip.org) is pleased to participate in the Fralin Life Sciences Institute Summer Undergraduate Research Fellowship Program, SURF, a 10-week training program that combines research experiences with related professional development activities. GlycoMIP researchers engage in a broad range of research activities related to carbohydrates, with emphasis on their material properties. Such work includes molecular modeling, oligosaccharide synthesis, and characterization of glycomaterials by techniques such as liquid chromatography, mass spectrometry, rheometry, and spectroscopy. One of only four NSF Materials Innovation Platforms (MIPs) in the country, the facility serves as a national resource for glycomaterial research, development, and training. GlycoMIP SURF students work directly with faculty, post-docs and graduate students in the GlycoMIP user facility, gaining hands-on experience with a wide array of techniques and instrumentation. Their work contributes directly to active research projects within the facility.

GLOBAL CHANGE CENTER UNDERGRADUATE RESEARCH PROGRAMS
Bill Hopkins (Director)
Jessica Zielske (Program Coordinator)

The Global Change Center (GCC) transforms careers by providing unique opportunities for undergraduate students to gain hands-on experiential learning by way of research grants, mentorship opportunities and science-policy fellowships. Students from two GCC undergraduate programs participate in the Virginia Tech research symposia:

Undergraduate Research Grants

The Global Change Center at Virginia Tech sponsors undergraduate students and their research projects that align with our mission for advancing collaborative, interdisciplinary approaches to address critical global changes impacting the environment and society. Projects that address basic and/or applied aspects of global change science, engineering, social science and the humanities are eligible for this funding opportunity, and proposals must include strong endorsement by a GCC-affiliated faculty member.

Hollins Undergraduate Research

The Hollins partnership provides summer research experiences at Virginia Tech for select Hollins undergraduate students, with the explicit goal of identifying possible mentor-mentee connections and relationships for their future graduate training. Hollins undergraduate students spend the summer on the Virginia Tech campus working with one or more GCC faculty mentors. Students are fully embedded in the broader undergraduate research community and participate in the Fralin Summer Undergraduate Research Fellowship program.

INCLUSIVE EXCELLENCE SUMMER RESEARCH FELLOWS
Deborah Good (Director)

The IE Summer Research Fellows is supported by The Virginia Tech Chapter of Sigma Xi, the Scientific Research Society, the Virginia Tech Office of Research, the Waste Policy Institute, and the Inclusive Excellence Grant from Howard Hughes Medical Institute.

During the intensive four-week summer program, IE Fellows attend weekly in-person group meetings and complete one pre-survey, one post-survey, and one focus group with the data from these used to assess the utility of the four-week rather than 10-week programs.

Research projects in the IE Fellows program have a broad environmental focus, with a broad, but justifiable application to the area of social, structural (built), behavioral, organismal, cellular, or molecular environmental systems. Based on successful completion of the program, IE Fellows will be inducted into Sigma Xi, The Scientific Research Honor Society in Fall 2022, and provided with one year of membership in the society.

MULTICULTURAL ACADEMIC OPPORTUNITIES PROGRAM (MAOP)
Monica Hunter (Director)

The MAOP Undergraduate Summer Research Internship (SRI) started in Summer 1993, and since then has been a transformative experience for hundreds of students. The purpose of the program is to provide undergraduates from diverse backgrounds an opportunity to conduct research on campus and to educate participants about graduate education. Students from a wide variety of academic disciplines spend ten weeks during the summer (late May - late July/early August) working closely with a faculty mentor in a mentor/mentee relationship to design, conduct and present a scholarly research presentation.

Since many SRI participants eventually enroll in graduate school at Virginia Tech or elsewhere, this program has been an especially effective way to invest in and prepare a talented, diverse

group of students for enrollment in graduate programs. Previous participants have been very successful in obtaining graduate degrees and in adding to the diversity of their institutions and within their professional fields.

CENTER FOR NEUTRINO PHYSICS REU

Professor Camillo Mariani (Director)
Betty Wilkins (Coordinator)

Our physics faculty is engaged in a broad spectrum of research within neutrino physics, including electron/neutrino scattering experiments, the search for sterile neutrinos, phenomenology studies, long baseline optimization for DUNE and the study of neutrino spectrum from nuclear reactors and supernovae neutrino experiments and theory. In this rich intellectual environment, the REU students will have the opportunity to pursue independent and productive activities, guided by an established team of faculty members together with assistant professors and postdocs.

SOLVING PROBLEMS WITH DATA SCIENCE

David Schmale (Director)
Shane Ross (Director)
Landon Bilyeu (Director)

This paid summer REU program is for undergraduates interested in solving problems with data at the interface of biology and engineering. Students will collect data and learn to make decisions from these data. Research projects will use sensor-based assets and/or computational-based assets at Virginia Tech. Students will learn to communicate effectively with fellow students, policymakers, and the public. Students will be fully integrated into participating research groups and will experience hands on research, group meetings, and close collaboration with other members of related research groups.

SUMMER UNDERGRADUATE FELLOWSHIP IN NEUROSCIENCE (SURF-N)

Sarah Clinton (Associate Director, VT School of Neuroscience)
Michael Fox (Director, VT School of Neuroscience)

The VT School of Neuroscience offers a vibrant research environment with faculty covering essentially every area of contemporary neuroscience. Our faculty's expertise spans a variety experimental approaches, ranging from molecular and cellular neuroscience, neurochemistry, pharmacology, behavioral neuroscience, and brain imaging. The competitive summer fellowship program provides VT undergraduate students with 10-week full-time research experience in a neuroscience laboratory, which allows them to contribute to research projects under the direction and leadership of a faculty mentor and gain valuable experience in data presentation at the end of the summer.

SURF-TSPC

Guillaume Pilot (Director)
The Translational Plant Science Center (TPSC) is composed by a group of faculty sharing a common interest in understanding fundamental aspects of plant biology and applying these discoveries to crops, to make agriculture more resilient, productive and efficient. Students in the SURF-TPSC program are conducting research in laboratories affiliated to the Center, dealing with plant research. The fellows are participating to the training activities of the SURF program offered by the Fralin Life Science Institute.

TRANSLATIONAL OBESITY UNDERGRADUATE RESEARCH SCHOLARS (TOUR)

Deborah Good (Department of Human Nutrition, Foods, and Exercise)
Dr. Samantha Harden (Department of Human Nutrition, Foods, and Exercise)
The Translational Obesity Undergraduate Research Scholars (TOUR-Scholars) is an NIH Funded research-intensive summer experience, which prepares students for graduate and medical education in translation obesity research.
Ten undergraduate students representing Virginia Tech and UVA were chosen to participate in the 2022 summer program and are working with 10 different mentors at Virginia Tech, FBRI, and VTCRI. In addition to research, students participated in professional development around inclusivity, communication, and career training, including trips to TechLabs, and NIH as well as VTCSOM and VTCRI in Roanoke.

VIRGINIA TECH RESEARCH AND EXTENSION EXPERIENTIAL LEARNING PROGRAM: SECURING OUR FOOD (VT-REEL)

Drs. Sasha Marine (Biochemistry) and Hunter Frame (SPES)
Virginia Tech's Research and Extension Experiential Learning (VT-REEL) program on Securing Our Food is a research-intensive 10-week summer experience, which engages undergraduate students in translational plant science research via a combination of hands-on laboratory and field-based experiences. VT-REEL fellows spend the first half of the program on-campus, working in molecular labs, and spend the second half of the program at an Agricultural Research and Extension Center (AREC), working in applied labs. Eight undergraduate students from diverse academic institutions across the United States were chosen to participate in the 2022 summer program. Faculty mentors were affiliated with the School of Plant and Environmental Sciences, Department of Biological Sciences, Department of Entomology, or Department of Biological Systems Engineering. Funding was obtained through the USDA-NIFA. The VT-REEL program on Securing Our Food will continue through 2025.

INFORMATIONAL BOOTHS

We invite you to talk with representatives from several graduate programs, from across Virginia Tech's Blacksburg, Roanoke, and National Capital region campuses.

MOLECULAR AND CELLULAR BIOLOGY GRADUATE PROGRAM

OFFICE OF SCHOLARLY INTEGRITY AND RESEARCH COMPLIANCE

TRANSLATIONAL BIOLOGY, MEDICINE AND HEALTH

VIRGINIA TECH GRADUATE SCHOOL

9:00-9:30am	**Check-in (Goodwin Atrium)** **Poster Session 1 set up**
9:30-9:40am	**Welcome- Keri Swaby (Goodwin Auditorium)**
9:40-9:55am	**Keynote Address- Dr. Dennis Dean (Goodwin Auditorium)**
9:55-10:00	**Break**

10:00-10:50 Poster Session 1 (Goodwin Atrium)

Presenter last name	Program Affiliation	Presentation Title	Poster #
Alsaihati	KAUST REU	Engineered Living Materials for Detection and Mitigation of Bacterial Infection	1
Amin	MAOP Summer Research Internship	Hydrocarbon Group Analysis of Petroleum Fuel Samples from Vehicle Testing	2
Ampt	MAOP Summer Research Internship	Effects of plant chemical diversity on pathogen evolution	3
Bechtold, Gardner & Duega	MAOP Summer Research Internship	The Development of Personalized Biomedical Prosthetics: 3-D Scanning and Modeling	4
Beltz	MAOP Summer Research Internship	The germ-free piglet: a new avenue to understanding the gut-brain-axis with translational outcomes	5
Carrington Jr.	MAOP Summer Research Internship	Real-Time Data Acquisition and Visualization of 3-D Printers	6
Coan	MAOP Summer Research Internship	Investigating the Eastern Distribution of Aneides aeneus in Virginia	7
Cole	MAOP Summer Research Internship	Small Scale Asset Management	8
Crudup	MAOP Summer Research Internship	The Ethno racial Aspects of Minority Participation in Private Land Conservation: an examination of African American landowners	9
Davis	MAOP Summer Research Internship	Characterization of Enzyme Binding	10
Draper	MAOP Summer Research Internship	Participation in Private Land Conservation: an Examination of Women Landowners	11
Fuge	Independent	Electrical Design Of A Humanoid Robot (PANDORA/ESCHER)	12
Han	Independent	FORCEBOT Foot Platform	13
Heizer	MAOP Summer Research Internship	Engineering Mix - Climate Action Commitment	14
Ingram	MAOP Summer Research Internship	Stress Wave Timing and Destructive Bending Tests using Iron Bamboo	15
Jamison	MAOP Summer Research Internship	A literature review of Net Zero Energy Buildings	16
Jung	MAOP Summer Research Internship	All Iced Up: How Bacteria May Utilize Ice Nucleation to Increase Their Survivability	17
Karns	MAOP Summer Research Internship	Identifying and Facilitating Positive Experiences for Birders with Disabilities	18
Katz, Prisbe, Dunya, Shah, Zhang & Wakefield	Solving Big Problems with Big Data REU	Patient-Specific Insulin Pump Design Using a Machine Learning Model	19

Larkin & Carlton	Independent	Parent-Adolescent-Clinician Agreement: Implications for the Assessment of Adolescent Social Anxiety Disorder	20
Leathers	MAOP Summer Research Internship	Using Remote Sensing Data Combined with Video Camera Collar Data to Determine NDVI and EVI Influence on American Black Bear Foraging	21
Lee	MAOP Summer Research Internship	Supporting Distributed Interdisciplinary Research Teams via Immersive VR	22
Mannings	MAOP Summer Research Internship	Demonstration of the Hong-Ou-Mandel Effect	23
McIrvin, Pastore & Wapperon	Independent	Development of Squeaky 2.0, the Open Source, 3D Printed, Quadruped Teaching Tool	24
Moore	MAOP Summer Research Internship	In the Spirit of Ut Prosim: Insights in Building Collaboration with the Monacan Indian Nation	25
Nieland	VT-REEL	Plants, Plasmids, and Pathogens... Oh My!	26
Noyes	MAOP Summer Research Internship	Detection of taeniid cestodes in wild canids in Virginia	27
Powell	MAOP Summer Research Internship	Associations between maternal sensitivity and 4-year-old children's attentional control	28
Pratt	MAOP Summer Research Internship	Impact of Pseudorandom Numbers on BB84 Protocol	29
Quarles	MAOP Summer Research Internship	An investigation of cognitive control as a moderator between emotion regulation difficulties and depression symptoms during adolescence	30
Rasnick	Independent	Exploring the Study of LGBTQ+ Parents Across the Past Three Decades: A Comprehensive Literature Review	31
Rogers	Independent	A Novel Technique for Biceps Tenodesis: Is it Strong Enough?	32
Roundtree	MAOP Summer Research Internship	Fashion, Merchandising & Design Undergraduate Research	33
Simon	MAOP Summer Research Internship	Examining the relationship between bacterial shape and chemical structure within Cyclobacterium marinum	34
Smeltz	Independent	Effects of Varied Copper Concentrations on the Growth of Legionella pneumophila in Potable Water	35
Thomas, Chappell & Dinwiddle	MAOP Summer Research Internship	Success Teaches Everyone More: An in-depth look into how different teaching methodologies correlate to student engagement	36
Walsky	MAOP Summer Research Internship	Investigating the association of Vibrio parahaemolyticus with the Eastern oyster	37
Wolfe	MAOP Summer Research Internship	Investigation of the Role of Threonine 240 in Substrate Binding in the Cadaverine Monooxygenase Enzyme GorA	38
Yoder	VT-REEL	Bug Off Pests: The Importance of Beneficial Predatory Insects	39
Young	MAOP Summer Research Internship	Conditions Necessary for the Transfer of Antimicrobial Resistance in Poultry Litter	40
Harp	IE Fellow	Zoonotic Spillover Research of Vampire Bats Across the Andes Mountains Insights	41

10:50-11:00am **Break**
Poster session 1 take down/Poster session 2 set up

11:00-11:50	Poster Session 2 (Goodwin Atrium)		
Presenter last name	**Program Affiliation**	**Presentation Title**	**Poster #**
Amin	Independent	Implementation of a Real-Time Occupant Injury Triage System in Motor Vehicles	1
Bellala	Solving Big Problems with Big Data REU	Meteorological and behavioral correlates of COVID-19 transmissibility across the United States	2
Bickley	VT-REEL	Host plant effects on the biochemistry and dispersal ability of tarnished plant bug, Lygus lineolaris (Palisot de Beauvois)	3
Watts	TOUR	The Role of Leptin Receptor-Expressing Cortical Neurons in Mediating Altered Pain Sensitivity Following Early Adversities	4
Byers	Solving Big Problems with Big Data REU	Epidemic Surveillance via Public Domain Sources	5
Carucci	TOUR	5-hydroxymethylation Specific Increases of POMC Is Not Sufficient to Slow Abnormal Weight Gain During the Development of Obesity	6
Chau & Parikh	Solving Big Problems with Big Data REU	Examining the effect of whole genome doubling on nuclear size in human colon tumors	7
Coyle	Solving Big Problems with Big Data REU	Influenza seasonality assessed through climatic variables and indoor activity across the United States	8
DeRieux & Kao	Solving Big Problems with Big Data REU	Cost-Effective Sensing Network For Forage Systems Management Through Methane Detection	9
Dotson	TOUR	Comparing the “Flex” Metabolic Chamber and the Metabolic Cart for Resting Energy Expenditure Measurements	10
Duffett	TOUR	Comparing the Effects of Voluntary Wheel Running on Complex Hippocampal Learning and Memory in C57 Versus C57/FVBN Mice	11
Fillo	Independent	Utilizing a VR System to Control the Quadruped Squeaky	12
Garifo	Solving Big Problems with Big Data REU	Mapping of Harmful Algal Blooms (HABs) in New Zealand Lakes using Drones	13
Gilmore	NIDDK	Conjugated linoleic acid-treatment improves muscle force and histology phenotypes in a genetically obese mouse model.	14
Harrell	Solving Big Problems with Big Data REU	Tracking Emitted Microplastics from City Landfills Using Atmospheric Forward Trajectory Models	15
Haywood	Solving Big Problems with Big Data REU	Body flattening in a close relative of flying snakes, Dendrelaphis pictus	16
Herzog	IE/Sigma Xi/Office of Research	Fungi of Stadium Woods	17
Jeheeb	Solving Big Problems with Big Data REU	Monitoring Nutrients, Phycocyanin, and Chlorophyll in Drone Water Samples from New Zealand Lakes	18
Katayama	Independent	Exploring Water Quality at Roadside Springs in Central Appalachia	19
Kim	TOUR	Development Process for Controlled Feeding Studies to Measure the Impact of Non-Nutritive Sweetener Consumption on Glycemic Markers	20
King	Solving Big Problems with Big Data REU	Tongue-sticking: Tongue behavior of arboreal colubrids during gap crossing	21
Klewicki	Independent	Copper Creek landowner perceptions of Great Blue Herons	22
Madsen	Independent	In silico genetic examination of single nucleotide missense mutations in NHLH2: possible involvement in obesity, exercise motivation, and fertility	23

Mauro	Sigma Xi/Inclusive Excellence	Playing COVID Proteins: Using genetic analysis to convert protein data to musical compositions	24
McHugh	TOUR	Evaluation of Physical Activity Opportunities in Seven Virginia Counties	25
Mitchener	Independent	Performance and Play: Fostering Student-Centered University Learning Cultures	26
Miyazaki	TOUR	The Leisure-time-as-cost Exercise Purchase Task: A novel method to quantify the reinforcing value of exercise	27
Morris	Solving Big Problems with Big Data REU	Vertical Gap Crossing in Close Relatives of Flying Snakes	28
O'Mara	Summer IE Fellows	Prophylactic and Therapeutic Effects of Aspirin and Ibuprofen on Frostbite in Rats	29
Payne	VT-REEL	The Interaction Between Auxin and Phosphate Signaling Pathways in Plants	30
Pleasant	Independent	Evaluated Pirfenidone Nanoparticles and their Potential Usage as TBI Treatment	31
Poncy	Solving Big Problems with Big Data REU	Developing Spring Dead Spot Maps Across Entire Golf Course Fairways Using Aerial Imagery	32
Roth & Yen	IE Fellows	Reduced mtDNA Content Has An Accumulative Impact on Skeletal Muscle	33
Rowe	TOUR	The Noncanonical NF-kB Pathway in Colitis-Associated Colorectal Cancer: Intestinal Epithelial Cell Specific Deletion of NIK Leads to Increased Susceptibility to Tumorigenesis	34
Shah	Solving Big Problems with Big Data REU	AutoCalibrate: Predicting the Voltage-Flapping Frequency Relationship in Insect Wing Models	35
Stallard	TOUR	Micronutrients as Predictors for Markers of Bone Health in Athletes	36
Trageser	Solving Big Problems with Big Data REU	Modeling Inland Transport of Toxins from Red Tide in Southwest Florida	37
Veith	Solving Big Problems with Big Data REU	Spring Dead Spot Impact on Athlete Safety and Performance	38
Warrior	TOUR	Situational Determinants of Interpersonal Expressions of Gratitude: Behavioral observations on the Virginia Tech campus	39
Watson	Independent	Compromising QKD Undetected: Impacts of a Polarizer on One-Time Pad Creation	40
Bobowick & Ramsahoye	Solving Big Problems with Big Data REU	Communicating Water Monitoring Data Through Art	41

11:50-12:00pm	**Poster session 2 take down/Poster session 3 set up**
12:00-1:00pm	**Lunch/Graduate school networking (Goodwin Atrium)**
1:00-1:50pm	**Poster session 3 (Goodwin Atrium)**

Presenter last name	**Program Affiliation**	**Presentation Title**	**Poster #**
Akinade	Summer Fellows - School of Neuroscience	Anti-epileptic drug, Topiramate, increases Lactobacillus johnsonii in the gut microbiome of mice	1

1:50-2:00pm	**Break**		
	Poster Session 3 take down/Poster session 4 set up		
2:00-2:50pm	**Poster session 4 (Goodwin Atrium)**		
Presenter last name	**Program Affiliation**	**Presentation Title**	**Poster #**
Bridgewater	Beckman Scholars	What Does Water Look Like When Confined in Nanospace?	1
Briganti	Fralin SURF	Combating antimicrobial resistance: Characterizing ribosomal antibiotic binding pockets to advance bidentate design	2
Cannon	Bowers Fellowship Program	Molecular Basis for the Interaction of Phafin2 with the Actin Network During Macropinocytosis	3
Choi, Feller & Will	Beckman Scholars	Vat Photopolymerization of Soy-based Resin for Tissue Scaffolds	4
Comhaire	Fralin SURF	Discovery of Antimalarial Drug Candidates Inspired by MMV008138	5
Davis	Fralin SURF	Understanding the Influence of American Black Bear Foraging Patterns on the Spread of Invasive Plants in the Central Appalachian Mountains	6
DeTroia	VT-REEL	Chromosomal Mapping of Genes Controlling Resistance to Pythium Disease in Soybean and Screening of Palmer amaranth Populations for Herbicide Resistance	7
Dorodnitsyna	Fralin SURF	PDGF/VEGF-related receptor PVR in mosquitoes is involved in juvenile hormone signaling from the plasma membrane	8
Fazal	Fralin SURF	Amphibian feeding mosquitoes are potential vectors of viruses	9
Freilich	Biochemistry-SURF	The Released Metabolites and Proteins of Soybean Seeds in Relation to Germination	10
Garrison	Fralin SURF	Standardizing an ELISPOT Assay for Rotavirus Titration	11
Gerry	Fralin SURF	Characterizing Developmental Brush Border Enzyme Activity Changes in Early Life Pigs	12
Harvey & Blasdell	Fralin SURF	Reducing Agricultural Greenhouse Gases Through Biopolymers	13
Horton	Independent	Characterization of phage resistant mutants of Agrobacterium tumefaciens	14
Kamineni	TPSC SURF	Identification of Key Amino Acids in Helix B of Brome Mosaic Virus Replication Protein 1a in Protein Targeting	15
Keith & Wang	Beckman Scholars	Characterizing a 6.3 MHz High Frequency Endoscopic Histotripsy System for Noninvasive Cancer Ablation	16
Lanier	Biochemistry-SURF	Kinetic Characterization of Inhibitors for the Flavin-Dependent Monooxygenase Siderophore A (SidA)	17
Ljuba, Osborne & Rizwan	Data Science for the Public Good REU	Illustrating Potential Opportunities for Community Schools in Loudoun County	18
LoBosco	GlycoMIP SURF	Modified Pectin as a Biodegradable Polystyrene Substitute	19
LoPresti	Biochemistry-SURF	Using Molecular Docking to Determine the Drug Targets of Cp*Rh Piano Stool Complexes in SARS-CoV-2	20
Malla, Vest & Inman	Data Science for the Public Good REU	Agricultural Land Use Change in Powhatan and Goochland County	21
McCoy	Anne McNabb Summer Fellowship	Isolation of giant viruses from Chlamydomonas reinhardtii	22
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2:50-3:00pm	**Break** **Poster Session 4 take down/Poster session 5 set up**		

3:00-3:50pm	**Poster session 5 (Goodwin Atrium)**		
Presenter last name	**Program Affiliation**	**Presentation Title**	**Poster #**
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Sosa Antunez	Hollins/Global Change Center Scholars	Investigating the impact of Latine ethnicity on public stigma toward men with Post-Traumatic Stress Disorder or Depression	38
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Valdisimo	Hollins/Global Change Center Scholars	As inflation surges, how long will this inflationary episode last compared to other episodes in history.	40
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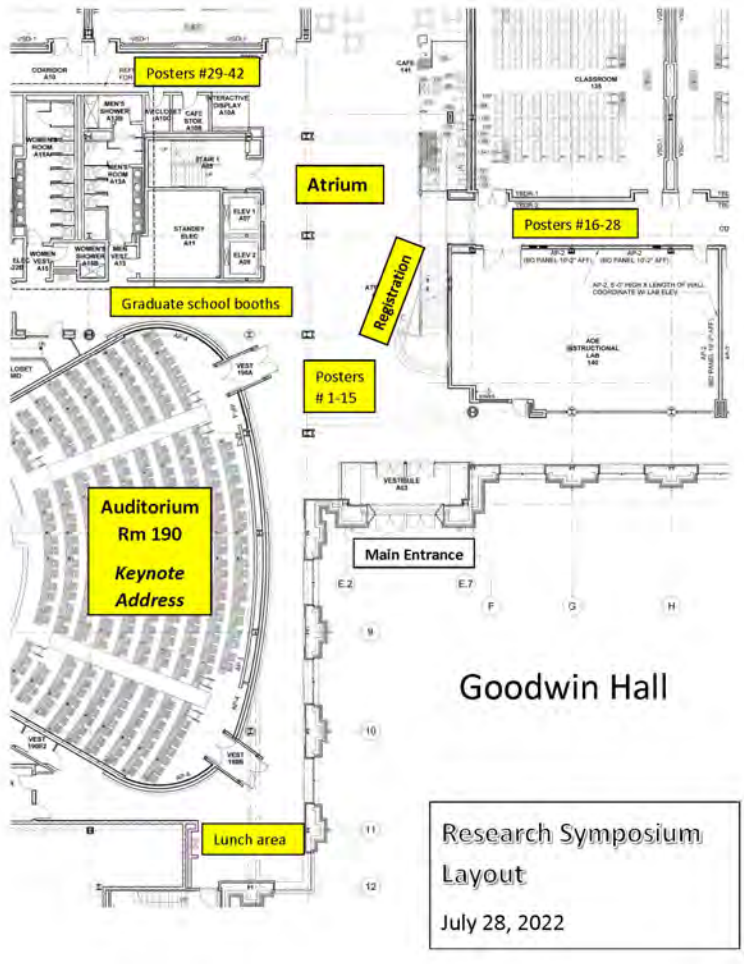
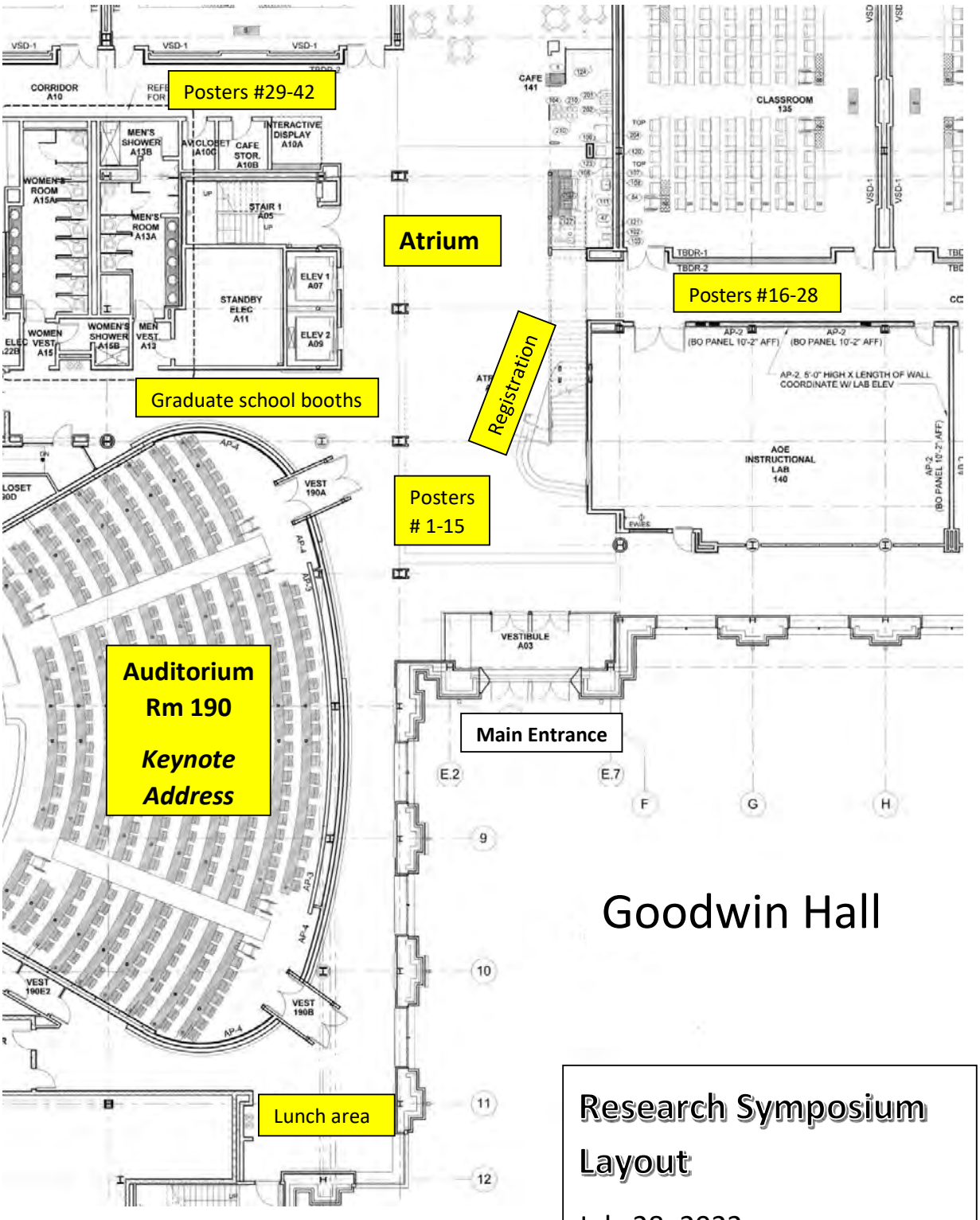
3:50-4:00pm	**End of symposium/ Poster session 5 take down**





Research Symposium Layout

July 28, 2022

Abstracts

Eunice Akinade
Virginia Tech/Clinical Neuroscience

Anti-epileptic drug, Topiramate, increases Lactobacillus johnsonii in the gut microbiome of mice

The gut microbiome consists of trillions of microorganisms, including bacteria, viruses, and fungi, which can contribute to an individual's immunity, aid in digestion, and impact the efficacy of medications. It has been shown that patients with epilepsy have an altered gut microbiome that is associated with seizure severity and drug-resistance; however, the relationship between anti-epileptic drugs (AEDs) and the gut microbiome has not been well studied. To determine if AEDs can impact the composition of the gut microbiome, we investigated the effect of the AED, Topiramate (TPM), on the gut microbiome in naïve mice. After receiving TPM for 4 weeks, we observed an increase in Lactobacillus johnsonii in the gut microbiome of mice. We then sought to determine if TPM directly impacted the growth of Lactobacillus johnsonii, in vitro. We isolated Lactobacillus johnsonii from fecal samples of mice and treated the bacteria with 100 uM, 1000 uM, or 2000 uM of TPM. Using hourly OD600 measurements. We see that TPM increases the growth rate of Lactobacillus johnsonii, in vitro. Further study is required to determine the potential role of Lactobacillus johnsonii in the treatment of seizures.

Mentor(s): Susan Campbell (Animal and Poultry Sciences)

Mohammed Al Darwish
Virginia Tech/Computer Science

KAUST REU

Monitoring the effects of bacteriophage perturbation on bacterial biofilms using spatiotemporal multivariate SERS analysis

Surface-enhanced Raman spectroscopy (SERS) is a highly sensitive technique that enhances the Raman scattering of molecules supported by some nanostructured materials. SERS allows for the structural fingerprinting of low-concentration analytes through the plasmon-mediated amplification of electrical fields or chemical enhancement. Biofilm evolution consists of several spatiotemporally coupled biochemical processes such as metabolic activity, extracellular polymeric substance (EPS) formation, and quorum sensing. Introduction of bacteriophages can selectively perturb the biofilm formation process via effects such as alteration of the metabolic pathway of infected cells and lysing of bacterial cells. For the molecular profiling of the spatiotemporal evolution of phage infected and uninfected biofilms, spatiotemporally resolved label-free SERS measurements were performed. Since the label-free SERS analysis of bacterial biofilms would provide highly complicated signals from molecular ensembles in the SERS hotspots, we will be using unsupervised (e.g., PCA) and supervised (e.g., LDA) statistical methods for analyzing the complex data and understanding the biochemical information embedded in the complex data. Principal component analysis (PCA) is the process of computing the principal components and using them to perform a change of basis on the data, sometimes using only the first few principal components and ignoring the rest. PCA was implemented for identifying the key spectral features responsible for the phage-dosage dependent variations in the SERS spectra. In addition, PCA was used as a data reduction tool for the subsequent supervised data analysis. Linear discriminant analysis is used as a tool for classification, dimension reduction, and data visualization. Despite its simplicity, LDA often produces robust, decent, and interpretable classification results. LDA was used for classifying the phage dosage dependent responses of the biofilms. Therefore, we envision that our method can potentially be extended to monitor other virus-cell interactions, enabling exciting applications including the detection of pathogenic viruses by monitoring their interactions with mammalian cells.

Mentor(s): Wei Zhou (Electrical and Computer Engineering)

Hashim Al Ibrahim
UW Madison/Computer Science

KAUST REU

10-Year-Old Finite Element Model

Child pedestrians have the highest mortality rate among road users. Finite Element (FE) models of children and vehicles can be used to simulate crashes and investigate pedestrian safety measures. The goal of the study is to develop a simplified 10-years-old pedestrian FE model. The model was created by linearly scaling the Global Human Body Model Consortium six-years-old FE model using anthropometric data obtained from World Health Organization. The model height was scaled to match the expected height of a 10-years-old. Then, the model was scaled in the transverse plane to match the 10-years-old weight. Small adjustments to the arms and legs of the model were made to match anthropometry data. 3-point bending validation tests were conducted on the femur and tibia and reported similar results to the 6-yo model. Vehicle impact tests need to be conducted to investigate the risk of injuries in the 10-year-old model. Based on the validations it is expected that the scaled 10-yo model will produce data that would be helpful to understand how injuries will occur.

Mentor(s): Daniel Grindle (Biomedical Engineering and Mechanics, Virginia Tech)
Costin Untaroiu (Biomedical Engineering and Mechanics, Virginia Tech)
Akshay Sahiya (Biomedical Engineering and Mechanics, Virginia Tech)

Maryam Al Jawad
University of Wisconsin-Madison/Chemistry B.S.

KAUST REU

Preparation of Plasmonic Nanoparticles for Surface-Enhanced Raman Spectroscopy Detection of Environmental Contaminants

Water pollution has been a trending global concern caused by human activities. Early detection of pollutants in the environment plays an immensely important role from the standpoint of public health and safety. Plasmonic nanomaterials such as gold and silver are compelling candidates for the development of highly sensitive Surface Enhanced Raman Spectroscopy (SERS)-based biosensors due to their unique Localized Surface Plasmon Resonances (LSPRs). In this work, two SERS responsive nanoparticles were prepared with different structures: spherical gold nanoparticles (AuNPs) and gold nanorods (AuNRs) for the detection of different water contaminants. The citrate coated AuNPs (~40 nm) were synthesized using a seed-mediated growth method and exhibited characteristic LSPR peak at ~540 nm. AuNRs were prepared using a binary surfactant mixture composed of hexadecyltrimethylammonium bromide (CTAB) and sodium oleate (NaOL) and showed the LSPR peak at ~758 nm. After that, the detection capabilities of the two nanoparticles were compared towards three different types of environmental contaminants: chemical molecule 4-mercaptobenzoic acid (4-MBA), biomolecule adenine, and pathogen bacteria Pseudomonas syringae. Both AuNPs and AuNRs showed high sensitivity towards 4-MBA and adenine at nanomolar level. AuNRs have higher sensitivity towards P. syringae at ~10^7 CFU/mL. These results suggest the potential of these nanoparticles for application in a broad range of analyte detection strategies.

Mentor(s): Peter Vikesland (Civil and Environmental Engineering)

Lena Alabdulwahab
University of California at Berkeley/Electrical Engineering and Computer Science

KAUST REU

Effect of Wheelchair Metal Selection on Pedestrian Injury Outcomes

In the US, there are more than 3 million residents that depend on wheelchairs for mobility. This number is expected to increase due to increased longevity. Meanwhile, wheelchair users experience 36%-75% higher mortality rates in pedestrian car crashes than standing pedestrians. In addition, pedestrian car crashes rates are steadily increasing making this problem even more urgent. Unfortunately, there is not enough research dedicated to investigating the reasons behind such rates.

Our research goal is to investigate the underlying causes of seated pedestrian car crashes and to explore the effect of ultralight wheelchair material selection on injury outcomes and risk of mortality. Finite element impact simulations were completed using LS-DYNA. Simulations included a human body, a vehicle, and either titanium or an aluminum ultralight wheelchairs. The human body and vehicle models are taken from The Global Human Body Model Consortium and the European New Car Assessment Program, respectively. The two lightweight wheelchair models are being developed from an open-source CAD drawing.

After the models' development phase and their validating tests, the car collision impact tests will be run at 30km/h. The wheelchairs will be tested in three different positions in relation to the car bumper, back (first ⅓), center, and front (last ⅓). After analyzing the results we are expecting to see large differences in injury outcomes between the two wheelchair models.

Mentor(s): Daniel Grindle (Department of Biomedical Engineering and Mechanics)
Dr. Costin Untaroiu (Department of Biomedical Engineering and Mechanics)

Mohammed Alamoudi
University of Texas at Austin/Biomedical Engineering

KAUST REU

A New Method to Make All Polysaccharide Hydrogels

Hydrogels are three-dimensional cross-linked polymeric networks, typically prepared from hydrophilic precursors such that the networks can retain a large amount of water. Hydrogels have found wide commercial application and research interest, including in biomedical applications such as contact lenses, wound dressings, and drug delivery. Using polysaccharides as the building blocks to make hydrogels is useful and promising for next generation clinic materials because polysaccharides are generally benign and biodegradable in human bodies.

Schiff base polysaccharide hydrogels are a unique class of polysaccharide hydrogels because it is formed by dynamic imine bond. This kind of chemical bond is pH-sensitive and reversible. As a result, the Schiff base polysaccharide hydrogels can be advantageous for applications like tissue engineering and sustained drug release. Such hydrogels are usually prepared by reaction between aldehyde-containing and amine-containing polysaccharides. The aldehydes are typically introduced by periodate oxidation of vicinal diols, common polysaccharide elements. This cleaves monosaccharide rings, resulting in degraded mechanical properties, reduced degree of polymerization (DP), and increased chemical instability.

In this work, we developed a new method to make Schiff base hydrogels without breaking the cyclic ring of the polysaccharides. We achieved this goal by introducing reducing ends to polysaccharide chains, which is in equilibrium between hemiacetal ring and an open-chain aldehyde form. And we use this kind of polysaccharides to make hydrogels with chitosan.

Mentor(s): Zhenghao Zhai (Sustainable Biomaterials)

Maxwell Albrecht
Virginia Tech/Systems Biology

Effects of variation in experimentalist, analyst, and methodology on observed cardiac conduction phenotype after perinexal widening

Ephaptic coupling is a form of action potential propagation involving voltage-gated sodium channels (Nav1.5) within narrow intercellular clefts between cardiomyocytes. Our lab uses a rationally designed peptide, βadp1, to interfere with cell-cell adhesion mediated by the β1-subunit of Nav1.5 and investigate the role ephaptic coupling plays in action potential conduction and arrhythmogenesis in the heart. Previously, our lab demonstrated that βadp1 reduces conduction velocity (CV), but not all subsequent experiments have reproduced this finding. The goal of my research is to determine which factor(s) underlie these apparent discrepancies in the observed effect of βadp1 on CV and inform more scientifically rigorous experimental design in future studies. I hypothesize that differences in the experimentalist, analysts, and/or experimental methods are having an impact on the observed conduction phenotype during βadp1 treatment. To test this hypothesis, three sets of experiments were designed. To test the effect of the experimentalist, two researchers repeated the published experimental protocol and the results were compared. To test the analyst, experiments performed by the same investigator were examined by two analysts and compared. To test experimental methods, a series of studies with minor protocol variations were performed by a single investigator and examined by a single analyst. This investigation demonstrated no statistically-significant difference in results between experimentalists or analysts. However, some small changes to the protocol produced significantly different results in some cases. This suggests that experimental protocols should be recorded and accounted for when extrapolating the overall results of a study.

Mentor(s): Steven Poelzing (Fralin Biomedical Research Institute)

Alwaleed Aldhirgham
Rensselaer Polytechnic Institiute /Mechanical Engineering

KAUST REU

Aero-thermal analysis using FEA for under-risk components in a biomimetic bat robot

To investigate an airflow on a bat robot body, which has some vents inside, that will carry the hot air to the end from inside. The procedure is to apply surface temperatures to the bodies inside that structure, and then analyze the thermal flow inside with the help of a thermal analysis software. The objective is to place the components wisely in a way that the heat flow is optimized, and no hot component is in front of the cold one to transfer the temperature via convection.

Mentor(s): Rolf Mueller (Mechanical Engineering)

Cordelia Aldridge
Washington and Lee University/Physics

Directional Analysis of Reactor Neutrino Detection

Since the beginning of the nuclear age, mankind has searched for a safeguard which would provide information about what is occurring in a nuclear reactor. As the number of nuclear plants grows throughout the world, it is in the world's best interest to have an all-encompassing, tamperproof detector to provide information about a reactor when other third-party safeguards fail. One such type of detector is a neutrino detector. Neutrinos are extremely light neutral fundamental particles and there is one specific type of neutrino - electron antineutrinos - which are produced in fission reactors. A neutrino detector would operate by tracking the neutrinos' interactions with the crystal inside the detector. This project focused on modeling the energies of incoming neutrinos and their following interactions within the crystal. By implementing various rotations of a cubic crystalline structure, we were able to model a detector which could relay the direction of the neutrino source. Such a detector is beneficial for tracking where a fission reactor is, whether the exact location is known or not. The energies and number of incoming neutrinos also helps relay what is happening in the reactor core. Through this project we can show just what type of crystal should be used and how well the detector can distinguish between various sources of neutrino production. Such detectors will allow for a safer and more controlled nuclear future.

Mentor(s): Patrick Huber (Physics)

Abdulmohsen Alghannam
University of Virginia/Computer Science
Tolu Odimayomi
Virginia Tech/Civil and Environmental Engineering

Effects of Temperature and Chlorination on Bacteria Growth in Drinking Water Systems

Drinking water systems are ideal environments for the growth of pathogenic bacteria such as Legionella pneumophila. As such, chlorination is commonly used as secondary disinfection after water treatment to decrease pathogens and the overall microbial growth in water systems. A major determinant of the amount of chlorine residual in building plumbing has been the time of travel from the water treatment facility. Furthermore, the bacteria in building plumbing systems are more influenced by the biofilm covering the inner pipe wall compared to distribution systems due to higher surface-area-to-volume ratio of small pipes Thus, we aimed to evaluate the effects of temperature and disinfectant concentration on bacteria growth. In this study, drinking water samples were collected from a water heater know containing L. pneumophila and incubated in glass bottles. Over four weeks, the number of live cells in chlorinated (0.30 mg/L Cl2) and unchlorinated (0.01 mg/L Cl2) samples stored at 25°C, 30°C, and 37°C were measured using flow cytometry. These concentrations were compared to cell counts in pipes receiving the same water. L. pneumophila was quantified using liquid culture. It is hypothesized that unchlorinated samples stored at 37°C will contain the greatest concentration of Legionella bacteria, as 37°C is the ideal growth temperature for Legionella. Preliminary results show that while chlorination can suppress bacteria growth, regrowth can occur after the chlorine decays. Results of this work could be used to provide water utilities and building owners recommendations for better operating their water systems to reduce dangers of pathogens in building plumbing.

Mentor(s): Dr. Marc Edwards (Civil and Environmental Engineering)
Dr. Amy Pruden (Civil and Environmental Engineering)

Mohammad Aljanoubi
University of California, Los Angeles/Chemical Engineering

KAUST REU

Engineering Solid Electrolyte Interphase for Lithium Metal Batteries

A challenge facing lithium-metal batteries is poor capacity retention and limited cycling life at high temperature which stems from unstable solid electrolyte interphase (SEI) formed between electrolyte and electrodes. SEI is a layer that transports ions between the electrolyte and the electrode and limits the electrolyte decomposition enhancing the battery life. Here, we studied a novel type of polymer electrolyte termed “Molecular Ionic Composites (MICs)[1] combined with additives to build stable SEI for high-performance lithium-metal batteries. Additives are chemicals that are decomposed to form SEI layer, which passivates electrodes from further side reaction with electrolytes, while conducting Li ions. In this study, we investigated a variety of additives to enhance the performance of Li symmetric cells with Molecular Ionic Composite (MIC) electrolyte. We explored fluoroethylene carbonate (FEC), vinylene carbonate (VC), and lithium bis(oxalate)borate (LiBOB). Other studies have shown that VC enhances the stability and conductivity of the battery[2], while FEC has been shown to improve cycling stability and eliminate adverse irreversible reactions[3]. Moreover, addition of LiBOB was shown to sustain capacity and improve the stability of the electrolyte[4]. Our results have shown that some of additives are beneficial for Li|MIC|Li symmetric cell cycling stability.

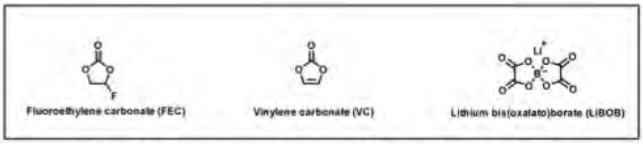


Figure 1. Chemical structures of FEC, VC, and LiBOB

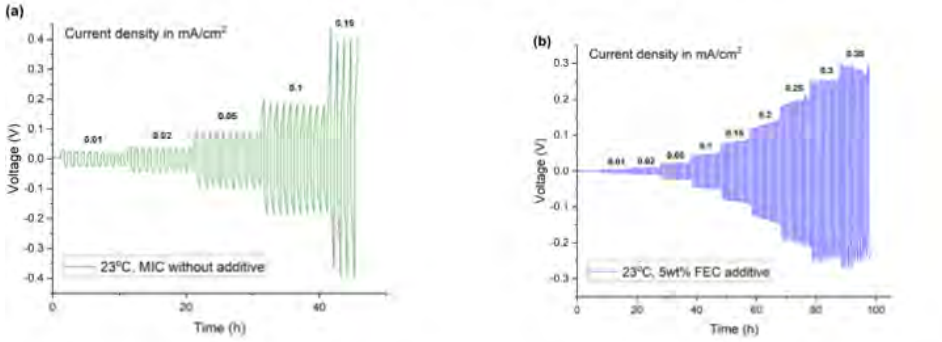


Figure 2. Lithium symmetric cell performance at 23°C for **a)** MIC electrolyte battery with no additive and **b)** MIC electrolyte membrane with 5%wt FEC additive

Mentor(s): Feng Lin (Department of Chemistry)
Jungki Min (Department of Chemistry)

Ahmad Almesned
New York University/Computer Science
Fernando Roman
Virginia Tech/Civil Engineering

KAUST REU

Impact of Sodium Chloride Concentrations on Hydrogen Evolution Within Water Heaters

The growing use of road salt in the United States has led to contaminated surface and groundwater resources, impacting water quality and plumbing infrastructure. Since the presence of chloride can increase rates of corrosion, and the corrosion of anode rods can produce hydrogen, we examined hydrogen evolution rates within four 6-gallon water heaters fitted with magnesium anode rods. Each water heater was dosed with a different concentration of sodium chloride (0, 100, 300, and 500 ppm of chloride as NaCl), and fitted with PVC pipes containing pressure gauges designed to capture and measure evolved hydrogen over time. Daily measurements of the pressure, anode-tank galvanic voltage, and galvanic amperage were taken for each water heater. The formation of evolved hydrogen in premise plumbing may be of great importance since $H_2(g)$ is an electron donor for hydrogen-oxidizing bacteria (HOBs), which can fix organic carbon, hypothetically supporting the development of pathogens through a microbial food web. We found that rates of hydrogen evolution were highest in the water heater containing the largest amount of dosed sodium chloride, and lowest in the control water heater not dosed with NaCl - which pressure gauge indicated 0 PSI throughout the entirety of the experiment. These results indicate that communities with high levels of salinity in their water may be susceptible to increased rates of hydrogen formation in their water heaters.

Mentor(s): Dr. Marc Edwards (Environmental and Water Resources Engineering, Virginia Tech)
Dr. Amy Pruden (Environmental and Water Resources Engineering, Virginia Tech)

Dalia Alsaihati
UCLA/Bioengineering

KAUST REU

Engineered Living Materials for Detection and Mitigation of Bacterial Infection

Bacterial biofilm on surfaces of medical devices is a leading cause of bacterial infection in healthcare settings. A non-toxic approach to overcoming these infections involves engineering nano-textures on the surfaces of the devices to minimize adhesion and biofilm growth. In this REU project, we develop a novel biohybrid nano-texturizing approach to not only hinder microbial attachment but also sense and treat any attached bacteria. To this end, we engineer Escherichia. coli bacteria to act as a biosensor for the presence of the model bacterial pathogen Pseudomonas aeruginosa (PA). The engineered E. coli detects acyl-homoserine lactone (AHL) secreted by the PA and reports it by expression of an easily detectable green fluorescent protein (GFP). The engineered bacteria will be incorporated into polymeric nanofibers that will coat the surface of medical devices (e.g., catheters). We have shown that E. coli is able to activate at very high dilutions of the PA supernatant containing AHL (1/128 of the original supernatant ~3900 CFU/mL). We are currently characterizing and optimizing the E. coli encapsulation in the nanofibers for developing highly sensitive living surface coatings that are at the frontier of biomaterial development and will find potential applications in smart wound dressing and implantable medical devices.

Mentor(s): Bahareh Behkam (Department of Mechanical Engineering, Virginia Tech, Blacksburg, VA, US)

Faisal Alshaiddi
University of California: Irvine/Computer Engineering

KAUST REU

Spatiotemporal SERS monitoring and multivariate analysis of the biofilm evolution process.

Raman signals are weak in nature, so a small number of scattered photons are visible through detection. One strategy commonly used to strengthen weak Raman signals is surface-enhanced Raman scattering (SERS). SERS uses Laser excitation on the nanostructures of roughened metal surfaces which drives the surface charges creating a highly active light field. Biofilm evolution consists of several spatiotemporally coupled biochemical processes such as metabolic activity, extracellular polymeric substance (EPS) formation, and quorum sensing. For the molecular profiling of the spatiotemporal evolution of biofilms, spatiotemporally resolved label-free SERS measurements were performed. Since the label-free SERS analysis of bacterial biofilms would provide highly complicated signals from molecular ensembles in the SERS hotspots, we will be using unsupervised (e.g., PCA) and supervised (e.g., LDA) statistical methods for analyzing the complex data and understanding the biochemical information embedded in the complex data. Principal Component Analysis (PCA) is a method of reducing dimensions in large sets of variables while still including most of the information. PCA was implemented for analyzing the spatiotemporal data by identifying the key spectral features responsible for the temporal variations in the SERS data. In addition, PCA was used as a data reduction tool for the subsequent supervised data analysis. Linear Discriminant Analysis (LDA) is another method of dimensional reduction that aims to maximize separation between groups. LDA was used for classifying the different stages of biofilm growth. Therefore, we envision that our method can potentially enable exciting applications such as assisting the development of novel antibiofilm therapy methods.

Mentor(s): Aditya Garg (Department of Electrical and Computer Engineering)

Arush Amin
Virginia Tech/Biomedical Engineering

Implementation of a Real-Time Occupant Injury Triage System in Motor Vehicles

Despite continued efforts to improve the safety of vehicles, in 2019, 2.74 million individuals were harmed in some way due to a Motor Vehicle Collision (MVC). When crashes occur, the effective treatment of injuries depends on a timely response from Emergency Medical Services (EMS). Current crash notification vehicle systems provide only limited support to EMS. This study aims to increase the effectiveness of EMS response by creating an in-vehicle occupant triage system that can relay information about crash victim(s) in real-time to EMS personnel. The system is designed to inform EMS about the anticipated medical condition of vehicle occupants prior to arrival, allowing for appropriate resource allocation and earlier anticipation of MVC victim transport to a suitable medical facility. The triage protocol used, Simple Triage and Rapid Treatment (START), classifies the patient status into four categories (i.e., Expectant, Immediate, Delayed, and Minor) and relies on three vital signs (i.e., respiration, perfusion, and mental status). As part of this study, multiple methods for collection of each vital sign were assessed. Currently, two methods for detection of respiration have been replicated in a laboratory and implemented in a vehicle. These methods employ ultrasound and targeted thermal infrared sensor technologies. Future work will assess the use of seat occupant classification systems to detect respiration and photoplethysmography (PPG) imaging and continuous wave radar to detect perfusion. In-car testing will be used to determine which combination of respiration and perfusion methods lead to the most accurate vital sign collection by comparing against “ground truth” metrics.

Mentor(s): Miguel Perez (Biomedical Engineering)

Malaika Amin
Hollins University/Biology

Fullerene-functionalized metal chalcogenide nanosheets for new electron transport material in flexible solar cells

Bulk heterojunction solar cells composed of fullerene electron acceptors and polymer electron donors now rule the field of flexible and transparent solar cells. The solubility of these components enables low-cost production of thin, transparent films. Unfortunately, these materials result in solar cells with low efficiency, usually less than 8%. A potential remedy for the low efficiency is the use of metal chalcogenide nanosheets, such as CdS and CdSe, although these materials are difficult to process because of their low solubility. It is hypothesized that chemically bonding fullerenes to CdX (X= S, Se, or Te) nanosheets will improve CdX nanosheet stability and solubility while maintaining flexibility and transparency, allowing them to be used as a new electron transport material to make efficient, flexible, and transparent solar cells. A series of reactions were initially performed attempting to bind alkylamine functional groups such as ethylenediamine, N-Boc-1,6-hexanediamine, and diethylenetriamine (DETA) to C60 to allow the fullerene to bind to CdX nanosheets. The results of these reactions were inconclusive. As an alternative method, nanosheets including Cd2S2(N-Boc-1,6-hexanediamine), Cd2S2(DETA), and Zn2S2(N-Boc-1,6-hexanediamine) were synthesized as precursors to fullerene-functionalized nanosheets. While further characterization is necessary, characteristic peaks were observed in N–H and sp3 C–H regions of IR spectra. Additionally, the fingerprint regions for some reactions contained multiple overlapping peaks with the literature compounds, Cd2S2(hexylamine) and Zn2S2(hexylamine), indicating the successful synthesis of alkylamine functionalized nanosheets with DETA and N-Boc-1,6-hexanediamine.

Mentor(s): Brian Reeves (Chemistry, Hollins University)

Muskan Amin
Virginia Tech/Civil Engineering

Hydrocarbon Group Analysis of Petroleum Fuel Samples from Vehicle Testing

Petroleum fuels are composed of varying hydrocarbons that can impact atmospheric chemistry, and potentially lead to environmental contamination, through the emissions they produce. Identification of these hydrocarbons is essential to understanding how much impact they can have on environmental processes; however, this has typically been a difficult task. Recently, a more accessible technique, using gas chromatography with a unit mass resolution electron ionization mass spectrometer (GC/EI-MS), was developed to identify complex hydrocarbons by hydrocarbon group based on molecular structure (carbon number, number of rings, etc.). This technique ultimately provides a detailed understanding of the properties and potential impacts of the hydrocarbons emitted. This is specifically done by obtaining the details of hydrocarbon groups in each sample through analysis of present molecular ion signals. These details can then be used to create chromatograms to visually perceive the breakdown of present hydrocarbon groups. This project applies this previously developed analytical technique to two groups of petroleum fuel: diesel and gasoline. The samples from these fuel sources were collected, through emissions produced from different vehicle testing conditions, and run through a GC-MS. Through creating and analyzing chromatograms, by the previously established approach, the breakdown of present hydrocarbons were seen for each sample. These chromatograms were then compared amongst each other to visualize how changes in vehicle operating conditions could impact the breakdown and magnitude of present hydrocarbon groups. Investigating this relationship may also provide insight on how different vehicle operating conditions could impact the environment by the hydrocarbon groups they produce.

Mentor(s): Gabriel Isaacman-VanWertz (Civil and Environmental Engineering)

Riley Ampt
Anderson University, IN/Psychology

Effects of plant chemical diversity on pathogen evolution

Plants produce numerous phytochemicals, some of which can play important roles in defense against pathogens. However, the functions of most phytochemicals are still unknown, and we don't know exactly why plants produce such a large diversity of compounds. The slowed adaptation hypothesis suggests that plants may produce complex mixtures of defensive chemicals simultaneously, as opposed to one, as a way to slow the adaptation of their enemies. This project studied the evolution of a fungal pathogen, specifically Penicillium expansum, through several generations of growth on media containing 14 different phenolic metabolites. We tested the effects of individual metabolites and of different mixtures that were composed of different numbers of compounds or levels of structural diversity. The growth of the fungi in 59 different solutions was measured in terms of changes in optical density of hyphae in 96 well plates over 5 days. Fungal spores from each solution were then transferred to begin the next generation. We predicted that fungi growing in solutions with greater phytochemical diversity would have a slower rate of adaptation over multiple generations than those growing in less diverse mixtures. Preliminary results from the first generation conclude that many of the individual phenolics and mixtures have negative effects on fungal growth, but the strength of these effects did not vary depending on the number of compounds or structural diversity of the mixture. Overall these results will improve our understanding of the evolution of plant chemical diversity as well as the mechanisms of crop resistance to pathogens.

Mentor(s): Susan Whitehead (Biological Sciences)

Sumaita Arowa
Virginia Tech/Clinical Neuroscience

Role of Perm1 in the Hexosamine Biosynthesis Pathway in the Heart

PERM1 is a striated-muscle specific protein that is predominantly expressed in cardiac and skeletal muscle. Our research team previously demonstrated that PERM1 is downregulated in human and mouse failing hearts, suggesting the role of Perm1 in pathogenesis of heart failure. However, the role of PERM1 in healthy and diseased hearts is largely unknown. Our recent study showed that the deletion of Perm1 (Perm1-KO) in mice led to reduced cardiac function, in association with the increased levels of total O-GlcNAcylation, a posttranslational modification of proteins. It is known that excessive O-GlcNAc is linked to heart failure and that hexosamine biosynthesis pathway (HBP) provides the donor sugar UDP-GlcNAc for O-GlcNAcylation, which is synthesized from glucose. I hypothesized that excess O-GlcNAcylation in Perm1-KO mice is associated with upregulation of glucose uptake and HBP. To address this hypothesis, I performed real-time PCR analysis using cardiac tissue from Perm1-KO mice and their wild-type littermates and measured the mRNA levels of key enzymes in glucose uptake and HBP. I found that the glucose transporters 1 and 4 (GLUT1;GLUT4), which are responsible for glucose uptake in myocardium, were upregulated in Perm1-KO hearts. Furthermore, the mRNA level of glutamine fructose-6-phosphate aminotransferase (GFAT), a rate-limited enzyme in HBP pathway, was significantly increased in Perm1-KO mice. These data suggest that loss of Perm1 leads to excess O-GlcNAcylation in the heart through upregulation of glucose uptake and HBP, which might contribute to reduced cardiac function in Perm1-KO mice. This study advanced our understanding of the role of PERM1 in the heart.

Mentor(s): Junco Warren (HNFE)

Katie Bechtold
Virginia Tech/Mechanical Engineering
Joshua Gardner
Virginia Tech/Materials Science Engineering
Yonatan Duega
Virginia Tech/Industrial and Systems Engineering

The Development of Personalized Biomedical Prosthetics: 3-D Scanning and Modeling

The incorporation of additive manufacturing, commonly known as 3-D printing, into prosthetic production has increased accessibility for those who are affected by a birth defect called Amniotic Band Syndrome. Accompanying methods, such as the use of 3-D scanning equipment and computer aided design software, have enabled prosthetics to be easily personalized to the needs of each individual. The structured-light scanning equipment captures several 3-D photographs of the limb from different angles that are then digitally merged together to create a full model used in printing of the prosthetic. It is often difficult to obtain an accurate scan due to the highlights and shadows caused by the lights on the scanning equipment. While a cast can be made and used during scanning to deter this effect, it was found that using matte paint instead can increase the efficiency of this process. Applying a thick coat of paint to the limb results in a significant reduction of highlights and shadows which produces an accurate scan in less time. Therefore, this research aims to enhance the 3-D printing prosthetic manufacturing process in a more efficient and cost-effective manner.

Mentor(s): Blake Johnson (Industrial and Systems Engineering)

Venkatsai Bellala
Brown University/Biomedical Engineering

Meteorological and behavioral correlates of COVID-19 transmissibility across the United States

Background: Respiratory virus transmission is driven by a multitude of factors ranging from population immunity and preventative measures to meteorological parameters and human behavior. Understanding the relationship between such factors and transmission is essential to predict future outbreaks of coronavirus disease 2019 (COVID-19) as new variants of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) spread across the globe.
Objective: The purpose of this study is to quantify the role of dry bulb temperature (DBT), relative humidity (RH), absolute humidity (AH), and relative indoor activity on COVID-19 transmissibility.
Methods: Daily COVID-19 surveillance data from January 2020 through December 2021 was collected from Johns Hopkins Center for Systems Science and Engineering and smoothed with a seven day moving average. Hourly meteorological measurements were collected from the National Oceanic and Atmospheric Administration (NOAA), and weekly indoor activity metrics were obtained from a study of cell phone records. All datasets were aggregated to the weekly temporal scale and grouped at the county level. Transmissibility was estimated with the instantaneous reproduction number (Rt), computed using the EpiEstim package in R. Linear regression models were generated for various combinations of each variable studied.
Results: Weekly mean reproduction numbers were normally distributed ($p < 0.05$) as per the Shapiro-Wilk Normality Test. Both meteorological and behavioral parameters realized weak relationships with transmissibility (adjusted $R2 < 0.1$) during the post-lockdown "Alpha phase" of the pandemic, likely due to a large susceptible population and enforcement of preventative measures such as social distancing and masking. During the "Delta phase" of the COVID-19 pandemic, DBT, RH, and indoor activity were significantly associated ($p < 0.05$) with SARS-CoV-2 transmission. We suspect this may be due to relaxation of preventative measures and presence of vaccinations and immune populations. A latitudinal trend was observed in our final model; said associations become weaker closer to the equator.
Conclusion / Implications: These associations suggest that DBT, RH, and indoor activity are significant drivers of SARS-CoV-2 transmission in the absence of preventative measures. These findings can inform predictions of future COVID-19 outbreaks and guide public policy planning in affected communities.

Mentor(s): Linsey Marr (Civil and Environmental Engineering)

Julianna Beltz
University of North Carolina at Chapel Hill/Biology (BS)

The germ-free piglet: a new avenue to understanding the gut-brain-axis with translational outcomes

The link between aberrations in host microbial composition and neurological deficits, including hallmark signatures of cognitive impairments, has become widely accepted in recent years. While studies in humans are typically restricted to correlative findings, those in rodents have provided a causal foundation for the importance of a healthy gut microbiome in promoting brain development; however, most reports are within the time window of adolescence to adulthood. Elucidating how microbiota shape brain growth shortly following colonization at birth is of critical importance in understanding neurological diseases/disorders of developmental origins which often involve imbalances in excitation and inhibition on the synaptic level. We aimed to determine whether piglets born and raised in germ-free (GF) conditions would serve as a suitable model organism for comparative medicine in humans. Because microglia are critical players in synaptic pruning, we first made assessments indicative of their activation within the prefrontal cortex at a human age equivalence of a neonate. We found no significant difference in the number of microglia between GF and control piglets paired with a significant shift towards a ramified phenotype in GF piglets. These findings suggest that microbiota did not influence microglia production or survival, but may influence their activation - potentially impacting synaptic density and overall functional outcomes. We next designed a platform to test cognitive outcomes in young piglets utilizing a touchscreen visual discrimination task. Piglets were able to learn the task at an exceptionally young age opening the possibility for further research in a model organism bioequivalent to ourselves.

Mentor(s): Paul Morton (Department of Biomedical Sciences and Biopathology)

Ashree Bhatta
Hollins University/Chemistry
Tram Nguyen
Hollins University/Chemistry

Stereoselective Glycosylation via Dynamic Kinetic Resolution

One of the most significant challenges in the construction of carbohydrate libraries is controlling the stereoselectivity of newly formed glycosidic linkage. While a number of impressive advances in this field have been made over the last few decades, the majority of approaches in controlling the stereochemistry of glycosylation rely on the use of neighboring group participation. Therefore, many types of linkage are still difficult to synthesize. Some methods achieve high stereoselectivity but very modern yield and vice versa. The central theme of this work is to develop a new method to achieve pure anomer of glycosylation products starting from a mixture of two α and β anomers via dynamic kinetic resolution (DKR). Our rationale in pursuing this research is that the approaches will provide effective method for the construction of libraries of stereo-defined glycoconjugtes. Moreover, mechanistic studies of these reactions will provide valuable insight into the factors which determine stereocontrol in glycosylation reaction.

Mentor(s): Son Nguyen (Chemistry)

Brandon Bickley
Virginia Tech/Biochemistry

VT-REEL

Host plant effects on the biochemistry and dispersal ability of tarnished plant bug, Lygus lineolaris (Palisot de Beauvois)

Lygus lineolaris (Palisot de Beauvois) (Hemiptera: Miridae) is an economically devastating pest of cotton and has recently emerged as a pest of concern in the mid-Atlantic region. An ongoing control challenge is understanding how L. lineolaris responds to host plant availability and variable winter climate. To better understand how this pest is responding to cropping system changes, such as the increased use of cover crops, our study was designed to measure how reproductive biology and dispersal ability change in relation to host plant nutritional value. L. lineolaris reproductive status (i.e., diapause) has historically been observed by dissecting insects and visually-quantifying the amount of lipid available. Other macronutrients, like carbohydrates used to fuel short term flights, are typically measured through observation of insect activity. Our study was designed to test whether biochemical assays could enhance, or replace, traditional methods. We hypothesized that 1) diapausing L. lineolaris would have higher total body lipid and protein levels than reproductive insects, and 2) L. lineolaris fed from different hosts would have different dispersal potentials. Our methods included pairing biochemical assays with either dissections or use of an insect flight mill (i.e., a specialized tool to determine dispersal capacity) to measure lipids and carbohydrates, respectively. Preliminary data indicate that biochemical assays can help determine diapause status and, potentially, dispersal ability. These assays can enhance, or replace, laborious dissections and visual estimates. Broadly, our findings may be applied for determining diapause status in other insects.

Mentor(s): Aaron Gross (Entomology)
Sally Taylor (Entomology)

Colden Bobowick
Brown University/Applied Mathematics-Computer Science
Michelle Ramsahoye
University of Colorado, Boulder/Mathematics

Communicating Water Monitoring Data Through Art

The Learning Enhanced Watershed Assessment System (LEWAS) Lab has been collecting high frequency water quality, quantity, and weather data from its field site located on Virginia Tech campus since 2016. The overall goal of this research is to communicate this copious amount of data to the public using art and data science tools. More specifically, this research tries to accomplish the following objectives: (1) improve the current LEWAS Lab online data portal layout and graph functionality, and (2) develop data-generated art to publicly display the data. Using HTML, JavaScript, and CSS, adjustments were made to the website code to optimize the interactive graph loading time, improve accessibility of the data, and update the website to a more aesthetically pleasing user interface. Utilizing Python libraries such as Pillow and Pandas, a tool was developed using the LEWAS data that generates digital art based on chosen metrics such as water temperature and salinity. Finally, an outdoor panel displaying this art as well as information about the LEWAS Lab will be installed at the LEWAS field site to draw the attention of the public and to communicate the significance of water quality and quantity monitoring. Communicating LEWAS Lab's data through art and tools of data science can lead to raising public awareness about the local environmental challenges and increasing public participation in activities that protect the environmental health of the Stroubles Creek Watershed.

Mentor(s): Kang Xia (School of Plant and Environmental Sciences)

Kaitiya Bowser
Spelman College/Biology

Analyzing Parent and Child Stress Reactivity in Children with Hemiparetic Cerebral Palsy Receiving Intensive Therapies

Baby CHAMP is a completed comparative efficacy trial that investigated intensive therapies for infants diagnosed with hemiparetic cerebral palsy (HCP), comparing three therapy versions. Two involved using constraints of differing types on the non-paretic upper extremity (UE), and one group with no constraint. It is unknown if using a constraint causes stress in the parents and children with HCP.

The parent and child's salivary cortisol was taken during weeks one and four. The collection of cortisol occurred at the beginning and end of the therapy day. Scoring therapy videos from weeks one and four allowed for measurements of the length of time children cried and the time parents were present during therapy. Group differences in cortisol levels were analyzed via ANOVA. A Pearson Correlation was used to examine relationships between other variables.

This study included eleven infants with a mean age of 18.73 months (SD =3.32). There were no group differences between cortisol levels for the child or parent. There was a moderate correlation between the parents' cortisol taken at the end of the therapy day and the amount of time the child spent crying r =-0.575, n =11, p =0.020. No other relationships were significant.

Results suggest no differences in stress levels between groups for either the parent or the child. Findings did indicate that when children cry during therapy, it raises the parent's cortisol level. It is unclear if this finding is unique to therapeutic processes versus a reflection of the parent/child relationship.

Mentor(s): Stephanie DeLuca (Associate Professor, VT School of Neuroscience; Department of Pediatrics VTCSOM)

Camille Bridgewater
Virginia Tech/Chemistry

What Does Water Look Like When Confined in Nanospace?

Metal-Organic Frameworks (MOFs) are crystalline porous nanostructures that are able to be uniquely tailored for specific purposes. MOFs have emerged as vessels for many applications in photo and electrochemistry due to their attractive characteristics. This study focuses on the pores of different MOFs and how the solvent environment within those pores affects ion transport and ion-pairing. We believe that the solvent in the pores is structured rather than free flowing and due to this we also think this has an impact on ion and charge transport through the MOF. To probe solvent structures' effect on ion-pairing we seek to incorporate and study ruthenium and iridium compounds when incorporated into different MOFs. For preliminary studies of the ruthenium compound, it was dissolved in various solvents and ultrafast emission data was recorded. For the iridium studies two compounds with differing ion-pairs were synthesized and incorporated into MOFs. These MOFs were characterized using various methods to verify successful synthesis. In further testing the MOFs will undergo characterization to look at how they behave when exposed to certain wavelengths of light.

Mentor(s): Amanda Morris (Chemistry)

Anthony J. Briganti
Virginia Tech/Biochemistry

Fralin SURF

Combating antimicrobial resistance: Characterizing ribosomal antibiotic binding pockets to advance bidentate design

Antimicrobial resistance (AMR) is a growing problem in modern medicine and there is a need for new antibiotic technologies to continue being able to treat common diseases. In 2019 globally, there were 4.95 million deaths associated with drug-resistant infections, and 1.27 million of these deaths were directly attributable to drug resistance. Triazole derivatives of pleuromutilin class antibiotics were also synthesized and tested experimentally for minimum inhibitory concentrations. Computational testing was able to predict the efficacy of these drugs. A potential tool for combatting antibiotic resistance is the creation of modified antibiotic molecules and novel bidentate antibiotic that targets the bacterial ribosome. A bidentate antibiotic has two known antibiotics covalently linked that simultaneously target two binding sites of the ribosome. Molecular docking studies of antibiotics were completed, and their ribosomal binding sites were characterized to determine strong candidates for the creation of high efficacy derivatives and a bidentate antibiotic. The antibiotics tiamulin, amicetin, lefamulin, and blasticidin were chosen to create the first bidentate antibiotic due to successful molecular docking studies completed with root mean square deviation (RMSD) values of approximately 2Å and low rates of errors. These strategies will reduce antibiotic production turnaround time and can increase the arsenal of tools we have to fight antimicrobial resistance.

Mentor(s): Anne Brown (Biochemistry)

Lillian Byer
Davidson College/Neuroscience

Distribution and development of ipsilateral projecting retinal ganglion cells labeled in the Sert-Cre reporter mouse

The mouse retina includes over forty different types of retinal ganglion cells (RGCs) that are typically classified by morphology, function, and/or expression of specific genes. RGCs can also be classified by whether their axons target the brain's ipsilateral (ipsiRGCs) or contralateral (contraRGCs) hemisphere. ContraRGCs are abundant and widespread throughout most regions of the mouse retina, while ipsiRGCs represent only 5% of RGCs with their cell bodies localized in the ventrotemporal (VT) crescent region. In this study, we examined how several subtypes of ipsiRGCs were spatially distributed at developmental stages before (P0, P3) and after (P14, Ad) eye opening. We labeled ipsiRGCs by crossing Sert-Cre (a.k.a. ET33-Cre) mice with a Rosa-Stop-tdT reporter line so that serotonin-expressing ipsiRGCs were fluorescently labeled. We then immunostained to label ipsiRGC subtypes. Examining ipsiRGCs in retinal whole-mounts revealed both ipsi- and contraRGCs in overlapping domains of the VT crescent as expected. We also observed that Sert-Cre::Rosa-Stop-tdT+ ipsiRGCs were scattered across over 20% of the mouse retina after eye-opening. Our immunostaining data further revealed that Sert-Cre::Rosa-Stop-tdT+ ipsiRGCs consisted of intrinsically photosensitive RGCs that express the photopigment melanopsin and subtypes of alphaRGCs. We also injected CTB, a retrograde tracer, into the ipsilateral superior colliculus to confirm laterality of RGC projections. Surprisingly, we found that some contraRGCs were also serotonin-labeled. Taken together, these results provide a more detailed characterization of a genetic tool frequently used to label ipsiRGCs and reveal novel features of the distribution of ipsiRGCs in the developing mouse retina.

Mentor(s): Dr. Michael Fox (Neuroscience, Virginia Tech)
Dr. Barbara Lom (Biology, Davidson College)

Jared Byers
Virginia Tech/Computational Modeling and Data Analytics

Epidemic Surveillance via Public Domain Sources

Using machine learning in audio recognition is a newly expanding field, which may have relevance for epidemic surveillance. We consider audio files in public domain, seeking to get an index of the amount of coughing, which can then be compared with flu cases during the years 2012-2014 in selected regions of Virginia. We use a pubicly available Convolutional Neural Network (CNN), Yamnet, that has been developed for classifying sounds. Yamnet conisders an audio file in 0.6 second intervals. Within each interval it classifies the sound from a potential list of 521 different sounds. For our audio, we considered recordings of city council meetings in several Virginia localities: Christiansburg, Fairfax, and Norfolk. We took the audio files from these council meetings and ran it through our CNN, to get a cough count signal for the years 2012-2014. However, since Yamnet is not completely accurate due to numerous reasons (such as the acoustics in the room being recorded), we quantified the accuracy by listening to at least one audio file per year per location, and manually counted coughs. Once we had the manual detection rate, we divided our raw data by that percentage, to offset the inaccuracies from the CNN. We obtained the Coughs Per Hour (CPH) from the video length, to have a standardized measurement across locations. Once we had the standardized measurement, we gathered Influenza Like Illnesses (ILI) cases from the surrounding area's clinics/hospitals, as reported to the Virginia Department of Health. Using the ILI data, we looked to see if there was a correlation between the CPH and ILI in Virginia.

Mentor(s): Shane Ross (Virginia Tech)

Hannah Cannon
Virginia Tech/Biochemistry

Molecular Basis for the Interaction of Phafin2 with the Actin Network During Macropinocytosis

Macropinocytosis is a vesicle-mediated process to allow the uptake of extracellular molecules and fluid. Recently, the protein Phafin2 has been shown to be involved in macropinocytosis at different steps, which depend upon its interaction with both phosphoinositides and the actin network. Phafin2 is modular with two phosphoinositide-binding domains, the PH and FYVE domains. During macropinocytosis, the PH domain binds both phosphatidylinositol 3-phosphate and phosphatidylinositol 4-phosphate, whereas the FYVE domain is specific for phosphatidylinositol 3-phosphate. Additionally, macropinocytic vesicle maturation depends on the actin network. Due to the requirement of actin, actin-associated proteins also play an important role in macropinocytosis. One of the actin network components, the cross-linking protein Filamin A, has been shown to interact with Phafin2, via its PH domain, in cell-based experiments. To characterize this association, we isolated the recombinant Filamin A Phafin2-binding region (PBR; residues 186-368) by conventional protein purification procedures. Using isothermal titration calorimetry, Filamin A PBR bound Phafin2 exothermically with a dissociation constant of 1.08 ± 0.40 uM, stoichiometry of 1, and a Gibbs free energy of -34.1 KJ/mol. We have obtained the NMR resonance assignments of the Phafin2 PH domain, which will allow us to identify the Filamin A PBR binding site in the Phafin2 PH domain. Given that this domain binds phosphoinositides, we also plan to explore the hypothesis that the binding of Filamin A to Phafin2 increases the affinity for phosphoinositides to proceed with the macropinocytosis process.

Mentor(s): Daniel Capelluto (Biological Sciences)

Audrey Carlson
Virginia Tech/Cognitive and Behavioral Neuroscience

Sex differences in the overlap of human and rodent cytokines and behavior in response to stress

Stress is one of the most impactful factors on how susceptible an individual is to mental health disorders, specifically mood disorders such as anxiety and depression. Females have a higher risk than men of experiencing one or more episodes of major depressive disorder but are underrepresented in literature and research. There is also a change in cytokine levels in the immune system during depression in humans and following stress in animals. We hypothesize that sex and condition (depression or stress) impact cytokines in the body and brin that relate to behavior. To test this hypothesis, we first examined correlations between peripheral circulating cytokines from depressed patients (n=78) clustered using a weighted gene network analysis (WGNA) and their correlations with symptoms identified using a Quick Inventory of depressive symptoms (QIDS). We identified a series of clusters of cytokines specific to sex and treatment resistant status that significantly correlated with eating/ sleeping behavior and energy. We used this same method to examine clustering of cytokines in relationship to behavior in male and female mice (n=40) exposed to 6 days of variable stress. In a new cohort of male and female mice (n=40) we examined cytokines altered by stress in the nucleus accumbens, a brain area associated with emotional processing. We will discuss which cytokines associated with symptoms in humans overlap with mice in the periphery and the brain. We show that we are able to back translate from humans into mice to identify cytokines that may contribute to symptoms of depression.

Mentor(s): Georgia Hodes (School of Neuroscience)

Antonio Carrington Jr.
Virginia State University/Manufacturing Engineering

Real-Time Data Acquisition and Visualization of 3-D Printers

Industry 4.0 is the driving force for digitalization, monitoring, and advanced analytics of both modern and traditional manufacturing processes. To this end, many shop floors work towards building industry 4.0-compliant systems into their manufacturing processes. This project aims to visualize the machine state of two new Stratasys F170 3-D printers based on a live data acquisition feed from the controller of each respective 3-D printer. The Stratasys 3-D printers natively expose process data such as the set point and actual position of the nozzle on the different axes, the temperature, and the print volume. We use MTConnect, a semantic vocabulary for manufacturing equipment, and a Learning Integrated Manufacturing System (LIMS) Box to collect and virtualize data. The LIMS box provides the ability to connect to MTConnect data streams and visualize collected data. The anticipated outcome of this project is to see various live data collected and add it to a dashboard that can be viewed through a server in the learning

Mentor(s): Benjamin Standfield (Industrial Systems Engineering)

Isabella Carucci
Virginia Tech/Clinical Neuroscience

TOUR

5-hydroxymethylation Specific Increases of POMC Is Not Sufficient to Slow Abnormal Weight Gain During the Development of Obesity

Obesity is a common medical condition affecting over 41% of the American population and costing over $173B in healthcare costs annually1. It is believed that genetics play a role in the development of obesity as it tends to run in families, and neuropeptides involved in appetite regulation, such as the appetite suppressant POMC, have been heavily studied in the context of obesity. It is known that the hypothalamus regulates appetite, and previous studies have shown that dysregulated gene expression in this region, especially of genes involved in controlling feeding behavior, may contribute to the onset and progression of obesity. However, little is known about what mechanisms control the dysregulation of these appetite genes during the development of obesity. The present study aimed to test if repression of POMC expression in the hypothalamus during the development of obesity occurred via epigenetic modifications. Male rats fed a high fat diet for 7 weeks showed increased DNA methylation at the Pomc promoter which correlated with reduced Pomc expression in the hypothalamus. To test if DNA methylation-mediated repression of Pomc was contributing to the development of obesity, we used the modified CRISPR-dCas9-TET1 system to demethylate the Pomc promoter in the hypothalamus of rats fed a high fat diet. However, surprisingly, this did not slow or prevent abnormal weight gain on the obesogenic diet. Together, these data suggest that while obesogenic diets result in increased DNA methylation and suppression of Pomc, this does not directly lead to the develop or progression of obesity.

Mentor(s): Timothy Jarome (Animal Science)
Taylor McFadden (Animal Science Graduate School, Virginia Tech)

Tran Chau
Virginia Tech/Statistics
Vansh Parikh
Virginia Tech/Computer Science

Examining the effect of whole genome doubling on nuclear size in human colon tumors

Whole genome doubling (WGD) occurs in over 30% of human tumors and is associated with poor prognosis. It is not fully understood how WGD affects cancer cells biologically and whether any changes associated with WGD may be of clinical value. Recently, we found that nuclear size does not always scale with changes in DNA content when diploid (WGD-) colorectal cancer (CRC) cells undergo WGD. WGD+ CRC cells that maintained smaller nuclear sizes displayed more aggressive tumor-like behavior in vitro compared to those with larger nuclei. The goal of this study was to examine the link between WGD, nuclear size, and malignancy in human tumors. To this end, we used digital whole-slide images (WSIs) of tissue biopsies from The Cancer Genome Atlas (TCGA) to measure nuclear area of tumors cells in vivo. WSIs have many thousands of cells, numerous cell types, and very large file sizes, making analysis computationally challenging. Therefore, we developed a processing pipeline using TIAToolbox–a Python-based computational pathology package– to extract cell-dense tissue regions with tumor-rich content. We then utilized HoVer-Net, a convolutional neural network, to identify and measure the nuclear area of tumor cells. Our analysis of CRC samples showed that nuclear size was higher in WGD+ compared to WGD- tumors. Additionally, nuclear area varied within WGD+ tumors, consistent with the results from our cell culture model. This analysis pipeline will be used to analyze nuclear area in other WGD+ tumors, and future studies will determine if variations in nuclear size are predictive of patient outcome.

Mentor(s): Daniela Cimini (Department of Biological Sciences, Virginia Tech)
Mathew Bloomfield (Department of Biological Sciences, Virginia Tech)

Lillian Chiang
Virginia Tech/Biological Sciences

VT-REEL

The Study of Innate Plant Defenses, Natural Pesticides, and Herbicides for Developing Solutions to Agricultural and Food Supply Issues

Crop breeding techniques typically emphasize high product yield with maximum quality and are often performed in controlled environments lacking natural predators. This reduces selective pressures on plant defense systems, resulting in a need for constant pesticide use. This study explores the resource-allocation trade-off concept using the *Brassica rapa* oilseed plant and *Trichoplusia ni* caterpillars to establish a baseline of oil yield with and without herbivore pressure. The total phenolics content within 30 families was determined through methanol extraction and colorimetric assays. We hypothesized that the phenolics content in *B. rapa* leaves would increase under herbivore pressure. The phenolics data collected established a baseline for the concentration of phenolics in *B. rapa* leaves, which will be compared with future data to assess the yield-defense trade-off and explore the possibility of generating high yield plants with natural herbivore defenses.

Weeds are one of the most detrimental biological factors that reduce crop yield. *Palmer amaranth* is a particularly harmful, prolific weed that causes extensive crop yield losses and has developed resistance against different groups of herbicides in various parts of the United States (US). This study explores the screening of 50 different *Palmer amaranth* populations collected across Virginia to various herbicides with different modes of action including: photosynthesis inhibitors, various enzyme inhibitors, plant growth regulators, and amino acid biosynthesis inhibitors. The results from this study will benefit region-specific herbicide recommendations to control *Palmer amaranth* in different cropping systems.

Mentor(s): Dorothea Tholl (Department of Biological Sciences, Virginia Tech)
Anne Jones (Department of Biological Sciences, Virginia Tech)
Susan Whitehead (Department of Biological Sciences, Virginia Tech)
Vijay Singh (Department of Plant Pathology, Physiology, and Weed Science, Eastern Shore AREC Virginia Tech)

Mufaro Chiduza
University of Maryland, Baltimore County/Biological Sciences

Individual Differences in Food Perception

Compared to minimally processed foods (MPFs), ultra-processed foods (UPFs) are taking over the modern American diet. With the rise in consumption of UPFs compared to MPFs, we seek to understand why people favor UPFs more than MPFs. It is hypothesized that UPFs contain greater rewarding properties over MPFs and this is driven by the gut-brain axis. Here, we seek to generate a picture set that can be used to probe the role of food processing on food reward. To this end, we used Amazon Mechanical Turk (mTurk) to collect data for our study. Participants were given a survey in mTurk and asked to rate 60 food pictures on variables including liking, familiarity, estimated food cost, estimated satiety, and estimated healthiness. Utilizing these food ratings and the demographics of mTurk survey participants, these data demonstrate how an individual's demographical background influences how much they like and value foods, whether these are UPFs or MPFs. From this research, emulating past studies, future work includes participants completing an auction task, similar to the mTurk survey format, with concomitant fMRI to analyze brain activity while participants make these subjective food ratings. Combining fMRI data and participants' food ratings, we seek to understand further how individuals value MPFs and UPFs differently, further answering why a food's influence on reward & behavior is linked to the growing obesity epidemic.

Mentor(s): Alexandra DiFeliceantonio (Center for Health Behaviors Research)

Sera Choi
Virginia Tech/Biological Sciences
Keyton Feller
Virginia Tech/Macromolecular Science & Engineering
John Will
Virginia Tech/Mechanical Engineering

Vat Photopolymerization of Soy-based Resin for Tissue Scaffolds

Tissue scaffolds are created to be implanted into the body and mimic the body's internal environment to provide structural support for cells and promote migration, proliferation, and nutrient and gas exchange. Traditional fabrication techniques are limited because successful scaffolds have to imitate many tissue features, such as pore size, shape, and distribution. To overcome these drawbacks, vat photopolymerization (VP) is being investigated for the advancement of tissue engineering and implantation. A type of 3D printing, VP uses light projected onto a photocurable resin to build layer-by-layer scaffolds of interest for tissue engineering.

However, it is hard to find biocompatible materials that are also printable. This study is experimenting with a soy-based resin printed with polyethylene glycol diacrylate (PEGDA) and the goal is to demonstrate its applicability for in vitro tissue regeneration. Different pore sizes and orientations will be tested with different scaffolds to test what range is optimal for this resin.

These scaffolds are created with the Ember, a 3D printer that uses vat photopolymerization. Three different geometries will be printed and their properties compared: Truncated Octahedron, Isotruss, and Voronoi Lattice. These first two are only achievable through 3D printing while the third mimics traditional scaffold geometries. Pore size will range from 300 - 600 μm with an expectation that scaffolds with larger pores (ca. 500 ~ 600 μm) should have more cell growth because of their increased access to nutrients and oxygen. Printed scaffolds will be characterized for pore size and orientation via microscopy, water content, and degradation temperature.

Mentor(s): Abby Whittington (Materials Science and Engineering)
Christopher Williams (Mechanical Engineering, Virginia Tech)

Hajar Chokhmane
Virginia Tech/Mechanical Engineering

Effects of Nanoscale Surface Topography on Adhesion and Near-Surface Behavior of Candida albicans

Healthcare-associated infections (HCAIs) cost $35-45 billion a year and are associated with a 6% mortality rate, which is more than the total annual mortality rate of breast and colon cancer combined. Microbial biofilm formation on medical devices is a leading cause of HCAIs. The emergence of antibiotic-resistant strains combined with limited penetration of antimicrobial compounds into biofilms are increasingly limiting the available options for chemical treatment of biofilms. We and others have shown that introducing micro-/nano-scale surface textures is an effective non-toxic approach for significantly hindering microbial adhesion, the first critical step of biofilm formation. Close examination of the interactions of microbes with nanoscale surface topography is necessary to further understand the biophysical and biological processes involved in the reversible attachment of microbes to surfaces to enable the design of optimal anti-adhesion topography. In this research, we studied these interactions by texturizing the surface with aligned nanofibers of well-defined diameters and controlled spacing. We investigated the near-surface movement and kinetics of adhesion of the non-motile fungal pathogen Candida albicans. Our results show that live C. albicans single cells select energetically favorable adhesion locations, despite their lack of motility. Future work will focus on unraveling the biological underpinning of this behavior.

Mentor(s): Bahareh Behkam (Department of Mechanical Engineering)

Julia Coan
Virginia Tech/Wildlife Conservation

Investigating the Eastern Distribution of Aneides aeneus in Virginia

The Green Salamander, Aneides aeneus, is a terrestrial salamander that utilizes rock outcrops in forested areas for breeding, foraging, and hibernation. Green Salamanders require cool, moist crevices to prevent desiccation and have been found foraging in nearby trees in humid conditions. Aneides aeneus ranges throughout thirteen states in the Eastern United States. The Virginia population has been previously documented from the Appalachian Plateau and Valley and Ridge regions. The goal of the project was to identify the eastern boundary of this range. Aneides aeneus is listed as a species of greatest concern in Virginia, and therefore it is important to know the full extent of the geographic distribution for conservation of the species. In the past, researchers used GIS to find sites, but because this is a time-consuming process, we retrieved data from the Virginia Department of Conservation and Recreation (DCR). Using Light Detection and Ranging (LiDAR), we identified potential study sites from Digital Elevation Models (DEMs). We conducted daytime searches by locating rock faces identified from DEMs and scanning crevices with flashlights. Aneides aeneus was present in the counties of Tazewell, Wythe, and Bland. Green Salamanders had previously been found in these counties, but we extended the eastern extreme of their range in Bland County further into the Valley and Ridge region. In the future we hope to continue to extend the range to accurately represent their distribution.

Mentor(s): Holly Kindsvater (Department of Fish and Wildlife in the College of Natural Resources and the Environment)
Kevin Hamed (Department of Fish and Wildlife, College of Natural Resources and the Environment, Virginia Tech)
Charlie Holguin (Department of Fish and Wildlife, College of Natural Resources and the Environment, Virginia Tech)

Josh Cole
Virginia Tech/Electrical Engineering

Small Scale Asset Management

Asset Management will play a critical role in achieving climate change goals. With proper Asset Management, sustainability projects like a green energy mix or a passive building become more realistic and achievable. Asset Management is a shift in categorizing priorities, along with an adjustment in mindset toward current facilities management practices. The original practices currently in use were initially developed at a time when green practices and sustainability procedures were a significant afterthought to industrialization and increased production. A study done by the Town of Blacksburg and Virginia Tech in 2014 proposes a new system that defines and reaches particular levels of Performance, Sustainability, and Resilience. From here a more refined prioritization index can be associated with a particular asset to help further define its business and economic case. In addition, Asset Management is understanding the overarching mission of the associated institution to better examine why this asset exists in the system and what role it plays in supporting that mission. With these shifts in the general paradigm, along with the collection and use of good data, more healthy and efficient systems can be created, leaving room and resources for critical green projects such as the installation of renewable energy or the construction of highly sustainable buildings. Asset Management creates a stronger foundation by being more proactive and efficient with the assets and resources at one's disposal.

Mentor(s): Jennifer Benning (Engineering Education)

Lander Comhaire
Virginia Tech/Medicinal Chemistry

Discovery of Antimalarial Drug Candidates Inspired by MMV008138

Over 600,000 individuals are dying every year due to malaria, most of which are due to Plasmodium falciparum. Field resistance has been observed to all clinically used antimalarials and thus there is a major need for new drugs. Inspired by MMV008138, an antimalarial candidate found to effectively inhibit the IPP pathway of the malaria parasite, a series of analogs can be synthesized to create a new effective antimalarial. Interestingly, these structurally similar compounds exert their antimalarial action by a different and as of yet unknown mechanism. Using organic synthesis techniques two analogs were created and one was sent for bioassay. This compound was found to be effective with a IC50 of 249 nM (preliminary), which is similar to the potency of MMV008138. Although the IC50 value ideally would be lower, progress is being made in drug discovery of new antimalarials.

Mentor(s): Paul Carlier (Department of Chemistry)

Annabel Coyle
Virginia Tech/Biology

Influenza seasonality assessed through climatic variables and indoor activity across the United States

Influenza outbreaks have occurred yearly over the past century in a seasonal fashion, infecting tens of millions and killing thousands each year. The nature of the factors underlying the seasonal outbreak patterns across climate zones is yet to be fully understood. Data science techniques were used to study the relationship between meteorological factors, human behavior, and the effective reproduction number (Rt) of influenza in three geographically diverse states over the 2018-2019 winter. This analysis employed weather data from National Oceanic and Atmospheric Administration (NOAA), indoor activity data from a study of cell phone records, and influenza incidence data from state health departments. R language and RStudio were utilized to clean, analyze, and visualize these variables. Previously, absolute humidity (AH) was shown to have the greatest predictive relationship with Rt across climates in China in a seasonal U-shape association. This was found not to be the case in the U.S., where weekly AH did not explain the increase in weekly mean Rt ($R^2 < 0.5$) in five out of six counties. Conversely, other researchers have proposed relative humidity (RH) and dry bulb temperature (DBT) to modulate the seasonality of influenza. Thus, a linear regression model combining DBT, RH, and indoor activity showed a more clear polarity between regions; in general, there were strong relationships with weekly mean Rt in northern counties ($R^2 > 0.5$) and weak relationships ($R^2 < 0.2$) in southern counties. These findings suggest that the best predictors of influenza outbreaks may be a combination of behavioral and meteorological variables. Differences between climate zones should be considered further.

Mentor(s): Linsey Marr (Civil and Environmental Engineering)

Abigail Craig
Virginia Tech/Cognitive and Behavioral Neuroscience

The Lack of an Effect of Exercise on CA2 Mitochondrial Morphology

CA2 of the hippocampus is a critical area involved in social memory, distinct from other hippocampal regions due to its unique mitochondrial gene expression and layer-specific plasticity profiles. Follow-up studies revealed that CA2 dendrites possess molecularly and structurally distinct populations of mitochondria that correlate with the layer-specific plasticity profiles. Mitochondria in CA2 distal dendrites appear larger in size, yet fewer in number, resulting in more tubular mitochondria precisely where robust synaptic strengthening occurs.

Extant literature demonstrates that exercise increases both synapse and mitochondrial number in CA1 and DG, suggesting that mitochondria may power exercise-induced changes in synaptic plasticity; however, exercise's effect on CA2 mitochondria remains unknown. Exploring this relationship may demonstrate how exercise differentially affects diverse populations of mitochondria across CA2 dendrites, potentially influencing the plasticity underlying social memory.

One experimental group of mice received home-cage enrichment from a running wheel for 30 days while the control group did not. We hypothesized that voluntary exercise would increase CA2 mitochondrial mass due to exercise-induced changes in energy demand. Immunohistochemistry for the mitochondrial electron transport chain protein Cytochrome C Oxidase Subunit 4 (COX4), was performed and mitochondrial mass across CA2 dendritic layers was compared between groups. No significant differences were found between running wheel versus control mice in either dendritic layer. Analyses are underway in CA1 and DG to determine the effect of exercise on mitochondrial mass in these regions. The distinct mitochondrial properties of CA2 neurons may have prevented the exercise-induced increase in mitochondrial mass seen previously in other hippocampal regions. These data underscore the potential influence of mitochondrial heterogeneity across specific cell types and circuits.

Mentor(s): Shannon Farris (Fralin Biomedical Research Institute at Virginia Tech Carilion)

Kara Crudup
Virginia Tech/Animal and Poultry Science

The Ethno racial Aspects of Minority Participation in Private Land Conservation: an examination of African American landowners

For generations, African Americans have been systemically hindered as farmers and land owners. The goal of this literature review is to synthesize current information on African American landowners who participate in private land conservation to focus on strengthening these programs and meeting the needs of African American communities. This study is part of a broader effort that will examine underrepresented groups, such as gender, sexuality, ethnoracial, and socioeconomic groups. This data will be used to improve conservation, inclusivity, accessibility, and research as a whole. The objective of this research is to: (1) evaluate African American landowners' motivation for participating in conservation programs and (2) identify documented barriers to African American landowner participation in conservation programs. We conducted a systematic literature review whereby we searched a combination of keywords in Google Scholar, examined the first 50 results, and consolidated the articles that met our criterion to develop a body of applicable literature. After that, a team of three researchers coded relevant articles to find recurring themes. Existing literature revealed that African American participants in these studies face many barriers to participating in federal programs including lack of culturally-relevant outreach, past/present discrimination, lack of funding, and overall psychological stress influencing their sense to participate in these programs. The results from this study will be used to inform conservation program development and modifications to promote a conservation direction that is inclusive and responsive. This effort will make it easier to provide conservation opportunities for underrepresented populations both now and in the future.

Mentor(s): Ashley Dayer (Department of Fish and Wildlife Conservation, College of Natural Resources and Environment)
Kathleen Holland (College of Natural Resources and Environment)

Dominique Cruz
Virginia Tech/Clinical Neuroscience

Observations of mitophagy in the developing tadpole brain, despite deletion of Parkin and PINK1 from the amphibian genome

Mitophagy is the primary cellular mechanism for removing unhealthy mitochondria, and mutations in genes that mediate mitophagy are associated with a variety of diseases in humans, such as Parkinson's. African clawed frog (Xenopus laevis) tadpoles are an excellent animal model for time lapse, in vivo imaging of subcellular structures like mitochondria, yet there are no published studies on mitophagy in amphibians. To fill this gap, we conducted genomic analysis and in vivo imaging to characterize mitophagy in the developing tadpole brain. We used the NCBI genome database to blast human sequences of ten critical mitophagy-related genes against all available amphibian genomes. To our surprise, two well characterized mitophagy genes are missing in amphibian genomes: Parkin and PINK1. To determine if mitophagy occurs in tadpoles, we challenged mitochondria by intracerebroventricularly injecting FCCP (10uM), a mitochondrial uncoupler, in brains that had mitochondria labeled with either TMRM (a fluorescent indicator of mitochondrial membrane potential) or electroporated with TOMM20-Emerald. We imaged mitochondria prior to treatment and 1hr post-treatment and analyzed changes in mitochondrial networking. FCCP induced mitochondrial fission and increased mitochondrial size, indicative of early stages of mitophagy. Last, we injected FCCP into brains electroporated with TOMM20-Emerald, euthanized tadpoles three hours later, and immunostained for GFP and LC3, a marker of mitophagy. Results showed LC3 recruitment to FCCP-treated mitochondria, suggesting that LC3 mediates mitophagy in amphibians. Together, these experiments show that while amphibians lack the full complement of mitophagy-related genes as seen in mammals, they are still capable of mitophagy, potentially mediated by LC3.

Mentor(s): Chris Thompson (School of Neuroscience)

Deena Daneshvaziri
Virginia Tech/Clinical Neuroscience

Necessity of Post-ingestive Signals in Food Reward and Motivation

Post-ingestive signals from the gut are relayed to dopamine (DA) cells in the midbrain and are believed to play a role in food reward and motivation. Midbrain DA cells include cells in the substantia nigra (SNc) that project to the dorsal striatum (DS). Direct infusion of calories to the gut, in the absence of oro-sensory input, increases DA levels in the DS. We designed a set of experiments to characterize the necessity of DS post-ingestive DA signals in food reward. A Cre-specific virus coding channelrhodopsin-2 (CHR2) was infused into the SNc of transgenic DAT-Cre mice to express a light activated cation channel in DS projecting DA neurons. Fiber photometry allowed visualization of DA dynamics within the DS. Mice were tested in a food preference paradigm with three different food types. We first established each mouse's preferred foods. Next, a series of nine training days occurred where mice freely consumed each food in a novel environment. After consuming their least preferred food, mice were optogenetically stimulated for ten minutes to augment post-consummatory, presumably post-ingestive DA release. The other food types were paired with sham stimulation. Each food/stimulation pairing occurred three times. We then tested their food preference a second time. There was an overall increase in food consumption across food types following optogenetic stimulation. Interestingly, we found a five-fold increase in foods paired with optogenetic stimulation compared to sham stimulation. These results provide support for post-consummatory, post-ingestive DA release in the DS in food reward.

Mentor(s): Matt Howe (Neuroscience)

Arianna Davis
Florida A&M University/Chemistry/ Pre-Dental

Characterization of Enzyme Binding

Enzymes have the potential to be an efficient, environmentally friendly tool to degrade polymers that pollute the environment. To be able to harness the potential of enzymes we must first understand how they bind to polymers and degrade them. As a result of this study, there will be a better understanding of the binding interactions and degradation kinetics of enzymes on polymer surfaces. Initially, trimethylsilyl (TMS) derivatives of cellulose and chitin were synthesized, these derivatives are more soluble than their original form which allowed us to create uniform model surfaces. Nuclear magnetic resonance was used to determine the chemical structure and the quality of the polymer derivatives. These soluble derivatives were used to spin coat polymer films of varying thickness. These films were then analyzed by a quartz crystal microbalance with dissipation monitoring and surface plasmon resonance, to study enzyme binding and the degradation kinetics of cellulose and chitin. Qualitative data for the kinetics and binding of cellulase enzymes have been determined and work is ongoing to determine how film thickness and environmental conditions affect the binding and degradation process.

Mentor(s): Alan Esker (Chemistry)

Kalin Davis
Virginia Tech/Wildlife Conservation

Understanding the Influence of American Black Bear Foraging Patterns on the Spread of Invasive Plants in the Central Appalachian Mountains

Invasive plants can outcompete native plant species that wildlife depends on for food and cover. In Virginia, wineberry (Rubus phoenicolasius) is an invasive species of concern for the Virginia Department of Wildlife Resources (DWR) because it outcompetes native species, including black raspberry (Rubus occidentalis), red raspberry (Rubus idaeus), and blackberry (Rubus fruticosus). We have found wineberries as a common food source in some American black bear (Ursus americanus) diets via video cameras placed on 15 black bear collars in 2018-2019. We used this data to better understand the presence and extent of invasive species in black bear diets and document where bears eat and potentially spread this species on the landscape. We identified all plant species in video data consumed by black bears and tested for differences in foraging proportions and rates on both invasive and native plant species to determine whether bears appeared to prefer invasive species. Preliminary results for the 2018 data set show that female black bears consume invasive species, primarily wineberries, exhibiting a higher proportion in their diet than males (0.42 and 0.03, respectively). We also used locational data from the collars taken at the same time as each video and plotted where on the landscape bears consumed invasive species to aid in predicting the spread across the Central Appalachian Mountains. We also assessed if bears consuming invasive species are centralized in a single region or are widespread across the landscape. This information can assist DWR in targeting invasive species removal on the landscape.

Mentor(s): Marcella Kelly (Fish and Wildlife Conservation)

Jean-Luc DeRieux
Virginia Tech/Electrical Engineering
Christopher Kao
Virginia Tech/Aerospace Engineering

Cost-Effective Sensing Network For Forage Systems Management Through Methane Detection

Global warming in the 21st century is at an all-time high. With the polar ice caps melting in the North and the global temperature rise, The National Science Foundation has been researching ways to combat this rise and stabilize the climate. The leading cause of this exponential rise in temperature is greenhouse gases. These gases consist of carbon dioxide (CO2), nitrous oxide (N2O), fluorinated gases, and methane (CH4). Of those four greenhouse gases, methane is the most potent. Compared to CO2, the greenhouse warming potential of CH4 is 25 times greater.

One of the biggest producers of methane is agriculture, primarily cattle, and other livestock. Understanding how much methane a farm will produce throughout a week or month will help us understand how to mitigate the increase in methane emissions. Thus, we are developing a cost-effective sensor network methane detection system for continuous herd CH4 production monitoring and localization.

Each node of the designed autonomous IoT system would be attached to a single cow and would record the Methane produced for various time intervals of a day, a week, and a month. The acquired data would help farmers understand the magnitude of the produced methane by their livestock. This is also to evaluate various forage types consumed by the livestock. The results of this study will help farmers and researchers to improve forage systems management.

Mentor(s): Hasan Seyyedhasani (School of Plant and Environmental Sciences)

Eva DeTroia
The College of New Jersey/Biology

VT-REEL

Chromosomal Mapping of Genes Controlling Resistance to Pythium Disease in Soybean and Screening of Palmer amaranth Populations for Herbicide Resistance

Soybeans (Glycine max (L.) Merr.) are a significant oil and protein crop grown worldwide. Annual soybean yield is reduced by various diseases such as the Pythium pathogen. In this study, a recombinant inbred line (RIL) population resulting from the cross of PI 408097 (resistant) by Williams (susceptible) was screened with three different species of Pythium. Disease reaction data was collected on 300 RIL individuals, and DNA samples from the same RILs were used for molecular marker data collection focusing on soybean chromosome 8. Based on the results from a previous study, our focus was on soybean chromosome eight. Using simple sequence repeat (SSR) DNA markers from chromosome 8, all RILs were genotyped. Disease reaction and marker data were analyzed using JoinMap and MapQTL computer programs. Two regions on chromosome 8 were associated with resistance to the three Pythium species. DNA markers from these regions should facilitate the development of Pythium-resistant soybeans.
Research at the Eastern Shore AREC focused on screening various populations of Amaranthus palmeri for resistance against herbicides of different chemical groups. A. palmeri, commonly known as Palmer amaranth, is known for its noxious characteristics and profuse growth, which create significant issues in crop yield reduction. Palmer amaranth has developed resistance to various herbicide modes of action in different parts of the United States. In this study, we grew fifty populations collected across Virginia, testing nine different herbicides within a controlled environment. Results from this study should help develop herbicide recommendations for Palmer amaranth management in various crops.

Mentor(s): M. A. Saghai Maroof (Department of Crop and Environmental Sciences)
Elizabeth Clevinger (Department of Crop and Environmental Sciences, Virginia Tech)
Ruslan Biyashev (Department of Crop and Environmental Sciences, Virginia Tech)
Vijay Singh (Department of Weed Science, Virginia Tech)

Maria Dorodnitsyna
Virginia Tech/Biochemistry

PDGF/VEGF-related receptor PVR in mosquitoes is involved in juvenile hormone signaling from the plasma membrane

Infectious diseases like malaria and zika fever are transmitted from female mosquitoes to humans through blood feeding as part of their reproductive cycle and are a leading cause of death in many developing countries. Growing mosquito resistance to pesticides currently on the market creates an urgency to investigate mosquito biology to find new targets that can be used for disease control. Juvenile hormone (JH) plays an essential role in mosquito egg maturation, acting via an intracellular receptor and a membrane receptor. The membrane receptor that binds JH to initiate the signaling pathway has not yet been identified. Our preliminary study suggests that PDGF/VEGF related receptor PVR is a top candidate for this role. To test this hypothesis, we performed RNAi-mediated knockdown of PVR in adult mosquitoes and CRISPR knockout in mosquito cell culture and measured JH-induced gene expression and protein phosphorylation. qPCR analysis indicates that PVR depletion caused a significant reduction in expression of the JH-controlled Krüppel-homolog 1 gene both in vivo and in vitro. Using western blot we observed that the JH-regulated phosphorylation of Serine/arginine-rich splicing factors was weakened after PVR knockout. Knockdown of PVR also repressed oocyte growth in adult females. These results suggest that PVR is indeed involved in juvenile hormone signaling. The elucidation of the juvenile hormone signaling pathway, especially the receptor binding JH, can facilitate the development of new pesticides with high mosquito specificity for disease control in the future.

Mentor(s): Jinsong Zhu (Biochemistry)

Jonathan Dotson
Virginia Tech/Human Nutrition, Foods, and Exercise

TOUR

Comparing the "Flex" Metabolic Chamber and the Metabolic Cart for Resting Energy Expenditure Measurements

"Flex" chambers are smaller (4.6 m3) metabolic chambers designed to accommodate a bed and measure an individual's resting energy expenditure (REE), typically for shorter durations than a larger, whole-room chamber (6 vs. 24 hours). Despite their potential to fill a niche between the metabolic cart and whole-room chamber in REE studies, few flex chambers exist, and little research has explored their applications. The purpose of this study is to compare data collected via metabolic cart and flex chamber to validate the flex chamber against an established REE measurement tool and to discuss potential applications of the flex chamber not satisfactorily fulfilled by the metabolic cart in REE studies. In a repeated measures design, metabolically healthy participants undergo REE measurements with both a metabolic cart and flex chamber. Measurements from 20 minute periods are averaged to approximate daily REE for comparison. Data collection is ongoing. Preliminary results indicate flex chamber REE measurements are mostly consistent with metabolic cart measurements, with the average REE being only 4.56 kcal (median=17.85) lower than metabolic cart measurements under similar conditions. A potential benefit of the flex chamber over the metabolic cart for REE studies is participant comfort, given the bed and lack of additional equipment. A metabolic cart often involves apparatuses which may be uncomfortable for participants and motivate them to move throughout the study to become more comfortable, which would inaccurately increase the measured REE. Future studies comparing the flex chamber and metabolic cart should examine differences in participant movement.

Mentor(s): Alexandra DiFeliceantonio (Human Nutrition, Foods, and Exercise)

Hailey Draper
Roanoke College/Environmental Studies

Participation in Private Land Conservation: an Examination of Women Landowners

How can environmental conservation programs most effectively serve historically underrepresented groups? In order to generate informed change in these programs, these organizations must first develop an understanding of what could prevent or encourage these groups in their participation. The goal of this research is to understand the motivations and barriers behind women's participation in private lands conservation programs. This study is part of a larger project examining underserved groups including ethnoracial, gender, and socioeconomic status. We conducted a systematic literature review utilizing combinations of keywords to develop search terms. We reviewed the first 50 results on Google Scholar for each combination. Each article that met our criterion was coded for analysis. Our findings indicate that women have diverse motivations (e.g. personal stewardship, financial) for participating in conservation programs but still face significant barriers (e.g. access to information, discrimination). Further, literature to date tends to assume gender as a binary. This stifles accuracy and inclusion and is a barrier to comprehensive understanding of the topic. Addressing this issue in all phases of research, from project design to publication, will be critical as the conservation community moves forward in program planning and engagement. Results from this study will be used for conservation planning and training related to federal conservation programs, as well as to inform conservation planning and outreach with the goals of increasing accessibility, inclusivity, and conservation.

Mentor(s): Ashley Dayer (Department of Fish and Wildlife Conservation)
Dr. Katie Holland (Department of Fish and Wildlife Conservation, Virginia Tech)

Katherine Duffett
Virginia Tech/Clinical Neuroscience

TOUR

Comparing the Effects of Voluntary Wheel Running on Complex Hippocampal Learning and Memory in C57 Versus C57/FVBN Mice

Exercise is a mechanism for weight regulation and obesity prevention; however, globally, and especially in the United States, physical activity rates are low while obesity rates are high. Obesity is linked with impairments in many neurobehavioral functions including learning and memory. Exercise can enhance hippocampal-dependent learning and memory; however, the physiological mechanisms underlying this effect are not well understood. Our laboratory seeks to understand how voluntary wheel running in rodents promotes alterations in hippocampal circuitry and the resulting behavioral outcomes. In our behavioral paradigm, mice are randomly selected to either receive an unlocked or locked wheel for 35 days. After this period, mice perform a Cheeseboard Task in which they are required to recall where sugar water rewards are located on a circular board across multiple days. Memory performance is quantified by the time spent in the reward quadrant. Previously this paradigm was performed in our lab on hybrid C57/FVBN mice due to their high learning and memory capacity. In this group (contrary to literature and our hypothesis), we found that running in our voluntary exercise paradigm did not significantly enhance complex hippocampal spatial learning and memory. We hypothesize that this may be due to a ceiling effect of cognitive function. Therefore, we conducted this same paradigm using C57 mice that have significant lower levels of baseline learning and memory performance, hypothesizing that the exercise-induced effects on hippocampal learning and memory would be more robust than in hybrid mice.

Mentor(s): Julia Basso (Virginia Tech)
Dr. Daniel English (Neuroscience, Virginia Tech)
Dr. Deborah Good (The Department of Human Nutrition, Foods, and Exercise, Virginia Tech)

Jessica Evans
Penn State University/Biomedical Engineering

Gatekeeper Connexin43 Phosphorylation Events Regulate Cardiac Gap Junction Coupling During Stress

Heart disease remains the leading cause of death worldwide. Gap junctions couple cardiomyocytes and propagate action potentials to effect cardiac contraction. Pathological alterations to the cardiac gap junction protein connexin43 (Cx43) impact gap junction function and localization, causing arrhythmias. Post-translational modification of Cx43 occurs rapidly during stress, with phosphorylation of serine residues impacting gap junction function. Specifically, phosphorylation at Cx43-Ser368 by PKC reduces gap junction function and induces channel internalization. Phosphorylation of Cx43-Ser365 and Ser373 negatively and positively impact Ser368 phosphorylation, respectively, but how dynamic phosphorylation of, and the interplay between, these 'gatekeeper' residues control gap junction loss is unknown. We hypothesized that prevention of Cx43-Ser373 phosphorylation would be cardioprotective through limiting Ser368 phosphorylation, preserving normal gap junction localization. To test this, we generated single and multiple serine-alanine mutations at Ser365,368, and 373 in Cx43 by site-directed mutagenesis. Additionally, transgenic mice harboring serine-alanine mutations at Cx43-Ser368 (PKC) or Ser365/Ser373 (AKT) were utilized of ex vivo studies where freshly explanted hearts were exposed to acute ischemia. By western blot we find that while AKT hearts had higher basal levels of pCx43-Ser368 this was completely abolished during 15 min ischemia while Cx43-Ser368 was hyperphosphorylated in wild-type hearts. To investigate changes to gap junction localization we employ Triton X-100 solubility assays complemented with confocal immunofluorescence microscopy. Ectopic expression of Cx43 mutants in GJA1 knockout cells will enable further interrogation of the interplay between these gatekeeper residues and inform therapeutic targeting of Cx43 phosphorylation in stressed hearts to preserve normal intercellular communication.

Mentor(s): James Smyth (Department of Biological Sciences, College of Science)

Isabella Faulkner
Virginia Tech/Cognitive and Behavioral Neuroscience

Impact of Perinatal exposure to the SSRI citalopram on hippocampal dendritic spine density

Millions of pregnant/postpartum women suffer from depression and are often prescribed selective serotonin reuptake inhibitors (SSRI) antidepressants. Human studies show that perinatal SSRI exposure alters neurodevelopment and increases risk for psychiatric illnesses like depression. Rodent studies find similar behavioral changes following perinatal SSRI exposure, and our lab found that it also dramatically disrupts gene expression in the developing hippocampus. This data led us to hypothesize that perinatal SSRI exposure alters formation of new synapses in the hippocampus. Thus, our study treated Sprague Dawley rat mothers with the SSRI citalopram 10 mg/kg/day in drinking water throughout pregnancy and the postpartum period. Control females received normal water. Offspring brains were collected at either postnatal day (P)14 when maximal SSRI-induced gene expression changes occur; or P60 (adulthood) when increased depression-related behavior occurs in perinatal SSRI-exposed offspring. Golgi staining was used to visualize CA1 hippocampal neurons and dendrites (n=5 rats per group at each age). Our results so far show that perinatal SSRI exposure does not impact dendritic spine density in the CA1 P14 hippocampus compared to the control. Ongoing work will examine dendrite density in other brain regions and examine other aspects of dendrites in P14 and adult offspring (e.g. Scholl analysis to observe dendritic complexity). Future work will aim to understand how perinatal SSRI-induced changes in hippocampus contribute to observed emotional and social behavior abnormalities.

Mentor(s): Sarah Clinton (Neuroscience)

Aqsa Fazal
Hollins University/B.S. in Chemistry with a Concentration in Biochemistry

Amphibian feeding mosquitoes are potential vectors of viruses

Amphibian populations have been consistently declining, directing some species toward extinction. Culex territans is a mosquito species that feeds on amphibian hosts, particularly frogs, and is a known vector of parasites. Many mosquitoes in the Culex genus carry viruses, but no research has been done on this species' capacity to transmit viruses of veterinary or human significance. Ranaviruses infect amphibians, reptiles, and fish and have been the cause of mass die-offs in amphibian populations. These viruses are commonly transmitted through amphibian contact or exposure to infected water, but the role of arthropod vectors, such as Cx. territans, is currently unknown. We hypothesized that Cx. territans is transmitting ranavirus to its amphibian hosts. To test this hypothesis, we first tested field-caught mosquitoes and frogs for ranavirus at Mountain Lake Biological Station (Pembroke, VA). We focused on collecting Cx. territans mosquitoes as well as two of their hosts, the green frog Lithobates clamitans and the bullfrog Lithobates catesbeianus. Blood fed mosquitoes and frog blood were screened for ranaviruses using cell culture overlay assays followed by DNA extraction and PCR for any positives. Ranavirus was found in several samples, indicating Cx. territans can uptake ranavirus and could potentially be ranavirus vectors and help amplify transmission to amphibian species they feed on. This research will add another piece to the puzzle of ranavirus epidemiology.

Mentor(s): Chloe Lahondere (Biochemistry)
Jonathan Auguste (Department of Entomology, Fralin Life Sciences Institute, Virginia Tech)

Nicky Fillo
Virginia Tech/Computer Engineering

Utilizing a VR System to Control the Quadruped Squeaky

The main motivation of this work is to allow the user to visualize and control a robot using an immersive environment for the user implementing Virtual Reality (VR) technologies. For this purpose, an in-house developed quadruped robot “Squeaky” has been used to provide visual assistance during its operation with the use of VR technologies. To achieve the visual assistance in real-time, the livestream of two different webcams feed into the VR headset using HTC Vive, Unity Software, and the Steam VR SDK. This creates a stereoscopic effect and the illusion of depth that allows the user to feel more immersed. The rotation values of the headset are sent to Squeaky using a TCP/IP connection for controlling the robot through VR. Thereafter, the movement of Squeaky is configured to follow the rotation of the headset and further, that allows it to rotate Squeaky following the user's movements. Presently, Squeaky can be able to rotate utilizing VR, however, the work will be further improved for allowing the robot to move freely using VR joysticks as well as autonomously. With the easy accessibility of the VR technologies, this work can be useful for education as a learning and experimental platform for human-robot interaction.

Mentor(s): Alexander Leonessa (Mechanical Engineering)

Joseph Frascogna
Mississippi State University/Physics

Modification of ProtoDUNE Cosmic Ray Tagger Calibration Code

Cosmic rays that are incident on Earth's atmosphere have the potential to produce energetic muons which can act as a source of interference in high-energy particle physics experiments. As an example, neutrino experiments using Liquid Argon Time Projection Chambers (LArTPC) such as the upcoming Deep Underground Neutrino Experiment (DUNE) and Micro Booster Neutrino Experiment (MicroBooNE) are affected by these cosmic ray muons due to the possibility that a high-energy muon may pass through the LArTPC and be incorrectly associated with a neutrino interaction. In order to account for this interference, a Cosmic Ray Tagger (CRT) is employed to reconstruct the path of the muons as well as their timing relative to the neutrino detector. The CRT utilizes layers of scintillation modules to track and time the crossing of the muons through the CRT in order to reduce the cosmic ray background present in the neutrino detector. I will detail the process of refining the calibration code for the CRT that is to be used in DUNE's prototype, ProtoDUNE.

Mentor(s): Camillo Mariani (Department of Physics)

Alexis Freilich
Virginia Tech/Biochemistry

The Released Metabolites and Proteins of Soybean Seeds in Relation to Germination

There are approximately 4.4 billion bushels of soybeans produced per year in the US, with a net value of about 57.5 billion dollars. They provide a source of protein, food, and oil worldwide. Soybean seeds are high in phytic acid, a compound that is used by the plant to store phosphate. When a soybean seed is consumed, phytate can be excreted unmodified, which in freshwater ecosystems can lead to environmentally detrimental algal blooms. In addition, phytic acid binds divalent cations, reducing the availability of important ions such as magnesium and calcium to livestock. Genetic engineering has led to two different low phytate soybean lines, but these lines exhibit low seedling emergence. As previous work established that low phytate lines released more biomolecules relative to their wild-type counterparts, we assessed the extracellular metabolomes and proteomes of the soybean lines that were used to engineer low phytic acid soybeans. Characterizing these differences may help identify how phytic acid levels are linked to low soybean emergence.

Mentor(s): Richard Helm (Department of Biochemistry and GlycoMIP)

Zachary Fuge
Virginia Tech/Mechanical Engineer

Electrical Design Of A Humanoid Robot (PANDORA/ESCHER)

In this work, the development of a cost-effective humanoid robot is the target. The primary goal of this specific project is to update the original electrical design on PANDORA, a 3D printed humanoid robot. With the secondary goal is to use the updated electrical design and apply it to an older humanoid (ESCHER). The purpose behind updating the electrical design is the improvement of hardware, new circuit designs and addition of new features. These are all combined into a in-house design sensor shield and motor shield which include: localization, current sensing, encoder I/O, Force Sensor I/O, CANBUS communication protocol I/O. The processes followed in the development and design of the new boards were establishing the needs of the project. Then breadboarding the circuits to verify that a desired result is achieved. Finally using AUTODESK EAGLE to design the in-house sensor shield and motor shield for fabrication. To confirm that circuits are functioning as intended, oscilloscopes and sensor experimentation validation methods are utilized. Features that are verified to confirm functionality are, Direction Output, PWM Output, absolute and quadrature encoders, linear-force sensors, and the CANBUS communication protocol. The outcome of this project is to use this new electrical design to build and test better controllers onto PANDORA and ESCHER for autonomous motion.

Mentor(s): Alexander Leonessa (Mechanical Engineering)

Samuel Garifo
Hampden-Sydney College/Psychology

Mapping of Harmful Algal Blooms (HABs) in New Zealand Lakes using Drones

Harmful algae blooms (HABs) are a pervasive danger in freshwater systems worldwide. HABs are caused by an overgrowth of cyanobacteria that can produce toxins, called cyanotoxins. Warming water temperatures and pollution in the form of excess nutrients can influence the growth and intensity of a HAB. Toxic blooms are a danger to people, aquatic mammals, fish, and birds in the area by contaminating their habitats. In this summer research, we worked to map HABs in New Zealand lakes through the use of drone (unscrewed aerial system, or UAS) technology. Our work combined the analysis of nutrient data and multispectral image data gathered by drones in a number of New Zealand lakes. Our goal is to put together a method of how to identify HABs in New Zealand, and hopefully, in lakes worldwide. Looking at phosphorus and nitrogen levels, we organized and analyzed data from over 30 lakes, and then compared drone images to determine which lakes we wanted to analyze using the available multispectral images. Our goal is to use UAS multispectral information in the future to assist in the characterization of HABs worldwide.

Mentor(s): David Schmale (School of Plant Sciences)

Sarah Garrison
Virginia Tech/Biological Sciences

Standardizing an ELISPOT Assay for Rotavirus Titration

Human rotavirus (HRV) causes acute gastroenteritis in young children, accounting for around 215,000 deaths yearly of kids under 5 years old. There are two licensed HRV vaccines; however, in low-income countries, the efficacy of the HRV vaccines is low. We are working on testing novel rotavirus vaccines using the gnotobiotic pig model of HRV infection and diarrhea. Previously, detection of rotavirus infection and virus shedding of the pigs has been done by the Cell Culture Immunofluorescence (CCIF) assay, which is labor intensive, requires plates to be read under a fluorescence microscope that strains the eye, and the counting of fluorescent cells is subjective to the researcher. For this project, we standardized the Enzyme-Linked Immunosorbent Spot (ELISPOT) assay protocol to replace CCIF as a more objective method to determine rotavirus infectivity. A series of experiments was done, each time altering the protocol to produce distinguishable and easy to count spots in the most efficient way. We tested different methods to fix the cells on the plate, altered the incubation time, changed the detector nanobody concentration, removed the centrifugation, and found the most suitable way and time to wash the cells. By enhancing the protocol, we now have an easier and standard way to determine rotavirus infectious titers in gnotobiotic pig fecal samples. Using the ELISPOT assay we can also measure the neutralizing antibody immune response after vaccination when pigs are challenged with the virus to determine the protective efficacy of the vaccines.

Mentor(s): Lijuan Yuan (Department of Biomedical Sciences and Pathobiology, Virginia-Maryland College of Veterinary Medicine)

Kinara Gasper
Harvard University /Applied Mathematics
Kayla Williams
The Ohio State University/Mathematics

Examining the Association between Socio-Demographics and Anterior Cruciate Ligament Injuries of ER Patients

Anterior cruciate ligament (ACL) injuries are common in younger females, and more specifically athletes. However, disparities among socio-demographic groups related to sports-related ACL injuries have not been well-studied. The purpose of this study is to examine the associations between race, residence location, income, sex, and age with sports-related ACL injuries using a nationally representative sample of 143,432,284 emergency department (ED) visits from the Healthcare Cost and Utilization Project. ICD-10 codes were used to categorize visits into ACL sports-related injuries versus not. Descriptive statistics were used to characterize the sample overall and by injury status. Univariate and multivariable logistic regression models were generated to examine the impact of the socio-demographic variables on the odds of an ACL sports-related injury. All analyses were performed using the survey package in R to incorporate sample weights and strata. Statistical significance was taken at the 0.0001 level given the large sample size. The sample was mostly female (55%), White (57%), living in central county areas (28%), with an annual 2019 income within the fourth quartile (17%), and the most common age group being between 20-30 (15%). Logistic regression models demonstrated that higher income and identifying as White were significantly associated with an increased odds of a sports-related ACL injury. Female sex, while protective, was not statistically significant in univariate models, but became significant in the presence of income. The results motivate a need to further study disparities among ACL injury patients across the United States, rather than patients diagnosed in the ED.

Mentor(s): Alexandra Hanlon (Center for Biostatistics and Health Data Science)
Monica Ahrens (Center for Biostatistics and Health Data Science, Virginia Tech)

Kiran Gautam
Hollins University/Mathematics with Data Science Concentration and Applied Economics

How do wars affect stock market?

Missiles and airstrikes hit several cities across Ukraine, minutes after Russian President Vladimir Putin announced a military operation on February 24, 2022.The impact of the conflict and crisis can be measured in many ways, including the instability of financial markets. Our research “How do wars affect stock market?” consists of case studies focusing on the reaction of financial markets to the major wars in recent years. Our research asks, “What are the effects that war has on the returns in U.S. financial markets?” We have chosen 7 conflicts in our case study: Korea War (1950), the Vietnam War (1955), the Cuban Missile Crisis (1962), the Gulf War (1990), The Iraq War (2003), Syrian War, and the Russian-Ukraine War (2022). We have gathered data set of daily prices of the Dow Jones Industrial Average index and S&P 500 index from the period of 1950 (The Korean War) to 2022 (the Russian-Ukraine war). We aim of our research is to model and predict the potential impacts of Russia-Ukraine war on the stock market, by studying the everyday news of all the days of 2% fluctuations on the indexes Dow Jones and S&P 500 as an exploratory approach.

Mentor(s): Lucas Long (Business and Economics, Hollins University)

Emma Gerry
Virginia Tech/Animal and Poultry Science

Characterizing Developmental Brush Border Enzyme Activity Changes in Early Life Pigs

The pig's small intestine undergoes many changes during the first month of life, but there is limited knowledge regarding changes to specific intestinal enzymes and how these changes affect nutrient utilization. The objective of this study was to examine changes in brush border enzyme activity in pigs from birth to seven days post-weaning. In total, 70 pigs were euthanized at seven time points (day 0, 3, 7, 20, 22, 25, 28; 10 pigs/day) and intestinal samples were collected and snap frozen in liquid nitrogen. Sucrase, lactase, and maltase activities were measured in protein extracted from frozen tissues by determining the amount of glucose liberated from each sample using a glucose oxidase kit. In both tissues, sucrase, lactase, and maltase activity changed over time ($P<0.001$). In jejunal samples, sucrase activity was first observed at day 20, peaked at day 25, then slightly decreased. Lactase activity was high at birth, peaked at day 7, then decreased slightly by day 20, before steeply decreasing post-weaning. Maltase activity was observed at birth and increased gradually until day 25. Enzyme activities in ileal samples followed a very similar pattern but activities were generally lesser. The most notable difference was that the highest ileal lactase activity was observed at day 0, after which it decreased. Overall these findings increase our knowledge of intricate changes in brush border enzyme activity that occur during the first month of a pig's life.

Mentor(s): Emma Helm (Animal and Poultry Science)

Carson Gilmore
Blacksburg High School

NIDDK

Conjugated linoleic acid-treatment improves muscle force and histology phenotypes in a genetically obese mouse model.

We have shown that obese mice with a deletion of the basic helix-loop-helix transcription factor Nhlh2 (N2KO) respond to a conjugated linoleic acid (CLA) diet with weight and fat loss. While N2KO mice normally are sedentary, compared to normal mice, CLA-supplemented N2KO mice have increased levels of exercise. The purpose of this project was to examine the effects of a CLA supplemented diet on the muscle tissue of both wildtype (WT)/normal mice, and N2KO mice. In vivo torque frequency measurements, normalized to body mass of N2KO, and WT revealed that while N2KO on standard high fat diet showed low torque values, N2KO + CLA showed a significant increase in torque values, comparable to the level of WT mice. Quadriceps and gastrocnemius muscles were then isolated from the four different groups of mice subjected to histological analysis, revealing a visual improvement in fiber size and structure in the N2KO+CLA groups, compared to N2KO alone, similar to the muscle function test. Histology tests to determine if intramuscular fat is reduced in CLA-treated animals, if there are changes in muscle fiber size, using laminin antibodies, and if there are changes in muscle proliferation or cell death are ongoing. The overall goal is to understand how CLA diet treatment improves physical activity level, muscle function and histology, possibly leading to a pharmaceutical treatment for sedentary behavior and obesity.

Mentor(s): Deborah Good (Human Nutrition, Food, and Exercise)

Thomas Gregory
Virginia Tech/Cognitive and Behavioral Neuroscience

SURF-N

Subjective pain ratings during conditioned pain modulation positively correlates with depression scores as part of a randomized clinical trial

INTRODUCTION
The salience of emotional stimuli and perceived pain are thought to be regulated by similar cortical structures. Studies report the presence of anxiety and depression influences pain perception, although results conflict. We tested the association between composite mental health scores and subjective heat-evoked pain perception using quantitative sensory testing (QST).
METHODS
Conditioned pain modulation (CPM) and temporal summation of pain (TSP) protocols were administered to 15 young, healthy participants (average age: 25.33 ± 3.35). Participants were subjected to individually thresholded thermal stimuli and asked to verbally rate the pain from 0-9. Pain data was compared to composite mental health scores. Continuous heart rate (HR) and heart rate variability (HRV) was also collected. Data was analyzed using two-sample t-tests and simple linear regressions (alpha = 0.05).
RESULTS
Simple linear regression demonstrated CPM pain scores correlated positively with Beck's Depression Index-II (BDI-II) (R^2 = 0.40, F-statistic = 6.07, p-value = 0.029). A two-tailed t-test comparing HR and HRV between the five highest and lowest scoring participants across surveys revealed no significant difference in HR (p-value = 0.7) or HRV (p-value = 0.83). A general trend of negative correlations with TSP and positive correlations with CPM across inventories was observed.
CONCLUSION
Our study revealed a positive correlation between BDI-II scores and baseline subjective pain ratings during CPM. TSP and CPM analyses trended towards significance and exhibited consistent directionality across mental health surveys. Taken together, individuals with higher anxiety and depression scores exhibit alterations in pain perception.

Mentor(s): Wynn Legon (Fralin Biomedical Research Institute)

Connor Guarniere
Virginia Tech/Experimental Neuroscience

Sleep and BMI Learning

Brain Computer Interfaces (BCIs) allow an individual to control an application by manipulating their brain activity. They are increasingly used in medical settings (e.g., to control a wheelchair), but often take a lot of time and effort to learn. We are examining whether sleep mediates BCI learning with the goal of speeding up the learning of BCI applications by manipulating sleep. The project moves toward this goal by fitting subjects with an EEG cap to test their abilities to move a cursor within a 2D space by modulating their brain activity. The BCI program is calibrated to recognize signals from a certain part of the brain that corresponds with the subject actually or imagining squeezing their left or right hand. From there, the subject should be able to imagine the squeezing motion and move a ball in the corresponding direction: Right for the right hand and up for the left hand. They are then tested again in the morning after sleeping a full night to see if their proficiency with the task has improved at all. As this is an ongoing experiment, no official results have been published yet. However, the preliminary data suggests subjects have a greater proficiency in the task after they have had a full night of sleep.

Mentor(s): Sujith Vijayan (School of Neuroscience)

Samantha Hall
Juniata College/Neuroscience

Low-intensity focused ultrasound to the left insula with a single-element transducer attenuates heart rate variability following noxious stimuli

Low-intensity focused ultrasound (LIFU) is a novel non-invasive tool with significantly improved spatial resolution and targeting to deeper cortical structures. One promising target for chronic pain management is the insula, which receives the majority of direct di-synaptic spinothalamic projections and is associated with interoception and subjective pain perception. Currently, little is known about the role of interoception in subjective pain perception. Here, we investigated the effects of LIFU on cardiovascular autonomic responses. Continuous heart rate (HR) and heart rate variability (HRV) data was extracted from two LIFU studies investigating pain modulation in the left insula through concurrent and pre/post-LIFU designs. Time-marked HR and HRV data from sham and verum LIFU sessions were averaged and compared across participants within each of the two studies. Following LIFU application to the left insula, we observed attenuation of HRV following painful stimuli in the verum versus sham sessions. While there are no statistically significant findings, the differences in HRV between sham and verum conditions trends towards significance. In the verum condition, pre and post LIFU HRV was 82.50 milliseconds (ms) and 72.25 ms, respectively, as opposed to 76.87 ms and 51.34 ms in the sham condition. We found that LIFU to the left insula attenuates HRV changes in response to noxious stimuli. There were no significant changes in average heart rates between verum and sham conditions. These findings provide initial evidence of LIFU's ability to modulate interoceptive responses to pain in the insula.

Mentor(s): Wynn Legon (Fralin Biomedical Research Institute)

Michael Han
Virginia tech/Mechanical Engineering

FORCEBOT Foot Platform

The main motivation of this project is to design, analyze, and develop a Foot Platform for the ForceBot, which fits human foot and rotates with respect to the human ankle. ForceBot is a robotic haptic interface for body-scale human physical interaction in virtual reality (VR). The human pilot's feet will be mounted on a gait simulator that consists of two foot platforms. The foot platform as a physical human robot interface (PHRI) must provide an adequate range of motion and degree-of-freedom corresponding to the pilot's input motions. Furthermore, the PHRI must be carefully analyzed to ensure the user's safety while maintaining high efficiency. Traditional aluminum CNC manufacturing ensures safety but has downsides of high-cost and long lead-time that hinder the project development. Therefore, 3D printing technologies and finite element analysis (FEA) were applied to optimizing the weight and strength ratio of the foot platform. To conquer the limitation of FEA software, which often doesn't support 3D printing material, a destructive tensile test is designed and conducted to eliminate an error derived from the difference between the material selected for FEA and the actual 3D printing material PLA+. Currently, the proposed project focuses on design and control mechanism to emulate ground by restricting the rotational motion on the foot platform using an electro-magnet. Proceeding toward establishing ForceBot as a dynamic scenario generator, that could significantly lower the cost and risk for various applications. Such as conducting training protocols, evaluating industrial prototypes, or as an experiment platform for human-machine interaction studies.

Mentor(s): Alexander Leonessa (Mechanical Engineering)

James Hardy
Virginia Tech/Biomedical Engineering

Engineering Methods to Stimulate Closure of Non-closing Wound Gaps

Wound healing requires fibroblast cell migration along fibrous extracellular matrix (ECM) in vivo. Scratch tests on flat 2D substrates remain the gold standard in studying wound closure in vitro. Wound gaps of almost all sizes and shapes close on flat 2D. Here we describe the ability to generate closing and non-closing using suspended fibers mimicking the fibrous ECM. By controlling the interfiber spacing, we demonstrate non-closing gaps over several weeks and the ability to architect wound gaps of varying sizes at desired locations. Here, we describe our attempts for stimulating the closure of these wound gaps. One method which shows promise is depositing nanofiber networks generated using the non-electrospinning STEP platform onto the non-closing wound gaps. Placing fibers across the wound gaps provides a structure for cells to migrate across the wound gap. It is important that the fibers remain under tension during placement so that cells will be able to generate the necessary forces for migration. We estimate single cell forces using nanonet force microscopy. In another approach, we place 3D gels with embedded nanofibers at wound sites. Developing methods for reliable wound closure has important implications for medical dilemmas such as treatment of chronic non-healing wounds, reduction of post-surgical scarring, and wound healing in microgravity.

Mentor(s): Amrinder Nain (Mechanical Engineering)

Dyess Harp
Virginia Tech/Wildlife Conservation

Zoonotic Spillover Research of Vampire Bats Across the Andes Mountains Insights

Dyess Harp, Luis E. Escobar
Department of Fish and Wildlife, Virginia Tech, Blacksburg, VA 24060

The impact of climate change on the spillover of zoonotic diseases such as rabies is an important topic within the field of disease ecology. Nevertheless, due to the limited time we have to prepare for these impacts, methods must be created to simulate the effects of climate change. For this research, vampire bats (Desmodus rotundus) were studied, as they are an important reservoir of the rabies virus. The abundance and distribution of vampire bats across elevations of the Andes Mountains were studied to make inferences regarding the likely effects of temperature variation on the transmission of the rabies virus. The multiple temperature ranges across these sites allowed for the collection of samples from vampire bat specimens that can be used to forecast areas suitable for rabies transmission in years to come. Gaps in the research of vampire bats as well as methods that might better capture them were identified. To address these zoonotic events in the future further research should be conducted by building upon our research and implementing our refined method.

Mentor(s): Dr. Luis Escobar (Fish and Wildlife)

Nicholas Harrell
University of Maryland, Baltimore County/Computer Science

Tracking Emitted Microplastics from City Landfills Using Atmospheric Forward Trajectory Models

The US is the top producer of plastic waste in the world. It is estimated that humans consume 100,000 microplastics annually with unknown health effects. In marine environments, microplastics have been found to disrupt reproductive systems, stunt growth, and diminish appetite. Compared to marine environments, microplastics in the air are far less studied. By studying landfills, where nearly 80% of plastic waste is stored, concentrated areas of atmospheric microplastic exposure can be identified. In this study, atmospheric forward trajectories originating from a number of city landfills across the US are simulated over various time periods using the Hybrid Single Particle Lagrangian Integrated Trajectory (HYSPLIT) model. Landfills for this study are chosen based on the product of the current landfill area and waste in place, according to the Landfill Methane Outreach Program Database. Configuring the range parameters to 200-1000 meters above ground level allows tracking of particles that are most likely to travel long distances in the air. Using a settling velocity of 2.1 centimeters per second for fibrous particles, it takes roughly 6 hours for deposition. By compiling these trajectories into a frequency/heat map, concentrated areas are highlighted. Simulation results show hot areas are within 20 kilometers of the landfill, and no farther than 170 kilometers. This work allows future experiments involving collecting deposition samples in high-risk areas, quantifying how many microplastics are being emitted from city landfills.

Mentor(s): Hosein Foroutan (Civil and Environmental Engineering)

Sydnee Harrison
Fralin Biomedical Research Institute/Clinical Neuroscience

Alternative Splicing in the CASK Gene Suggests Functional and Structural Diversity

Mutations in CASK (calcium/calmodulin-dependent serine protein kinase) are associated with microcephaly and pontocerebellar hypoplasia (MICPCH). Experimental evidence suggests that the MICPCH phenotype results from loss of CASK function. Recently, CASK mutations within exons 19 and 20 have been found to be associated with isolated microcephaly without any pontocerebellar hypoplasia. The precise molecular function of CASK remains unknown, although CASK has been variously described to be present in pre and postsynaptic compartments. In this project, we first use biochemical fractionation and immunolocalization experiments to demonstrate that CASK is not a component of the pre- or post-synapse. Further, we demonstrate that CASK is expressed in all tissues of the body and exhibits differential splicing patterns of exons 19 and 20. Finally, our data indicate that splicing differences of exons 19 and 20 between the hindbrain and forebrain may not be sufficient to explain why the mutations in these two exons do not produce pontocerebellar hypoplasia. We suggest that the inclusion of the evolutionarily new exons 19 and 20 attributes novel molecular function to CASK such as dimerization. Furthermore, our data suggest that this function is likely to be non-synaptic in nature.

Mentor(s): Konark Mukherjee (Fralin Biomedical Research Institute, Neurobiology)

Morgan Harvey
Virginia Tech/Environmental Science
Anna Blasdell
Virginia Tech/Environmental Science

Reducing Agricultural Greenhouse Gases Through Biopolymers

Plastic waste is a global issue and the increase in plastic pollution creates demand for biopolymers and other biodegradable plastic alternatives, such as Polyhydroxyalkanoates (PHA) and Polybutylene Succinate Adipate (PBSA). PBSA/PHA are newer biopolymers that could be used for agricultural applications; however, it is necessary to understand their effects on biogeochemical cycling. Our objectives were to determine the effect of PHA/PBSA on greenhouse gasses (GHG) fluxes from soil: Methane (CH_4), Nitrous Oxide (N_2O), and carbon dioxide (CO_2). We used controlled soil mesocosms in the laboratory with the following treatments: control, digested PHA/PBSA, digested LDPE, direct PHA/PBSA, and direct LDPE. For three weeks we measured GHG fluxes across a range from aerobic to fully anaerobic conditions. Results show PHA/PBSA directly applied to the soil significantly ($p<0.01$) decreased CH_4 and N_2O fluxes in partially anaerobic soils compared to the control and decreased cumulative evolution of CH_4 by 60% of the control. Digested PHA/PBSA was not significantly different from control or LDPE, and there was no difference in CO_2 among treatments. Once the soils became fully anaerobic, GHG from all treatments were significantly higher than the control soils. These findings suggest that PHA/PBSA blends applied to soils in stratified systems could reduce greenhouse gasses, but digested blends may not offer the same benefits. In addition, all plastics should not intentionally be exposed to anaerobic conditions, as they would likely increase the rate of GHG emission. In sum, PHA/PBSA may provide a potential tool to mitigate GHG from agricultural production in soils.

Mentor(s): Meredith Steele (School of Plant and Environmental Science)

Sydney Haywood
UMBC/Chemical Engineering

Body flattening in a close relative of flying snakes, Dendrelaphis pictus

Flying snakes (Chrysopelea) are the only snakes that have been observed to use dorsoventral flattening while locomoting: they expand their ribs, allowing for more surface area and enabling it to glide. However, not all species have been observed closely for the presence of this behavior. Recently, we observed possible dorsoventral flattening in a closely related species to flying snakes, specifically in Dendrelaphis pictus, commonly known as the painted bronzeback. Although it cannot glide, Dendrelaphis pictus is capable of a similar behavior to Chrysopelea: jumping. Does D. pictus use dorsoventral flattening when jumping? To determine if D. pictus utilize dorsoventral flattening, they were incentivized to jump using a horizontal gap-crossing setup, and recorded with multiple cameras to examine the body before they jumped. We found that the anterior body flattened in 4 specimens tested. To compare this behavior to rib movement during breathing, we also conducted recordings of the snake while breathing at rest in a tank. While D. pictus has been observed using dorsoventral flattening, it differs significantly to that of Chrysopelea: D. pictus only appear to pulsate in and out of dorsoventral flattening, and only in one part of the body. This could explain why Dendrelaphis are not able to generate sufficient aerodynamic forces to glide from tree to tree. This study demonstrates that some traits specific to gliding may have evolved prior to gliding in flying snakes. This research was supported in part by the National Science Foundation (NSF) under grant numbers 1922516 and 2027523.

Mentor(s): Jake Socha (Department of Biomedical Engineering and Mechanics)

Levi Heizer
Virginia Tech/Mechanical Engineering

Engineering Mix - Climate Action Commitment

Engineering mix is the highly complex and nebulous entity between energy as it naturally exists and how you as the end user makes use of it. Virginia Tech has a Climate Action Commitment in which the university has set goals including becoming greenhouse gas neutral by 2030. Where Virgina Tech gets its energy, how that energy is stored, and all of the infrastructure that gets it to where it needs to be on campus was studied this summer. Furthermore, existing and future technologies that can help the university reach its goals were investigated. Finally, comparisons with peer universities were made.

The purpose of this research was to analyze what Virginia Tech is doing to reach the goals laid out in the CAC in relation to energy mix alongside seeking potential alternatives or advancements that could be used to alter the university's plan. A large majority of the research was studying existing publications rather than experimental research. Through this research it was found that Virginia Tech is correctly focusing on solar in its plan, but a large roadblock for renewables in general can be energy storage. More research may be necessary with a focus on energy storage. Another technology considered but not fully explored in the CAC is using geothermal to improve the efficiency of the university's HVAC systems.

Mentor(s): Jennifer Benning (Engineering)

Vanity Hernandez
Hollins/Psychology

The Impact of Childhood Poverty on US Latinx Adults' Financial Literacy and Management

There are currently few studies regarding Latinx financial skill development. The present study investigates how the lack of culturally responsive financial management skills affect U.S. Latinxs impacted by poverty. Participants reported their experiences with poverty during childhood and completed questionnaires relating to financial management. We hypothesize that this research will illuminate systems that create poverty and perpetuate financial immobility, and it will better highlight the relationship between trauma and financial skills within the U.S. Latinx community.
Keywords: Latinxs, poverty, financial management

Mentor(s): Seunghee Han (Psychology, Hollins University)

Christine Herzog
Virginia Tech/Biochemistry

Fungi of Stadium Woods

Fungi of Stadium Woods
Christine Herzog and Dr. Jordan Metzgar, Department of Biological Sciences, Virginia Tech, Blacksburg, Va, 24060

Old-growth forests are ancient woods that have survived for centuries mostly untouched by major disturbances. Fungal biodiversity could be a key factor in understanding the effects of ecological disturbances on woodlands. Stadium Woods is an 11.3 acre urban old-growth forest on the Virginia Tech campus. It is comprised of more than 500 living trees and is dominated by white oaks, some over 300 years old. This rare on-campus primary forest suffers from many human impacts, including construction, heavy foot traffic, and litter. Center Woods is a 39.5 acre secondary-growth forest dominated by a mixture of oak and hickory, located off of the main campus. Center Woods is impacted by several research programs but overall suffers considerably less human traffic. We are surveying the funga of both forests and have collected over 150 specimens, with at least 30 different genera represented. We predict that the heavy foot traffic in Stadium Woods has resulted in this forest having similar levels of wood-dwelling fungi and lower level of soil fungi compared to Center Woods due to impacts from trampling. We also hypothesize that Stadium Woods will have a higher frequency of species that prefer disturbed areas. Our project will assess the fungal component of Stadium Woods' unique ecosystem and provide useful baseline data to track changes in the forest's health over time. This analysis will improve our understanding of the myco-plant relationships of old-growth forests as a whole.

Mentor(s): Jordan Metzgar (Department of Biological Sciences)

Kate Hildebrandt
University of Minnesota, Twin Cities/Physics

Boosted Dark Photons: Minimal Model of Boosted Dark Matter

We investigate a class of models in which pairs of dark matter particles decay into two low-mass dark photons. These dark photons are subsequently “boosted” (moving relativistically) due to conservation of energy. Dark photons are unstable due to mixing with ordinary photons, but they are long-lived enough to reach Earth for small mixing. The predicted flux of dark photons arriving at Earth can produce distinctive experimental signatures via dark photon scattering in neutrino detectors. We derive new constraints on important parameters governing this interaction, including the kinetic mixing parameter and the dark photon mass. Our theoretical constraints will then be compared to existing data from the Super-K detector. This will give a better understanding of the detection prospects for dark matter of this type using existing detectors such as Super-K or future neutrino detectors like DUNE and Hyper-K.

Mentor(s): Ian Shoemaker (Physics)

Abigail Horton
Virginia Tech/Microbiology

Characterization of phage resistant mutants of Agrobacterium tumefaciens

The world around us is populated with microorganisms, among which are bacteria and viruses. There are also viruses that infect bacteria- these are known as bacteriophages. Bacteriophages are highly specialized and most only infect one or two species. One group of bacteriophages are referred to as 'flagella-trophic' phages, which require an intact, actively rotating bacterial flagellum to infect the host cell. A flagellum is a thread-like structure that extends from the host cell, and its rotation promotes bacterial motility. Bacterial flagella also aid in eukaryotic host infection. One bacterial species that uses flagella for motility and infectivity is Agrobacterium tumefaciens, a plant pathogen that is the causative agent behind crown gall disease in eudicots. A. tumefaciens utilizes its flagellar structures to swim through the soil in search of a worthy host, such as a grapevine or a horseradish bulb. A flagella-trophic bacteriophage that infects A. tumefaciens has been isolated and identified - the Milano phage. To understand the mechanism behind Milano's infectivity, transposon and targeted mutagenesis combined with various infectivity assays were employed. We isolated six motile, phage-resistant mutants, one of which had a deletion in a gene encoding a lipopolysaccharide (LPS)-modifying glycosyltransferase. This finding allows the conclusion that an intact LPS is essential for Milano's infectivity, in addition to flagellar motility. Understanding the infection mechanism is important in developing a method of control for this pathogen. Knowledge accrued from this research could be transformed to other flagella-trophic phages and to bacteriophages as a whole.

Mentor(s): Birgit Scharf (Biological Sciences)

Muhannad Hussain
University of Minnesota - Twin Cities/Chemical Engineering

KAUST REU

Ocean Wave Energy Powered Lithium Extraction from Seawater

Our research focuses on using ocean wave energy to power an electrochemical device that sustainably extracts lithium from seawater for use in Li-ion batteries. The ocean can provide over 10,000x as much lithium as the lithium reserves on land, which will be exhausted by 2080 (1). Expanding lithium mining to the ocean will greatly improve our energy security. The ocean also houses enormous energy, such that the energy potential of waves off the coasts of the United States is estimated to be as much as 2.64 trillion kilowatt hours annually, or the equivalent of about 66% of U.S. electricity generation in 2020 (2). Part of that energy can then be converted to power lithium extraction with a wave energy converter device. Wave energy is renewable and can power the lithium extraction device entirely on its own, allowing the whole system to be self-sufficient and sustainable. An electrochemical cell with copper and platinum electrodes was used to extract lithium from seawater samples. Applying a current across the H-cell will cause lithium ions to transport across the membrane and reduce into metallic lithium on the copper foil. Characterization methods were used to determine the success of the experiment. This preliminary experiment will determine the feasibility of using electrolysis to extract lithium from seawater, which can then be industrialized to combat the global lithium demands and slowly phase out traditional lithium land mining.

Mentor(s): Lei Zuo (Mechanical Engineering)
Jia Mi, Ph.D. student supervisor (Mechanical Engineering, Virginia Tech)

Waleed Iftikhar
University of Virginia/Economics

MOLVIS SURF

Enrichment of Vascular Fragments From Adult Mouse Brain For Endothelial Cell Analysis

Introduction:
Endothelial cells in the brain form a specialized barrier that limits and controls the passage of molecules from the bloodstream into the brain. Brain endothelial cells interact closely with many glial cells and pericytes. Dextran separation can be used to study the enrichment of these vascular cells. By using homogenization and centrifugation techniques, these cells can be further studied by using biochemical assays and help in determining the downstream analysis of the blood-brain barrier.
Methods:
Perfusion of mouse was carried and brain was extracted. High-Density centrifugation was used to separate the myelin layer from vascular fragments. Staining of vascular fragments was done by IHC and confocal microscope was used for the imaging process to study the interaction of pericytes and endothelial cells with the blood-brain barrier.
Conclusion:
1- Isolation of highly enriched vessel fragments w/overall structure is conserved.
2- Isolated vessels by this method could be used for downstream applications like qPCR, RNA-seq, and Western Blot.
3- Potential use of this technique in vitro culture of brain vessel fragments.
4- Not highly pure as in ultra-centrifugation or cell sorting.

Mentor(s): Dr. John Chappell (FBRI)

Marissa Incer
College of William & Mary/Neuroscience

Utilizing Machine Learning Enhanced Electrochemistry to Explore Valence Dependent Dopamine Signaling in the Human Brain

To date, most studies on dopamine signaling and its relation to reward were performed in animal models limiting translation to humans. In the current study, we developed a method for detecting neurotransmitter levels (e.g., dopamine, serotonin, norepinephrine) in conscious and awake humans undergoing deep-brain stimulation (DBS) surgeries. Specifically, patients played an emotional stroop task where they responded to blocks of positively, negatively, and neutrally valence words while their dopamine levels were measured in the caudate nucleus or left ventral intermediate nucleus of the thalamus. Considering that language is unique to humans, we wanted to explore if the valence of words causes the dopamine system to respond in a similar manner to primary rewards or punishments. For the first time, we showed that dopamine release increases at the onset of positive words and decreases at the onset of negative words. These results suggest that the abstract nature of positive and negative word valence does affect the dopamine system in a similar way to primarily rewarding or punishing stimuli. Overall, these results display the effectiveness of taking neurochemical measurements in awake humans while also increasing our knowledge of dopamine signaling as it relates to abstract rewards and punishments.

Mentor(s): Read Montague (Fralin Biomedical Research Institute at VTC; Department of Physics)

Anna Ingram
Virginia Tech/Mechanical Engineering

Stress Wave Timing and Destructive Bending Tests using Iron Bamboo

Bamboo is a strong, flexible, and renewable material that is mostly used for traditional single story construction. To ensure safe and efficient construction of taller structures, the creation of more building codes, standards, and grading methods are necessary. Non-destructive methods, including stress wave timing, are used to measure mechanical properties of wood and wood composites, and have been proposed to be used for bamboo as well. The purpose of this research was to compare the modulus of elasticity of Iron bamboo (either Dendrocalaus strictus or Thyrsostachys siamensis) measured using stress wave timing and destructive bending tests. A total of 40 culms of Iron bamboo were tested. Measurements included dimensions, stress wave timing, four-point bending load-deflection testing, moisture content and specific gravity. The modulus of elasticity(E) from stress wave timing was correlated with the destructive modulus of elasticity and strength. Other dimensional measurements with good correlations included mass per unit length multiplied by diameter squared(qDˆ2) for both the stress wave and destructive bending stiffness. Specific gravity, and mass per unit length multiplied by diameter(qD) were good correlations for bending moment. By itself, diameter of a culm was not considered a good predictor of strength or stiffness. Based on these results, stress wave timing seems to be a useful method for identifying the mechanical properties of Iron bamboo. This data can be used to establish grades for Iron bamboo. Future work will examine other bamboo species and attempt to recreate the correlations found above with similar methods.

Mentor(s): Daniel Hindman (Sustainable Biomaterials)

Adithya Iyer
Virginia Tech/Computer Science

Singular Value Decomposition for Noise Reduction in OPM-MEG Data

Optically pumped magnetometer magnetoencephalography (OPM-MEG) enables novel sensor recordings of magnetic signals from the brain. However, OPM's sensitivity can lead to low signal-to-noise ratio (SNR) recordings. We hypothesized that significant noise sources degrade the signals globally across multiple sensors. Thus the purpose of this research was to evaluate whether singular value decomposition (SVD) could be used to remove global sources of unwanted variance. Our procedure consisted of analyzing the z-oriented OPM signals from a left-vs-right button press task in a single individual. Sensor × time data decomposed into three SVD matrices consisting of "eigensensors," eigenvalues, and "sensor loadings." Spectrograms from each eigensensor were generated and qualitative analysis was performed to judge their noisiness. Next, the original data were reconstructed after removing noisy eigensensors. Spectrograms for the denoised (real) sensors were generated and analyzed with respect to the button press task to see whether beta frequency signal was detectable in the contralateral hemisphere. It was found that high variance noise interfered with the detection of brain signal. After denoising, clear beta frequency signal (as expected for the task) was seen for sensors on the opposite brain side for left/right pressing in the actual sensor space. The major conclusion of this work is that OPM-MEG recordings are dominated by global, high variance, noise sources, but the underlying neural signatures can be recovered by removing these sources with SVD-based methods.

Mentor(s): Stephen LaConte (Fralin Biomedical Research Institute)

Samuel Jamison
Virginia Tech/Mechanical Engineering

A literature review of Net Zero Energy Buildings

In its 2020 Climate Action Commitment (CAC) Virginia Polytechnic Institute and State University set the goal of completing a zero net energy building (ZNEB) by 2026, specifically, “By 2026, build a signature zero-net-energy (ZNE) building on campus as a showcase and learning model for the Climate Action Living Laboratory”. This fits into the larger context of goal 5 of the CAC, which concerns improving campus building efficiency, by exploring options for more efficient buildings and the ability to apply these methods to other buildings. This report summarizes literature regarding this goal beginning with the exact parameters and requirements for a ZNEB based on other ZNEBs and the US Department of Energy’s findings. Next, the report looks at different methods currently used to achieve zero net energy, then concludes with what specific issues will need to be addressed in implementing these solutions at Virginia Tech in order to assist planning to meet the ZNE goal by 2026.

Mentor(s): Jennifer Benning (Engineering Education)

Emilio Jarrin
University of Iowa/Physics

CNP REU

Characterizing the NuLat Detector Using Coincidence Techniques

The Neutrino Lattice Experiment (NuLat) was designed to detect neutrinos, in particular an- tineutrinos produced from nuclear reactors which may indicate signals of the so-called ”sterile” neutrino. The most recent use of the NuLat detector focuses on detecting electron antineutrinos via inverse beta decay (IBD). With the use of a scintillating cube lattice that comprises NuLat, signals of positron annihilation and neutron capture that appear from the resulting IBD plus the interaction with the material are collected and amplified by photomultiplier tubes (PMTs) installed in the detector. An objective for this summer’s project is then to characterize the response of NuLat. This can be done employing coincidence techniques that will help overcome some of the technical challenges. In this case, the gamma spectrum of a radioactive source is collected with two detectors in coincidence. The source that produces the scintillation is the radioactive element Cobalt-60 which serves as the gamma emitter. When Cobalt-60 decays, it emits two gamma rays almost simultaneously that can be used for coincidence triggering between the two detectors. One of the detectors is the scintillation detector thallium-doped sodium iodide (NaI(Tl)). The other is a single cube from NuLat which initially will be thoroughly characterized, and this information will be extended to effectively determine a calibration of the NuLat detector.

Mentor(s): Bruce Vogelaar (Physics)

Rasheed Jeheeb
Morehouse College/Biomedical Engineering

Monitoring Nutrients, Phycocyanin, and Chlorophyll in Drone Water Samples from New Zealand Lakes

Potentially harmful algal blooms (HABs) occur in freshwater lakes worldwide.

Cyanobacteria, commonly referred to as "blue-green algae", populate lakes worldwide and may produce blooms in response to increased levels of nutrients such as nitrogen and phosphorus. Cyanobacteria may also produce cyanotoxins that are harmful to human and animal health. There are currently broad knowledge gaps in identifying HABs and informing citizens about the threats to public health and safety that they can impose. In many countries, there are few to no standards for lake water safety in terms of HABs in lakes or how this information can be communicated to the public. Nitrogen and phosphorus are known to be indicators of HABs.

Excess phosphorus in a lake can be the result of agricultural runoff and can cause increased growth of cyanobacteria and aquatic plants. Nitrogen fuels cyanobacterial growth. A pressing topic to inform citizens and communities of would be that excess nutrients in lakes can act as a precursor to the growth of HABs. Eutrophication, a term for nutrient surplus of lakes, puts them at a higher risk of experiencing HAB conditions. Drone (uncrewed aerial system, or UAS) water samples were collected from a number of New Zealand Lakes in 2020 and 2021. Drone multispectral images were also captured for the surface of the water of these lakes. Nutrients, phycocanin, and chlorophyll were analyzed from each of lakes. Lake Waikare (North Island, New Zealand) and Lake Te Wapu (Chatham Islands, New Zealand) had relatively high levels of phosphorus with respect to the other lakes sampled. Visible algal blooms were also captured with multispectral data gathered from the UAS flights. Monitoring of HABs in lakes needs to become more widely utilized because of the potential health hazards that can be identified with these methods.

Mentor(s): David Schmale (Plant Science)

Albrun Johnson
Gettysburg College/Physics

CNP REU

Determination of the titanium spectral function from JLab (e,e'p) data

The experiment E12-14-012 at Thomas Jefferson National Accelerator Facility (JLab) gathered data from (e,e'p) scattering on a titanium-48 natural target. The (e,e'p) cross section was extracted as a function of the missing momentum p_m and the missing energy E_m, respectively, to get the titanium proton spectral functions and the spectroscopic factors. The measurements were then fitted against a Monte Carlo simulation varying orbitals' strength, position and width, and the reduced χ^2 values were determined using TMinuit in ROOT. The fitting procedure was performed with and without the correlated part of the spectral function for both the p_m and E_m fits, and, the latter, with and without including the results on spectroscopic factors obtained from the p_m fits. There was no significant difference between using or not using the correlated spectral function for the p_m fits but the reduced χ^2 value was closer to 1 at 0.57 when not using it. For the E_m fits, there was no significant difference between using all priors and not using the p_m fits but there was a slight difference to not using the correlated spectral function. The reduced χ^2 value was best when using all priors at 0.95. Neither fit shows a bias and while the p_m fits should be run without the correlated spectral function, the E_m fits should be run with all priors to obtain the best fit.

Mentor(s): Camillo Mariani (Center for Neutrino Physics)

Taniya Johnson
FBRI/High School

Assessing the Relations Among Maternal Emotional Language and Infant Behavioral Responses

The way mothers use emotional terms and the context of the interaction (i.e., how they sound when using the term) could greatly affect the way their baby responds and reacts to the terms. This is important because differences in infant responses may indicate later risk for problem behaviors. The goal of this study is to explore how babies respond to their mother's behavior following an emotional book viewing task. We first developed a scale to quantify the emotional terms used throughout the reading and discussion of the book. Mothers and their babies watched a video of an adult female reading a book about feelings, and mothers were then instructed to talk to their babies about the book for 1 minute. We coded and analyzed how many positive and negative emotion words the mother said and how she interacted with her baby (i.e., facial expressions and tone), and how the baby responded to their mother. We hypothesize that when a mother uses a positive emotional term in a warm voice (e.g,, "are you a happy baby?" while smiling), baby might smile and laugh. However, when a mother uses a negative emotional term (e.g., "you are a grumpy baby" with frown face), baby might frown or cry. We also hypothesize that babies will respond more to tone and facial expressions than to the valence of the words themselves. Future work will incorporate these findings with non-sedated sleep MRI also being collected to look at brain behavior links in infancy.

Mentor(s): Britney Howell (Howell Lab)
Dr. Eunkyung Shin (Howell Lab)

Emanuel Jung
Virginia Tech/Microbiology

All Iced Up: How Bacteria May Utilize Ice Nucleation to Increase Their Survivability

Bacteria have a spectacular array of survival mechanisms, allowing them to withstand stressful conditions and flourish in unique niches. One such mechanism found in some species is ice nucleation activity (INA), giving bacteria the ability to induce the formation of ice crystals. This could contribute to the fitness of these bacteria for two reasons. One, for bacteria suspended in the atmosphere, their INA ability could allow them to precipitate sooner from clouds, where temperature fluctuations and UV radiation pose stressful conditions. Two, for plant-associated bacteria, such as the plant pathogens Pseudomonas syringae (Ps) and Pantoea allii (Pa), INA could drive frost formation on plant surfaces allowing bacteria better access to nutrients. It is theorized that this leads to increased bacterial growth. However, not all species fall neatly into this pattern. One species of particular interest is Lysinibacillus parviboronicapiens (Lp), which is not a known plant pathogen. Thus, research is required to investigate how the INA molecule produced by Lp increases fitness. My foundational experiment aims to do just that. I will examine how the ability of Ps, Pa, and Lp to nucleate ice impacts their survival on plant leaves in cold temperatures compared to mutant strains that do not have INA. If the strains with INA were to survive in higher numbers than their mutant counterparts in this simulated plant environment, this would provide evidence for the hypothesis that the INA molecules did in fact evolve in these species because their ability to nucleate ice increases their fitness.

Mentor(s): Boris Vinatzer (School of Plant and Environmental Sciences)

Makda Kalayu
Hollins University/International Studies

Erasing Tigray: Ethiopia and the Use of Cultural Erasure As A Tool for Ethnic Cleansing

When the ethnic cleansing of the Tegaru people in northern Ethiopia began in November 2020, the destruction of both a people and symbols of their heritage followed. Over the past two years, the perception of this conflict has been minimally addressed by the international community due to a variety of reasons. As the 1954 Hague Convention for the Protection of Cultural Property in the Event of Armed Conflict expresses, cultural property destroyed or stolen amid conflict must be protected to minimize the loss of valuable historical, artistic, or religious artifacts. To expand the conversation of cultural property ownership that 1954 Hague opens, this research will analyze the implications of cultural erasure or theft as a tool for ethnic cleansing. Through gathering empirical data for lost forms of heritage in the ongoing conflict in Tigray and analyzing legal frameworks for the repatriation of such heritage for the Tegaru, this research will construct a baseline understanding of how to value the practice of repatriation in ongoing conflicts. Much literature around repatriation involves atonement for conflicts of the past and the sins of ancestors long gone, while this research addresses a process for this practice in an ongoing and ever-evolving conflict.

Mentor(s): Ashleigh Breske (GPS)

Meghana Kamineni
Virginia Tech/Medicinal Chemistry

TPSC SURF

Identification of Key Amino Acids in Helix B of Brome Mosaic Virus Replication Protein 1a in Protein Targeting

Brome mosaic virus (BMV) is a model plant virus in the Alphavirus-like superfamily which infects cereal plants. BMV, a positive-strand RNA virus, encodes replication protein 1a which localizes to the perinuclear endoplasmic reticulum (nER) membrane, where it induces the formation of viral replication complexes (VRCs). An amphipathic helix termed helix B is responsible for targeting 1a to the nER membrane. The goal of my project is to identify the key amino acids critical for helix B targeting the fluorescent protein mCherry to the nER membrane. Site-directed mutagenesis through overlapping polymerase chain reactions was used to introduce single amino acid mutations in helix B. Fluorescence microscopy was utilized to visualize the localization of various helix B mutants in yeast cells. While wildtype (wt) helix B-mCherry localized at the nER membrane, the W416A mutant localized to the cytoplasm, suggesting a critical role of W416. To further understand the contribution of each amino acid, potential structures of wt and helix B mutants were derived using a structural prediction program that utilizes a deep neural network. These results will provide structural and functional correlations of helix B in targeting proteins to the ER membrane and can be applied to the development of antiviral treatments for similar viruses in the alphavirus-like superfamily, such as Hepatitis E and Rubella virus.

Mentor(s): Xiaofeng Wang (School of Plant and Environmental Sciences)
Anne Brown (Department of Biochemistry, Virginia Tech)

Lauren Kannally
Virginia Tech/Clinical Neuroscience

Low-intensity focused ultrasound modulation of hippocampus improves behavior in a rodent model relevant to depression

Depression is a serious psychiatric disorder affecting millions of people worldwide. Many of the available medications are not fully effective, so it is important to investigate alternative treatments. Transcranial focused ultrasound (FUS), a region-specific, non-invasive neuromodulation technique, has shown promise to aid in treating neurological and psychiatric disorders. Previous studies show that hippocampal abnormalities contribute to depression, so we explored whether FUS modulation of the hippocampus could improve depression-related behavior. We treated adult male Wistar Kyoto (WKY) rats with FUS neuromodulation of the dentate gyrus 5 min per day for 14 days. WKY rats display high levels of depression-related behavior, and we found that chronic FUS neuromodulation of the dentate gyrus improved aspects of their behavior. We next examined brain tissue following FUS treatment to better understand neurobiological changes driving these behavioral improvements. We performed immunocytochemistry to detect Fos, a protein indicating cell activation, on the brain tissue of rats exposed to a single, acute FUS treatment of the dentate gyrus as well as on chronic FUS-exposed brains. Results revealed decreased cFos-immunoreactive cells in the dentate gyrus following acute FUS neuromodulation compared to homecage control rats. Our analysis of chronic FUS-exposed brains is ongoing. Future studies will determine specific cell types in the dentate gyrus impacted by FUS neuromodulation, along with examining activity in other brain regions to better understand the effects of dentate gyrus neuromodulation. Ultimately, understanding the impacts of FUS neuromodulation could pave the way for translational clinical studies where FUS is used to treat psychiatric disorders.

Mentor(s): Sarah Clinton (Department of Neuroscience)

Morgan Karns
Virginia Tech/Wildlife Conservation

Identifying and Facilitating Positive Experiences for Birders with Disabilities

People with disabilities make up about 25% of the US adult population and 15% of the total global population, yet are some of the most misunderstood and understudied groups in recreation research and planning. People with disabilities face more barriers to involvement in outdoor recreation and education activities, yet would greatly benefit from participating. In this study, we explore whether people with disabilities experience greater barriers and benefits to birding compared to others. Birding is intentionally watching or listening to, identifying, or interpreting birds. Birding is overall lacking in diversity, lending itself to the opportunity for expansion of the community. To understand what changes can be made to make birding more inclusive to those with disabilities, we analyzed responses from a survey administered by nonprofit Birdability (n=149) in 2021. The survey questions focused on changes that could be made to increase accessibility to birding and the unique benefits birders experienced due to their disabilities. The top three changes noted that would make birding more accessible are 1) more accessible trails, 2) access to information, and 3) benches. The top three expressed unique benefits of having a disability while biding are 1) the ability to slow down, 2) enriched viewing opportunities, and 3) experiencing relationships with birds and/or nature. These results can encourage experienced based management in recreational birding through facilitating more inclusive birding experiences with the increased understanding of the unique barriers and benefits of birding for those with disabilities.

Mentor(s): Ashley Dayer (Department of Fish and Wildlife Conservation)

Jett Katayama
Virginia Tech/Biological Systems Engineering

Exploring Water Quality at Roadside Springs in Central Appalachia

Roadside springs are places in which groundwater comes to the surface and is usually caused by a cut in the hillside for nearby roads. Previous work reports that water from roadside springs is generally high in total coliforms, conductivity, and over 80% of samples tested positive for E. coli (Krometis et. al, 2019). This is of real concern since 63% of households surveyed near springs in the central Appalachian areas claim to visit roadside springs for water at least once a week (Krometis et. al, 2019). Although reliance on roadside springs for drinking water may seem shocking, it is not surprising since 82.6% of households in nearby communities in rural Virginia, West Virginia, and Kentucky did not trust their home tap water due to aesthetic issues and lack of testing (Patton et. al, 2020). The goal of this project was to examine potential links between local land use and soil types with the presence of waterborne E. coli and total coliforms. This required compilation of existing water quality data for 22 springs as well as geospatial analyses combining land use data from the USGS website, soil data from the MRLC website, and spring location in GIS (ESRI.com, Redlands, CA, USA). There appeared little to no correlation between E. coli and soil type. However, springs surrounded by over 90% forest averaged only 0.625 MPN/100 mL E. coli per sample while springs surrounded by less than 50% forest averaged 14.83 MPN/100 mL E. coli per sample. Specific information regarding the infrastructure of the plumbing in nearby houses and the amount of cattle in nearby pastures would yield additional insights into this relationship.

Mentor(s): Leigh-Anne Krometis (Biological Systems Engineering)

Cayla Katz
Virginia Tech/Biomedical Engineering
Jessica Prisbe
Virginia Tech/Biomedical Engineering
Adaliah Dunya
Georgia Tech/Biomedical Engineering
Vedent Shah
Virginia Tech/Computer Science
Shuyu Zhang
Virginia Tech/Biomedical Engineering
Julia Wakefield
Virginia Tech/Biomedical Engineering

Patient-Specific Insulin Pump Design Using a Machine Learning Model

Over 500 million people are affected by diabetes worldwide. For insulin-dependent patients, treatments include bulky and inconvenient battery-powered insulin pumps and painful syringe injections. The InsulPatch is an alternative, smaller-scale insulin delivery pump currently under development. It provides an inexpensive way to administer insulin easily, painlessly, and without a power source, making insulin delivery more convenient for Type 1 diabetics. Inspired by the insect respiratory system, the InsulPatch features a multilayer microfluidic pump system. It uses the wearer's radial pulse to pump insulin transdermally via a microneedle array. Photolithography and stereolithography (SLA) 3D printing microfabrication techniques were used to create device design molds. The molds were then used to create the InsulPatch device layers by pouring liquid polydimethylsiloxane (PDMS) into the molds and baking to cure the PDMS. The devices contain three layers: a top layer consisting of actuation channels, a thin middle membrane, and a bottom layer containing the flow channels. Flow rate data was collected at different actuation pressures and frequencies for different flow and actuation channel geometric design parameters. The devices were actuated using pressurized air signals representing different blood pressures and heart rates. The flow rate data was collected and analyzed using Graphpad Prism. This data was then used to create a sequential regression machine learning model with 80% prediction accuracy, enabling the solution of the inverse problem of producing device designs for specific patients. After successful clinical trials, the InsulPatch will allow for accessible, painless, and convenient insulin delivery.

Mentor(s): Anne Staples (Biomedical Engineering and Mechanics)

Rose Kaur
Virginia Polytechnic Institute and State University/Clinical Neuroscience

Comparison of the substitution between different tobacco/nicotine products as a function of tobacco-user type

The tobacco marketplace is constantly expanding regulations on novel products. This study compares the effects of different tobacco/nicotine products (i.e., conventional cigarettes, Nicotine Vaping Products [NVPs], Heated Tobacco Products [HTPs], and Nicotine Pouch Products [NPPs]) on purchasing and substitution in the Experimental Tobacco Marketplace (ETM), as a function of tobacco user type. In a within-subject repeated measures design, participants (n= 3 exclusive cigarette smokers and n= 3 dual cigarette and NVP users) completed seven ETM conditions: a) all products at market price (control), b) NVPs at _ market price, c) NVPs at 2x market price, d) HTPs at _ market price, e) HTPs at 2x market price, f) NPPs at _ market price, and g) NPPs at 2x market price. Participants were provided an experimental income to make five days of tobacco-product purchases as the price of cigarettes increased across trials. Preliminary results show that: 1) cigarette demand decreases as the price of conventional cigarettes increases, 2) substitution of HTPs and NVPs increased when those products are at _ market price, 3) HTPs were substituted more frequently among exclusive smokers, 4) NVPs showed greater substitution among dual users, and 5) limited purchases of NPP suggests this may not function as a substitute for cigarettes. Data collection is ongoing. This study will characterize the relative substitutability and appeal across novel and widely used tobacco products improving our understanding about the implications of these products for tobacco control.

Mentor(s): Warren Bickel (Fralin Biomedical Research Institute at VTC)

Nikki Keith
Virginia Tech/Biological Sciences
Sammi Wang
Virginia Tech/Biological Sciences

Characterizing a 6.3 MHz High Frequency Endoscopic Histotripsy System for Noninvasive Cancer Ablation

Histotripsy is a non-thermal, non-invasive focused ultrasound (FUS) ablation method guided by real-time imaging. Other FUS ablation technologies yield limitations for cancer treatments due to thermal effects on surrounding tissue. Histotripsy overcomes thermal effects by using mechanical cavitation–the rapid expansion and collapse of bubble clouds–to emulsify tissue. Histotripsy is generally delivered at frequencies of 500 kHz to 1 MHz; a 6.3 MHz high frequency endoscopic histotripsy system with a co-registered US imaging probe was developed for higher precision intraoperative cancer ablation. To determine the microbubble behavior of the system, a series of thresholding tests were performed at different pulse repetition frequencies (PRF) and pressures (MPa) with tissue-mimicking phantoms. Bubble cloud dimensions were analyzed at 1 Hz PRF for pressures between 5-35 MPa at 5, 10, and 20 cycles for each pressure level. Submillimeter bubble clouds were visible on the first pulse of each cycle parameter starting at an 18 MPa pressure, demonstrating the 6.3 MHz transducer was capable of generating defined, precise submillimeter ablations. Coupling bowls and staging set-ups were concurrently developed for prospective rodent studies characterizing the 6.3 MHz system. Future studies will use several ex vivo and in vivo rodent tissue models in a feasibility study for precise, non-invasive intraoperative cancer treatments.

Mentor(s): Eli Vlaisavljevich (Biomedical Engineering and Mechanics)

Zoey Kim
Virginia Tech/Human Nutrition, Foods, and Exercise

TOUR

Development Process for Controlled Feeding Studies to Measure the Impact of Non-Nutritive Sweetener Consumption on Glycemic Markers

Individuals with Type 2 Diabetes (T2D) often use non-nutritive sweeteners (NNS) to improve glycemic control. Middle-aged and older adults are among the highest NNS consumers and have the highest incidence of T2D. Dietary guidelines surrounding NNS consumption remain unclear, and long-term usage is discouraged despite a lack of supporting research. Based on current research, it is postulated that sucralose, but not aspartame, may impair glycemic control and insulin sensitivity. To investigate this further, we will conduct two controlled feeding studies to measure acute and long-term impacts of sucralose and aspartame on glucose homeostasis in prediabetic middle-aged/older adults (50+ years). Participants will receive 50% of the acceptable daily intake of NNS (2.5 or 25 mg/kg body weight for sucralose or aspartame, respectively). A three-way crossover acute study will examine changes in fasting and postprandial glucose and insulin concentrations prior to and 2 hours after consuming a standardized breakfast with the addition of a test beverage and capsules containing either sucralose, aspartame, or control. For the long-term study, participants will be randomized into either a sucralose, aspartame, or control group and receive a daily test beverage and capsules. Glucose and insulin levels will be measured with an oral glucose tolerance test prior to and after a 6-week feeding period. Prior to starting these studies, a sensory evaluation was performed to improve palatability of the NNS beverages and increase participant compliance. We aim to explore the impact of sucralose and aspartame intake on glycemic control in a population at high risk for T2D.
Zoey Kim1, Valisa E. Hedrick, PhD, RDN2
1Translational Obesity Undergraduate Scholar (TOUR), Department of Human Nutrition, Foods, and Exercise, Virginia Tech
2Assistant Professor, Department of Human Nutrition, Foods, and Exercise, Virginia Tech

Mentor(s): Valisa Hedrick (Human Nutrition, Foods, and Exercise)

Zoe King
Brown University/Environmental Engineering

Tongue-sticking: Tongue behavior of arboreal colubrids during gap crossing

Tongue movement in snakes has been previously attributed to chemo- and mechanosensation characterized as a sweeping, vertical oscillation of the tongue, followed by the tongue being pulled back into the mouth to allow particle transfer to sensory organs. In previous studies, flying snakes (Chrysopelea) have been observed to protrude their tongue without oscillation in the context of locomotion. Do close relatives of flying snakes also exhibit this behavior? To investigate this question, we recorded the tongue behavior in close relatives (Ahaetulla prasina, Dendrelaphis pictus, caudolineatus, and formosis) as well as less related species (Dryocalamus subannulatus, Boiga cynodon, drapiezii, and nigriceps, Lycodon capucinus) as they traversed gaps. The setup consists of two artificial branches oriented horizontally and suspended 118 cm off the ground. Each snake completed four trials, recorded on four GoPro Hero4 cameras, crossing gaps of 0%, 15%, 30%, and 45% of the snake's snout to vent length. Among these species, only the close relatives of flying snakes (Ahaetulla and Dendrelaphis spp.) exhibited the presence of a tongue protrusion variant when crossing a gap. This behavior followed an oscillation, stick, oscillation (OSO) pattern. Generally, the tongue stick could be characterized by a rigid proximal half of the tongue while the tines show variable motion. The other species tested did not show any signs of tongue stick behavior. All snakes in this study were caught and examined at the University of Brunei Darussalam. This research was supported in part by the National Science Foundation (NSF) under grant numbers 1922516 and 2027523.

Mentor(s): Jake Socha (Biomedical Engineering & Mechanics Virginia Tech)

Anna Klewicki
Virginia Tech College of Natural Resources and Environment: Department of Fish and Wildlife Conservation/Environmental Conservation & Society

Copper Creek landowner perceptions of Great Blue Herons

Since the 1960s, Great Blue Heron (Ardea herodias) populations have grown dramatically in Virginia, with some regions seeing the numbers increase by over three times. This creates a higher potential for interactions between herons and people, including more sightings on private lands. However, to our knowledge, public opinions about Great Blue Herons have not previously been assessed. To better understand landowners' perceptions of herons, we conducted semi-structured phone interviews with individuals with property bordering a creek in southwest Virginia (Copper Creek). Copper Creek is entirely privately owned, meaning landowners, through stream management practices or lack thereof, may impact heron populations in the area. Anecdotal evidence led us to predict that most interviewees would express negative opinions about herons. We asked participants about their personal knowledge of the species, experiences with them, and changes they have noticed in the local ecosystem. We found that most participants had seen herons on their property and the large majority expressed positive feelings towards herons. Contrary to our hypothesis, only a small portion of landowners had negative opinions or experiences with herons. A handful of interviewees discussed perceived ecological benefits and drawbacks of herons, such as balancing fish populations in the ecosystem, or depleting their populations. The generally positive attitudes landowners expressed demonstrate that landowners may have an inclination to permit research that examines Great Blue Heron populations or ecosystem health. This study may serve as a framework for other research on people's perceptions of herons, as there is currently limited understanding of this.

Mentor(s): Ashley Dayer (Virginia Tech College of Natural Resources and Environment: Department of Fish and Wildlife Conservation)

Layan Kutbi
Virginia Tech/Computer Engineering

KGSP

Robotic Bat Head

This research is about creating a bat head that reproduces a dynamic biosonar system of bats.

Mentor(s): Rolf Mueller (Virginia Tech)

Jamie LaGrange
Mary Baldwin University /Biology

Identifying Novel Therapeutic Targets in Glioblastoma

Glioblastoma (GBM) is the most common primary central nervous system (CNS) malignancy yet demonstrates a lack of precision treatments, due in part to difficulty in accurately predicting patient prognosis. Recently, the Sheng lab identified 31 genes as the GBM progression gene signature (GBM-PGS), which allows us to justify patients into high or low risk of disease progression. This stratification could be exploited for developing precise treatment approaches unique to high- and low-risk patients. The goal of this study is to identify risk group-specific therapeutic targets using GBM-PGS. Therefore, we hypothesize that high- and low-risk GBM patients differentially express genes essential for the survival and growth of tumor cells, thereby becoming ideal targets for precision medicine. Based on data from the Cancer Dependency Map and The Cancer Genome Atlas, we stratified GBM cell lines and patient samples into high- or low-risk using GBM-PGS. By comparing gene expression data from patient samples to normal CNS tissues, we identified 476 and 81 genes uniquely highly expressed and essential in high- and low-risk GBM cell lines, respectively. Further analyses revealed 34 and 18 candidate genes in high- and low-risk GBM patient samples, respectively. Using cBioPortal, STRING, and the Reactome program, we further characterized these candidates. The most important finding of our research is that patients with a high risk of progression have a different set of genes essential for cell survival compared to patients with a low risk of progression. These findings verify the need for precision medicine and individualized therapies.

Mentor(s): Zhi Sheng (Fralin Biomedical Research Institute)

Alysa Lanier
Virginia Tech/Biochemistry

Kinetic Characterization of Inhibitors for the Flavin-Dependent Monooxygenase Siderophore A (SidA)

Aspergillus fumigatus is a prevalent and lethal airborne pathogenic fungus that causes lung infection in immunocompromised individuals. The flavin-dependent monooxygenase siderophore A (SidA) is an essential protein for the virulence of this fungus. SidA produces iron-chelating molecules known as siderophores, which sequester free iron from a human host in nutrient-limiting conditions. SidA hydroxylates L-ornithine using NADPH, which is then incorporated into A. fumigatus siderophores. The NADPH and L-ornithine binding sites are attractive targets for inhibition studies. The goal is to study six candidate compounds as SidA inhibitors (RITA, Nisoldipine, Ethacrynic Acid, MNS, Olipraz, Cefsulodin) which may be used as a drug to treat A. fumigatus infections. IC50 values were determined through an oxygen consumption assay using an oxygraph, which measures oxygen consumption as a function of enzyme activity. AutoDockVina was used to perform molecular docking on each inhibitor to investigate their potential mechanism of action. All inhibitors bound to the NADPH binding site. MNS docked into the L-ornithine and NADPH binding site which justifies the low IC50 value obtained experimentally. From this data, MNS and Cefsulodin were picked for further in vitro studies due to their low IC50 values, high decrease in activity, and high free energies from docking. Mode of inhibition was determined through the oxygen consumption assay with varying the inhibitor concentration and varying the corresponding substrate concentration (L-ornithine for MNS, NADPH for Cefsulodin). Future directions include, in vivo studies, which will be conducted to determine if these compounds inhibit the growth of Aspergillus fumigatus in iron-limiting circumstances.

Mentor(s): Pablo Sobrado (Department of Biochemistry)

Emma Larkin
Virginia Tech/Biological Sciences
Corinne Carlton
Virginia Tech/Psychology

Parent-Adolescent-Clinician Agreement: Implications for the Assessment of Adolescent Social Anxiety Disorder

Social anxiety disorder (SAD) frequently onsets during adolescence and is characterized by a persistent and debilitating fear of social and or performance situations. Currently, the assessment of SAD relies on reports from multiple informants (e.g., parents, adolescent, etc.). However, despite the use of multiple reporters, prior studies have consistently shown that there are significant discrepancies among reporters. This misalignment is problematic when assessing for SAD during adolescence and for treatment planning, with clinicians often using a composite score to represent agreement. As such, the present study aimed to accomplish the following: 1) Evaluate the degree to which parents and their adolescents agree on social anxiety symptom severity; 2) Determine if agreement between parents and adolescents predicts improvement of social anxiety severity (i.e., clinician-rated) and interference ratings (i.e., parent- and adolescent-report) across treatment and; 3) Assess if clinician-rated social anxiety severity more strongly aligns with parent- or adolescent- reported social anxiety interference. Participants included 58 adolescents between 12 and 16 years of age (Mage = 14.29, SD = 1.30; 70.7% female). Participants and their parents completed a diagnostic interview and separate self-report measures regarding social anxiety. Additionally, clinician-rated SAD severity scores were collected. Results indicate that parent-adolescent agreement regarding the adolescent's social anxiety severity and interference was low. Furthermore, parent-adolescent agreement was associated with improved treatment outcomes for socially anxious adolescents. Lastly, results indicate that clinicians more strongly align with parental report over adolescent report of social anxiety strongly align with parental report over adolescent report of social anxiety.

Mentor(s): Thomas Ollendick (Psychology)

Madison LaRoche
Virginia Tech/Clinical Neuroscience

Differential regulation of Zbed6 in differentiating layer 2/3 projection neurons with full heterozygous deletion of genes associated with 22q11.2 Deletion Syndrome versus heterozygous deletion of Txnrd2, a 22q11 candidate gene.

Zbed6 is a transcription factor that our recent data suggests may be associated with neuronal growth in layer 2/3 Projection Neurons (PNs). Based upon transcriptome comparisons from differentiating layer 2/3 PNs grown in a previously validated in vitro assay, we found that Zbed6 is down-regulated, compared to wild type (WT), in layer 2/3 PNs cultured from LgDel mouse fetuses that carry a heterozygous deletion of 28 genes orthologous to those on human Chromosome 22 that are deleted in the human neurodevelopmental disorder 22q11.2 Deletion Syndrome (22q11DS). In contrast, parallel transcriptome analysis indicates that Zbed6 is upregulated in layer 2/3 PNs with a heterozygous deletion of Txnrd2 (Txnrd2+/-), a single 22q11DS candidate gene associated with mitochondrial metabolism. To determine whether Zbed6 targets layer 2/3 PNs in the developing cortex in vivo, we asked if Zbed6 mRNA can be localized in layer 2/3 PNs labeled with Cux1, a layer 2/3 PN selective marker at P7, a time of peak in vivo differentiation of layer 2/3 PNs. Zbed6 is expressed in layer 2/3 PNs in WT, LgDel, and Txnrd2+/- P7 mouse pups. Preliminary analysis suggests that per cell levels of Zbed6 are diminished in LgDel and enhanced in Txnrd2+/- layer 2/3 PNs compared to WT at P7. In parallel, we are assessing whether Zbed6 expression levels vary over the course of late fetal and early postnatal cortical development using quantitative PCR. Together, this quantitative analysis of Zbed6 expression in WT, LgDel and Txnrd2+/- indicates that Zbed6 may differentially regulate transcriptional responses to full heterozygous 22q11 gene deletion versus heterozygous deletion of the 22q11 candidate gene Txnrd2. Thus, full deletion of 22q11 genes in layer 2/3 PNs may elicit a distinct transcriptional response from that of single candidate genes that influence layer 2/3 PN differentiation.

Mentor(s): Anthony-Samuel LaMantia (Center for Neurobiology Research)

Hannah Leathers
University of North Carolina at Chapel Hill/Geography

Using Remote Sensing Data Combined with Video Camera Collar Data to Determine NDVI and EVI Influence on American Black Bear Foraging

American black bears (Ursus americanus) utilize food resources within their home ranges, with their summer diets comprising a high proportion of vegetation. A method to remotely assess vegetation quality is to use satellite imagery to calculate the Normalized Difference Vegetation Index (NDVI) and Enhanced Vegetation Index (EVI), both ranging from -1 to 1. NDVI assesses the greenness and vegetation quality, while EVI corrects for atmospheric conditions and is more sensitive in dense vegetation areas. We aimed to isolate whether bears primarily foraged in areas with higher vegetation index values than other areas within their home range. We used video collar data collected from 9 black bears in Bath County, VA, in 2018, where each video of foraging events was paired with its location. We extracted NDVI and EVI values from remote sensing data with 30X30m resolution using USGS's AppEEARS for each foraging point. We compared these to non-foraging and random points selected from each bear's home range over 16-day satellite imagery from May to August. We then compared foraging points to the average NDVI and EVI of each bear's home range via raster files in ArcGISPro. Preliminary results show that black bear points had an average NDVI of 0.8931 (range:0.2215-0.9944) and an average EVI of 0.6304 (range:0.1401-0.8880). The average NDVI of bear's home range was lower at 0.2920 (range:0.4259-0.2299) and EVI cannot be calculated with this method. This information is valuable to wildlife managers because it allows NDVI/EVI to be a potential predictor of good foraging habitat for black bears.

Mentor(s): Marcella Kelly (FWC)
Brogan Holcombe

Tony Lee
Virginia Tech/Industrial & Systems Engineering

Supporting Distributed Interdisciplinary Research Teams via Immersive VR

The goal of the VR Teams project is to explore the benefits and barriers of using immersive tools, specifically virtual reality (VR), for research and to better understand user experience and interaction requirements.

Initially supported by the College of Engineering, the project represents a critical aspect of how VR can be integrated into Metacampus. Studies show that the use of VR in the classroom helps increase motivation and self-efficacy among students (Radianti et al., 2020). Recently, many universities are looking to implement immersive tools into their educational structures but have encountered a common problem that seems to be centered around insufficient cross-institution planning (EDUCAUSE, 2021). With this in mind, Metacampus strives to enhance the university's various missions through immersive technology with its intention to enhance on-campus student life.

VR Teams project will use a mixed methods approach which allows for the analysis of quantitative, qualitative, and observational data. To explore the use of VR as a research tool, the study affords participants the opportunity to engage in two-forms: Structured and Open Exploration. Structured Exploration aims to recruit 25 individuals that will complete 5 research tasks in each of the 4 platforms. Open Exploration intends to recruit 7 research teams with a minimum of 3 members who will utilize VR in the way they deem best fit.

Anticipated project outcome is that we will acquire empirical evidence to inform VT COE on new ways of conducting interdisciplinary research and that immersive tools can be a beneficial and effective tool for education.

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Mentor(s): Rafael Patrick (Industrial & Systems Engineering)

Eleanor Little
FBRI

Cancer cells' response to chemotherapeutic treatments is time-of-day dependent

Circadian rhythms are endogenous, self-sustained physiological processes with a periodicity of ~24h. Interconnected cycles of transcription and post-translational modifications maintain rhythms by regulating the expression of core transcriptional components and other clock-controlled genes. Thus, the interplay between timing and dosage is an important factor for optimizing treatment efficacy and reducing toxicity. PERIOD 2 (PER2) is a core clock component that directly modulates the stability and transcriptional activity of the tumor suppressor p53. Activation of p53 triggers cell cycle arrest, DNA repair, and apoptosis and thus, prevents damaged cells from proliferating. As a result, we ask whether cancer cells lacking p53 can be susceptible to chemotherapeutic treatment if delivered at different circadian times.

Circadian-synchronized human colon cancer cells HCT116 p53 wildtype and its isogenic p53 knockout line were treated with chemotherapeutic drugs at peak (t=6h) or trough (t=16h) of their PER2 expression. Accordingly, we treated cells with various concentrations of methyl methanesulfonate, doxorubicin hydrochloride, 5-fluorouracil, and irinotecan. Cell viability was >80% even 96h after drug treatment. Interestingly, RT-qPCR results show p21 expression is significant when drugs were delivered at the trough. A remarkable finding is that apoptosis is specifically triggered via PUMA, instead of the traditional Bax, pathway. As expected, no changes were detected for c-myc. These results show that even highly resistant p53-deficient cancers can be susceptible for treatment if chemotherapeutics are given at specific circadian times.

Mentor(s): Carla Finkielstein (Department of Biological Sciences)

Baitong Liu
Virginia Tech/Clinical Neuroscience

Role of BMP-induced connexin43 interaction with β-catenin in glioblastoma stem cells.

Glioblastoma (GBM) accounts for over 60% of adult brain tumors and is one of the most malignant types of tumors in the central nervous system. Due to its resistance to treatments such as radiotherapy and chemotherapy, GBM has a poor prognosis with patients succumbing 12 to 18 months after diagnosis. GBM resistance has been linked to the heterogeneity of these tumors composed of a subpopulation of chemoresistant GBM cancer stem cells (GSCs). GSCs can be found in a self-renewing state, but also differentiate through asymmetric division, contributing to tumor recurrence following treatment. Several signaling pathways regulate the maintenance and differentiation of GSCs including the Wnt/β-catenin and bone morphogenic protein (BMP) signaling pathways. We have previously shown that BMP can induce expression of the gap junction protein connexin43 (Cx43) through β-catenin transcriptional activity in GSCs.
In addition, we found BMP increases the interaction between Cx43 and β-catenin at the plasma membrane in GSCs. The Cx43/β-catenin interaction has previously been characterized and can be disrupted through Src-dependent phosphorylation in the carboxy-terminus tail of Cx43 on tyrosines 265 and 313. To determine the role of Cx43 interaction with β-catenin in GSCs, we generated two phospho-mimetic Cx43 mutants incapable of binding to β-catenin, Cx43 Y265E/Y313E and Cx43 Y265D/Y313D , and a Cx43 mutant resistant to Src-dependent phosphorylation, Cx43 Y265F/Y313F. We are now overexpressing these mutants in Cx43 knockdown GSCs to assess their effects on cell migration and cell-cell communication. Our findings will aid in novel therapeutic development to eradicate GSCs in GBM and prevent post-treatment tumor recurrence.

Mentor(s): Samy Lamouille (Fralin Biomedical Research Institute at Virginia Tech Carilion, Roanoke, VA)

Amanda Ljuba
Virginia Tech/Sociology
Jontayvion Osborne
Austin Peay State University/Business Management
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Virginia Tech/Computational Modeling and Data Analytics

Illustrating Potential Opportunities for Community Schools in Loudoun County

Community Schools is a term used to describe schools that bring educators, families, community partners, and local government together to address the comprehensive needs of students, families, and communities. The U.S. Department of Education states that the primary purpose of community schools is to “provide comprehensive academic, social, and health services for students, student's family members, and community members that will result in improved educational outcomes for children". Loudoun County started this program in their public schools in 2016, transforming one elementary school into a community school. This initiative has grown over the past several years to involve six elementary schools with high percentages of low-income families in 2022.

This project aims to describe and visualize the resources and services available to students and families in the Loudoun County area to help the Community School Program. We will use publicly available data to analyze available resources in four key areas: Health and Social Services, Mental Health, Family Engagement, and Youth Development. This analysis will help ensure that children from such vulnerable areas meet state academic standards using the available support. Our results will enable stakeholders to understand the challenges facing students and families in these community schools and provide insights into potential opportunities for improvement to meet the needs of the students, families, and the community.

Mentor(s): Chanit'a Holmes (Agricultural and Applied Economics)

Mikaela LoBosco
Virginia Tech/Biochemistry

Modified Pectin as a Biodegradable Polystyrene Substitute

Plastics are notorious for wreaking havoc on our ecosystems due to their chemical toxicity and slow degradation rate. Plastics are also unsustainable, being products of crude oil. An environmentally-friendly approach to minimize plastic accumulation is via the manufacturing of sustainable biomaterials abundantly sourced from biological sources. Polysaccharides represent a major class of sustainable biomaterials actively sourced from plants, bacteria, and animals, and are chemically composed of long chains of carbohydrates. Polygalacturonic Acid (PolyGalA) or pectin is a polysaccharide abundant in current food industry waste products, including the peels of citrus fruits. Through a one-step conjugation scheme, we were able to modify PolyGalA and synthesize a bioplastic material. We coupled PolyGalA to benzylamine using a standard amide coupling strategy to generate Polygalacturonan-Benzylamide (PolyGalA-BA), which contains side chains that mimic polystyrene (Styrofoam). For structural and DS analyses, we employed NMR, size exclusion chromatography, and UV-Vis using a benzylamine standard curve. Our bioplastic with a degree of substitution (DS) of 7-19% resembles the visual and textual characteristics of polystyrene with the expected degradability of polysaccharide-based materials. This novel glycomaterial could potentially decrease the use of polystyrene, helping to mitigate harmful plastics accumulation in our environment.

Mentor(s): Richard Helm (Department of Biochemistry and GlycoMIP)
Ryan Porell (GlycoMIP, Virginia Tech)

Laurel Logan
Virginia Tech/Mechanical Engineering

Heterotypic Contact Inhibition of Locomotion for Cells on Suspended Nanofibers

When cells migrate, they interact with other cells exhibiting a behavior termed “Contact Inhibition of Locomotion” (CIL). This phenomenon classically describes cells colliding, repolarizing to form a new leading edge, and migrating away from one another (reciprocal CIL). Studies have found that malignant cancer cells interact differently with nonmalignant cells, often continuing along their migratory path without repolarizing (nonreciprocal CIL), which may contribute to their invasive nature. Inside the body, the cellular environment is fibrous in nature and termed the extracellular matrix (ECM). Cells migrating within the ECM interact with suspended nanofibers of various diameters and mechanical properties. CIL has mostly been studied in vitro in environments that do not represent the fibrous ECM. We recently found that nonmalignant cells migrating on nanofiber networks mimicking the ECM demonstrate CIL behaviors distinct from those on flat substrates. We saw a large increase in nonreciprocal CIL and “walk past” events (where neither cell repolarizes) for cells on fibers compared to flat surfaces. Here, we extend the studies to interrogate CIL interactions between malignant and nonmalignant cells in fibrous environments to better understand the invasive nature of cancer cells in vivo. Using quantitative microscopy, we aim to describe the spatiotemporal outcomes as two cell types collide with each other on aligned and crosshatch networks of fibers of various diameters and spacings.

Mentor(s): Amrinder Nain (Mechanical Engineering)

Joshua Long
Virginia Western Community College /Engineering

NSF

Development and Validation of an Efficient Image Processing Method for Quantifying Bacterial Biofilm Coverage on Nanofiber-textured Surfaces

Biofilms are communities of bacteria encapsulated in extracellular polymeric substances to become resistant to unfavorable conditions and antibiotics. According to the National Institute of Health, 80% of human bacterial infections are caused by biofilms; this fact inspires researchers in our lab to develop biofilm mitigation strategies. One of our goals is to develop mussel-inspired linear topographies consisted of a parallel array of nanofibers to limit bacterial adhesion and biofilm formation. The intent of this REU project was to develop and validate image processing strategies that quantify bacterial surface coverage on nanofiber-textured surfaces. Commonly used image processing methods that rely on thresholding do not work well with nanofiber-coated substrates as the fibers tend to be included in the percentage output. To circumvent this, we developed a method that utilizes shading compensation, contrast adjustment, and destripe filtering to eliminate fibers resulting in a more accurate analysis. When calculating the surface coverage of Staphylococcus aureus on fiber-coated substrates, a 10% decrease in coverage was observed after image filtration. The filtering that takes place in our method allows for binary image conversions that can accurately represent the bacteria. Binary images can be batch analyzed to produce more repeatable results at an improved efficiency compared to manually thresholding each one. They can also be selectively eroded to exclude singular planktonic bacteria to determine the surface coverage exclusive to biofilms. Upon validation through colony counting experiments, this method should allow for a more efficient and adjustable analysis of bacterial surface area coverage with less user bias.

Mentor(s): Bahareh Behkam (Mechanical Engineering)

Marion LoPresti
Virginia Tech/Biochemistry

Using Molecular Docking to Determine the Drug Targets of Cp*Rh Piano Stool Complexes in SARS-CoV-2

SARS-CoV-2 caused over 6 million fatalities worldwide and has only two FDA-approved drugs, Remdesivir and Baricitinib. However, these approved drugs are primarily used as rheumatoid arthritis treatments and are not specifically designed to combat SARS-CoV-2. To create more strain-specific drugs, non-toxic organometallic rhodium compounds with a pentamethylcyclopentadienyl (Cp*) piano stool complex are being studied for their antiviral and antimicrobial properties. Complex two (IC50: 15.31μg/mL) and complex four (IC50: 0.4381μg/mL), exhibit antiviral activity against SARS-CoV-2; however, mechanisms of action are unknown. To predict molecular targets and design more efficacious and strain-specific organometallic compounds, all four complexes were docked into four structural proteins and two non-structural proteins (nsps) of SARS-CoV-2, PLpro and Mpro. These proteases are vital to the replication and transcription of SARS-CoV-2. Docking studies demonstrate that complex one and complex four successfully dock in SARS-CoV-2 proteins. Complex four was the only compound with favorable free energy of binding to possible target proteins, as determined by MM/GBSA calculations. Of SARS-CoV-2 proteins scanned, complex four bound favorably in the E-protein, M-protein, S-protein and Mpro. When docked unbiasedly, complex four bound in two known inhibitor sites: the active site in Mpro and the receptor binding domain (RBD) in the Spike protein. Fingerprinting data and high virucidal activity of these complexes in experimentation indicate Mpro is the potential main target for these complexes and complex four is the most effective inhibitor. Cp*Rh piano stool complexes can now be further functionalized for the Mpro active site and work to combat SARS-CoV-2 infections.

Mentor(s): Anne Brown (Biochemistry)

Chu Luo
Smith College/Chemistry

Understanding Pediatric Dysphagia by Mapping out the Brainstem in Neonatal Mice

Pediatric dysphagia, or disrupted suckling, feeding, and swallowing (SFS) following birth, is a common clinical manifestation of 22q11.2 Deletion Syndrome, which is a disorder caused by a deletion on chromosome 22. However, the underlying mechanism of this phenomenon is still unknown. Since the brainstem houses motor nuclei that give rise to cranial motor nerves V, IX, X, and XII, as well as sensory nuclei, including the principal sensory nucleus of CN V (PrV), the spinal trigeminal nucleus (SpV), and the solitary nucleus that are essential for controlling SFS at and immediately after birth, developing a map of the brainstem structures in neonatal mice is necessary for understanding the neural circuitry involved in SFS. By using different reporter mouse lines, including for choline acetyltransferase (ChAT), neurofilament (NF), and Six1-Tdt, (and potentially Wnt1-Tdt), we were able to preliminarily map out the motor, mechanoreceptive, and nociceptive nuclei, respectively. The distinction between mechanoreceptive and nociceptive sensory relay nuclei can be helpful in the next step of studying dysphagia by comparing the level of immediate early gene expression in mechanoreceptive (PrV) and nociceptive (SpV) nuclei of the trigeminal nerve using cFOS immunostaining in WT and LgDel mice (a genetically accurate model for 22q11DS) in response to nociceptive stimuli. We've successfully detected nuclear cFOS immunoreactivity in distinct cranial nerve nuclei in WT P7 mouse pups with no additional stimuli, which confirms that the cFOS staining protocol works reliably and consistently, and that it can be developed into an assay to measure neuronal activation in sensory relay nuclei following nociceptive stimulation in future studies.

Mentor(s): Anthony-Samuel LaMantia (Center for Neurobiology Research)

Allison Madsen
Virginia Tech/HNFE science option

In silico genetic examination of single nucleotide missense mutations in NHLH2: possible involvement in obesity, exercise motivation, and fertility

The NHLH2 (Nescient Helix-Loop-Helix 2) protein interacts with the hypothalamic-pituitary-gonadal axis to regulate body mass, physical activity, and the male reproductive systems. Dysfunction of the NHLH2 gene has been linked to obesity and infertility. Single nucleotide variants (SNVs) are the most common type of mutation in the human genome, and may cause alteration in protein structure, function, or regulation. Missense variants result from 109 of the 4704 SNVs present in the NHLH2 gene, but there is limited data available about the impact of these SNVs on the post translational modification (PTM) pattern and function of the NHLH2 protein in carriers of the missense variants. The research purpose is to examine SNVs along NHLH2 utilizing in silico techniques to model alterations in protein structure. Missense variants were analyzed using BLAST technology and PROVEAN scoring to predict the severity of the SNV. Thirty-six missense mutations with a PROVEAN score below -2.5 were considered deleterious and were then examined for PTMs using MuSiteDeep. Twelve SNVs that modified one or more types of PTMs, compared to the wild protein, were further analyzed using 3D protein modeling. Since PTMs directly impact the regulation of protein function, it is possible that these SNVs could change the function, or stability of the NHLH2 protein in vivo, resulting in metabolic or sexual dysfunction. Comparison of human population frequency data for these SNVs will allow us to predict the likelihood of these mutations existing in the human population and potentially contributing to the rising rate of obesity and infertility.

Mentor(s): Deborah Good (HNFE)

John Malla
Virginia Tech/Computational Modeling and Data Analytics
Christopher Vest
Jacksonville State University/Finance
Rachel Inman
Virginia Tech/Smart and Sustainable Cities

Agricultural Land Use Change in Powhatan and Goochland County

Goochland and Powhatan are two rural counties on the outskirts of the City of Richmond. This project uses publicly available geospatial data and administrative parcel records to construct a profile of land parcels over time. We focus on the factors that drive land conversion from agricultural to other uses. We use geospatial links to track these land parcels over time and geospatial visualizations to map parcellation of land. Our geospatial analysis includes interactive plots of parcel conversion and analysis of parcellation hot spots. We also construct a parcel profile for each parcel of land. The profile includes the crops grown on the land, the soil type, annual daily traffic, travel time to Richmond, and provision of utilities by the town. We use these data in a statistical model to understand the association between parcel-level characteristics and land conversion out of agriculture. Our research allows us to define the driving forces of parcellation and land use conversion. With the help of data science and statistical modeling, we estimate the probability of each land parcel changing its land use class. Our geospatial and statistical analysis can help Goochland and Powhatan understand land use and agriculture loss in their counties.

Mentor(s): Susan Chen (Agricultural and Applied Economics)

Cassidy Mann
Fralin Biomedical Research Institute

CHBR SURF

Do Demographic Factors Moderate the Effect of Episodic Future Thinking on Delay Discounting?

Episodic Future Thinking (EFT) is a technique used to reduce delay discounting (the decreased value of a delayed reward). EFT encourages a person to vividly imagine what could happen in one's future. More specifically, this helps those suffering from addiction make better health-related decisions. However, participants' demographic or smoking factors influence the effect of EFT on delay discounting. For this study, we examined gender, education level, age, household income, and smoking frequency. All data used were collected from smokers from two studies - Stein, Tegge, Turner, & Bickel, 2018 (study 1; n=117) & Ruhi-Williams, King, Stein, & Bickel, 2022 (study 2; n=199). In both studies, EFT participants had a lower discount rate than the control episodic thinking (CET) group. Moderation was examined using ANOVA, including interactions between groups and all demographic/smoking characteristics. In study 1, the only moderator found to have a significant interaction effect was age (p=0.035), with smaller reductions in discounting in the intermediate group (30-39 years). This finding was not replicated in study 2. In study 2, smoking frequency was the only significant interaction found (p = 0.0007), with larger reductions in discounting in moderate smokers (11-19 cigarettes/day). These findings suggest the effects of EFT are generally robust across most participant characteristics, although larger reductions in delay discounting may be observed in younger participants and heavier smokers. Future work should seek to identify if there are other demographic factors that influence the effect of EFT and ways we can discard this disparity between factors.

Mentor(s): Jeffery Stein (Department of Human Nutrition, Foods, and Exercise, Virginia Tech)
Haylee Downey (Fralin Biomedical Research Institute at VTC, Graduate Program in Translational Biology, Medicine, and Health, Virginia Tech)

Tyler Mannings
Prairie View A&M University/Electrical Engineering

Demonstration of the Hong-Ou-Mandel Effect

The Hong-Ou-Mandel or HOM effect is a photon interference phenomenon that occurs when photons with identical properties reach a beam splitter at the same time, causing them to always travel the same output path. This effect has many applications in quantum computing, such as alternative global positioning systems and logic gates in optical quantum computing. In order to understand and demonstrate the HOM effect, we have used a QuTools quantum entanglement generator to send entangled photons into a beam splitter at varied path lengths until the photons reach the splitter at the same time. The HOM effect has been demonstrated in our experiments as a significant dip in the number of photons registered at both output paths of the beam splitter at the same time. With the phenomenon recreated successfully, we will now be able to develop experiments that can explore and demonstrate applications of the effect.

Mentor(s): Wayne Scales (Electrical Engineering)

Shannon Mauro
Virginia Tech/Human Nutrition, Foods, and Exercise

Playing COVID Proteins: Using genetic analysis to convert protein data to musical compositions

The SARS-CoV-2 virus strain has led to the COVID-19 pandemic plaguing the world over the last 2.5 years. Mutations in the spike glycoprotein (S-protein) amino acid sequence that provide better evasion of the immune system and/or higher infectivity, without impairing the function of the S-protein itself are selectively kept by viral sub-species.
Using the process of "sonification" to translate data about the amino acid sequence of SARS-C0V-2 S-protein to music we will tell the story of the COVID-19 pandemic. The NCBI SARS-CoV-2 website contains over 5.9 million viral sequences and was used to obtain the amino acid sequence from the original Wuhan strain, as well as the sequences of ten different COVID-19 variant subspecies. The location and number of mutations within each variant, omicron variants possessing the largest number, were compared between subspecies using the CLUSTAL Omega site with phylogenetic analysis. NetNGlyc was then used to predict post translational glycosylation locations of the Wuhan, and variant strains to provide more diversity for the sonification process. Algorithms that will guide sonification of the data to musical compositions are being developed. Two pieces are planned: (1), An orchestral piece, to be premiered by the VT Philharmonic Orchestra in Spring 2023, and (2) A chamber piece, to be premiered by an ensemble of Music faculty performers in Fall 2024, in the Cube of the Moss Arts Center. This music will provide a presentation that melds the physical research-based environment of science with the emotional expression of music, telling the story of the COVID-19 pandemic.

Mentor(s): Deborah Good (HNFE)
Charles Nichols

Emily McAlpin
Virginia Tech/Nanomedicine

Examining REDD1 Localization Using Confocal Microscopy

Cardiovascular disease is the leading cause of death in the United States and worldwide. Diabetes is characterized by insulin resistance and increases a patient's risk of developing cardiovascular disease by more than 2-fold, termed 'diabetic cardiomyopathy.' Our lab identified regulated in development and DNA damage response (REDD)1 as a potential mediator of cardiac insulin sensitivity and resistance. Our preliminary data demonstrates that insulin mediates REDD1 nuclear localization and chromatin binding, while fatty acids drive its cytosolic retention. We hypothesize that REDD1 nuclear localization is critical for insulin sensitivity, an effect which is prevented with fatty acids and underlies insulin resistance. Herein, we aim to examine REDD1's localization using immunostaining and confocal microscopy. To do so, we optimized the cellular density and extracellular matrix preferences of wild type and REDD1-null Hap1 cells for plating and visualization. In addition, we tested four antibodies for the detection of endogenous REDD1. Finally, we optimized the dosage of an adenovirus expressing REDD1 tagged with turboGFP (REDD1-tGFP) in Hap1 cells, as well as in neonatal rat ventricular myocytes. Our data demonstrate that 200,000 Hap1 cells per well (area=1.3 cm 2), plated on fibronectin is ideal for visualization via confocal microscopy. Further, we found that utilization of REDD1-tGFP may be ideal for visualization of REDD1 versus detection of endogenous protein. These optimization experiments are critical for ongoing studies confirming localization of REDD1 in response to insulin and/or fatty acids, and uncovering the mechanistic role for REDD1 in mediating cardiac insulin sensitivity and resistance.

Mentor(s): Jessica Pfleger (Biological Sciences, Fralin Biomedical Research Institute)

Tiffany McCoy
Virginia Tech/Biological Sciences

Anne McNabb Summer Fellowship

Isolation of giant viruses from Chlamydomonas reinhardtii

Giant endogenous viral elements (GEVEs) that were previously believed to exist primarily in prokaryotes have recently been discovered in the genomes of unicellular eukaryotic organisms. These GEVEs are thought to be involved in crucial environmental processes by altering the host genome through integration. The viruses have been isolated from various amoeba and algal species, but they have yet to be obtained from the algal model organism Chlamydomonas reinhardtii. The purpose of this study is to attempt the first isolation of giant viruses from various strains of C. reinhardtii and environmental algal samples in order to better understand the interactions between the two microorganisms. Environmental samples were identified as Chlamydomonas through PCR and gel electrophoresis. Once pure cultures were obtained, cells were grown in liquid media, and a standardized growth curve was created using cell counting and concurrent absorbance measurement. Plaque assays were performed along with infection experiments to visualize viral lysis. To induce virus excision from the genome, stress experiments were performed using heat shock, UV, and mitomycin C treatments. Successful isolation of these giant viruses would help us study the host/virus relationship and application of this knowledge could be used to combat large-scale environmental issues, such as widespread algal blooms.

Mentor(s): Frank Aylward (Biological Sciences)

Cate McHugh
Virginia Tech/Human Nutrition, Foods, and Exercise

TOUR

Evaluation of Physical Activity Opportunities in Seven Virginia Counties

Rates of physical activity in the United States are below the recommended levels and can contribute to high rates of diabetes, obesity, heart disease, and premature death. There are disparities in access to opportunities to be physically active; which may be contributing to physical inactivity in some populations. An environmental scan of Virginia was conducted in which County Health Rankings were used to determine five poorly scored counties in Virginia. These were compared to the best scored urban county and best scored rural county. Data on the opportunities available in each county was collected, including stakeholders, community and recreation centers, free events for the community, parks, trails, and programs or policies geared towards increasing physical activity opportunities. A content analysis of each county's comprehensive plan was performed and semi-structured interviews were conducted with representatives from Falls Church City (the highest ranked county) and Petersburg City (the lowest ranked county) in order to determine progress made on the goals found in the plans. Each county presented varying levels of physical activity opportunities. The healthier counties had more free activities and programs geared towards increasing physical activity and also contained more in depth comprehensive plans with goals relating to improving physical activity infrastructure. This information can be used to determine what may be helpful in decreasing the gap in opportunities between counties. Future research should focus on which physical activity opportunities are utilized and valued by community members in each county.

Mentor(s): Sarah Misyak (Human Nutrition, Foods, and Exercise)
Elena Serrano (Human Nutrition, Foods, and Exercise, Virginia Tech)

Juliana McIrvin
Virginia Tech/Mechanical Engineering
Vittorio Pastore
Virginia Tech/Robotics and Mechatronics
Eliza Wapperom
Blacksburg High School

Development of Squeaky 2.0, the Open Source, 3D Printed, Quadruped Teaching Tool

In this work, we are designing and developing the 12-degree of freedom quadruped robot Squeaky 2.0, which is the advanced version of the existing robot, Squeaky, with a more powerful, modular, and agile platform on a simple programmable framework. The design of both versions of the quadruped is inspired by the behaviors and locomotion of dogs, which exhibit unique interactions and connections with humans. To redesign Squeaky 2.0, we explored the shortcomings of the existing design with respect to the power requirement and the overall size of the robot. To achieve more complex tasks such as running and jumping, we replaced the existing servo motors with more powerful brushless DC motors in Squeaky 2.0. To accommodate the DC motor in the new design of the quadruped, we used Siemens NX CAD software to design the new limbs with a modified in-leg power transmission system. We have performed several design iterations to finalize the limb size, movement, and spacing for the new limb design of Squeaky 2.0, which we then validated through 3D printing and prototyping. The DC motors have been successfully integrated with the new design and currently, we are working on further design improvement in the overall structure of Squeaky 2.0 including more efficient ways to charge and cleaner wiring aesthetics. Finally, this affordable quadruped robot can be used as a learning platform for research and education as well as a companion robot.

Mentor(s): Alexander Leonessa (Mechanical Engineering)

Cassell McMillian
Virginia Tech/Biochemistry

Synthesis and Characterization of Dextran/PLA block copolymers as Compatibilizing Agents in PLA/Starch Blends

Synthetic polymers from nonrenewable resources have proven to be useful materials because of their versatile properties and cheap production costs. Along with these useful properties comes their persistent environmental threats, prompting the need to transition to sustainable polymers. Biopolymers such as amylose and amylopectin from starch, and biodegradable polymers such as poly (lactic acid) (PLA) have been researched as alternatives, but their lack of useful properties compared to their synthetic counterparts limits their applications. One solution is the blending of biopolymers and biodegradable polymers which can result in a wider range of physiochemical properties, provided there is cooperative interaction between the two polymer components to overcome the unfavorable entropy of mixing. The blending of immiscible polymers causes phase separation leading to blends with poor mechanical properties. Block copolymer compatibilizers have been shown in the literature to reduce interfacial tension and phase separation in blends, resulting in enhanced mechanical properties superior to each individual component. In this work, we synthesized and characterized novel block copolymers of dextran and PLA as compatibilizers for starch/PLA blends using a facile, efficient, and versatile, azide/alkyne cyclo addition reaction. We hypothesize that the dextran-b-PLA will be an ideal compatibilizer for PLA/starch or PLA/ starch ester blends due to the structural similarity between dextran and amylopectin branches. This blend would be inexpensive, sustainably sourced, and fully biodegradable, thereby reducing our reliance on non-renewable synthetic plastics.

Mentor(s): Kevin Edgar (Sustainable Biomaterials)
Rana Ashkar (Department of Physics, Virginia Tech)

Lyat Melese
Fralin Biomedical Research Institute/High School Student

CHBR

Delay Discounting as a Target for Self-Regulation in Prediabetes

Prediabetes increases the risk of developing type 2 diabetes, heart disease, and stroke. Delay discounting (DD), the preference for smaller, sooner rewards over larger, later ones, is a behavioral marker of impulsivity. Steep DD curves (i.e., decreased area under the curve (AUC)) have been demonstrated among individuals with prediabetes, indicating a shortened temporal perspective. Individuals with prediabetes also have heightened blood glucose variability (BGV), used to predict the risk of developing type 2 diabetes. It is currently unknown if DD is related to BGV. Therefore, this pilot study was designed to assess (1) the relationship between DD and BGV in adults with and without prediabetes and (2) the effects of Episodic Future Thinking (EFT) intervention on DD and BGV. Normoglycemic (n=17) and prediabetic (n=12) individuals were randomly assigned to EFT or daily check-in control. Results showed that higher baseline DD AUC values were correlated with lower baseline BGV (fmax: $r = -0.665$, $p = 0.018$). EFT showed a trend in increasing DD AUC values in participants without prediabetes but not in participants with prediabetes ($F(1.199, 17.989) = 1.975$, $p = 0.177$, partial eta = 0.116). Additionally, EFT showed a trend in reducing BGV in prediabetic participants but not in normoglycemic participants ($F(1,12) = 3.449$, $p = 0.088$, partial eta = 0.223). These preliminary data indicate that EFT may help to decrease DD and slow blood glucose rhythmicity. Future work will use larger sample sizes to increase the statistical power of the study.

Mentor(s): Julia Basso (Department of Human Nutrition, Foods, and Exercise)

Gabriel Mendelson
Virginia Tech/Biochemistry

Fralin SURF

Characterization of AHASS2 Mutations in Arabidopsis

Proteinogenic amino acids are organic compounds that constitute protein structure, and are vital for developmental and metabolic functions. Essential amino acids (EAAs) are a group of nine proteinogenic amino acids that monogastric animals cannot synthesize. Only plants, bacteria, and archaea can de novo synthesize EAAs. The EAAs Valine, Leucine, and Isoleucine are classified as branched-chain amino acids (BCAAs). Acetohydroxyacid Synthase (AHAS) is the first enzyme within the conserved BCAA synthesis pathway, which is inhibited upon binding of amino acids with its regulatory subunit (RSU), preventing over-synthesis of BCAAs. The AHASS2 gene encodes one of the two the RSUs, in Arabidopsis thaliana. Four Arabidopsis lines were obtained from a forward genetic screening for plants resistant to toxic concentrations of Val. These lines carry mutations in AHASS2. Mutations in AHASS2 might reduce the feedback inhibition of AHAS by BCAAs, enabling the mutant plants to exhibit higher resistance to Val. For this hypothesis, I measured AHAS activity of mutant and wild-type plant extracts in the presence of BCAAs. Because AHAS is difficult to isolate for enzymatic assay measurement, I first optimized the extraction protocol to increase enzyme stability, as well as the throughput of the assay. The phenotype of the lines grown on toxic BCAA concentrations was determined and compared to their respective AHAS activities. Understanding the molecular regulation mechanism of AHAS activity would enable us to engineer more nutritious plant containing more BCAAs in their seeds and organs. This allows cost-effective and increased supplementation of BCAAs within commercial crops and livestock feed.

Mentor(s): Guillaume Pilot (PPWS)

Evan Miller
Virginia Tech/Biological Sciences

Investigating the activity and function of the Sinorhizobium meliloti response regulator FlcA

Sinorhizobium meliloti is a gram-negative soil bacterium that forms a symbiotic relationship with alfalfa plants by inducing nodule formation in their roots. This mutualism enables the fixation of atmospheric nitrogen, resulting in increased host biomass production. As alfalfa is one of the top revenue-generating crops in the US, an improved understanding of its interactions with S. meliloti is of great relevance to our economic interests. Moreover, improvements in alfalfa cultivation practices will allow for a reduction in the use of environmentally damaging fertilizers. The S. meliloti chemotaxis-like system, which bears similarity to the better understood chemotaxis system, includes the protein FlcA. FlcA resembles the chemotaxis response regulator CheY2, which is phosphorylated by the histidine kinase CheA. To determine whether a similar interaction occurs between FlcA and its putative kinase CheAY, we purified the two proteins using the IMPACT and Ni-NTA systems, respectively, before performing phosphorylation assays. We did observe phosphorylation, however the phosphorylated band in a time course reaction of CheAY appeared lower than expected, possibly due to the inadvertent co-purification of an FlcA chaperone protein alongside FlcA. Furthermore, prior RNA-seq analysis has indicated elevated expression of the pilin gene pilA2 in the presence of activated FlcA. To investigate the phenotypic effect of this elevation on cell adherence mediated by Type IV pili, we conducted adherence assays, which we expect to demonstrate increased adherence as a result of FlcA expression. Our findings suggest that, when phosphorylated by CheAY, FlcA triggers pilA2 expression and thus promotes cell adherence.

Mentor(s): Birgit Scharf (Department of Biological Sciences)

Sarah Mitchener
Virginia Tech/Biology

Performance and Play: Fostering Student-Centered University Learning Cultures

“You are endowed with a storytelling legacy. You are free to risk failure. Your growth is legitimate. You have the right to claim space. You are, and have always been, an artist. “

These affirmations guided the journey through an Introduction to Applied Collaborative Techniques (I-ACT) course taught at Virginia Tech in Fall 2021. I-ACT serves students across academic disciplines who apply creative principles of applied theatre to develop intrapersonal and interpersonal communication capacities. In the course, students unlearn what Paulo Freire called the “banking model” of education. We share an approach to learning rooted in self-discovery, self-directed learning, and interdependence. We also invite students who may not identify as artists to see themselves as such. In this way, we explore how storytelling, theatre, and art-making offer us the aesthetic means to analyze our past, consider the context of our present, and invent our future. How do we, as educators, support young people in freeing themselves from habits and certainty? How do we create learning environments that encourage students to disrupt the culture of scarcity, perfectionism, and urgency that academia instructs, and that capitalism desires? The goal of the workshop was to help participants to re-imagine academic learning environments as spaces where a culture of consent, relationality, storytelling, and serious silliness can facilitate liberation. Additionally, as participants of the Pedagogy and Theatre of the Oppressed, we learned how theatre can be utilized by traditionally marginalized groups to challenge oppressive systems and advocate critical thinking and popular education for social justice.

Mentor(s): Laura Epperson (School of Performing Arts|Music|Theatre|Cinema)
C. Meranda Flachs-Surmanek; (Theatre: Directing & Public Dialogue and Urban & Regional Planning; Virginia Tech)

Emi Miyazaki
University of Virginia/Statistics

TOUR

The Leisure-time-as-cost Exercise Purchase Task: A novel method to quantify the reinforcing value of exercise

Approximately 80% of Americans do not engage in the recommended amount of physical activity. One reason may be that individuals may not value exercise as much as other activities; however, existing measures of reinforcing value are limited, highlighting the need for improved methods. This study examines operant behavioral economic demand (a measure of reinforcing value) for recreational exercise using novel hypothetical purchase tasks (a self-report questionnaire used to measure the reinforcing value of a commodity) wherein time, not money, is the cost. Amazon Mechanical Turkers (expected N = 485) were randomly assigned to one of three purchase tasks: gym membership purchase task (GMPT), probability exercise purchase task (P-EPT), and discrete choice exercise purchase task (D-EPT). The GMPT measures likelihood from 0-100 to purchase one month of gym membership at various prices; the P-EPT measures likelihood from 0-100 to give up a certain amount of leisure time for exercise time; the D-EPT assesses whether or not (yes or no) participants would give up a certain amount of leisure time for exercise time. Participants completed other measures, including delay discounting (i.e., delayed reward sensitivity) and real-world exercise behaviors (i.e., IPAQ-SF). After data collection, the purchase task that best estimates the valuation of exercise will be determined by creating a multiple linear regression model using IPAQ-SF score as the dependent variable and breakpoint, task type, and the breakpoint by task type interaction as independent variables.

Mentor(s): Jeffrey Stein (Human Nutrition, Foods, and Exercise)

Charlotte Moore
Virginia Tech/Wildlife Conservation

In the Spirit of *Ut Prosim*: Insights in Building Collaboration with the Monacan Indian Nation

Faculty in Virginia Tech's (VT) Department of Fish and Wildlife are part of a larger group of faculty across VT that are exploring collaborations with the Monacan Indian Nation (MIN) related to land management. This project was undertaken to assist faculty and students in building collaborative relationships and action research plans with the Monacan Indian Nation. We conducted a literature review, visited the Monacan Ancestral Museum and walked Bear Mountain with tribal leaders, and volunteered at the MIN Annual Pow Wow 2022. To share our insights and inform future collaborations between the College of Natural Resources and Environment (CNRE) and the MIN, we developed this poster and are preparing a document for CNRE students and faculty that acknowledges legal basis and collaborative precedence. Based on our experiences, we feel it is critical that VT seek collaborative projects and action research plans. These partnerships should strive to share powers of authority and envision the future together. Collaborators should foster an academic environment of “Knowledge Mutualism” and acknowledge that it can be challenging for some researchers to be truly collaborative due to academic individualism and scientific paradigms. In order to sustain long-term collaborative relationships, researchers must be committed beyond a particular grant or program; therefore, in order to serve the interests of the Monacan Indian Nation, we compiled funding opportunities for a potential solar photovoltaic project on Bear Mountain. We will continue to strive for collaboration by making literature and perspectives of the Monacan Indian Nation more accessible within CNRE.

Mentor(s): Ronald Meyers (Department of Fish and Wildlife Conservation)
Dr. Ashley Dayer (Department of Fish and Wildlife Conservation, Virginia Tech)

Emily Morris
College of William & Mary/Physics

Characterization of sensors for cryogenic particle detectors at the milli-Kelvin scale

Cryogenic particle detectors are a useful tool in neutrino research, particularly neutrinoless double beta decay searches, due to their excellent energy resolution, potential to be made with high radiopurity and their high detection efficiency. To maximize energy resolution, such detectors are operated at extremely low temperatures (~10mK), where the low heat capacity of the detector maximizes the intrinsic detector response to energy depositions. Such detectors require high-sensitivity thermometers that can operate in an ultra-low temperature environment. In this project we explore neutron transmutation doped germanium thermistors and superconducting tungsten thin films, both of which are expected to exhibit very strong resistance vs. temperature behavior. We will also explore the resistance vs. temperature curve of metal foil resistors to determine if they are suitable to use as reference heaters to monitor detector thermal response. In this report, we describe the design and construction of a sample holder, the cooldown process, and the analysis of the collected data.

Mentor(s): Thomas O'Donnell (Physics)

Giovanni Morris
Virginia Tech/Aerospace Engineering

Vertical Gap Crossing in Close Relatives of Flying Snakes

Though limbed animals possess the ability to reach across horizontal and vertical gaps, limbless animals must find alternative methods of overcoming gaps in the arboreal environment. One strategy employed by snakes is cantilever locomotion. When navigating from one surface to another, snakes extend their bodies headfirst into the gap until they have reached their target. The snakes must provide proper stability and rigidity with the body in order to prevent themselves from buckling or pitching into the gap. How do snakes cope with gaps oriented in the vertical axis? Here, we investigated the vertical gap-crossing abilities of snakes, focusing on the effect of the substrate curvature on a snake's ability to cantilever. In this experiment, 6 painted bronzebacks (Dendrelaphis pictus) and 6 Asian vine snakes (Ahaetulla prasina) were allowed to cross from a base to a target perch, starting from one of four origin perches of varying curvature (diameter = 27, 43, and 157 mm, and a flat plane). The target perch was initially set at a small vertical distance (based on the size of the snake in percentage of snout-to-vent (SVL) length. As the snake rose to cross the gap, the distance was increased manually until the snake reached its maximum cantilever height and failed to reach the perch. Based on preliminary data, it is expected that the snakes will be able to gap cross at least 70-75% SVL. This research was supported in part by the National Science Foundation (NSF) under grant numbers 1922516 and 2027523.

Mentor(s): Socha Socha (Biomedical Engineering and Mechanics)

Josue Navarrete
Miracosta College/Computer Science
Ari Liverpool
Virginia Polytechnic Institute and State University/Applied Economic Management
Frankie Fan
Smith College/Mathematics & Statistics

Using Remote Sensed Data for Social and Economic Decision Making in Zimbabwe

In Zimbabwe, agriculture is a mainstay of the economy and livelihood for most rural poor. Zimbabwe has experienced increased social and economic unrest since 2000, with macroeconomic instability and diseases contributing to the problem. Extreme droughts in 2003 and 2016 contributed to increased food insecurity and a significant increase in rural poverty. Additionally, an ill-conceived fast-track land reform beginning in 2000 led to the decapitalization of the commercial agriculture sector. In this project, we identify publicly available remotely sensed climate-related data suitable for Zimbabwe. We collected Precipitation, Soil Moisture, and Enhanced Vegetation Index. We use these indices to provide a geospatial analysis of the five agro-ecological regions in the 2010-11 and 2016-17 growing seasons. And we analyze the climatic conditions ideal for maize, the primary crop grown in Zimbabwe. We disaggregate our analysis to the 60 administrative district-level to study the association between poverty and climate indicators. To do this, we augment the climate data with poverty variables constructed from the national Poverty, Income, Consumption, Expenditure Survey (PICES) conducted in 2011 and 2017. We then use these data in a statistical model to examine the association between district-level poverty and climatic conditions. The Zimbabwean government has recently approved an agricultural policy framework based on climate-smart principles. Still, it contains little geographic specificity in an incredibly diverse agricultural economy. Our analysis provides a spatially disaggregated look at whether climate data can be used to identify at-risk regions for potential policy intervention.

Mentor(s): Brianna Posadas (School of Plant and Environmental Sciences)
Susan Chen (School of Plant and Environmental Sciences, Virginia Polytechnic Institute and State University)

Meena Niamati
Virginia Tech/Clinical Neurocience

Engineering Saccharomyces yeast strains for measuring low amino acid transport activities

Amino acids are the building blocks of biological systems. They function as precursors to proteins, as well as the primary nitrogen storage and transport units within organisms. Amino acid transporters are responsible for moving amino acids throughout the cell and towards and from intercellular space. Functional properties of amino acid transporters are typically studied through heterologous expression in Saccharomyces cerevisiae mutants lacking amino acid transport activity. The goal of this project was to develop a suite of yeast lacking the ability to natively synthesize and transport specific amino acids. This would enable us to measure transport of amino acids when provided at low concentrations. This was done by removing the gene encoding amino acid biosynthesis enzymes through homologous recombination in the yeast strain Y22Δ10α that already lacks 10 amino acid transporters. Deletion of 11 genes was attempted, but only four were successful (histidine, methionine, phenylalanine, tyrosine) despite changing the procedure and conditions several times. The auxotrophic strains could still grow on media with concentration as low as 10 μM amino acids. This research shows that the six endogenous amino acid transporters from yeast are sufficient enough to take up amino acids at low concentrations. However, the auxotrophic strains can still be used to understand the relationship between amino acid metabolism and transport in yeast.

Mentor(s): Guillaume Pilot (SPES)

Emma Nieland
Iowa State University/Microbiology

VT-REEL

Plants, Plasmids, and Pathogens... Oh My!

Crop loss due to pathogens is currently a major issue worldwide, costing the industry billions of dollars each year. As such, finding efficient, effective, and safe solutions is crucial to the future of food production. To help reach these goals two projects were completed, one in lab and one applied. Both of these studies focused on how pathogens overcome the plant immune system to cause disease and crop loss. The lab study aimed to develop a biosensor recapitulating the Jasmonic acid recognition mechanisms from Arabidopsis in yeast to study how pathogen effector proteins stimulate this perception to trick plants into mounting the wrong defense response. By using molecular biology protocols such as restriction enzyme digestion and ligation of DNA, one of these intermediate biosensors was produced. This intermediate will be used in the development of further biosensors, expanding our knowledge surrounding pathogens' effects on a plant's immune system. The applied project focused on determining the effects of Anthracnose (Colletotrichum orbiculare) on cucumbers when treated with various combinations of salicylic and jasmonic acid elicitors to prime different defense responses in the plant. These treatments were applied to the first true leaf of the cucumber plant. The whole plant was then inoculated with the fungus and left to develop for another seven days. At that point, the health of the cucumber was assessed by determining the number of lesions on the second true leaf. While results have not yet been collected, the outcome will hopefully show the most effective regiment to protect against Cucumber Anthracnose.

Mentor(s): Clay Wright (Biological Systems Engineering)
David Langston (Plant Pathology, Virginia Tech)

Yousef Noori
University of Illinois at Urbana-Champaign/Materials Science and Engineering

Regulating Interfacial Chemistry in Lithium-Ion Batteries by a Weakly Solvating Electrolyte

Lithium-ion battery performance varies depending on the interfacial chemistry of its electrode. When batteries age, characteristics such as their working capacity and charging speed degrade over time due to changes in the interfacial chemistry of the cathode when lithium is used as the anode. This is significantly observed when graphite and/or hard carbon electrodes are used in the cathode. The choice of weakly solvating electrolyte (WSE) affects the interfacial chemistry of the electrode as it forms unique interphases due to its solvation structure. The unique solvation structure allows the batteries to carry characteristics like long-term cycle stability and the ability to fast-charge. The choice of graphite and/or hard carbon material, the selection of electrolytes, and the ratio between the materials are all factors that affect the stability, cycling efficiency, and solvating behavior. The process includes creating the electrode, assembling batteries, testing the cells using a battery cell-cycler, and assessing the data collected to compare the results from the different materials.

Mentor(s): Lei Tao (Chemistry)

Jennifer Noyes
Hollins University/Biology

Detection of taeniid cestodes in wild canids in Virginia

The most common taeniid tapeworms in wild canids in North America are Echinococcus multilocularis, Echinococcus granulosus, and Taenia spp. E. multilocularis, the causal agent of alveolar echinococcosis (AE), is a zoonotic parasite widely distributed within the Northern Hemisphere. Although the presence of the parasite in the Midwest US has been known for a while, only recently it has been reported in Eastern US. The prevalence of E. multilocularis in the United States is difficult to estimate, but its appearance in Virginia raises the alarm about its spread. Some species of Taenia can cause economic losses in affected livestock intermediate hosts. The aim of this study was to determine the prevalence of E. multilocularis, E. granulosus, and Taenia spp. in wild canids in Virginia. For this, fecal samples of 94 foxes and coyotes were assessed by a multiplex PCR for amplification of the mitochondrial gene nad1 of E. multilocularis and the small subunit ribosomal RNA (rrnS) of E. granulosus and Taenia spp. Samples that amplified the expected amplicons were submitted for sanger sequencing. Sequences were processed using Geneious 2022.1.1 and compared with GenBank. Out of 94 wild canids, 1% (1/94) was positive for E. multilocularis and 65% (62/94) were positive for Taenia spp. E. multilocularis was detected in a red fox from Loudoun County, in Northern Virginia. The most common species of Taenia detected were T. crassiceps and T. polyacantha. These results demonstrate that wild canids are commonly infected with taeniid tapeworms and that E. multilocularis is endemic in Northern Virginia.

Mentor(s): Roger Ramirez-Barrios (Department of Biomedical Sciences and Pathobiology)

Nour Omar
Virginia Tech/Cognitive and Behavioral Neuroscience

The behavioral and sex-specific mechanisms of indirectly acquired fear memories

Post-traumatic stress disorder (PTSD) is caused by experiencing a traumatic event. In the US, 6% of the population, or 12 million adults, acquire PTSD during a year with women being three times more likely than men to develop this. While prior studies have provided insight into the mechanisms controlling the development of PTSD, little is known about how individuals indirectly acquire PTSD from witnessing a traumatic event happen to someone else in close proximity. For this study, we developed a model of indirect fear conditioning in rats in which one animal watches (observer) another animal associate an auditory cue with a mild footshock (demonstrator). This allowed us to understand the mechanisms by which fear memory is indirectly acquired and whether this differs by sex. Using this paradigm, we found that on average both females and males could indirectly develop fear memory, though males performed slightly better when paired with a same-sex demonstrator. Interestingly, female observers placed with a male demonstrator acquired more fear than male observers placed with a female demonstrator, suggesting that the sex of the demonstrator is an important consideration in this paradigm. In terms of the behavioral mechanisms, FMR1 knockout rats, which have deficits in social behavior, indirectly acquired more fear than wild-type (WT) rats. Together, these results suggest that while fear memories can be indirectly acquired, there are some notable sex differences in how this occurs and that the mechanism by which fear memories are indirectly acquired is likely not solely based on social behaviors.

Mentor(s): Dr. Timothy Jarome (School of Neuroscience)

Neena O'Mara
Virginia Tech/Human Nutrition, Foods, and Exercise

Prophylactic and Therapeutic Effects of Aspirin and Ibuprofen on Frostbite in Rats

Frostbite is a devastating tissue injury caused by exposure to freezing temperature, which often happens to soldiers, mountaineers, and outdoor winter sports enthusiasts. When parts of the body (mostly limbs) are exposed to extremely cold temperatures for a given period of time, the interstitial fluid can freeze, causing cell damage and even death in the injured parts. Currently, post-injury managements (e.g., medications and hyperbaric oxygen chamber) and surgical intervention (e.g., debridement and care) are major approaches in clinical therapy for patients with frostbite; but the delayed or inaccessible treatments, especially in the remote areas where frostbite mostly takes place, can lead to unnecessary loss of limbs and even life in extreme cases. The present study sought to examine the efficacies of two commonly used drugs, aspirin (ASA) and ibuprofen (IBP), in preventing or treating frostbite using a rat model. The right foot of animal was injured with dry ice and the left foot was used as a control. The blood flow, skin temperature, and clinical score of both limbs in each animal were measured before (1x), during (1x), and 21 days (weekly) after injury using Laser Speckle, Thermal and Photo imager. Blood and limb tissues were also collected to dissect the potential mechanisms associated with phenotypic changes. The preliminary data found that ASA and IBP show prophylactic (new findings) and therapeutic (known in clinic) benefits on the injured rat limbs. Our findings can be potentially transferred to clinical trials to prevent or reduce frostbite.

Mentor(s): Jia-Qiang He (Biomedical Sciences and Pathobiology)

Jacob Parkullo
Virginia Tech/Biological Systems Engineering

Intercepting Enemy Signals: Biosensors for Measuring and Re-Engineering Plant-Pathogen Interactions

Plants defend themselves against microbes, insects and other biological stresses using two hormone signaling pathways: the Salicylic acid (SA) pathway and the Jasmonic Acid (JA) Pathway. These two pathways are mutually exclusive, when one is on the other is turned off. Some microbes have found a way to interact with these pathways by promoting or directly degrading JA-repressor proteins (JAZs). This leads to the activating of the JA and the suppression of the SA pathway. The SA pathway is responsible for part of a plant's microbe defenses, without it the plant is more prone to infection and disease. The aim of this project is to develop a molecular level understanding of these interactions between the microbial effectors and JAZ proteins and to use this information to help develop microbe resistant plants. The goal of my project was to design and develop a ratiometric fluorescent biosensor for JAZ9 protein levels, based on a previously established biosensor for a similar hormone signaling pathway. The biosensor was assembled through golden gate and traditional cloning techniques. Complications arose in the golden gate cloning process, when analyzing our new biosensor with sequencing parts of the biosensor template were still inserted in our construct. Our next steps will be, to research other cloning techniques to use instead of golden gate or ways to reduce template contamination. In the future, I hope to create a series of biosensors for each JAZ repressor protein to study their degradation with different microbial effectors to help develop microbe resistant plants.

Mentor(s): Clay Wright (Biological Systems Engineering)

Riya Patel
Roanoke College

The Relations Among Maternal Reference to Emotional Terms, Infant's Attention Span, and Infant Hippocampal and Amygdala Growth

The first two years of life are crucial for human brain development, as these are the years where humans learn key motor skills, speech comprehension, and the ability to distinguish between emotions. This development is impacted by how infants interact with their environment and other people. Specifically, the way a mother interacts with her child, the speech infants are exposed to, and an infant's ability to focus on an activity can have drastic impacts on the subcortical areas of the brain. Therefore, the goal of this project is to observe the language surrounding emotion a mother uses with her infant and the attention span of an infant to see how that impacts the infant's hippocampal and amygdala growth. These behaviors were observed longitudinally using the methods created by the Howell MIND Lab, which included asking the mother and her infant to observe a book reading followed by the mother talking to her baby about the book. Non-sedated sleep MRI scans of the infant's brain were collected concurrently. The infant's attention span was coded by timing the infant's gaze towards the screen as the book reading video played, while the mother's language was quantified by coding specific emotional terms the mother used during the book discussion. These data were then compared to infant hippocampus and amygdala volumes extracted from MRI scans. It is anticipated that a higher infant attention span or greater number of emotional terms used by the mother will positively correlate with hippocampal and amygdala volumes.

Mentor(s): Brittany Howell (Fralin Biomedical Research Institute and Human Development and Family Science)

Madison Payne
Virginia Tech/Biochemistry

VT-REEL

The Interaction Between Auxin and Phosphate Signaling Pathways in Plants

The overall objective of this study was to evaluate the interaction between phosphate (P) and auxin response in various plants and utilize phosphate signaling for maximum crop yield. Inositol phosphates (InsPs) act as second messengers within the phosphate signaling pathway. These molecules are also known to bind to auxin receptor proteins, and it is our hypothesis that this forms the nexus between P signaling and the regulation of plant growth by auxin. To further understand the interaction, Arabidopsis thaliana plants were grown in vitro on media with various concentrations of auxin and phosphate and root phenotypes were observed. Flow cytometry was used to analyze auxin signaling in Arabidopsis root protoplasts over-expressing enzymes that increase InsP levels, the kinases ITPK1 and VIP2KD. In plants, over-expression of these enzymes increased inositol pyrophosphate levels and altered auxin signaling. In the in vitro growth assays, the primary root had less total growth as auxin concentration increased and as phosphate concentration decreased. Transformed root protoplasts showed a two-fold increase in auxin signaling when the auxin treatment was applied. Protoplasts transformed with the ITPK1 gene or the VIP2KD gene showed no significant difference in auxin signaling levels compared to the control. At the ESAREC, we evaluated the interaction of two auxin-herbicides (2,4-D and dicamba) with different phosphate application rates (0 and 224 kg P2O5 ha-1) on both soybean (Glycine max) and weed biomass. Fertilizer and herbicide treatments were applied utilizing a randomized complete block design in each herbicide resistant soybean variety.

Mentor(s): Bastiaan Bargmann (School of Plant and Environmental Sciences)
Mark Reiter (Soils and Nutrient Management)

Celeste Phillips
The College of William & Mary/Biology

VT-REEL

Biological Nitrogen Fixation: Micro Process, Macro Impact

Atmospheric nitrogen must be fixed, mostly by bacteria, before it can be utilized as a plant nutrient. Maximizing this biological nitrogen fixation may reduce the need for costly fertilizer. Project one: Alfalfa (Medicago sativa L.) roots secrete attractants that cause the nitrogen-fixing bacterium Sinorhizobium meliloti to increase its swimming velocity to move towards the plant, ultimately nodulating its roots to provide bioavailable nitrogen. The objective of this project was to determine how the S. meliloti protein CheT impacts bacterial swimming velocity in the presence or absence of attractants. S. meliloti wild type and CheT mutants were grown under motile conditions and mounted on microscope slides with or without the attractant proline. Videos of bacterial movement were recorded and processed in MatLab software to determine swimming velocity. Reduced velocities of some CheT mutants with proline present suggest that CheT may play a role in increasing velocity to accomplish forward movement towards the host. Project two: Prior studies suggest that fertilizer application may reduce nitrogen fixation by bacteria. The objective of this project was to test how different levels of fertilizer impact biological nitrogen fixation by measuring peanut (Arachis hypogaea L.) nodulation. Peanut plants were collected from plots with varying amounts of nitrogen fertilizer and root nodules were counted. Shoot and root dry weight were recorded as well. The results from this project indicate how fertilizer affects nodulation and how nodulation impacts plant biomass. Additionally, photographs were taken of roots for future development of an app to determine when fertilizer is necessary.

Mentor(s): Birgit Scharf (Microbiology)
Maria Balota (Crop physiology, Virginia Tech Tidewater AREC)

William Pleasant
Georgia Institute of Technology/Biomedical Engineering

Evaluated Pirfenidone Nanoparticles and their Potential Usage as TBI Treatment

Blast related traumatic brain injury (bTBI) is prevalent among military personnel and veterans, with limited therapeutic strategies to address the outcomes of this injury. Recent studies have utilized the drug Pirfenidone, initially used to treat idiopathic pulmonary fibrosis, to address mitigating TBI outcomes. Furthermore, nanoparticle treatment studies have been shown to have advantages in permeability, biocompatibility, targeting, and stability. This study explored the therapeutic role of pirfenidone encapsulated in hemostatic nanoparticles (pHNPs) by investigating behavioral changes caused by blast injury using an in vivo TBI model. Rats were subjected to a repeated blast exposure with shams receiving all procedures with the exception of the blast insult. Sprague Dawley rats were randomly assigned to four different treatment groups receiving either a vehicle, nanoparticles with pirfenidone, or nanoparticles without pirfenidone (n=7-8). Two and seven-days following blast injury, animals underwent open field testing (OFT), a behavioral assessment to identify movement deficiency and anxiety-like behaviors. Total distance traveled, maximum velocity, and time and frequency spent in the center of the arena was analyzed to understand whether pHNPs can aid in these problems over time. Overall, Pirfenidone was a significant treatment option, but in comparison to HNPs used previously, there is nothing behaviorally to set the drug apart from other options.

Mentor(s): Pamela Vendevord (Biomedical Engineering)

Yannick Pleimling
Virginia Tech/Physics

Temperature-dependent nonlinear optics of a lead-free, photovoltaic perovskite

In recent years, halide perovskites have been of significant interest for their high photoconversion rate, which make them prime candidates for solar panel development and thus improvements in clean energy. The nonlinear optical properties of lead-based perovskites have been studied extensively. In this project, the temperature-dependent nonlinear optics of thin films of a lead-free halide perovskite were examined. Samples were exposed to a pulsed-femtosecond laser, leading to the emission of higher energy light due to second harmonic generation (SHG). These signals can be used to probe material ferroelectricity and thus can indicate phase transitions involving changes in electrical polarization. The light emitted by the samples was focused into a spectrometer and captured by a charge-coupled device. The sample temperature was altered to observe the effect on the SHG signal generated by the thin films. As the sample temperature increased, the SHG amplitude was observed to reduce substantially. During the heating process, the SHG signals were observed to not change significantly after a temperature of roughly 60 °C, which could be due to a phase transition that involved a change in electrical polarization.

This project and continued work on these samples were made possible by the ICTAS Undergraduate Research Fellowship Program. This material is based upon work supported by the Air Force Office of Scientific Research under award number FA9550-17-1-0341 and DURIP funding (FA9550-16-1-0358). We also acknowledge support from the L. C. Hassinger Fellowship.

Mentor(s): Giti Khodaparast (Physics)

William Poncy
Virginia Tech/Environmental Informatics

Developing Spring Dead Spot Maps Across Entire Golf Course Fairways Using Aerial Imagery

Spring dead spot (SDS) is a recurring disease caused by several species of Ophiosphaerella fungi which damages bermudagrasses (Cynodon dactylon) grown on golf courses and other recreational fields. This pathogen infects the grass in the fall, attacking the rhizomes, stolons, and roots of the plant, leaving the turfgrass more susceptible to cold damage. These areas fail to green up the following spring and appear as circular patches of sunken necrotic grass. Previous work using aerial imagery in SDS treatment required time-intensive identification of patches by hand within imagery. Last spring our team developed a python script to automate the SDS detection process and reduce the time to generate these disease maps. The objective of this research was to validate the effectiveness of aerial imagery analysis in SDS computer identification across all 18 fairways of a golf course. Drone imagery was collected over Independence Golf Club in June 2022 and analyzed using the aforementioned SDS detection python script. Kernel density analysis was used to generate SDS cluster maps with site specific management units (SSMU) for each fairway encapsulating the disease while leaving asymptomatic areas unsprayed. Maps of SSMU generated using the computer-identified SDS clusters resulted in an 85% reduction in necessary sprayable areas. The treated acreage reduction for this golf course equates to savings of over $21,000 and 78 liters of the highly effective fungicide, isofetamid, compared to full coverage applications. Adoption of this technology could improve the economic and environmental impact of SDS on golf courses and provide a framework for additional pest mapping and associated pesticide reductions.

Mentor(s): David McCall (School of Plant and Environmental Sciences)

Destiny Powell
Virginia State University/Psychology

Associations between maternal sensitivity and 4-year-old children's attentional control

Attentional control (AC) is the ability to both focus attention (FA) and shift attention (AS) when needed (Rueda & Checa, 2010). AC is important for inhibiting or initiating behavior. Children who can better regulate behavior experience fewer behavior problems (Sawyer et al., 2015). Parenting may be related to children's AC. Specifically, maternal sensitivity (MS) is the quality in which mothers respond to their child's cues in a timely and appropriate manner (Leerkes et al., 2009). MS facilitates AC by teaching children how to regulate behavior in a sensitive and responsive fashion. However, AC is commonly assessed using parent-report questionnaire. The current study utilized behaviorally coded AC to investigate the relation between FA, AS, and MS.

Data analysis for the current project is ongoing (N = 95). Age 4 FA and AS was coded for during an independent puzzle task and age 4 MS was derived from previously coded behavior during a mother-child interaction task. To assess relations between MS and attention behaviors, independent sample t-tests and correlations were calculated using SPSS software. MS was negatively related to FA ($r = -.272$, $p = .01$), but not related to AS ($r = .489$, $p = .49$). A t-test revealed no significant differences in MS based on high versus low FA. MS influences children's FA more than AS behavior when working independently. MS is negatively related to AF perhaps because children are less likely to attempt the task on their own if they expect a more sensitive mother to assist them instead.

Mentor(s): Martha Ann Bell (Psychology)

Anna Prater
Virginia Tech/Clinical Neuroscience

Effects of Germ-Free Conditions on Radial Glial Cells in the Subventricular Zone

Interference with colonization of the body by commensal bacteria during postnatal development is associated with an array of neurological disorders (e.g. - autism) that manifest later in life. Radial glia (RG) are specialized stem cells lining the subventricular zone (SVZ) and ascribed to the evolutionary expansion of the cortex. However, the impact of gut microbiota on RG remains largely unknown. Utilizing germ-free (GF) piglets at the age equivalence of human neonates, we sought to address this gap in knowledge. Control (C) piglets exhibited a significant increase in SVZ volume at p16 compared with newborns (p0), whereas there was no expansion in GF piglets. A significant decline in the number of RG was seen with age in both GF and C - compared with numbers at birth - paired with a significant reduction in GF compared with C at p16. Taken together, a lack of SVZ growth, paired with a reduction in RG density is suggestive of aberrations in the proliferation capacity in GF piglets. Because RG are important players in white matter (WM) development and RNAseq data revealed differentially expressed genes, we evaluated changes in an understudied gene - SLC13A5. We found a significant increase in SLC13A5 protein levels in the WM of GF compared with C piglets at p16. SLC13A5 has been implicated in regulating stem cell homeostasis in Drosophila and autism-like phenotypes in rodents; therefore, further exploration of this sodium citrate transporters role in RG development will lend new insights into how microbiota positively influence healthy cortical growth.

Mentor(s): Alicia Pickrell (School of Neuroscience, Virginia Tech)
Paul Morton (Department of Biomedical Sciences and Pathobiology, Virginia-Maryland College of Veterinary Medicine, Virginia Tech)

Alaijah Pratt
Virginia State University/Manufacturing Engineering

Impact of Pseudorandom Numbers on BB84 Protocol

Quantum computers can easily break classical protocols used to secure data. Both BB84 and E91 quantum protocols or quantum key distribution (QKD) are used to make it harder for a quantum computer to break a classical encryption protocol. Although both these two quantum protocols work well in most situations, they may be still susceptible to being infiltrated. Depending on the bias of a pseudorandom data string it might be easier or harder for someone to eavesdrop into the system without being detected and potentially decrypt secure information. The Qutools Quantum Entanglement Generator (QED) based on Quantum Photonics was used for quantum random number generation as well as sending the BB84 quantum protocols. Different random strings of data with different biases were used. The QED setup was used to determine the impact on the error rates and to determine the degree of entanglement. The data collected will allow determination of the importance of the bias of a pseudorandom data string on the performance of the BB84 Protocol.

Mentor(s): Wayne Scales (Electrical and Computer Engineering)

Aaron Price
Virginia Tech/Crop and Soil Environmental Science

Predicting Mineral-Associated Soil Carbon Changes with MIMICS-CN

Predicting Changes in Soil Carbon Pools for Southeastern US Pine Forests Using MIMICS-CN

Utilizing forest soils for carbon (C) capture and sequestration requires accurate predictions of the spatial distribution and magnitude of changes in the C cycle in response to management and global change. With an increase in relevant empirical data and improved capacity to examine microbial communities, computational models can generate increasingly accurate representations of soil C cycling by explicitly accounting for microbial processes. The Microbial-Mineral Carbon Stabilization-CN (MIMICS-CN) model was developed to explicitly represent the impact of microbial physiology and physicochemical stabilization mechanisms on soil C dynamics while maintaining a stoichiometric balance of C to nitrogen (N). Using MIMICS-CN and observational data, we predicted changes in soil carbon pools across Southeastern US pine forests under a variety of management and climate scenarios over decadal and centennial time steps. We show how climate and management changes impact soil microorganisms' biomass between two pools defined by metabolic strategy. Furthermore, we show how changes in climate, N fertilization, cultivar selection, and planting density impact predictions of soil C pools, and highlight the mechanisms for maximizing stable, mineral-associated C with the greatest potential for offsetting anthropogenic greenhouse gas emissions through forest management.

Mentor(s): Brian Badgley (SPES)
Brian Strahm (FREC)

McKenzie Proffit
Virginia Tech/Experimental Neuroscience

Using Artificial Intelligence to Detect Differences in Mitochondrial Morphology in Hippocampal CA2

CA2 of the hippocampus is a critical region for social memory; however, the underlying mechanisms remain unknown. To determine which genes are enriched in CA2 that are potentially involved in social memory, we conducted subregion-specific transcriptional profiling and found selective enrichment of mitochondrial-related genes in CA2 neurons compared to neighboring neurons. In particular, the mitochondrial calcium uniporter (MCU), a pore regulating mitochondrial calcium uptake, showed a striking pattern of expression in CA2. MCU is asymmetrically distributed across CA2 dendrites, whereby distal dendrites have larger, more tubular mitochondria with enriched expression of MCU compared to proximal dendrites. The CA2 distal dendrites receive different inputs than proximal dendrites, demonstrating mitochondrial heterogeneity across CA2 circuits. To determine the relationship between MCU expression and mitochondrial morphology we generated CA2-specific MCU knockout (KO) mice by crossing Amigo2-cre to MCU floxed mice. We hypothesized that, compared to wildtype (WT) mice, MCU loss would result in smaller mitochondria selectively in CA2 distal dendrites. To visualize densely packed mitochondria, we performed protein-retention expansion microscopy and stained for MT-5, a novel fluorescent mitochondrial marker. We then trained a convolutional neural network to automatically segment MT-5 labeled mitochondria to analyze mitochondrial morphology in CA2 dendrites. Anticipated results support that loss of MCU expression decreases mitochondrial size within distal dendrites of KO mice when compared to WT. The interdependence between MCU expression and mitochondrial morphology in this distal circuit could confer unique synaptic properties that contribute to CA2's ability to encode social memory.

Mentor(s): Shannon Farris (Fralin Biomedical Research Institute at Virginia Tech Carilion)

Emma Quarles
Virginia State University/Psychology

An investigation of cognitive control as a moderator between emotion regulation difficulties and depression symptoms during adolescence

Abstract
Adolescence is a prominent time for brain development that relates to mental health. Poor emotion regulation strategies are associated with increased depression symptoms during adolescence (Berking et al., 2014). Research shows that the dorsal anterior cingulate cortex (dACC), a brain region involved in cognitive processing, is altered in depression (Davey et al., 2012). This study aimed to examine how neural and behavioral cognitive control moderates the association between emotion regulation and depression in a community sample of adolescents.

Participants included 167 adolescents (53% male) that were 13-14 years old at Time 1 and were assessed annually for 6 years. Emotion regulation was measured using the Difficulties in Emotion Regulation Scale (DERS). To assess cognitive control, participants completed the Multi-Source Interference Task (MSIT) during an fMRI scan. The Adult Self Report (ASR) was used to indicate levels of depression symptoms.

Using hierarchical regression in SPSS, we found that emotion regulation difficulties predicted higher depression symptoms (β= .348; p=. 000; R2 = .126; p = .000). However, both neural (β= -.066; p=.427) and behavioral (β= .011; p=.132) cognitive control did not moderate this association (R2 = .128; p = .590). These results suggests that cognitive control does not significantly moderate the association between emotion regulation difficulties and depression symptoms.

The association between emotional regulation and depression symptoms is widely established in the literature (Joorman et al., 2016; Hendricks et al., 2015). Future research should consider other possible moderators (such as social relationships) that attenuate the effects of emotion regulation difficulties on depression.

Mentor(s): Morgan Lindenmuth (Psychology at Virginia Tech)
Jungmeen Kim-Spoon (Psychology at Virginia Tech)

Spruha Rami
Virginia Tech/Computational and Systems Neuroscience

Influence of mosquito larval growing conditions on host-seeking behavior and neural encoding of human host odors

Each year, several hundred thousands of people worldwide are affected by mosquito-borne diseases. Female Aedes aegypti mosquitoes vector viruses causing chikungunya, dengue, Zika, etc. when biting hosts for a blood meal to nourish their eggs and meet their reproductive needs. Several factors, both extrinsic (e.g. environmental conditions) and intrinsic (e.g. reproductive status), influence the host-seeking behavior of these mosquitoes. Work from the Vinauger Lab has shown that larval growing conditions, intraspecific larval competition, in particular, affect the host preference of Ae. aegypti adults: large-sized females show a very strong preference for host odors while the small-sized females show preference towards plant odors. However, the mechanistic underpinnings of these effects remained unknown. In this context, my project's goal is to determine the neural mechanisms mediating the observed relationship between adult female body size and their host-seeking behavior. Electrophysiological recordings from the antennal lobe of these female mosquitoes when exposed to host and plant odors, in the presence and absence of carbon dioxide (CO_2), allowed me to investigate the size-dependent neural responses to host odors in these mosquitoes. CO_2 is a potent host cue that heightens mosquito host-seeking responses. My presentation will highlight findings from this study as well as other experiments conducted in the Vinauger Lab that uncover the relationship between mosquito larval ecology and adult behavior and neurobiology.

Mentor(s): Clement Vinauger (Biochemistry)

Kaitlyn Rasnick
Virginia Tech/Human Development

Exploring the Study of LGBTQ+ Parents Across the Past Three Decades: A Comprehensive Literature Review

Contemporary estimates reflect that there are more than 114,000 same-sex couples raising children in the U.S. This comprehensive literature review was done to examine the shifting perspectives of LGBTQ+ parents and parenting over the last thirty years because looking at past research will inform and guide what should be studied next. We examined articles from 1990 to 2019 as this was a time of rapid growth and change in LGBTQ+ research. The evolving sociopolitical climate that informed the marginalization of LGBTQ+ families was heavily reflected in research that was conducted. The goal of this project was to investigate literature on parenting in the LGBTQ+ community, to examine how it shifted over time, identify gaps and goals for future research. The research published in the 90's reflected a deficit approach by comparing same-sex parenting to opposite-sex parenting. The research in the early 2000s reflected a shift from how LGBTQ+ parents compare to cisgender, opposite-sex parents to focusing on how cisgender, same-sex parents build their family. The 2010s shifted to a more person-centered approach where the focus was on the person as a distinctive individual with unique characteristics and experiences, not just their sexuality. This approach examined specific characteristics and needs of LGBTQ+ families. The overall uniform themes emerging from the articles analyzed of deficit comparison, lack of representation, and lack of resources presents a clear need for inclusive research on other groups within the LGBTQ+ community, including transgender and bisexual parents, and on resources to inform parenting LGBTQ+ children.

Mentor(s): Cynthia Smith (Human Development and Family Science)
Meredith Atanasio (Human Development and Family Science, Virginia Tech)

Siddarth Ravikanti
Virginia Tech/Computational Modeling and Data Analytics
Taj Cole
Virginia Tech /Agriculture and Applied Economics

DSPG

Assessing Livelihood Diversification in Sundarban, India using High Frequency Data

The overall goal of this project is to evaluate livelihood-diversification strategies using weekly financial data for approximately 300 households from 10 representative villages in the region. The team aims to create a public-facing dashboard to describe and visualize households' livelihood diversification strategies, including changes in income, expenditure, and consumption patterns. The insights from this dashboard are essential for designing effective and targeted poverty-reducing strategies and aiding those affected by shocks such as natural disasters and climate change. Climate change is a global issue; however, its impact is not felt equally across all regions. Developing countries, especially areas with widespread poverty and poor infrastructure, are more ill-equipped to cope with these environmental threats. The worsening of extreme weather patterns such as high temperatures, droughts, floods, and rising sea levels are especially problematic for countries with large coastal areas and populations that primarily depend on agriculture for their livelihood. Our purpose is to create an increased awareness regarding the issues faced and to inform the suitable entities responsible for taking action. Our team used data analytic skills through programs like R to create visualizations such as plots, graphs, and other graphic images to conduct an analysis of the Sundarbans region and draw conclusions. After conducting an analysis and deriving conclusions, we were able to gather a deeper understanding of the impact the high poverty livelihood had on the households. Our team was able to gather and visualize over 30 variables that consist of demographics, basic financial data, and high-frequency financial data.

Mentor(s): Chanit'a Holmes (Agriculture and Applied Economics)

Kathleen Reuwer
Virginia Tech/Experimental Neuroscience

SURF-N

Examining the role of Astrocytic BDNF/TrkB.T1 Signaling in the Whisker Barrel Cortex

The TrkB.T1 receptor, a brain-derived neurotrophic factor (BDNF) receptor predominantly expressed in astrocytes, has recently been found to play a critical role in the morphogenesis of astrocytes (Holt et al., 2019). Since this discovery, how this receptor plays a role in behavioral development warrants further investigation. Using the rodent whisker barrel cortex as a model, we currently aim to 1) determine if TrkB.T1 is necessary for the development of tactile whisker discrimination and 2) determine how whisker enrichment alters active translation. We employed a global TrkB.T1 KO animal model to evaluate tactile whisker discrimination using a texture discrimination test. To evaluate active translation, mice were exposed to an environmental enrichment before live brain slices were treated with and tagged for puromycin, an antibiotic that terminates translation. Preliminary results from the texture discrimination test suggest that disruption of TrkB.T1 disables animals from discriminating between two textures. Further, based on preliminary data, we anticipate increases in puromycin-tagged translation in brain hemispheres innervated by enriched whiskers. Understanding these aspects of the TrkB.T1 receptor will give further insight into the role of astrocytes in neurodevelopment.

Mentor(s): Michelle Olsen (School of Neuroscience)

Tyler Rhodes
Virginia Tech/Aerospace Engineering

VT MARS: Design of a Highly Customizable and Modular CubeSat Structure to Maximize Future Missions

This project outlines the design, features, and potential implementations of Virginia Tech's Modular Adaptable Rigid Structure (VT MARS). This CubeSat structure can adapt to the different requirements of various missions, i.e., CubeSat size, CSD specifications, and satellite components. Utilizing this chassis will decrease the cost of development for future CubeSat missions in multiple forms and provide an ideal foundation for mission developers to design around. VT MARS consists of three fundamental components that can be rapidly customized to meet the needs of developers. These parts form modules of the designers' specifications and can seamlessly join together, allowing for numerous possibilities for developers to utilize. The project analyzes potential mission profiles, detailing their structural properties, manufacturing costs, and other pertinent information for mission designers to consider. VT MARS has been motivated by the lessons learned from previous missions at Virginia Tech (VT) and other structures developed by the CubeSat community. VT MARS intends to serve as a structural foundation for future CubeSat missions at VT to build from and for other CubeSat developers to expand.

Mentor(s): Leon Harding (Kevin T. Crofton Department of Aerospace and Ocean Engineering)

Jocelyn Robbins
University of Colorado Boulder/Physics
Melinda Yuan
Columbia University/Physics

An Optimization of Double Deeply Virtual Compton Scattering Experiments at Jefferson Lab Hall C

The goal of Double Deeply Virtual Compton Scattering (DDVCS) experiments is to better understand the internal structure of the nucleon. Previous attempts to resolve the internal structure of nucleons have resulted in electromagnetic form factors and parton distribution functions for elastic scattering and deep inelastic scattering processes. Generalized Parton Distributions (GPDs) are the latest attempt to unify these models of nucleon structure. The GPDs of DDVCS give us the ability to investigate off of the diagonal into unknown Compton Form Factor regions. The main goal of our analysis is to determine the best experimental setup in order to deduce the kinematic variables on which GPDs depend from the lab observables (in this case the detection of muons). The effectiveness of our data collection in the laboratory is determined by the physical kinematics such as the Bjorken x and momentum transfer. We can then run the DDVCS experiments and collect data, which is implicitly used to calculate the GPD of the nucleon.

Mentor(s): Marie Boer (Physics)

Amiaya Robinson
Virginia State University/Chemistry

Effects of maternally perceived stigma on infant neurodevelopment.

Maternal stress is known to affect neurodevelopment beginning in the womb, impacting a child's lifelong risk for emotional, behavioral, and/or cognitive problems. Stress can be experienced in various forms: natural disasters, maternal illness (such as anxiety or depression), life circumstances, discrimination, and/or stigmas. Stigma has been associated with increased stress and further agitates preexisting stressors. With stigma leading to stress, and maternal stress impacting neurodevelopment, we hypothesize that perceived maternal stigma will affect the neurodevelopment of infants during the first three months of life. In a previous study, there was no association observed between hippocampus volume and perceived stigma in children aged 9-10 years; however, the impacts of maternal stigma during infancy were not addressed. Given the rapid rate of change in the brain early in life, and the time period of focus for the current study, it is likely that stigma experienced and transmitted through mothers will impact brain development. Thus, this study aimed to determine the effects of maternally perceived stigma on infant brain development, including regional and total tissue volumes. Using a single time point of analysis, three months, we analyzed each infant's structural MRI (T1 or T2-weighted) and assessed the amount of stigma their mother perceived using interviews. Our interviews resulted in 50% of the mothers experiencing quantifiable stigma. We anticipate a positive correlation between the structural data and the stigma the mother's perceived.

Mentor(s): Brittany Howell (Center of Health Behaviors Research)

Emerson Rodriguez
Virginia Tech/Electrical Engineering

Controlling Cell Movement and Accelerating Wound Healing with Galvanotaxis

Galvanotaxis, also called electrotaxis, is the movement of cells caused by electric fields, and it is one of the ways the body directs where cells should go, such as during wound healing. When a wound opens up, a local imbalance of ions generates a voltage between the wound site and the surrounding unbroken skin layer, causing cells to polarize and produce actin, the fibers cells use to move across the Extracellular Matrix (ECM), towards the site of the wound. The strength of galvanotaxis is not dependent on the body's health or on gravity, so electric fields are vital for wound healing in the elderly and astronauts. I am designing a device that can direct the movement of cells using electric fields along a two-dimensional matrix of nanofibers, which our lab spins using a non-electrospinning Spinneret based Tunable Engineered Parameters (STEP) procedure. The current prototype consists of a metal scaffold strung with nanofibers, which will hold our cells, placed inside a pool of cell media enclosed by silicone rubber and a petri dish. To send electrical signals to our cells, an external DC power supply sends an electric current through a pair of silver chloride electrodes, then through agarose gel, and finally into the cell media. Once I understand how cells respond to different strengths and types of electric signals, I will work with my colleagues to design a bioelectronic patch to improve wound healing.

Mentor(s): Amrinder Nain (Department of Mechanical Engineering)

Emily Rogers
Virginia Tech/Biomedical Engineering

A Novel Technique for Biceps Tenodesis: Is it Strong Enough?

Biceps tenodesis is used to surgically repair damage to the biceps tendon. It currently is unclear which fixation technique is clinically superior. We propose a novel technique that utilizes an all-suture knotless anchor with an oblong button. This approach overcomes some of the limitations of other techniques, such as interference screw fixation, which requires an osseous tunnel of ~7-9 mm in diameter. Our novel technique requires only a 1.8 mm osseous tunnel and maintains the tendon's natural length-tension relationship. Biceps tenodesis fixation was performed using ovine humeri and flexor digitorum profundus tendons via tenodesis screw (n = 6), all suture anchor (n = 7), or all suture anchor with button (n = 6). Biomechanical testing consisted of cyclic loading followed by a load to failure test. Results were evaluated using a non-inferiority statistical design. Maximum load at failure was 393.1±74.9 N for the tenodesis screw, 163.9±31.0 N for the all suture anchor, and 102.4±16.5 N for the anchor with button. All groups exhibited similar secant stiffness during cyclic loading (30.8±6.1 N/mm, 27.9±7.4 N/mm, and 29.3±5.9 N/mm, respectively). Though we did not show non-inferiority through the maximum load, all groups exhibited similar stiffness during cyclic loading which simulated rehabilitative loading. The novel technique maintains the natural tendon tension, requires a smaller bone tunnel, and is technically easier to complete. These benefits may outweigh its lower maximum load. Further studies are needed to determine which technique is clinically superior.

Mentor(s): Vincent Wang (Biomedical Engineering and Mechanics)

Elizabeth Roth
Virginia Tech/Animal Science
Con-Ning Yen
Virginia Tech/Animal Science

Reduced mtDNA Content Has An Accumulative Impact on Skeletal Muscle

The shift of beef cattle feeding regimes from forage-based to carbohydrate rich systems are a major concern worldwide due to its environmental impact. Grass-fed cattle are more desirable due to animal welfare concerns and are less impactful to the environment unlike that of carbohydrate fed cattle. While more favorable for the environment, grass fed cattle have a slower growth rate and a higher mitochondria abundance. However, mitochondrial contribution to skeletal muscle growth remains a mystery. To understand mitochondria's role in muscle growth, we asked whether maintenance of mitochondrial DNA (mtDNA) content is necessary for skeletal muscle growth. Mammalian mtDNA encodes mitochondrion-specific proteins with the total number of copies of mtDNA varying dramatically at different stages of tissue development. We utilized a knockout mouse model for mitochondrial transcription factor A (Tfam), an essential gene for mtDNA transcription initiation and nucleoid formation, was specifically deleted from skeletal muscle of mice. On a protein level, we confirmed that TFAM was indeed knocked out in skeletal muscle at 43 weeks of age. In these Tfam-/- (mKO) mice, mtDNA copy number in skeletal muscle was reduced by 50%, compared to that of the wild-type (WT) muscle. Additionally, mKO mice exhibited reduced body weight from 34 to 42 weeks of age, without changes in final total lean and fat mass at 43 weeks of age. However, gastrocnemius and tibialis anterior muscle weights were significantly reduced in the mKO mice. Together, these findings suggest that there is an accumulative effect of reduced mtDNA content over time.

Mentor(s): David Gerrard (Animal Science)
Tim H. Shi (Animal Science, Virginia Tech)

Rachel Roundtree
Elizabeth City State University/History

Fashion, Merchandising & Design Undergraduate Research

The Department of Apparel, Housing, and Resource Management has been working with Data Services in the University Library to address the pressing issue of the terminology used to describe historical garments/artifacts. “The solution is to use natural language processing (NLP) to analyze historical versus contemporary descriptions. This way, it is possible to map similar terms better together to categorize historic dress artifacts.” There are various ways to define fabrics, colors, and clothing, which is a difficult task for today’s readers to comprehend; it is also found quite challenging amongst donors. And it is up to the collection manager to correct this. It is essential to reexamine artifacts/garments to expand our knowledge by comparing terms used to describe the garments/artifacts when it was initially made versus how they are being told over time and skimming through Costume Core terms. We use the Oris Glisson Historic Costume and Textile Collection (OGHCTC) using Costume Core, a metadata schema that controls descriptive vocabulary to collect the data. It helps minimize any possible bias or incorrect clarifications from the curator. So far, we have been able to map color names through software that has been created to look at the color in the original historical description and pre-fill the color column in the spreadsheet. With the implications, extracting information from historical reports and automatically filling in columns/fields is easy, saving time for catalogers.

Mentor(s): Dina Smith-Glaviana (Apparel, Housing, and Resource Management)

Audrey Rowe
Virginia Tech/Public Health

TOUR

The Noncanonical NF-kB Pathway in Colitis-Associated Colorectal Cancer: Intestinal Epithelial Cell Specific Deletion of NIK Leads to Increased Susceptibility to Tumorigenesis

Colitis-associated colorectal cancer (CAC) is induced by chronic inflammation in the colon. The protein complex NF-kB is involved in signaling immune responses, inflammation and cell growth. NF-kB becomes activated through the canonical or noncanonical pathways. We investigated the role of NF-kB-inducing kinase (NIK) in CAC activation of the noncanonical pathway. We hypothesize that dysregulation of the noncanonical NF-kB pathway increases susceptibility to CAC formation in intestinal epithelial cells (IECs), which is modeled using AOM/DSS mouse models for inflammation-induced tumorigenesis. Mice with deletion of NIK in their IECs (Nikfl/fl x Villincre) were compared to control mice (Nikfl/fl). We found that Nikfl/fl x Villincre mice had increased susceptibility to CAC formation. We also compared mice with deletion of NIK in their myeloid cells (Nikfl/fl x LysMcre) to (Nikfl/fl) control mice and saw no significant difference in susceptibility. We further investigated samples from Nikfl/fl x Villincre mice using IHC staining for Ki67 and observed increased proliferation. Tumors from Nikfl/fl x Villincre and Nikfl/fl mice were evaluated as a heterogeneous cell population including both immune cells and IECs. Transcriptomics of Nikfl/fl x Villincre samples were performed to investigate phagocytosis, apoptosis, proliferation and innate immune signaling. Our findings suggest a cell-specific role for NIK in CAC that is critical in IECs and minor in myeloid cells. These findings suggest NIK is a potential drug target for CAC patients and a biomarker for early detection in cancer screening. Future directions include performing in vitro assays to further investigate IEC functionality in relation to NIK expression.

Mentor(s): Irving Allen (Biomedical Sciences and Pathobiology)

Riley Rudd
Virginia Tech/Economics
Milind Gupta
Virginia Tech/Computer Engineering
Catherine Back
UCSD/Data Science

Sensing drought in the Sahel for Household Climate Resilience

Decades of economic research has shown that without effective social protection, extreme weather in sub-Saharan Africa has resulted in people resorting to harmful coping strategies, including removing children from school, skipping meals, and selling off assets. These coping strategies further perpetuate the poverty cycle, preventing future generations from achieving a higher quality of life. Weather trends in the past few decades have also shown that the number of people exposed to drought in the Sahel has increased, creating significant obstacles in alleviating poverty. This research seeks to help break the link between drought and distress, by identifying where droughts have created the greatest harms, allowing humanitarian aid to be used in more efficient manners. This will be achieved by analyzing publicly available data on historical drought indicators, including precipitation and biomass indices from remote sensing data, and comparing them with historical welfare measures, focusing on the country of Niger. Results will examine the linkage between anomalies in a year versus aggregate welfare, presented in the form of a R-shiny webapp with interactive maps on weather risk and links to welfare as well as comparisons among indicators for both drought and welfare. Findings will be used to allow for a more proactive approach to social protection by developing targeting mechanisms, identifying the most vulnerable and quickly scaling up programs when needed.

Mentor(s): Elinor Benami (Agicultural and Applied Economics)

Olivia Sacci
Hollins University /Biology

Changes in the American Toad Microbiome During Development

The microbiome (the collection of microbes and their genes that reside in or on hosts) can have both positive and negative impacts on overall host health. For instance, in amphibians, the skin bacterial community can reduce pathogen infection. Adding beneficial bacteria to these bacterial communities could protect amphibians from potentially lethal infections, but knowing when to apply beneficial bacteria during development to achieve positive health outcomes remains unknown. The first step is to understand normal changes in the microbiome that occur over the typical complex life cycle of amphibians: embryos, tadpoles, juveniles, adults. In this study, we surveyed the whole-body microbiome of American toads (Anaxyrus americanus) during embryo, tadpole, and juvenile (recently metamorphosed) stages. For ten samples at each stage, whole-body bacterial communities were investigated using 16S rRNA gene amplicon sequencing. Understanding these developmental changes can have important practical implications for amphibian conservation.

Mentor(s): Lisa Belden (Biological Sciences)

Khalema Salome
College of William & Mary/Neuroscience

Initial Development of a Snack Purchase Task

Highly processed foods (HPF) consumption has been linked to obesity, cardio-metabolic risks, cancer, type-2 diabetes, and cardiovascular disease, yet HPF consumption has increased among US adults from 2001-2018. Gauging individuals' demand for HPF against other dietary characteristics may aid in differentiating and understanding the multivariable nature of HPF consumption and food addiction. Hypothetical purchase tasks measure an individual's demand or the reinforcing value of a substance. This study aimed to develop a Snack Purchase Task (SPT) to investigate an individual's demand for HPFs and identify any relevant group differences between overweight and non-overweight individuals. A total of 21 participants (n=8 overweight and n=13 non-overweight) completed the SPT. Participants who reported at least somewhat enjoying 1 of 8 of the following highly processed snacks completed the SPT: Doritos®, Reese's Peanut Butter Cups®, Oreos®, Cheetos®, Lays Potato Chips®, Ritz Crackers®, Chips Ahoy cookies®, and M&Ms®. The SPT asked participants how much of their favorite snack they would purchase over a range of increasing prices from $0 to $100. Preliminary findings show a trend of separation between groups in the fitted demand curves, however, lacking statistical significance across demand indices. Data collection is ongoing as a larger sample size is required. The results indicate that the SPT may be successful in differentiating individuals who are overweight or non-overweight. Future analysis may also examine group differences among individuals vulnerable to food addiction and/or overeating.

Mentor(s): Warren Bickel (Center for Health Behaviors Research)
Roberta Freitas-Lemos (Bickel Lab, Virginia Tech)
Yu-Hua Yeh (Bickel Lab, Virginia Tech)
Devin C. Tomlinson (Translational Biology, Medicine, and Health, Bickel Lab, Virginia Tech)

Jinny Sattayaphanichkul
Virginia Tech/Biochemistry

Towards the Automated Synthesis of Rhamnose-Containing Glycans

Carbohydrates are some of the most abundant molecules found in nature and serve critical roles in living organisms, ranging from providing structural rigidity in plants, to binding interactions between viral and human cells. As the extraction, purification, and analysis of glycomaterials from natural sources can be challenging, synthetic approaches are often employed to prepare glycans with known structures. While benchtop glycan synthesis requires specialized training, Automated Glycan Assembly (AGA) is a technique that expedites the preparation of discrete complex sugars by automating the synthetic process. AGA requires specialized “building blocks” - monosaccharides with selected protecting groups that allow for controlling the assembly process. Commercially available building blocks are primarily limited to glucose, galactose, and mannose derivatives. The goal of this project is to prepare an L-rhamnose (6-deoxy-mannose) building block and assess its use in assembling rhamnose-containing molecules. Rhamnose, a naturally occurring sugar, is present in glycomaterials with commercial value such as biosurfactants and food thickening agents. In order to explore the structure-function relationship of rhamnose in glycomaterials, specific rhamnose building blocks are needed. Starting from L-rhamnose, a fully protected rhamnoside was produced in a 5-step reaction: peracetylation of L-rhamnose, bromination to the anomeric carbon, formation of a p-tolyl thioglycoside, deacetylation, and finally benzylation. The fully protected rhamnoside was used in AGA and characterized by NMR spectroscopy and mass spectrometry. The ability to produce and utilize a rhamnose building block for AGA lays the foundation for future research regarding the generation of discrete rhamnose-containing glycomaterials.

Mentor(s): Rich Helm (Department of Biochemistry)
Brady Hall (GlycoMIP)

Shirin Sayani
Virginia Tech/Biochemistry

Assessing Physiological Responses of Various Winter Wheat Cultivars as Means to Better Understand Nitrogen Uptake and Metabolism.

The current agricultural practices for nitrogen application place strain on both the environment and the economy. As such, nitrogen use efficiency (NUE) has been established as a metric that indicates how effective a crop is at nitrogen uptake and utilization in relation to how much nitrogen was initially applied to the soil. Depending on the crop, NUE is defined as the yield or biomass obtained per unit of nitrogen applied to the field. The aim of this project is to measure differences in NUE for various winter wheat cultivars grown within a controlled environment and determine if NUE correlates with TOR kinase activity, a major regulatory gene for cell growth. While the NUE of these cultivars has been determined previously in the field, a sterile growth environment has been employed for this project. This was done by establishing a protocol for growing the wheat through hydroponic cultivation in growth chambers. The liquid medium contained NO3 as the nitrogen source at low, high, and control concentrations in order to measure plant growth under various nitrogen conditions. After a two week growth period, plants were harvested and root and shoot length, fresh and dry mass, and number of leaf blades were determined. This data was analyzed using RStudio to determine any notable differences between cultivars at different dosage rates. Moving forward, this data will be used to determine the proper conditions to estimate TOR activity.

Mentor(s): Guillaume Pilot (School of Plant and Environmental Sciences)

Amelia Schmidt
Virginia Tech/Animal and Poultry Sciences

Best Practices for Increasing Belonging, Equity, Inclusion, and Diversity (BEID) in Environmental Education

Environmental education is the process of growth in understanding, skills, and attitudes on the environment in order to engage individuals in environmental problem solving. Historically, environmental education has failed to be equitable, inclusive, and diverse, especially in youth programs. This insufficient diversity in environmental education organizations and programs creates a diminished sense of belonging for underrepresented groups in environmental fields. We conducted a comprehensive literature review on environmental education efforts to highlight common practices in environmental education to determine approaches that would best contribute to a heightened sense of belonging for all participants in environmental education programs. After an in-depth analysis of the basics of environmental education, we identified five best practices-or instructional standards which contribute to positive results-for increasing belonging, inclusion, equity, and diversity (BEID) in environmental education. Based on the literature, environmental education programs can boost BEID by maintaining flexibility in lesson materials and facilitation, promoting valued instruction through relevant content, acknowledging barriers, performing varied evaluations, and facilitating mentorship opportunities. Each of these five practices consist of various instructional, cooperative, and social strategies to enhance BEID in environmental education programming. These best practices gear programs toward the target audience, making the material more applicable and engaging. A collective solution is required in order to mitigate modern environmental issues, and this can not occur if only a segment of the population is represented in environmental decisions, thus, creating belonging in environmental education is crucial.

Mentor(s): Ashley Dayer (Department of Fish and Wildlife Conservation)

Ryan Schurr
Virginia Tech/Biochemistry

Purifying Methylases involved in Methanopterin Biosynthesis

Methanogenesis involves the biological production of methane, a very potent greenhouse gas that has 25 times the global warming potential of carbon dioxide. A key coenzyme in methanogenesis is methanopterin, a one-carbon group carrier. The pterin ring contains methyl groups at the C-7 and C-9 positions, however, the enzymes responsible for these methylations have not been determined. In Methanocaldococcus jannaschii, the proposed enzyme responsible for the methylations is a radical SAM enzyme encoded by the gene MJ0619. In Methanosarcina acetivorans, there are two proposed radical SAM enzymes, MA1114 and MA1486, both of which are homologous to MJ0619. Here, we describe our work to recombinantly express and biochemically characterize these gene products. MJ0619 was successfully expressed with a his-tag in E. coli, followed by anaerobic purification of the enzyme by nickel-affinity chromatography. Because the protein was synthesized in a non-native species, it was reconstituted with iron and sulfur to ensure formation of the iron-sulfur clusters necessary for radical SAM activity. MA1114 and MA1486 were shown in previous work to be insoluble when expressed in E. coli, so here we worked towards expressing the proteins in the native host, M. acetivorans. The previously transformed strains of M. acetivorans were grown with trimethylamine as a growth substrate and protein expression was induced by the addition of tetracycline. Unfortunately, initial methods to purify the MA proteins have not been successful, and alterations to the induction are being investigated. This work provides the foundation for the future characterization of these radical SAM methylase.

Mentor(s): Kylie Allen (Biochemistry)

Brannon Semp
Virginia Tech/Physics

Upgrades to miniCHANDLER

In preparation for the assembly and deployment of the prototype antineutrino detector MiniCHANDLER we are assembling 80 sets of photomultiplier tubes (PMT), PMMA light guides, and PMT bases. This is an involved, multistep process that includes identifying the ideal adhesive, carefully gluing together the light guides and PMTs, and soldering wires to the PMT bases. We expect the PMMA light guides, a new addition prototype, to increase light collection efficiency by 60%, which will lead to an expected decrease in RMS of 25%. This will increase the energy resolution of the detector. This increase in energy resolution combined with a new technique for matching gamma event will make reconstructing inverse beta decay event much easier.

Mentor(s): John Link (VT)

Sara Shah
UC Berkeley/Molecular and Cell Biology

KAUST REU

Examining Biophysical Characteristics of Programmed Cell Death

Programmed cell death (PCD) occurs when a cell commits to its suicide. The most extensively studied form of PCD is apoptosis, which is essential to embryonic development, eliminating immunologically insufficient T-cells, and preventing tumor formation. Recently, there has been an exciting development in the field whereby apoptosis can be reversed in a process called anastasis. The 'resurrection' of the cell from the execution phase after removal of lethal stresses opens windows of opportunity to study how cells live and die. Studying the interplay between apoptosis and anastasis can lead to the development of improved therapies for human diseases, particularly cancers and autoimmune diseases. Here, we plan to understand the biological basis of apoptosis and anastasis through a biomechanical lens in cardiomyocyte cells attached to in vivo mimicking fibrous extracellular matrices (ECM). The STEP platform technology allows precise estimation of cellular forces at single-cell resolution. Cardiomyocytes are used because physical forces from overwhelming pressure on the heart are thought to stimulate apoptosis. Analysis reveals a new force signature as cells cycle between apoptosis and anastasis. We extend the studies to include cardiomyocyte migration and mitosis, key determinants in cardiac mechanobiology.

Mentor(s): Amrinder Nain (Mechanical Engineering)

Vedant Shah
Virginia Tech/Computer Science

AutoCalibrate: Predicting the Voltage-Flapping Frequency Relationship in Insect Wing Models

A mechanical insect wing station has been constructed to understand the underlying fluid dynamic principles which guide the circulation of hemolymph in an insect wing. The frequency at which the wing flaps depends on the voltage fed to the motor and on the inertial properties of the wing. Using machine learning (ML) to perform regression, estimating the values of dependent variables based on independent variables, is a well-studied task both in academia and industry. While many generic regression models are available, we wanted to be able to calibrate the apparatus for new wings using only sparse data. A custom regression model was built using Tensorflow with the adaptive moment estimation algorithm (Adam) as the optimization function and Huber as the loss function to learn the relationship between the voltage and frequency of specific insect wing models fabricated with stereolithography resin printers. Datasets were prepared by manually tracking the flapping wing in video data in order to find the flapping frequency in Hertz and the voltage from the power source in Volts at that frequency. The mean absolute percentage error is used to measure the accuracy of the prediction. The model predicts voltage based on input frequency with a 94% success rate. Automating this manual task with an ML model improves the accuracy of values. This is essential to improve data accuracy in the insect wing hemodynamics experiments which has a broader application to downstream tasks such as developing systems for drug delivery and other applications in human health.

Mentor(s): Anne Staples (Biomedical Engineering and Mechanics)

Elyse Shoppell
Virginia Tech/Biology

Fralin SURF

Elucidating Auxin Signaling Specificity Through ARF/IAA Interactions Using Synthetic Biology in Protoplasts

Auxin is a hormone that plays essential roles an almost all aspects of plant growth and development. Harnessing Auxin signaling could allow us to control plant development and may have numerous applications in advancing agriculture and could be invaluable in combating global hunger. In addressing such challenges, manipulating components of the auxin response pathway is an area of opportunity. Auxin response is, in part, regulated by large families of auxin response factors (ARF) transcription factors and Aux/IAA transcriptional repressors. This system of ARF and Aux/IAA interactions is highly complicated and interconnected. By using synthetic protein interaction domains, placed in our proteins using Circular Polymerase Extension Cloning (CPEC) and validated in cells, we hope to isolate ARF and Aux/IAA pairings to elucidate functional differences of specific combinations. Synthetic interaction domains allow us to eliminate naturally occurring interactions between ARF and Aux/IAA proteins and isolate just one pairing that we have artificially created. We can test these combinations rapidly by using individual plant cells called protoplasts. By putting reporter genes (GFP, RFP) under the promoters targeted by the ARF and Aux/IAA proteins, we can see the effect on expression levels that these proteins have while also reducing confounding effects from the naturally occurring ARF and Aux/IAA proteins in the protoplasts. By understanding the effect these different proteins have on gene expression, we can then aim to manipulate gene expression and plant growth and development.

Mentor(s): Bastiaan Bargmann (SPES)

Cole Simon
Hampton University/Biology

Examining the relationship between bacterial shape and chemical structure within Cyclobacterium marinum

The size and shape of bacteria are controlled by a biopolymer called peptidoglycan, a material that forms a net-like sac surrounding the bacterial cell. Peptidoglycan (PG) gives the cell rigidity, protects it from differences in osmotic pressure, and also provides the mechanical strength that leads to cell shape. Interestingly, the bacterium Cyclobacterium marinum is a non-motile microbe found in marine environments that exhibits a circular shape; a phenotype unique to this genus. We hypothesized that the bacterium's shape is controlled by the peptidoglycan structure and hence sought to isolate and characterize the structure and compare it to the structures of other microbes of different overall shapes. The organism was grown in cell culture and the peptidoglycan isolated through a series of treatments involving heat and enzymatic degradation. The resulting samples were examined by liquid chromatography-mass spectrometry (LC-MS), with the structures identified compared to those available in the literature.

Mentor(s): Richard Helm (Department of Biochemistry and GlycoMIP)

Rania Smeltz
Virginia Tech/Biological Sciences

Effects of Varied Copper Concentrations on the Growth of *Legionella pneumophila* in Potable Water

Legionella pneumophila is an opportunistic pathogen (OP) which can inhabit residential plumbing and cause Legionnaire's disease via contaminated droplets from faucets and showers. Prior research shows conflicting information about the effect of copper on Legionella, as it is reported to act as a nutrient in some cases and as an antimicrobial in others. Here we attempted to conduct the first experiment defining the levels of copper that are nutrient limiting, optimal, and antimicrobial for L. pneumophila under realistic circumstances found in potable water plumbing. In a bench-scale experiment, we utilized simulated glass water heaters (SGWHs) to test 5 influent copper concentrations (0, 4, 30, 250, and 2000 g/L) in triplicate. The SGWHs contained PEX pipe coupons with >3.5-year-old biofilms known to release L. pneumophila. In the case of no added copper, traces of copper at approximately 1 g/L were released to the water from a reservoir in the biofilm. At the higher doses of copper, between 2-45% of the copper was removed from the water. Total cell counts, indicative of overall microbial growth, were optimal at 250 g/L copper and lowest at 2000 g/L copper ($p \leq 0.03$). Similarly, one of the replicate SGWHs with 250 g/L copper produced the greatest L. pneumophila growth and all those at 2000 g/L were below the detection limit, but the results were not yet significant at 95% confidence. Future work will involve re-inoculating the SGWHs and continuing to monitor the system as it matures.

Mentor(s): Marc Edwards (Department of Civil & Environmental Engineering (CEE))
Amy Pruden (Department of Civil & Environmental Engineering, Virginia Tech)

Penelope Smith
Patrick Henry High School, Roanoke Valley Governor's School

Relative localization of astrocytes to vascular cells within the cerebral microcirculation

The blood-brain barrier (BBB) regulates the movements of molecules between circulating blood and the extracellular fluid of the central nervous system (CNS). Such regulation includes protecting the brain from pathogens in the bloodstream as well as prohibiting efficient drug transmission into the brain. The BBB is composed of endothelial cells (EC) held together by tight junctions, pericytes (PC), and astrocytes. Brain PCs are important in angiogenesis as well as regulation of the BBB. Astrocytes communicate with PCs and ECs by secretion of factors regulating how capillary ECs transfer substances into the CNS from the blood. It is speculated that astrocytes within the directly couple to vascular cells, though it remains to be determined if vascular cells and astrocytes form cell-cell contacts or if they remain separated by the vascular basement membrane at all locations and depend on paracrine signaling for their communication. The goal of this study was to determine spatial interactions of these astrocytes and vascular cells. Distinct regions of direct cell contact that exist within the micro-vessel wall through astrocyte coupling to vascular cells was examined through highly magnified confocal images in addition to images taken by serial block face electron microscopy (SPF-SEM). Points of direct cell contact between astrocytes and vascular cells appears to be minimal. The majority of direct contact points seem to be associated with thin strand PCs, compared to mesh PCs and ensheathing PCs.

Mentor(s): John Chappell (Center for Vascular and Heart Research, FBRI-VTC, Department of Biomedical Engineering and Mechanics, Virginia Tech)

Yareli Sosa Antunez
Hollins University/Psychology

Investigating the impact of Latine ethnicity on public stigma toward men with Post-Traumatic Stress Disorder or Depression

Public stigma toward mental illness often prevents those with psychological disorders from seeking and utilizing mental health services, and further impairs recovery by creating barriers to employment and housing (Clement et al., 2015). The consequences of mental illness stigma are likely worse for racial and ethnic minorities since they also are also subject to minority stress and structural discrimination. Research indicates higher levels of mental illness stigma among racial and ethnic minorities, and lower rates of mental healthcare utilization (Alegria et al., 2002; Keyes et al., 2012). While previous research has explored levels of self-stigma among the Latine community as a barrier to treatment (Corrigan & Watson, 2007), few studies have examined the impact of ethnicity (especially Latine) on public mental illness stigma. Therefore, a survey was distributed on the Mturk platform (N=40) to investigate (non-Latine) Americans' perceptions of Latino and White men with Post-Traumatic Stress Disorder or Depression. Participants were presented with two vignettes, one describing a person with PTSD and the other with depression. The ethnicity of the characters (White or Latine) was randomly assigned; all other details remained constant. Following each vignette, stigma was assessed via: a Social Distance Scale (Link et al., 1999), the Warmth and Competence SCM Sub-scales (Cuddy, 2009), and a Dangerousness Scale (Corrigan et al., 2003). We hypothesized that participants would report greater stigma toward the Latine person with mental illness, and that this would occur across both conditions (PTSD and depression).

Mentor(s): Caroline Mann (Psychology Department, Hollins University)

Jacobie Spence
Virginia Tech/Nanomedicine

Understanding the influence of LdtR and Orf23 on motility Sinorhizobium meliloti

Sinorhizobium meliloti is a soil bacterium that forms a symbiotic relationship with alfalfa, an agriculturally important legume. S. meliloti use flagella, corkscrew-shaped appendages powered by rotary motors that propel the cell towards nutrients and host plants. A transposon mutagenesis screen to identify additional motility proteins revealed that the transcriptional regulator, LdtR, is important for motility but does not control motility gene transcription. LdtR regulates genes that encode peptidoglycan-restructuring enzymes but is not required for synthesis of the flagellum, which is embedded in the cell wall. Spontaneous suppressor mutants readily arise in the ΔldtR mutant on soft agar swim plates causing improved swimming motility. Genomic sequencing of the mutants revealed that the suppressor mutations commonly occurred in the uncharacterized motility gene orf23. Deletion of orf23 causes a minor swimming defect on soft agar swim plates. However, the ΔldtRΔorf23 strain shows nearly completely restored motility compared to ΔldtR. Therefore, improper peptidoglycan remodeling in ΔldtR may cause Orf23 to become detrimental to motility. Computerized motion analyses were used to determine the influence of the ΔldtR and Δorf23 mutations on swimming velocity and percentage of motile bacteria. The ΔldtR strain is severely impaired in the percentage of motile bacteria and swimming velocity, while Δorf23 and ΔldtRΔorf23 exhibit wild-type motility phenotypes. We are analyzing motility phenotypes in varying viscosities to determine how the ΔldtR and Δorf23 mutations affect torque generation by flagellar motors. Altogether, Orf23 appears to serve as peptidoglycan-dependent protein for optimizing torque generation in the S. meliloti flagellar motor.

Mentor(s): Richard Sobe (Biological Sciences)

Noah Stallard
Virginia Tech/Human Nutrition, Foods, and Exercise

TOUR

Micronutrients as Predictors for Markers of Bone Health in Athletes

Micronutrients as Predictors for Markers of Bone Health in Athletes
Noah Stallard1, Rohit Ramadoss1, Kristen Osterberg2, Stella L. Volpe1
1Virginia Polytechnic Institute and State University, Blacksburg, VA
2Gatorade Sports Science Institute, Bradenton, FL

Objective: We conducted a cross-sectional study to identify specific micronutrients that influence bone health in athletes. Methods: Female and male endurance and non-endurance athletes, 18 years of age and older, participated. Body weight (kg), height (m), and body mass index (BMI) (kg/m2) were assessed. Lean body mass (LBM) (kg), total (TBMD), lumbar (LBMD), and dual femur (FBMD) bone mineral density (BMD) were measured using dual-energy X-ray absorptiometry. Dietary consumption was measured by Food Frequency Questionnaire. We used univariate analysis of variance, Pearson's correlation coefficients, and linear regression (age, sex, and LBM as covariates) for statistical analyses. Results: A total of 262 athletes (130 women, 132 men), 35.8±11.3 years of age, with a BMI of 24.5±3.3 kg/m2 were included. Zinc intake was positively associated with FBMD (p=0.011) for all athletes. Iron intake was positively associated with FBMD (p=0.036) in all athletes, 18 to 29 years of age, with LBMD (p=0.038) in non-endurance athletes, 18 to 29 years of age, and negatively correlated with LBMD (p=0.024) in non-endurance athletes, 30 to 39 years of age. Phosphorus intake was negatively associated with LBMD (p=0.005) in endurance athletes, 40 years of age and older. Conclusion: Dietary zinc and iron were the two micronutrients most associated with FBMD and LBMD in athletes 18 to 29 and 30 to 39 years of age. Vitamin C and phosphorus intakes were both negatively correlated with LBMD in athletes 40 years of age and older. More prospective research is required to evaluate micronutrient intake and BMD among athletes.

Mentor(s): Stella L. Volpe (Human Nutrition, Foods, and Exercise)

Stella Sun
Fralin Biomedical Research Institute/High School Student

Data Analysis To Match Energy Density, Macronutrients, Fiber, and Sodium of Foods In Different NOVA Groups

The introduction of Ultra-Processed Foods (UPF) has greatly changed the modern food environment and become a large part of our daily diet. Here, we seek to test why UPFs are so rewarding and over consumed. To develop this research plan, we are creating a picture set that is matched on all nutrition factors except for NOVA (not an acronym) classification. The NOVA classification system classifies all foods into four groups by the extent of the industrial processing they undergo. UPF is defined within this system as formulations of ingredients that result from a series of industrial processes. UPF has been reported to be typically high energy-dense products, meaning they contain a lot of calories in a small amount of food. In this study, we analyze the nutrition data of 58 food items including energy density, macronutrients, fiber, and sodium. Our goal is to match those factors of the foods in different NOVA groups. The result we get mostly satisfies what we expected to see, but there are exceptions such as the result for sodium. Through creating a picture set of matched items, we will be able to study the relationship between food processing and food reward.

Mentor(s): Alexandra DiFeliceantonio (Fralin Biomedical Research Institute)

Deborah Thomas
Virginia Tech/Clinical Neuroscience

Ultrastructural Analysis of Retinogeniculate Synapses

Retinal Ganglion Cell (RGC) axons are critical for the transmission of visual information to the mammalian brain. Mice RGCs form synaptic connections called retinogeniculate (RG) synapses in the dorsal lateral geniculate nucleus (dLGN) of the thalamus. The dLGN has been classically known to consist of simple synapses where a signal RGC axon terminal (or a few retinal terminals of the same functional class) innervates a relay cell dendrite. Remarkably, current research suggests the additional presence of complex synapses where multiple RGC axon terminals (functionally similar and dissimilar RGC classes) innervate a relay cell dendrite. Our lab previously discovered that the dLGN expressed molecule Leucine Rich Repeat Transmembrane Neuronal 1 (LRRTM1) is important for synaptic formation. Mutant mice lacking LRRTM1 experienced a loss of complex dLGN RG synapses and impaired visual function. Our study used serial block-face scanning electron microscopy (SBFSEM) to perform ultrastructural analysis of the role of LRRTM1 on synaptic strength. Our analysis specifically focused on counting active zones (AZs), which are presynaptic sites containing neurotransmitter synaptic vesicles, thereby indicating synaptic strength. We made three important observations. First, active zones still form in LRRTM1 lacking mice. Second, there are fewer active zones in simple synapses as compared to complex synapses in both control and mutant dLGN. Third, complex synapses in mutant dLGN show a decrease in the number of active as compared to control dLGN. These results highlight a potential consequence on the strength of synaptic transmission in the absence of LRRTM1 and complex RG synapses in dLGN.

Mentor(s): Michael Fox (College of Science and Virginia Tech Carillon School of Medicine, Virginia Tech)
Rachana Deven Somaiya (Fralin Biomedical Research Institute at Virginis Tech Carillon, Center for Neurobiology Research)

Garsha Thomas
Bethune Cookman University /Mathematics Education
Dy'nasti Chappell
Bethune Cookman University /Mathematics Education
Payton Dinwiddie
Bethune Cookman University/ Mathematics Education

Success Teaches Everyone More: An in-depth look into how different teaching methodologies correlate to student engagement

In the words of Shakuntala Devi, “without mathematics there’s nothing you can do.” However, mathematics is a discipline that has social messaging that discourages some students from taking mathematics or doubt their ability to be successful in mathematics classes. The purpose of this study was to determine factors that positively influence students’ attitude toward mathematics, particularly students who have expressed anxiety related to their abilities to be successful in mathematics. The study specifically focused on identifying the classroom and teaching practices that have a positive impact on students’ attitude toward mathematics. This is a mixed methods study involving fifteen pre-service teachers who are first year graduate students enrolled in a four-week intensive summer mathematics education course. The mathematics course engages students in inquiry-based practices in which they discover mathematics concepts for themselves. The attitude toward mathematics survey was administered pre and post to determine any changes that occurred in their attitude toward mathematics from taking the course. Interviews were conducted to identify factors that may have influenced the change in their attitudes. The findings reveal the changes that occurred in the students’ attitude toward mathematics and the instructional practices that they found to be most beneficial to their learning.

Mentor(s): Brenda Brand (Science Education)
Lexly Taylor
Bettibel Kreye

Kirby Trageser
Virginia Tech/Statistics

Modeling Inland Transport of Toxins from Red Tide in Southwest Florida

Known to occur over the past few hundred years, Florida red tides are a natural phenomenon which have increased in severity over the past decade. Karenia Brevis, a toxic dinoflagellate, produces neurotoxins, known as brevetoxins, which kill marine animals, birds, contaminate the food that humans eat, and become a part of the marine aerosol leading to irritation in humans and animals when inhaled. Ranging in severity over the course of the year, these algal blooms lay economic and social consequences when the irritation caused by the brevetoxins becomes too potent. Past studies have shown that the brevetoxin can travel inland and cause the same irritation symptoms as present on the beaches of Southwest Florida.

Here we aim to create a model using previously collected data of brevetoxin air concentrations as well as local historical weather data in order to predict the extent of the brevetoxins that transport inland. A standard Gaussian Plume Model was initially used to model the toxin dispersion. Due to limitations in the standard model, other versions of the Gaussian Plume were utilized in order to account for an aerosol line source along the coast, rather than a single point, as well as a varying wind direction. Eventually, an improved Gaussian Plume allowed for the study of previous days where the wind was not mainly on shore.

Despite the positive use of these models, more detailed inland concentration data should be collected in order to validate the use of the Gaussian Plume Model for operational forecast use.

Mentor(s): Shane Ross (Aerospace and Ocean Engineering)

Nina Lauren Valdisimo
Hollins University/Business (Finance Track)

As inflation surges, how long will this inflationary episode last compared to other episodes in history.

As the pandemic entered the third year, there is another headache people must face. The new inflationary episode introduced itself to us at the beginning of 2022. US inflation hit the highest level in 40 years as CPI climbed to 7.5%. The Federal Reserve finally ditches its ”Transitory” tag on inflation and begins to deal with inflation more seriously. More surprisingly, The Federal Reserve on June 15, 2022, lifted interest rates by 0.75 percentage point, the third hike this year and the largest since 1994. The move is aimed at countering the fastest pace of inflation in over 40 years.

But how long will this inflation last, what did the past inflations tell us, what are the similarities and differences between the current inflation and the past inflations, and what are the actual reasons behind this inflation? Is soft landing even possible after such rapidly interest rate hike? And lastly, what does this mean for consumers and the economy?

By studying the past inflations and reading the FOMC meeting reports as well as monthly CPI reports, we are planning to provide answers to the above questions.

Mentor(s): Dr. Xiang Long (Business Department, Hollins University)

Ava Veith
Virginia Tech/Systems Biology

Spring Dead Spot Impact on Athlete Safety and Performance

Spring dead spot (SDS) of bermudagrass presents a major concern on athletic fields due to the non-uniform surface created. However, the impact of SDS on athlete safety and performance has not been evaluated. The primary objective of this study was to define the influence of SDS on key metrics associated with field performance and athlete safety, including surface hardness and shock absorption, moisture levels, ball rebound, shear strength, force reduction, vertical deformation, energy restitution, and force impact. Additional metrics to define the impact of SDS on field uniformity were also collected. Data was collected from three hybrid bermudagrass baseball field fields in Richmond, VA in late May when SDS symptoms were most visible. Twenty matched pairs of SDS symptomatic and asymptomatic bermudagrass served as replications for each data collection. Data were analyzed using ANOVA with means separated when appropriate ($p=0.05$). Our data suggests that SDS impacts surface depression, ball rebound, firmness of surface, shear strength, vertical deformation, energy restitution, impact values, and soil moisture. We conclude that SDS impacts hybrid bermudagrass athletic field playing surfaces by creating a significant surface void that is firmer than the surrounding turf grass and absorbs more force from the athlete, therefore returning less energy to the player. Additionally, athletes' cleat grip will be impacted by a weaker shear strength in SDS patches, suggesting an increased likelihood of slipping. Ball rebound is impacted by SDS, altering player perception of ball travel. Finally, our data suggests that SDS impacts field performance and player safety more on wet fields, though more data is needed to validate.

Mentor(s): David McCall (Virginia Tech)

Christine Walsky
Virginia Tech/Animal and Poultry Sciences

Investigating the association of *Vibrio parahaemolyticus* with the Eastern oyster

Vibrio parahaemolyticus (VP) is a primary cause of global seafood-borne gastroenteritis in humans. VP is present in marine and brackish waters and accumulates in shellfish that filter the water, including oysters. Within the Chesapeake Bay watershed, the Eastern oyster helps maintain water quality and serves as an economically important food source. Better understanding the host-microbe relationship will provide insights to improve VP mitigation efforts in seafood. To investigate this association, VP colony-forming units (CFU) in the water column were compared to the CFUs within homogenized oyster tissue over two eight-day trials. Inoculation tanks, each containing 2-3 consumer-ready oysters, were set up in a Biosafety Level-2 cabinet. Following chloramphenicol treatment to reduce the native microbiome, the experimental tanks were inoculated with a chloramphenicol-resistant VP laboratory strain, while the uninoculated tanks served as negative controls. Water column samples were spread onto TCBS + chloramphenicol-infused plates, while tissue samples were spread on TCBS + chloramphenicol-infused plates and TCBS plates to compare the inoculated VP to total native *Vibrio* spp. levels. The results show both the water column and tissue CFUs trending downward in parallel until a steady level was reached, suggesting that initially, transient VP cells were removed, but over time the oyster served as a reservoir for VP. A second, five-day, experiment examined if feeding the oysters an algae-based diet enhanced oyster-associated VP levels; the results suggest that the presence of the algae did not significantly impact inoculated VP levels. Further studies are planned to attempt to visualize VP within oyster tissues.

Mentor(s): Ann Stevens (Biological Sciences)
Ian S. Hines (Department of Biological Sciences; Center for Emerging, Zoonotic, and Arthropod-borne Pathogens)
A Rayne Layton (Department of Biological Sciences)
Stephen A. Smith (Center for Emerging, Zoonotic, and Arthropod-borne Pathogens; Department of Biomedical Science and Pathobiology)
David D. Kuhn (Center for Emerging, Zoonotic, and Arthropod-borne Pathogens; Department of Food Science and Technology)

Trey Warren
Virginia Tech/Environmental Horticulture

VT-REEL

Screening wheat varieties for tolerance of brome mosaic virus, and observing, counting, and identifying pollinators on blackberries.

The first objective of my project was to screen and identify wheat varieties that are resistant or tolerant to brome mosaic virus (BMV). BMV infects multiple monocot crops such as wheat and barley. BMV is also a model virus for positive-strand RNA viruses, and what we learn from BMV can then be applied to other viruses. In this project, five wheat varieties were infected with BMV to assess the different varieties for levels of severity, height, and speed of infection. First, BMV viral particles were prepared from previously infected plants. Next, wheat plants were inoculated via mechanical wounding using the prepared viral particles. Symptoms were closely monitored after five, seven, and ten days. Based on symptom development, the Shirley wheat variety appeared to be the most resistant to BMV. The second objective of my project was to test if pollinators were more attracted to one of four treatments, including salicylic acid, calcium, sun, and shade. In addition to monitoring the four different treatments, I also placed traps for pollinators to count and identify which pollinators were most common in the blackberry patch. To monitor for pollinators, I would randomly select one plant from each treatment each morning and afternoon and watch these plants for 10 minutes while counting the number of self-pollinations, outcrosses, and bumps. The shade appeared to be the least visited treatment, likely because the shade cloth prevented pollinators from reaching the plants.

Mentor(s): Xiaofeng Wang (PPWS)
Lisa Horth (Biology, Old Dominion University)
Jayesh Samtani (School of Plant and Environmental Sciences, Virginia Tech)

Sonia Warrior
Virginia Tech/Cognitive and Behavioral Neuroscience

TOUR

Situational Determinants of Interpersonal Expressions of Gratitude: Behavioral observations on the Virginia Tech campus

Psychological science has shown that interpersonal gratitude can increase subjective well being and happiness among those who express gratitude regularly. Previously, Virginia Tech students observed whether pedestrians waved an expression of gratitude to drivers of vehicles who stopped for them at marked crosswalks on campus. On intermittent weeks, a sign was placed at crosswalks with the message “Please Thank Drivers with a Wave.” The mean percentage of thank-you waves was 15% of 127,728 pedestrians during Baseline, and 21% of 93,430 pedestrians crossing the street when the behavioral prompt was in place. This project observed the frequency of prompted versus unprompted expressions of gratitude among students entering and leaving a campus exercise facility. 493 participants were observed entering and exiting this facility. The observer recorded whether the receptionist gave a friendly prompt like “Have a good workout” to those entering the facility or said something like “Have a nice day” when an attendee was leaving the facility. When entering the facility, the percentage of attendees who expressed “Thank you” following the receptionist’s prompt was 67.59%, but was only 21.91% when the receptionist did not offer a prosocial prompt to the attendee. When leaving the facility, 77.48% voiced a “Thank you” when the receptionist gave a positive prompt, but only 34.07% expressed a “Thank you” when the receptionist did not offer a positive prompt first. Additional factors were observed and recorded for follow-up analyses, including the gender of the receptionist, the time of day, and whether the attendee was accompanied by someone.

Mentor(s): Scott Geller (Psychology)

Carter Watson
The University of Georgia/Ecology

Compromising QKD Undetected: Impacts of a Polarizer on One-Time Pad Creation

The logic behind the BB84 protocol, or any quantum cybersecurity protocol dependent on quantum key distribution is that no eavesdropper can disrupt or intercept the communication of the one-time pad (a randomly created string of 0's and 1's); otherwise, the CHSH inequality, a measurement useful to identify entanglement, will fall below 2, thereby alerting the receiver that the communication is not secure. As there is a desire to test the strength of quantum cybersecurity protocols, we were interested in whether the initial creation of the one-time pad can be disrupted. Our goal was to obtain a string of numbers that had a bias of 95% or greater either towards 0's or 1's without dipping the CHSH inequality below 2, thereby skewing the final secret key used in decryption so that can be cracked easily. This was simulated using quTools quantum entanglement generator based on quantum photonics principles. We were able to achieve this by creating an opening in the beam splitter and putting a polarizer in one of the pathways, disrupting the creation of 1's. This polarizer was undetected and acted as an attenuator, as it was downstream from the CHSH motors. What is observed from this data is the need to use more than quantum metrics to measure any disruptions in the initial creation of the one-time pad, to not just use the CHSH inequality but to also incorporate a measure of bias to terminate the protocol if disruptions are measured.

Mentor(s): Wayne Scales (Department of Electrical and Computer Engineering)

Lana Watts
Virginia Tech/Human Nutrition, Foods, and Exercise

TOUR

The Role of Leptin Receptor-Expressing Cortical Neurons in Mediating Altered Pain Sensitivity Following Early Adversities

Stress modulates pain perception. This happens when the central or peripheral nociceptive neurons exhibit maladaptive function following stress exposures, producing altered pain responses to noxious stimuli. Early life trauma (ELT), in the form of child abuse/neglect exerts long-term detrimental effects on physiological functions, yet how the specific neural substrates or the neuromodulatory signaling adapt in response to ELT and how they underlie the altered pain sensitivity has not been addressed. Here, we found that adult mice exposed to ELT (i.e., 23 hours of separation from dam and littermates at postnatal day 3) show impaired inflammatory pain responses following formalin injection. Using immunohistostaining of c-fos, the neural activity marker, we show that the increased neural activity in the dysgranular insular (DI) cortex of ELT mice may cause impaired responses in formalin-induced inflammatory pain. Interestingly, the DI has been known to contain an abundance of leptin receptor (LepR), and we found that shRNA-mediated LepR knockdown in the DI mimics the impaired inflammatory pain responses of ELT mice. Our results, which illustrates how a specific neural pathway governs ELT-induced maladaptive pain responses, may create an important advancement in understanding the central mechanisms underlying pathophysiology of chronic pain syndrome induced by traumatic stress events, providing a basis on which novel treatments can be built.

Mentor(s): Sora Shin (Human Nutrition, Foods, and Exercise; Virginia Tech; Fralin Biomedical Research Institute)
Yeeun Bae, PhD student (Human Nutrition, Foods, and Exercise; Virginia Tech; Fralin Biomedical Research Institute)
Alec Beck, Research Assistant (Human Nutrition, Foods, and Exercise; Virginia Tech; Fralin Biomedical Research Institute)

Claire Wei
Fralin Biomedical Research Institute at VTC/High School Student

Collagen XIX Point Mutant Leads to Schizophrenia-Related Behaviors and Brain Disorder in Mice

Schizophrenia is a complex brain disorder that affects 1% of the population and is characterized by alterations in cognitive function, acquisition and expression of behaviors not seen in healthy individuals, and loss of behaviors normally present in healthy individuals. Mounting evidence suggests that schizophrenia-associated behaviors result from alterations in the assembly and function of synapses. Our lab recently identified roles for an extracellular matrix molecule that has been loosely associated with familial schizophrenia, Collagen XIX (COL19A1), in the assembly of inhibitory synapses. We also identified a family with a heterozygous mutation in COL19A1 that exhibit a number of neurologic and psychiatric symptoms. To study the impact of this mutation (COL19A1[p.Ala388Cysfs*56]), we engineered mice to harbor a similar mutation (Col19a1[p.Ala385Cysfs*57]) and explored its impact on mouse behavior and the underlying neural circuits. Here, I tested the performance of these novel mutant mice (and controls) in nest building behavior, drug induced seizures, and social behavior. Mice with the mutation consistently scored lower in the first two tests and interacted significantly differently in testing social memory in comparison to than wild type mice. Moreover, inserting this mutation into mouse Collagen XIX led to the loss of perisomatic inhibitory synapses, a type of synapse whose loss has been associated with schizophrenia. Using immunohistochemistry, I also determined that this loss of synapses was likely due to deficits in their initial formation rather than from phagocytosis by activated microglia. Taken together, these studies identify a novel mutation in Collagen XIX that cause structural and behavioral changes similar to those associated with schizophrenia.

Mentor(s): Michael Fox (Department of Biological Sciences, Fralin Biomedical Research Institute)
Jianmin Su (Center for Neurobiology Research, Fralin Biomedical Research Institute at Virginia Tech Carillon)

Omar West
Virginia Tech/Biological Sciences

Characterization of connexin43 expression and localization in human colon cancer

Colon cancer is the third highest cause of cancer in the world, and one of the leading causes of cancer-related deaths in the US with a 5-year relative survival rate of only 8%-20% in late-stage disease. Variation in the expression and subcellular localization of the gap junction protein connexin43 (Cx43) is associated with oncogenesis, but is relatively unexplored in colon cancer progression, with Cx43 described as tumor suppressor and oncogene. Non-junctional Cx43 is now understood to influence pathways central to cancer progression including cytoskeletal organization, gene expression, cellular trans-differentiation, and the cell cycle. Prior work in the Lamouille lab has demonstrated increased Cx43 expression and enrichment of cytoplasmic Cx43 away from the plasma membrane in necrotic and surrounding regions in stage 3 and 4 colon cancer tumor tissue isolated from patients. We hypothesize that cytosolic Cx43 promotes colon cancer progression and that this shift in localization is induced during hypoxia and inflammation within tumors. To replicate the necrotic tumor environment in vitro, colon cancer cells were exposed to hypoxia and/or inflammatory cytokines. Specifically, we are currently assessing how TNF-α, IL-6, and/or hypoxia induce enrichment of cytosolic Cx43 to promote cancer progression. Western blotting was employed to measure the expression of Cx43 and complemented by confocal immunofluorescence microscopy to observe alterations in Cx43 localization. Identification of the signaling pathways regulating such oncogenic Cx43 redistribution will inform future therapeutic interventions for colon cancer aimed at limiting the inflammation-oncogenic axis and limit progression to metastatic disease.

Mentor(s): Sammy Lammouille (Fralin Biomedical Research Institute at VTC)
James Symth (Fralin Biomedical Research Institute at VTC)

Jessica Willebeek-LeMair
Hollins University/Environmental Science

Investigating Factors of Perceptions of State Fish and Wildlife Agency Prioritization of Wildlife Viewing

A growing desire to increase the relevance of State Fish and Wildlife Agencies (SFWA) to members of the public with mutualistic wildlife values (view wildlife as friends/family, not for human gain) has led to calls for management reform. This includes efforts to ensure relevance to wildlife recreationists other than hunters, such as wildlife viewers (intentionally observe, photograph, or feed wildlife). To identify possible disconnects between SFWA management approaches and constituency values, we investigated whether there was a relationship between SFWA employee wildlife value orientations along with their related wildlife views and wildlife viewers' perceived prioritization of wildlife viewing. We hypothesized that SFWAs with a) higher percentages of mutualist employees, b) lower percentages of employees that viewed their SFWA as prioritizing hunter recruitment and retention, and c) higher percentages of employees that viewed their agency as prioritizing adapting to changing social conditions, would be associated with wildlife viewers having higher levels of perceived wildlife viewing prioritization. Survey data on wildlife viewers' perceived level of SFWA prioritization of wildlife viewing collected from nine different states was used in conjunction with State Fish and Wildlife Agency Culture Survey data from America's Wildlife Values project. No significant relationships were found between SFWA employee wildlife value orientations or their related wildlife views and wildlife viewers' perceptions of agency prioritizations. Results indicate that altering these aspects of SFWA culture may be insufficient in ensuring relevance to wildlife viewers, and further research is needed to quantify what SFWA actions would engender a stronger relationship with wildlife viewers.

Mentor(s): Ashley Dayer (Department of Fish and Wildlife Conservation)

Kaitlynn Wolfe
Columbia University/Biochemistry

Investigation of the Role of Threonine 240 in Substrate Binding in the Cadaverine Monooxygenase Enzyme GorA

The GorA enzyme catalyzes the nitrogen oxidation of cadaverine to N-hydroxy-cadaverine, which is the first committed step in desferrioxamine B (DesB) synthesis. DesB is a siderophore (e.g. iron-chelating molecule) that serves as a virulence factor by allowing Gordonia rubripertincta to live in iron-limiting environments. Understanding the mechanism of action, including residues involved in substrate binding, is important for drug discovery efforts. Docking and structural analysis identified a threonine at position 240 as a potential residue that could bind cadaverine in the GorA active site, and site-directed mutagenesis was used to replace this threonine with alanine. Determination of effects on GorA activity allowed for investigation of the role of threonine in substrate binding and therefore a greater understanding of an enzyme that assists in G. rubripertincta survival. To make the mutation, polymerase chain reaction was used to incorporate a single nucleotide change at nucleotide 718. After confirmation by Sanger sequencing, the mutant enzyme was expressed in Escherichia coli with the pVP56k plasmid. Once purified, steady-state kinetics of the mutant were analyzed based on oxygraph recordings of oxygen consumption of the enzyme during turnover. The T240A mutant had a kcat of 0.31 ± 0.04 s-1, which is very close to the wild-type 0.32 s-1 value. Similarly, the mutant Km of 53 ± 30 μM was comparable to the wild-type 36 ± 2 μM value (within experimental error). Therefore, results are consistent with the T240 residue not playing a significant role in the interaction between GorA and its substrate.

Mentor(s): Pablo Sobrado (Biochemistry)

Mackenzie Woolls
Virginia Tech/Public Health

Suppression of the Pre-Metastatic Niche through NLRX1

Triple-negative breast cancer (TNBC) commonly affects women who are Black, under the age of 40 or have the BRCA1 mutation. TNBC lacks estrogen receptors, progesterone receptors and the HER2 protein commonly targeted during treatment making it aggressive and prone to severe disease outcomes. The pre-metastatic niche, hypothesized in the "seed and soil theory", is a favorable microenvironment in healthy distant organs created by tumors to promote metastasis through immunosuppression, angiogenesis, remodeling of the extracellular matrix and inflammation. In previous studies using the 4T1 model of TNBC, NLRX1, a pattern recognition receptor, has demonstrated its ability to suppress lung metastasis when expressed by healthy host cells. We hypothesize that when NLRX1 is expressed by the mouse lung it protects against the formation of the premetastatic niche. We injected 4T1 cells into BALB/cJ Wildtype and Nlrx1 -/- mice and collected lung samples at pre- and post-metastasis timepoints to compare lung microenvironments. Using immunohistochemistry, western blots, and flow cytometry, we found Nlrx1-/- lungs had significantly more premetastatic niche factors present including CD31, IL-6, TGF-β, fibronectin, and LOX. There were significant differences in inflammatory dendritic cells (CD45+ CD11b+ CD11c+ Ly6C+ F4/80+ MHCII+) , CD4+ T cells (CD45+ CD3+ CD19- CD4+ CD8-), natural killer cells (CD45+ CD3- NK1.1+ CD19-), and double negative T cell populations (CD45+ CD3+ CD8- CD4- FoxP3-) between genotypes ($p \leq 0.05$). Overall, we conclude that when NLRX1 is present in the lung it protects against metastasis by decreasing pre-metastatic niche factors suggesting potential as a drug target.

Mentor(s): Allen Irving (Biomedical and Veterinary Science)

Jonathan Yoder
William & Mary/Biology

VT-REEL

Bug Off Pests: The Importance of Beneficial Predatory Insects

PredaLures are lures that utilize the plant volatile methyl salicylate to attract beneficial insects to feed on pests. The ability of PredaLures to attract beneficial predatory insects to apple orchards was investigated using a combination of sentinel eggs and sticky card traps. We found no significant difference in the predation rates on sentinel eggs paired with PredaLure versus the control. However, there was a significant difference in egg predation rates among the four orchard blocks, suggesting other management factors can have important consequences for predatory insect abundance. Our ongoing work will use the data from sticky card traps to assess any effects of PredaLures on the predatory insect community composition.
The relationship of pests and natural enemies was further explored in a project that tested how sublethal effects from insecticide exposure to pests can impact their predators through bioaccumulation. Additionally, the unintended effects of insecticides on the environment and natural systems were examined. Fall armyworms were fed with corn and diet that contained the active ingredients tetraniliprole, indoxacarb, and bifenthrin at dilutions of the application rate to be fed to predatory green lacewings. I hypothesize the green lacewings will have lower survival rates when feeding on fall armyworms that were exposed to higher concentrations of insecticides, particularly with bifenthrin because it is a pyrethroid, a broad-spectrum insecticide that affects a wide variety of insects. Overall, these two projects highlight a need for sustainable pest control solutions in agriculture that encourage healthy populations of beneficial predatory insects.

Mentor(s): Susan Whitehead (Biological Sciences)
Alejandro Del-Pozo (Entomology, Hampton Roads Agricultural Research and Extension Center, Virginia Tech)

Tamesha Young
North Carolina Agricultural and Technical State University/Animal Science

Conditions Necessary for the Transfer of Antimicrobial Resistance in Poultry Litter

The emergence of antimicrobial resistance is dependent on conditions optimal for the transfer and persistence of the plasmid in its new bacterial host. The genetic background of the bacterial host also dictates plasmid acquisition and retention. This project focused on the possible transfer of antimicrobial resistance from litter to Salmonella. The ability of Escherichia coli strains (MC4100 or 1932) with different conjugative plasmids (pR100, pRS2) (Donors) to transmit antimicrobial resistances to a rifampicin-resistant Salmonella Typhimurium strain (Recipient) was assessed in poultry litter at 77oC, the ambient temperature of the poultry house environment. The abundance of the E. coli plasmid donor, the Salmonella recipient, and transconjugants, Salmonella with a conjugative plasmid, was determined by plating litter filtrate onto either XLT4 or MacConkey agar with rifampicin (Rif; 64 µg/ml), nalidixic acid (Nal; 64 µg/ml), chloramphenicol (25 µg/ml; pR100) or kanamycin (Km; 50 µg/ml; pRS2) alone or in combination. There was no indication of plasmid transfer in this study with either plasmid. The persistence of the E. coli donor varied depending on strain background and plasmid type, although Salmonella levels, starting at 10^-3 CFU/g, slowly declined over 14 days at room temperature. While the plasmid pRS2 was capable of transferring resistance at 25oC, in E. coli strain 1932, did not persist long enough to encounter Salmonella and transmit kanamycin resistance. The plasmid donor's persistence in litter and conditions favorable to plasmid transfer (temperature) appear to be the two most important factors driving the transfer of resistance to Salmonella in this environment.

Mentor(s): John Maurer (Animal and Poultry Sciences)