2023 Summer Conference

Office of Undergraduate Research

August 27, 2023

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Welcome

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

Welcome all to the 2023 Summer Undergraduate Research Conference at Virginia Tech. It is always a highlight of the summer to learn from and celebrate with the host of students who spend the summer with us.

The students presenting today have spent weeks to months immersed in a research project. Summer affords undergraduates the opportunity 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 provide 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, Sophie DeSimone, Kristen Bretz, 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 of Undergraduate Research

Welcome to the 12th annual Summer Research Conference at Virginia Tech being hosted by the Office of Undergraduate Research (OUR)! Today we welcome 193 presenters from 30 organized funded programs and many independent labs, who will give 168 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. As always, 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, the OUR offered comprehensive professional development programming that would not have been possible without the expertise and time of several generous colleagues. 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 writing proposals and creating an effective poster; and a number of faculty and students who offered a variety of seminars and workshops throughout the summer including the VT Graduate School, Kory Trott (Research Integrity), Kelsey Reed (PhD candidate in Translational Plant Sciences), Suzanne Shelburne (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 –Hannah Jane, Mackenzie, and Olivia - 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 Sophie DeSimone and Nicole Bottass, who were instrumental in planning and 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

Bev Watford

Dean Watford is the Associate Dean for Equity and Engagement and the Executive Director of the Center for the Enhancement of Engineering Diversity (CEED). The Equity and Engagement office is responsible for the recruitment and retention of diverse students, both undergraduate and graduate. This includes a wide array of programs developed and implemented for precollege students as well as programs supporting the academic, professional and personal development of current students. The office is also engaged with engineering faculty and staff to promote diversity and a culture of inclusion for all.

Dean Watford earned all of her degrees from Virginia Tech's College of Engineering (BS Mining Engineering, MS and PhD in Industrial Engineering and Operations Research).

Dean Watford has worked at Virginia Tech since 1992. She has two children, Devon (BIT ‘15) and Leah (SBIO ‘18). Her professional interests are focused on ensuring that all students who desire an engineering degree are successful. She is particularly interested in helping under-represented students achieve their educational and professional goals, whether these goals are in engineering or any other field.

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.

CUBE Summer Program
Director: Dr. Alexandra Hanlon, Center for Biostatistics and Health Data Science (CBHDS)
The Collaborative Undergraduate Biostatistics Experience (CUBE) is an 8-week summer program designed to expose underrepresented students in STEM to the field of collaborative biostatistics. CUBE aims to bring visibility to, and diversify, the profession of collaborative biostatistics. The CUBE program is built on four pillars: 1) training in introductory biostatistics; 2) training in R programming; 3) professional development; and 4) a collaborative research project addressing research questions in various disciplines, including addiction and health behavior research. This program is currently funded by an NIH NIDA/NIAAA R25 award (1R25DA058482-01), the integrated Translational Health Research Institute of Virginia (iTHRIV), Merck, along with Virginia Tech's Fralin Life Sciences Institute (FLSI) and the Institute for Society, Cultures, and Environment (ISCE).

CHBR SUMMER PROGRAM
Directors: Dr. Warren Bickel, Dr. Alexandra DiFeliceantonio, Dr. Jeff Stein
Coordinator: Taryn Pelletier (Fralin Biomedical Research Institute at VTC)
The Center for Health Behaviors Research Summer Program is an 8-week experience designed to increase exposure to scientific research, provide educational and career

mentorship, and to foster an imagination for a career in science for underrepresented high school juniors and seniors from the Roanoke Valley. The foundation of this program is mentored research at the Fralin Biomedical Research Institute at VTC in the research areas of neurobiological and decision making sciences, molecular and clinical metabolic sciences, and implementation, dissemination and health policy sciences.

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 CardioSURF
Director: Dr. Jamie Smyth (FBRI + VT Biological Sciences)
Coordinator: Dr. Alexandria Pilot-Chambers (FBRI)
The FBRI CardioSURF 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. The CardioSURF program is funded by the American Heart Association.

FBRI neuroSURF
Dr. Michael Fox (FBRI + VT Biological Sciences)
Dr. Alexandria Pilot-Chambers (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 and Cave Spring 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 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. A unique component of the program is a specially designed Communicating Science series. For over ten years, 15 to 30 exceptional students from a variety of majors have been selected to participate in this competitive program each year. This program is funded by the Fralin Life Sciences Institute.

GLYCOMIP SUMMER UNDERGRADUATE RESEARCH EXPERIENCE (GlycoSE)
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. GlycoSE is a 10-week training program that combines research experiences with 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. GlycoSE 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.

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.
Special thanks to Fincantieri Marine Group (FMG) that partnered with MAOP this year to support 6 students with a summer research project + scholarship. FMG is a subsidiary of one of the world's largest shipbuilders, uniquely positioned to provide cost-effective solutions to new construction, repair and conversion challenges for both government and commercial markets.

CENTER FOR NEUTRINO PHYSICS REU
Professor Camillo Mariani (Director)
Betty Wilkins (Coordinator)
Our physics faculty are engaged in a broad spectrum of research within neutrino and astronomical physics, including but not limited to 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, supernovae neutrino experiments and theory and radio-astronomy experiment and observations. 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 (Ph.D Candidate and Instructor)
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.

STUDENTS TRANSFORMING ENERGY AND ENVIRONMENTAL RESEARCH (STEER)
Amanda Morris (Director)

Rachel Dalton (Director)
The Department of Chemistry at Virginia Tech, in collaboration with the National Science Foundation (NSF), presents a **Research Experience for Undergraduates (REU)** program titled **Students Transforming Energy and Environmental Research (STEER)**. STEER will bring together undergraduate students with faculty and graduate student mentors to address the grand challenges associated with global warming and climate change. The broader environmental and economic impacts of next-generation energy solutions and mitigation of the impacts of global climate change are immense. STEER research will lead to advances in energy storage, energy-relevant catalysis, rare-earth element management, and green chemistry. Students will conduct research with diverse investigators at the forefront of their fields, including batteries, solar fuels, water purification, mineral sequestration, catalysis, and sustainability. University partners and experts in scientific communication, leadership, DEIR (diversity, equity, inclusion, and respect), career development training, grantsmanship, and community outreach for REU student professional development will be utilized to enrich the students.

SCHOOL OF NEUROSCIENCE SUMMER UNDERGRADUATE RESEARCH FELLOWSHIP (SURF-N)
Sarah Clinton (Associate Director, VT School of Neuroscience)
Dr. Lina Ni (Associate Professor, 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.

THE TRANSLATIONAL PLANT SCIENCE CENTER SUMMER UNDERGRADUATE RESEARCH PROGRAM (TSPC-SURP)
Guillaume Pilot (Director)
The Translational Plant Science Center (TPSC) is composed 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 plant-related research in laboratories affiliated to the Center. The fellows are participating to several training activities of the SURF program offered by the Fralin Life Science Institute.

TRANSLATIONAL OBESITY UNDERGRADUATE RESEARCH SCHOLARS (TOUR)
Dr. 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.
Nine undergraduate students representing Virginia Tech and UVA were chosen to participate in the 2023 summer program and are working with 7 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, VTTI, as well as VTCSOM and VTCRI in Roanoke. This year the TOUR Scholars took the Hokie Bird planes to Bethesda, MD to visit NIH laboratories and participant in a career panel with NIH Scientist and administrators.

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 Agricultural Research and Extension Centers (ARECs), working in applied labs. Four undergraduate students from academic institutions within Virginia were chosen to participate in the 2023 summer program. Faculty mentors were affiliated with the School of Plant and Environmental Sciences, Department of Biological Sciences, 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.

VTCSOM Early Identification Program (EIP)
Director: Dr. Melanie Prusakowski (Dean of Admissions, Virginia Tech Carilion School of Medicine)
Coordinator: Katherine Murphy (Admissions Operations Manager, Virginia Tech Carilion School of Medicine)
The Virginia Tech Carilion School of Medicine's Early Identification Program is a two-year summer program that is designed for undergraduate students who are from groups that are underrepresented in medicine. The program aims to assist participants in becoming competitive applicants to medical school. The first summer of the program provides participants the opportunity to engage in ten weeks of hypothesis-driven research at the Fralin Biomedical Research Institute through the Summer Undergraduate Research Fellowship program. The second summer, selectees participate in six weeks of clinical experiences through Carilion Clinic as well as participate in MCAT preparation and tutoring.

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

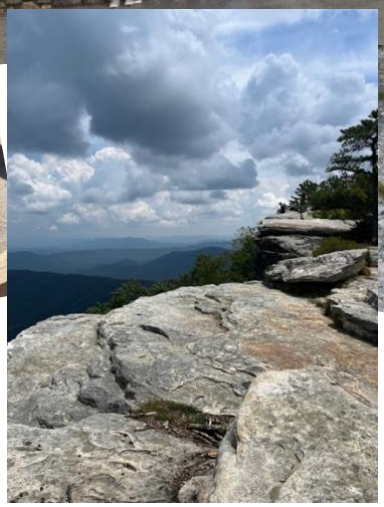
VIRGINIA TECH GRADUATE SCHOOL

TRANSLATIONAL PLANT SCIENCE CENTER

TPSC, CEZAP + GCC

ENVIRONMENTAL HEALTH AND SAFETY

Thank you, OUR Summer Peer Mentors!!

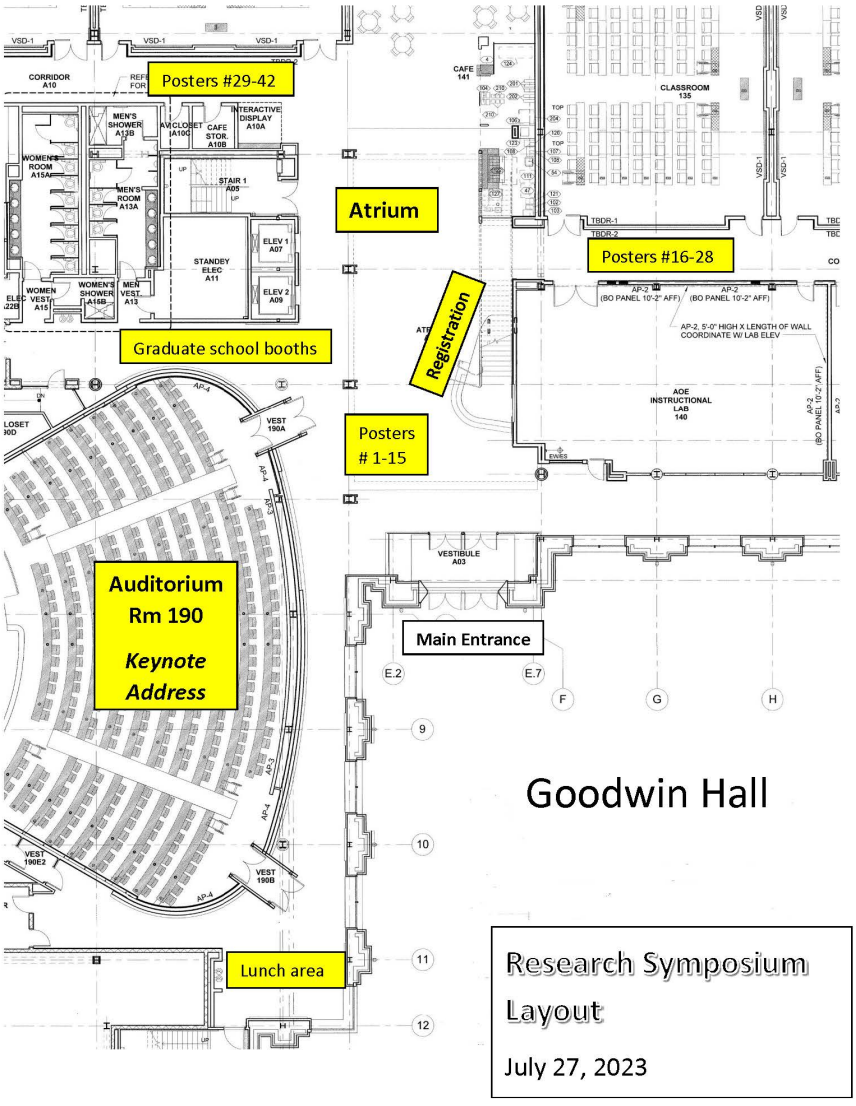


Schedule and Abstracts

2023 Summer research Symposium at Virginia Tech

July 27, 2023 | Goodwin Hall

9:00-9:20am	Check-in (Goodwin Atrium) Poster Session 1 set up
9:20-9:30am	**Welcome- Keri Swaby (Goodwin Auditorium)**
9:30-9:50am	**Keynote Address- Dr. BevLee Watford (Goodwin Auditorium)**
9:50-10:00am	Break
10:00-10:50am	**Poster Session 1 (Goodwin Atrium)**
10:50-11:00am	Break Poster session 1 take down/Poster session 2 set up
11:00-11:50am	**Poster Session 2 (Goodwin Atrium)**
11:50-1:00pm	Lunch/Graduate school networking (Goodwin Atrium) Poster session 2 take down/Poster session 3 set up
1:00-1:50pm	**Poster session 3 (Goodwin Atrium)**
1:50-2:00pm	Break Poster Session 3 take down/Poster session 4 set up
2:00-2:50pm	**Poster session 4 (Goodwin Atrium)**
2:50-3:00pm	End of symposium/ Poster session 4 take down



Poster Session 1: 10-10:50am			
Registered Presenter	**Program Affiliation**	**Poster number**	**Poster Title**
Ahmed	MAOP	1	AI Tools vs Debugging Tools: Exploring User Perceptions on Bug Locating Performance
Allotey	MAOP	2	Quantum Entanglement on spatially separated photons
Almalkawi	Independent	3	Influence of the Addition of Phase Change Materials and Cellulose Nanofiber on the Strength and Thermal Conductivity of Cement Pastes and Concrete
Angel	MAOP	4	Investigating Haptic Feedback with the Dynamics and Control of a Quadrotor and Natural Pendulum
Beasley	Independent	5	Evaluating Possible Hybridization Between Two Crayfish In Stroubles Creek
Bradshaw	MAOP	6	Purification of Molten Salt for Energy Storage
Braxton-Hall	MAOP	7	Nest Box Orientation and Breeding Success in Tree Swallows (Tachycineta bicolor)
Brown	MAOP	8	The Role of Extracurricular Activity Involvement in the Social Outcomes of Adolescents with and without ADHD
Brunelli	MAOP	9	Using transposon mutagenesis in Serratia marcescens to characterize pigment overproduction in response to bacteriophage Chi
Burnap	MAOP	10	Determining Practices for the US Forest Service to Better Engage With Private Landowners
Carter	MAOP	11	Using Virtual Reality To Complete Research Training
Casey	Independent	12	ATLAS: Multi-variable Artistry and Diversity in the Film Industry
Choute	MAOP	13	Surveillance of Extended Spectrum Beta Lactamase (ESBL) producing Escherichia coli in a Rural Watershed
Collins	MAOP	14	Validation of Canine White Blood Cell Library using MALDI-TOF MS
Cox	MAOP	15	Does the Impact of Parental Divorce on Child Anxiety and Depression Differ for Neurodivergent vs. Neurotypical Youth?
Donaldson	MAOP	16	ESTABLISHING POTENTIAL CONNECTIONS BETWEEN THE PDGF-BB PATHWAY AND EXTRACELLULAR MATRIX REMODELING IN HYPERGLYCEMIC MURINE KIDNEYS.
Essex	MAOP	17	Feasibility Study for Using MALDI-TOF MS to Diagnose Equine Melanoma
Fink	MAOP	18	Diving Deep into Mesopelagic Fisheries
Gambrell	MAOP	19	Comparison of Entropy in Random Number Generation
Garza	MAOP	20	Food Insecurity Predicts Excessive Exercise Among College Students Across One Semester
Gatuku	MAOP	21	Sewershed Surveillance of ARGs in Central Appalachia: Building a Monitoring Framework for Rural Systems
Gomez	MAOP	22	The Cat is in the Bag - an Exploration into Cat Strollers
Graham	MAOP	23	Sex Hormones Impact on Herpes Simplex Virus Productive Infection
Grimes	MAOP	24	Support for Post-Crash Care Improvement
Klier	MAOP	25	Promoting Food Safety and Stability in Value-Added Products: Analyzing pH, Water Activity, and Ingredient Contributions for Virginia Food Producers
Lewis, E.	MAOP	26	Postmortems: The Game Development Process
Liburd	MAOP	27	Mannopyranoside synthesis towards production of glycomaterials
Mason	MAOP	28	Developing aerial robotic systems for human and environmental science research
McCarthy	Independent	29	Mass Transfer Through a Beaver Dam Analog
McCaskill	MAOP	30	Accelerating Carbohydrate Chemistry using Flow
Nimmo	MAOP	31	Identification of active site residues in YUC10 from Arabidopsis thaliana
Orfaly	MAOP	32	Modelling Corrosion
Oyediran	MAOP	33	Overstepping boundaries: How fluid flow impacts different tumor cell populations to invade in brain cancer
Roberts	MAOP	34	AutoPrint:
Robinson, S.	MAOP	35	Quantum Sensing of Magnetic Fields
Rovira	MAOP	36	Analysis of GNSS Radio Frequency Interference in Ports and Coastal Areas
Smith, A.	MAOP	37	Assessment of the T4 phage ac gene function in relation to bacterial lysis
Tam	MAOP	38	Euclidation of Mechano-Bactericidal Nanospikes on Electrochemically Etched Stainless Steel Surfaces.
Thornbury	MAOP	39	Pressing for Progress: Black Newspaper Activism in Early 20th Century Chicago
Wierer	MAOP	40	Development of free surface tracking methods
Yusif	MAOP	41	POC as a Promising Scaffold For Bone Tissue Regeneration.
Flather	Neutrino Physics REU	42	Constraining Beyond the Standard Model Sub-MeV Neutrino Fluxes using the XENONnT Detector

Poster Session 2: 11-11:50am			
Registered Presenter	**Program Affiliation**	**Poster number**	**Poster Title**
Abe	Independent	1	Prevalence of emerging geologic contaminants with possible health concerns in a State private drinking water system from 2012 to 2022
Acosta	neuroSURF EIP	2	Using AI to assess the ultrastructural effects of mitochondrial calcium uniporter deletion in CA2 neurons
Adams	neuroSURF EIP	3	Examining Criteria for Successful Testbed Development and Implementation in Healthcare Systems
Alvarez	CUBE SURF	4	Quantifying the Relationship of Reward Certainty with Delay-based Decision Making
Banka	CardioSURF	5	Effect of sleep and circadian rhythm disruptions on Pulmonary Arterial Hypertension
Barakat	neuroSURF	6	Early Life Trauma Dysregulates Immune System Response to Inflammatory Pain
Barrow	neuroSURF	7	Tracking Vigilance with Real-Time fMRI
Biggs	VT-REEL	8	Evaluation of image-processing techniques as high throughput-phenotyping method for pollen viability assessment under heat stress
Braxton	CardioSURF	9	AMPK Regulation of Glycolysis After Acute Exercise through Enolase 3
Carvalho	CardioSURF	10	The Role of Connexin 43 in Endothelial Cells During Vascular Wound Healing
Davis	neuroSURF	11	New Pipeline to Precision Medicine for Glioblastoma
Dhruva	neuroSURF	12	Evaluating Verity Through Latency and Accuracy of Open-Source Biometric Sensor Devices
Dinakin	CHBR	13	Dietary Patterns Involving Ultra Processed Foods in Eating Behavior
Doceti	neuroSURF	14	The Effect of Sleep Quality on Neural Response to Sweet Taste
Emmanuel	neuroSURF EIP	15	Relevance of p53 binding to PER2 for circadian rhythm remodeling in colorectal cancer cell
Ezigbo	neuroSURF	16	Quantification of Changes in Dendritic Spine Morphology After MCU Knockout in the CA2 Subregion of the Hippocampus
Guo	CHBR	17	Smoking as a moderator of the association between BMI and delay discounting
Henderson	CUBE SURF	18	Examining the Impact of Cognitive Restraint on Flavor Nutrient Conditioning
Holsinger	neuroSURF EIP	19	Optic Nerve Astrogliosis: A Response to Retinal Ganglion Cell Stress
Hubshman	neuroSURF	20	Does Episodic Future Thinking decrease Consumption of Alcohol and Cocaine in individuals with Substance Use Disorders?
Keverline	Independent	21	Establishing Standard Operating Procedures for Bathymetric Mapping of Small Freshwater Reservoirs
Kosolapov	CardioSURF	22	Role of connexin43 / β-catenin interaction in epithelial-mesenchymal transition and induced pluripotent stem cell derived cardiomyocytes
Le, N. T.	CUBE SURF	23	Examining the Mediating Effect of Delay Discounting on the Impact of Simulated Scarcity with Cigarette Smoking Behavior
Loyd	Sch of Neurosci Summer Fellow	24	The Effect of State Anxiety on Heart Rate Variability
Ngo	Independent	25	Case Study: Determining the Optimal Approach for Comparing Rhythmic Datasets
Nguyen	CHBR	26	The Associations of Delay Discounting, Chronic Pain, and Obesity with Unhealthy Behaviors in Individuals in Recovery from Substance Use Disorder
Noel	Sch of Neurosci Summer Fellow	27	Elucidating potential signaling proteins involved in astrocytic BDNF/TrkB.T1 dependent responses
Pereira	neuroSURF	28	Assessing motor learning in children with hemiparesis undergoing ACQUIRE therapy
Quader	CardioSURF	29	Regulation of gap junction function through connexin 43 phosphorylation during stress
Rahyab	neuroSURF	30	Effects of Hyperglycemia on Capillary Pericytes, Endothelial Cells, and Extracellular Matrix (ECM) in Murine Brain Vessels
Reddy	neuroSURF	31	Interaction with Tumor Suppressor p53 and Core Clock Gene Per2 alters DNA Binding Ability
Rehmat	Independent	32	Soliciting Stakeholder Feedback on the Unwinding Anxiety App to Reduce Adolescent Social Anxiety
Roane	VT-REEL	33	Learning Laboratory and Field-Based Pest Management Techniques for Crop Production
Rygalski	neuroSURF	34	Non-retinal Sonic Hedgehog Signaling Impacts the Development of Principal GABAergic Neurons but not Glutamatergic Inputs in the Rodent Ventral Lateral Geniculate Nucleus
Sane	neuroSURF	35	Do GLP-1 Agonists Reduce Intake and Effects of Alcohol?
Stiles	neuroSURF	36	Investigating associations between personality and the effects of LIFU neuromodulation in the context of acute pain
Su	neuroSURF	37	Accessing the Level of Compensatory Activities of Children With Hemiparesis During Acquire Therapy
Taylor	VT-REEL	38	Protein Hydrolysate Biostimulant Effects on Plant Growth and Development
Upreti	CHBR	39	Investigating the Impact of lifestyle factors on Heart Rate Variability

Waller	VT-REEL	40	Fungal Bioluminescence Pathway for Gene Reporters in Apples
Williams	Independent	41	Unwinding Anxiety: Utility of a Mindfulness-Based App to Reduce Adolescent Social Anxiety
Wisniewski	neuroSURF	42	Developing Precision Medicine for Glioblastoma Based on Molecular Subtypes

Poster Session 3: 1-1:50pm

Registered Presenter	Program Affiliation	Poster number	Poster Title
Abe	Fralin SURF	1	Does place matter? An analysis of environmental perspectives of Ivorians from Abidjan: Port Bouet vs Cocody
Adongo	Hollins/Global Change Center Scholars	2	Pragmatic Iranian Foreign Policy in Central Asia
Bickley	Independent	3	Investigating the mechanism of action of a neuropeptide derived from hobo spider venom
Bridgewater	Beckman Scholars	4	Mimicking Nature for Solar Fuel Generation
Choi	Beckman Scholars	5	Investigation of Different Pore Geometries on Cell Proliferation and Infiltration of Soy- based Resin via Vat Photopolymerization for Tissue Scaffolds
Cleveland	Independent	6	Characterizing Oligomeric Amyloid-β42 and POPC Interactions Through Molecular Dynamics: A Computational Approach for Understanding Alzheimer's Disease
Collett	Fralin SURF	7	Identification of Ligand Specificity of Bradyrhizobium diazoefficiens Chemoreceptor Bll7062
Desai	Fralin SURF	8	Observing Changes in Glutamatergic Signaling Proteins in a Preclinical Model of Repeated Blast-Induced TBI
Dong	Hollins/Global Change Center Scholars	9	Comparing Acoustic and Mist Netting Sampling Techniques for Chiroptera Species Diversity across Elevational and Landscape Gradients in Colombia
Ferguson	Fralin SURF	10	Iron-sulfur Cluster Assembling Thioredoxin from Methanocaldococcus jannaschii
Gangwani	Hollins/Global Change Center Scholars	11	Comparing Outcomes of Community-Based and ICT-Based Mental Health Interventions for Adolescents with Parents Affected by Alcoholism and Addiction in India
Harvey	Fralin SURF	12	Language Use Preferences in Autistic Identities
Helms	Hollins/Global Change Center Scholars	13	Shifting Geopolitics: The Shanghai Cooperation Organization
Hessian	Fralin SURF	14	A Morphometric and Spatial Analysis of the White Shark Population in the Mediterranean Sea.
Kaswinkel	NSF-REU Supplement	15	Toward Nanofibrous Engineered Living Materials: Optimization of a Biocompatible Nanofiber Matrix
Kinsey	College of Science Pilot REU Program	16	Effects of topography on bacterial adhesion and cell membrane organization
Le, M.	PREP	17	East vs. West: Exploring the Role of Culture in Parent Emotion Socialization Practices
Lee	Fralin SURF	18	Antibiotic assay of Ice-Nucleating Lysinibacillus parviboronicapiens on other bacterial and fungal species
Leruth	Fralin SURF	19	Antibody Cross-Reactivity in Gnotobiotic Pigs Immunized with rRRV-P Candidate Vaccines against Human Norovirus
Lewis, A.	SURF - Hollins University	20	Edinburgh Fringe Festival: Exploring New Writing and Spoken Word Productions
Mayfield	Independent	21	Visualizing The Impacts of Laboratory Class Design on Student Performance
Mercedes Casado	College of Science Pilot REU Program	22	Lipid Membrane Interactions with Recombinant Proteins
Moore	Beckman Scholars	23	Histotripsy: Cancer Treatment using Focused Ultrasound inducing Mechanical Ablation, Successfully Ablates Pancreatic Tumor
Morgan	Independent	24	Exploring Computational Methods in Wet Lab Sciences
Newman	Fralin SURF	25	Measuring circulating glucose concentrations in dairy cattle to predict the response to summer heat stress.
O'Hara	David Lyerly Foundation Undergraduate Microbiology Research Fellowship	26	Detergents Including Bile Salts Promote Increased Bacterial Twitching Motility
Orlando	Fralin SURF	27	Exploring patterns in microbial activity across altered stream flowpaths
Paka	Independent	28	Potential Role of L-Arabinose as Chemoattractant in Sinorhizobium meliloti
Peters	Fralin SURF	29	Understanding Altruistic Enzymes: Biochemical characterization of the self-sacrificing p-aminobenzoate synthase from Nitrosomonas europaea
Russell	Independent	30	Stereoselective Glycosylation via Dynamic Kinetic Resolution
Samson	Fralin SURF	31	Expression and purification of Chi phage tail fiber protein to study interactions with Salmonella enterica flagella

Seymour	Independent	32	The Influence of Deadline and Distraction on Children's Task Performance
Smith, R.	Fralin SURF	33	The Wonderful World of Eosinophils: Assessing the Role of NIK on Eosinophil Proliferation and Maturation in a Murine Model
Stein	GlycoMIP SURF	34	Mucinomics: Characterizing the carbohydrates from human and lab-grown mucins
Styles	Fralin SURF	35	Temporal Expression of Key Herpes Simplex Virus Proteins During Latency Establishment
Svetanant	Independent	36	Peripheral-derived immune cells contribute to the remodeling of pre-existing pial collateral vessels following ischemic stroke
Thomas	Undergraduate Scholar in VT Biochemistry	37	Radical SAM Catalyzed Methylation for Tetrahydromethanopterin Biosynthesis in Methanogenic Archaea
Vaughan	Fralin SURF	38	Effects of Embryonic Heat Conditioning on the Hypothalamic Responses to Stress, Appetite, and Thermoregulation in Broiler Chicks
Walsh	GlycoMIP SURF	39	Mucinomics: Characterization of glycoproteins in human tissue and synthetic mucus
Wangler	ICTAS Undergraduate Research Fellowship Program	40	Motor Characterization of a Wearable Device to Treat Upper Extremity Lymphedema
Wilkes	Fralin SURF	41	Examining the Role of Lrp during growth of Pantoea stewartii in Extracted Corn Xylem Fluid
Youngs	Beckman Scholars	42	Determining Histotripsy Treatment Parameters to Successfully Ablate Pancreatic Tumors and Understanding the Role of Immunological Response

Poster Session 4: 2-2:50pm

Registered Presenter	Program Affiliation	Poster number	Poster Title
Ajyeman	Solving Problems with Data Science REU	1	Sexual Dimorphism in the Feeding Apparatus of Blood Feeding Mosquitoes
Alading	Solving Problems with Data Science REU	2	Data Analysis for Florida Red tide-induced respiratory irritation: Feature Identification and Forecasting Model
Band	TOUR	3	Resolution and Accuracy Improvements of Whole-Room Indirect Calorimeters
Blacksten	Solving Problems with Data Science REU	4	Look Mom, No Hands: Effects of perch diameter on vertical gap crossing capabilities in arboreal snakes
Blackston	Solving Problems with Data Science REU	5	Tracking Atmospheric Microplastics Using Trajectory Modeling
Callin	Neutrino Physics REU	6	Calibration of Fe-57 Mössbauer Spectrometer for Hyperfine Interaction Analysis
Cashman	Independent	7	Does the fungal microbiome of germinating orchid seeds change in response to habitat disturbance?
Catterton	STEER REU	8	Stepwise Recycling of Unsaturated Polyester Resin to Benzene and Uncrosslinked Polyesters
Chen	Independent	9	Cathepsin S as mediator of acidosis-associated organ damage
Chester	Independent	10	Utilization of Texture Analysis to Identify Echocardiogram Features in Patients with Reduced Left Ventricular Ejection Fraction
Copeland	STEER REU	11	C-H Bond Functionalization and Copper (II) Metalation
Coughlon	STEER REU	12	Molecular Ionic Composites as Solid Electrolytes for Lithium Metal Batteries
DeShong	Neutrino Physics REU	13	Angular Dependence of Compton Scattering Within Plastic Scintillators
Dooley	Solving Problems with Data Science REU	14	Do snakes feed differently in an arboreal environment?
Ellis	TOUR	15	Exploring the Impact of Long-Term and Short-Term Usage of Aspartame and Sucralose on Glycemic Control
Garg	Neutrino Physics REU	16	Analyzing Neutral Hydrogen and Midplane Pressure in NGC 3941
Harris	STEER REU	17	Phosphine-catalyzed Hydroamidation of Alkynoates
Kern	Solving Problems with Data Science REU	18	Studying Biofilm Formation of Environmental Bacteria Samples on Various Types of Microplastics
Kibue	TOUR	19	Effects of nutrient availability on ATP synthesis and thyroxine-mediated changes in neurogenesis in the optic tectum of Xenopus laevis larvae
Klemba	Solving Problems with Data Science REU	20	Comparing Multispectral Satellite and Drone Imagery for Monitoring Harmful Algal Blooms
Krishnan	TOUR	21	Nitric Oxide alters Skeletal Muscle Mitochondrial Quality Control
Lattig	TOUR	22	Dance on the Brain: Examining how dance enhances social skills through physiological synchrony
Le, T.	TOUR	23	Determining the Effects of Varying Amounts of NIK Gene Expression on the Function of Epithelial Cells
Liu	Sure program	24	Squares of bivariate Goppa codes

Makatura	Solving Problems with Data Science REU	25	Effect of physiological stress on the evolution of chromosome and centrosome numbers in newly formed tetraploid cells
Marsh	Solving Problems with Data Science REU	26	Distribution of Winter Injury on Bermudagrass Athletic Fields Relative to Athlete Movement
Mehari	TOUR	27	The Role of eNOS in Mediating Hepatic Mitochondrial Quality Control
Miyazaki	Solving Problems with Data Science REU	28	Validating an Atmospheric Dispersion Model using a Historical Field Experiment
Moy	VT Data Science for the Public Good	29	VCE: Optimizing Extension Services
Odibo	Solving Problems with Data Science REU	30	Development of a Surface-Enhanced Raman Scattering (SERS) based Nanoprobe for Leaf pH Detection
Parker-Rollins	TOUR	31	Psychological Safety in Higher Education
Price	Solving Problems with Data Science REU	32	Understanding Perceptions Limiting Adoption of Precision Turfgrass Management: An Analysis of Barriers
Pudasaini	Solving Problems with Data Science REU	33	Autonomous Systems for Specialty Crops Load, Canopy, and Disease Estimations
Pulla	VT Data Science for the Public Good	34	Effects of Prenatal Exposure to Flooding on Child Health Outcomes: Evidence from Bangladesh
Robinson Jr, D.	STEER REU	35	Synthesis of Cyclam-Based Metal-Organic Framework for Water Oxidation
Sawyer	Independent	36	Raising Black Solider Fly Larvae to Recover Value from Food Waste
Smith, D.	STEER REU	37	Synthesis and Characterization of Ion-Imprinted Polymers for Selective Lanthanide Separation
Veraa	Neutrino Physics REU	38	Commissioning of Data Acquisition System for Gamma Ray Spectroscopy
Wiggins	VT Data Science for the Public Good	39	Land Use and Solar Farming Assessment in Hanover County, Virginia
Xiang	Solving Problems with Data Science REU	40	Early Stress Detection in Tomato Plants using Computer Vision and 2D/3D Imaging
Yu	TOUR	41	Young Adult Eating Habit(YAEH)--Influence of Ultra-Processed Food on Brain Reward Response and Energy Intake
Zaslavsky	Independent	42	Scaling Analysis of Taenidia in Beetle (Zophobas morio) Tracheae

This conference was made possible by funding provided by the Fralin Life Sciences Institute, the Institute for Critical Technology and Applied Science, and NSF grant number 1922516 (Grant Title: HDR DSC: Engaging Undergraduates in Data and Decisions Research at the Engineering/Biology Interface).

Assi Abe
Hollins University/Public Health

Prevalence of emerging geologic contaminants with possible health concerns in a State private drinking water system from 2012 to 2022

The Virginia Household Water Quality Program (VAHWQP) is a Cooperative Extension program that works to improve the water quality and health of Virginians using private water supplies (wells and springs) through water testing and education. Because private water supplies are not regulated under the US Safe Drinking Water Act (SDWA), homeowners are directly and solely responsible for water quality monitoring and system maintenance. Between 2012 and 2022, 21,904 samples from across Virginia were analyzed through this program for a suite of health (e.g. lead, E. coli) and nuisance/aesthetic contaminants (e.g. iron). The present study aims to examine patterns and incidence of geologic water quality contaminants that have been included on the US EPA's Unregulated Contaminant Monitoring Rule (UCMR) monitoring list for municipal drinking water, including strontium, vanadium, cobalt, and manganese, but are not presently regulated by SDWA. Although these contaminants do not have established associated health standards, US EPA has established recommendations.
Statistical analyses were conducted using Microsoft Excel and Arc GIS to explore the distribution and occurrence of these contaminants in samples collected from private wells and springs across the state of Virginia and analyzed through Cooperative Extension. Because these contaminants are not associated with established health standards, observations were compared to existing recommendations. Although 10% of samples exceeded 50 ppb manganese, less than 1% of samples exceeded recommendations for vanadium, cobalt, and strontium. Over 40% of participants had never tested their water quality, and 33% had tested it once, though USEPA recommended testing annually.

Mentor(s): Leigh Anne Krometis (Biological Systems Engineering Department)
Erin Ling, M.S., M.EPC State Coordinator (Virginia Household Water Quality Program
Virginia Tech Biological Systems Engineering Department)

Assi Abe
Hollins University/Public Health

Does place matter? An analysis of environmental perspectives of Ivorians from Abidjan: Port Bouet vs Cocody

Little up-to-date research on environmental perceptions of people from developing countries, particularly those from the Ivory Coast has been conducted. To address this, we surveyed individuals in Abidjan (N=143), the capital of the country, during May and June of 2023. The study was conducted using an on-site survey questionnaire that included questions asking individuals to identify their top five environmental concerns and to rate the impacts these concerns could have on different constituents (e.g. health, future, future generations, wildlife). The survey targeted people living principally within two Abidjan communities: Cocody (N=51) and Port Bouet (N=73), though included individuals in other districts within the capital. In addition, individuals were asked to share specific thoughts on their town's environmental issues, the work of the government in each location, and to evaluate how they spent time outside. Overall, air pollution, trash, global warming, deforestation, and ocean pollution were the top five issues of concern, with global warming being identified more often in Cocody and ocean pollution more commonly identified in Port Bouet. The majority of Ivorians felt that their future, future generations, and natural spaces would be significantly to severely impacted by these issues. There were no differences between people in the two communities except in the trust they had in the government. As environmental issues have an impact on the participants' actions, perception, and desire to spend time outside, understanding the concerns and perceptions of Ivorians may address and direct action within these communities.

Mentor(s): Renee Godard (Biology and Environmental Studies, Hollins University)
Kaila Thorn, PhD (Visiting Assistant Professor of Environmental Studies, Hollins University)

Nicole Acosta
Virginia Tech/Clinical Neuroscience

Using AI to assess the ultrastructural effects of mitochondrial calcium uniporter deletion in CA2 neurons

Hippocampal area CA2 plays a role in social memory, the ability to recognize a familiar member of the same species. RNA sequencing revealed that CA2 is enriched in mitochondria-related genes, including the mitochondrial calcium uniporter (MCU). Calcium entry into mitochondria regulates ATP production, cytoplasmic calcium levels, and mitochondrial motility. Notably, CA2's distal dendrites, where social information is received, contain larger, MCU-enriched mitochondria compared to proximal dendrites. Mitochondria are crucial for powering synaptic transmission and long-term potentiation (LTP), a form of synaptic plasticity that supports memory and learning. Previous experiments in CA2-specific MCU knockout mice resulted in LTP deficiency at distal dendrite synapses, suggesting a role for MCU in plasticity there. To study the underlying mechanism, we quantified dendritic mitochondrial morphology and abundance in electron micrographs from MCU conditional knockout (cKO) and control (CTL) CA2. Based on our previous observation that MCU-enriched mitochondria being larger in size, we hypothesized that loss of MCU will decrease the size of mitochondria. Using the artificial intelligence (AI) platform, Biodock, we trained and validated a subset of manually annotated data from CTL and cKO samples. Preliminary analysis identified a small but significant decrease in mitochondria area in cKO distal dendrites compared to CTL. A size reduction in dendritic mitochondria could lead to decreased ATP production, impaired LTP, and potentially affect social memory. Determining the mechanisms regulating LTP in CA2 neurons can help us understand disorders with social deficits, such as autism.

Mentor(s): Shannon Farris (Center for Neurobiology Research)
Katy Pannoni (Center of Neurobiology Research)

Jana Adams
Virginia Tech/Public Health

Examining Criteria for Successful Testbed Development and Implementation in Healthcare Systems

Testbeds are structured facilities and/or environments that allow transparent and rigorous testing of innovative ideas and technologies, while limiting the risk that these changes might pose. Testbeds have been applied in many elevated risk, resource intensive fields, where prediction is critical; weather prediction, city planning, transportation. However, there are few testbeds that can replicate the complexity of work in healthcare. With the increasing ubiquity of passive sensing and remote monitoring, it is more efficient to measure responses to new technology implementation in a controlled environment, like a testbed. In this work, the goal is to identify and distinguish tactics, components, and guidelines that have contributed to "successful" testbeds for application in the healthcare sphere. 90 Testbed articles were presented after systematic search by the library. Each article was then analyzed and reviewed individually with criteria extracted (e.g.: industry, equipment hardware and software; modalities of data; network set-up; simulation; robot deployment). A qualitative assessment was conducted to identify challenges encountered with each testbed. Of the 90 articles, 45 (50%) were relevant for this review. Shared challenges across the different testbeds were at least 17.7% data processing/data structure and storage for user(s), 26.6% network and connectivity stability, 13.3% security and privacy, 11.1% defining variables, 17.7% level of realism, 13.3% and software setup. This work allowed us to understand the challenges and criteria for successful development and deployment of a testbed within healthcare delivery.

Mentor(s): Sarah Parker (Implementation Science)

Sylvia Adongo
Hollins University /Political Science

Pragmatic Iranian Foreign Policy in Central Asia

Since the 1979 Iranian Revolution, one of the core facets of Iran is its Revolutionary Identity. This identity is promoted in its foreign policy: its hardline stance against the state of Israel and in its support for non-state actors such as Hamas, Hezbollah, PIJ, and Al-Qaeda. Iran's ideological identity, especially towards Israel, has proven more important than pragmatic self-preservation in relations with the west. Iran has doubled down in its stances in the face of U.S. and European imposed economic sanctions, despite the immense toll these sanctions have had on the Iranian economy.

However, Ideology seems to be bend in Iran's growing relationships with five Central Asian countries: Kazakhstan, Kyrgyzstan, Turkmenistan, Tajikistan, and Uzbekistan. Why have relations with these five nations warmed so much in recent years? Why doesn't Iranian Ideological Identity seem as important in foreign policy towards Central Asia?

In this paper, we examine the different motivations for more pragmatic Iranian foreign policy in Central Asia. We then compare these motivations to its ideological foreign policy regarding Israel. By considering recent changes in regional context (The fall of Afghanistan, the Russian invasion of Ukraine, and the U.S. imposed sanctions on Iran) we hope to better understand the environmental shifts that have allowed for the recent warming of relations between Iran and Central Asia.

We also examine the history of other self-identified Revolutionary Regimes in order to find patterns and anticipate the regional outcomes of Iran's foreign policy approaches in Central Asia.

Mentor(s): Edward Lynch (Head of the Political Science Department at Hollins University)

Omer Ahmed
Virginia Tech/Computer Science

AI Tools vs Debugging Tools: Exploring User Perceptions on Bug Locating Performance

AI advancements have led developers to increasingly rely on tools like ChatGPT for debugging, a process that involves locating bugs within code. This study compares the effectiveness of AI in locating bugs to regular debugging tools by incorporating both approaches into the development process of a debugging tool. We found that debugging tools provide precise control over code but require significant effort and expertise to identify and fix bugs, especially in large programs. AI tools excel in automating the debugging process, providing insights into code behavior, and predicting potential issues. However, AI tools may not fully comprehend code intent due to a lack of domain-specific knowledge, leading to misleading bug-fix suggestions. As a result, beginners, and even experienced, programmers prefer to use print statements to debug their code. To address their needs, we're developing a debugging tool that automatically inserts print statements into code in areas where bugs may arise. When the user runs the code, they will be able to track and see if there are any unusual changes to any values in that section of the code.
This study highlights the pros and cons of manual debugging and AI tools and introduces a novel approach that attempts to combat these issues. Developers can use this information to make informed decisions when selecting their preferred approach. Insights from this study can guide future research, aiming to enhance these tools for a more efficient and effective debugging process.

Mentor(s): Chris Brown (Computer Science)

Kandis Ajyeman
Virginia Tech/Computational Neuroscience

Sexual Dimorphism in the Feeding Apparatus of Blood Feeding Mosquitoes

Mosquitos are among various species of fluid-feeding insects. Although mosquitoes are commonly known for blood-feeding, not all species of mosquito feed on blood, and all drink other fluids such as nectar. Mosquito species that do participate in blood-feeding may also have different hosts, ranging from ectothermic and endothermic vertebrates and even other invertebrate species. The differences in feeding sources and the associated differences in fluid viscosity and temperature may result in different feeding behavior among species and sexes. Among blood-feeding mosquitoes, only females are known to feed on blood, which is utilized for egg production. Regardless of food source, all mosquito feeding is mediated by two muscular pumps known as the cibarial and pharyngeal pumps. This two-pump feeding system is hypothesized to provide flexibility for adjusting pumping in accordance to the mosquito's host or environment. This conserved feeding system raises the question of dimorphism or trade-offs in the systems between blood-feeding and non-blood-feeding mosquitoes. Here, we studied the morphology of the mosquito pumping system using tomographic images collected at the Advanced Photon Source (Argonne National Laboratory). From the synchrotron x-ray image slices, 3D models of mosquito feeding systems were created using the 3D Slicer software. Volume measurements of the two pumps were also taken with the use of this program to further explore the morphology of these systems. Due to differences in feeding preferences, hosts, and behavior among species, it is expected that male mosquitoes will display significantly reduced pump size relative to body size.

Mentor(s): Sara Wilmsen (Biological Sciences)
Dr. Jake Socha (Virginia Tech - Department of Biological Sciences and Mechanical Engineering)

Kun Alading
Virginia Tech/CMDA

Data Analysis for Florida Red tide-induced respiratory irritation: Feature Identification and Forecasting Model

This study performs comprehensive data analysis of the impact of various factors such as temperature, time, wind direction, and velocity on the Florida red tide-induced respiratory irritation level for beaches along the Florida Gulf Coast. Red tide events, caused by algal blooms--the rapid growth of microscopic algae--often lead to respiratory discomfort among residents of the coast. Through data analytics and statistical inference, this research uncovers significant associations between the different factors and the respiratory irritation level. It also exposes a temporal relationship, revealing how respiratory irritation levels follow a time series and trend throughout the years. After discovering these associations, we leverage them as features to construct a machine-learning model aiming to predict red tide-induced respiratory irritation. The model is trained and validated using the significant features identified in the earlier part of the study. The model demonstrates promising preliminary results in forecasting red tide-induced respiratory irritation, thereby potentially assisting in the development of early warning systems and public health measures for red tide events. This research contributes to our understanding of red tide-related respiratory irritations and the variables influencing them, which would improve the lives of many people living in areas affected by algal blooms and provide a foundation for further predictive modeling and preventive strategies.

Mentor(s): Shane Ross (Virginia Tech)

George Allotey
Virginia Tech/Electrical Engineer

Quantum Entanglement on spatially separated photons

In quantum physics photons are packets of light that are described as individual particles. The interference pattern shows that photons also have a wave-like property meaning that photons have particle-wave duality. Wave-like interference is an important aspect of quantum information engineering and demonstrates the quantum entanglement properties of photons. This is useful for nonlocal interference patterns where two photons separated by a distance can still be entangled and interfere with each other. This is proven through Franson Interferometry which uses two interferometers to look at the interference pattern of entangled photons where some photons go through one interferometer and the other photons to the other and create three interference patterns. The Bell test measures the entanglement of photons and has an S parameter that describes the strength of entanglement. When $S > 2$ the photons are entangled and when $S < 2$ there is no entanglement. The main purpose of this research is to see whether the interference pattern violates the S parameter throughout the entire wave pattern. The experiment used two Michelson Interferometers to create the interference of the photons and two polarizers in front of the optical receivers to perform the bell test and calculate the S parameter. When observing the results at the maximum and minimum of the interference pattern the parameter, $S > 2$. This was true for each interference pattern of the Franson interferometer. This experiment finds that the interference patterns show entanglement throughout the wave for spatially separated photons and that entanglement is mostly time dependent.

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

Amal Almalkawi
Virginia Tech/Architecture
Ahmed Meselhy
Virginia Tech/Architecture

¬¬¬¬¬¬Influence of the Addition of Phase Change Materials and Cellulose Nanofiber on the Strength and Thermal Conductivity of Cement Pastes and Concrete

Nanotechnology dominated the various aspects of this life, especially in materials science. It's a promising technology for building construction materials related to energy conservation and engineering properties. In the construction industry now, nanotechnology significantly influences construction materials markets and modern manufacturing technology. Portland cement, one of the most extensive common building materials used by the construction field, will be developed with based nano-level materials to produce a new generation of concrete. However, in light of the rising awareness of energy efficiency, nanotechnology using cellulose nanofiber (CNF) and phase change materials (PCM) can become promising natural materials that will be used to enhance the thermal and mechanical properties of building materials. Therefore, in this research, the addition of (CNF) and (PCM) to cement pastes will be investigated to enhance heat capacity, thermal conductivity, and compressive strength. (CNF), as a thermal enhancer, will be incorporated in (PCM) to test an optimum proportion to increase the heat storage capacity of PCM. Portland cement/(CNF) pastes, cement/(PCM) pastes, cement/(PCM)/(CNF) pastes, and concrete mixture will be prepared. Then, the thermal and mechanical properties of enhanced cement pastes and concrete mixtures will be evaluated and analyzed to carry out the objectives of this research. Finally, the results and recommendations will be discussed and presented.

Mentor(s): Luis Monsivais (Architecture, Virginia Tech)

Alicia Alvarez
California State University, East Bay/Statistics

Quantifying the Relationship of Reward Certainty with Delay-based Decision Making

Delay discounting (DD) is the devaluation of an outcome as a function of its delay. As with other decision-making processes, DD is complex and has multivariate influences. Delayed outcomes are often uncertain in the natural environment, but standard assessments of DD do not account for potential bias when participants assume that delayed rewards will not be received. In this study, we sought to examine the effects of specifying whether rewards in the DD task are certain on DD and perceptions of certainty.

A total of 161 participants were randomly assigned to one of two groups where the certainty of reward was specified or unspecified. Two-sample t-tests, Mann-Whitney tests and linear regression were used to examine group differences in DD and perceived certainty. Linear regression was used to assess the relationship between DD and perceived certainty, as well as to examine the moderating effects of group on this relationship. Statistical significance was taken at the $p<0.05$ level.

Participants were mostly non-Hispanic (93%), White (82%), with a mean age of 37 years (SD:13.6). The unspecified group had lower perceived certainty (median: 69 vs. 88, $p<0.01$) than the specified group, with no significant group differences in DD ($p=0.19$). Lower perceived certainty was associated with higher DD (Pearson's $r=-0.35$; regression: $\beta=-0.03$, $p<0.01$), with no significant moderating effects by group ($\beta=-0.01$, $p=0.72$).

Results from this study can be used to target interventions focused on uncertainty to reduce DD and perhaps decrease maladaptive health behaviors.

Mentor(s): Alexandra Hanlon (Center for Biostatistics and Health Data Science, Department of Statistics)
Jeff Stein (Center for Health Behaviors Research)
Alicia Lozano (Center for Biostatistics and Health Data Science, Department of Statistics)

Bryan Angel
Virginia Tech/Aerospace Engineering

Investigating Haptic Feedback with the Dynamics and Control of a Quadrotor and Natural Pendulum

Haptic feedback refers to technology utilizing touch responses to react and communicate. This technology proves vital for analyzing forces or interruptions to simulations. The growth and change of technology increases the demand for research in this field. Haptic feedback can be used to study the effect of static and dynamic payloads on the dynamics of unmanned autonomous vehicles (UAVs). Prior to implementing this technology, it is necessary to ensure simulation models and controllers work as desired. Coding a simulation on software such as MATLAB provides a gateway to implementing and studying haptic feedback. I created separate simulations for both the drone and spherical pendulum payload, so that I could understand the dynamics of the two. The drone simulation takes a throttle command and outputs the angular speeds of the propellers. These speeds can then be used to find the thrust and moments about the axes, and thus equate the dynamics of the drone. A simple Proportional-Derivative (PD) controller was employed to analyze the error between current and desired states, adjusting inputs to follow a desired trajectory. The payload model simply takes inputs for the azimuth and polar angles and their derivatives. These can be used to find the dynamics and position of the payload by solving a system of differential equations. By integrating both the drone and payload dynamics into a unified simulation, this study further investigates haptic feedback technology. This research and its findings contribute to advancing future software and technology pertaining to haptic feedback and control.

Mentor(s): Ella Atkins (Kevin T. Crofton Department of Aerospace and Ocean Engineering)

Keaton Band
Virginia Tech/Human Nutrition, Food and Exercise

TOUR

Resolution and Accuracy Improvements of Whole-Room Indirect Calorimeters

Whole-Room Indirect Calorimetry is performed by measuring the concentrations of CO2 and O2 gasses entering and exiting a sealed chamber containing a human participant. By knowing the amount of O2 consumed and CO2 produced, energy expenditure in real time can be calculated. An important component to this calculation is an accurate measurement of the internal volume of the chamber. Therefore, to improve the accuracy of the metabolic measurement, it is important to identify an accurate method for measuring the internal chamber volume. In addition, it remains unknown if differences in participant body volume influence chamber accuracy and need to be accounted for. Here we investigate novel methods for determining chamber volume through the use of sealed 5-gallon jugs that can be placed in the chamber to simulate different body volumes. We predict this novel approach will provide critical insights into measuring chamber volume and ultimately provide improvements in chamber measurement accuracy.

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

Dhanush Banka
University of Virginia/Biomedical Engineering

Effect of sleep and circadian rhythm disruptions on Pulmonary Arterial Hypertension

Pulmonary Arterial Hypertension (PAH) is a progressive lung disease characterized by hyperproliferation of the pulmonary vascular cells (PVCs) leading to pulmonary vascular remodeling. Although PAH patients often experience poor sleep quality, how poor sleep affects PAH progression is currently unknown. Sleep is regulated by the internal molecular circadian clock controlled by oscillating clock genes, and circadian rhythm disruptions have been implicated in diverse human diseases. Whether sleep and clock disruptions affect PVC phenotype and contribute to PAH progression has not been investigated. To test whether circadian clock disruption affects PVC proliferation and PAH progression, we treated human pulmonary artery endothelial cells and smooth muscle cells with siRNAs targeted to Clock and Bmal1 genes, core clock genes acting as transcription factors for other clock genes. We measured transcript expressions of clock and cell cycle genes. In an in vivo experiment, wild-type mice with fragmented sleep were subjected to an animal model of PAH, treated with hypoxia and Sugen (VEGF inhibitor) for three weeks. Our results demonstrate that the knockdown of Clock and Bmal1 affects the expression of other core clock and cell cycle genes, leading to dysregulated PVC proliferation. Our results also show that sleep fragmentation affects the pulmonary expression of all core clock genes, increases right ventricular pressures, and exacerbates PAH in mice. Altogether, our preliminary results indicate that circadian rhythm disruption and poor sleep affect pulmonary vascular cell function and exacerbate PAH.

Mentor(s): Yassine Sassi (Department of Biomedical Sciences and Pathobiology)

Naija Barakat
Washington and Lee University/Neuroscience

Early Life Trauma Dysregulates Immune System Response to Inflammatory Pain

Psychological stress impacts perception of pathological pain. Inflammatory pain, a type of pathological pain, is driven by immune activation, prompting tissue repair, pathogen clearance, and healing. Early life trauma (ELT), stress due to childhood abuse, neglect or other trauma, has deleterious effects on the immune system. Previous work has demonstrated that ELT increases mechanical nociception, but has not investigated the impact of ELT on inflammatory pain. We propose that ELT has an immunosuppressive effect on the adult immune system, resulting in impaired response to inflammatory pain.
ELT model was simulated using maternal separation, a 23-hour period of isolation from the dam and littermates at postnatal day 3. At 7-9 weeks, Complete Freund's Adjuvant (CFA) was injected to deliver inflammatory pain. Blood was drawn 3 hours post-injection. Serum levels of proinflammatory cytokines, TNF-α, IL-1β, IL-6, and IL-17A, were measured using enzyme-linked immunosorbent assay.
IL-6 and IL-1β concentrations in the serum of control mice significantly increased following CFA injection and were significantly greater than levels seen in ELT mice after CFA administration. There was no significant change in TNF-α and IL-17A serum levels in control mice following injection and in all four cytokines for ELT mice after CFA treatment.
These data suggest that ELT results in the dysregulation of the adult immune system by suppressing response of pro-inflammatory cytokines, IL-6 and IL-1β, to inflammatory pain. Our findings highlight the maladaptive immune response of ELT to inflammatory pain and possible therapeutic targets for ELT-driven immunosuppression and impaired recovery from inflammation-driven injury.

Mentor(s): Sora Shin (Human Nutrition, Foods and Exercise, College of Agriculture and Life Sciences)

Maia Barrow
Georgia Institute of Technology/Neuroscience

Tracking Vigilance with Real-Time fMRI

Recent advances in characterizing the neurocorrelates of vigilance have led to the development of fMRI-based signatures (Falahpour et al., 2018; Goodale et al., 2021) that we hypothesize can be tracked with real-time fMRI. We sought to adapt previous work in auditory vigilance to develop a visual detection task. Further, we aimed to demonstrate vigilance tracking on a TR-by-TR basis. With these foundations established, we examined the reproducibility of vigilance-behavior relationships with the goal of designing future closed-loop detection experiments. Thus this work is a preliminary step towards building a real-time fMRI platform to examine the causal links between vigilance and target detection. In our preliminary results, we found no correlation between reaction times and vigilance measures for alert participants and a weak, negative correlation for a drowsy participant. Additionally, the average of all participants showed a similar relationship between vigilance and behavior as reported by Goodale et al. (2021). Finally, we found no significant relationship between behavioral variability (fast and slow hits) and vigilance score compared to Goodale et al. (2021).

Mentor(s): Stephen LaConte (Department of Biomedical Engineering and Mechanics)

Claire Beasley
Virginia Tech/Fish Conservation

Evaluating Possible Hybridization Between Two Crayfish In Stroubles Creek

Faxonius virilis (the virile crayfish) and Faxonius cristavarius (the spiny stream crayfish) are invasive crayfish species in Stroubles Creek, which is part of the New River watershed and flows through Blacksburg in Montgomery County, Virginia. F. virilis is invasive in many eastern and western drainages, and has been known to hybridize with Faxonius punctimanus in Missouri. Hybridization can lead to hybrid depression or hybrid vigor, which can affect population size and stability. The combination of F. virilis and F. cristavarius traits and varying abundance would impact animals that eat the crayfish or use their burrows. This project aims to use quantitative morphological characteristics to determine the presence of hybridization between F. virilis and F. cristavarius in Stroubles Creek. Crayfish of both species were collected from the creek during the spring and summer of 2023, when these species were in their nonreproductive forms. The specimens were collected using dip nets and identified based on their morphology. The crayfish were measured for four different traits: carapace length, areola width, gonopod length, and weight. Areola width and gonopod length were normalized by dividing them by the carapace length. A two-way ANOVA test was used to evaluate the similarity of the measurements between species. The areola widths of F. virilis and F. cristavarius are significantly different from each other, as opposed to the gonopod lengths, which are not significantly different. This similarity indicates possible hybridization. Further research will include evaluating morphological characteristics when crayfish are in their reproductive forms, or genetic analyses.

Mentor(s): Bryan Brown (Department of Biological Sciences)

Brandon Bickley
Virginia Tech/Biochemistry

Investigating the mechanism of action of a neuropeptide derived from hobo spider venom

Various insect species present risks to public/animal health and cause damage to agricultural crops through vectoring diseases and feeding. Insecticides are vital for managing pest insects and there is a constant need for novel insecticides to circumvent the evolution of insecticide resistance in pest populations. Spider venoms may represent an expansive, underutilized source of insecticidal capabilities. Peptides in most spider venoms have evolved to target the insect nervous system and a large number show low mammalian toxicity, thereby improving mammalian safety. In addition to directly serving as insecticidal agents, these peptides could be used to guide development of new small molecule insecticides or as tools for studying existing insecticide chemistries. Using competitive binding assays and extracellular electrophysiology, we investigated the mechanism of action of an insecticidal neuropeptide, which was derived from the venom of the hobo spider (Tegeneria agrestis) by the Vestaron Corporation. Nicotinic acetylcholine receptors (nAChRs) are ligand gated ion channels acted on by the excitatory neurotransmitter acetylcholine. In competitive binding assays with [3H]-methyllycaconitine ([3H]-MLA), an antagonist of nAChRs, we found that the neuropeptide does not compete with [3H]-MLA for binding to house fly nAChRs but affects the high affinity binding of nicotine in competition with [3H]-MLA. Electrophysiology experiments in fruit fly larvae show a decrease in the CNS firing rate in the presence of nicotine and MLA, and the neuropeptide does not influence the CNS firing rate alone. Collectively, the results indicate that spider neuropeptides interact with the nervous system differently than nicotinoids.

Mentor(s): Aaron Gross (Entomology)

Torie Biggs
Norfolk State University/Biology

Evaluation of image-processing techniques as high throughput-phenotyping method for pollen viability assessment under heat stress

Rising global temperatures are negatively impacting crop yield, particularly in heat sensitive crops such as peanut. This is, in part, due to reductions in the amount of viable pollen (pollen grains with the material needed for germination) produced. Studies have shown that even moderate elevations in temperature during early anthesis can significantly reduce the proportion of viable pollen grains in peanut (Lohani et al., 2019). Thus, it is critical to identify germplasm that is heat tolerant, yet current methods for pollen viability assays are time-consuming and somewhat subjective. The objective of this study was to determine the most well-suited staining method for peanut pollen and to develop a high-throughput analysis method via Image J to objectively quantify the proportion of viable pollen from hundreds of field grown samples. Various staining methods, 2,3,5-Triphenyltetrazolium chloride (TTC), lactophenol aniline blue (LAB), and 2',7'-dichlorodihydrofluorescein diacetate (H2DCFDA), were compared to evaluate which was the most efficient for viewing pollen grains with LAB producing the most favorable results. Petunia plants were randomly assigned to placement outside or inside a greenhouse to represent control and heat stress conditions, respectively. These staining methods were implemented using petunia pollen as a model for peanut and ImageJ software was used to analyze images and quantify the proportion of viable pollen grains. This phenotyping method will enable quicker and more efficient selection of thermotolerant lines for development of climate resilient peanut cultivars and provide future avenues of research in this area.

Mentor(s): David Haak (School of Plant and Environmental Sciences)
Maria Balota (Tidewater Agricultural Research and Extension Center - Virginia Tech)

Sydney Blacksten
Virginia Tech/Biomedical Engineering and Mechanics

Look Mom, No Hands: Effects of perch diameter on vertical gap crossing capabilities in arboreal snakes

Arboreal environments are characterized by discontinuous arrangements of branches. The distance between these cylindrical structures, which forms a gap, as well as their physical make-up, impact the locomotor behaviors animals use to traverse them. Gap crossing is advantageous to arboreal animals because it reduces the need to take indirect routes between locations. Limbless animals, such as snakes, rely on extending their elongate bodies headfirst into the gap towards their desired target. However, the dimensions of the perch can influence the snake's ability to grip and maintain balance during the cross. Here, we investigated how diameter of the origin perch influences the vertical gap crossing ability of arboreal snakes from Southeast Asia. In the experiment, we recorded snakes crossing vertically from one of three origin perches of varying diameter (21.5, 33.3, and 48.4 mm) to a target perch. To begin, the target perch was situated a small vertical distance above the origin perch. After the snake began to move upward toward the target, the target was raised at a constant rate until the snake achieved its maximum height. Vicon motion tracking cameras were used to track points located at 10% increments along the snake's body as it extended upwards across the gap. Using the three-dimensional coordinates of the points, we calculated maximum height, instantaneous velocity, frequency and sinuosity. Based on preliminary results, we expect that greater diameter values will lead to increases in maximum height reached and velocity, with sinuosity values closer to one.

Mentor(s): Jake Socha (Biomedical Engineering and Mechanics)
Josh Pulliam (Biomedical Engineering and Mechanics, Virginia Tech)
Jeff Anderson Jr. (Biological Sciences, Virginia Tech)

Dominic Blackston
Ohio State University/Data Analytics

Tracking Atmospheric Microplastics Using Trajectory Modeling

Microplastics are pieces of plastic less than 5mm long that are the result of the degradation of larger plastics. They pose a significant health risk to organic life and have been found in a wide variety of environments. A common way these particles are transported to remote areas is through the atmosphere. The goal of this study was to investigate atmospheric deposition of microplastics in southwest Virginia and to trace back their trajectories and identify their potential sources. The sampling sites used to collect microplastics for this project were Kentland Farms near Virginia Tech's campus and National Atmospheric Deposition Program (NADP) Site VA13 in Giles County, Virginia. Since sampling efforts are ongoing, visualizations created for this project focused on data from one three-week sampling period beginning May 31, 2023. Backward trajectory modeling and visualization were performed using the Hybrid Single-Particle Lagrangian Integrated Trajectory (HYSPLIT) atmospheric transport model. The meteorological fields were from the National Centers for Environmental Protection (NCEP) / National Center for Atmospheric Research (NCAR) reanalysis data. The frequency map, which finds the percentage of trajectory simulations that pass through a given area, shows that particles collected in this three-week period likely passed from southern West Virginia to northwestern Virginia before landing at the sampling site. Future work includes extending this process to more sites to investigate potential sources of atmospheric microplastics in the Appalachian Mountain region.

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

Trevor Bradshaw
Virginia Tech/Ocean Engineering

Purification of Molten Salt for Energy Storage

The maritime industry is facing increasing pressure to meet its growing energy demands while reducing greenhouse gas emissions. To address this issue, this project focused on investigating molten salt for maritime application as a means of energy storage. Molten salt has gained attention in the energy sector due to its ability to store and release large amounts of thermal energy efficiently. However, impurities such as oxygen, moisture, and sulfides in molten salt will result in material corrosion, thus the objective of this research was to purify salt and evaluate its purity as a means of gauging its performance as an energy storage solution in the maritime domain. The project involved purifying both chloride-based and fluoride-based salts. The salts were stored and purified in gloveboxes filled with argon gas to prevent the introduction of impurities after purification due to oxidation. The chloride-based salt underwent thermal purification at specific temperatures that separated moisture and oxides from the salt. It was then chemically purified using magnesium metal to further eliminate oxides. The fluoride-based salt was thermally purified using argon as a carrier gas, chemically purified with hydrogen fluoride gas, and finally physical separation to remove sediments. Combustion analyses were conducted to assess the salt's oxygen, hydrogen, carbon, and sulfur concentration after purification. The salts exhibited impressive levels of purity after relatively quick purification processes, suggesting consistent and reliable energy availability with few purification challenges. The purified salt exhibited significantly lower concentrations of oxygen, hydrogen, carbon, and sulfur.

Mentor(s): Amanda Leong (Mechanical Engineering)

Daniel Braxton
Virginia Polytechnic Institute and State University/Biological Sciences

AMPK Regulation of Glycolysis After Acute Exercise through Enolase 3

5' AMP-activated kinase (AMPK) is a master regulator in sensing energetic stress and a potential mediator of exercise benefits. We have generated AMPKa2-T172A (the site involved in canonical activation of AMPK) mice to study its downstream regulatory pathways in exercise. Metabolomics analyses in exercised AMPKa2-T172A mouse gastrocnemius (GA) tissue, as opposed to WT, showed a significant accumulation of Beta-Glycerophosphoric acid (2-PG), a substrate of β-Enolase (ENO3), an intermediate enzyme in glycolysis. Phosphorylation of ENO3 at S176/177 is also found by untargeted phosphoproteomics in the same tissue. ENO3 deficiency is associated with diseases like rhabdomyolysis and submaximal exercise performance as seen in AMPKa2-T172A mice. We hypothesize: AMPK phosphorylates ENO3 and regulates its enzymatic function to regulate glycolysis after acute exercise. Our experiments showed that ENO3 abundance does not change regardless of physical exercise or WT and AMPKa2-T172A genotype. Enolase enzymatic activity assay showed AICAR treatment (a strong AMPK activator) does not alter ENO3 activity in C2C12 myoblasts and myotubes. Native gel western blot showed no detectable phosphorylation of ENO3; however, we could not make final conclusions due to the sensitivity of detection. We must improve methodology, e.g. 2-D gel electrophoresis, immunoprecipitation, and mass spectrometry, before ruling out AMPK's direct phosphorylation of ENO3. Investigating this pathway in vivo is another critical future step. An alternative hypothesis is that rather than directly regulating ENO3 activity, AMPK may facilitate translocation of ENO3 subcellularly to regulate glycolysis. Our research increases our understanding of the glycolytic pathway while implicating AMPK's significance in metabolism.

Mentor(s): Zhen Yan (Center for Exercise Medicine Research)

Kamau Braxton-Hall
Virginia Tech/Biology

Nest Box Orientation and Breeding Success in Tree Swallows (Tachycineta bicolor)

For migratory animals, knowing which direction to go is crucial for success and survival. For behaviors other than migration, other cardinal directions may be equally important. In this study, we investigated the nesting behavior of Tree Swallows (Tachycineta bicolor) during their breeding season at VT's Kentland Farm. To see if Tree Swallows prefer a certain nest box orientation, we varied the directional orientations (North, South, East, and West) of the nest boxes they use on the farm. Previous studies in other locations have shown that Tree Swallows prefer south facing nest boxes, presumably for thermoregulation benefits. We visited the nest boxes every other day during the breeding season to observe activity within each nest box, to see which orientation is preferred. We predicted that if one of the cardinal directions is preferred by the Tree Swallows, then boxes facing in the preferred direction(s) would be occupied first. Second, if one of the directions increases reproductive success, we'll see more chicks surviving to fledge the nest in boxes facing the favorable direction. In contrast to our predictions, we found that Tree Swallows have no preference in the box's orientation. We anticipate that this lack of preference may be due to the latitude and elevation of this nesting site. In this area, nest box orientation may not be important enough to be selected for.

Mentor(s): Ignacio Moore (College of Science, Biological Sciences)

Camille Bridgewater
Virginia Tech /Chemistry

Mimicking Nature for Solar Fuel Generation

Global climate change has emerged as one of the most pressing challenges of our time. Numerous approaches are being studied to develop carbon-neutral or carbon-free fuel sources. Biomimicry is one place many have landed, looking specifically at the process of photosynthesis. In photosynthesis, plants use water, carbon dioxide, and sunlight to generate nature's fuel – sugar. However, the overall process is relatively inefficient and requires constant repair. Researchers are working to artificially mimic this process with higher efficiency and stability. In natural photosynthesis, water channels and nanoconfined protein structures impact the efficiency of certain processes. In this study, we aim to mimic the nanoconfinement effect within compounds called metal-organic frameworks. We can use tailored synthesis to focus specific molecular interactions and geometries and use ultrafast spectroscopy to probe solvent structure within metal organic frameworks as a function of synthetic changes. These fundamental investigations will help us better understand how energy is converted and used in various systems, which will aid in the development of technologies that are both sustainable and efficient.

Mentor(s): Amanda Morris (Chemistry)

Taylor Brown
Concord University/Psychology

The Role of Extracurricular Activity Involvement in the Social Outcomes of Adolescents with and without ADHD

Extracurricular activities are important for adolescent social development and can result in better academic outcomes. Attention-deficit/hyperactivity disorder (ADHD) is a neurodevelopmental disorder that is associated with significant academic and social difficulties. Notably, participation in extracurricular activities is related to decreases in ADHD symptoms and fewer absences from school. In this study, we examined involvement in extracurricular activities for adolescents with and without ADHD, and examined whether extracurricular activity participation was associated with better social outcomes in adolescents with compared to without ADHD.

Participants included 302 adolescents (55.3% male; Mage=13.17) who were recruited in 8th grade to participate in a longitudinal study examining the role of sleep in the social-emotional and academic functioning of adolescents with (n = 162) and without (n = 140) ADHD. Parents reported on adolescent extracurricular involvement in 8th grade; parents, teachers, and adolescents reported on adolescent social functioning in 8th and 10th grade.

Adolescents with ADHD were reported to engage in significantly less extracurricular activities in 8th and 10th grade than neurotypical adolescents. Two significant interactions emerged in multiple regression analyses. Specifically, participation in school sports was associated with significantly less teacher-reported peer rejection for adolescents with ADHD; this relation was non-significant for neurotypical adolescents. In contrast, participation in club sports was associated with significantly better parent-reported social functioning for neurotypical adolescents; this relation was non-significant for adolescents with ADHD. Results suggest that participating in school sports may result in less rejection for adolescents with ADHD; future research should explore specific types of sports.

Mentor(s): Rosanna Breaux (Psychology)

Bryce Brunelli
Virginia Tech/Biology

Using transposon mutagenesis in Serratia marcescens to characterize pigment overproduction in response to bacteriophage Chi

Serratia marcescens is a Gram-negative opportunistic human pathogen known for high levels of antibiotic resistance. One of the visually distinct attributes of the bacterium is the production of a red pigment called prodigiosin. Regulation of pigment production is complex, and the quantity of pigment produced varies based on several factors. Infection of S. marcescens by the flagellum-dependent bacteriophage Chi results in overproduction of pigment by the bacterial cells via an unknown mechanism. This easily observable phenotype allowed for the investigation of S. marcescens pigment production using a method called transposon mutagenesis. This process permits the random inactivation of genes in the bacterial chromosome by transposon insertion. A large quantity of mutants can be tested until a desired phenotype is found. We developed a high-throughput screening method using 96-well plates. Individual mutants were inoculated into two wells on the plate. After a short incubation, phage was added to one set of wells. The bacterial pigmentation phenotype of the half of the plate containing phage was visually compared with its uninfected control. Mutants that no longer increased pigmentation in response to Chi infection were selected for further investigation. Phenotypes of interest were verified twice, first, via the same process as our 96-well plate screening method, and second, in flasks for quantitative results. After phenotypes were confirmed, the location of the transposon insertion was determined via arbitrary-primed PCR and Sanger sequencing. The results of this experiment will inform future research toward clinical applications of Chi against antibiotic resistant S. marcescens.

Mentor(s): Birgit Scharf (Biological Sciences)

Jonathan Burnap
Virginia Tech/Environmental Science

Determining Practices for the US Forest Service to Better Engage With Private Landowners

More than half of the United State's forested lands are divided amongst private landowners. Individual landowners independently choose how to manage their land, which can create positive or negative impacts on the ecosystems within it. To reinforce beneficial practices and to support landowners, the US Forest Service offers multiple programs for a wide spectrum of land use. Although these programs have proven successful for those who enroll in them and, many barriers and social challenges have created a less than desirable rate of participation. Varying demographics across the US have created many different motivating factors for both owning land and deciding how one chooses to actively manage it. By examining existing literature that examines practices for private landowner engagement as well as participating in field work with the US Forest Service, a set of 6 broad principles were identified to help close this social gap. These 6 principles include concepts such as: catering projects to match local ecological and social conditions, emphasizing relationship building, creating accessible and easier participation, and others. These principles, in practice, will help the US Forest Service and National Government to promote easier access and better engagement to professional conservation help.

Mentor(s): Kathleen Holland (Fish & Wildlife Conservation)

Brittany Callin
University of Colorado Boulder/Physics
Bronwen Olson
The University of Texas at Dallas/Physics

Calibration of Fe-57 Mössbauer Spectrometer for Hyperfine Interaction Analysis

Mössbauer spectroscopy is used to probe the fine nuclear structures of isotopes of Mössbauer nuclei. A common isotope used in Mössbauer spectroscopy is Fe-57 due to its low energy ɣ-rays, its abundance, and its long nuclear lifetime. We calibrated a Mössbauer setup with a Co-57 source by optimizing the full width at half-maximum (FWHM) and resolution using a Kr gas counter detector. We minimized FWHM and resolution through the relationship the FWHM has with the gain, threshold, shaping, and shaping time in the ORTEC 590A amplifier and ORTEC 672 preamplifier. We cross-checked the relationship between channels and velocity of the drive unit with α-Fe, ferric oxide, iron(II) oxalate dihydrate, and potassium magnesium hexacyanoferrate(II). From the spectroscopy of each absorber we also determined the absorption energies of the peaks and the hyperfine interactions such as the isomer shift, quadrupole splitting, and magnetic dipole interactions.

Mentor(s): Camillo Mariani (Physics)

Nathanyal Carter
Virginia Tech/Electrical Engineering

Using Virtual Reality To Complete Research Training

Researchers are responsible for conducting exceptional science while protecting participants from physical and psychological harm. To do so successfully, researchers at all levels are required to obtain Institutional Review Board approval for all research activities. Virginia Tech utilizes the Collaborative Institutional Training Initiative (CITI) program to provide educational material and facilitate the management of research-related certifications; however, it is time-consuming and can be disengaging leading to the possibility of reduced knowledge retention and quiz retakes which further exacerbates the problem. This study aims to determine to what extent virtual reality (VR) can improve user experience associated with CITI training; more specifically, the Financial Conflict of Interest certificate. The study uses a within-subjects design to investigate two levels of CITI training presentation formats (computer-based vs. VR-based) on user experience defined by cognitive workload, knowledge retention, engagement, and comfort. Objective measures of knowledge retention are gathered through post-training quiz results while subjective measures are captured in two forms: cognitive workload using the NASA TLX and engagement and comfort using post-study QuestionPro questionnaires. Additionally, the overall time to completion is measured. Data collection is ongoing; however, results are expected to show a significant difference between presentation formats associated with overall user experience. T-Tests will evaluate the difference between presentation formats for each dependent measure. In sum, VR provides a novel way of completing research training that has the potential for a more efficient, engaging, and enjoyable experience.

Mentor(s): Rafael Patrick (Industrial and Systems Engineering Department)

Alicia Carvalho
University of Virginia/Biomedical Engineering

The Role of Connexin 43 in Endothelial Cells During Vascular Wound Healing

Within 6 years of coronary angioplasty, approximately 17 percent of stents fail. A primary contributor to this failure is endothelial cell (EC) loss due to stenting-induced blood vessel damage. The gap junction protein Connexin 43 (Cx43) has an established role in wound healing, but is not normally found in healthy EC of large conduit arteries. Despite this, preliminary data (RNAseq, published dataset GSE115618) suggest that Cx43 expression increased in mice aortic endothelium during the healing process. Based on this, we hypothesize that Cx43 plays a role in regulating endothelial wound healing. We developed an in vivo ligation model of carotid endothelial damage and healing to study Cx43 gene and protein expression. First, qPCR was used to confirm connexin gene expression in whole tissues. To specifically study Cx43 in carotid endothelium, a lysis buffer was flushed through carotid lumen to collect EC for qPCR analysis. This data confirmed that Cx43 is not highly expressed in healthy arterial endothelium. To investigate Cx43 in healing endothelium, qPCR was performed in carotid-flushed EC 24 hours post-injury compared to sham surgical controls. Our data indicates Cx43 expression is significantly upregulated during EC wound healing. Immunofluorescence and western blot analysis confirm that Cx43 transcriptional upregulation relates to increased endothelial Cx43 protein expression. Finally, we generated and confirmed the endothelial specificity of Cx43 knockout mice for future studies in defining the contribution of Cx43 to mice endothelial healing rates and investigating Cx43 as a potential target in future wound healing therapeutic design.

Mentor(s): Scott Johnstone (Center for Vascular and Heart Research)

Kieran Casey
Virginia Tech/Music

ATLAS: Multi-variable Artistry and Diversity in the Film Industry

Atlas was a research project in which we created a film that focused on breaking the traditional hierarchy of production. The purpose of this study was to create a movie in an environment that was ever-evolving through collaboration and engagement. Actors of the movie got to create their personalities based on their characters, scripts changed based on the improv of the moment. Using the Meisner technique and inspiration from eastern media, we created a short that is an abstract but engaging piece of work. Unfortunately, the movie was never fully created. Originally written as a feature film, we planned ahead to try to actually shoot 70 minutes of film. Because of COVID-19 and problems out of our control, we could only create a pitch film that explained the basic plot of the movie.

Mentor(s): Charles Nichols (Music)

Matilda Cashman
Virginia Tech/Biological Sciences

Does the fungal microbiome of germinating orchid seeds change in response to habitat disturbance?

Orchids are a diverse family of flowering plants that face increasing environmental pressures such as human-driven climate change and habitat degradation. One reason for orchid susceptibility to such pressures may be a reliance on mycorrhizal and endophytic fungi, which are necessary for orchid germination, growth, and survival. Previous research shows that the orchid microbial community in the roots of adult plants changes in response to habitat disturbance. To further explore this, we are investigating the community structure of the fungal microbiome in seeds of two species of orchid, Tipularia discolor and Goodyera pubescens, in habitats described as either undisturbed or disturbed. Seeds that had been placed at each site in November 2022 were collected, surface sterilized, and used for DNA extraction and fungal isolation. Isolated DNA was used for PCR with fungal-specific ITS primers. The generated amplicons have been submitted for Illumina MiSeq analysis at the Fralin Life Sciences Sequencing Center at Virginia Tech. This procedure will provide sequence data for individual amplicons that can be used for species identification. Analysis of this data will be carried out using the Dada2 and Phyloseq microbiome processing packages in R. It is hypothesized that there will be differences in the fungal microbiome of orchid seeds from each site, with less fungal activity expected in seeds from the disturbed habitat as compared to undisturbed seeds. The human impact on the diversity of the fungal microbiome of germinating orchid seeds will be discussed with respect to these results.

Mentor(s): Jonathan Watkinson (Biological Sciences)

Casandrah Catterton
Reed College/Chemistry

Stepwise Recycling of Unsaturated Polyester Resin to Benzene and Uncrosslinked Polyesters

Unsaturated Polyester Resin (UPR), once cured with polystyrene (PS), is a crosslinked polymer with high durability, making it an ideal material for several industries, such as wind energy, watersport, construction, and automotive. However, like other plastics, once a UPR product is no longer in service, it is replaced, disposed of in landfills, and essentially never breaks down. In a previous study, the Liu Group devised a "degradation-upcycling" mechanism in which benzene is collected from degraded PS, then derivatized into valuable chemicals for pharmaceutical and other industrial applications. This study explores the Lewis acid-promoted degradation of PS crosslinks in UPR, collecting benzene from the PS linkers, which can then be derivatized to value-added aromatics. The remaining free polyester component can be recycled via traditional methodologies, such as enzymatic and base degradation. In a typical study, UPR is first refluxed in a KOH solution under varying reaction times (0-96 h). Subsequently, the pretreated UPR is subjected to Lewis acid ($AlCl_3$, $FeCl_3$, $ZnCl_2$, $SbCl_3$)-mediated degradation in various solvents (benzene-d6, CS_2, hexane, cyclohexane) under nitrogen at 80 °C for 5 h. Interestingly, $AlCl_3$ produced the highest yield of benzene in all tested solvents. In addition, benzene-d6 (a good solvent for PS component) produced significantly higher benzene yields than the other solvents. Ultimately, our method demonstrates a facile and scalable process to degrade and extract value from the vast amount of UPR waste currently occupying landfills.

Mentor(s): Guoliang (Greg) Liu (Chemistry)

Bentley Chen
Virginia Tech/Biological Systems Engineering

Cathepsin S as mediator of acidosis-associated organ damage

Cysteine protease cathepsin S (CatS) is a major contributor in the lysosomal digestion of protein antigens and the degradation of many important structural proteins. During illnesses such as stroke, ischemia, and aneurysm, research has suggested a correlation between lethality and CatS digestion of elastin and collagen, and, separately, lethality and the magnitude of the pH drop in acidosis. However, there is currently no research investigating the relation between these two phenomena. Our lab has hypothesized that the specificity of CatS proteolysis changes under different pHs. Peptide sequences of interest were digested for 16 hours under serum pH (7.4) and lysosomal pH (5.0) and analyzed with LC-MS. The resulting chromatograms showed significant differences in digestion products. In particular, the elastin peptide sequence was only digested at lysosomal pH. Experimentation on the digestion of full proteins is still ongoing with the current focus being on optimizing the reaction conditions. Additional data will be collected for pHs 7.2 and 6.5 to represent the pH drop of severe metabolic acidosis and ischemic events, respectively. It is expected that both will show a difference in elastin and collagen digestion compared to that under healthy serum pH. The results of the experiment will further explain the mechanism by which tissue damage occurs during cardiovascular disease and aid in the design of effective vaccine antigens for production of desired antibodies.

Mentor(s): Chenming Zhang (Biological Systems Engineering)

Gabriel Chester
Virginia Tech/Biomedical Engineering

Utilization of Texture Analysis to Identify Echocardiogram Features in Patients with Reduced Left Ventricular Ejection Fraction

Abnormalities in the heart chambers are routinely diagnosed using point-of-care ultrasound imaging. Furthermore, current blood ejection fraction (EF) calculations rely on the subjective assessment of a cardiologist. We hypothesize that echocardiogram texture parameters can distinguish between patients with preserved and reduced EF. This method could allow for the rapid determination of heart failure status in the absence of a clinician to interpret the imaging. Quantitative ultrasound image texture analysis utilizes a statistical approach to describe individual grayscale values within a medical image. From this, echocardiogram texture can be characterized through a series of calculations that describe the spatial distribution of signal intensities within an image. The publicly available CAMUS dataset, consisting of 450 patients with the corresponding ejection fraction and the segmented left ventricular wall, is the target population for this study. From the 450 patients in the dataset, 408 were included in the analysis. A total of 90 texture analysis parameters were calculated using PyRadiomics during end-systole and end-diastole. Results indicate that there are ten texture parameters that are highly correlated with left ventricular heart failure status during end-systole for males and 20 for females ($p < 0.05$). For end-diastole, there are 12 texture parameters for males and six texture parameters for females that are able to differentiate between preserved and reduced ejection fraction ($p < 0.05$). Our study shows that quantitative ultrasound image texture analysis of the heart could serve as a reliable means of determining left ventricular ejection fraction status.

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

Sera Choi
Virginia Tech/Biology

Investigation of Different Pore Geometries on Cell Proliferation and Infiltration of Soy- based Resin via Vat Photopolymerization for Tissue Scaffolds

When bone fractures reach above a critical size, healing may be impaired and tissue scaffold implementation can help replace lost bone. This process is made difficult because of many features scaffolds have to imitate, such as pore size and geometry. 3D printing allows for consistent replication and detailed parameters. However, few biocompatible materials are available for printing.
This study investigated how different specific pore shapes from a novel epoxidized soybean acrylate hydrogel blended with polyethylene glycol diacrylate resin printed via vat photopolymerization impacted cellular response in vitro. Three different geometries, Voronoi, IsoTruss, and Truncated Octahedron lattices were printed at 10 mm and seeded with NIH 3T3 cells, one set for four days and another set for seven days. They were scanned using a confocal microscope and 3D models of the scaffolds were created. The models confirmed that the cells were able to penetrate the three types of scaffolds fully and proliferate. The models are being further investigated to measure the cell dispersion and determine which geometry was the most compatible with the cells' growth.

Mentor(s): Abby Whittington (Chemical Engineering & Materials Science and Engineering)

Hanifah Choute
Florida Agricultural & Mechanical University/Chemistry

Surveillance of Extended Spectrum Beta Lactamase (ESBL) producing Escherichia coli in a Rural Watershed

Antibiotics are a class of drugs used to kill bacteria, causing an array of infections in humans. Unfortunately, antibiotic use has some disadvantages: while they are vital life-saving drugs, overuse can contribute to the evolution of resistant forms that no longer are effectively killed by the antibiotics. One concern is that when patients take antibiotics, they excrete resistant gut bacteria, such as Escherichia coli. These bacteria then end up in sewage and, if not effectively treated by a wastewater treatment plant, could end up in the watershed. There is concern that people might get exposed and re-infected from contact with the water, but little research is being conducted. The study's objective is to track ESBL-producing E. coli as a representative fecal-associated antibiotic-resistant bacterium in a small watershed impacted by poorly treated wastewater. Additionally, we monitored the blaCTX-M1 gene, which is carried by E. coli and other ESBL bacteria, and sul1, which encodes resistance to sulfonamide antibiotics, as general indicators of the level of antibiotic resistance carried by the microbial communities in the wastewater-impacted watersheds. We cultured cefotaxime-resistant E. coli and total E. coli and quantified concentrations of blaCTX-M1 and sul1 genes, using ddPCR. The proportion of culturable cefotaxime-resistant E. coli to total E. coli was 4.97%, 0.77%, and 0.51% at WWTP effluent, WWTP influent, and from septic effluent respectively. These preliminary results highlight the importance of monitoring antibiotic resistance in rural water bodies to better understand the dissemination of antibiotic resistance into the environment in these settings and potential human health implications.

Mentor(s): Amy Pruden (Department of Civil & Environmental Engineering)

Emma Cleveland
Virginia Tech/Systems Biology
Allison Pennington
Virginia Tech/Biochemistry

Characterizing Oligomeric Amyloid-β42 and POPC Interactions Through Molecular Dynamics: A Computational Approach for Understanding Alzheimer's Disease

Alzheimer's Disease (AD), among other neurodegenerative diseases, progresses due to the formation of senile neural plaques consisting of aggregated amyloid proteins, specifically Amyloid-β42 (Aβ42). Aβ42 is the principal toxic species associated with AD, and its cytotoxicity arises from its oligomerization and interaction with membrane lipids, causing membrane destabilization and ion leakage. Free lipids have been found to enable cell membrane penetration of Aβ42 peptides, which can induce perturbation and apoptosis. Due to its abundance in cell membranes, 1-palmitoyl-2-oleoyl-sn-glycero-3-phosphocholine (POPC) serves as a model free lipid to investigate peptide-lipid interactions and their impact on Aβ42 oligomerization. Here, molecular dynamics (MD) simulations were used to investigate the aggregation and structural morphologies of octameric and decameric Aβ42 in the presence of free POPC. Using the CHARMM36m forcefield, simulations of 350 ns were performed and then analyzed on the basis of clustering, secondary structure, and POPC residue interactions. Residues 16-22 and 30-35 of Aβ42, the hydrophobic regions responsible for aggregation, have the potential to interact with the aliphatic chains of POPC. We predict that if the association of these Aβ42 residues and POPC is observed in simulation data, it would indicate an elevated risk of membrane destabilization and ion leakage due to resultant bilayer penetration imposed by Aβ42 peptides interacting with free lipids. This work will collectively determine the oligomerization events of amyloid with and without the presence of free lipids, providing atomistic details that can be used to understand the mechanisms and prevention of a vast array of neurodegenerative conditions.

Mentor(s): Anne Brown (Biochemistry)

Katelyn Collett
Virginia Tech/Microbiology

Identification of Ligand Specificity of Bradyrhizobium diazoefficiens Chemoreceptor Bll7062

Soybean (Glycine max) is an extremely important crop in the food industry and the most common source for vegetable oil. An important growth-limiting factor for soybean is biologically-available nitrogen. Synthetic nitrogenous fertilizers are used to provide crops with usable nitrogen. However, these fertilizers often have negative environmental effects. To overcome nitrogen limitation, soybean plants have evolved to secrete molecules from their roots that specifically attract a species of nitrogen-fixing bacteria, Bradyrhizobium diazoefficiens. B. diazoefficiens uses chemotaxis and flagella-driven motility to sense and swim toward host-secreted compounds in order to colonize host roots and promote nitrogen fixation. B. diazoefficiens possesses 36 genes encoding chemoreceptors used to sense various compounds, including those secreted by the host. The region coding for the periplasmic sensing domain of chemoreceptor Bll7062 was cloned into an expression vector for overexpression in Escherichia coli. After induction and cell lysis, the protein was isolated and purified using IMPACT affinity and size exclusion chromatography. Potential ligands in 96-well Biolog plates were then screened using differential scanning fluorimetry (DSF). DSF uses fluorescence to measure protein stability by monitoring protein unfolding in relation to temperature. Ligand binding stabilizes the protein, which can be measured by the PCR cycler. The protein domain has been successfully purified and characterization studies are ongoing. Characterizing chemoreceptor periplasmic ligand binding domains will expand understanding of the host cues that B. diazoefficiens responds to. A better understanding of B. diazoefficiens chemotaxis toward host-secreted small molecules will allow for optimization of soybean yields and reduced reliance on environmentally-harmful synthetic fertilizers.

Mentor(s): Birgit Scharf (Biological Sciences)

Angel Collins
Virginia Tech/Animal & Poultry Sciences

Validation of Canine White Blood Cell Library using MALDI-TOF MS

Melanocytic neoplasms are common tumors diagnosed in dogs. Malignant melanocytes are commonly found in the oral cavity and nailbed epithelium of dogs. These neoplasms may not be visible on external evaluation and can release circulating malignant melanocytes in the blood, resulting in metastasis to other organs. Therefore, early detection of melanomas with metastatic potential through the evaluation of circulating tumor cells (CTC) can improve the treatment and prognosis of the affected animals. Matrix-assisted laser desorption/ionization time-of-flight mass spectrometry (MALDI-TOF MS) is an analytical technique that has been successful in identifying bacteria and mammalian cells. We aim to use MALDI-TOF MS to develop a non-invasive and rapid technique to detect CTC in dogs. We propose a pilot study to initially create a reference spectra library of canine white blood cells (WBC). For this, we isolated WBC from canine blood samples, performed a formic acid-acetonitrile-based protein extraction, and spotted MALDI target plates for analysis. We determined the lower limit of detection, stability, and specificity of the method. Then, in future studies, we will spike blood samples with melanocytes to determine the sensitivity of the method. The impact of this study is the generation of data to support future investigations to predict metastatic potential, develop new therapeutic options, and assess treatment response in dogs with melanoma. Furthermore, it will develop the group's expertise to expand the use of the technique to other neoplastic diseases in domestic animals.

Mentor(s): Priscila Sepra (Clinical Pathology at the Virginia-Maryland College of Veterinary Medicine)

Diayla Copeland
Hampton University/Biochemistry

C-H Bond Functionalization and Copper (II) Metalation

Researchers have been interested in converting methane to methanol due to the transportation challenges and rising environmental concerns associated with methane usage and production. Industrially, this transformation currently necessitates high amounts of energy which has led to an interest to identify more efficient alternatives. A copper-based heterogeneous catalyst has been found to promote this conversion at much lower temperatures in comparison to typical industrial processes. In the lab this summer, I aimed to reproduce a simplified model of this catalyst to understand how it works and what properties allow it to carry out this transformation. To this end, I sought to prepare a copper (II) complex using a diphenyl-substituted dibenzofuran bisalcohol ligand. To do so, n-butyl lithium was used to deprotonate dibenzofuran, and benzophenone was subsequently added to give the alkoxide ligand. Once powderized, the ligand was deprotonated using benzyl potassium, and then metalated with copper (II) bromide to form a copper complex. The complex was characterized by proton nuclear magnetic resonance (NMR) and electron paramagnetic resonance spectroscopy (EPR). Attempts to identify the structure of the complex were made through crystallization under various conditions.

Mentor(s): Diana Thornton (Chemistry)

Jay Coughlon
Murray State University/Chemistry

Molecular Ionic Composites as Solid Electrolytes for Lithium Metal Batteries

Increased research interest in high-energy-density electrodes for lithium-based batteries has brought about safety and viability concerns which may be alleviated with enhanced electrolyte components. Replacing graphite anodes in conventional lithium-ion batteries with lithium metal greatly increases the energy density of the anode, but irreversible reactions between the anode and electrolyte cause the build-up of finger-like lithium projections, or dendrites, which increases the risk of short-circuiting, battery failure, and safety incidents. To solve this issue, solid-state polymer electrolytes (SPEs) are emerging as a promising alternative to liquid electrolytes. SPEs are mechanically rigid and non-volatile, making them capable of impeding dendrite growth while eliminating flammability issues associated with volatile liquid electrolytes, particularly in the high-temperature conditions created during battery operation. Herein, we explore the use of a unique SPE known as a molecular ionic composite (MIC) in lithium-metal coin cell batteries. MICs incorporate a charged, double-helical rigid rod polymer called poly-2,2'-disulfonyl-4,4'-benzidine terephthalamide (PBDT) which allows for the free transport of lithium ions throughout the electrolyte. This conductivity is an advantage over comparable SPEs which often sacrifice conductivity for mechanical stability. We assembled batteries with lithium metal anodes and lithium nickel manganese cobalt oxide, LiNi0.8Mn0.1Co0.1O2 (NMC811), cathodes. We tested the performance of a battery with a MIC electrolyte in elevated temperatures over multiple electrochemical cycles and compared the results to a similar battery assembled with a liquid LiPF6 (LP57) electrolyte. We anticipate the results to show both favorable performance and less dendritic growth in the battery assembled with the MIC electrolyte.

Mentor(s): Feng Lin (Chemistry)
Jungki Min ((graduate student mentor), Chemistry, Virginia Tech)

Olivia Cox
Virginia Tech/Psychology

Does the Impact of Parental Divorce on Child Anxiety and Depression Differ for Neurodivergent vs. Neurotypical Youth?

Watching your parents divorce/separate can be troubling for any child, with these children exhibiting more anxiety and depression than children from intact families on average. Youth with neurodevelopmental disorders frequently experience comorbid with anxiety and depression, and have increased rates of parent divorce/separation. In this study, we examined if the impact of parental divorce on child anxiety and depression differs for neurodivergent and neurotypical youth. Participants include 475 children (66.5% male) ages 5-17 years who completed a psychoeducational assessment through the Child Study Center. Approximately two-thirds (69.1%) were neurodivergent, and 21.3% had divorced/separated parents. Two caregivers (90.9% biological mothers and 81.0% biological fathers) and a subsample of youth (n = 99) reported on child anxiety and depression symptoms. The proportion of married/separated parents did not significantly differ for families of neurodivergent (20.6%) vs. neurotypical (22.8%) youth. Neurodivergent and neurotypical youth did not significantly differ on caregiver or self-reported anxiety or depression. Multiple regression analyses failed to find any significant interactions. A main effect of marital status was found for female caregiver-reported anxiety and depression, such that female divorced/separated caregivers reported more anxiety and depression. Results suggest that children were generally resilient in the face of parental divorce/separation, with minimal associations between parental divorce/separation and child internalizing symptoms, and similar associations for neurodivergent and neurotypical children. Future research should explore whether the association for female caregivers is explained by parental stress and utilize multi-method assessment. This research provides insight into therapeutic practices to help children of divorce adjust and cope.

Mentor(s): Rosanna Breaux (Psychology)

Natalie Davis
The University of Alabama/Biology

New Pipeline to Precision Medicine for Glioblastoma

Glioblastoma (GBM) is the most aggressive brain cancer and can be divided into two main groups, high-risk and low-risk using the newly identified gene signatures (GBM-PGS) from our lab. Precision medicine targets the specific genes and tumor types patients have, important in GBM because of its heterogeneous and unpredictable characteristics. It is imperative to investigate if precision medicine could be applied to high-risk and low-risk GBM patients differently. The objective is to determine if we can develop a new pipeline to identify drug targets for developing precision treatments for individual GBM patients. Our hypothesis is that GBM cell lines with high-risk or low-risk of poor prognosis have diverse drug candidates. GBM-PGS was utilized to stratify 54 new survival genes of GBM cell lines into high-risk and low-risk groups using the approach previously published. The top 25% of normalized and averaged expressions and dependencies were used and common genes were found. A two sample t-test was run and any genes with a $p < 0.25$ became drug targets. To confirm results, GBM cell lines were treated with drugs and cell viability was measured using the MTS assay. The analysis results confirmed the hypothesis that different risk groups have different pathways. Testing cells with drugs in vitro confirmed the analysis. In conclusion, we developed a new pipeline to identify drug targets for GBM patients with different risks. In the future, these candidate genes can be further tested in vitro to confirm that they are authentic drug targets to treat GBM patients.

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

Soham Desai
Virginia Tech/Nanomedicine

Observing Changes in Glutamatergic Signaling Proteins in a Preclinical Model of Repeated Blast-Induced TBI

Known as the “signature wound” of Afghanistan and Iran, Blast-Induced Traumatic Brain Injury (bTBI) has affected over 200,000 military personnel over the past decade through exposure to explosive devices. bTBI can induce neuronal damage and disrupt major neurotransmitter signaling pathways such as that of glutamate. As the primary excitatory neurotransmitter in the brain, glutamate is crucial in memory, cognition, and mood regulation. Glutamatergic dysfunction as a result of alterations in glutamate receptor and transporter protein expression levels have been linked to neuronal damage and other secondary diseases as reported in TBI patients.This study aimed to observe changes in specific glutamate receptor and transporter expression levels at short-term timepoints following bTBI in order to better understand which components of the signaling pathway if any are affected. Using this information, we can target future research and drug therapies for bTBI to specific glutamatergic components that may be significantly affected. During the experiment, 10-week-old Male Sprague-Dawley rats were exposed to three blast waves spaced 1 hour apart. Western blot analysis on brain tissue collected from the hippocampus and cortex at 24 and 72 hours post-bTBI revealed no statistically significant changes in expression levels of GluN1, GluN2A, GluN2B, and GLT-1 proteins. However, at 72 hours, GLT-1 protein expression in the hippocampus of bTBI animals appeared to be slightly downregulated, although not significantly ($p=0.0679$). Further investigation should focus on examining changes of these protein levels at a longer time point following exposure to repeated bTBI with a specific focus on GLT-1.

Mentor(s): Pamela VandeVord (Biomedical Engineering and Mechanics)

Justin DeShong
Lebanon Valley College/Physics

Angular Dependence of Compton Scattering Within Plastic Scintillators

In recent years the study of neutrinos has been very prevalent in particle physics. They are challenging to detect, so many teams have created more extensive and accurate detectors. NuLat is one of these projects, made of 125 plastic scintillator cubes. Here, four optically isolated scintillators are connected to photomultiplier tubes (PMTs). We are using these detectors to observe the gamma rays associated with the decay of Na-22. There are two main ways in which we designed this experiment to reduce noise and see precisely what we are looking for. Firstly, we chose Na-22 because it emits two 511 keV gamma rays, which we will collect on either side of the source. Secondly, those are put in coincidence with the other gamma-ray of energy 1275 keV that will Compton scatter from one scintillator to another. The coincidence between all four detectors allows us to reduce counted events to primarily those that involve only the gamma rays produced in the decay of Na-22 while also giving us the advantage of knowing where each gamma ray goes. We will also create many different geometric arrangements of the scintillators, allowing us to observe the energy and rate of events for various angles of Compton scattering. The intent of this project is to use what we learn here to help us calibrate each cube in the NuLat detector much more easily.

Mentor(s): Bruce Vogelaar (Physics)

Harsheel Dhruva
Virginia Tech/Computational and Systems Neuroscience

Evaluating Verity Through Latency and Accuracy of Open-Source Biometric Sensor Devices

Wearable biometric technologies capable of monitoring multiple vitals noninvasively are well-integrated into people's everyday lives. Yet as the current market devices are being improved in multiple domains, the corresponding costs of medical-grade products remain high. Open-source devices such as the EmotiBit wearable sensor show promise in expanding applications and have a larger variety of sensors in comparison to their commercial counterparts. Thus, this study aimed to develop and test the competency of the wrist-worn EmotiBit in comparison with the Empatica E4 wristband. The efficacy was evaluated through the cross-examination of the signals the sensors recorded alongside the measurement of clock drift between the timestamps of data packets being recorded, logged, and parsed over increasing periods. Taking both data recording and streaming methods into account, we aim to affirm the validity of the EmotiBit in high-precision laboratory environments, justifying it as a viable alternative to current devices. We expect the results will indicate that the wifi-compatible Emotibit will outperform the Bluetooth-dependent Empatica E4 in streaming quality and the reliability of data collected. The versatility and multi-streaming capability of the EmotiBit and the efficiency of the complementary Arduino Adafruit Feather M0, suggest the EmotiBit project would be the opportune medium for measuring vitals for future research studies. The study highlights the promise of low-cost, open-source biometric sensors in high-precision laboratory settings and clinical practices.

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

Moyo Dinakin
Virginia Tech

Dietary Patterns Involving Ultra Processed Foods in Eating Behavior

Binge Eating Disorder (BED) is an eating behavior disorder that affects 1.6 % of adolescents. This condition is characterized as a sporadic episode of an individual losing control of their eating habits. This commonly means excessively overeating, which commences a poor relationship with food. Ultra-processed foods are a commonly consumed food in the United States and have had a significant increase over the past two decades. It is estimated that 57% of people consume ultra- processed foods every day. With one of the most popular food items being heavily changed during processing, we seek to understand how this nutrient level affects binge eating qualities. Understanding these relationships can help target food choices among individuals with this disorder and ultimately use it for dietary counseling. However, there is a lack of research dedicated to following individuals diagnosed with BED dietary patterns. Here we use a dietary fat and sugar questionnaire to gauge consumption in normal and participants with uncontrolled eating patterns. We will investigate the correlation between dietary fat and sugar consumption and these eating behaviors. In this study we hypothesize that people with higher scores of uncontrolled eating will consume a higher level of fats and sugars. We expect there to be an uncontrolled dietary pattern in the results. This is an ongoing study and, here we present the preliminary results of this investigation.

Mentor(s): Alexandra DiFeliceantonio (Center for Health Behavior Research)
Amber Kelly (Center for Health Behavior Research, Virginia Tech)

Madison Doceti
Virginia Tech/Biology

The Effect of Sleep Quality on Neural Response to Sweet Taste

Sleep is an important mechanism by which the body can correctly regulate food intake signals. Deprivation of sleep leads to uninhibited activity in the reward-processing areas of the brain, which can lead to an increased risk of addiction to a certain behavior. Hormones that respond to appetite and satiety regulate these brain regions, namely the nucleus accumbens and the ventral tegmental area, which suggests that food can have addictive properties. However, how much these reward areas are affected by sleep deprivation and food intake is unknown. To investigate this question, we will first expose participants to drinks containing carbohydrates six times to establish a connection between nutrient load and a specific flavor. Then, we will measure blood oxygenation level-dependent signaling following a taste of these flavors with fMRI analysis. Second, we will obtain self-reported wanting scores of the beverage before and after scanning. To complete the investigation, we will compare the wanting scores and fMRI data to the Pittsburgh Sleep Quality Index questionnaire answers from our participants. We expect that a lower-quality sleep score will be correlated with a greater brain response to simple and complex carbohydrates. Further, we hypothesize that these types of responses over time will lead to increased wanting of the given drink. From the presented study, we can understand how sleep is associated with eating behaviors and create a greater awareness of how these actions may lead to health problems such as obesity.

Mentor(s): Alexandra DiFeliceantonio (Centers of Health Behaviors Research)
Amber Kelly (Centers of Health Behaviors Research, Virginia Tech)

Amoya Donaldson
Hampton University/Biology Pre-Medical

ESTABLISHING POTENTIAL CONNECTIONS BETWEEN THE PDGF-BB PATHWAY AND EXTRACELLULAR MATRIX REMODELING IN HYPERGLYCEMIC MURINE KIDNEYS.

The band of the extracellular matrix (ECM) between kidney microvascular cells is thin and precise in measure. Kidney pericytes in particular contribute to this ECM, regulated in part by their response to Platelet-Derived Growth Factor-BB (PDGF-BB) signaling. In order to establish potential correlations between the PDGF-BB signaling pathway and ECM remodeling in the context of high blood glucose, a series of quantitative RT-PCR reactions were conducted comparing kidney mRNA from hyperglycemic (LepR-/-) and normoglycemic (LepR+/-) mice at 6 and 8 months of age. We hypothesize that misregulated ECM remodeling may decrease the blood flow capacity through kidney vasculature. To study PDGF-BB pathway regulation, we measured the following target genes: Full Length- (signaling) and soluble- (potential negative regulator) Pdgfrβ . We found that with this specific target, sPdgfrβ there is an almost 12-fold increase for the 6 mos knockout (LepR-/-) compared to LepR+/- kidneys. We also found that there were similar expression values for the 8 mos kidneys, though notable differences were seen between the LepR+/- and LepR -/- backgrounds. In order to validate these initial data, further research will be conducted assessing these targets on the protein level and adding biological replicates to facilitate statistical comparisons.

Mentor(s): Dr. John Chappell (Vasculalr Biology Fralin Biomedical Research Institute)

Quan Dong
Virginia Tech/Wildlife Conservation

Comparing Acoustic and Mist Netting Sampling Techniques for Chiroptera Species Diversity across Elevational and Landscape Gradients in Colombia

Colombia hosts potentially the highest biodiversity of bats, Chiroptera. The complex ecosystems present in Colombia face the impending effects of climate change and the modernization of industries. Understanding ecosystem changes and their effect on biodiversity is critical for their future conservation. Bats represent an integral group to ecosystem health due to their roles in seed dispersal, pollination, insect control, and disease transmission. Current Chiroptera surveying methods include mist-netting, harp traps, and roost site captures. These methods can have significant sampling biases from major variations in these animals' life histories. Acoustic surveying has emerged as an important supplementary tool to conduct more thorough evaluations of species diversity. Although neotropical Chiroptera acoustic libraries are relatively underdeveloped than North American libraries, acoustics remain necessary for accurately assessing an area's biodiversity. This study aims to evaluate the criticality of acoustic surveying in neotropical surveys for comprehensively understanding Chiroptera species diversity. We compared mist netting data with acoustic monitoring data across elevation and landscape gradients. Mist nets and acoustics were deployed from June 22th - July 8th, 2022 across sites selected for their elevation and general landscape characteristics. Mist net captures were identified in the field, while recorded echolocation sonograms were identified by use of Kaleidoscope Pro Analysis Software. This data will be used to generate various models relevant to compare species diversity between mist net and acoustically recorded captures, elevational gradients, and landscape cover types. These models will help to refine the understanding of bat activity and population in our study range.

Mentor(s): Luis Escobar (Deparment of Fish and Wildlife Conservation)

Mason Dooley
Virginia Tech/Biomedical Engineer

Do snakes feed differently in an arboreal environment?

Certain species of snakes have evolved the ability to locomote and feed efficiently in arboreal environments. Arboreal feeding contains potential risks that do not exist with terrestrial feeding: specifically, the risk of itself or its prey falling, which can result in injury to the snake and/or the loss of the prey item. Some arboreal pythons/boids have been observed utilizing constricting body loops when in an arboreal setting to stabilize prey for ingestion. However, little is known about how semi-arboreal snakes handle prey methods in an arboreal environment. This study examines the differences in prey handling ability and behaviors of a semi-arboreal species, the Eastern black rat snakes (Pantherophis alleghaniensis), in an arboreal vs. terrestrial setting. These snakes were wild-caught locally in Montgomery County Virginia. In experimental trials in the lab, we fed the snakes in simulated arboreal and terrestrial environments. Arboreal trials were conducted on a horizontal pipe stationed 1.73 m above the ground. Snakes were placed on the pipe and given 15 seconds to acclimate before being fed its prey item. Terrestrial trials utilized a similar protocol, but instead snakes were placed on the floor in an arena with a surface area of 4 square meters. Preliminary results suggest that P. alleghaniensis exhibit longer feeding bouts in arboreal settings compared to terrestrial settings. Furthermore, while in both settings P. alleghaniensis utilized constriction, a greater amount of the body was used for constriction in the terrestrial setting, suggesting that feeding in arboreal environments may be biomechanically limiting.

Mentor(s): Jake Socha (Biomedical Engineering and Mechanics)
Jeff Anderson Jr. (Biological Sciences, Virginia Tech)
Joshua Pulliam (Biomedical Engineering and Mechanics, Virginia Tech)
Sydney Blacksten (Biomedical Engineering and Mechanics, Virginia Tech)

Leah Ellis
Radford University/Nutrition and Dietetics

TOUR

Exploring the Impact of Long-Term and Short-Term Usage of Aspartame and Sucralose on Glycemic Control

Individuals with Type 2 Diabetes often use non-nutritive sweeteners (NNS) for glycemic control. Middle-aged individuals with are the most common consumers and are at highest risk for prediabetes . The guidelines surrounding NNS usage and effectiveness in glycemic control are unclear. NNS interact with sweet taste receptors in the oral cavity, stimulating insulin secretion; a response which varies in the GI tract among types of NNS. This study assesses short term (acute) and long term (chronic) usage of two types of NNS (sucralose and aspartame) using a controlled feeding study design. The acute study will assess the change in blood glucose and insulin before and two hours after a standardized breakfast meal using a three-way crossover design which includes either aspartame, sucralose, or control. The long-term study is a randomized controlled trial that includes a 2-week lead-in period for participants, followed by a 6-week intervention period, where participants are randomized into one of three groups receiving aspartame, sucralose, or control. This study assesses the change in blood glucose and insulin at fasting and over a 2-hour period via an oral glucose tolerance test at baseline and post-intervention. Both studies provide the respective NNS type in a standardized amount through means of a study beverage and 25% of the Acceptable Daily Intake (ADI) in capsules, determined by body mass (i.e., mg/kg body weight). Through analysis of preliminary data collected from these studies, we plan to demonstrate the connections and impacts of long-term and short-term usage of NNS on glycemic control.

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

Hezekiah Emmanuel
James Madison University/Health Sciences

Relevance of p53 binding to PER2 for circadian rhythm remodeling in colorectal cancer cell

The mammalian circadian clock is a cell autonomous molecular clock that oscillates over a period of roughly 24 hours thus regulating physiology and behavior through differential gene expression in concordance with the time of day. Remarkably, perturbations in the mammalian clock due to genomic alterations or abnormal feeding cycles result in various health issues ranging from sleep disorders to proliferative diseases. The hierarchical nature of the clock manifests itself in multiple points of control on the daily cell division cycle, which relies on synthesis, degradation, and posttranslational modification for progression. A case in point is the interplay among the circadian factor PERIOD2 (PER2), the tumor suppressor p53, and p53's negative regulator, the oncogenic mouse double minute-2 homolog protein (MDM2).
Our previous work shows PER2 binding to p53 influences circadian oscillation in various cell types. In this work, we determine the interplay between Per2 and p53 in HCT116 colorectal cancer cells. We hypothesize that binding of PER2 to p53 sequesters the circadian component for the pool that binds Cryptochrome and controls clock oscillation. Isogenic HCT116 wild-type and HCT116 p53 knockout cells will be circadian synchronized and samples will be collected at different times.

Mentor(s): Carla Finkielstein (Department of Biological Sciences)
Siqi Jia (Biological Sciences, Virginia Tech Graduate School)

Kennedi Essex
Virginia Tech/Animal Science

Feasibility Study for Using MALDI-TOF MS to Diagnose Equine Melanoma

Melanocytic tumors are commonly diagnosed in horses. While benign tumors present as dark-colored skin nodules, malignant tumors, or melanomas, can spread to internal organs and cause death. The diagnosis of melanoma requires a histological sample of affected tissues, a procedure that is invasive and difficult depending on the anatomical location. Detection of circulating tumor cells (CTC) is a possible approach in diagnosing metastasis, which can be done through a less invasive technique. We propose the use of matrix-assisted laser desorption/ionization time-of-flight mass spectrometry (MALDI-TOF MS) for early recognition of equine melanoma through identifying CTC. MALDI-TOF MS uses a laser to ionize particles to detect proteins by fingerprinting. Before creating a library of neoplastic melanocytes, we first established a library of white blood cells (WBC). We used whole blood for WBC isolation, followed by red blood cells lysis, and protein extraction. We tested specificity of the equine WBC library by comparing to other species, its lower limit of detection, stability, and precision. We found that the library construct is specific for horses in comparison with canine, feline, porcine, caprine, and bovine WBC, and that samples can be stored up to 72 hours and still produce accurate data. Further studies will create a melanocyte library, when melanoma cells will be spiked into blood to test the sensitivity of this technique for CTC detection. This project can impact animal health by improving the early diagnosis and prognosis of equine melanoma and a variety of cancers in many different species.

Mentor(s): Priscila Serpa (Pathology, Virginia-Maryland College of Veterinary Medicine)

Chisom Ezigbo
Duke University/Psychology

Quantification of Changes in Dendritic Spine Morphology After MCU Knockout in the CA2 Subregion of the Hippocampus

The hippocampus encodes episodic memories—namely, information about the "who," "what," "when," and "where" of past experiences. The CA2 subregion is required for social recognition memory, or the "who" aspect of memory. Previously, we found that the mitochondrial calcium uniporter (MCU) protein is enriched in CA2 neurons, specifically in the distal apical dendrites, where social input is received. The MCU complex regulates mitochondrial calcium uptake, which plays a role in ATP production. Mitochondria support active synapses by responding to local energy demands. To explore MCU's role in synaptic function, we knocked out MCU in CA2 in mice and uncovered a loss of long-term potentiation (LTP) in CA2 distal dendrites. LTP is a strengthening of the synapse, typically involving structural changes to the dendritic spine. To determine how spine morphology in CA2 is affected by MCU knockout, we performed the Golgi-Cox staining technique on control (CTL) and MCU knockout (KO) hippocampal sections. We then quantified the spines using Fiji, with morphological classifications including stubby, mushroom, thin, filopodia, and branching spines. We hypothesize that MCU KO will result in fewer mature mushroom spines and more immature filopodia. Immature spines form weaker synaptic connections than mature spines, so this could support our finding of LTP loss. Abnormal spine morphology is observed in neurodevelopmental disorders like autism and schizophrenia, which involve deficits in social recognition. Observing abnormal spine morphology after MCU KO will reveal an unknown role for MCU in regulating critical synaptic properties that may lead to novel therapeutic targets for such disorders.

Mentor(s): Shannon Farris (Department of Biomedical Sciences & Pathobiology)

Maddie Ferguson
Virginia Tech/Biochemistry

Iron-sulfur Cluster Assembling Thioredoxin from Methanocaldococcus jannaschii

Methanocaldococcus jannaschii (Mj), is a chemolithoautotrophic, hyperthermophilic, strictly anaerobic, methanogenic archaeon, containing a simpler thioredoxin (Trx) system with two thioredoxins, MjTrx1 and MjTrx2. Thioredoxins are small acidic proteins present in all domains of life, acting as a redox regulator of metabolism through protein cysteine disulfide bond reduction activity. MjTrx2 is non canonical, reducing cysteine disulfide bonds poorly. During purification of a recombinant form produced with a His-tag in Escherichia coli, the protein was found with a brown color that quickly disappeared. We hypothesized that MjTrx2 formed an iron-sulfur cluster that was either oxygen sensitive or removed by nickel-NTA chromatography. To test this hypothesis, MjTrx2 was expressed with a Strep-tag in E. coli aerobically followed by both aerobic and anaerobic purification. The anaerobically purified protein had higher iron-sulfur cluster content. We concluded that the iron-sulfur cluster was not removed by Ni-NTA chromatography, but was oxygen sensitive. To prevent aerobic degradation, MjTrx2 is currently being expressed in E. coli and also purified anaerobically. A plasmid based system containing the E. coli narG promoter and nitrate induction were employed for anaerobic expression of MjTrx2 with a Strep-tag. A concentration of 0.1% for glucose and 50 hours of cultivation were found optimal for a high level of MjTrx2 production. We are currently purifying the anaerobically expressed MjTrx2 for characterizing the iron-sulfur cluster. A previous in vitro iron-sulfur cluster assembly work in our laboratory has shown that this cluster potentially has a low midpoint redox potential, and MjTrx2 could act as a redox sensor.

Mentor(s): Biswarup Mukhopadhyay (Biochemistry)

Cassandra Fink
West Virginia University/Wildlife and Fisheries Biology

Diving Deep into Mesopelagic Fisheries

The mesopelagic zone is the region of open ocean that lies between 200-1000m, where some of the highest biomass of oceanic fish lives. This has led to interest in establishing mesopelagic fisheries around the world as a source of Omega-3 fish oils. While some countries have already begun harvesting mesopelagic fish, few have reported their landings to the Food and Agriculture Organization (FAO) and little is known about the sustainability of these fisheries, even though 194 nations participate in their reporting program. I found 10 sources and compiled a list of families and genres to find how many mesopelagic species are listed within the FAO database. I found approximately 400 species that reside in the mesopelagic according to the FAO and summarized the available information. I used FishBase, an open-source fisheries database, with records of 1,013 species caught in the mesopelagic zone, with 195 commonly residing at this depth. Amongst these, only 12 species have the basic life characteristics necessary for sustainable fisheries management: length/weight data, length at maturity, and catch information. The FAO database reports that 1.5 million tonnes of these 12 species have been landed in 2021 alone. The findings of this study highlight the lack of information on biological characteristics of mesopelagic fish required for sustainable harvest. More basic life-history information is needed to inform the proper management of developing fisheries in this relatively unexploited ecosystem to prevent the reactive management approach seen in previous marine fisheries.

Mentor(s): Holly Kindsvater (Fish and Wildlife Conservation)

Amy Flather
Rutgers University/Physics
Noah Chavez
Amherst College/Physics

Constraining Beyond the Standard Model Sub-MeV Neutrino Fluxes using the XENONnT Detector

Although naturally occurring neutrino fluxes have been observed across a range of energies, none have been detected below the MeV-scale. These same energy scales are often probed by dark matter direct detection experiments like XENONnT. XENONnT measures electronic recoil events with sensitivity in the 1-30keV range and recently agreed with the predicted Standard Model background event rate. However, this data can be repurposed as a method of constraining a Beyond the Standard Model (BSM) low-energy neutrino flux. Here, we extract the first sub-MeV model-independent neutrino flux bounds using the latest experimental data from XENONnT. We place BSM flux constraints on the order of 10E5 per (cm squared seconds eV) (90% C.L.) for neutrinos at energies from 16keV to 1.8MeV. These flux bounds constrain new regions of parameter space and are relevant for models of decaying dark matter and decaying primordial black holes. Our results illustrate how the high sensitivity of dark matter direct detection experiments can be used to constrain neutrino fluxes. We expect this work to apply to other dark matter direct detection experiments.

Mentor(s): Ian Shoemaker (Department of Physics)

Faith Gambrell
Virginia State University/Computer Engineering

Comparison of Entropy in Random Number Generation

Photons can be used to create a true Quantum Random Number Generator (QRNG) because of the randomness of their quantum particle-like nature. Qubits (photons) have a mathematical superposition because instead of being just a 0 or a1 it's the probability of 0 or 1 defined as |ψ≥1/√2(|0> +|1>) (50-50 chance). When prepared in a superposition state, an optical beam splitter forces a photon to go down one output path or the other resulting in a random sequence of zeros and ones. Such a random sequence has numerous applications for practical secure quantum communication systems. Experimental tests have been performed to consider the effects of photon polarization on the bias of a QRNG and its entropy. The measurement of the entropy value will reflect the changes and consistency in the predictability of the QRNG. If the values are not easily skewed it could prove how secure the generated random sequence is. The experiment uses a motorized polarizer attached to a beam splitter input with two outputs connected to inputs of photodetectors used to measure coincidences. The second polarizer is connected to a third photodetector and used as a control group for the number of photons. The QRNG is initially run with the polarizers at 0 degrees. After that, it is ran incrementing by 45 degrees for each run (45,90,135…). The bias and bit length are used to calculate the entropy and are graphed. If the entropy is consistent, it proves the security of QRNGs for communication and security.

Mentor(s): Wayne Scales (Engineering)

Charvi Gangwani
Hollins University /Biology

Comparing Outcomes of Community-Based and ICT-Based Mental Health Interventions for Adolescents with Parents Affected by Alcoholism and Addiction in India

Adolescents with parents affected by alcoholism and addiction often face challenges, such as unmet developmental needs, impaired attachment, economic hardship, legal problems, emotional distress, and even violence (Lander et al., 2013). They are also at a higher risk of developing substance use disorders themselves. Moreover, studies conducted in India have shown that adolescents with alcoholic parents exhibit significantly higher levels of depression and anxiety than their peers (Omkarappa et al., 2019). With the rise of online interventions as a promising avenue for mental health support, this research study aims to compare the experiences of online and in-person interventions for adolescents affected by parental alcoholism and addiction and to examine potential treatment impacts via comparison to a non-clinical reference group of children of alcoholics (COAs) in India (Omkarappa et al., 2019). The focus of the interventions includes group discussions, information sessions, and activities. A total of 27 participants between 14 and 19 years of age (12 participants from the online intervention and 15 participants from the in-person intervention) were recruited from a mental health program for COAs in Pune, India. The measures utilized in this study included the Coping Self-Efficacy Scale (CSE-7), Mental Help Seeking Intention Scale, Positive and Negative Affect Schedule (PANAS-SF), Rosenberg Self-Esteem Scale, Spence Children's Anxiety Scale, and Family Stigma Scale. Data collection is ongoing, but initial analyses indicated no significant differences in any outcome measures between online and in-person participants. Furthermore, this study's sample showed lower levels of anxiety and higher self-esteem compared to the reference study. However, given the small sample size, these results are offered cautiously, and further research is needed to investigate the effectiveness of in-person versus online support interventions.

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

Divij Garg
University of Illinois Urbana Champaign/Mathematics
Jessica Burns
University of Cincinnati /Physics

Analyzing Neutral Hydrogen and Midplane Pressure in NGC 3941

This paper presents a study conducted on NGC 3941, an early type galaxy, with the aim of examining its hydrogen content. The investigation of atomic and molecular hydrogen composition in galaxies has proven valuable in understanding their structural characteristics, such as kinematics of gas, star formation tendencies, and crucially the hydro-static mid-plane pressure (Walter et al., 2008). Previous research established relations between R_{mol}, the molecular to atomic hydrogen surface density ratio, and the hydro-static mid-plane pressure, P_HM. Specifically, the THINGS study examined 34 spiral galaxies and found that R_mol exhibits a proportionality to P_HM^0.8 (Walter et al., 2008). However, this relationship is from observations of spiral galaxies, implying that early-type galaxies might exhibit a different correlation. Early-type galaxies diverge from spiral galaxies when considering their stars' radial orbits, absence of spiral arms, and lower levels of star formation activity. Furthermore, the ATLAS3D study reported a disparity in the amount of atomic hydrogen present in early-type galaxies compared to spiral galaxies (Serra et al., 2012). These discrepancies raise the possibility that the correlation might be altered in early-type galaxies. Consequently, the focus of this paper centers on NGC 3941, an early-type galaxy HI rich, in order to test the previously established THINGS proportionality. This investigation is part of a broader study on the distribution of HI in 32 early-type galaxies, and employs data from the Very Large Array (VLA), enabling a comprehensive analysis of the hydrogen content and its spatial distribution within NGC 3941.

Mentor(s): Danielle Lucero (Physics)

Mari Garza
Johns Hopkins University/Psychology

Food Insecurity Predicts Excessive Exercise Among College Students Across One Semester

Introduction: Food Insecurity is associated with eating disorder behaviors such as binge eating in college students. However, given correlations between food insecurity and higher body weight, college students with food insecurity also may be more likely to engage in weight loss behaviors such as excessive exercise (exercise for the primary purpose of altering weight or shape). We tested associations between food insecurity and excessive exercise cross-sectionally and across one semester.
Methods: College students (n = 277) were assessed at baseline (August 2022) and three months later at follow-up (November 2022). Self-report measures included the Eating Pathology Symptoms Inventory (ESPI-EES; to assess excessive exercise), weight/height, and the 30-day USDA household food insecurity survey module (to assess food insecurity). We conducted two multiple regression models with the EPSI-EES specified as the outcome and food insecurity status, body mass index, and gender as predictors (given evidence for associations among body mass index, gender, and exercise). In longitudinal models, we also controlled for the EPSI-EES at baseline.
Results: At baseline, food insecurity status was not significantly associated with excessive exercise, gender, or BMI. However, baseline food insecurity status predicted follow-up excessive exercise ($p = .004$), over and above baseline excessive exercise, BMI, and gender. Lower BMI was significantly associated with follow-up excessive exercise. Gender was not a significant predictor.
Conclusions: Excessive exercise behavior increased across one semester in students who were food insecure, independently of gender and body mass index. Results suggest the downstream effects of food insecurity may prompt excessive exercise in college students.

Mentor(s): Heather Davis (Virginia Tech Psychology)

Sneha Gatuku
Virginia Commonwealth University/Psychology

Sewershed Surveillance of ARGs in Central Appalachia: Building a Monitoring Framework for Rural Systems

Unregulated antibiotic use and resulting antibiotic waste streams can lead to the dissemination of antibiotic resistant bacteria (ARB) and antibiotic resistance (ARGs) into the environment, especially where wastewater treatment infrastructure is not present and/or underdeveloped. However, wastewater-based surveillance (WBS) is a promising methodology for monitoring health outcomes and mitigating negative impacts from potential future, novel epidemics. The difference in regional trends in measured antibiotic concentrations compared to public sales data indicates that WBS can be useful in detecting ARGs and antibiotic resistant-bacteria that can't be diagnosed as effectively and promptly with clinical surveillance. For this study, phenotypic and genotypic analysis of ARGs and ARB was conducted in a rural sewershed with a population size of ~2,500. Samples were collected at regular intervals at five wastewater sampling points (WWTP influent, WWTP effluent, a manhole downstream of a residential facility, a manhole downstream of septic effluent, and a manhole downstream of a veterinary hospital) and two surface water sampling points (one downstream and one downstream of the WWTP effluent discharge). We cultured for total and cefotaxime-resistant E.coli and quantified concentrations of two ARGs (intI1 and blaCTX-M-1) using ddPCR. Preliminary results show the percentage of cefotaxime-resistant E.coli compared to total culturable E.coli was highest at WWTP effluent (at 4.97%) compared to 0%-0.9% across other sites. However, concentrations of blaCTX-M-1 in log (gene copies per mil) were highest at the WWTP influent (at 3.38 Log (CFU/100mL)).

Mentor(s): Alasdair Cohen (Public Health)

Yasmeen Gomez
Virginia Tech/Animal Sciences
Yhakira Grey
Virginia Tech/Animal Sciences

The Cat is in the Bag - an Exploration into Cat Strollers

Feline ownership includes a variety of human-animal interactions, some of which are similar to those involved in dog ownership, but many that vary compared to canine ownership. Most notably, this includes the increased connection dog owners receive through the added duty of walks, which increases physical activity and social interaction between the dog-owner dyad. Cat owners, however, might not see the same benefits of pet ownership as dog owners, particularly in regard to activity levels and social interaction, since it is uncommon to walk a cat. However, with the recent popularity of cat strollers a whole new avenue has opened for cat owners, with a possibility to increase their activity levels. Consequently, because of the relatively novel invention, research on cat's behavior in the stroller is nonexistent. One of the concerns, however, of taking a cat in a stroller is how it affects the cat's welfare. This research aims to investigate whether any significant behavioral differences between cats that received stroller training and cats that were taken for a stroller ride without any training. Eighty shelter cats from Montgomery County Animal Care and Adoption Center (MCACAC) were assessed, enrolled, and placed into either a training or control group where the training and stroller rides were recorded and later behaviorally coded. With the use of shelter cats, we can also gather evidence for the potential benefits for improving their stress levels and voluntary social interactions. Once the research is complete, this will allow us to gather evidence on whether or not handling shelter cats in this situation will improve their welfare and likelihood of getting adopted. Specifically, we intend to see further research into this field with these findings as it opens a myriad of opportunities. While we have been limited to shelter cats, branching outwards to owned cats may allow further research into the differing stress levels in cats such as any deviations in the effectiveness of a vet visit or owner-pet bonds.

Mentor(s): Erica Feuerbacher (Animal Sciences)
Allie Andrukonis (Postdoctoral Research Associate, School of Animal Sciences - Virginia Tech)

Zenovia Graham
Oakwood University/Biology: Pre-Veterinary Medicine

Sex Hormones Impact on Herpes Simplex Virus Productive Infection

Herpes simplex virus (HSV) most commonly causes sores on the skin of the lips or genitals, which can recur throughout a person's life, but can sometimes cause life-threatening disease in newborns, encephalitis, or recurrent meningitis. About 67% of the global population are currently infected with HSV-1 and 13% have HSV-2. HSV is more prevalent in females than males with HSV-2 showing more severe primary infection in females. During primary infection, HSV can establish latency within sensory and autonomic neurons of the peripheral nervous system. To determine if hormones underlying sex differences may have a direct effect on HSV replication, we infected primary sensory and autonomic neurons in culture with either HSV-1 or HSV-2 and compared the differences in viral replication in response to estrogen, progesterone, and testosterone treatment. Although we detected modest changes in viral replication in response to treatment with progesterone and testosterone, these changes did not reach statistical significance. However, we also discovered that estrogen and progesterone were able to cause reactivation of HSV-1 and HSV-2 from latency in the neurons. This suggests that sex hormones do not directly impact productive infection of HSV, but are involved in reactivation of the virus to contribute to differences in recurrent disease between men and women.

Mentor(s): Andrea Bertke (Virginia-Maryland College of Veterinary Medicine)
Greyson Moore (Virginia-Maryland College of Veterinary Medicine)

Miles Grimes
Michigan State University/Mechanical Engineering

Support for Post-Crash Care Improvement

Around 5.5 million motor vehicle crashes (MVCs) are reported in the United States each year. Medical care is often needed after these MVCs; increasing the effectiveness and efficiency of this care will save lives. This investigation involved (1) the collection of data to determine heart rate from in-vehicle sensors; (2) quality assessment of video view classification from naturalistic driving (ND) data; and (3) initial analysis of ND data from two ambulances. The goal is to identify solutions that improve roadway safety for first responders, reduce time of care of crash victims, and streamline resource allocation.

The different efforts varied in their stages and levels of work. Data collection for the in-vehicle sensor study was completed for 4 consenting participants. These participants experienced several levels of motion testing while data was collected. This effort required completion of Collaborative Institutional Training Initiative training and involvement in the Institution Review Board application, which outlined the consenting process, data security, and tasks to be completed by each subject. Results are expected to show a seat pressure sensor can effectively assess occupant heart rate after a crash. Assessment of the ND videos yielded a process, based on image color characteristics and variability in brightness between video frames, that is being tested to identify misclassified videos. Finally, analysis of the ND ambulance data required the use of data visualization software to manually investigate recorded trips and understand variable entries. The primary task was to assess the presence and accuracy of the recorded data; these results will streamline future analysis efforts.

Mentor(s): Miguel Perez (Virginia Tech Transportation Institute (VTTI))
Jacob Valente (Virginia Tech Transportation Institute (VTTI))

Clara Guo
Virginia Tech

Smoking as a moderator of the association between BMI and delay discounting

Delay discounting (DD) is a measure of how much a person devalues a reward in the future. In prior observational research, a positive correlation has often been found between higher DD rates and higher BMI; however, the strength of this association varies substantially across studies, suggesting the presence of one or more variables that moderates this association. Aside from BMI, cigarette smoking is also associated with high DD rates. However, evidence suggests that cigarette smoking can decrease BMI through faster metabolism and appetite suppression, which may complicate the association between BMI and DD. Thus, this project examined whether DD rates' relation to high BMI might be moderated by smoking. 295 participants were recruited online, completed a survey consisting of DD and other measures, and were analyzed for this study (146 adults who smoke and 149 adults who have never smoked). Multiple univariate linear regression was used to analyze the data gathered. Without controlling for demographics, a significant association was found between smoking and DD (β= 1.33, p <.001) but not between BMI and DD (β = 0.032, p = 0.052) or the interaction of BMI and DD with smoking (β = 0.02156, p = 0.490). Further results will be presented when demographics (i.e. income and education) are controlled for. The present study shows no moderating effect of smoking on BMI and DD, nor does it support any significant positive association between BMI and DD.

Mentor(s): Jeff Stein (FBRI, Center for Health Behavior Research)

Kaamia Harris
Hampton University/Biochemistry

Phosphine-catalyzed Hydroamidation of Alkynoates

Unnatural amino acids are types of amino acids that have been synthesized or isolated from specific sources in nature.1 Dehydroamino acids are a particular type of unnatural amino acid, which have been found to contribute to antibiotic, antifungal, antitumor, and phytotoxic activity.2 They can also serve as precursors for synthesizing other unnatural amino acids.3 Because amino acids are essential for life and play a crucial role in numerous biological processes, we sought to develop a convenient method for synthesizing dehydroamino acids. A phosphine catalyst was employed in the presence of an amide and alkynoate to form our desired product. By methodically adjusting the reaction's time, temperature, concentration, catalyst, and other parameters, this reaction was optimized and made as efficient as possible. Using our optimized conditions, we were able to make a precursor to “Scutianene M”, a natural product isolated from a species of tree native to South America.4 The project's next step will be to finish the substrate scope, which will reveal which amides and alkynoates are acceptable under our idealized conditions. After developing the substrate scope, we will consider various mechanistic pathways to better understand our reaction.

Mentor(s): Webster Santos (Chemistry)

Naomi Harvey
Virginia Tech/Psychology

Language Use Preferences in Autistic Identities

In recent years, many self-advocates in autistic communities have expressed preference for identity-first language (i.e., autistic person) to be used when communicating about autistic individuals in interpersonal and medical contexts instead of person-first language (i.e., person with autism) which is the preferred style of communication in healthcare systems when referring to people with disabilities. This study surveyed 9 autistic adults(Mage = 25.00, SDage = 8.92, range 19-47, Sex: males = 5, females = 3, intersex =1, Gender: male = 3, female = 3, agender = 1, bigender = 1, genderqueer = 1, Race: White = 5, Black or African American =3, Multiracial = 1) and 5 caregivers of autistic adults (Sex: female=5, Gender: female=5, Race: White =3, Asian = 2) about their autism cultural identity and language-identifying preference. Survey questions asked participants to identify terms they were happy to use and favorite terms to use across different social perspectives regarding autism. Preliminary results show no difference between autistic individuals and caregivers regarding preference for certain language terms across varying social contexts, ps > .085. However, preference of use for the term 'typically-developing people' significantly differed between autistic individuals and caregivers [X2(1, N = 15 = 5.63, p = .018] such that 50% of caregiver respondents chose 'typically-developing people' as a term they would be happy to use to describe a person without a diagnosis of autism, whereas none of the autistic participants chose it as a preferred term. Future data analysis should consider further data collection and larger sample populations to continue analyzing language preferences across autistic identities.

Mentor(s): Angela Scarpa-Friedman (Department of Psychology)

Susanna Helms
Hollins University/International Studies

Shifting Geopolitics: The Shanghai Cooperation Organization

Following the dissolution of the Soviet Union, the former Soviet Socialist Republics were left to forge their own identity in the realm of international relations. This need, as well as the motivations of bordering Russia and China, led to the creation of the Shanghai Cooperation Organization (SCO). The SCO is an intergovernmental organization that focuses on the economic and security needs of member states. Originally formed in 2001 with China, Kazakhstan, Kyrgyzstan, Russia, Tajikistan, and Uzbekistan, the organization has also come to include India, Iran, and Pakistan. Together, the SCO encompasses nearly 40% of the world population and almost a fourth of the global GDP. Over the last two decades, the SCO has resolved border disputes, conducted joint military exercises, established a regional anti-terrorism organization, expanded infrastructure, and more.

The SCO provides a unique geopolitical realm for member states. Central Asian nations benefit from increasingly diversified economic development and security infrastructure whilst China and Russia benefit from an increased foothold on the region. Additionally, the two main powers are able to monitor the influence of one another. With the more recent additions of India, Iran, and Pakistan, the potential of the organization has shifted. This project will further analyze the establishment, motivations, activities, and potential of the Shanghai Cooperation not only within Central Asia but on a global scale.

Mentor(s): Edward Lynch (Global Political Societies, Hollins University)

David Henderson
University of Dayton/Biology

Examining the Impact of Cognitive Restraint on Flavor Nutrient Conditioning

The food environment in the US has changed rapidly in the last 50 years, with an uptick in consumption of ultra-processed foods (UPF), defined as industrial formulations of sources of energy, nutrients, and additives. UPF consumption has been linked with various forms of cancer and increased cardiovascular disease. Therefore, basic understanding of the mechanisms that drive consumption of UPFs must keep pace with their increasing availability and expanding percentage of the US food supply. We aim to examine whether people with high cognitive restraint in relation to food are less likely to have successful flavor nutrient conditioning (FNC). Data from four distinct cross-over randomized studies within a FNC paradigm, which connects a food's flavor to its nutritional value, were used. The primary outcome is FNC, measured by the difference from a pre- to post-conditioning liking score. The Three Factor Eating questionnaire (TFEQ) was used to evaluate and measure individual differences in cognitive restraint on eating behaviors. Linear mixed effects modeling was used to examine predictors of FNC, including sex, condition (CS+fast, CS+slow, CS-control), TFEQ cognitive restraint score, and BMI. Model results demonstrated that when compared to the CS-, the CS+slow condition was associated with the highest change in liking across varying TFEQ scores (estimate=1.58, p=0.046). Additionally, BMI, and the main effects of TFEQ, and condition showed statistically significant results in the model. This suggests that there is a link between FNC and physiological and pathological variables, which can be explored in future studies.

Mentor(s): Alexandra Hanlon (Center for Biostatistics and Health Data Science, Department of Statistics)
Monica Ahrens (Center for Biostatistics and Health Data Science, Department of Statistics)
Alexandra DiFeliceantonio (Center for Health Behaviors Research)

Zoe Hessian
Virginia Tech/Geography

A Morphometric and Spatial Analysis of the White Shark Population in the Mediterranean Sea.

Mediterranean white sharks (Carcharodon carcharias) have been recently raised from 'Endangered' to 'Critically Endangered' although more research is needed to clarify current population trends and the local dynamics of this species. To help fill these data gaps, I conducted a morphological analysis using different variables measured relative to total body length. Data was collected by two field assistants in Tunisia who conducted daily monitoring in fishing ports, registered records, and took photographs of white sharks' accidental fishing. Additional datasets were obtained from the historical database of Mediterranean white sharks, which includes over 800 individuals, 45 historical photographs, and 30 photographs. I used the software IC to obtain morphometric measures and R studio to fit linear models between each morphometric variable and total length measures. I explored the relationships between these variables with scatter plots and fitted linear regression models to these data to obtain parameter estimates and confidence intervals. The models showed a strong and significant relationship between dorsal fin height and total length, which can be used for future research aiming to estimate total length from dorsal fin height. Additionally, I created a map showing white shark records. For this scope, I had to reconstruct the capture locations from the records available, which, most of the time, were landings and, thus, land projections of the actual catches. This research is the first Mediterranean white shark morphometric study in the literature and will help gain a better understanding of the size, morphometrics, and distribution of this data-poor white shark population.

Mentor(s): Francesco Ferretti (Fish and Wildlife Conservation)
Felipe Carvalho (PhD Candidate - Fish & Wildlife, Virginia Tech)

Kali Holsinger
Fralin Biomedical Research Institute/Clinical Neuroscience

Optic Nerve Astrogliosis: A Response to Retinal Ganglion Cell Stress

Over 80 million people worldwide are affected by glaucoma and other optic neuropathies (ONs), stripped of their vision. Glaucoma is associated with progressive degeneration of retinal ganglion cell (RGC) axons that comprise the optic nerve and astrogliosis. The mechanism of astrogliosis in ONs remains unknown. Variations in the essential X-linked CASK (calcium/calmodulin-dependent serine protein kinase) gene have been implicated in optic nerve hypoplasia (ONH), optic nerve atrophy, and glaucoma. Heterozygous CASK knockout mice and a Cask hypomorph mouse line (CASKhypo) expressing ~50% CASK are both known to manifest ONH. Here, we show that optic nerves from CASKhypo mice display astrogliosis even before its complete myelination, however, optic atrophy has not been observed in these mice. Interestingly, RGC-specific deletion of CASK in the CASKhypo background produced progressive optic atrophy and worsening of astrogliosis. This data indicate that astrogliosis in the optic nerve is solely a response to RGC stress. We additionally examined astrogliosis in glaucomatous human optic nerves. Surprisingly, an abundance of active, localized astrogliosis was observed in the optic nerve where the degeneration was at an early stage but little astrogliosis was observed in the optic nerve with advanced degeneration from the same subject. Our results demonstrate that astrogliosis in ONs is a direct response to RGC axonal stress. Lack of optic atrophy in CASKhypo mice argues against a destructive role of astrogliosis in optic nerve pathologies. However, further experiments are required to examine if increasing or decreasing the astroglial response could modify the course of ONs.

Mentor(s): Konark Mukherjee (Fralin Biomedical Research Institute at Virginia Tech Carilion, Neurobiology)

Zachary Hubshman
Virginia Tech/Cognitive and Behavioral Neuroscience

Does Episodic Future Thinking decrease Consumption of Alcohol and Cocaine in individuals with Substance Use Disorders?

Individuals with substance use disorder have a preference for discounting the future, resulting in increased consumption in the present. To shift an individuals' focus to the future Episodic Future Thinking (EFT) has implications of decreasing present substance use, allowing it to be considered as a treatment novel approach in use disorders. EFT works by asking individuals to project into the future by describing upcoming, positive events. A clinical trial which utilized EFT with cigarette users found that higher frequency EFT correlated with lower cigarette use and lower future discounting. While EFT shows promise, more in-depth, longer studies are necessary to further reinforce this potential treatment. To examine this phenomena, we examine the relationship between Episodic Future Thinking and Control Episodic Thinking. We conducted two studies with these groups, one study examined cocaine users (n=7) and their consumption use and the other study observed daily alcohol use (n=9). In the lab, participants generated either EFT cues (positive events arrayed in the future) or CET cues (positive cues from the prior day). These cues were then texted daily to the participant as a reminder. We then asked about daily use of the participant's drug. Despite the small sample size, we saw a downwards trend for drug consumption in EFT and an upwards trend in CET. These results indicate that with more data we could see a significant distinction between CET and EFT, further bolstering the use of EFT as a treatment for substance use disorder.

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

Spencer Kaswinkel
Virginia Tech/Biomedical Engineering

Toward Nanofibrous Engineered Living Materials: Optimization of a Biocompatible Nanofiber Matrix

Healthcare-acquired infections are a substantial cause of morbidity and mortality worldwide. Early infection detection can enable clinicians to treat patients before their infections reach an unsafe level. The high sensitivity, sustainability, and low cost of living sensors offer an exciting opportunity for point-of-care diagnosis of infection. Successful implementation of this emerging technology requires the development of matrices for biocontainment without adverse effects on the living sensors' performance. The goal of this project is to develop nanofibrous engineered living materials wherein the living sensors are encapsulated in nanofiber arrays. Encapsulating bacterial whole-cell biosensors in nanofibers offers unique advantages, including preserved spatial arrangement, arrested growth due to physical constraint, and minimal separation between the living sensor and the environment to allow for rapid and sensitive detection of target analytes. Toward this goal, this work aimed to optimize polymer compositions and nanofabrication processes to fabricate poly(ethylene oxide) (PEO) nanofibers that are non-fouling and resistant to degradation in aqueous environments. The effect of PEO molecular weight, poly(ethylene glycol) diacrylate (PEGDA) crosslinker concentration, and UV light wavelength and exposure time for polymer crosslinking were investigated. Fiber stability was assessed in water, phosphate-buffered saline, and culture media using optical microscopy. In parallel, the effect of UV dosage on the viability of a potential bacterial whole-cell biosensor chassis was analyzed to inform decisions about the appropriate UV doses for crosslinking nanofibers with encapsulated bacterial biosensors. The long-term goal of this project is to develop nanofibrous engineered living materials, such as smart bandages, that detect and mitigate infection.

Mentor(s): Bahareh Behkam (Mechanical Engineering)
Naimat Bari ((Postdoctoral Fellow) Mechanical Engineering, Virginia Tech)

Kelsey Kern
Virginia Tech/Biological Sciences

Studying Biofilm Formation of Environmental Bacteria Samples on Various Types of Microplastics

The presence of microplastics in the environment is of growing concern due to being found in every type of ecosystem on earth, including remote locations such as the arctic. It is important to consider the possibility of microbial growth in the form of biofilms on these polymers, as they can be ingested and inhaled by living organisms, along with being deposited across ecosystems and throughout the oceans. Recent research has shown that wave breaking can cause these small plastic particles to make their way back into the atmosphere. This research aimed to study the adherence of bacteria captured from the environment to microplastics, as growth on these polymers presents a new method of bacterial cell dispersion when microplastics travel through water sources and are aerosolized. The microbial samples studied were collected from marine environments in Virginia Beach and captured from an air filter on a ship traveling through the Arctic Ocean off the coast of Alaska. Utilizing DNA amplification and sequencing techniques, these bacterial species were identified, then cultured in a liquid media containing microplastics to assess their ability to form biofilms on various types of polymers. Multiple species identified from the arctic samples demonstrated adherence and the generation of an extracellular matrix on the surface of different plastics. Ongoing and future work aims to study the aerosolization of biofilm-coated microplastics and viability of these bacteria once aerosolized.

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

Ryan Keverline
Virginia Tech/Environmental Science
Michael Kricheldorf
Virginia Tech/Computer Science
Evelyn Tipper
Virginia Tech/Biological Systems Engineering

Establishing Standard Operating Procedures for Bathymetric Mapping of Small Freshwater Reservoirs

Bathymetric data are essential to understanding and modeling lakes and reservoirs. An Acoustic Doppler Current Profiler (ADCP) is commonly used to gather bathymetric data by using sound waves to measure water column depth. Despite being an essential instrument, there are few comprehensive, open-source resources detailing ADCP usage in collecting and processing depth data to generate bathymetric maps. The goal of this project was to establish and document a reproducible workflow for modeling bathymetry of small lakes and reservoirs using widely-accessible software. We tested our methods at Falling Creek Reservoir, a small drinking water reservoir in southwest Virginia. The high catchment:surface area ratio of reservoirs makes them dynamic ecosystems, resulting in shifting bathymetry over time due to episodic events depositing high sediment loads or flushing existing sediment downstream. Existing bathymetric data of the reservoir are outdated, having last been collected 12 years ago, reducing the accuracy of the models used for ecological forecasting at this site. To collect up-to-date depth data of the reservoir, we used a Teledyne Rio Grande ADCP in conjunction with a Trimble DSM 232 GPS, and consolidated the depth and location data using WinRiver II software. Data were exported into the USGS Velocity Mapping Toolbox (VMT) to increase output resolution. Lastly, we generated a bathymetric map in R software using the marmap package, which was superimposed onto an Open Street Map. Comparison with the previous map revealed substantial changes in the reservoir's morphometry; however, further research is needed to understand how and why these changes occurred.

Mentor(s): Adrienne Breef-Pilz (Biology)
Dexter Howard (Biology Department - Virginia Tech)
Dr. Cayelan Carey (Biology Department - Virginia Tech)

Kimuchu Kibue
Virginia Tech/Cognitive and Behavioral Neuroscience

TOUR

Effects of nutrient availability on ATP synthesis and thyroxine-mediated changes in neurogenesis in the optic tectum of Xenopus laevis larvae

Nutrient availability will often vary over the course of an animal's life, including during development. Many species will conserve energy by slowing growth and other biological processes. In the African clawed frog, Xenopus laevis, mothers provide a yolk to growing embryos in the fertilized egg. Eventually, the yolk will begin to run out, and the larvae will need to forage for food. If the larvae fail to find food for a significant period of time, they will undergo developmental stasis, in which they pause development as larvae and do not transition to the tadpole stage. One core feature of this is a near complete pause of neurogenesis in the developing brain. Moreover, recent results have shown that mitochondria play a crucial role in regulating the rate of neurogenesis. Our study aims to determine the effect of nutrient restriction on mitochondrial physiology and thyroxine-mediated neurogenesis. By altering nutrient availability for several days as the yolk is being exhausted, we examined changes in ATP production in neural progenitor cells (NPCs) in the optic tectum using time-lapse in vivo imaging. We also examined the effects of nutrient availability on thyroxine-mediated changes in tectal neurogenesis in fixed brains. Preliminary results indicate that nutrient availability resulted in an increase in ATP production in NPCs two days after the onset of feeding. Further, nutrient availability appeared to increase neurogenesis, similar to the effects of thyroxine treatment. This data shows that neurogenesis appears to be tightly regulated by nutrient availability in the brains of Xenopus larvae.

Mentor(s): Chris Thompson (Biological Sciences)

Emma Kinsey
Scripps College/Molecular Biology

Effects of topography on bacterial adhesion and cell membrane organization

Investigations of bacterial attachment and biofilm development on patterned surfaces are necessary to understand how cells sense their natural environment. It could also lead to the development of materials resistant to microbial propagation. In this study, we hypothesized that the mechanosensitive channels play a role in bacteria interactions with surface nanostructures. To test our hypothesis, we conducted bacterial adhesion assays on nanostructured surfaces using wild-type and a large mechanosensitive ion channel (△MscL) mutant of Staphylococcus aureus. We used suspended 350 nm and 700 nm diameter suspended polystyrene nanofibers, which mimic the mechanical properties and dimensions of extracellular matrix (ECM) in vivo. Fluorescence microscopy showed that the mutant bacteria attached and grew less robustly on multiple variations of surfaces, suggesting that the diminished ability to receive sensory impact affects their proliferation. To understand this sensing mechanism on the cell membrane level, we used cell membrane mimics comprised of lipid bilayers deposited on substrates with similar structural features. Recent simulations show that the lateral organization of lipids into ordered and disordered domains strongly depends on the local membrane curvature. Therefore, the localization of proteins like MscL in different lipid domains may be affected by imposed curvature. Here, we performed confocal fluorescence microscopy studies of supported lipid membranes on flat and patterned surfaces to reveal the qualitative relationship between surface topography and lipid domain distribution. Future work will confirm how altering cell mechanosensing and lipid distribution within cell membranes influences communication pathways within the cell.

Mentor(s): Rana Ashkar (Center for Soft Matter and Biological Physics)
Bahareh Behkam (Center for Soft Matter and Biological Physics)

Neal Klemba
Brown University/Mechanical Engineering
Tavon Hill
Morehouse College/Environmental Engineering/Applied Physics

Comparing Multispectral Satellite and Drone Imagery for Monitoring Harmful Algal Blooms

Harmful algal blooms (HABs) caused by toxic cyanobacteria are a major hazard to freshwater ecosystems and human health. HABs are exacerbated by changing environmental factors, such as increasingly high water temperatures and nutrient runoff, making them a growing concern. Current HAB monitoring technology relies on manual water sampling which is both time-consuming and expensive. Thus, research into remote monitoring methods, particularly multispectral satellite imagery, is becoming increasingly popular. However, this approach is limited by the spatial and temporal resolution of the satellite images: one pixel of the Landsat 8/9 satellite images represents a 900 square meter area, which makes it difficult to resolve small geographic features. This project examined methods for mapping HABs in freshwater lakes by comparing multispectral image data gathered by satellites with drone imagery. Using drone and satellite data collected in New Zealand and Virginia lakes, we developed a method to first stitch together multiple multispectral drone images into an orthomosaic map, and then process the spectral data to identify HABs. By comparing the output with water sample data, we can tune the image processing algorithm to more accurately predict HABs. We showed that the drones' increased spatial and temporal resolution provides an accurate and cost-effective alternative to traditional remote sensing methods. Ongoing and future work aims to investigate potential associations of images from satellites and drones with data for concentrations of cyanobacteria, nutrients, chlorophyll, phycocyanin, and cyanotoxins.

Mentor(s): David Schmale (School of Plant and Environmental Sciences, Virginia Tech)
Landon Bilyeu (School of Plant and Environmental Sciences, Virginia Tech)

Alessandra Klier
Virginia Tech/Food Science and Technology

Promoting Food Safety and Stability in Value-Added Products: Analyzing pH, Water Activity, and Ingredient Contributions for Virginia Food Producers

Agriculture is Virginia's largest private industry, and this abundance is the basis for Virginia's thriving food and beverage processing industry. In addition to large food manufacturing companies, Virginia law also allows for the production and sale of value-added food products from home-based operations ("cottage food laws") and commercial kitchens. Starting and sustaining a food business can be challenging for entrepreneurs who may not understand food safety and labeling regulations. Working with large private testing laboratories may require time and money start-ups cannot spare and there is little chance of a personalized experience. The principal objectives of the Food Producer Technical Assistance Network are to support these food producers in starting their own businesses by assessing food safety through product analysis and creating nutrition facts panels for their products. The safety of food products is often based on the pH and/or water activity, which are the primary analyses performed in the program. It is important to understand how the pH of raw and processed food ingredients affects the intended finished product. To provide producers with accurate nutritional facts for their consumers, panels were generated through inputting recipes into software while accounting for changes caused by processing. Because there is limited information available to support food scientists in this area, a selection of fresh and commercially-processed ingredients were analyzed to determine how they contribute to the safety and stability of value-added products.

Mentor(s): Melissa Wright (Food Science and Technology)

Alexander Kosolapov
Virginia Polytechnic Institute and State University/Biological Sciences

Role of connexin43 / β-catenin interaction in epithelial-mesenchymal transition and induced pluripotent stem cell derived cardiomyocytes

TGF-β signaling and epithelial-mesenchymal transition (EMT) play important roles in cardiac development and fibrosis. Intercellular communication is central to normal cardiac function and is dependent upon connexin 43 (Cx43) gap junctions. Alterations to Cx43 localization and gap junctions create electrical disturbances underlying arrhythmia and sudden cardiac death. Importantly, change from the epithelial to mesenchymal phenotype involves remodeling of gap junctions and cytosolic redistribution of Cx43 with decreased complexing of Cx43 with □-catenin. Cx43 subcellular localization and interaction with other proteins are highly dependent on multiple phosphorylation events that occur on its C-terminus. □-catenin interacts with Cx43 directly at tyrosine-265 and tyrosine-313, and this interaction can be inhibited via Src phosphorylation on these residues. To dissect the contribution of Cx43 interaction with □-catenin, we generated phosphomimetic and phospho-null mutations at 265 and 313 for ectopic expression in cells where endogenous Cx43 was knocked out. This project focuses on manipulating Cx43/□-catenin interaction during TGF-□-induced EMT and in induced pluripotent stem cell derived cardiomyocytes using an adenoviral and transient expression vectors carrying the Cx43 mutants. Inhibition of the Cx43/□-catenin interaction is expected to modulate Cx43 localization to the plasma membrane or cytosol, which in turn would affect gap junction function during EMT and in cardiomyocytes. This research may contribute to development of therapies though revealing mechanisms of gap junction loss that underlie arrhythmias and/or fibrosis.

Mentor(s): Samy Lamouille (Cancer Research Group)

Abhinav Krishnan
Virginia Tech/Biochemistry

TOUR

Nitric Oxide alters Skeletal Muscle Mitochondrial Quality Control

Mitochondrial quality control (MQC) is the balance of mitochondrial biogenesis, the creation of new mitochondria, and mitophagy, the targeted degradation of damaged mitochondria. MQC is crucial in maintaining mitochondrial health, especially in response to exercise. Mitochondrial dysfunction, or an imbalance in MQC, is a significant contributor to energetic diseases, such as obesity and hypertension. Previously, our lab conducted an experiment determine whether MQC is driven by a transient, fast-acting signaling molecule, nitric oxide (NO). Using endothelial nitric oxide synthase (eNOS), an enzyme that plays a pivotal role in the production of NO, our study aimed to investigate whether NO is involved in the immediate responses, such a gene expression, following acute exercise in skeletal muscle. To explore this, we utilized both wildtype mice and mice lacking eNOS. The study showed evidence of NO regulating gene expression associated with MQC post exercise. What is unknown and the focus of the current projects is to elucidate if NO alone is sufficient to drive MQC. The project utilizes C2C12 (mouse skeletal muscle cells) and S-Nitroso-N-acetylpenicillamine (SNAP), a nitric oxide donor, to analyze MQC. MQC was assessed via gene expression and MitoTracker, a tool used to investigate the structure of the mitochondrial network. mRNA expression via qPCR of known MQC genes (Pgc1-α, Fundc1, Nrf1) indicated that SNAP statistically increased MQC expression while MitoTracker displayed shifts in mitochondrial network fragmentation. In conclusion, the data suggests that NO via SNAP is sufficient to induce MQC, however further studies are needed to elucidate the underlying mechanism.

Mentor(s): Siobhan Craige (HNFE, Virginia Tech)

Katherine Lattig
Virginia Tech/Human Nutrition, Foods & Exercise

Dance on the Brain: Examining how dance enhances social skills through physiological synchrony

The Surgeon General has recently identified loneliness and social isolation as a public health crisis, necessitating interventions to increase social connection. Here we investigate whether dance can be used as a means of increasing connection at the level of physiological synchrony. Heart rate variability (HRV) quantifies the variation in time intervals between consecutive heartbeats, reflecting activity of the autonomic nervous system. HRV coherence has emerged as a tool for studying interpersonal physiological dynamics. In this randomized control trial, participants were assigned to a 4-week (twice/week, 90-minute sessions) dance (n=6) or dance movie-watching control (n=7). Before and after the intervention, participants underwent a series of interactive experiences with their instructor. The pairs wore a photoplethysmyography (PPG) sensor to capture blood volume changes; alterations in HR, HRV, and HRV coherence were subsequently assessed. Coherence analyses are currently in progress to examine the degree of synchrony between the HRV signals from the instructor and the respective participant during each of the interactive experiences. This study tests the hypothesis that 1) HRV coherence will be higher during these interactive experiences, and 2) that dance training will elicit heightened HRV coherence compared to the control. Anticipated findings are expected to support The Synchronicity Hypothesis of Dance and provide evidence that dance serves as an intervention to support social connection. Further research is warranted to explore the specific mechanisms underlying the observed coherence and to determine the generalizability of these findings to different dance-related therapeutic interventions.

Mentor(s): Julia Basso (Human Nutrition, Foods & Exercise)

Michelle Le
Virginia Tech/Psychology

East vs. West: Exploring the Role of Culture in Parent Emotion Socialization Practices

The preschool years are characterized by rapid behavioral and cognitive growth, with parents playing a critical role in shaping children's development through their use of emotion socialization (ES) practices. Research supports the importance of culture for shaping both parenting practices and youth emotional/behavioral development. Despite this, the majority of the ES literature has focused on Western cultures, particularly the United States (US). The present study explored differences in ES practices among 345 parents (56.8% female; Mage=32.92) of preschoolers (48.3% female; Mage=4.41) who were born and living in Eastern cultures (n=75), born in Eastern cultures and currently living in the US (n=84), or native to the US (n=186). One-way ANOVAs revealed significant differences in supportive and non-supportive ES practices. Follow-up comparisons revealed that parents born in Eastern cultures living outside of the US used significantly less supportive and significantly more non-supportive practices than native US parents. Parents born in Eastern cultures living in the US used significantly more non-supportive practices than Eastern parents living outside of the US and native US parents. Notably, supportive practices were not associated with child internalizing or externalizing problems; non-supportive practices were associated with both internalizing and externalizing problems, with these associations being stronger for families from Eastern cultures relative to the US. Results suggest that parents from Eastern cultures living in the US are particularly at-risk for displaying non-supportive reactions to child negative affect. Additionally, they support the need for interventions focused on helping parents cope with and effectively manage emotional/behavioral difficulties in young children.

Mentor(s): Rosanna Breaux (Psychology)
Delshad Shroff (Psychology, Graduate Student Mentor,Virginia Tech)

Nhu Thieu Le
University of Massachusetts Amherst/Economics

Examining the Mediating Effect of Delay Discounting on the Impact of Simulated Scarcity with Cigarette Smoking Behavior

Scarcity is associated with the devaluation of future outcomes, referred to as delay discounting (DD), which has previously been shown to be linked to smoking behaviors. This study sought to assess the effects of simulated scarcity on DD and cigarette outcomes (craving, demand), along with the mediating effect of DD on the relationship between simulated scarcity with these outcomes. A total of 207 current cigarette smoking adults were recruited via Amazon Mechanical Turk; most participants were non-Hispanic (96%) and White (95%), with a mean age of 41 years (SD:12.1). Participants were randomly assigned to read either a negative narrative describing a transition to poverty or a neutral control narrative. Two-sample t-tests and Mann-Whitney U tests were used to examine group (negative vs. neutral narrative) differences in DD and cigarette outcomes and the mediating effect of DD on cigarette outcomes were examined using a Baron and Kenny approach. To account for multiplicity, statistical significance was taken at the $p<0.0125$ level. The negative narrative group showed higher DD (mean:-3.3 vs. -4.4, $p<0.001$) and cigarette craving (mean: 6.2 vs. 5.1, $p<0.001$), with no statistically significant group differences in cigarette demand (all $p>0.05$). Partial mediation of DD was observed for cigarette craving, where 14% of the effect of simulated scarcity on cigarette craving was mediated by DD (Indirect effect:0.13, 95%CI:0.04-0.26). These findings suggest a causal role of DD on smoking behavior and motivate a need to identify targets for intervention to reduce cigarette cravings in adults.

Mentor(s): Alexandra Hanlon (Center for Biostatistics and Health Data Science)
Alicia Lozano (Center for Biostatistics and Health Data Science)
Monica Ahrens (Center for Biostatistics and Health Data Science)
Jeff Stein (Center for Health Behaviors Research)

Timothy Le
Virginia Tech/Biochemistry

TOUR

Determining the Effects of Varying Amounts of NIK Gene Expression on the Function of Epithelial Cells

Inflammatory Bowel Disease (IBD) is a chronic condition that affects nearly 3.1 million Americans. Unrestrained inflammation of the colon causes IBD patients to be more susceptible to chronic conditions such as obesity or colorectal cancer. In epithelial cells, the NF-κB pathway plays a vital role in regulating inflammation and development within the colon. Our focus is on the non-canonical NF-κB pathway, which is understudied when compared to its canonical/"classical" counterpart. When activated, the non-canonical NF-κB pathway generates an inflammatory response that fights off pathogens or foreign objects. The NF-κB Inducing Kinase (NIK) gene is a central regulating gene within the non-canonical NF-κB pathway. Preliminary results show that an absence of the NIK gene in colonic epithelial cells leads to increased cell proliferation and tumor formation in mice. This summer research project investigates how under expression and/or deletion of the NIK gene affects an epithelial cell's ability to cope with inflammation. The human colonic epithelial cell line Caco-2 cells were cultured and transfected with lentiviral particles that contained the NIK gene and green fluorescent protein marker. We quantified the results by analyzing cell morphology and proliferation. These findings were paired with the generation of "organoids" to assess the effect of NIK on growth/development. We found that loss of the NIK protein results in increased cell proliferation and tumorigenesis. These results will help better identify how amounts of NIK gene activation in epithelial cells relates to rate of inflammation and thus a person's susceptibility to tumorigenesis and IBD.

Mentor(s): Irving Allen (Virginia-Maryland College of Veterinary Medicine, Virginia Tech Carilion College of Medicine)
Holly Morrison (Virginia-Maryland College of Veterinary Medicine)

Ki Lee
Virginia Tech/Psychology

Antibiotic assay of Ice-Nucleating Lysinibacillus parviboronicapiens on other bacterial and fungal species

Ice nucleation is the process by which ice crystals form. It is fundamental to the formation of precipitation and influences earth's radiation balance. Few bacterial species have the ability to induce ice nucleation, i.e., they have Ice Nucleation activity (INA). Among them, Lysinibacillus parviboronicapiens (Lp) is the only Gram positive bacterium that secretes Ice Nucleation Particles (INP). In most bacteria, INA depends on a protein on their outer membrane. However, INA in Lp is genetically dependent on a polyketide synthase and a non-ribosomal peptide synthetase (PKS-NRPS). This type of pathway is known to produce antibiotics. This preliminary study focused on whether the INP produced by Lp had antibiotic activity. To that end, the impact of Lp on the growth of other soil and plant bacteria was determined. Lp and the other bacteria were spotted on Nutrient-Yeast Dextrose Agar (NYDA) plates containing another bacterial species and monitored for the formation of an inhibition zone. For fungi, Lp or a mutant strain that lost INA was spotted onto a plate containing either fungal species. Preliminary findings revealed that Lp does not appear to have significant antibiotic properties towards tested bacterial or fungal species. Additional results were gathered from liquid culture sequencing of both Lp and a mutant strain that has lost INA cultured with soil bacteria. Future studies will aim towards further investigating interactions between the INA of Lp and other bacterial and fungal species in order to understand if the PKS-NRPS in Lp's primary function is INA or antibiotic activity.

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

Alice Leruth
Virginia Tech/Biological Sciences

Antibody Cross-Reactivity in Gnotobiotic Pigs Immunized with rRRV-P Candidate Vaccines against Human Norovirus

Human norovirus (HuNoV) is an enteric pathogen which causes vomiting and diarrhea in people and represents a significant public health burden worldwide. Norovirus are divided into 10 genogroups and 48 genotypes. HuNoVs are mainly among genogroups GI, GII, GIV, GVIII, and GIX, and GII.4 is the predominant global variant. GII.4/2012 Sydney variant is particularly dominant. Development of vaccines capable of protecting against GII.4/2012 Sydney in addition to other variants would thus be incredibly useful in efforts to reduce the public health impact of HuNoV. One class of candidate vaccines utilizes the P domain of HuNoV capsid proteins expressed by recombinant rhesus rotaviruses (rRRV) using a reversed genetic system platform. Here, two groups of gnotobiotic pigs were orally immunized with different rRRV-P candidate vaccines, each expressing the P domain of GII.4/2003 Cin-2 variant. Serum samples were collected from the pigs at 0-, 14-, 28-, and 35-days post-immunization. Levels of HuNoV-specific IgG in the serum of each pig and reactivity to GII.4/2012 Sydney versus the Cin-2 P domain included in the vaccines, were assessed via antibody ELISA in order to evaluate the cross-reactivity of antibodies induced in the pigs and the possibility of the vaccines conferring cross-variant protection. IgG responses varied depending on the animal and vaccine formula received, but were typically strongest at post-immunization days (PID) 35 and 28. Cross-reactivity of antibodies to GII.4 Sydney NoV was detected in the majority of pigs tested. These results indicate that the candidate vaccines tested may have the capability to protect against multiple variants of GII.4 HuNoV.

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

Edwin Lewis
Morehouse College/Software Engineering

Postmortems: The Game Development Process

Postmortems play a vital role in video game development by providing a platform for analyzing completed games and extracting valuable lessons. This project explores the significance of postmortems as a learning tool for developers and industry professionals to evaluate successes and failures during the game development process. While postmortems lack a standardized structure, they typically encompass multiple aspects, including summaries, assessments of what worked well and what went wrong across various development areas, and lessons learned with accompanying recommendations.

To investigate the impact of postmortems, this study involved an extensive review of research papers and interviews with diverse game developers. The collected information demonstrated the wide-ranging benefits of postmortems beyond enhancing coding efficiency. It revealed their potential for improving marketing strategies and provided valuable insights into other areas of game development.

The findings emphasize the crucial role postmortems play in fostering continuous improvement and knowledge sharing within the video game industry. By analyzing challenges faced and solutions implemented, developers can refine their development processes, optimize gameplay mechanics, narrative design, level creation, and address technical hurdles. Furthermore, postmortems enable developers to learn from critical reception and player feedback, informing future projects and enhancing player engagement.

Overall, this study highlights the immense value of postmortems in video game development, encouraging developers to embrace this practice as a means of driving innovation, quality, and success in their future endeavors.

Mentor(s): Chris Brown (Computer Science)

Alaya Lewis
Hollins University/Theatre
Faolan Timm
Hollins University/Theatre

Edinburgh Fringe Festival: Exploring New Writing and Spoken Word Productions

The Edinburgh Fringe Festival is the largest performing arts festival in the world. Every year thousands of performers gather in Scotland to perform poetry, theatre, music, stand-up comedy, and much more. These performances include shows created by universities from all over the world. We are researching the Edinburgh Fringe Festival with the intention of creating a general overview of the event and collecting datasheets exploring University-specific and non-specific demographics, within the categories of Spoken Word and New Writing. This research design will answer the question of what makes a successful fringe festival show for both universities and individual theatre artists specifically in regards to devised work.

Mentor(s): Wendy-Marie Martin (Theatre, Hollins University)

Hadeia Liburd
Howard University/Chemical Engineering

Mannopyranoside synthesis towards production of glycomaterials

Glycomaterials are biomaterials that are derived from carbohydrates, or sugars, naturally found in nature or chemically synthesized. Starch and cellulose are prominent examples of glycomaterials with starch being an edible thickener and food stabilizer and cellulose exhibiting mechanical strength with applications as films and bioplastic products. Both polysaccharides are almost identical, consisting of glucose monosaccharide units, however they have different linkages between the glucose units, which presents unique 3D conformations. These structure-property relationships are critical to understanding and applying glycomaterials. Chemists can synthesize polysaccharides with structural control, but it requires monosaccharides with chemical protecting groups, allowing for selectivity over how the monosaccharides are linked together. Our goal was to chemically synthesize a protected mannose building block that would allow us to make mannose polysaccharides with potentially interesting material properties. Synthesis of a fully-protected mannose consisted of a series of five sequential reactions that were optimized using flow chemistry or batch approaches. This mannose building block can be used in automated assembly to successfully produce a novel mannose polysaccharide. We can further analyze the material properties and characteristics of this glycomaterial as well as prepare similar glycomaterials by modifying the building block synthetic scheme. This research will provide insight into the structure-function relationship and greater applications of these synthetic mannose polysaccharides, such as their use as sustainable and biodegradable products.

Mentor(s): Ryan Porell (GlycoMIP, FLSI)

Yihan Liu
Virginia Tech/CMDA & Math
Wesley Basener
Virginia Tech/ACM

Squares of bivariate Goppa codes

Squares of bThe goal of this project is to determine the dimensions of squares of bivariate Goppa codes, which are a new family of error-correcting codes introduced in 2021. Error-correcting codes are typically used to ensure reliable communication. Over the past decade, they have been considered for use in public-key cryptography, because current systems are vulnerable to attack via quantum algorithms. The security of such a system depends on the code behaving as a random one. The code distinguishing problem is to distinguish efficiently a generator matrix of the code from a randomly drawn one. Because a randomly drawn code has a large square, codes with small squares may be considered distinguishable, revealing structure which facilitates private key recovery in a code-based cryptosystem. Here, we rely on the structure of the underlying polynomials to reveal functions which give rise to codewords in the square an associated augmented Cartesian code. Multivariate Goppa codes are subfield subcodes of augmented Cartesian codes, a generalization of Reed-Muller codes. We demonstrate that bivariate Goppa codes arise from augmented Cartesian codes in two variables whose squares are not in general of the same form. By considering the relationship between the squaring and subfield subcode operations, we obtain a bound on the dimensions of squares of bivariate Goppa codes.ivariate Goppa codes

Mentor(s): Gretchen Matthews (Mathematics)
Giuseppe Cotardo (Mathematics, Virginia Tech)

Elly Loyd
Virginia Tech/Clinical Neuroscience

The Effect of State Anxiety on Heart Rate Variability

Heart rate variability (HRV) is the variation in beat-to-beat heart rate. Higher HRV is indicative of the body's ability to adapt well to dynamic environments. HRV varies widely among individuals, and long-term health (conversely, the risk for disease) is associated with autonomic regulation. Better understanding the relationship between HRV, anxiety, and medications will aid in more effective clinical applications. In this study, we were interested in looking at the relationship between heart rate variability measures and state anxiety as well as medication use. State anxiety is situational, and we use the State-Trait Anxiety Inventory-State (STAI-S) to index transient emotional states. In a healthy cohort (N=34, F=24) aged 18 to 44, we examined the relationship between STAI-S scores and HRV metrics. Additionally, we analyzed the effect of SSRIs or attention-deficit stimulants on HRV metrics. HRV metrics were derived from a five-minute resting baseline period across several studies in the lab prior to any therapeutic intervention. The analysis compared State Anxiety Inventory scores and HR metrics including mean normal-to-normal RR intervals (mNN), percentage of successive RR intervals that differ by more than 50ms (pNN50), and the ratio of low frequency power to high frequency power (LF:HF). Preliminary results indicate a significant positive correlation between STAI-S scores when compared to mNN and LF:HF ($p<0.0001$), and negative correlation between STAI-S and pNN50. These results suggest that with greater state anxiety, subjects have higher mNN and lower pNN50 (low variability in HR).

Mentor(s): Wynn Legon (School of Neuroscience)

Kendall Makatura
Virginia Tech/Biological Systems Engineering
Seneca Ung
Virginia Tech/Systems Biology

Effect of physiological stress on the evolution of chromosome and centrosome numbers in newly formed tetraploid cells

Approximately 40% of tumors are tetraploid (i.e., contain twice the number of chromosomes) and tetraploidy can induce tumorigenesis. Most mammalian cells are diploid but can become tetraploid if they fail to complete cell division, resulting in doubling of DNA and organelles, including the centrosome, a vital organelle for cell division. In evolution experiments conducted in standard culture conditions, newly formed tetraploid cells rapidly lost their extra centrosomes while maintaining near-tetraploid chromosome numbers. This is at odds with the observation that many cancers possess supernumerary centrosomes and near-tetraploid chromosome numbers. This led us to hypothesize that specific tumor microenvironmental conditions may influence the evolution of cancer cells after tetraploidization. To test this, we experimentally induced tetraploidy in mouse cells and then maintained these cells in oxidative stress or low glucose culture conditions, both often found in the tumor microenvironment. Analysis of chromosome numbers at regular time intervals showed that a greater fraction of the cell population remains aneuploid and near-tetraploid under oxidative stress while the control has a greater fraction of diploid cells. In low glucose, the fraction of tetraploid cells in the population mirrors that of the control. These results indicate that oxidative stress in the tumor microenvironment contributes to the potential discrepancy of centrosome and chromosome number between the in vitro and in vivo environments. An automated pipeline is currently being developed to quantify centrosome numbers in individual cells. This will allow us to determine how the culture conditions being tested influence the evolution of centrosome numbers after tetraploidization.

Mentor(s): Daniela Cimini (Biological Sciences)

Jeremy Marsh
Virginia Tech/Geography

Distribution of Winter Injury on Bermudagrass Athletic Fields Relative to Athlete Movement

Turfgrass winter desiccation commonly impacts bermudagrass within the transitional zone during spring green-up. This study is designed to explore the relationship between the distribution of cold-related injury of bermudagrass athletic fields and patterns of athlete movement during practice and games. It has been hypothesized that the presence of winter desiccation is increased when there is a higher presence of athlete foot traffic. Winter desiccation can cause poor field conditions, leading to more injuries among athletes and individuals who use the fields recreationally. To collect this data, a drone was used to take images which were then stitched together into an orthomosaic using Pix4d. A Clegg Impact Tester was used to collect surface firmness data on most of the sites in a repeated pattern. The surface firmness data was then made into a heat map using the kriging tool in ArcGIS Pro. A heat map of the playing patterns of Collegiate NCAA Division I Women's soccer players was laid over the orthomosaics of the affected fields to study the correlation between athlete foot traffic tendencies and the occurrence of winter injury. The anticipated results of this project are that there is a correlation between surface firmness data, the locations of the winter desiccation, and the frequency of athlete movement over the observed fields. The hope is that there is a higher surface firmness and a higher presence of athlete movement over areas of winter desiccation.

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

Kofi Mason
Virginia State University/Computer Engineering

Developing aerial robotic systems for human and environmental science research

Aerial robots, or drones, can support a range of important engineering and scientific research objectives. For example, drones can support human factors research involving telerobotic operations. Drones can also sample the atmosphere to support weather science. The Nonlinear Systems Laboratory (NSL) is developing Quadditch, a unique research tool for studying human-robot teaming. My work this summer has involved developmental testing of the Quadditch hardware, a set of telerobotically operated drones. I have also worked to determine and document performance capabilities of all of the NSL's uncrewed aircraft, allowing the NSL to quickly match aerial robotic assets to emerging research opportunities. An important emerging application is weather science. Society depends on timely and accurate weather forecasts. Drones can improve the spatial and temporal resolution of atmospheric measurements to improve the accuracy and timeliness of forecasts. More specifically, small uncrewed aircraft can autonomously, economically, and more persistently measure the boundary conditions for atmospheric models at low altitudes enabling more accurate weather modeling. Part of my work involved running experiments in Virginia Tech's 0.7m Subsonic Open Jet Wind Tunnel to measure the dynamic response of a vaned air data unit to be mounted on wind-sensing aircraft. Overall, the implications of the research conducted will enhance the capabilities of both manned and unmanned flight operations by equipping pilots with the necessary tools for safe flight.

Mentor(s): Craig Woolsey (Kevin T. Crofton Department of Aerospace & Ocean Engineering)

Skylar Mayfield
Virginia Tech/Computer Science

Visualizing The Impacts of Laboratory Class Design on Student Performance

A notable issue in scientific research and academic institutions is a lack of accessibility within laboratory settings and accommodating those with disabilities who face unique struggles. To investigate this matter, an ongoing research study was conducted on a total of eighty-four biochemistry students in four different class sections for a laboratory class. Data on each student's learning outcomes, disability and demographic traits, challenges faced, and recommendations for improvement were collected for the duration of the class. As a part of analyzing these datasets, this research aims to visualize important trends and features, and to display this data in a way that clearly summarizes the key findings for a general audience. To achieve this, after scoring the surveys and preparing the data, graphical packages from R were used to create static visualizations. Concurrently, an initial round of statistical testing was performed to identify any significant differences in learning outcomes between class sections and to determine if student scores progressed over time. Using a p-value of 0.05 with McNemar's Test, these initial results indicated an improvement in performance for some questions throughout the semester. Additionally, an increase in mean student scores was observed. To complement these results, an interactive dashboard was created using Tableau, and additional methods of analysis will be considered and performed in the future. At the end of this research, the goal is to help inform the creation of effective interventions that laboratory classes can implement to improve student outcomes and experiences through better accessibility.

Mentor(s): Anne Brown (Biochemistry)
Jonathan Briganti (University Libraries)

Grace McCarthy
Virginia Tech/Chemical Engineering

Mass Transfer Through a Beaver Dam Analog

During the fall of 2022 we built a Beaver Dam Analog (BDA) along Stroubles Creek in Blacksburg, VA at the StREAM Lab. The overall goal was to evaluate the impact of the man-made beaver dam on the mass transfer and storage of sediment, phosphorus, and nitrogen in Stroubles Creek during storm events. This effort supports an ongoing research effort in the StREAM Lab that studies water quality and biogeochemical changes immediately surrounding the BDA. During the 24 hours surrounding two significant rainfall events, a 1 L sample of water was taken every hour using an ISCO automatic water sampler both upstream and downstream of the BDA. These samples were then analyzed to measure content of total suspended solids, total phosphorus, total nitrogen, nitrate, ammonia, and orthophosphate. As the stream moves across the BDA, we expected the BDA to act as a natural filtration system and decrease sediment, nitrogen, and phosphorus levels. However, results were not as straightforward as hoped. Due to the complicated nature of variable flow during storms and flooding through the BDA, the relative content levels of sediment, nitrogen, and phosphorus were not consistent with location upstream versus downstream during the two storm events.

Mentor(s): Cully Hession (VT Department of Biological Systems Engineering)

Tryston McCaskill
Howard University/Chemical Engineering

Accelerating Carbohydrate Chemistry using Flow

Flow chemistry is a chemical engineering discipline that has recently advanced reaction efficiency in the industrial world. Continuous flow reactions use syringe pumps to push reagents through a series of tubes, allowing them to react at a particular flow rate and increase reaction mixing. The flow reactor design allows for control over reaction conditions including temperature, concentration, and flow rate, which can often be tuned to achieve higher product yields in shorter times. While flow chemistry has proven to be efficient when it comes to small molecule pharmaceutical processes, it has yet to be fully developed for producing complex carbohydrates, which are biomolecules with an incredible diversity of biological functions and material properties. Creating a flow setup of our own, we sought to optimize flow reaction conditions toward the synthesis of mannopyranosides in order to determine if flow chemistry could be advantageous within the carbohydrate chemistry field. We were able to successfully optimize some of the reactions via flow to where they outperformed the comparable batch reaction in a flask. We found that flow rate and concentration were the main factors that influenced the product yield and purity. These results prove that flow chemistry is an advantageous approach for carbohydrate chemistry and may improve or allow for the synthesis of complex carbohydrates. Flow chemistry offers the additional modular design where multiple syringe pumps and connective junctions are combined in order to streamline reactions in a single flow system. Future work will expand on these flow reactors for carbohydrate synthesis applications.

Mentor(s): Ryan Porell (GlycoMIP, FLSI)

Genet Mehari
Virginia Tech/Biochemistry

TOUR

The Role of eNOS in Mediating Hepatic Mitochondrial Quality Control

The extensive physiological benefits of exercise are known to mitigate the onset of cardiometabolic disease. The endothelium is especially important, as it houses endothelial nitric oxide synthase (eNOS), a producer of the vasodilator nitric oxide (NO). eNOS has been demonstrated to influence hepatic adaptations to repeated aerobic exercise (Cunningham et al., 2022). Furthermore, acute exercise has been shown to induce controlled mitochondrial degradation (mitophagy) (McCoin, et al., 2022). Since there is little to no research elucidating the role of eNOS on hepatic mitophagy, this project seeks to address the following gap in knowledge: how does endothelial nitric oxide synthase (eNOS) influence hepatic mitochondrial quality control in response to a single event of aerobic exercise? Three hours after a single bout of acute exercise, mice were euthanized, and livers were homogenized to perform subsequent RNA and protein isolation. The RNA was converted to cDNA, which was subjected to quantitative polymerase chain reaction (qPCR) analysis. Isolated protein was then subjected to SDS-PAGE and western blot analysis to assess proteomic expression. Interestingly, Pgc1a, a regulator of mitochondrial biogenesis, and Pgyl, a gene encoding for glycogen phosphorylase in glycogenolysis, were increased in exercised WT mice, but not in eNOS KO mice. These data suggest that eNOS-derived NO influences mitochondrial quality control and hepatic metabolism through glycogenolysis, ultimately increasing our understanding how NO manages mitochondrial homeostasis.

Mentor(s): Siobhan Craige (Human Nutrition Food and Exercise (HNFE))

Alison Mercedes Casado
Williams College /Physics

Lipid Membrane Interactions with Recombinant Proteins

The recombinant protein Target of Myb1 (TOM1) is involved in several physiological processes such as neuroinflammation, autophagy, and immune responses. TOM1 is an adaptor protein that works to perform trafficking of ubiquitinated transmembrane protein receptors (cargo). During infection states, however, TOM1 is sequestered to signaling endosomes by interacting with the membrane lipid, phosphatidylinositol 5 phosphate (PtdIns(5)P), hindering its trafficking functions. Another adaptor protein, Phafin2, is involved in the process of autophagy through its interaction with the phosphoinositide, phosphatidylinositol 3 phosphate (PtdIns(3)P). To investigate the interaction mechanism between TOM1 and Phafin2 and their mode of incorporation into membranes, we performed Langmuir studies of model lipid monolayers with and without the binding substrates, PI3P and PI5P. Kinetic runs are performed by tracking the surface pressure of the monolayers over time after the injection of the protein in the water subphase. Analyzing the change in surface pressure as a function of time illustrates how these proteins interact with the phospholipids that compose cell membranes. Repeating measurements with different protein combinations will indicate whether the existing theories relating to the functions of certain domains of each protein hold.

Mentor(s): Rana Ashkar (Center for Soft Matter and Biological Physics)
Daniel Capelluto (Center for Soft Matter and Biological Physics)

Emi Miyazaki
University of Virginia/Statistics

Validating an Atmospheric Dispersion Model using a Historical Field Experiment

Numerical models serve as valuable tools for predicting various outcomes, including sales forecasting, weather prediction, and atmospheric transport of biological and chemical agents. However, it's important to acknowledge that while all models are imperfect, some models can be useful, so validation studies are necessary to determine their reliability and accuracy. This study validates a modern transport dispersion model on historical experimental data from the mid-20th century. The Lagrangian Stochastic (LS) model was primarily used in this study, which describes the trajectories of particles within a turbulent flow based on a statistical representation of the random velocity field (Wilson, 1995). This study uses data from the Hanford-67 atmospheric field diffusion experiment, which consists of four chemical tracers and 103 tracer releases during 54 release periods conducted over six years (1967-1973), to validate a LS model (Nickola, 1977). The LS model was used to predict crosswind integrated concentration values observed in the Hanford-67 experiment. Five meteorological parameters were used to drive the LS model in each simulation, and were obtained from historical reanalysis data. Upon comparing the observed concentration data with the model's predictions, numerically compared using root mean square error, the experimental values consistently exceeded the predicted values. However, the overall similarity in dispersal kernels indicates that further investigation of the input parameter values utilized in the LS model is warranted.

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

Tyler Moore
Virginia Tech/Biochemistry

Histotripsy: Cancer Treatment using Focused Ultrasound inducing Mechanical Ablation, Successfully Ablates Pancreatic Tumor

Pancreatic cancer, with a rapid spread rate and extreme difficulty in pre-stage IV diagnosing, has consistently been one of the most lethal diseases. With a poor prognosis, pancreatic cancer is rarely discovered and diagnosed before metastasis. Even with early diagnosis, modern treatment methods struggle, as radiation, surgical, and thermal based treatments each have short/long-term flaws. Histotripsy, a non-invasive, non-thermal developing tumor treatment alternative, utilizes focused ultrasound (FUS) to mechanically ablate tumor cells. Through the extreme formation and breaking of bubble clouds within desired tissues, cavitation occurs in diseased areas, allowing for an extremely precise and non-invasive treatment on cancerous cells. Our aim is to determine parameters which yield effective partial and full ablation in murine cell-count assays (Pan02) and microscopy post-treatment. By altering the frequency of the ultrasonic transducers, in-vitro and in-vivo studies have shown promising feasibility results. The expected results involve observing small regions of ablation in intended organs/tissues, whether within a healthy study or tumor-injected treatment practices. These results convey the possibility of a new substitution for modern cancer treatments with significant practical applications in treating cancer without surgery. Future in-vivo studies look to identify efficient parameters including pulse repetition frequency (PRF), length of treatment, and organ of interest. With fine tuning of parameters to identify effective ablation techniques in upcoming mouse and pig trials, histotripsy challenges modern cancer techniques by inducing diseased tissue cavitation and allowing natural immune response to finish the job.

Mentor(s): Irving Coy Allen (Department of Biomedical Sciences and Pathobiology)
Eli Vlaisavljevich (Biomedical Engineering and Mechanics, Virginia Tech)

Richard Morgan
Virginia Tech/Computational and Systems Neuroscience

Exploring Computational Methods in Wet Lab Sciences

Computational methods are becoming more frequently used in studying biological systems. Working in two areas of biology, I explored how computational tools can be used to inform future experimental directions. In the Bertke lab, molecular pathways and mechanisms of HSV (Herpes Simplex Virus) are studied to identify antiviral targets to prevent recurrent disease. HSV affects over 60% of the population. Once the host is infected, the virus lies latent for life, but can reactivate to cause skin sores and in some cases, life-threatening disease. Using biological systems modeling software and analysis of previous studies, I visualized signaling pathways downstream of triggers that lead to HSV reactivation, enabling identification of interactions between these pathways and previously unexplored mechanisms. In the Vinauger lab, the connection between circadian rhythm and feeding pattern of Aedes aegypti mosquitoes is explored as a way of predicting mosquito behavior, but mass studies of mosquito activity monitoring are difficult to perform. Inspired by previous solutions to this problem, I designed an economically viable solution to detect motion in large groups of mosquitos in a lab environment. Furthermore, I used a program named “SLEAP” to train a machine learning model that tracks the individual joints of mosquitoes to quantify the behavioral correlates of their sleep-like state, without requiring time-consuming manual tracking. This work will guide further studies to accurately assess how changes to the mosquito’s environment affect its sleep and circadian rhythms. Using data-centered research, we can model computational solutions for laborious procedures and analyses to guide bench-side experiments.

Mentor(s): Andrea Bertke (Department of Population Health Sciences)
Andrea Bertke (Department of Population Health Sciences, Virginia Tech)
Clement Vinauger (Department of Biochemistry, Virginia Tech)

Sareth Moy
Berea College/Economics
Vivian Peregrino
Virginia Tech/Environmental Economics

VCE: Optimizing Extension Services

Virginia Cooperative Extension Family and Consumer Sciences (VCE FCS) agents are essential contributors to the well-being of Virginian individuals, families, and communities. Their commitment to knowledge and resources greatly benefits communities throughout Virginia. However, these dedicated professionals currently face challenges that hinder them from delivering their services and educational programs across the entire Commonwealth. Our project aims to achieve two objectives. In the first component of our project, we develop a mathematical programming model to optimize current VCE FCS agent territories and propose optimal new agent locations that are best able to alleviate the demanding workload agents currently face while also meeting the specific needs of local communities across the Commonwealth. Our results from this part of the project can be used to inform policymakers and VCE FCS leadership where the best locations for new agent hires might be.

In the second component of our project, we build an interactive dashboard for agents so that they can learn more about their communities, enabling them to tailor their services and interventions accordingly. This dashboard displays data on critical health variables that influence the well-being of Virginia's localities and the work of FCS agents. This dashboard will allow agents to gain valuable context regarding the public health landscape of the counties they serve. Overall, this project aims to empower FCS agents and leadership with the knowledge and insights necessary to make informed decisions and have an even larger positive impact on the well-being of individuals and families in Virginia.

Mentor(s): Michael Cary (Virginia Tech Agricultural and Applied Economics)
Susan Chen (Virginia Tech Agricultural and Applied Economics)

Sarah Newman
Virginia Tech/Animal and Poultry Sciences

Measuring circulating glucose concentrations in dairy cattle to predict the response to summer heat stress.

In dairy cattle, heat stress reduces milk yield and quality, decreases fertility, and causes a variety of general health and welfare concerns. Heat stress is a growing issue in animal agriculture and causes significant financial losses within the U.S. dairy industry. During periods of heat stress, dairy cattle exhibit unique physiological responses that cannot be induced under any other circumstances. For example, most cows exposed to summer heat stress become hypoglycemic, which may represent a beneficial adaptation enabling cows to better sustain production during heat stress. The objective of this experiment was to determine the relationship between blood glucose concentrations and productivity during heat stress in early lactation dairy cattle. Blood samples and rectal temperatures were collected twice weekly from 50 Holstein dairy cows housed at the VT Dairy Complex. Blood glucose concentrations were measured using a handheld glucometer. Cows were milked twice daily and milk production records were obtained from farm records. It was found that in periods of high heat, specifically coupled with high humidity, up to 40% of lactating dairy cows go into a hypoglycemic state. It is also shown that in the summer season when there are periods of continuous heat stress, average glucose declines as the weather intensifies. Furthermore, average daily milk weights fluctuate depending on the individual cow and their susceptibility. These findings suggest that dairy producers can use glucose measurements as a tool to predict how an individual cow will respond to heat stress, enabling precision management based on susceptibility.

Mentor(s): Shelly Rhoads (School of Animal Sciences)

Katherine Ngo
Virginia Tech/Biological Sciences
Lin Miao
Virginia Tech/Biological Sciences

Case Study: Determining the Optimal Approach for Comparing Rhythmic Datasets

Circadian rhythm is an internal process that regulates various biomedical and behavioral processes over a 24-hour cycle. It can be characterized by three parameters: period, amplitude, and phase. While numerous algorithms have been developed and widely utilized to detect rhythmicity and circadian parameters under single conditions, there has been growing interest in the development of algorithms for identifying differential rhythmicity in transcriptomic data under two or more conditions. This study aims to compare the distinct characteristics of six algorithms employed for detecting differential rhythmicity: DODR, LimoRhyde 1/2, circaCompare, CompareRhythms, DiffCircadian, and DryR. We present their distinct features, capabilities in detecting rhythmicity and differential rhythmicity, as well as the differential genes detected by each algorithm. We applied the same transcriptomic dataset to each algorithm, consisting of gene expression data from wildtype and Bmal1 knockdown NIH3T3 cells, which is a critical clock gene that maintains gene expression rhythmicity. We found that the circaCompare algorithm detects the highest number of rhythmic genes in wildtype NIH3T3 cells, while the dryR algorithm identifies the most differential rhythmic genes between the two conditions across three statistical cut-offs. Interestingly, only 27 genes were detected by all six algorithms among the differentially rhythmic genes. These results highlight the significant variations in rhythmic patterns detected by different algorithms. The outcomes of this study provide valuable insights for researchers, aiding them in selecting the most suitable algorithm for their specific study.

Mentor(s): Shihoko Kojima (Department of Biological Sciences)

Jenny Nguyen
William Byrd High School

The Associations of Delay Discounting, Chronic Pain, and Obesity with Unhealthy Behaviors in Individuals in Recovery from Substance Use Disorder

Individuals in recovery from substance use disorder (SUD) often present high levels of delay discounting (DD), which is associated with a range of unhealthy behaviors. However, whether chronic pain and obesity affect DD and unhealthy behaviors remains unclear. This study examines the association between chronic pain and obesity with DD, and whether DD predicts unhealthy behaviors as a function of chronic pain and weight status. Individuals in recovery from SUD (N = 172 [101 female]; age: 40.64±12.55) were separated into four groups: chronic pain/obesity (CP/OB; N=40), chronic pain/non-obesity (CP/NOB; N=61), non-chronic pain/obesity (NCP/OB; N=24), and non-chronic pain/non-obesity (NCP/NOB; N=47). Participants reported weight and height and completed a DD task and questionnaires about pain and unhealthy behaviors (e.g., binge eating, risky behaviors, etc). ANOVAs and regressions tested the effects of group on DD and unhealthy behaviors, and the association between DD and unhealthy behaviors controlled by group, respectively. Results revealed that individuals in the NCP/NOB group were less sedentary than those in the CP/OB group ($p = .01$). Trends found that the CP/OB group showed worse personal development (e.g., goal setting/social interactions) than the NCP/NOB group ($p = .07$), and the NCP/NOB group indicated that they drive more irresponsibly than the NCP/OB group ($p = .07$). Additionally, DD was positively associated with binge eating ($p = .01$), sedentary behavior ($p < .01$), lack of overall health behaviors ($p = .04$), risky behaviors ($p = .01$), and financial irresponsibility ($p < .01$). Findings have implications for improving decision-making skills and health behaviors.

Mentor(s): Daniel Cabral (Addiction Recovery Research Center)
Warren K. Bickel (Center for Health Behaviors Research and Addiction Recovery Research Center, Fralin Biomedical Research Institute)

Abigail Nimmo
High Point University/Biochemistry

Identification of active site residues in YUC10 from Arabidopsis thaliana

Auxins are plant hormones involved in plant growth and development. YUCCAs are flavin-dependent monooxygenases (FMO), which convert indole-3-pyruvic acid (IPA) to indole-3-acetic acid (IAA), the main plant auxin. Residues that make up the active site and are important for catalysis of YUCCAs are unknown. A 3-dimensional model of YUC10 from Arabidopsis thaliana was generated using AlphaFold, and IPA was docked close to the flavin to identify potential active site residues. Based on proximity to IPA, H52 and N180 were predicted to be involved in substrate binding. To probe the roles of these residues in catalysis, site-directed mutagenesis was used to create the YUC10 H52A and N180A variants. The mutant enzymes were recombinantly expressed and purified using Ni-NTA immobilized metal affinity chromatography (IMAC). Steady-state kinetic data was measured utilizing an oxygen consumption assay, as oxygen is a co-substrate for FMOs. Initial kinetic findings are consistent with H52A exhibiting a decrease in kcat (how many substrate molecules are turned into product per second), but no change in KM (the concentration of substrate needed to reach one half the maximum velocity). These results suggest that H52 may be involved in catalysis rather than substrate binding, as originally hypothesized. Since YUCCA proteins are found within the entire planta domain, this research has applications with green chemistry and the agricultural industry, especially with crop engineering.

Mentor(s): Pablo Sobrado (Biochemistry)

Kamryn Noel
Virginia Tech/Biochemistry & Clinical Neuroscience
Hunter Dyche
Virginia Tech/Computational & Systems Neuroscience

Elucidating potential signaling proteins involved in astrocytic BDNF/TrkB.T1 dependent responses

Brain derived neurotrophic factor (BDNF) is a vital growth factor involved in maturation and survival of the CNS. Previous work has identified the truncated isoform of BDNF's receptor, TrkB.T1, to play a critical role in astrocyte morphogenesis and development (Holt et al., 2019). However, the signaling mechanisms that govern these processes are not well understood. Using wildtype and TrkB.T1 knockout mice, we used magnetic activated cell sorting (MACS) to isolate primary, cortical astrocytes in vitro. At DIV 10, we treated astrocytes with 50ng/mL of BDNF across four separate timepoints: 0 hours, 1 hour, 6 hours, and 12 hours. Post-treatment, cell lysates were obtained for immunoblot analysis to quantify relative protein changes. It is well established that protein kinase C (PKC) is involved in signaling pathways that promote neurite outgrowth via transcription (Cheng et al., 2007). Therefore, we probed WT and TrkB.T1 KO immunoblots with antibodies against PKC and p-PKC, in addition to CREB and p-CREB, which activate transcription downstream of PKC. Our results show a significant decrease in p-PKC expression at the 12 hour time point in WT astrocytes. Conversely, we found that TrkB.T1 KO astrocytes alone do not appear to elicit p-PKC changes in response to BDNF. Additionally, our data suggests up to a 40% decrease in relative p-PKC expression at the 12 hour time point when comparing WT and TrkB.T1 KO astrocytes. These data suggest potential proteins in the BDNF/TrkB.T1 signaling pathway that drive developmental and morphological processes in astrocytes.

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

Megan O'Hara
Virginia Tech/Microbiology

Detergents Including Bile Salts Promote Increased Bacterial Twitching Motility

Twitching motility allows bacteria to crawl on and between solid surfaces. It is powered by the bacterial type IV pilus (T4P) which is a critical virulence factor for many pathogens with increasing antibiotic resistance. It was previously observed that the twitching motility of Acinetobacter nosocomialis, an opportunistic human pathogen, only exhibits twitching motility on MacConkey but not LB agar plates. Here, we analyzed MacConkey agar to determine which of its components was responsible for activating A. nosocomialis twitching. Our results identified bile salts as the key ingredient because their addition to LB medium allowed A. nosocomialis to move by T4P-mediated twitching. We present evidence that twitching motility is possibly stimulated by surface interactions, as the addition of selected detergents into LB agar enabled A. nosocomialis twitching. This stimulatory effect is not confined to Acinetobacter spp. because the twitching motility of Pseudomonas aeruginosa is also enhanced by bile salts and other detergents. This work here indicates that host and other environmental factors may impact the functionality of virulence factors critical for a bacterial pathogen to initiate and establish the infection of its hosts.

Mentor(s): Zhaomin Yang (Department of Biological Sciences)

Nicole Odibo
Virginia Tech/Public Health
Rishab Desai
Virginia Tech/Computational Modeling and Data Analytics

Development of a Surface-Enhanced Raman Scattering (SERS) based Nanoprobe for Leaf pH Detection

Accurately measuring pH outside of laboratory settings is a persistent challenge due to the lack of portability of pH meters and the destructive nature of traditional measurement methods. Our research endeavors to overcome these limitations by developing an innovative, efficient, and cost-effective method for pH measurement in both liquid and solid substances. Conventional methods for measuring the pH of solid materials often involve destructive processes such as soaking and grinding, which compromise the integrity of the sample. To circumvent this issue, we have devised a non-destructive approach utilizing a nanoparticle-based pH probe and Surface Enhanced Raman Spectroscopy (SERS). In our method, gold nanoparticles (AuNP) were functionalized with 4-MBA, resulting in distinct SERS peaks corresponding to different pH levels. By constructing a calibration curve using known pH values, we established a reliable reference for subsequent pH determinations.
To determine the pH of leaves, we applied a droplet of the pH probe onto the leaf surface, and subsequently captured SERS spectra. The pH measurements were conducted on leaves from five distinct trees, both in their fresh and dried states. By comparing the acquired spectra with a calibration curve, we achieved accurate pH determination without sacrificing the sample or requiring elaborate equipment. The pH variation between these two states was significant, potentially attributed to alterations in metabolic and decomposition processes that affect the pH. This non-destructive methodology enables pH measurements to be carried out in non-laboratory settings. Moreover, by eliminating sample destruction and minimizing equipment requirements, our method opens up new avenues for future research and real-world applications, fostering innovation and progress in the field of pH analysis.

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

Gaith Orfaly
Virginia Tech/Aerospace Engineering

Modelling Corrosion

The hulls of boats experience corrosion due to the exposure to water around them. A fundamental understanding of the interplay of chemistry and fluid transport can reduce maintenance and component lifetime. The purpose of this research is to investigate the effects that Reynold's number has on pitting corrosion, how the size of the pit scales with corrosion (disturbances in the flow increase the corrosion rate), and how the chemistry, coupled with the mechanics of the fluid, affect this system. Additionally, the research will investigate the use of sacrificial anodes to reduce the effect of corrosion as well. This will include investigations of which types of anodes, the location of the anodes, and how they will maintain the integrity of the ship's hull. The goal is to apply our findings to the sacrificial anodes, which would reduce the effects of corrosion. To conduct this investigation, the conductivity equation (with the governing equations of liquid assumed as neutral), the conservation of current, Poisson equations, Navier Stokes, and the Butler Volmer expressions are used to analyze and solve the electrochemistry. A triple-deck asymptotic analysis of the Boundary layer is presented. An analysis of flow and electrolyte concentration in pits of different sizes and the Reynold's number scaling is presented. The results of this work show the potential in the pitted geometry and determine the flowfield as a function of Reynold's number, which determines the concentration of electrolytes and corrosion rates. Higher Reynolds numbers increase separation and recirculation in the pit, thus increasing corrosion.

Mentor(s): Luca Massa (Aerospace)

Cleo Orlando
Virginia Tech/Microbiology

Exploring patterns in microbial activity across altered stream flowpaths

Streamwater chemistry can be altered by flow changes, such as flooding, drought, and dam construction, which have implications for biogeochemical processes such as metabolism. Here, we looked at how flow path alterations affect stream metabolism in Stroubles Creek. Stroubles is a third-order stream running under and through the town of Blacksburg and Virginia Tech's campus, further making its way to the New River. We collected weekly surface water samples at seven sites, including inputs to, within, and exports from the Duck Pond, to characterize biological and chemical differences across the upper Stroubles network. The water samples were used to inoculate EcoPlates, 96-well assays that quantify microbial metabolism of different carbon substrates. We also analyzed water samples for dissolved organic carbon(DOC), dissolved oxygen, turbidity, temperature, and conductivity. Preliminary results show differences in conductivity, temperature, oxygen, and DOC. Conductivity is initially high but gradually lowers across the pond and is lowest in the outlet. Temperature is initially low in both inlets and increases across the pond, remaining at a similarly high temperature in the outlet. Both carbon and oxygen are initially low in the inlets; the amounts vary across the pond but trend up with higher amounts available around the outlet. Downstream of the Duck Pond seems more bioreactive; the incubated EcoPlates had higher absorbances in the outlet. This could be because the temperature is inhabitable for a broader range of creatures (microbes included), and there may be more nutrient availability from animal and human activity within the pond.

Mentor(s): Erin Hotchkiss (Biological Sciences)

Khadijat Oyediran
Virginia Tech/Mechanical Engineering

Overstepping boundaries: How fluid flow impacts different tumor cell populations to invade in brain cancer

In the U.S., an estimated 2 million cancer diagnoses are expected this year. Despite advances in cancer research, where strides have been made in understanding various cancers and their hallmarks, 60% of cancer deaths result from metastasis. Metastasis is the spread of cancer to other parts of the body away from where it first developed. Cancer cell invasion, where cells invade beyond the border of the tumor into the surrounding normal environment, is mediated by fluid within the tissue and increased fluid flow from the tumor contributes to invasion. This study focuses on the response of fluid flow of different populations from patient-derived brain cancer stem cells, which are the most aggressive population of tumor cells. We previously isolated specific populations and found that they respond to fluid flow differently. Further, through fluorescent staining and imaging of mouse brain tumor tissues, we examined cellular invasion of these different populations with findings showing the most flow-responsive colony being the most invasive. The role that fluid flow plays on the invasion of cancer cells and interactions within and outside of the tumor are still being explored. Ultimately, preliminary findings indicate that there are different populations within the same tumor and they respond to fluid flow differently, which can possibly be considered another hallmark in the cancer field.

Mentor(s): Monet Roberts (Biomedical Engineering and Mechanics)

Sharat Paka
Virginia Tech/Biological Sciences
Nisha Dhiman
Virginia Tech/Biological Sciences

Potential Role of L-Arabinose as Chemoattractant in Sinorhizobium meliloti

Sinorhizobium meliloti is a natural symbiont of Medicago sativa (alfalfa). Bacterial directional movement, i. e. chemotaxis, forms the basis of the symbiotic relationship between S. meliloti and alfalfa. S. meliloti senses chemoattractants released by plant seeds and roots via different chemoreceptors. Specific chemoreceptors like McpU, McpX, McpV, and McpT respond to amino acids, QACs, and carboxylic acids, respectively. Sugars also contribute to about 29% of the root exudates of alfalfa; however, information regarding their potential role as chemoattractants is sparse. To determine the ability of S. meliloti to utilize sugars as a nutrient source, a Biolog growth assay was conducted utilizing PM1 and PM2 plates. The assay revealed L&D-arabinose as the best utilized carbon sources by S. meliloti. However, to analyze the chemotactic response of S. meliloti towards arabinose in a capillary assay, the bacteria need to be preconditioned in a growth medium containing L-arabinose to activate its arabinose catabolism regulators. Therefore, a growth curve experiment using L-arabinose was conducted to determine the physiologically relevant and optimal concentration for the growth of S. meliloti. In this experiment, a defined minimal medium was supplemented with various concentrations of L-arabinose. 2% L-arabinose supplemented growth medium supported highest bacterial growth followed by 0.2% and 0.02% arabinose. This optimized medium can aid in conducting biological assays to identify potential sugar molecules serving as chemoattractants for S. meliloti. Understanding of S. meliloti chemotactic response to host cues through characterization of chemotaxis to sugars can further revolutanize the optimization of alfalfa crop yields.

Mentor(s): Birgit Scharf (Biological Sciences)

Tyler Parker-Rollins
Virginia Tech/Psychology

TOUR

Psychological Safety in Higher Education

Psychological Safety, or the general degree of psychological comfort one experiences in a given situation, has recently become a topic of extreme interest in industry (Clarke, 2020). Recent research indicates that in workplace settings, psychological safety can increase creativity (Castro et al., 2018), engagement (Frazier et al., 2016), and reduce distress (Obrenovic et al., 2020). Although research on psychological safety has increased dramatically in recent years, this concept has seldom been studied beyond the workplace. Because increasing creativity, improving engagement and reducing distress are all critical factors in improving education, the examination of studying psychological safety in the college classroom warrants systematic empirical investigation. The present study examines student perceptions of psychological safety in individual courses at Virginia Tech through an innovative 36-question survey. Thus far, 97 participants have provided answers to this survey, each responding in reference to a particular singular course they have recently taken. This questionnaire measures psychological safety with an eight-question "Psychological Safety in Education" scale, adapted from psychological safety scales created for industrial settings. Additional questions on our survey assess variables that may impact a student's perception of psychological safety, including the student's academic year, the number of students in the course, the course subject, as well as other related issues. While a larger sample is needed for confidence in these results, the current data indicate that psychological safety is influenced significantly by the number of students taking a course, the student's success (grade) in the course, and the subject matter of the course.

Mentor(s): E. Scott Geller (Psychology, Virginia Tech)

Daniela Pereira
Virginia Tech/Clinical Neuroscience

Assessing motor learning in children with hemiparesis undergoing ACQUIRE therapy

ACQUIRE is a type of pediatric constraint induced movement therapy (P-CIMT) developed to improve motor skills in children with hemiparesis, commonly resulting from cerebral palsy (CP) or stroke. ACQUIRE centers treatment around goal-oriented tasks while incorporating learning principles like operant conditioning to improve function of the weaker upper extremity (UE). This treatment process has documented evidence of improving performance of different motor skills but an understanding of how and when learning occurs may enhance our understanding about the mechanistic learning processes involved. This research aims to answer how motor learning is changing across four weeks of ACQUIRE therapy. We developed the dynamic behavioral motor learning scale (DB-MLS) to score weekly videos of children with hemiparesis between the ages of 1-5 years participating in ACQUIRE therapy. The DB-MLS evaluates motor learning of two behaviors, grasp and reach, as a composite score of three performance metrics: acquisition, retention, and transfer. The scale is dynamic because it allows raters to choose activities to rate, potentially making the scale useful for retrospective analysis across various treatment regimens. We assessed changes in motor learning weekly throughout the four-week therapy regimen. Descriptive data across the three performance metrics and two behaviors will be presented for all four weeks. A comparison between the weeks will provide data regarding how learning progresses across time and is expected to provide preliminary data for this topic to be further investigated with a larger sample.

Mentor(s): Stephanie DeLuca (Neuromotor Research Clinic)

Logan Peters
Virginia Tech/Biochemistry

Understanding Altruistic Enzymes: Biochemical characterization of the self-sacrificing p-aminobenzoate synthase from Nitrosomonas europaea

Tetrahydrofolate (THF) is an essential one-carbon carrier cofactor involved in amino acid and nucleic acid biosynthesis. Our lab investigates a unique self-sacrificing enzyme involved in a non-canonical route for the synthesis of the p-aminobenzoate moiety of THF in select bacteria. Garnering a deeper understanding of the mechanistic details of this reaction could contribute important information towards the development of novel antibiotics. Previous work showed that the self-sacrificing pAB synthase from Chlamydia trachomatis, CT610, utilizes a heterodinuclear Mn/Fe cluster for catalysis. However, interestingly, the pAB synthase from Nitrosomonas europaea, NE1434, seems to prefer a Fe/Fe cofactor. Here we report the detailed investigation of the metal-dependence of the pAB synthase activity of NE1434. Additionally, site-directed mutagenesis was utilized to create variants proposed to be important for the self-sacrificing reaction. His-tagged versions of the wild-type NE1434 along with the variants were expressed in E. coli and purified by metal-affinity chromatography. The reaction uses molecular oxygen as a substrate, so purification of the protein was performed anaerobically, allowing control over when the product formation could begin. Overall, the preliminary results support the role of Tyr25 as the sacrificial source of the aromatic group for pABA synthesis, as well as the role of Lys159 as the sacrificial amino group donor. These self-sacrificing amino acids are thus conserved between CT610 and NE1434. The increase in activity in the F148/177Y mutants as well as the conversion in metal preference demonstrates that the tyrosine residues have a role in dictating metal preferences as well as a role in the process of radical translocation. Thus, this work provides new insights into the mechanism of self-sacrificing pAB synthases.

Mentor(s): Kylie Allen (Biochemistry)

Katie Price
Virginia Tech/Industrial and Systems Engineering

Understanding Perceptions Limiting Adoption of Precision Turfgrass Management: An Analysis of Barriers

Precision turfgrass management (PTM) is the method to optimize performance and use minimal amounts of human, natural, mechanical, and chemical resources by only applying what, when, and where the inputs are needed. However, very few turfgrass managers use PTM to its full potential due to a lack of understanding or access to research. The present study used a user-centered design (USD) framework to identify the needs of turfgrass professionals to identify barriers to the adoption of targeted pesticide applications using GPS sprayers among golf course managers. Participants consisted of users and non-users of GPS-enabled sprayers. Two focus groups of 6 participants were conducted, one with users and one with non-users, while a survey was sent out on a much larger scale. The questions asked in the surveys and focus groups had three primary goals: to identify the primary reasons that managers have not adopted, the best ways to address and change these barriers and characteristics of superintendents and their courses that impact their decision to adopt PTM. The results suggested that a primary barrier to adoption is the high cost of entry, especially among golf courses with smaller turfgrass management budgets (less than one million dollars). Other drawbacks, such as sprayer inaccuracy and a lack of technical support, also contributed to the low rate of adoption among turfgrass professionals.

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

Riyos Pudasaini
Virginia Polytechnic and State University/CS
Sandi Bhamidipati
Virginia Tech/CMDA/CS

Autonomous Systems for Specialty Crops Load, Canopy, and Disease Estimations

Fruit orchards often face the challenge of pests and disease that severely impact fruit yield and pose a significant threat to the quality of produce. Due to limited human resources on apple orchards, addressing this issue requires minimal human intervention. A potential solution involves an autonomous system that can identify potential risks and take appropriate action to resolve any detected discrepancies among these crops. Since classical computer vision models of object detection are not robust enough to detect apple fruitlets under various visibility conditions, such as sunlight, we use a deep learning model for object detection and segmentation to enhance performance. This system aims to locate regions of fruitlets, discern whether they require further investigation, and collect data through a mobile robot to deliver suggestions on the crop-field.

We begin by identifying the Detectron2 object-detection library as sufficient means to develop our model. Through the open source Visual Geometry Group (VGG) image annotator software, we annotated seventy-two apple-tree images, obtained from an orchard owned by Virginia Agricultural Research and Extension Centers, identifying apple fruitlets among the images. These annotations were used to establish a robust object detection tool for potential deployment onto an autonomous machine. The project requires additional time to compare the Detectron2 results with other state-of-the-art machine learning models, such as YOLOv7, and to see the model deployed onto a robot for on-site testing.

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

Riya Pulla
Virginia Commonwealth University/Bioinformatics
Jade Nguyen
Virginia Tech/Business Information Technology
Sotaire Kwizera
Berea College/Economics

Effects of Prenatal Exposure to Flooding on Child Health Outcomes: Evidence from Bangladesh

Bangladesh is one of the most flood-prone countries in the world. Prenatal exposure to flooding can have adverse health effects on children under 5 years old leading to stunting and underweight. This study uses a combination of nationally representative household data from the Bangladesh Integrated Household Survey (BIHS) and remotely sensed satellite flood statistics to examine the relationship between flood events and various child health outcomes. We obtained flood statistics from the Global Flood Database (GFD) supplemented with precipitation data obtained from Climate Hazards Group InfraRed Precipitation with Station data (CHIRPS). Results disaggregated by trimester and gender reveal that flooding during the first and third trimesters were positively associated with prevalence of stunting, especially among girls. However, no clear trends were observed regarding underweight. Examination of potential pathways through which floods impact health outcomes suggests that women in more flood-prone regions experienced reduced access to antenatal care, a higher likelihood of home births, and a lower consumption of essential supplements such as iron, calcium and vitamin A. Additionally, the general use of groundwater and open water sources increases the risk of illness among pregnant women as these sources are susceptible to flood water contamination. These findings aid the development of strategies and interventions for mitigating the adverse impacts of flooding on child health in Bangladesh.

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

Zain Quader
Virginia Commonwealth University/Biology

Regulation of gap junction function through connexin 43 phosphorylation during stress

Cardiovascular disease remains the leading cause of death worldwide. During each heartbeat, intercellular electrical coupling via gap junctions enables synchronous cardiac contraction. Gap junctions of the working myocardium comprise the protein Connexin 43 (Cx43) which localizes to intercellular junctions of cardiomycoytes Altered regulation of Cx43 during ischemic stress can result in electrical disturbances and arrhythmias due to losses in gap junction function. It has been previously shown th.at Cx43 is phosphorylated, specifically at residues Ser373 and Ser368 in stressed cardiac tissue. Phosphorylation at Ser368 results in gap junction closure, butthe relationship between Ser368 and Ser373 remains unclear. Moreover, Cx43 phosphorylation is associated with loss of binding to junctional scaffolding protein ZO-1, which regulates gap junction formation and stability. We hypothesize that phosphorylation of Cx43-Ser373 maintains Cx43-Ser368 phosphorylation during cellular stress to effect gap junction remodeling. To test this, we utilize a phospho-null Cx43-S373A mutant transiently expressed in cells where endogenous Cx43 has been knocked out by CRISPR/Cas9 gene editing. Cx43 phosphorylation is induced using phorbol 12-myristate 13-acetate and detected by western blotting. Complexing with known Cx43 binding partners 14-3-3 and ZO-1 was assessed by co-immunoprecipitation and super resolution location microscopy. We find loss of Cx-Ser373 phosphorylation inhibits 14-3-3 complexing and levels of Ser368 phosphorylation. Understanding the regulatory steps of gap junction regulation during stress may contribute to development of therapeutics aimed at preserving restoring normal electrical function to diseased hearts.

Mentor(s): Jamie Smyth (Virginia Tech)

Razia Rahyab
Virginia Commonwealth University/Chemistry in concentration with Biochemistry

Effects of Hyperglycemia on Capillary Pericytes, Endothelial Cells, and Extracellular Matrix (ECM) in Murine Brain Vessels

Hyperglycemia refers to a condition characterized by elevated levels of glucose in the bloodstream. Prolonged periods of elevated blood sugar levels, such as in diabetes mellitus, can lead to complications that affect multiple organ systems, particularly blood vessels. Understanding the effects of high blood sugar on brain blood vessels, in particular, is critical given the recent rise in diabetic patients worldwide. Here, we determined the impact of hyperglycemia on pathways that impact pericytes and endothelial cells, specifically on gene expression related to the Platelet-Derived Growth Factor-BB (PDGF-BB) signaling (Pdgfb, full-length (FL) and soluble (SOL) Pdgfr-beta) and extracellular matrix (ECM) production (Col4a1) and degradation (Mmp2). To do so, we performed quantitative polymerase chain reaction (qPCR) on mRNA collected from hyperglycemic mouse brain tissue. Our early results suggest substantial alterations in the PDGF-BB pathway and extracellular matrix (ECM) between hyperglycemic and normoglycemic mice. Specifically, we noted a 3-fold increase in FL-Pdgfrb, suggesting increased signaling for proliferation and migration in hyperglycemic murine brains. Conversely, we observed a notable decrease in SOL-Pdgfrb, which is proposed to inhibit PDGFR-beta signaling under normal circumstances. Additionally, a noticeable shift was observed with increased Col4a1 expression, which likely contributes to increased ECM production. Mmp2 expression decreased, potentially limiting ECM degradation. Overall, these findings provide valuable insight into the dysregulation of the PDGF-BB pathway and ECM dynamics associated with hyperglycemia, which likely contributes to damaged blood vessels in certain disease conditions like diabetes.

Mentor(s): John Chappell (FBRI)

Diya Reddy
Roanoke Valley Governor's School/Biology

Interaction with Tumor Suppressor p53 and Core Clock Gene Per2 alters DNA Binding Ability

The circadian clock manages various human physiological and biological processes including cell homeostasis, apoptosis, and cell metabolism, by precisely regulating gene expression. One of the core components of the clock, Period2 (Per2), directly interacts with the transcriptional activity of tumor suppressor protein p53. The activation of p53 plays is needed in response to genotoxic stress. Accordingly, about 85% of all cancer cases express a mutated form of p53, with a Thy-to-Cys (YC) being the 9th most prevalent missense mutation. The YC mutation is located in a loop within the p53's core DNA-binding domain; however, it opposes the DNA binding interphase and does not impact p53's overall structure. As a result, the mechanism for how tp53(YC) negatively impacts p53 transcriptional activity remains to be established.
Thus, we hypothesized that the binding of Per2 hinders the YC from being able to bind the p53 response element in the regulatory region of response genes. After conducting a bacterial culture, purifying and concentrating protein, and performing an electrophoretic mobility shift assay (EMSA) experiment, I found that Per2 binding to p53 YC mutant impedes DNA binding. This intricate interaction would effectively prevent p53 from engaging in the crucial DNA binding interphase essential for its transcriptional functionality and, additionally, alter circadian oscillations.

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

Alexa Rehmat
Virginia Tech/Psychology

Soliciting Stakeholder Feedback on the Unwinding Anxiety App to Reduce Adolescent Social Anxiety

Adolescents with social anxiety disorder (SAD) are a hard population to treat; research has sought to utilize technology to reach this population, with encouraging results. Patient buy-in is critical for utilization and effectiveness. The present study sought to examine adolescent and parent perceptions of a mindfulness-based app, Unwinding Anxiety (UA), for treatment of adolescent SAD. Participants include 11 adolescents ages 12-16 (M=13.55; 90.9% White; 18.2% Latine) who engaged with UA over a 12-week period. Parents and adolescents completed rating scales and engaged in an interview to provide feedback. Feedback regarding the feasibility, acceptability, and appropriateness was mixed, with 54.5% rating the app as acceptable and appropriate and 63.6% rating it as feasible. No clear overall theme emerged regarding adolescent-report on what was helpful; instead, several themes arose: (1) app was easy to use, (2) liking the different exercises, and (3) nothing was helpful. In contrast, a clear theme from parents was that they perceived the app to be easy for their adolescents to use independently, with teens generally being willing to do so. Adolescents suggested that the videos in the app should be more engaging, with more flexibility in the number of modules they can complete per day. Parents overwhelmingly wanted to be involved with the intervention including wanting to access the app and learning the skills themselves. The main theme regarding difficulties was finding time to engage with the app. This poster will discuss the modifications we plan to make to the UA app based on this stakeholder feedback.

Mentor(s): Rosanna Breaux (Psychology)
Katelyn Garcia (Psychology, Graduate Student Mentor, Virginia Tech)

J'Lynn Roane
Norfolk State University/Biology

Learning Laboratory and Field-Based Pest Management Techniques for Crop Production

Pest control is one of the most common problems farmers face in agriculture. There are many ways to deter them, but new methods are constantly being developed. To prevent the Southern Green Stink Bug from eating crops, a crop that can replicate their mating/aggregation pheromone is being explored. By infiltrating a test plant with the genes responsible for pheromone production, the goal is to prove if given the correct gene combination the test plant can synthesize the mating/aggregation pheromone. So far, the genes have transferred successfully, but pheromone production is not as high as hoped. Another common problem farmers face is controlling weeds. There are many proven successful approaches to weed control, but herbicides are considered the most preferred tool. Along with conventional herbicide spray applications with tractors and backpack sprayers, novel technologies, such as Unmanned Aerial Systems (UAS), are currently evaluated for herbicide efficacy. The UAS-based technology is in its early stages and requires standardization of spray parameters, such as spray altitude, speed, pressure, volume, and nozzle type. A spraying drone was used to cover two separate fields with the only difference being the direction the drone flew in. The results of these two projects can be utilized to improve insect and weed control approaches for advancing agricultural sciences.

Mentor(s): Vijay Singh (Weed Science)
Hailey Larose (Agriculture, Virginia Tech)

Colin Roberts
Virginia Tech/Psychology

Enhancing Debugging Efficiency: User Perspectives on AutoPrint, an Automated Print Statement Tool

Debugging is an essential aspect of software development, and the use of print statements is a common technique needed to diagnose and understand program behavior. However, manually inserting print statements throughout the codebase can be relatively time-consuming and prone to errors. This research presents AutoPrint, a novel debugging tool for the Java programming language that automates the process of inserting print statements, thereby reducing the workload on developers. The purpose of this study was to conduct user studies to gather qualitative feedback on the usability and effectiveness of AutoPrint. To achieve this, the tool was distributed to a group of volunteers, along with sample code that required debugging. Participants were instructed to utilize AutoPrint in their debugging process and provide their feedback on its performance and usefulness. A post-survey was administered to the participants, consisting of questions regarding their testing experience. The survey aimed to gather their opinions on the ease of use, efficiency, and overall satisfaction with the tool. Additionally, participants were encouraged to provide suggestions for improvements or additional features. Per responses from a prior study that indicated positive feedback, it is expected that from this study that AutoPrint has the potential to reduce the manual effort in inserting print statements for debugging purposes. This study provides valuable insight into the effectiveness of AutoPrint as a debugging tool for code. The feedback obtained from participants will inform further refinements of the tool, potentially enhancing its utilization for developers and improving their productivity in the debugging process.

Mentor(s): Chris Brown (Virginia Tech)

Stefan Robinson
Virginia State University/Computer Engineering

Quantum Sensing of Magnetic Fields

Quantum Magnetic Field Sensing is one of the most important constructs in the field of quantum engineering. It has the potential to replace GPS and even improve the various technological fields we already have. Though it can improve many technological sectors and is predicted to revolutionize society, an ongoing challenge, for now, is to find out how photodiode levels are affected by different magnetic field geometries. By using Optically Detected Magnetic Resonance (ODMR) on Nitrogen Vacancy (NV) and various magnetic configurations we assess the photodiode levels by using the data to make magnetic field calculations v (change in frequency) = 2YNV(Bz) (YNV = 28MHz/mT) from theory. The levels were at their highest value (5.9259) when the magnetic field was at its strongest (stack) and positioned in a 45-degree position; with the magnetic field being measured at 1.25mT. Flipping the magnetic field North-South poles had no effect on photodiode levels while flipping the pole in the 45-degree position alters the photodiode levels significantly. The experiment proves that a stronger magnetic field has been proven to increase the photodiode levels and sense a three-dimensional (3D) magnetic field. This study demonstrates the effectiveness of using ODMR on NV centers in measuring 3D magnetic fields.
Keywords: Quantum, Magnetic fields, Frequency, Nitrogen Vacancy, Optically Detected Magnetic Resonance

Mentor(s): Wayne Scales (Quantum Engineering)
Guannan Shi (Quantum Engineering)

De'Quinte Robinson, Jr.
Tuskegee/Chemistry

Synthesis of Cyclam-Based Metal-Organic Framework for Water Oxidation

Traditional energy methods are causing the environment to slowly degrade due to toxic byproducts such as CO2 and many other environmental pollutants that such methods release. This is why we are searching for more efficient and cleaner sources of energy. One of the most common clean energy sources is solar energy. Solar energy is radiant light and heat from the sun that is stored through many natural and technological methods to generate energy. An example of using solar energy is photosynthesis in plants, which uses solar energy to produce Adenosine Triphosphate (ATP) which yields energy for cellular processes. One part of this process is water oxidation or water splitting ($2H_2O \rightarrow 4H^+ + 4e^- + O_2$.) The new protons and electrons can be used to reduce CO2 to hydrocarbons, creating that can be used to reduce CO2 to hydrocarbons, creating that can be used to reduce CO2 to hydrocarbons, creating electrons created can be used to reduce CO2 to hydrocarbons which creates a carbon-neutral energy source. Copper-based catalysts have shown good efficiency for water oxidation. In this project, we used a copper-based metal-organic framework (MOF) known as VPI-100. A MOF is a compound consisting of metal ions or clusters coordinated with organic ligands to form multi-dimensional porous structures. MOFs are good catalysts because they can incorporate homogenous molecular compounds into a heterogeneous material. VPI-100 consists of zirconium-oxo clusters bound by a copper-coordinated cyclam linker. We first synthesized the MOF and then we deposited the copper-based VPI-100 onto FTO electrodes to measure the water oxidation capabilities using the electrochemical method of controlled potential electrolysis in an aqueous solution and recorded the oxygen concentration over time.

Mentor(s): Benjamin Thomas (Chemistry)
Dr. Amanda Morris (Chemistry Chair, Virginia Tech)

Nikolas Rovira
Virginia Tech/Aerospace Engineering

Analysis of GNSS Radio Frequency Interference in Ports and Coastal Areas

The increasing reliance on global navigation satellite systems (GNSS, including GPS) for global navigation, for example in naval transport applications, reinforces the need for protection of GNSS frequency bands. GNSS signals are vulnerable to jamming (denial of service), spoofing (manipulated signals), and interference from malicious or inadvertent sources. In an effort to track these radio frequency interference (RFI) events, SINTEF, one of Europe's largest independent research organizations, deployed monitors and collected tens of thousands of events from 2019 to 2022 in Norwegian and Dutch coastal cities. This project sets out to determine if these recorded RFI events actually impacted GNSS data acquisition, reclassify these events, and detect RFI patterns. We first generate power-vs-time plots, power spectral density plots, and spectrograms to visually analyze raw data and then automatically reclassify these events. We process the raw data using a software-defined-GNSS-receiver to check whether or not GNSS signals can be acquired during these events. We show that many detected events are false-alerts with respect to jamming, and that they are benign RFIs potentially caused by spurious emissions from automotive communication devices. In addition, looking at the time of day or day of the week of each event, we identify daily or weekly RFI patterns probably coinciding with a jammer-carrying road-user or port-user's schedule. We found several event clusters either spanning several hours or occurring repeatedly at the same time of day for several-month-long segments. The ability to identify patterns and predict RFI can be used in future research to disable RFI sources.

Mentor(s): Mathieu Joerger (Kevin T. Crofton Department of Aerospace and Ocean Engineering)

Caroline Russell
Hollins University/Chemistry
Lillian Burns
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. Although a number of impressive advances in this field have been made over the last few decades, some methods achieve high stereoselectivity but very modest yield and vice versa. The central theme of this work is to develop a new method to achieve highly stereoselective glycosylation products starting from a mixture of two enantiomers via dynamic kinetic resolution. We aim to apply our method for the construction of libraries of stereo-defined glycoconjugates. Moreover, mechanistic studies of our method will provide valuable insights into the factors which determine stereocontrol in glycosylation reaction.

Mentor(s): Son Nguyen (Chemistry)

Eddie Rygalski
Roanoke College/Psychology

Non-retinal Sonic Hedgehog Signaling Impacts the Development of Principal GABAergic Neurons but not Glutamatergic Inputs in the Rodent Ventral Lateral Geniculate Nucleus

Retinal ganglion cell axons project visual information to the thalamus, specifically the lateral geniculate nucleus (LGN), which can be subdivided into functionally and anatomically distinct regions. The dorsal lateral geniculate nucleus (dLGN) processes image forming visual information, and the ventral lateral geniculate nucleus (vLGN) processes non-image-forming visual information. While the dLGN has been well studied, relatively little is known about cellular development in the vLGN. The vLGN can be divided into an external and internal layer (vLGNe & vLGNi). vLGNe exhibits adjacent laminar organization of at least 4 transcriptionally distinct types of GABAergic projection neurons. In addition to principal GABAergic neurons, there is a subset of local GABAergic interneurons in vLGN. Previous studies from our lab have shown that retinal inputs and the morphogen Sonic Hedgehog (SHH), which they release, are critical for the recruitment and migration of these interneurons into the vLGN. Moreover, we showed that retinal-derived SHH elicits astrocytic production of the attractive signaling protein fibroblast growth factor 15, which is crucial in guiding the migration of interneurons into vLGN. However, the role of non-retinal derived SHH in the development and organization of vLGN remains unclear. Using transgenic mouse lines, in situ hybridization, and immunohistochemistry we compared organization of projection neurons in control mice and mice with Shh expression knocked out in all neural tissue. While principal GABAergic cells were reduced in Shh fl/fl;NesCre, as compared with controls, cortical glutamatergic inputs appeared normal. Thus, non-retinal SHH appears specifically necessary for the development of GABAergic projection neurons in vLGN.

Mentor(s): Michael Fox (Neurobiology)

Tony Samson
Virginia Tech/Biochemistry

Expression and purification of Chi phage tail fiber protein to study interactions with Salmonella enterica flagella

Bacteriophage Chi is known to infect motile Salmonella enterica ser. Typhimurium by binding to the flagellum, likely using a tail fiber protein putatively encoded by the Chi_31 gene. The goal of this study was to express and purify this protein and study its binding to bacterial flagella. This could lead to a more complete characterization of the Chi phage infection pathway via the S. enterica flagellum. The Chi_31 gene was first cloned into an expression vector which was then introduced into Escherichia coli. Expression of the protein was induced, and proteins were extracted via cell lysis and centrifugation. The Chi_31 protein was purified on an affinity column using the IMPACT system followed by Size Exclusion Chromatography. The resulting protein had an apparent molecular weight of 27 kDa on an SDS-PAGE gel which was identical to the size predicted from the amino acid sequence of the Chi_31 protein. The purified protein was then characterized via competitive binding assays, chemical crosslinking, and pull-down binding assays to study possible interactions with the bacterial flagellar filament. Addition of the chemical crosslinker glutaraldehyde resulted in the disappearance of phage and flagellar protein bands on a gel compared to control samples, indicating that some level of crosslinking occurred. Further experiments with higher concentrations of phage protein may better ascertain possible effects like phage inactivation or binding inhibition. Understanding the mechanism of phage binding could lead to phage treatments for antibiotic-resistant Salmonella.

Mentor(s): Birgit Scharf (Biological Sciences)

Daniel Sane
Virginia Polytechnic Institute and State University/Biochemistry

Do GLP-1 Agonists Reduce Intake and Effects of Alcohol?

Alcohol Use Disorder (AUD) contributes significantly to global mortality. Recently, Glucagon-like Peptide-1 (GLP-1) agonists, FDA-approved for managing type 2 diabetes, have shown to effectively reduce the consumption of alcohol in animal models and humans. More research, however, is needed to understand the mechanisms by which GLP-1 agonists reduce alcohol consumption and their possible long-term efficacy to treat AUD. In this study, we investigated the effects of GLP-1 agonists on drinking behaviors to explore these medications as a potential treatment for AUD. We administered an online survey to adults (n=96) with a BMI > 30, who were current social drinkers, and either a) on a GLP-1 or a Tirzepatide medication or b) not on any medication to manage diabetes or weight loss. Changes in alcohol use and effects, from prior to starting the medication to currently, were assessed through adapted forms of previously validated questionnaires. We found a significantly lower self-reported intake of alcohol in the past 30 days and during each drinking period in the medication groups compared to the control. Complementary to this, a significant reduction in Alcohol Use Disorders Identification Test (AUDIT) scores was also observed. Furthermore, individuals on GLP-1 or Tirzepatide medication reported experiencing significantly less sedative and stimulative effects of alcohol while on their medication. In summary, we provide real-world evidence of reduced alcohol consumption and effects by GLP-1 agonists, suggesting potential efficacy for AUD treatment.

Mentor(s): Warren Bickel (Fralin Biomedical Research Institute)
Alexandra G. DiFeliceantonio (Fralin Biomedical Research Institute, Virginia Tech)

Georgie Sawyer
Virginia Tech/Biological Systems Engineering

Raising Black Solider Fly Larvae to Recover Value from Food Waste

Yearly, The United States of America alone produces roughly 60 billion tons of food waste contributing to the overall landfill crisis and creating toxic greenhouse gasses such as methane. However, raising the black solider fly larvae (BSFL) in either private or commercial settings can help greatly reduce that number, as their larvae can consume up to four times their body weight per day. Using the full life cycle of the black solider fly can produce environmentally beneficial outcomes. The BSFL feces, substrate residues, and shed BSFL exoskeletons can be used in the making of frass, which is a compost-like product. The flies in their larval state can be used as poultry feed, aquaculture feed, or biodiesel, depending on their body composition. This summer we have constructed the units of a BSF facility: the incubator unit/laravarium, the pupation habitat, and the reproduction unit/insectarium. We are testing how different food waste streams impact the body composition of BSFL, and how different environmental factors such as temperature, humidity, and light effect survival and bioconversion rates. The aim of this project is to test the effectiveness of raising BSF as a solution to waste production as well as testing defining and comparing the possible interaction between feed and density on BSF larval performance, body composition and conversion efficiencies.

Mentor(s): Jactone Arogo (Biological Systems Engineering)

Willow Seymour
Hollins University/Psychology

The Influence of Deadline and Distraction on Children's Task Performance

A child's capability is infallibly tied to the environment in which they learn, to the point where even a slight change in the physical or verbal cues present can alter behavior. However, a deadline's presence may be able to negate the effect of distraction on the child's ability to complete tasks. In this research study outline, children 7 to 12 years of age will attempt to finish two separate 60-piece puzzles. The first puzzle acts as the controlled condition and the second acts as the experimental condition, in which the presence of a deadline and/or a distraction (e.g., video) is introduced. It has been established that distracting visual cues have a negative effect on learning scores in a classroom setting (Hanley et al., 2017). In both experimental sessions, the percentage of pieces placed in the correct position will be analyzed via Repeated Measures ANOVA to assess if any significant change has occurred. We hypothesize that children with the sole distraction condition will experience a decrease in the percentage of completion. As displayed in previous research, in order for children to reliably complete a time-based task, they may need more external reminders than adults (Mäntylä et al., 2007), indicating a lack of internal time regulation. Because of this, it is our belief that the children with the deadline condition, in which they are reminded of how much time they have left, will be able to complete more of the puzzle than they were able to with no strictly implied deadline.

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

Rebekah Smith
Virginia Tech/Biomedical Sciences

The Wonderful World of Eosinophils: Assessing the Role of NIK on Eosinophil Proliferation and Maturation in a Murine Model

The noncanonical NF-κB signaling pathway is critical to our bodies' innate immune response. Mice lacking the regulatory protein, NIK, in this pathway develop Hypereosinophilic-like syndrome, a multifactorial disease characterized by increased numbers of circulating eosinophils. Previous work demonstrated that this phenotype was caused by differences in this pathway's effect on T-helper 2 cells though the effects on the bone marrow has not been fully studied. To evaluate this, eosinophil maturation and proliferation was assessed in continuously cultured environments mimicking the bone marrow on days 6,10,13 and 15. The effects of IL-5 withdrawal was also studied. We found that Nik-/- eosinophil maturation was slightly enhanced compared to wildtype (WT) eosinophils on days 6 and 13 while Nik-/- proliferation was slowed on day 10. Furthermore, Nik-/- eosinophils demonstrated resistance to IL-5 withdrawal when compared to WT controls on days 13 and 15. Conversely, freshly isolated Nik-/- eosinophils showed no proliferation differences regardless of IL-5 presence. Surprisingly, cells cultured on day 13 showed the highest proliferation rate regardless of IL-5 presence when compared to freshly collected cells. In conclusion, the loss of NIK does not only effect T-helper 2 cells but also appears to impact eosinophil maturation and proliferation in an in vitro bone marrow microenvironment regardless of IL-5 concentration, suggesting an inherent resistance to dysregulated growth conditions. By further studying this pathway's effect on the bone marrow microenvironment and eosinophil education and maturation in vivo potential treatments can be developed to mitigate the development of Hypereosinophilic syndrome in people.

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

Danielle Smith
Radford University/B.S in Chemistry

Synthesis and Characterization of Ion-Imprinted Polymers for Selective Lanthanide Separation

Rare-earth elements (La–Lu, Y, Sc) are critical metals that are used in magnets, renewable energy, and other important technologies. These metals are thinly distributed throughout the Earth's crust, only existing as viable ore pockets in select locations. Developing an effective separation technique for these elements has been a challenge for chemists due to their similar properties. The key difference between these elements is their size. Molecularly imprinted polymers are one strategy used to separate specific molecules by size and we have adapted this technique for lanthanide ions. We synthesized an imprinted polymer templated around three different lanthanide ions (Lanthanum, Europium, and Lutetium) with the goal of selectively capturing these ions in high yield. Initially, less metal was captured than expected, which was overcome by ensuring complete removal of the templating ion. Current work focuses on manipulating the cross-linking ratio of the polymer to study the effect of cross-link density on size-based selectivity. This work has the potential to improve isolation of these elements and can benefit applications in magnets, medical devices, and renewable energy technologies.

Mentor(s): Michael Schulz (Department of Chemistry)

Analis Smith
Virginia Tech/Biological Sciences

Assessment of the T4 phage ac gene function in relation to bacterial lysis

Low levels of acridine compounds, such as acriflavine hydrochloride, have demonstrated a propensity to inhibit bacteriophage propagation while allowing their bacterial counterparts to survive. Previous research has identified a currently unelucidated gene within related T-even phages, the acriflavine resistance gene (ac gene), connected to the uptake of acriflavine during phage infection. This results in phage resistance to acriflavine when the gene is mutated or knocked down, permitting phage propagation. Interestingly, preliminary data also suggests a connection between the ac gene and phage lysis. Within this study, we developed a construct for an ac gene knockout in T4 phage and studied the effect on phage infection and propagation. Our results demonstrate that interruptions in the ac gene cause an increase in lysis of bacterial cells during phage infection compared to wildtype T4 phage, with the largest differences resulting from differing nutrient compositions. These methods are fundamental in understanding potential functions to the ac gene and its implications in the regulation of phage lysis.

Mentor(s): Bryan Hsu (Department of Biological Sciences)

Connor Stein
Virginia Tech/Biochemistry

Mucinomics: Characterizing the carbohydrates from human and lab-grown mucins

Mucins are high molecular weight proteins containing numerous carbohydrate groups. These carbohydrates (also termed glycans or oligosaccharides) provide mucins with lubricant properties that can assist with movement (snails for example) and the ability to coat surfaces, protecting that surface from pathogens. Mucins in our respiratory system protect lung tissue from inhaled particles and pathogens. While mucins are abundant proteins, researchers face several significant challenges when characterizing their chemical and physical properties. One rather daunting challenge is determining the structures and locations of the carbohydrate groups on mucins, which are predominantly O-glycans. As there are currently no enzymatic methods available to selectively remove O-glycans from proteins, chemical treatments are required. The goal of this project was to identify the O-linked glycans found in several different mucins, ultimately comparing the O-glycans from human isolates and lab-grown mucin obtained from human cells. A recently published oxidative release procedure was used to degrade the mucins and release the O-glycans at the attached amino acid (serine and threonine). After release, the samples were purified by solid phase extraction (SPE) cartridges containing porous graphitic carbon (PGC). The isolated O-glycans were then characterized by LC-MS/MS. This work resulted in a database of O-glycans that can be used to compare human and lab-grown mucins.

Mentor(s): Rich Helm (Department of Biochemistry)

Abigail Stiles
Virginia Commonwealth University/Chemistry and Psychology

Investigating associations between personality and the effects of LIFU neuromodulation in the context of acute pain

Personality is known to influence physiology and behavior. The Five-Factor model (FFM) indexes five personality traits: neuroticism, extroversion, openness, agreeableness, and conscientiousness. Higher openness is correlated with activity in brain regions related to pain processing including the anterior cingulate cortex (ACC) and insula. In addition, activity in the anterior insula (AI) is associated with higher neuroticism. Low-intensity focused ultrasound (LIFU) applied to the AI and ACC was previously shown to impact pain perception, pain processing, and autonomic function. This study investigates associations between personality and the effects of LIFU neuromodulation in the context of acute pain. We hypothesize higher neuroticism scores will correlate with reduced pain responses in LIFU to the AI and higher openness will correlate with observed changes under any LIFU target. In 13 healthy participants (M=5, age 20-44) who completed LIFU pain studies, we administered the NEO Personality Inventory-Revised. Physiological responses, including contact heat-evoked potential (CHEP) amplitudes, and subjective pain ratings for LIFU (to the ACC, AI, and posterior insula (PI)) from each subject were correlated with percentile ranks of the FFM personality traits. Higher openness positively correlated with decreased pain ratings with the ACC LIFU intervention ($p < 0.01$) and higher neuroticism positively correlated with greater reductions in CHEP amplitudes with AI LIFU ($p = 0.074$). Preliminary results support that trait openness and neuroticism are associated with pain processing and LIFU neuromodulation in the ACC and AI. Future clinical application of LIFU may find these results useful, as personality, specifically neuroticism, has associations with chronic pain.

Mentor(s): Wynn Legon (Fralin Biomedical Research Institute at VTC, School of Neuroscience)

Samantha Styles
Virginia Tech/Clinical Neuroscience

Temporal Expression of Key Herpes Simplex Virus Proteins During Latency Establishment

Herpes Simplex Viruses 1 and 2 (HSV1, HSV2), which affect more than 60% of the global population, are neurotropic viruses that establish lifelong latent infection in neurons following primary infection. In response to various triggers, HSV can reactivate to cause recurrent episodes of skin sores throughout a person's life, and in some cases, reactivation causes life-threatening disease. The mechanisms of latency establishment are not well understood but specific viral proteins are known to be involved in the process. First, antibodies against five key viral proteins (ICP27, VP16, ICP4, ICP8, and ICP4) were tested and validated using uninfected, HSV-1-infected, and HSV-2-infected Vero76 cells. Then, to quantify temporal expression of these key viral proteins as the virus establishes latency in neurons, primary sensory neuronal cultures were infected with HSV-1 or HSV-2 under conditions that promote the establishment of latency. Uninfected and infected neurons were collected each day as the viruses established latency and western blots were used to detect expression of the HSV proteins. Over time, some of these proteins increased while others decreased, showing dynamic temporal expression that suggests these viral proteins have functional roles at different times during latency establishment. The results of this study will provide new insights into how HSV-1 and HSV-2 establish latency in sensory neurons that support reactivation, which leads to recurrent disease. Understanding the molecular mechanisms of latency will advance our understanding about HSV to guide the development of new strategies for preventing recurrent disease.

Mentor(s): Andrea Bertke (Virginia-Maryland College of Veterinary Medicine)

Christina Su
Cave Spring High School

Accessing the Level of Compensatory Activities of Children With Hemiparesis During Acquire Therapy

ACQUIREc is an evidenced-based form of pediatric constraint-induced movement therapy(P-CIMT) designed to improve the functional competence of the impaired upper extremity (UE) of children who have neuromotor disabilities. The goal is to support each child's daily functional activities and improve movement patterns. However, children with neuromotor disabilities often use compensatory strategies in completing functional activities and little is known about how these compensatory strategies impact the development of functional abilities.

This research aimed to understand the relationship of compensatory activities in children receiving ACQUIRE Therapy by evaluating various levels of compensation throughout the course of treatment on a specific activity, eating. We developed a Compensatory Behavior Scale to evaluate kids of age 1-5 years with hemiparesis who participated in the ACQUIRE project. The 0-2 scale was used on video recordings made during the treatment. The scale measured the level of compensation occurring when children were using a utensil to bring food to their mouth.. The scores reflected the following; 0 little to no compensation, 1 moderate compensation, and 2 severe compensation. An average compensation score was created each week for the purpose of data analysis. Preliminary data suggests that there was an overall trend for the children to decrease their tendency of using compensatory strategies across weeks when receiving the ACQUIRE Therapy. Data will be presented across weeks for individual children, and a discussion will present factors that might have influenced a decrease in compensation.

Mentor(s): Stephanie DeLuca (Neuromotor Research Clinic)

Thinna Svetanant
Virginia Tech/Biology

Peripheral-derived immune cells contribute to the remodeling of pre-existing pial collateral vessels following ischemic stroke

A stroke is a life-threatening medical condition caused by decreased perfusion to the brain. Of all diagnosed ischemic strokes, 85% result from an occlusion of the middle cerebral artery (MCA) in the pial surface of the brain. Pre-existing pial collateral vessels, which are vascular redundancies that retrogradely re-supply cerebral blood flow (CBF) to the penumbra following vascular occlusion, connect the MCA branches to the anterior or posterior arteries. The remodeling of pial collateral vessels (arteriogenesis) is crucial to promote reperfusion of CBF. The ischemic penumbra is reperfused through the anterior cerebral artery in order to prevent tissue damage. Increased fluid shear stress stimulates arteriogenesis, leading to the activation of endothelium and subsequent recruitment of peripheral-derived immune (PDI) cells. These PDI cells activate the outward growth of collateral vessels. While little is known about cell-type specific contribution of PDI cells in the remodeling process, our studies reveal that EphA4 receptor tyrosine kinase serves as a critical suppressor of arteriogenesis in ischemic stroke. The objective of our current study is to investigate the role of EphA4 in regulating PDI cell-mediated arteriogenesis of permanent middle cerebral artery occlusion (pMCAO) in a mouse model. Using EphA4 bone marrow chimeric mice and selective arteriole labeling technique and vessel painting, our results indicate that PDI-specific EphA4 negatively regulates arteriogenesis and influences PDI cell recruitment following pMCAO. Overall, our studies will explore how PDI-specific EphA4 contributes to neuroinflammatory milieu, discover EphA4 targets for improving collateral, and functional recovery following ischemic stroke.

Mentor(s): Michelle Theus (Department of Biomedical Sciences and Pathobiology)
Jing Ju (Department of Biomedical Sciences and Pathobiology)

Kobe Tam
Virginia Tech/Material Science and Engineering

Euclidation of Mechano-Bactericidal Nanospikes on Electrochemically Etched Stainless Steel Surfaces.

Prevention of bacteria adhesion on material surfaces is a paramount concern in the medical and food industries. Although modern techniques like hot steam, chemical solutions, and bacteriocins are efficient, these procedures typically require continuous, repetitive treatments. Recent techniques to electrochemically etch stainless steel to create mechano-bactericidal nano-structures have been discovered as a promising strategy to inhibit bacterial adhesion and survival. However, there is minimal knowledge about the relationship between etching conditions and the resulting nano-topography. The purpose of this study is to enhance our understanding of process-structure relationships in order to refine the design and formation of mechano-bactericidal nanospikes on stainless steel 316 (SS316) surfaces. Using a 3-electrode setup for etching, both polished and unpolished samples of SS316 were etched under a variety of voltages and analyzed using scanning electron microscopy (SEM). The SEM analysis was used to determine etching parameters that yielded the best formation of nanospikes without significantly etching the grain boundaries, which could serve as a haven for bacteria. The most promising structures were formed under middle to high voltage conditions (1.9V - 2.1V), where lower voltages resulted in significant grain boundary etching and higher voltages resulted in electropolishing and a lack of nanospikes. Mechanical bactericidal properties could be extremely beneficial to the food industry, reducing the need for repeated antimicrobial treatments in favor of inherent material properties. The best etching conditions for mechano-bactericidal stainless steel still need to be thoroughly confirmed by bacterial adhesion experiments.

Mentor(s): Yifan Cheng (Food Science and Technology)

Chloe Taylor
Virginia Tech/Sustainable Biomaterials

Protein Hydrolysate Biostimulant Effects on Plant Growth and Development

Protein hydrolysate biostimulants are agricultural products that can improve crop yield and quality, providing an opportunity to reduce synthetic fertilizer application rates, thereby reducing runoffs that lead to surface water and groundwater pollution. Additionally, protein hydrolysates are produced from chemical and/or enzymatic hydrolysis of agroindustrial byproducts, offering an avenue for reduced agricultural waste and a more circular economy. This study aimed to test the effects of various protein hydrolysates and different application rates on the growth and development of Arabidopsis thaliana and soybean [Glycine max (L.) Merr.] grown under varying nitrogen (N) and phosphorus (P) concentrations. In Blacksburg, these characteristics were assessed with Arabidopsis leaf area and root length measurements, along with monitoring soybean growth stage progression . At the Virginia Tech Eastern Shore Agricultural Research and Extension Center, protein hydrolysate application effects on soybean growth were assessed with leaf SPAD index and biomass measurements from field trials. In Arabidopsis, one product tested was found to increase average leaf area at a low application rate (with 0.5 mM N fertilizer) and all products tested were found to decrease average root length (in 4 mM N medium). In soybean, protein hydrolysate application was found to accelerate soybean development during V4 and V5 growth stages. Field trial preliminary results indicate significantly increased soybean leaf SPAD index with protein hydrolysate application in low soil P conditions ($p = 0.0008$). In summary, protein hydrolysate application results depended heavily on the plant treated, the product applied, application rates, and N/P levels.

Mentor(s): Guillaume Pilot (School of Plant and Environmental Sciences)
Mark Reiter (Eastern Shore AREC, Virginia Tech)

Jamiah Thomas
Oakwood Univeristy/Biochemistry

Radical SAM Catalyzed Methylation for Tetrahydromethanopterin Biosynthesis in Methanogenic Archaea

Methanogenic archaea rely on methanogenesis for energy production. They live in harsh, anaerobic environments like hydrothermal vents, gut of animals, and sediments. Methanogenesis employs several specific coenzymes including tetrahydromethanopterin (H4MPT). Emulating tetrahydrofolate (H4F) in function and structure, H4MPT is a carbon carrier, and unlike the former it contains methyl groups on C7 and C9. It is unknown how those methyl groups are introduced. It has been hypothesized that a SAM (S-adenosyl-L-methionine) radical enzyme creates radicals on the C7 and C9, and catalyzes methylation at these positions. It is further hypothesized that MJ0619 is the methyltransferase involved in this process in Methanocaldococcus jannaschii, a hyperthermophilic methanogen that lives in hydrothermal vents. It is because when MJ0619 is expressed in E. coli, H4F is methylated at C7 and C9. To demonstrate this activity in M. jannaschii, a strain has been constructed to express MJ0619 with a Strep tag. In parallel for the same purpose, a strain of Methanococcus maripaludis has been constructed. M. maripaludis is a mesophilic and amenable organism and closely related to M. jannaschii. The purification of recombinant MJ0619 from the engineered M. maripaludis strain has been accomplished, and preliminary activity assays demonstrate that the enzyme methylates the substrate analog, dihydrofolate (H2F) to produce a dimethylated product. Further work is being carried out to confirm the identity of dimethyl-H2F and to complete the preparation of the M. jannaschii strain for future studies. Taken together, this work is defining the overall biosynthesis of H4MPT by identifying and biochemically characterizing the missing methylase.

Mentor(s): Biswarup Mukhopadhyay (Biochemistry)
Kylie D. Allen

Kate Thornbury
University of Virginia/History

Pressing for Progress: Black Newspaper Activism in Early 20th Century Chicago

Racially restrictive covenants were widespread in early 20th century Chicago, shaping the racial dynamics of the city. Covenants were legal agreements in property deeds that prohibited the sale, rental, or occupancy of properties by individuals of specific racial or ethnic backgrounds. There was a particular focus on excluding African Americans through these agreements. Covenant implementation stemmed from prevalent discriminatory practices that sought to reinforce racial segregation within Chicago's residential areas. As the Great Migration brought a significant influx of African Americans from the South, racially restrictive covenants restricted their housing options, concentrating poverty and limited resources in black neighborhoods. Black newspapers were champions of publicly bringing attention to these injustices, empowering social movements against them, and creating a deeper sense of community among black Chicagoans. As property restriction associations spread in the 1920-1930s, black newspapers followed cases of racial housing injustice. Specifically, The Chicago Defender gave special coverage to Supreme Court housing decisions and subsequent protests or uprisings in the affected black communities. Defender articles condemned the practice of barring any citizen from purchasing property in any area. Extensive reporting on racial segregation riots and the subsequent promotion of fair housing initiatives amplified the urgency for change and helped pave the way for advancements in fair housing policies and practices in Chicago and other cities. Research and analysis of this activism yields an understanding of how black communities responded to housing injustices and used grassroots organizing to ignite and strengthen the fair housing movement in Chicago and beyond.

Keywords: Racially restrictive covenants, Early 20th century Chicago, Black newspaper activism, Chicago Defender, Housing injustice

Mentor(s): LaDale Winling (History)

Ronisha Upreti
Patrick Henry High School

Investigating the Impact of lifestyle factors on Heart Rate Variability

This study aimed to investigate the correlation between heart rate variability (HRV) and lifestyle factors including sleep, caffeine intake, and physical activity. The autonomic nervous system and cardiovascular health are both measured by HRV, a measurement of the variability in the time intervals between consecutive heartbeats. By studying these factors, we intend to improve our knowledge of how daily habits may affect the regulation in the heart. This study included a total of 35 subjects (24/F)) aged between 18 and 44 and utilized questionnaires on three lifestyle factors including a questionnaire that gathered data on participants' sleep duration, caffeine consumption, and exercise. Additionally, heart rate variability was analyzed during a five-minute resting baseline period prior to the research study tasks. To assess the significance and extent of the correlations between the HRV and the factors of interest, they were analyzed statistically, including the calculation of Pearson correlation coefficients and p-values. Our analysis revealed a significant positive correlation between sleep duration and HRV ($r=0.17$, $p=0.014$). There was no significant correlation between physical activity ($r=0.05$, $p=0.47$) and caffeine intake ($r=0.02$, $p=0.75$) with HRV. These results suggest that sleep duration is significantly associated with HRV in the study population, while indicating that factors such as physical activity and caffeine consumption may have limited influence on HRV. Further research is necessary to understand how caffeine, sleep habits, and exercise impact cardiac health by examining additional factors that may influence HRV.

Mentor(s): Wynn Legon (Fralin Biomedical Research Institute, School of Neuroscience)

Reagan Vaughan
Virginia Tech/Animal and Poultry Sciences

Effects of Embryonic Heat Conditioning on the Hypothalamic Responses to Stress, Appetite, and Thermoregulation in Broiler Chicks

Neural control of stressor responses, thermoregulation, and appetite in birds are mediated in part by the hypothalamic-pituitary-adrenal axis. Embryonic heat conditioning (EHC) is associated with improved stress resilience at a later age, but the mechanisms medicating these responses are unreported. Thus, our aim was to measure mRNA abundance following EHC in the paraventricular nucleus (PVN), and nucleus of the hippocampal commissure (NCPA); two hypothalamic nuclei associated with initiating and maintaining stressor response, and the pre-optic anterior-hypothalamus (POAH), which mediates thermoregulation. Chicks (control and EHC) were heat challenged for 12 h and samples collected at 0, 2, and 12 hours from the start of challenge. In the PVN, EHC chicks had decreased corticotropin-releasing factor (CRF) mRNA abundance. Heat challenge caused increased neuropeptide Y (NPY) mRNA abundance at 2 h compared to 0 and 12 h, proopiomelanocortin (POMC) mRNA abundance increased at 0 compared to 2 and 12 h, urocortin 3 increased its mRNA abundance at 0 relative to 2 and 12 h, and thyrotropin-releasing hormone mRNA abundance decreased at 2 h compared to 0 and 12 h. In the POAH, there was increased mRNA abundance of CRF but decreased POMC mRNA, and POMC mRNA increased at 12 relative to 0 and 2. Control and EHC were similar for the NCPA; however, NPY mRNA expression increased at 2 relative to 0 and 12 h after heat challenge. These data suggest that improved stress resilience following EHC is likely due to changes within the PVN and POAH in chicks.

Mentor(s): Elizabeth Gilbert (School of Animal Sciences)
Mark Cline (School of Neuroscience, Virginia Tech)

Elizabeth Veraa
Texas Tech University/Physics
Paraskevas Tsimberdonis
National and Kapodistrian University of Athens/Physics

Commissioning of Data Acquisition System for Gamma Ray Spectroscopy

High-energy particles such as gamma rays and muons, present in the environment from naturally occurring radioisotopes and cosmic rays, form a background in rare event experiments studying the properties of neutrinos and dark matter. Gamma ray spectroscopy with High Purity Germanium (HPGe) detectors is a powerful tool to screen materials to be used in such experiments for contamination with naturally occurring radioisotopes. Operating multiple detectors in coincidence can increase the sensitivity of this screening by rejecting uncorrelated background in the screening setup and enabling localization of observed gamma rays to the sample in question. Our team at Virginia Tech set up two HPGe detectors to test and validate the performance of a CAEN DT5780 data acquisition (DAQ) unit. This unit will be deployed later this summer to serve the so-called 'TWINS' screening setup at the Sanford Underground Research Facility (SURF) in Lead, South Dakota. We report on the setup of the detectors and the DAQ, and the performance of the setup in terms of energy resolution, energy linearity and source localization capabilities enabled with the continuous time and energy information logged by the DAQ unit.

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

Challen Waller
Virginia Tech/Biological Systems Engineering

Fungal Bioluminescence Pathway for Gene Reporters in Apples

Measuring gene expression in plants can be very difficult, as there are many genes that can contribute to phenotypic changes in plants; finding a direct correlation can be difficult and time consuming. We investigated the use of fungal bioluminescence pathways (FBPs) as synthetic reporters of abscisic acid signaling in apple trees as a way of quantifying abscisic acid response gene expression. To do this we inserted a transfer DNA (T-DNA) from the plasmid p447 that had been used in previous studies to quantify abscisic acid responses in other plants. This plasmid was transformed into Agrobacterium tumefaciens as the vector for plant transformation. As a control, we used Nicotiana benthamiana, which was previously shown to be bioluminescent in response to abscisic acid after transformation with p447. After infiltrating both apple and N. benthamiana plants with the p447 agrobacterium and abscisic acid simultaneously, the controls showed a strong bioluminescence response, but the apple trees showed no response. The plasmid p447 uses several commonly used promoters in synthetic biology, but it is possible that these do not express well in apples. Additionally the coding sequences of the enzymes in the fungal bioluminescence pathway in p447 are optimized for N. benthamiana, not apple. In future work we will build new versions of the FBP pathway that are perhaps more well suited for apple tree gene responses.

Mentor(s): Clay Wright (Biological Systems Engineering)
Hunter Frame (Virginia Tech Agricultural Research and Extension Center)

Lily Walsh
Virginia Tech/Biochemistry

Mucinomics: Characterization of glycoproteins in human tissue and synthetic mucus

Mucins are a family of high molecular weight, carbohydrate-containing (glycosylated) proteins that are produced in the epithelial tissues of most animals. They act as a lubricant and physical barrier against pathogens, aid the immune system in fighting infections, and help selectively transport nutrients, drugs, and pathogens in and out of the cell. Mucins are also involved in a variety of diseases such as cystic fibrosis and cancer. The potential biomedical applications of mucins are extensive due to their unique hydration, barrier, and lubricant properties. The goal of this research was to characterize lab-grown mucins and compare their structural properties to that of human tissue donor samples. Analysis of molecular weights by Size Exclusion Chromatography combined with Multi-Angle Light Scattering (SEC-MALS) indicated that their sizes and molecular weight ranges were similar. Liquid Chromatography-Mass Spectrometry (LC-MS) based proteomic analysis was also conducted to compare the relative abundances of both total proteins present in each sample type as well as the specific mucins. It was found that there was much more variability in the human samples, predominantly due to the presence of non-mucin protein contaminants. However, the most abundant mucin in each sample type was the same (MUC5AC), supporting the concept that cell culture can be used to produce synthetic mucins.

Mentor(s): Rich Helm (Biochemistry)

Selah Wangler
Virginia Tech/Biomedical Engineering

Motor Characterization of a Wearable Device to Treat Upper Extremity Lymphedema

3-5 million Americans and 140-200 million people worldwide are affected by lymphedema [1,2]. We created a wearable device to treat upper-extremity lymphedema. This uses eccentric rotating mass vibration motors to create massage patterns that mimic manual lymphatic drainage massage - the standard therapy. This study characterizes the vibration, acceleration, and frequency produced by motors with and without custom housing pods, as well as different pod types and the impact of a velcro strap to secure the pods. The goal is to optimize the device's performance for future clinical studies. A cylindrical tissue was made using a 2:1 ratio of Dragon Skin and mineral oil (Baby Oil, Johnson's) [3] to simulate the upper-arm. A Metawear accelerometer was inserted into the cylinder to capture x, y, and z acceleration data. A sleeve made of the same material as the wearable device was placed onto the model at 4 different heights. The vibration motor (NFP-E1015) was placed into a pod, put into the sleeve, and then wired to the power supply. The accelerations and frequencies were measured at all heights using 4 different motors with and without pod housing. Frequencies and accelerations for most voltages were higher when the motor was in a pod. Accelerations were significantly higher with a velcro strap than without. The regular pod had higher accelerations and frequencies than the baby oil pod. Future goals would consider various pod types and the effect of motor(s) at varying distances. This motor characterization will aid in future device development.

Mentor(s): Christopher Arena (Director of Experiential Learning - Biomedical Engineering)

Jacob Wierer
Virginia Tech/Aerospace Engineering
Menwa Besheer
Virginia Tech/Aerospace Engineering

Development of free surface tracking methods

When the interface between water and air is wavy, measurements of its profile and height are challenging. In this study, a combination of measurements are conducted to observe (1) the profile of the surface with high speed photography and (2) the height at a single point using a constructed wave gauge. Waves were produced in a large tank using a flapping device and were measured by both methods. A MATLAB code was developed to analyze images from a high speed camera filming the waves at 2000 fps. The code uses gradient-based edge detection to find the free surface of the wave. Small white beads floating on the free surface provide contrast against a black background. A submerged pressure sensor was used to verify the height of the wave at discrete points. The pressure sensor was calibrated by measuring pressure at the bottom of a tank filled to different water levels and computing the known hydrostatic pressure. Data from the pressure sensor was directly measured and used to compute wave height from the measured pressure. The two methods of measuring the wave were compared to fully understand the wavy surface. Uncertainty estimations were made on each method. The results of this study will be used to measure wavemaker outputs, wakes of surface and subsurface vessels, and wave breaking events.

Mentor(s): Christine Gilbert (Aerospace and Ocean Engineering)
Craig Woolsey (Aerospace and Ocean Engineering)

Gabe Wiggins
Virginia Tech/Environmental Economics, Management and Policy
Deep Datta
Virginia Tech/Computer Science
Ariadne Tynes-Roker
Berea College/Economics; Methods and Models

Land Use and Solar Farming Assessment in Hanover County, Virginia

Hanover County, Virginia, located north of Richmond, balances suburban and commercial growth with a rich rural history. Amid the rapid increase in renewable energy development prompted by the Virginia Clean Economy Act, protecting prime farmland from development becomes critical for ensuring long-term food security. This project utilizes geospatial data and administrative parcel records to assess land parcels for their suitability for solar farm development, with a focus on agricultural and rural areas possessing prime farmland and favorable solar farm characteristics. By analyzing factors such as parcel zoning, soil quality, land cover, conservation areas, and relevant policies, we create geospatial visualizations on an interactive website, mapping key land characteristics countywide. Additionally, an index is constructed to rate each parcel based on proximity to energy infrastructure, suitability for solar farms, prime farmland presence, and road accessibility. We also consider an alternative mixed land-use approach known as agrivoltaics, and address its potential within Hanover County. Leveraging these data in a statistical model, we investigate the relationship between prime agricultural land and land suitable for solar farms. Our research provides valuable insights into areas vulnerable to solar farm development in Hanover County, aiding informed decision-making in solar energy planning and development.

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

James Wilkes
Virginia Tech /Microbiology

Examining the Role of Lrp during growth of Pantoea stewartii in Extracted Corn Xylem Fluid

Pantoea stewartii subsp. stewartii (Pss) is a bacterial phytopathogen that causes leaf blight and wilt disease in corn. The corn flea beetle serves as a vector for Pss, initially infecting the apoplast areas of corn leaves. Subsequently, Pss moves through the plant to the xylem where it forms a biofilm that blocks water flow, thus inducing wilt disease. The bacterium senses its shifting environment through transcriptional regulators that respond to environmental metabolites and alter patterns of gene expression. Previous work in the laboratory has highlighted the leucine responsive regulatory protein (Lrp) as a global transcription factor that is essential for the in planta growth and virulence of Pss. Recent RNA-Seq data has shown genes involved in nutrient acquisition and metabolism to be regulated by Lrp. In this study, wild-type and lrp deletion strains of Pss were grown in extracted corn xylem fluid as monocultures and in competition with each other to further study the role of Lrp with respect to growth and survival in planta. Previous data has shown that the wild-type strain significantly outcompetes the mutant in planta. Current trends indicate that the wild-type also outcompetes the mutant in vitro, but to a lesser degree than in planta. Additional in vitro growth experiments are underway. However, the available data suggests that Lrp plays a role during the disease process in planta beyond just nutrient acquisition and metabolism. Future work is planned to obtain a more complete picture of the role of the lrp regulon in planta.

Mentor(s): Ann Stevens (Biological Sciences)

Cheyenne Williams
Virginia Tech/Psychology

Unwinding Anxiety: Utility of a Mindfulness-Based App to Reduce Adolescent Social Anxiety

Adolescents with social anxiety disorder (SAD) are a notoriously hard population to treat; growing research has sought to utilize technology to reach this population, with encouraging results. Prior work has explored the utility of Unwinding Anxiety (UA), an online mindfulness-based app, for adults with social anxiety. The present study sought to examine the feasibility and utility of UA for treatment of adolescent SAD. Participants include 11 adolescents ages 12-16 (M=13.55; 90.9% White; 18.2% Latine) who engaged with the UA app over a 12-week period. Treatment outcome measures include the Liebowitz Social Anxiety Scale for Children and Adolescents (LSAS-CA), Perceived Stress Scale (PSS), and Five Facet Mindfulness Questionnaire (FFMQ), which were completed pre- and post-treatment.
Completion of app modules was highly variable at the 6-week (range= 2-30 M=13.18) and 12-week (range=5-30 M=20.45) milestone. At 6 weeks, only 9.1% (n=1) completed the app; this increased to 36.4% (n=4) at 12 weeks, with 72.7% completing at least half of the modules.
Paired sample t-tests were used to compare participants' social anxiety, stress, and mindfulness levels before and after using the UA app. It was found that participants' LSAS-CA (t=2.94, p=.007, d=.89) and PSS (t=3.62, p=.002, d=1.09) scores significantly decreased. However, FFMQ scores did not significantly improve. These findings suggest initial promise of the UA app, and that targeting mindfulness may result in reduced social anxiety and stress for adolescents, even if it does not improve their mindfulness in daily life. Adolescents needed longer than adults to complete UA. Further large-scale research is needed.

Mentor(s): Rosanna Breaux (Psychology)
Katelyn Garcia (Psychology, Virginia Tech)

Zoey Wisniewski
UNC Chapel Hill/Neuroscience

Developing Precision Medicine for Glioblastoma Based on Molecular Subtypes

Glioblastoma is an aggressive type of brain cancer with distinct tumors at molecular and cellular levels among patients, which has led to the discovery of three molecular subtypes: mesenchymal, classical, and proneural. Each category has distinct gene expression profiles. This presents an urgent need for precision/individualized therapies to better treat patients. Recent release of large-scale genomic data, including gene expression profiles and tumor-specific dependency maps (genes essential for different tumor types' survival), from DepMap has permitted the discovery of new drug targets for each subtype. This study aims to identify novel drug targets for GBM molecular subtypes. We hypothesize that GBM subcategories depend on unique molecular pathways/genes to survive, making these genes better targets. First, GBMs' RNAseq data was divided into molecular subtypes using GlioVis. Drug target candidates were then identified by determining genes in the top 25th percentile of expression and dependency with a p-value less than 0.25. The resulting candidate genes were analyzed using gene ontology software. To validate these findings, specific inhibitors targeting molecular pathways in each subtype were tested in GBM cell lines. The computer analysis demonstrated that molecular subtypes highly express different sets of genes and rely on separate molecular pathways. Testing chemical compounds in cultured tumor cells supported these findings. These molecular subtypes of GBM have distinct sets of genes as drug targets, which will be further developed into clinically applicable treatments in the future.

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

Samuel Xiang
Williams College/Computer Science
Samantha Gratta
Virginia Tech/Environmental Horticulture

Early Stress Detection in Tomato Plants using Computer Vision and 2D/3D Imaging

Phenotypic changes of plants under stress is difficult to quantify through human observation. Advanced imaging sensors and computer vision algorithms can potentially improve early detection accuracy and aid management decisions. To test whether neural network models are capable of detecting changes in complex plant geometry, we focused on automating 2D and 3D imaging technologies to assess water stressed conditions of tomato plants. Tomato plants were grown from seed under a controlled indoor environment until each plant had three true leaves. The plants were divided into two equal batches, where one was well-watered and the other received 50% the amount of water as the first. Our two imaging stations consisted of a Canon EOS RGB camera to take front and back 2D side-view photos and an Intel LiDAR L515 camera to take 3D top-down snapshots. We manually analyzed the plant height data using ImageJ for 2D images and MeshLab for 3D point clouds. We developed two Python scripts to automate the 2D/3D height measurement using Segment Anything Model (SAM) and Open3D. Each imaging technique produced a different height for the same plant with significantly high correlation between techniques. We observed a reduction in growth over the 5-day period for stressed plants compared to well-watered plants. Using 2D imaging is more efficient for tracking plant growth compared to LiDAR technology. This is due to the lack of easy to use 3D AI algorithms that perform automatic plant segmentation of 3D point cloud data.

Mentor(s): Song Li (School of Plant and Environmental Sciences)

Cora Youngs
Virginia Tech/Biochemistry

Determining Histotripsy Treatment Parameters to Successfully Ablate Pancreatic Tumors and Understanding the Role of Immunological Response

Pancreatic cancer is a uniquely lethal malignancy, with an unmatched speed of progression and consistently low survival rate, demonstrating that new effective therapies are urgently needed. Histotripsy is a non-thermal, non-ionizing ablation treatment with real-time imaging that utilizes acoustic cavitation to breakdown tissue into acellular homogenate. Proof-of-concept studies have demonstrated the capability of precise targeting and ablation of pancreatic tissue. Our aim is to determine the most effective partial and full ablation parameters. Standard parameters of 500 and 1000 pulse repetition frequency (PRF) for 30 seconds and 5 minutes were tested using in-vitro Pan02, mouse pancreatic ductal adenocarcinoma, cell line models. Preliminary results demonstrate the lack of an effective partial ablation parameter and future testing will focus on a broader manipulation of PRF and time settings. The expected results are to determine effective parameters for partial and full ablation of Pan02 cells. Due to the mechanical ablation occurring in the tissue, we also expect to see damage-associated molecular patterns (DAMPs) and cytokines present in the acellular homogenate collected. The presence of these inflammatory mediators is expected to stimulate the innate immune system and cause a shift from a “cold” to “hot” tumor immune microenvironment (TME). Future studies will aim to optimize treatment parameters with in-vivo mice and porcine models. These studies hope to demonstrate the effectiveness of histotripsy as a new non-invasive therapy, with the potential to modulate the systemic anti-tumor immune response, creating a more effective treatment and improving the survival rate of pancreatic cancer.

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

Wenjing Yu
Virginia Tech/Biological Sciences

TOUR

Young Adult Eating Habit(YAEH)--Influence of Ultra-Processed Food on Brain Reward Response and Energy Intake

Authors: Wenjing Yu, Emma H. Leslie, Maria Rego, Bailey Capra, McKenna Helder, Monica Ahrens, Alexandra L. Hanlon, Brenda Davy, Alexandra G. DiFeliceantonio

Ultra-processed foods(UPF), defined by NOVA food system as entirely or mostly made by industrial food additives, has shown negative effects on human health and all-cause mortality in recent decades. Experiments with animals revealed UPF can alter the brain reward circuit in rats, and in 2019 a human study has shown that UPF led to excess food intake and weight gain.However, no experimental human research (using controlled feeding) has tested the impact of food processing on brain reward circuitry. In the US, the majority of obesity starts in adolescence, therefore, our study is focused on young adults(age 18-25). UPF and un/minimally processed food will be provided to the participants in a crossover of 2 weeks diet with a 4 weeks washout in between. fMRI will be conducted to measure the brain's response to UPF milkshakes before and after each diet period. Other measurements such as executive function, eating in the absence of hunger, ad libitum intake at a buffet meal, etc, will also be collected to test the effects of the two different diets. Sensory ratings and texturometer data will be assessed to make sure the diets are matched well between the two groups.

It is expected that the outcomes from this study can lead to a more comprehensive understanding of processed food and potentially improve dietary guidelines.

Mentor(s): Alexandra DiFeliceantonio (HNFE)

Hunsuyador Yusif
Virginia Tech/Chemical Engineering

POC as a Promising Scaffold For Bone Tissue Regeneration.

Over the years, the increase in bone defects has motivated the search for new and better biomaterials capable of providing structural support and facilitating bone tissue regeneration. Polymeric scaffolds have gained considerable attention in the field of bone tissue engineering due to their tunability and versatility. Poly(1,8-octanediol citrate) is a biodegradable and biocompatible polymer that exhibits favorable mechanical properties, such as high tensile strength and flexibility, two crucial properties for bone tissue engineering. DMA, DSC, TGA, and tensile tests will be conducted to assess the polymer's ability to withstand bone regeneration in vivo. The influence on cell behavior and tissue regeneration, when bioactive molecules are incorporated in POC, is also investigated using Hydroxyapatite(HA). In vitro biodegradation, osteoconductive, and osteoinductive potential of POC scaffolds are summarized to exhibit their regenerative capabilities. Data from mechanical tests and other assays conducted are expected to verify POC's ability to support bone regeneration. Overall, this research provides valuable insights into the potential of Poly(1,8-octanediol citrate) as a scaffold material for bone tissue regeneration. By elucidating its synthesis, cellular interactions, biological behavior and good mechanical properties, this study demonstrates the potential of POC scaffolds in addressing the challenges associated with bone defects and injuries; eventually paving the way for the development of advanced biomaterials in bone tissue regenerative medicine.

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Scaling Analysis of Taenidia in Beetle (Zophobas morio) Tracheae

Insects rely on a network of tubes called tracheae that directly deliver oxygen to muscles and other tissues. In some species, the tracheal network is dynamic and flexible, with tubes periodically collapsing and reinflating with changes in internal body pressure, allowing for the modulation of oxygen delivery for different tasks, such as insect flight. Along the length of each trachea, ringlike structures called taenidia line their inner wall. Taenidia have been most commonly understood as purely structural features that strengthen the tracheal wall, so their effect on airflow remains poorly understood. We aim to understand the influence of taenidial geometry on airflow patterns, but we know little about the actual three-dimensional anatomy of these structures and how it varies with size. We analyzed tracheae from darkling beetles (Zophobas morio), including samples from the abdomen and antennae. These samples were imaged via transmission x-ray microscopy (TXM), using synchrotron imaging at the Advanced Photon Source (Argonne National Laboratory). Sample images were segmented and rendered in Avizo, and measured using 3D Slicer. We performed a scaling analysis using taenidial width, height, and spacing, with tracheal cross-sectional area as a measure of size. These findings will be useful for the creation of idealized tracheal models, which may have implications on the design of bio-inspired microfluidic devices that employ features of insect systems.

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