2024 Summer Conference

Office of Undergraduate Research

July 25, 2024

Table of Contents

Welcome

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

Welcome all to the 2024 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, 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 13th annual Summer Research Conference at Virginia Tech being hosted by the Office of Undergraduate Research (OUR)! Today we welcome 254 presenters from 25 organized funded programs and many independent labs, who will give 215 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 the work on show today and invite you to enjoy and marvel at the wealth of research that took place this summer.

I would like to extend an extra special welcome to our colleagues and their research students from Hollins University in Roanoke, VA and Concord University in Athens, WV. We are so excited that you are a part of this event today… welcome!

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 Dr. Lisa Lee (Research Integrity), Regina Allen, Vanessa Oetjens, 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 Dr. Lisa Lee (Virginia Tech Training and Compliance), Christina McIntyre (Honors College), the VT Graduate School, Suzanne Shelburne (Career and Professional Development), Dr. Paul Heilker (Honors College), and Monica Hunter (MAOP) who organized and 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 – Cleo, Kamau, and Maddie - who offered activities throughout the summer and were instrumental in building a vibrant research community. Without these dedicated mentors, this summer would not have been as fun and engaging for everyone.

An especially big thank you to Nicole Bottass and Dr. Kristen Bretz, 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

Dr. Irving Coy Allen

Dr. Allen is an immunologist at Virginia Tech in the Department of Biomedical Sciences and Pathobiology. His research program is focused on understanding the role of the immune system in host-pathogen interactions, inflammatory diseases, and cancer. Dr. Allen is internationally recognized for his work in understanding the contribution of unique families of pattern recognition receptors in modulating disease pathogenesis. These receptors are proteins that cells utilize to recognize pathogen-associated molecular patterns and damage-associated molecular patterns, which are associated with pathogen infection and cellular stress. Complementing his immunology expertise, he also has a strong background in the development of novel animal models, human preclinical studies, and expertise in human clinical trials. His teams routinely collaborate with diverse multinational research groups from academia, government, and industry. This transdisciplinary research approach has afforded his team and other groups at Virginia Tech with exciting opportunities to perform immensely needed, translational research to improve patient outcomes. Since arriving at Virginia Tech, Dr. Allen has mentored 49 undergraduate students, with the overwhelming majority continuing their training in graduate, veterinary, or medical school. Of Dr. Allen's current or former undergraduate students, 10 have received national or international awards for research excellence.

SUMMER RESEARCH PROGRAMS AT VT
PROGRAM DIRECTORS

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), AbbVie, Virginia Tech's College of Science and the Department of Statistics, and the University of Virginia's Division of Biostatistics.

CEED Summer Research Experience
Directors: Dr. Bevlee Watford
The CEED Summer Research Experience offers transfer students the opportunity to do research with our College of Engineering faculty. This research experience, funded by the National Science Foundation, is designed to provide research opportunities for this population of undergraduate students that often do not have access to such an experience. It intended to encourage these students to think about graduate education, hopefully here at Virginia Tech.

CHBR SUMMER PROGRAM
Directors: Dr. Warren Bickel, Dr. Alexandra DiFeliceantonio, Dr. Jeff Stein
Coordinator: Dr. Alexandria Pilot-Chambers
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)
Manager: Dr. Alexandria Pilot-Chambers (FBRI)
The American Heart Association Fralin Biomedical Research Institute at VTC 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 implemented in cardiovascular research and housed within FBRI to understand appropriate application of each technology. From functional magnetic resonance imaging of their own brains to echocardiography right down 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 related to cardiovascular disease. The CardioSURF program is funded by the American Heart Association.

FBRI neuroSURF
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. The program encompasses a full time, 40 hour weekly schedule and supports neuroSURF students with a competitive stipend. Housing will also be providing at no cost to the students. In addition to independent research, the program includes coursework in translational neurobiology, mentoring on science communication and presentation skills, and professional development and DEI events and activities. neuroSURF students participate in the VT symposium and FBRI symposium at the end of the program.

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.

MULTICULTRUAL ACADEMIC OPPORTUNITIES PROGRAM (MAOP)
Monica Hunter (Director)
Laila Kirkpatrick (Assistant 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 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 Thomas O'Donnell (Director)
Betty Wilkins (Coordinator)

Our physics faculty are engaged in a broad spectrum of research within neutrino experimental and theoretical physics, including dark matter, the search for sterile neutrinos, phenomenology studies, and the study of neutrino spectrum from nuclear reactors. 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 associate professors and postdocs.

SOLVING PROBLEMS WITH DATA SCIENCE
David Schmale (Director)
Shane Ross (Co-Director)

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

participating research groups and will experience hands on research, group meetings, and close collaboration with other members of related research groups.

STUDENTS TRANSFORMING ENERGY AND ENVIRONMENTAL RESEARCH (STEER)

Amanda Morris (Director)

Mandy Swope (Coordinator)

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.

Summer Undergraduate Research Fellowship (SURF@Hollins) Program

Dr. Christopher Florio (Director)

SURF@Hollins offers a concentrated opportunity for a select number of students to work collaboratively with faculty over the summer. The program provides a stipend and summer housing to accepted students who participate in a cohort model during the summer. Students in the program emerge with an "action plan" that often includes a report and presentation covering their learning experience. Research fellows come from across all academic divisions of the university.

SCHOOL OF NEUROSCIENCE SUMMER UNDERGRADUATE RESEARCH FELLOWSHIP (SURF-N)

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 of 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 weeks of 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.

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

Drs. Sasha Marine (BCHM), Caitlin Cridland (BCHM) 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. Each VT-REEL fellow is mentored by two faculty members, who are located on-campus or at an Agricultural Research and Extension Center (AREC). Nine undergraduate students pursuing bachelor's degrees in Virginia, Oregon, North Carolina, and Iowa were chosen to participate in the 2024 summer program. In addition to their individual research projects, all fellows participated in a weekly bioinformatics and "big data" workshop series. Faculty mentors were affiliated with the School of Plant and Environmental Sciences, Department of Biological Sciences, Department of Biological Systems Engineering, Department of Biochemistry, or Department of Food Science & Technology. 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 (Associate 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 enrichment program designed to assist undergraduate students 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 application counseling and 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

TRANSLATIONAL BIOLOGY, MEDICINE AND HEALTH

VIRGINIA TECH GRADUATE SCHOOL

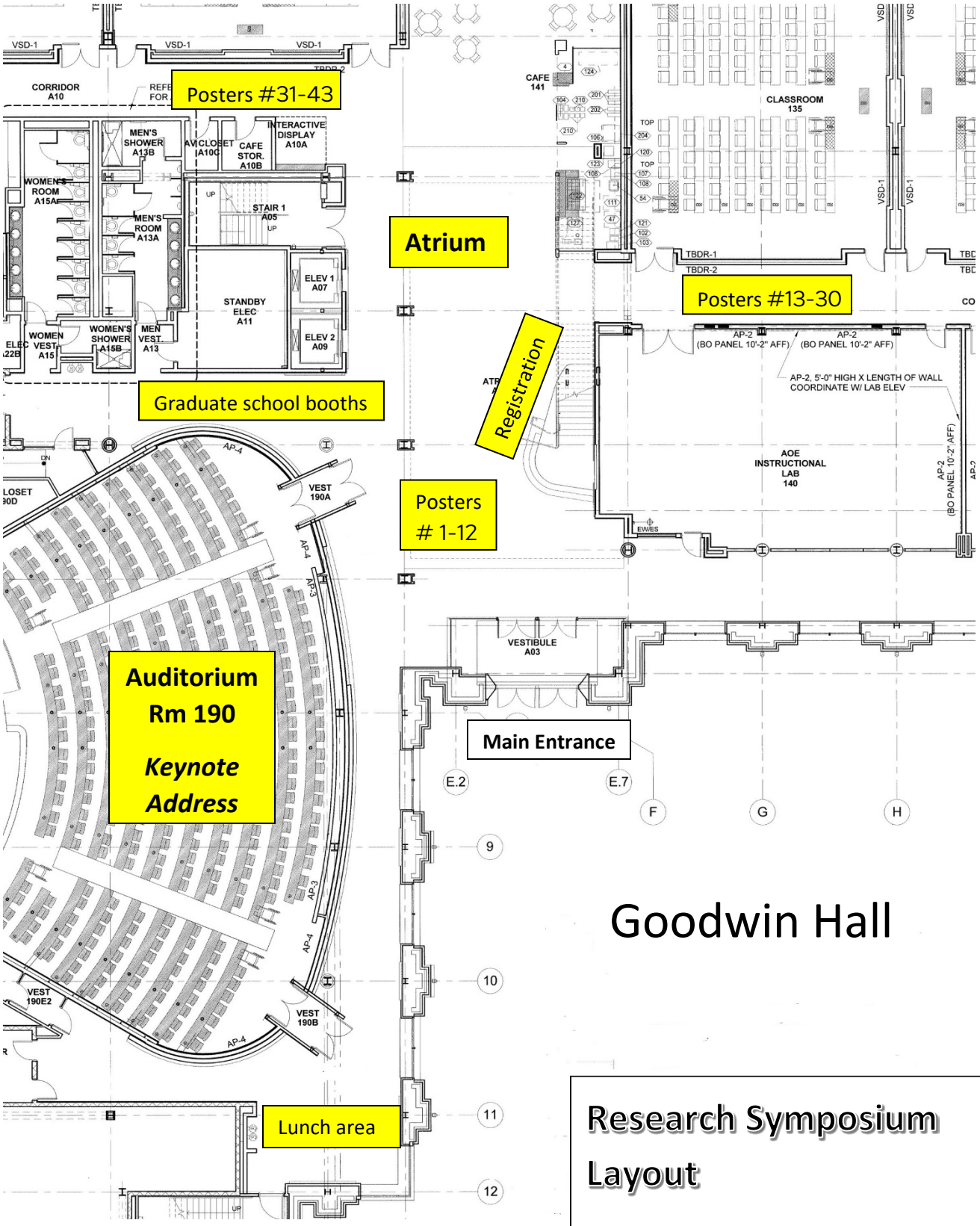
Thank you, OUR Summer Peer Mentors!!

Schedules, Map and Abstracts

2024 Summer Undergraduate Research Symposium at Virginia Tech

July 25, 2024 | Goodwin Hall

9:00-9:20am	Check-in (Goodwin Atrium) Poster Session 1 set up
9:20-9:30am	**Welcome- Jill Sible (Goodwin Auditorium)**
9:30-9:50am	**Keynote Address- Dr. Irving Coy Allen (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	Break Poster Session 4 take down/Poster session 5 set up
3:00-3:50pm	**Poster session 5 (Goodwin Atrium)**
3:50-4:00pm	End of symposium/ Poster session 5 take down



Goodwin Hall

Research Symposium Layout

July 25, 2024

2024 Summer Undergraduate Research Conference			
Schedule-at-a-Glance			
Poster Session 1: 10-10:50am			
Registered Presenter	**Program Affiliation**	**Poster number**	**Poster Title**
Allen	MAOP Summer Research Internship	1	The adventure and Dynamic Based On In Game Immersion
Amin	MAOP Summer Research Internship	2	Quantum Tomography of a Single Qubit
Anderson	VT-REEL	3	Refining Tissue Culture in Potato (Solanum tuberosum)
Bhan	Independent	4	Optimizing Quantification Methods for Carbon and Sulfur Impurities in Molten Salt Reactors
Assefa	MAOP Summer Research Internship	5	The Hidden World of Data Brokers: Acxiom and Beyond
Bartlett	Independent	6	Effects of Nitrogen and Calcium Nutrition on Vegetable Production
Beery	VT-REEL	7	Evaluating Cover Crop Nitrogen Uptake, Fixation, and Release
Brisbin	VT-REEL	8	Gaining insight into plant-yeast interactions regarding auxin activity through the use of fluorescence microscopy
Bryan-II	Solving Problems with Data Science	9	The Mechanics of Wing Coupling in Cicadas
Burgiss	VT-REEL	10	Chemical Defense Mechanisms in Plant-Plant and Plant-Insect Interactions
Cain	VT-REEL	11	Identifying a Chromosomal Region for Soybean Protein and Oil Content Using Molecular
Cao	Solving Problems with Data Science	12	Sensing the Issue: Methane Emissions in Dairy Cattle at Kentland Farm
Chen	BEEHIVE	13	Evaluating Gene Regulatory Network Inference Algorithms
Craine	Solving Problems with Data Science	14	Evaluating the Accuracy of the U.S. EPA's MOVES4 Model in Estimating Particulate Matter Emissions from Electric Vehicles
Crook	Solving Problems with Data Science	15	Potential Sources and Interannual Variability of Atmospheric Microplastics Deposited in South Central Appalachia
Delaporte	Independent	16	Does an association exist between retention rates and senses of belonging and care in the field of ornithology?
Dreesbach	VT-REEL	17	The effect of secondary metabolite diversity on pathogen evolution
Ergasheva	Solving Problems with Data Science	18	Leveraging AI to analyze centrosome and chromosome numbers in tetraploid cells
Fares	Solving Problems with Data Science	19	Systematic Approach for Cluster Detection of Countable Applets in Quantitative Data
Fearer	Independent	20	Examining relations between maternal intrusiveness and ADHD symptoms in children with low inhibitory control
Guerrero Perez	Independent	21	First Principles Simulation of Color-Center Defects in Lithium Fluoride for Sensing Low-Energy Nuclear Recoils
Hausler	Anne McNabb Fellowship	22	Role of Dipeptide Permease Transporters in Metabolism of Peptides by Sinorhizobium meliloti
Horrall	Solving Problems with Data Science	23	Monitoring Biological Aerosol Particles (BAPs) in Spruce Forest in Mauerbach, Austria
Jackson	VT Data Science for the Public Good	24	Estimating the Effect of a Utility-Scale Solar Facility on House Prices: A Case Study in Prince George County
Janjua	Solving Problems with Data Science	25	Where There's Smoke, There's AI: Advanced techniques in Smoke Plume Analysis
Jones	VT Data Science for the Public Good	26	Projecting Food Insecurity in Southwest Virginia
Linville	Solving Problems with Data Science	27	What's Wrong With my Motor? Utilizing Instantaneous Frequency to Extract Motor Component Signatures
Mach	Solving Problems with Data Science	28	Does water loss or blood pumping explain mass loss in cicada wings during adult wing development?
Matheson	MAOP Summer Research Internship	29	Disparities in Leadership and Sense of Belonging Between White and BIPOC Members of Ornithological Societies
Melia	Independent	30	Denitrifying bioreactors for legacy nitrate removal from springs in the Chesapeake Bay watershed
Miller	MAOP Summer Research Internship	31	Machine Learning-based Cybersecurity for Invertor Based Resources
Mistry	Solving Problems with Data Science	32	Development of surface-enhanced Raman spectroscopy (SERS)-based nanoprobes and machine learning models for predicting droplet pH
Molinares Hess	MAOP Summer Research Internship	33	Foveated Side-Channel Attacks on VR Rendering
O'Dowd	Independent	34	Evaluating the Effects of Traumatic Brain Injury on Cognition and Memory using the Novel Object Recognition Test
Orenuga	MAOP Summer Research Internship	35	Low-Cost, Rapidly Deployable Drone Detector to Protect Airports from Denial of Service
Rehmatulla	Solving Problems with Data Science	36	Identifying Spring Dead Spot in Bermuda Grass Using Aerial Imagery and Machine Learning
Roberts-Tsoukkas	Solving Problems with Data Science	37	Earth-Moon Cycler Orbits with a Stable Subfamily
Smedley	Solving Problems with Data Science	38	Transport of Biological Particles in the Atmosphere
Sobrado	Independent	39	Internalizing Symptoms as a Protective Factor Against Drug and Alcohol Use for Highly Impulsive College Students
Spillman	VT-REEL	40	Quantifying Differences in GHG Emissions in Biological-Treated Fertilizer and Untreated Fertilizer
Vikesland	VT-REEL	41	Transforming Cannabis sativa Leaf Discs and Meristem with Transcription Factor CsWoolly
Wasserman	VT Data Science for the Public Good	42	Deaths of Despair in Virginia: Analyzing Socioeconomic Factors and Demographics

Poster Session 2: 11-11:50am			
Registered Presenter	**Program Affiliation**	**Poster number**	**Poster Title**
Anthus	VT-REEL	1	Modeling and Mutating the C4-COPI Dimer in TYLCV to Inhibit Viral Infection
Battle	neuroSURF	2	Effect of Dlk1 on Neighboring Cells Analysis in the Developing Cortex of DiGeorge Syndrome Mouse Model
Chhabra	neuroSURF	3	Unveiling the Overlap: Are RNA Binding Protein ZNF326,AKAP8,AKAP8L are Functionally Redundant ?
Cross	neuroSURF	4	Retrospectively analyzing children with CASK-related disability undergoing Global Developmental Delay Intensive Therapies
Dempsey	neuroSURF EIP	5	Examining the relationship between amygdala volume and fear response in 3-month-old infants
Dessert	Independent	6	A Narrative Review of Interventions Addressing Stimming Behaviors in Autistic Individuals
Disbrow	neuroSURF	7	PDE9 Inhibition as a Therapeutic Target for Mitochondrial Quality Control in Cardiometabolic Disorders
Garrastegui Segarra	Independent	8	Ubiquitination in the prefrontal cortex as a sex-specific mechanism of fear memory formation
Habte-Mariam	neuroSURF EIP	9	Novel Combinational Therapies for Melanoma
Halvonik	neuroSURF	10	Pioneering a c-FOS Staining Approach to Map Motor Circuits
Harris	neuroSURF	11	Age Impacts Synchronous Network Activity in Mouse Model of Childhood Genetic Epilepsy
Hawkinson	neuroSURF	12	Investigating Mosquito Flight Behavior Using Virtual Reality Tools to Enhance Control Strategies
Henderson	neuroSURF	13	Comparison of Babel Brain and k-WAVE for brain modeling
Johnson	Independent	14	Time Delay due to Scattering of High Energy Supernova Neutrinos with Dark Matter
Minnivk	Independent	15	Small Angle Monitor for The Moller Experiment
Blue	MAOP Summer Research Internship	16	Visceral Notices and Privacy Mechanisms for Eye Tracking in Augmented Reality
Portis	MAOP Summer Research Internship	17	Large Language Models for Alert Investigation
Prather	MAOP Summer Research Internship	18	Classical vs. Quantum RNG in the BB84 Protocol
Ralat	MAOP Summer Research Internship	19	AskAResearcher: Transforming Research to Practice
Rechani	MAOP Summer Research Internship	20	LYMPHEDEMA
Reid	MAOP Summer Research Internship	21	Enhancing Interactive Learning through Wireless Communication Simulations
Roadman	CNP REU	22	Neutrino Emissions from Plutonium-241 and Spent Nuclear Fuel
Robbins	neuroSURF	23	Using Feeding Experimentation Device (FED3) to Evaluate Non-Motor Symptoms of Parkinson's Disease in Mice
Roberts	neuroSURF	24	Alterations in Excitatory Corticothalamic Synapses in a Dravet Syndrome Mouse Model
Robinson	MAOP Summer Research Internship	25	Polarizer changes affecting local and non-local interferometry
Rubley	neuroSURF	26	Monoubiquitination of Histone H2B decreases in the amygdala of male and female rats during fear memory formation
Sekyere	MAOP Summer Research Internship	27	Microbes vs. Preservatives: Microbial Activity in Cosmetic Products and How Preservatives Affect Growth
Shannon	MAOP Summer Research Internship	28	How Dogs Experience Loss: The Impacts of Permanent Disruption of Familial Social Structure on Age Related Decline in Canines
Si	MAOP Summer Research Internship	29	Purification of Molten Salt For Energy Storage Systems
Sigrist	MAOP Summer Research Internship	30	Purification of the MalE-McpWPR fusion protein using a pTEV cloning vector and characterization of its ligand spectrum.
Taah	neuroSURF	31	Aligning EEG and EmotiBit Data: Development of Effective Synchronization Methods
Taylor	MAOP Summer Research Internship	32	Innovative Phage-Based Strategies to Combat Virulence in Antibiotic-Resistant Salmonella Typhimurium (STm)
Trubenbach	MAOP Summer Research Internship	33	The Impact of Adsorption Materials for Passive Sampling of Aquifer Microbes
Varshney	Independent	34	AI-Enhanced Teaching Assistant: Bridging Professor Knowledge and Web Intelligence
Wallen	Hollins SURF	35	Solid Waste Management and Infectious Diseases: Exploring Perceptions in Freetown, Sierra Leone
Wang	neuroSURF	36	Mapping the functional pathways in Euchromatin-Disrupted Human Development Disorders
Wcisel	MAOP Summer Research Internship	37	Investigating an Accessible Multi-Agent Robotic System for Air Quality Monitoring in Construction Inspection
Wiley	Independent	38	Enterobacter spp. in Amended Hardwood and Softwood Biochar: Assessing the Survivability of Microbial Communities
Wiley	MAOP Summer Research Internship	39	Analyzing effect of deactivation of various genes in Salmonella Typhimurium on susceptibility to bacteriophage χ
Wilson	neuroSURF	40	Investigating Phenotypic Differences of Drosophila melanogaster Ir21a Mutants
Winfield	MAOP Summer Research Internship	41	Correlation Curves and Descriptions of Quantum Entanglement
Zhang	neuroSURF	42	Investigating Chromatin Biology and Its Role In Cancers

Poster Session 3: 1-1:50pm			
Registered Presenter	**Program Affiliation**	**Poster number**	**Poster Title**
Abouelenein	CardioSURF	1	Investigating SARS-CoV-2 Encoded Protein Sufficiency in Phosphorylation of Connexin43
Antony Baskar	A-Lab SURF	2	A canine osteosarcoma treatment pilot study investigating histotripsy combined with immune stimulant IP-001.
Athumani	A-Lab SURF	3	The Role of BMP3 in the Pathogenesis of Pulmonary Arterial Hypertension
Ayub	Hollins SURF	4	On efforts to prepare and characterize Ph2PCH(CCl3)PPh2
Bentley	CHBR	5	Are food demand and delay discounting associated with diabetes management
Brousseau	Hollins SURF	6	The impact of perpetrator race, identification procedures, and encoding time on eyewitness identification
Burt	CUBE SURF	7	How Connections Are Made: Investigating the Role of Trust on the Relationship between Social Isolation and Mental Health and Behavioral Outcomes
Carr	MAOP Summer Research Internship	8	Fluorescence-Based Characterization of Polymer-Protein Interactions
Chan	MAOP Summer Research Internship	9	User Interface Development using CustomTkinter for Automating Python Dependency Recognition
Chipman	A-Lab SURF	10	Family Ties: Associations between Familial Relationships, Delay Discounting, and Unhealthy Behaviors in Substance Use Disorder Recovery
Cooper	MAOP Summer Research Internship	11	The Dark Side of the Screen: How Social Media Impacts Mental Health
Crum	MAOP Summer Research Internship	12	Weller's Wannabe? Investigating Possible Mimicry between Desmognathus orestes and Plethodon welleri
Cullinane	Hollins SURF	13	Community Speaks: Queer Roanoke and Verbatim Theater
Cutler	MAOP Summer Research Internship	14	Effects of Concentration of PEGDA and Exposure Time on Mechanical Properties of 4D Biomaterials
Davis	Hollins SURF	15	Public Causal Beliefs about Binge Eating Disorder
Dinakin	CHBR	16	Comparing the Labeled Magnitude Scale Trainings to Flavor Ratings
Elbash	A-lab SURF	17	Chronic Pain and Delay Discounting: The Cognitive Struggle of Substance Use Disorders Recovery
Hopson	CHBR	18	Evaluating Human Milk Composition Fluctuations Over the First 6-Months of an Infants Life.
Kang	Fralin SURF | CHBR SURF	19	Exploring the Efficacy of Nicotine Replacement Therapy Interventions
Lathrop	CUBE SURF	20	GLP-1s Beyond Weight Loss: Social Media Insights on Discussion, Taste, and Mental Health
Lee	A-Lab SURF, CHBR	21	Differential brain morphology after UPF diet compared to nonUPF diet using voxel based morphology
Mathis-Ehlers	Hollins/Global Change Center Scholars	22	Art & Hunger: An Empty Bowls Project
Merritt	Hollins/Global Change Center Scholars	23	Studying Abroad: Continuity and Change in Study Abroad Programing and Experiences at Hollins University
Mitchem	Independent	24	Parental Perceptions on Their Children's Technology Use
Assefa	MAOP Summer Research Internship	25	Exploring Data to Support Evidence-Based Tech Hiring for GitMeter
Neres	CUBE SURF	26	Examining the Effect of Price, User Type, and Nicotine Strength on E-Cigarette Demand among Smoking Adults
Nguyen	CHBR	27	Examining the Association between Familial Relationships, Unhealthy Eating Habits, and Delay Discounting in Individuals in Recovery from Substance Use Disorder
Pierce	Hollins/Global Change Center Scholars	28	The Impact of the Russia-Ukraine War on Central Asian Republics
Otoo	MAOP Summer Research Internship	29	Technology Use in the Black Church: Perspectives of Black Church Leaders
Palmer	Independent	30	Comparative Synthesis of NaGdF4 Nanoparticles Using Acetic Acid and Oleates as Precursors
Pozo-Aranda	A-Lab SURF	31	Identifying native NMDA receptor diversity in the mouse thalamus
Rai	A-Lab SURF	32	Development of Glutamatergic Synapse in Somatosensory Thalamus Decrease in Number in Dravet Syndrome Mice Model
Rai	Hollins SURF	33	The impact of perpetrator race, identification procedures, and encoding time on eyewitness identification.
Ruppel	Hollins/Global Change Center Scholars	34	"A Push for Democracy:" The United States' Democracy Promotion in Chile, Peru, Bolivia, and Ecuador
Suber	Hollins/Global Change Center Scholars	35	Hope of Escape Research Archive (HERA)
Thompson	Fralin SURF	36	Itching for an Answer to the Late Enzymatic Steps in Poison Ivy Urushiol Biosynthesis
Varshney	Independent	37	Development of AI-assisted Chatbot for Water Monitoring Environment Lab
Whittle-Hage	Fralin SURF	38	Nanobody Protein Expression for use in a Nanosensor to detect a Pig Virus
Zaengle	Hollins SURF	39	Community Speaks
Zalenski	Fralin SURF	40	Characterization of active site mutants for Acinetobacter baumannii siderophore biosynthesis enzyme FbsI
Zeman	Fralin SURF	41	Elucidating the Function of a Novel Electron Transferring Protein in Methanogenic Archaea
Hasan	MAOP Summer Research Internship	42	Exploring Data to Support Evidence-Based Tech Hiring for GitMeter
Khan, Asfandiyar	CEED	43	Cross-Omics Integration in Foundation Models: Bridging Single-Cell and Bulk RNA-Seq, Proteomics, and Spatial Data

Poster Session 4: 2-2:50pm			
Registered Presenter	**Program Affiliation**	**Poster number**	**Poster Title**
Aronson	Fralin SURF	1	Exploring the Thermal Biology of Invasive Aedes Mosquitoes
Bhaumik	Independent	2	Ab initio properties of color center defects for mineral detection of dark matter
Chan	Fralin SURF	3	RNA polymerase A subunit deletions inhibit Brome mosaic virus replication
Copening	Fralin SURF	4	Development of Vaginal Dilation Device for In Vivo Mechanical Testing in Murine Models
Deal	MASBio	5	Inclusion Complex Optimization Process of Amorphous Polyhydroxyalkanoates and Beta-Cyclodextrin
Detloff	Fralin SURF	6	Identifying Protein-Protein Interactions on the Bacterial Spore Membrane Surface
Docev	Independent	7	20th Century Microplastic Accumulation and Storage in Bayside Salt Marshes of the Eastern Shore, Virginia.
Fisher	MASBio	8	Using Hemp Lime in Building Materials for Carbon Sequestration
Forbes	Fralin SURF	9	Interactions of Flagellotropic Bacteriophages with Various Agrobacterium Species
Galvan	MAOP Summer Research Internship	10	Teaching Systems Engineering Fundamentals to K-12 Students through a Robotics Educational Bootcamp
Huneidi	MAOP Summer Research Internship	11	Patient Pain and Quality of Life Outcomes after Histotripsy Treatment for Canine Osteosarcoma
Huq	Fralin SURF	12	Investigating effects of media and surface hydrophilicity on type IV pilus-dependent biofilm formation
Jernigan	MAOP Summer Research Internship	13	Bioassay-guided Isolation of Antibiofilm Compounds from Marine Egg Mass Microbiota
Jones	Summer Fellows-School of Neurosci	14	The flavor enhancer Maltol potentiates RXR/Thyroid Hormone-mediated Mechanisms of Neural Development in Xenopus laevis larvae.
Judy	Independent	15	Dispersion of Aluminum Particles using Pressurized Air
Kane	MAOP Summer Research Internship	16	Quantum key distribution protocol without using classical channel communication
Kelly	MAOP Summer Research Internship	17	Examining the relationship between the goal setting behaviors of individuals with ADHD and their substance use habits
Khan	MAOP Summer Research Internship	18	Seeing the Unseen: New Tools to Measure Hidden Volatile Organic Compounds (VOC) in the Air
Knorr	CNP REU	19	Gamma Ray Spectroscopy for Neutrino Experiments
Kuhtenia	CNP REU	20	Finding Neutrons in MiniCHANDLER
Lawson	MAOP Summer Research Internship	21	Examining Home-Prepared Diets for Companion Dogs Using Data from the Dog Aging Project
Linkous	MASBio	22	Transpiration drying and associated leaf physiology of common Appalachian hardwood species used in biofuel production
Luff	Fralin SURF	23	Feeding Behavior of Male and Female Mosquitoes of Different Species with Respect to Different Sucrose Concentrations
Moore	Beckman Scholars	24	Histotripsy: Using Focused Ultrasound to Target and Treat Pancreatic Cancer
Moore	Fralin SURF	25	Low-intensity Focused Ultrasound is a Promising Noninvasive Procedure Which May Potentially Reduce Anxiety
Patel	Summer Fellows-School of Neuroscience	26	Exploring the complex relationship between aggression and testosterone in urban and rural song sparrows (Melospiza melodia)
Patton	Summer Fellows - School of Neuroscience	27	Urbanization and behavior: Does Neuropeptide Y mediate behavioral shifts among urban and rural song sparrow (Melospiza melodia) populations?
Peppers	Independent	28	Functional Analysis of HA-Tagged GR28B(D) Warmth Receptor in Drosophila
Pho	Fralin SURF	29	Adrenergic Receptor Antagonists Reduce Herpes Simplex Virus 1 Recurrences with The Presence of Epinephrine
Gioia	Independent	30	Variable Gearing In Jumping
Robinson	Summer Fellows-School of Neuroscience	31	Visual Spectral Sensitivity of Jamaican Fruit-eating bat (Artibeus jamaicensis)
Samanta	Summer Fellow- School of Neuroscience	32	Investigating the Effect of Peripheral CSF Overexpression and Psychological Stress on Macrophage Function in Ovarian Tissue
Shimozono	Fralin SURF	33	The Effect of Hypoxia on Exercise Responsive Genes in Mouse Skeletal Muscle
Stanley	Fralin SURF	34	Transcriptional Activity of Per2AS is Dampened in the Presence of its Enhancers
Strobel	Fralin SURF	35	Social Cognition Deficits as a Transdiagnostic Risk Marker of General Psychopathology
Sturgill	Fralin SURF	36	Quantifying Natural Antibody and Complement levels in House Finches through Hemolysis-Hemagglutination Assays
Taylor	MASBio	37	Effect of Modified Cyclodextrin on Polylactic Acid Inclusion Complex Formation
Wickman	MASBio	38	Assessing Regional Biomass Operations, Economics and Best Management Practices in Virginia
Wildermann	Summer Fellows-School of Neuroscience	39	Designing the Cold Pressor Task for Human Neuroimaging
Williams	Independent	40	MICROPLASTIC ACCUMULATION SINCE 1950 IN BAYSIDE AND SEASIDE SALT MARSHES OF THE EASTERN SHORE, VIRGINIA.
Winberg	National Science Foundation	41	Spider-mite adaptability in their native fibrous environments
Youngs	Beckman Scholars	42	Focused Ultrasound Modifies Tumor Microenvironment and Improves Systemic Anti-Tumor Immunity During Ablation of Pancreatic Tumors
Rogers	MAOP Summer Research Internship	43	Recombinant Protein Expression and Purification: The Isolation of Glutathione S-Transferase

Poster Session 5: 3-3:50pm			
Registered Presenter	**Program Affiliation**	**Poster number**	**Poster Title**
Adisalem	CEED	1	Platform design for Future Testing of a Swing Stabilization Algorithm on Hahn 130 Catwalk
Alexander	CEED	2	The Use of Generative AI in Collaborative Projects
Ashra	STEER REU	3	Studying the effect of crosslink density and chelation site hydrophobicity on the capture of rare earth elements.
Barnes	CEED	4	Exploring the potential of sigB as a rapid detection tool for Listeria directly from environmental DNA
Bechtold	CEED	5	Conformal 3D Printing on Deformable Objects with Point Cloud Path Planning
Chen	CEED	6	The relationship between online and in-store shopping demand and its connection to travel demand
Chhetri	CEED	7	Task-Oriented Time Management: Integrating Screen Tracking and Digital Resource Metadata in a To-Do List Application
Davis	CEED	8	The Impact of Water-to-Cement Ratios on the Durability and Performance of Concrete Repair-Substrate Interfaces
Deb	Independent	9	Tunable Transport In Topological Metal Mn2Au For Spintronics Applications
DeLoatch	STEER REU	10	Determining the extinction coefficient of RAFT agents for monitoring polymerizations
Dulli	CEED	11	Enhancing Resilience of Low-Rise Large Volume Structures Against Extreme Winds
Evani	CEED	12	Characterizing the Flow Field of Virginia Tech's Hypersonic Wind Tunnel
Farnsworth	Independent	13	Does Gender Impact the Association Between Mindfulness and IPV Perpetration?
Gannon	STEER REU	14	Investigating the effects of casting method and ionic liquid composition on the structural and chemical properties of molecular ionic composites.
Green	Independent	15	Fiber Reinforced Polymer Diaphragm Retrofits For Earthquake Resilience
Hahn	STEER REU	16	Use of Zirconium Metal Organic Frameworks for Photon-Upconversion in Solar Cells
Hanger	David Lyerly Foundation Undergraduate Microbiology Research Fellowship	17	Isolation of Pantoea spp. Jumbo Phages from Soil Samples
Harvey	STEER REU	18	Post-Modification of Polymer Networks for Metal Binding
Hawkins	STEER REU	19	Modification of Spns2 Inhibitors to Treat Multiple Sclerosis
Hayes	CEED	20	Development of Mechanical Engineering Related Labs for Applied Electrical Theory
Hossain	CEED	21	Understanding User and Developer Perceptions of Dark Patterns in Software
Hu	CEED	22	Utilization of Persona Creation through LLMs to Enhance Human Storytelling
Huynh	CEED	23	Persona-Based AI Web Automation: Tailored Automation of Online Tasks
Jah	CEED	24	How Do Visually Impaired Users Navigate Privacy Risks in an Ad-Driven Web?
Lin	CEED	25	Improving Vat Polymerization through Rheological Analysis of Novum Glass Particles in Photoresin
Mann	CEED	26	Identifying the Effects of Stress and Sex on Unique Pathology in Blast TBI
McCarley	Independent	27	Electrophysiological and Behavioral Factors as Predictors of Negative Emotion in Infancy and Toddlerhood
Medeck	STEER REU	28	Optoelectrical properties of chiral quasi-2D Halide Perovskites
Montemayor	Independent	29	Drosophila melanogaster larvae integrate tonicity into temperature preference
Ordoobadi	CEED	30	The Effectiveness of Data Sonification on Wind Speed during Thunderstorms
Rhudy	Neutrino Physics REU	31	Mechanical Properties of 304-Steel Springs in Cryogenic Environments
Ryder	STEER REU	32	Tuning Catalytic Efficiency of Synthetic Enzyme Kemp Eliminase 15 by Attaching a DNA Fragment
Saintile	STEER REU	33	Synthesis and electrochemical performance optimization of P2 (prismatic crystal structure) layered NaxMn0.8Fe0.1Ti0.1O2
Sandberg	Independent	34	Small Scale Aluminum Combustion Ignition System
Sanna	CEED	35	Developing Pneumatic Air Muscles to be used in a Robotic Snake
Savelyev	BRIDGE Summer Grant	36	Phone Use and Gratitude Expression: Naturalistic observations of pedestrian-driver interactions
Scarpa-Friemdan	CEED	37	Ultra-High Temperature Ceramics (UHTC) Test Rig Electronics Modification and Torch Replacement
Smith	CEED	38	Sandponics: A new approach to traditional nitrification and solids removal processes in aquaponics systems
Wilsher	CEED	39	Developing a Field Programmable Gate Array (FPGA) Elevator Door Project for ECE 2804
Young	CEED	40	A Study for determining the demand for Urban Air Mobility
Zhang	Independent	41	Quantification of 3D in vivo model of embryonic mice during late pregnancy
Hernandez-Mendez	MAOP Summer Research Internship	42	Mapping and Sensor Fusions
Bowen	MAOP Summer Research Internship	43	Use of Matrix - assisted Laser Desorption/Ionization Time-of-Flight Mass Spectrometry to Identify Melanoma Tumor Cells

Karim Abouelenein
Virginia Tech/Biological Sciences

CardioSURF

Investigating SARS-CoV-2 Encoded Protein Sufficiency in Phosphorylation of Connexin43

SARS-CoV-2 has been a leading cause of death in the United States since the COVID-19 pandemic began in 2020. Symptoms are primarily respiratory, but severe neurological and cardiac effects can also occur. Upon infection, the cell intrinsic innate antiviral immune response is a first line of host defense and is propagated via direct intercellular communication between infected cells and uninfected neighbors. Gap junctions, which comprise connexin proteins, couple the cytoplasms of apposing cells to effect such communication. Connexins are subject to dynamic regulation, and viruses have been reported to target intercellular communication to limit gap junction function and the antiviral immune response. Adenovirus, for example, activates the protein kinase C (PKC) pathway, leading to phosphorylation of connexin43-Ser368, resulting in gap junction closure. Preliminary data from the Smyth lab demonstrates that SARS-CoV-2 infection results in rapid hyperphosphorylation of connexin43-Ser368. How SARS-CoV-2 targets gap junction function remains unknown, however. We hypothesize SARS-CoV-2 encoded proteins limit gap junction function via PKC activation, resulting in connexin43 hyperphosphorylation. To test this, gateway cloning was utilized to create a library of SARS-CoV-2 expression plasmids, which were transfected into A549 cells. Western blotting was employed to determine connexin43 phosphorylation status and confirm ectopic expression of viral proteins. Immunofluorescence confocal microscopy was used to visualize localization of SARS-CoV-2 and connexin proteins. Upon completion, this work will provide insight into viral mechanisms of immune response perturbation. Future directions include using PKC inhibitors to confirm phosphorylation via PKC-mediated pathways and test impact on SARS-CoV-2, and general coronaviral replication.

Mentor(s): James Smyth (FBRI/Virginia Tech Biological Sciences)

Ze-Nable Adisalem
Virginia Tech/Mechanical Engineering

CEED

Platform design for Future Testing of a Swing Stabilization Algorithm on Hahn 130 Catwalk

This poster presents a portable, modular platform design for the catwalk at Virginia Tech's Hahn Hall 130, which is an auditorium where the catwalk is situated approximately 6 m above the floor. Prior work in Hahn Hall 130 stabilized the swing of a low mass planar pendulum. The prior experimental results demonstrated that the implementation of algorithm published by the prior team can reduce the swing angle of a low mass payload swinging in two dimensions. There is a need for testing with larger masses, which can be as high as approximately 270 kg in rescue scenarios. This project presents a design of a platform structure that can be strapped to the catwalk to support larger mass of up to approximately 8.5 kg. The Virginia Tech Prototyping Studio was consulted for their input into the structure.

Mentor(s): Mary Lanzerotti (ECE)

Daniel Alexander
Virginia Tech/Computer Engineering

CEED

The Use of Generative AI in Collaborative Projects

Generative AI has been revolutionary in improving creativity by creating detailed images based on minimal inputs and drawings. In addition, group assignments have been shown to be beneficial towards social skills such as effective communication and overall productivity. In this project, we explore the collaborative potential of generative AI in image creation. Two children provide a sketch of a character or object they wish to include in a game and a separate generative AI model creates an image for each based on the provided sketch. It then combines these created images into a unique image, using characteristics from both generated images. This approach leverages the benefits of AI for artistic expression as well as collaborative creativity that is found in group projects. While formal testing was not conducted, the project sets the foundation for future exploration and experiments into the improvement of creativity through the use of AI in a group setting.

Mentor(s): Pinar Yanardag (Computer Science)

Michael Allen
Old Dominion/Game Studies & Design

The adventure and Dynamic Based On In Game Immersion

The Objective of this project was to add on to a 3D art gallery and create a in game immersion while trying to implement a branching story narrative and use elements to make branching decision. With this we aim to push the boundaries of gaming and create a new benchmark for immersive gameplay. Throughout this project, we aspire to contribute to growing the field of VR game development and showcase the potential of this technology to create a truly immersive experience. The resulting 3D VR game stage will offer players a new level of engagement and present in the virtual world, paving the way for future innovations in VR gaming. Some of our approaches include developing a unique game concept that capitalizes on the potential of VR technology. Another one being Creating an immersive and interactive 3D environment that leverages the strengths of VR or in this case the 3D art gallery. There are many more approaches that goes into VR but some of the results we were able to get came from protestants who tried the VR headset and walk around the art gallery. There feedback was how it felt like if they were in an art gallery.

Mentor(s): Dr. Brendan David John (College of Engineering)

Dhruv Amin
Virginia Tech/Electrical Engineering

Quantum Tomography of a Single Qubit

Quantum tomography is the procedure of determining an unknown qubit using measurements of different bases to determine the unknown state. Quantum tomography assesses the quality of the qubit and determines how good it is and how close it is to other measurements. Since quantum tomography informs us of the quality of the qubit, it can help it with quantum communications and other quantum phenomena; furthermore, as the quality of the qubit increases, so does the quality of experimentation and applications. In this study, only one qubit is assessed. Six measurements were derived from the purer quantum state wavelength = 1/sqrt2 (|H> + |V>). From this original equation, four more additional polarizations can be represented in terms of H and V and shown on a Bloch sphere. A density matrix was used for these calculations, and the polarization states of photons were measured. In addition, the experimental method of the setup was determined to have a quarter wave plate using the Qu-tools and a polarizer to allow different projections on different states. The six states in H, V, P, M, R, and L all utilize different measurements from the quarter-wave plate and the polarizer. The source that produces the photons is identical, and the count detection event is recorded. The results show high fidelity, showing that our prepared quantum state closely matches our target quantum state. This experiment illustrates how the quality of a single qubit can be measured and the importance it provides for quantum information applications.

Mentor(s): Jamie Sikora (Computer Science)
Wayne Scales

Sinclair Anderson
Virginia Tech/Environmental Science

VT-REEL

Refining Tissue Culture in Potato (Solanum tuberosum)

Potato (Solanum tuberosum) is a worldwide staple crop that faces yield losses due to climate change. Genetic modification is a valuable tool for increasing yield and is currently being researched. However, there is no standard process for tissue culture, or the regeneration of sterile tissue needed for this research, in the Atlantic and Lamoka cultivars. A staple tissue culture method is inducing the growth of undifferentiated, pluripotent cells, known as callus, from plant tissue using the synthetic auxin 2,4-D. We examined callus production for these cultivars when using leaf, root, and node tissue and when grown in media with 2, 4, and 6 mg/L of 2,4-D. Under a laminar flow hood, explants were cut from potato and placed onto callus induction media in petri dishes. They were then incubated at room temperature for 14 days. Nodes produced the most callus in both cultivars. In Atlantic, 16.30% of leaves, 0.74% of roots, and 65.93% of nodes produced callus. In Lamoka, 0% of leaves, 4.44% of roots, and 100% of nodes produced callus. There were no significant differences in callus production between 2,4-D concentrations. Using nodes in future potato callus induction will produce the highest quality and quantity of callus, increasing research efficiency. To continue refining regeneration methods in the potato, a similar design of testing hormone concentrations should be employed in shoot and root induction media, and protocol should be established for regeneration from protoplasts.

Mentor(s): Courtney Leisner (School of Plant and Environmental Sciences, Virginia Tech)

Jacqueline Anthus
Virginia Tech/Biochemistry

VT-REEL

Modeling and Mutating the C4-COPI Dimer in TYLCV to Inhibit Viral Infection

Tomato Yellow Leaf Curl Virus (TYLCV) contributes to the extensive Geminiviridae family, infecting and spoiling crops and causing a mass loss of crops used to feed families worldwide. C4 is a common viral protein amongst geminiviruses, carrying the ability to change the function of proteins post-translationally. In previous studies, the importance of the C4 and COPI-B binding interaction during the viral infection of TYLCV has been determined, indicating that an interruption to this could potentially stop the spread of infection. The research question can then be asked, if interacting residues of the C4 and COPI-B are mutated, can the infection process be mitigated. Homology models of C4 and COPI-B as monomers and a bound subunit were created using AlphaFold3 and validated. After validating the top two models (Model 0 and Model 1), interactions within 5Å between the two protein chains were determined and subjected to in silico site directed mutagenesis. The residue mutation with the most favorable change in affinity was found to be THR79 to TRP79 and was modeled using PyMOL. Creating this mutation in a wet lab is hypothesized to yield results of a slowed, or completely stopped, spread of TYLCV in tomato plants. In the future, it is expected that these targeted interface mutations between C4 and COPI-B can stop the spread of geminiviruses found in fruiting plants to increase crop yield across the world.

Mentor(s): Anne Brown (Department of Biochemistry)
Dr. Xiaofeng Wang (School of Plant and Environmental Science)

Kidus Assefa
Virginia Tech/CMA

The Hidden World of Data Brokers: Acxiom and Beyond

Data brokers collect personal information, package it into groups, and sell it to third parties. Of greatest concern is the lack of transparency regarding how our data is used, to whom it is shared, and the absence of federal laws or regulations protecting against the misuse of our information. This raises significant concerns about privacy and security. This research focuses on Acxiom, a leading data broker, to examine the vulnerabilities and threats inherent in data brokerage practices. The study identifies critical vulnerabilities, including weak encryption, supply chain weaknesses, and incorrect data collection, along with threats from criminals, competitors, regulators, and hackers. Through a comprehensive risk assessment, the research highlights the high likelihood and impact of these risks, particularly emphasizing the dangers of weak encryption and incorrect data collection.

To mitigate these risks, the research suggests enhancements in encryption standards, regular security audits, strict data collection policies, and improved consumer transparency. The study underscores the importance of strong regulatory frameworks and advanced security measures to protect consumer privacy and security. Furthermore, this research explores into the regulatory landscape and operational practices of data brokers, offering insights into how these entities can balance their commercial interests with ethical responsibilities. By exploring the intersection of data brokerage, privacy, and security, this research aims to contribute to the ongoing discourse on consumer protection in the digital era, advocating for stronger regulations and more transparent data handling practices.

Mentor(s): Arianna Schuler Scott (Department of Management)

Triniti Antony Baskar
Virginia Tech /Biological Sciences

A-Lab SURF

A canine osteosarcoma treatment pilot study investigating histotripsy combined with immune stimulant IP-001.

Osteosarcoma is the most prevalent bone cancer in dogs and humans. The non-invasive, non-thermal, and non-ionizing ablation modality, histotripsy, uses high-intensity focused ultrasound to generate acoustic cavitation to mechanically destroy targeted areas of the tumor. Histotripsy has shown promise as a novel treatment for osteosarcoma. IP-001 is a proprietary formulation of dihydrogalactochitosan, that has been used as an immunostimulant in combination with thermal tumor ablation. The objective of this study is to explore the clinical outcomes of histotripsy + IP-001 for osteosarcoma treatment. Two canine patients were enrolled in an ongoing study with gait analysis, pain and quality of life assessments (QOL) using two validated assessments for dogs: Canine Brief Pain Inventory and Canine Owner-Reported Quality of Life Questionnaire, and MRIs of tumor-bearing limb pre-/post-histotripsy performed at specific timepoints. Histotripsy treatment was administered at 700 kHz over 4 sessions fractionated over 2 weeks. A post-histotripsy MRI and IP-001 administration were done after the final histotripsy treatment. Both patients had clear ablation shown on MRI with treated areas displaying hypointense signals and a lack of contrast enhancement. Both patients did not show a decrease in gait analysis parameters after histotripsy ablation. Patient %231 had a decrease in pain. Patient %232 showed an increase in mobility from QOL assessments from baseline to post-treatment %232. These patients will continue to be followed for 12 weeks after the combination treatment's delivery. These results show a potential clinical treatment option combining histotripsy and IP-001 for dogs with primary osteosarcoma.

Mentor(s): Joanne Tuohy (VTCVM/ACCRC)

Helle Aronson
Virginia Tech/Biochemistry

Exploring the Thermal Biology of Invasive Aedes Mosquitoes

Aedes japonicus is an invasive disease vector mosquito species found in the United States and with climate change, its distribution is expected to expand. Thus, a better understanding of their biology is crucial for better predicting their future distribution and the development of efficient control methods to limit populations. For this project, mosquitoes were collected at two locations with varying elevations (high elevation at Mountain Lake Biological Station (MLBS) and lower elevation at Plantation Road behind Virginia Tech's experimental farms). The goal of this project was to explore the mechanisms underlying thermal adaptation in this species of epidemiolocal importance. Behavioral assays were conducted to determine their thermal preferences and thermal tolerance. To determine their thermal preference, adults were released into a thermal gradient with a range of cold to warm temperatures and humidity. For the determination of thermal tolerance, mosquitoes were gradually heated up in an aluminum plate and their knockdown temperature was recorded. Temperature and humidity were also monitored at both field collection sites. Results show that the MLBS population has a slightly lower temperature preference compared to the Plantation Road population. Despite this, results show that both populations have relatively the same heat temperature tolerance. Overall, these results increase our understanding of the factors that drive the invasive success of major disease vector organisms such as Aedes japonicus.

Mentor(s): Chloé Lahondere (Biochemistry)

Jaimin Ashra
James Madison University/Chemistry

Studying the effect of crosslink density and chelation site hydrophobicity on the capture of rare earth elements.

Rare Earth Elements (REEs), including lanthanides, scandium, and yttrium, are vital in technologies like magnets and semiconductors. Current extraction method such as solvent-solvent extraction, are energy-intensive and generate significant chemical waste, as a result alterative methods are being investigated. We investigated the use of crosslinked metal chelating polymers as a cost-effective and environmentally friendly alternative. Specifically, an activated ester polymer, poly(tetrafluorophenyl), which can be quantitively modified, to study changes in the binding sties while keeping rest of the polymer structure consistent. We hypothesized that polymers with lower crosslinking would capture more REEs due to larger pore sizes and increased surface area. Polymers with 5%, 15%, and 20% crosslinking were synthesized. We believe the binding reactions are driven by the release of water, so we hypothesized that more hydrophobic polymers would lead to more REEs being captured due them releasing water more effectively. We modified each of the crosslinked polymer with four different amino acids: Alanine, Glycine, Leucine, and Valine. To measure the binding efficiency, we ran flowthrough experiments. In a flowthrough experiment, a solution containing REEs is passed through the modified polymer to measure binding efficiency. Results showed the more hydrophobic polymers captured more REEs and higher crosslinked polymers captured more REES. Future research involves creating different levels of crosslinked polymers to analyze if the trend of higher crosslinking leads to more REEs being captured follows. These results will enable the next generation of materials for REE capture, thus manufacturing critical technologies more sustainable.

Mentor(s): Michael Schulz (Chemistry Department)

Kidus Assefa
Virginia Tech/CMA

The Hidden World of Data Brokers: Acxiom and Beyond

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To mitigate these risks, the research suggests enhancements in encryption standards, regular security audits, strict data collection policies, and improved consumer transparency. The study underscores the importance of strong regulatory frameworks and advanced security measures to protect consumer privacy and security. Furthermore, this research explores into the regulatory landscape and operational practices of data brokers, offering insights into how these entities can balance their commercial interests with ethical responsibilities. By exploring the intersection of data brokerage, privacy, and security, this research aims to contribute to the ongoing discourse on consumer protection in the digital era, advocating for stronger regulations and more transparent data handling practices.

Ultimately, this study addresses the pressing question: What risks do data brokers pose to individuals and groups of people?

Mentor(s): Arianna Schuler Scott (Department of Management)

Zaujia Athumani
Virginia Tech/Microbiology - Biomedical

A-Lab SURF

The Role of BMP3 in the Pathogenesis of Pulmonary Arterial Hypertension

Pulmonary arterial hypertension (PAH) is a severe vascular disease that leads to heart failure and death. While the current therapies primarily target pulmonary vasoconstriction, there is currently no cure for PAH, and the available classes of drugs only modestly affect pulmonary vascular remodeling. The Bone Morphogenetic Protein (BMP) signaling pathway is important in PAH development; however, our current understanding of the exact pathophysiological roles of the different BMP ligands remains limited. The aim of our study is to determine the specific effects of BMP3 in PAH. To do that, wound healing assay was applied by treating pulmonary arterial endothelial cells either directly with recombinant BMP3 or by conditioned medium from treated pulmonary arterial smooth muscle cells. The latter was treated with Adenovirus-BMP3 to overexpress our protein or by Adenovirus-BMP3-shRNA to suppress its expression. We found that the overexpression of BMP3 inhibits migration of cells. Next, we generated global BMP3 knock-out mice that were harvested at young (3 months-old) or old age (1 year-old). Hematoxylin and eosin staining analysis for lungs revealed a significant increase in pulmonary vascular remodeling in aging Bmp3 knock-out mice comparing to wild type mice. To assess the effect of Bmp3 on cardiac remodeling, we measured cardiomyocytes size by WGA staining. We demonstrated a significant increase in cardiomyocytes area in knock-out mice compared to wild type mice. Our results indicate that Bmp3 plays a pivotal role in pulmonary vascular remodeling and may have therapeutic value for PAH.

Mentor(s): Yassine Sassi (FBRI)
Aymen Halouani (FBRI)

Eisha Ayub
Hollins University/Biochemistry

On efforts to prepare and characterize Ph2PCH(CCl3)PPh2

D. R. Derringer and coworkers have published papers that focus on the preparation and characterization of dirhenium compounds, which contain diphosphine ligands of the type Ph2P–B–PPh2 (where B is CH2, CH2CH2, or NH). In order to study further the reactivity of certain dirhenium starting materials towards molecules of the type Ph2PCH(R)PPh2, we set out to make the derivative in which R is CCl3. This summer, we have attempted to synthesize Ph2PCH(CCl3)PPh2 by employing the method used to make Ph2PCH(CH3)PPh2, which involves the deprotonation of HPPh2 by MeLi followed by the substitution of the chlorine atoms in HCl2CCH3 by two Ph2P– moieties. The starting material we used was HCl2CCCl3. Infrared, mass spec, and proton nmr data suggest we have not successfully synthesized Ph2PCH(CCl3)PPh2. A peak at 1176 cm–1 in the FTIR spectrum of our product may be due to the presence of P=O. A base peak of m/z = 201 in the mass spectrum is consistent with the presence of Ph2P=O, and an integral ratio of about 11-to-1 for the aromatic-to-aliphatic protons is compatible with the formulation Ph2P(=O)CHCl(CCl3) and not so for the phosphine oxide derivative of Ph2PCH(CCl3)PPh2, viz., Ph2P(=O)CHCl(CCl3)P(=O)Ph2. In addition to providing the details of the work we did to prepare and characterize Ph2P(=O)CHCl(CCl3), we will report the results of several Hartree-Fock calculations that were done in order to gain insight into the acidity of HCl2CCCl3 and the electron-withdrawing and steric properties of the CCl3 group in Ph2PCH(CCl3)PPh2.

Mentor(s): Daniel Derringer (Chemistry, Hollins University)

Audrey Barnes
Virginia Tech/Chemical Engineering

CEED

Exploring the potential of sigB as a rapid detection tool for Listeria directly from environmental DNA

The bacterial genus Listeria, which includes L. monocytogenes, is ubiquitous in the environment, inhabiting soil, water, and food. L. monocytogenes is a foodborne pathogen that causes listeriosis in humans, primarily affecting vulnerable populations such as pregnant women and their newborns, adults aged 65 or older, and individuals with weakened immune systems. Detecting Listeria using polymerase chain reaction (PCR)-based methods can expedite testing procedures compared to traditional culture-based methods. In this project, we investigated the use of the sigB gene as a tool for the rapid detection of Listeria from environmental DNA by amplifying this gene using PCR. The sigB gene is a core gene and a critical component of the Listeria genome, encoding the sigma factor B, a stress response sigma factor that contributes to the bacterium's resistance to harsh conditions. We optimized a protocol and successfully detected sigB from Listeria pure cultures. However, we were unable to directly amplify sigB from environmental DNA, indicating that a high abundance of Listeria in environmental samples is necessary. This detection limitation requires further investigation. Future research will focus on determining the detection limit for the direct identification of Listeria in environmental samples. Overall, this project suggests the potential of the sigB gene for rapid Listeria detection from environmental DNA, which could be utilized in the future to inform interventions and management strategies to reduce the risk of contamination and illness associated with Listeria.

Mentor(s): Lioa Jingqiu (LEAPH)

Grace Bartlett
Virginia Tech/Crop and Soil Environmental Science
Will Ubben
Virginia Tech/Environmental Science

Independent Research

Effects of Nitrogen and Calcium Nutrition on Vegetable Production

Nitrogen and calcium are both essential for plant growth and plant defense against pests and pathogens. Nitrogen is a major component of chlorophyll for photosynthesis and many secondary metabolites for chemical defense. Calcium strengthens the cell wall and upholds substantial structural barriers against pests and pathogens. Management of these two nutrients has a direct impact on yield and quality of vegetable production. To better understand potential interactions between these two nutrients, we applied six nitrogen and calcium treatments to two varieties of cucumbers and one variety of cabbage, which were grown in the Virginia Tech Homefield Farm (cabbage) and the St. Mary Community Garden (cucumber) at Blacksburg, VA. The treatments had a fully factorial design between the nitrogen treatment (soybean meal (13.6% nitrogen) and the zero control) and the calcium treatment (wollastonite, gypsum,and the zero control), and were randomized with three to four replicated blocks per treatment. . We applied one teaspoon of the nutrients to each plant three to four weeks after transplanting. We monitored pest and disease pressure and quantified yield at harvest. Overall, we did not detect any significant pest/pathogen damage in cabbage. In comparison, the cucumbers were attacked by the stripped cucumber beetles (Acalymma vittatum F.) and later suffered severely from the pathogen Erwinia tracheiphila, which was vectored by the cucumber beetles and caused bacterial wilt. Our preliminary data showed that the cucumber yield and bacterial wilt did not differ among the nutrient treatments. In comparison, cabbage yield increased by 11% with the addition of the soybean meal ($P = 0.07$) and was not affected by calcium treatments. We will continue to monitor the cucumber plants and explore other strategies to manage cucumber beetles.

Mentor(s): Huijie Gan (SPES)

De'Onna Battle
University of Maryland, Baltimore County/Biochemistry and Molecular Biology

Effect of Dlk1 on Neighboring Cells Analysis in the Developing Cortex of DiGeorge Syndrome Mouse Model

22q11.2 deletion syndrome (22q11.2 DS), also known as DiGeorge syndrome, is a genetic disorder caused by the deletion of human Chromosome 22. This deletion significantly increases the risk for neurodevelopmental disorders (NDDs) including ADHD, anxiety, autism spectrum disorder, and schizophrenia. We are addressing how this deletion disrupts neurodevelopmental processes, leading to these disorders. Dlk1 has been linked to neurogenesis in neural stem cells and may be facilitated through direct cell-to-cell contact between neural progenitors and Dlk1-expressing cells. Understanding the role of Dlk1 could reveal mechanisms underlying neurodevelopmental disruptions in 22q11.2 DS. We used the LgDel mouse, a genetically accurate model of 22q11.2 DS, to determine if Dlk1 influences the neurogenic state of neighbor cells in the LgDel cortex. Embryos were collected after 14.5 days of pregnancy. Coronal sections of the cortex, each 12 µm thick, were cut and prepared on slides. Dlk1 mRNA was labeled using RNAscope in situ hybridization. Neurons and basal progenitors (bPs) were labeled through immunostaining with NeuroD1 and Tbr2. Our analysis revealed that for NeuroD1/Dlk1+ cells in WT, neighboring cells were predominantly NeuroD1 at 52% and Dapi at 44%. In LgDel, neighboring cells were predominantly NeuroD1 at 63% and Dapi at 38%. For Tbr2/Dlk1+ cells in WT, neighboring cells were predominantly Tbr2 at 21% and Dapi at 74%. In LgDel, neighboring cells were predominantly Tbr2 at 35% and Dapi at 50%. This data suggests in the LgDel cortex, more Dlk1+ neighboring cells are NeuroD1+ than WT, suggesting premature differentiation.

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

Katie Bechtold
Virginia Tech/Mechanical Engineering

CEED

Conformal 3D Printing on Deformable Objects with Point Cloud Path Planning

The development of nonplanar (conformal) 3D printing methods has transformed the ability to manufacture personalized and customized devices, such as form-fitting technologies (e.g., prosthetics and wearable electronics). However, target surfaces and objects may deform during printing posing a challenge to path planning. We investigated the use of point cloud-based path planning methods for conformal 3D printing on objects undergoing deformation after initial path plan generation. The experiment was conducted by conformal 3D printing with silicone on a balloon using an established point-cloud-based nonplanar 3D printing path planning methodology. This approach enabled the printing of unfilled, single-layer rectangular paths on a stretchable, nonplanar membrane (balloon) after deformation. Quality challenges associated with the printing of multi-layer structures were investigated and attributed to the low contrast of the printed material (RTV silicone) with the structured-light scanning measurement. Future work could involve the incorporation of a contrast agent into the printed elastomer to increase light contrast. Overall, the point cloud-based path planning method for nonplanar 3D printing enabled conformal 3D printing of single-layer paths on an object that underwent deformation after the initial path plan was generated.

Mentor(s): Blake Johnson (Department of Industrial and Systems Engineering Virginia Tech)

Chessie Beery
Oregon State University/Crop and Soil Science

VT-REEL

Evaluating Cover Crop Nitrogen Uptake, Fixation, and Release

Legume cover crops fix atmospheric nitrogen (N), thereby may serve as practical and economical source of N and reduce need for inorganic fertilizers. The objective of the study was to quantify N accumulation of cover crops and measure the release of N to the succeeding cotton cash crop. The cover crops were cereal rye (CR), hairy vetch and crimson clover (LM), and rye-legume mix (RH). Biomass samples from cover crops were collected at 50% flower/heading and analyzed for percent N to determine total N uptake. Soil samples were collected to a depth of 0.91 m every 30 days from the planting of cotton until 120 days after planting. Cotton received 0 kg N ha-1 following LM, 60 kg N ha-1 following RH and 120 kg N ha-1 following CR. Cotton nutrient uptake was measured at first open boll and cotton lint yield was measured at harvest. Results show the LM had the highest total nitrogen content in cover crop biomass and soil over 120 days. Nitrogen soil concentrations decreased with sampling depth. CR had the lowest N in cover crop biomass and no significant impact on soil N concentrations until after side-dress N application. No differences in cotton N uptake were observed between cover crop with varying N fertilization. CR with 120 kg N ha-1 had the highest lint yields, however they were not significantly different from the LM receiving 0 kg N ha-1. The LM was able to supply enough N to produce similar yields to CR.

Mentor(s): Hunter Frame (Crop and Soil Environmental Sciences)

Izi Bentley
Community High School (CHS)

CHBR

Are food demand and delay discounting associated with diabetes management

Diabetes affects approximately 530 million adults worldwide with a global prevalence of 10.5% of adults aged 20-79 years (Robertson, 2024). More than 38 million Americans have diabetes and about 90-95% of them have type 2 diabetes (CDC, 2024). Diabetes can lead to severe health risks such as heart attacks, strokes, and kidney failure (WHO, 2023). Prior research shows that delay discounting (DD; preference for smaller, sooner over larger, delayed rewards) is related to obesity (temporal discounting as a candidate behavioral marker of obesity) and type 2 diabetes management (patients' impatience is an independent determinant of poor diabetes control). Likewise, prior research shows that greater demand for highly palatable foods (a measure of reinforcing value) is related to obesity. However, no work has examined food demand in type 2 diabetes management. The present study examines the association between delay discounting, food demand, and the management of type 2 diabetes. Participants are 120 patients with poorly controlled type 2 diabetes (HbA1c >=7.7% & BMI >=30) who enrolled in a clinical trial examining a behavioral intervention for weight loss and diabetes management. Only baseline (pre-intervention) measures were examined in this analysis. We hypothesize that higher food demand and higher delay discounting would result in poorly controlled diabetes management. These potential findings would suggest that food demand and delay discounting are related to diabetes management.

Mentor(s): Jeff Stein (Fralin Biomedical Research Institute)

Jamie Bhan
Virginia Tech CEED/Mechanical Engineering

Independent Research

Optimizing Quantification Methods for Carbon and Sulfur Impurities in Molten Salt Reactors

Given the increasing demand for energy, clean energy sources are crucial for supporting decarbonization efforts. Molten salt reactors (MSRs) are considered a promising advanced nuclear reactor option for promoting sustainable energy. However, since salts are hygroscopic, the absorption of impurities could significantly influence chemical reactions, corrosion, thermal conductivity, chemical stability, and radioactivity. This study focuses on improving the quantification of impurity concentrations in molten salts, specifically carbon and sulfur. Analyses were conducted using a combustion analyzer, G4 ICARUS Series 2, with variations in sample form, types of mortar and pestle, crucible baking duration and temperature, and sample packaging methods. The results indicated substantial differences in carbon and sulfur content depending on the types of mortar and pestle used. Lower baking temperatures resulted in higher sulfur concentrations, while extended baking times led to higher carbon concentrations. Furthermore, significant differences in carbon and sulfur concentrations were observed based on the sample packaging method. The folding method resulted in the lowest sulfur concentration, while the droplet shape method resulted in the lowest carbon concentration. These findings demonstrate that impurity content can vary significantly depending on the method used, even when consistent samples and conditions are maintained. This study provides suggested “best practices” for analyzing carbon and sulfur impurities in molten salts.

Mentor(s): Amanda Leong (Virginia Tech NMFC)

Pranshu Bhaumik
Virginia Tech/Physics

Independent Research

Ab initio properties of color center defects for mineral detection of dark matter

The existence of dark matter is strongly motivated by decades of astronomical measurements of its gravitational influence across a variety of scales, which have constrained its properties as stable over billions of years, electromagnetically non-interacting, and produced at low velocities. No known particles have these exact properties, making the detection and study of dark matter an essential part of developing particle physics beyond the Standard Model. Many existing theories predict dark matter to weakly interact with ordinary matter through nuclear recoils that generate detectable scintillation light or phonons. Experimental efforts to detect dark matter based on these effects are limited by target masses on the order of tons and observational timescales of years, making the detection of low-probability nuclear recoil events challenging. Instead, one proposal to improve detection involves using optically active point defects formed through nuclear recoils over millions of years in ancient deposits of common crystalline minerals such as fluorspar and calcium fluoride. Here, we perform ab initio simulations of simple defects in calcium fluoride, including interstitials and vacancies, and analyze their electronic and optical properties. We discuss how these potential signatures of nuclear recoils might be observed in fluorspar used for mineral detection of dark matter.

Mentor(s): Vsevold Ivanov (Physics Department and National Security Insitute)

Kailon Blue
Virginia Tech/Computer Engineering
Nissi Otoo
Virginia Tech/Computer Engineering

Visceral Notices and Privacy Mechanisms for Eye Tracking in Augmented Reality

Extended reality continues to evolve as an industry and eye-tracking data is used to support gaze interactions and other applications such as foveated rendering. At the same time, entities collecting data within such applications may also be able to reveal sensitive and identifying information about a subject. We propose using real-time visualizations called visceral notices to ensure users are aware of what data is being collected. To better understand how these privacy-preserving mechanisms and visceral notice can work together in augmented reality (AR) to increase privacy awareness or data-sharing attitudes, we evaluated two visceral notice techniques and three privacy mechanisms across two AR tasks: exploring an art gallery and a gaze-based selection game. We used privacy mechanisms to add noise or degrade the eye-tracking data quality to reduce the risk of leaking private information about the user. Our pilot results suggest that users prefer the tendril interface and are more willing to share their data with a privacy mechanism applied. Users felt the safest using Gaussian Noise over the other privacy mechanisms.

Mentor(s): Brendan David-John (Computer Science)

Samya Bowen
Hampton University/Biology Integrative

Use of Matrix - assisted Laser Desorption/Ionization Time-of-Flight Mass Spectrometry to Identify Melanoma Tumor Cells

Melanomas are malignant tumors affecting several species. In dogs, melanoma often occurs on the skin and oral cavity. Melanoma poses as a serious health concern due to its variety in size and aggressiveness. If left undiagnosed, it can grow, metastasize, and become life-threatening. We used matrix-assisted laser desorption/ionization time-of-flight mass spectrometry (MALDI-TOF MS) to detect white blood cells (WBC) and melanoma cells of dogs. This method has been widely used for identifying microorganisms, such as bacteria and fungi, but its use to identify mammalian cells has not been fully explored for diagnostic purposes. The overarching goal of this project is to use MALDI-TOF MS to identify melanoma cells either from tissue aspirates or circulating in blood to help diagnose cancer. This study aimed to optimize the previous developed method of detecting WBC and to create reference spectra library of melanoma cells.
First, WBC were isolated from whole blood, concentrated at 1 x 105 cells/mL, and a protein extraction using 100% ethanol, 70% formic acid, and acetonitrile was performed. Protein extracts were spotted on a MALDI target and analyzed using MALDI-TOF MS and alpha-4-ciano-hydroxi-cinnamic acid as matrix. Cells at different concentrations (0.5 x 106, 1 x 105, 0.5 x 105, 1 x 104, and 0.5 x 104 cells/mL) were used to test the lower limit of detection of the library. We found that 1 x 105 cells/mL is the lowest concentration that accurately detects dog WBC. Next, we cultured TLM-1 canine melanoma cells and performed the same protein extraction method to create a melanoma library. Lastly, we mixed different proportions of WBC and melanoma cells extracted proteins to obtain a range of two-component cell populations to test the sensitivity of detection of both libraries. WBC:melanoma cells mixtures ranged from 1 part of WBC extract to 9 parts of melanoma extract (1:9) to 3:7, 5:5, 7:3, and 9:1. When 90% of WBC and 10% melanoma cells were mixed, the canine WBC library was superior to identify WBC in comparison with the melanoma library (when 90% melanoma cells were mixed with 10% WBC), although samples do not differ statistically ($p = 0.43$). Regardless of the percentage of each component, the melanoma library poorly identified melanoma cells across all cell mixtures ($p = 0.73$, and all scores < 1.69). The MALDI-TOF MS canine melanoma and WBC libraries were successfully created. The detection limit of the WBC library is 1 x 105 cells/mL. The two-component sensitivity test requires further improvements.

Mentor(s): Priscilla Serpa (VA-MD College of Veterinary Medicine)

Cassie Brisbin
Virginia Tech/Biological Systems Engineering

VT-REEL

Gaining insight into plant-yeast interactions regarding auxin activity through the use of fluorescence microscopy

With a rapidly growing world population, it is critical for our food supply to keep pace in the face of an ever-changing climate and current unsustainable agricultural practices. In response to these circumstances, decades of research have been conducted to better understand how plants and microbes interact, yet many questions remain regarding inter-kingdom relationships and crosstalk, specifically implicating auxins, a plant growth hormone that can be found in many kingdoms of life. Auxins play several roles in plants, influencing crop behavior and yields and playing complex roles in plant-pathogen interactions. Here, we focus on the most naturally abundant auxin, indole-3-acetic acid (IAA), and explore the interaction between the genetic model baker's yeast Saccharomyces cerevisiae and the genetic model plant Arabidopsis thaliana. More specifically, the use of transcriptional- and degron-based auxin reporters within Arabidopsis in addition to a ratiometric, genetically encoded auxin biosensor in S. cerevisiae provides us with a method to measure relative IAA perception in each organism. Furthermore, we use fluorescence microscopy to visualize the reciprocal auxin response between the plant roots and yeast. We hypothesized that S. cerevisiae will generate sufficient exogenous IAA to induce a transcriptional response within Arabidopsis.

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

Madison Brousseau
Hollins University /Psychology
Bhumika Rai
Hollins University/Psychology

The impact of perpetrator race, identification procedures, and encoding time on eyewitness identification

Eyewitness misidentification is the leading cause of DNA exonerations (Innocence Project, 2024). There are various factors that can influence eyewitness identification (ID) accuracy such as how long the witness viewed the perpetrator (encoding time), the race of the perpetrator (i.e., the cross-race effect [CRE]), and the identification procedure (showup or lineup) used by police. The purpose of this study is to investigate how these variables interact with one another, and to better understand under which conditions provide the most accurate ID decisions. To do so, we plan to conduct a large online study using Prolific using a within-subjects factorial design. In the study, White participants will view a Black (cross-race) or White (same-race) perpetrator for either a short or long amount of time. Later, participants will be given a showup (1-person) or a six-person lineup that will either contain a guilty or innocent suspect. Lastly, confidence ratings will be obtained. We expect that ID accuracy will be better for: long compared to short encoding times, lineups compared to showups, and same- compared to cross-race suspects. However, we are unsure how these variables will interact. It is possible the CRE will be the strongest during short encoding times and when a witness views a showup.

Mentor(s): Alex Wooten (Psychology, Hollins University)

Trevor Bryan-II
Morehouse College/Computer Science

The Mechanics of Wing Coupling in Cicadas

Diverse mechanisms of fore- and hind wing coupling have been observed in insects ranging from hooks in bees to dorsal contact in butterflies, allowing them to fly effectively. Most studies have characterized the coupling mechanism in the orders Hymenoptera (e.g., bees), Lepidoptera (e.g., butterflies), and Coleoptera (e.g., beetles), leaving the order Hemiptera (e.g., cicadas) underexplored. Our research sought to address the question, what is the mechanism wing latching in cicadas and how does it work? To explore this question, we collected over 500 adult cicadas (Magicicada septendecim) from Illinois and Virginia. We performed tethered flight experiments in the lab using five high-speed cameras recording at 1000 or 2000 frames per second, recording short bursts of wingbeats where both wing latching and unlatching could be observed. We recorded 45 cicadas, and video analysis provided insights into the timing of wing connections. Comparisons of wing connection duration were also made with flight data from wild periodical cicadas collected in 2020, which showed that the wild animals latched using the same method as the tethered animals in the lab. Microtomography scans of the wings offered a 3D perspective on their anatomical structure and connection mechanisms. Lastly, we repeated these measurements on a small sample of annual cicadas (n=3, Neotibicen spp.). Preliminary findings revealed a reflexed ventral fold at the leading edge of the hind wing and trailing edge of the fore wing. These folds typically latched when the fore wing was lowered over the extended hind wings, sliding until the wings are coupled. This process typically occurred at the top of the wing beat cycle. The wings took on average 0.125 seconds to connect. Furthermore, when the fore wing fold was blocked with tape, the cicadas' wings could not latch, confirming the role of this anatomy. Preliminary observations also suggest cicadas unlatch the wings by maneuvering them in opposite directions until the latch disengages, allowing them to fold their wings inward.

Mentor(s): Jake Socha (Biomechanical Engineering)

Kate Burgiss
Virginia Tech/Biology

VT-REEL

Chemical Defense Mechanisms in Plant-Plant and Plant-Insect Interactions

Plants develop defense responses against various biotic and abiotic stresses. However, some defense mechanisms are not always successful. For instance, tree of heaven's defense mechanism fails against spotted lanternfly. Spotted lanternfly (Lycorma delicatula) is an invasive insect which feeds on grapes and preferentially tree of heaven (Ailanthus altissima), from which it sequesters ailanthone (a plant defense metabolite) for antipredator defense. While trying to understand the longevity and sequestration of ailanthone in the insect, we expected spotted lanternfly (collected from tree of heaven in the field) to lose ailanthone more rapidly when placed on grape plants than when placed on tree of heaven. Ailanthone was then extracted from the insects and detected using liquid chromatography mass spectrometry. Preliminary results indicate that less sequestered ailanthone remains in insects kept on grape plants than in insects kept on tree of heaven, indicating a reduction in efficacy of defense via ailanthone sequestration. In other cases, plant defenses can be more effective, as can be observed in one of the carrot cultivars against the parasitic plant, swamp dodder (Cuscuta gronovii). Parasitic plants survive by draining the essential resources from their host plants. In this study, the objective was to identify the resistance mechanism of the carrot cultivar (0493B) against swamp dodder. Thus, we utilized histochemical techniques to compare the susceptible and resistant cultivars. The results showed that dodder failed to make successful vascular connections with the resistant cultivar. Additionally, a localized defense response was observed around the haustoria in the resistant cultivar, warranting further investigation.

Mentor(s): Dorothea Tholl (Biological Sciences)
James H. Westwood (School of Plant and Environmental Sciences)

Chloe Burt
Virginia Tech/Biological Sciences
Miriam Sack
Juniata College/Mathematics and Data Science
Grayson Weavil
Wake Forest University/Statistics

How Connections Are Made: Investigating the Role of Trust on the Relationship between Social Isolation and Mental Health and Behavioral Outcomes

Social isolation and loneliness are known to be associated with negative mental health and behavioral outcomes, although the underlying mechanism behind these relationships is not well understood. The objective of the current study is to examine the role of trust (mediating, moderating) on the relationship between socialization (social network index [SNI], loneliness, disability symptoms) and outcomes (depression, anxiety, alcohol use). Data were collected from adult participants (59 in-person, 409 online) using surveys and an iterative social exchange game for trust variables (mean trust ratio [TR], reciprocity prediction [RP], and reciprocity change [RC]). General linear modeling was used, with moderation and mediation assessed via interaction terms and Baron and Kenny methodology, respectively. In-person and online participants were mostly White (85% and 93%) and non-Hispanic (90% and 87%), with median ages of 31 and 34, respectively. No significant moderation or mediation was observed among in-person participants. For online participants, trust significantly moderated the relationships between: loneliness and depression (TR $p=0.012$, RP $p<0.001$, RC $p=0.027$); loneliness and alcoholism (TR $p=0.004$, RP $p<0.001$, RC $p=0.003$); SNI and depression (RP $p=0.025$); and SNI and alcoholism (RP $p=0.014$, RC $p=0.012$). Additionally, trust partially mediated the relationship between disability symptoms and alcoholism (TR $p<0.001$, RP $p<0.001$), as well as SNI with alcoholism (TR $p=0.004$, RP $p<0.001$, RC $p=0.026$). This work suggests that trust serves as a mechanism through which social isolation and loneliness may lead to negative mental and behavioral outcomes, motivating the creation of future interventions involving trust.

Mentor(s): Alexandra Hanlon (Department of Statistics)
Dr. Brooks Casas (Fralin Biomedical Research Institute at VTC)
Dr. Pearl Chiu (Fralin Biomedical Research Institute at VTC)

Jenna Cain
Virginia Tech/Crop and Soil Science

VT-REEL

Identifying a Chromosomal Region for Soybean Protein and Oil Content Using Molecular

Soybean is a major source of seed protein and oil, comprised of 40% protein and 20% oil. Soybeans are a common source of protein within the livestock and poultry industries. For the 2022/2023 marketing year, soybeans had a crop value of $60.7 billion in the United States alone. Soybean protein content is inversely related to oil content, which hinders breeding for higher protein cultivars. For this study, a recombinant inbred line (RIL) population, PI 507429 x PI 399084, was replicated twice in the field over one year (2022). Seed protein and oil content data were collected on 100 RIL individuals using near-infrared spectroscopy, and DNA samples from the same RILs were used for molecular marker data collection. Based on results from a previous study, our focus was on soybean chromosome two. Using simple sequence repeat (SSR) and single nucleotide polymorphism (SNP) DNA markers from soybean chromosome two, all RILs were genotyped. Protein and oil content data and molecular marker data on the same RILs were analyzed using JoinMap and MapQTL computer programs. The quantitative trait locus (QTL) identified on chromosome 2 and the associated molecular markers could be used in breeding efforts for higher protein content soybean cultivars.

Mentor(s): M.A. Maroof (Virginia Tech)
Elizabeth Clevinger (Crop Genetics, Virginia Tech)

Michelle Cao
Dickinson College/Environmental Science, Data Analytics

Sensing the Issue: Methane Emissions in Dairy Cattle at Kentland Farm

Methane (CH4) is a potent greenhouse gas and a key contributor to climate change. Increased methane emissions insulate the Earth by absorbing and retaining heat. Agriculture, specifically cattle farming, contributes around 40% of global methane emissions yearly. The gas is released into the atmosphere due to digestive processes - breaking down cattle feed through fermentation. Our two-prong approach aims to (1.) engineer and test a sensor to detect and record methane emissions from dairy cattle breaths, and (2.) convert and compare methane data to a commercial GreenFeed system to validate and ground truth sensor accuracy and precision. We strapped two sensors on each of the 11 Holstein dairy cows and collected methane data every second for 7 days. Despite technical difficulties and sensor malfunctions, we successfully collected data from 9 cows. After cleaning and processing the data using R, we plotted methane emissions for each cow and compared it to the data collected from the GreenFeed system. The results of this study will prime the next phase of the investigation - employing methane sensors in beef cattle grazing on silvopasture.

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

Caidyn Carr
Valdosta State Unversity/Chemistry

Fluorescence-Based Characterization of Polymer-Protein Interactions

Synthetic polymers are an exciting substrate to interact with proteins owing to their tunability in terms of size and diversity of functional groups. For example, green fluorescent protein (GFP) is a beta-barrel protein that fluoresces green light upon excitation with UV light. If a strand of the beta-barrel is removed, fluorescence does not occur. α-Synuclein (αSyn) is a protein implicated in Parkinson's disease, which is believed to progress through the formation of large αSyn aggregates. We use polymers with peptidomimetic pendant groups to interact with proteins, monitoring these interactions by fluorescence spectroscopy. We measured the restoration of fluorescence at 507 nm for a non-functioning GFP in the presence of different monomers and small polymers. We used a Thioflavin T assay to measure the rate of αSyn aggregation and monitored the influence of monomers and oligomers on the aggregation. Future work will focus on designing polymers that interact strongly and selectively with GFP and αSyn, with implications for drug development and therapeutic applications.

Mentor(s): Adrian Figg (Department of Chemistry and Macromolecules Innovation Institute)
Darwin Gomez (Department of Chemistry and Macromolecules Innovation Institute)
Stephen Koehler (Department of Chemistry and Macromolecules Innovation Institute)

Kenneth Chan
Virginia Tech/Biochemistry

RNA polymerase A subunit deletions inhibit Brome mosaic virus replication

Brome Mosaic Virus (BMV) is a positive-strand RNA virus that infects cereal plants and can stunt growth. It is comprised of a tripartite genome and serves as an outstanding model for studying RNA virus replication and gene expression. BMV's replication can be recapitulated in the baker's yeast, Saccharomyces cerevisiae. During replication in yeast, BMV induces the formation of spherules on the perinuclear endoplasmic reticulum (ER) membrane serving as viral replication complexes. In this study we seek to determine the role of several Rpa (RNA polymerase A) subunits in the replication of BMV. We tested 3 knockout mutants and found that the deletion of the host genes RPA14 or RPA34 showcased a decrease in the accumulation of all forms of viral RNAs while having a faster doubling time compared to wild-type (wt) cells. We additionally found that the accumulation of viral replication protein 1a decreased, a possible reason contributing to the inhibited viral replication. However, in the Δrpa12 mutant, accumulation of viral RNAs was equal to wt. We conclude that the absence of the Rpa14 and Rpa34 subunits hinder the proper replication of BMV. To further explore the role of these genes in viral replication we will determine whether the localization of BMV replication proteins 1a and 2a are disrupted in these mutants.

Mentor(s): Xiaofeng Wang (School of Plant and Environmental Sciences)

Travis Chan
Virginia Tech/Data-Centric Computing

User Interface Development using CustomTkinter for Automating Python Dependency Recognition

Python libraries are packages of code utilized to accelerate Python developer productivity. Given dependencies often existing between Python libraries, timely recognition of and actionability toward issues derived from dependencies are crucial in supporting efficient software engineering. To detect such issues, state-of-the-art dependency management tools have been created for numerous programming languages and environments. However, there has yet to be a tool engineered to provide Python developers recommendations and in turn a seamless experience in updating critical dependencies. We introduce AutoPyDep, a developer-centered tool designed to present Python developers with automated dependency information visualized to inform decisions when resolving dependency issues. Machine learning (ML) models and graph analysis in Python have been utilized for backend development. Considering not all Python developers have ML knowledge, direct interaction with an ML model is not an optimized user experience. Thus, usability engineering plays a critical role in enabling Python developers with actionable information. We have spent an extensive amount of time designing and prototyping using the Tkinter and CustomTkinter Python libraries to achieve a preliminary UI prototype. Currently, a user study is being conducted to establish a comprehensive understanding of user experience that will inform researchers in optimizing the tool for scalability and deployment. Expected results include positive user sentiment toward key tool components along with proposed ideas for improved usability. Initial data analysis suggests participant recognition of the need for such a recommendation tool. Future work involves UI development to provide an improved user experience.

Mentor(s): Chris Brown (Department of Computer Science)

Kevin Chen
Virginia Tech/Computer Science
Tim Wilson
Virginia Tech/Computer Science

Evaluating Gene Regulatory Network Inference Algorithms

Gene regulatory networks (GRN) are networks that connect transcription factors to genes whose expression they inhibit or promote. These networks can be reconstructed, or inferred, from single-cell RNA (scRNA-seq) data. However, the process of doing so is challenging. Dozens of machine learning algorithms have been developed for this task. This proliferation of methods leads to the inevitable need to determine how successful the algorithms are at rebuilding gene regulatory networks, which consequently requires a standardized computational approach to evaluate them. We utilize BEELINE, a comprehensive GRN inference algorithm benchmarking pipeline. We extend BEELINE by integrating recently published algorithms for the purposes of benchmarking. The standardized pipeline implemented in BEELINE produces results through Dockerized algorithms, which are sent through a provided suite of tests producing each algorithm's stability throughout analysis, area under precision-recall and receiver operating curves, and early precision ratio. We will present results comparing these algorithms to each other and to other high-performance methods. The benchmarking of new algorithms provides a knowledge base as to which prediction methods may be useful to an experimental biologist seeking to analyze their own scRNA-seq dataset. Adding new algorithms to BEELINE's pipeline also allows other researchers to benchmark against a wider selection of algorithms. Currently, BEELINE currently supports unsupervised algorithms. Future steps may include improving BEELINE's scope to supervised machine learning algorithms, as advancements in GRN inference have occurred in a variety of deep learning models.

Mentor(s): T. M. Murali (Department of Computer Science)

Xiaomin Chen
Virginia Tech/Industrial and System Engineering
Daud Nabi Hridoy
Virginia Tech/Civil & Environmental Engineering

CEED

The relationship between online and in-store shopping demand and its connection to travel demand

The study investigates household-level shopping demand for in-store and online shopping, travel demand, and the relationship between them. The study utilizes data from the 2022 National Household Travel Survey, focusing on daily non-commercial travel of individuals and households. By studying the household characteristics, a bivariate ordered probit model is used to investigate their shopping demand, travel patterns, and the relationship between them. The model results capture the e-commerce demand of household and the relationship between in-store shopping demand and online shopping demand. The variables used in modeling include the frequency of online deliveries for various product types, monthly transit modes, and the frequency of using different transportation methods such as driving, biking, and public transit, etc. Understanding consumer shopping and travel demand helps develop a recommendation system for retailers in the future. This system can enhance shopping convenience, reduce traffic congestion, and lower CO2 emissions.

Mentor(s): MD SAMI Hasnine (Civil & Environmental Engineering)

Diya Chhabra
University of Virginia (Transfer student; Brightpoint Community College)/Neuroscience

Unveiling the Overlap: Are RNA Binding Protein ZNF326,AKAP8,AKAP8L are Functionally Redundant?

RNA-binding proteins (RBPs) are a large family of over 2000 proteins that bind to RNA through RNA-binding domains (RBDs) to form ribonucleoprotein complexes. RBPs play key roles in cell metabolism, proliferation, differentiation, and carcinogenesis. Among these, zinc-finger protein ZNF326 and A-kinase anchoring proteins AKAP8 and AKAP8L are notable for their involvement in tumorigenesis and cancer progression. Despite limited research on their individual roles, the potential functional redundancy among these RBPs remains largely unexplored.
AKAP8L exhibits a 61% protein sequence similarity with AKAP8, suggesting similar functions in tumorigenesis. ZNF326 is involved in transcriptional regulation and potentially tumorigenesis. AKAP8, AKAP8L, and ZNF326 share the AKAP95 subtype of zinc-finger domains, indicating potential structural and functional similarities that contribute to their roles in transcription regulation and alternative splicing. This study aims to investigate whether ZNF326, AKAP8, and AKAP8L exhibit functional redundancy. Understanding their interplay could provide new insights into cellular functions and offer therapeutic targets in cancer.
We generated lentiviruses and infected MiaPaca2-Cas9 cells with knockouts of ZNF326, AKAP8, and AKAP8L, both individually and in combination, using AAVS1 as a control. Knockout efficiency and protein expression were analyzed through Western blotting, and mRNA levels were assessed using quantitative PCR. Our findings suggest that ZNF326, AKAP8, and AKAP8L may share redundant roles in regulating alternative splicing and gene expression, offering insights into their contributions to cellular function and potential implications for cancer therapy.

Mentor(s): Kathleen Mulvaney (Biological Sciences & Pathobiology)

Kushal Chhetri
Virginia tech/Computer Science

CEED

Task-Oriented Time Management: Integrating Screen Tracking and Digital Resource Metadata in a To-Do List Application

In today's digital age, efficient time management, and productivity are essential, especially as computer usage dominates both work and leisure activities. However, traditional task management tools often lack contextual information, leaving tasks isolated from corresponding digital resources. This research addresses these issues by developing a novel to-do list application integrated with screen tracking software. The application is designed to provide users with visual feedback on their computer usage patterns, helping them better plan their activities and reflect on their actions to foster a more balanced and productive computer usage. The application combines a traditional to-do list with a screen tracking component (Screen Track) that monitors and logs computer activity. By incorporating metadata of digital resources, it emphasizes how this information can enhance to-do lists by providing a richer context for each task. This integration allows users to track their tasks and understand the digital resources associated with each task, such as documents, websites, and applications. This holistic view of tasks and associated resources can lead to more efficient time management and improved productivity. The effectiveness of the application will be evaluated through user studies, where participants will report changes in their productivity and computer usage habits over a specified period. It is anticipated that the application will help users become more aware of their computer usage patterns, leading to improved planning and task management. We expect users to report higher productivity levels and more balanced computer usage, with a notable reduction in time spent on non-productive activities.

Mentor(s): Sang Won Lee (Computer Science)

Emily Chipman
Virginia Tech/Neuroscience

A-Lab SURF

Family Ties: Associations between Familial Relationships, Delay Discounting, and Unhealthy Behaviors in Substance Use Disorder Recovery

Background: Having healthy familial relationships may help those recovering from substance use disorders (SUD). Family relationships may impact one's temporal window, as measured by delay discounting (DD; preference for smaller, sooner rewards over larger delayed ones). In turn, having a shorter temporal window (high DD rates) may lead to engagement in several unhealthy behaviors that could compromise SUD recovery. Objectives: This study examines the associations between family relationships, DD, and unhealthy behaviors among individuals recovering from SUD. Methods: Participants (n = 129) were recruited through the International Quit & Recovery Registry (IQRR). Participants completed the Brief Family Relationship Scale (higher scores indicate greater familial relationships), a monetary DD task and the Health Behaviors Questionnaire, which measures 8 different behaviors. Linear regressions with model selection were used to test these associations. The model with the lowest BIC was used. Results: A negative relationship between family relationships and DD was found (β=-0.05, p=.007), but when adding level of education and income to the model, the relationship vanished (p=.096). Additionally, greater family relationship was negatively associated with poor eating behaviors (β=-0.17, p<.001), lack of personal development goals (β=-0.13, p=.001). Finally, greater DD rates were associated with lack of personal development goals (β=0.49, p=.014). Conclusion: The findings suggest that familial support plays a role in promoting positive lifestyle behaviors like healthy eating and personal development goals, which are important to their recovery journey. In summary, practitioners should take into account patients' family history to understand how their behavior could compromise their recovery.

Mentor(s): Daniel Cabral (FBRI, VTC)
Ghada Nusair (FBRI, VTC)
Kirstin Gatchalian (FBRI, VTC)
Warren Bickel, (FBRI, VTC)

Joshua Cooper
Fayetteville State University/Business Administration with a concentration in Marketing

The Dark Side of the Screen: How Social Media Impacts Mental Health

Social media has become an essential component of contemporary life, with millions of users daily utilizing platforms like Facebook, Instagram, and Twitter. Social media has the potential to negatively affect mental health in addition to its many beneficial effects, which include fostering a sense of connection and community. Social media's ability to bring people together who might otherwise feel alone or isolated is one of its benefits. For instance, online communities of like-minded people can provide support and understanding to those dealing with mental health issues. Social media gives people a platform to creatively express themselves and communicate their ideas and emotions to a larger audience. Social media use, though, can also be negative to mental health. According to research, people who use social media excessively may experience low self-esteem and feelings of inadequacy because they compare themselves to other users and are continuously looking for likes and comments to validate their posts. Anxiety and depression can also result from the never-ending flow of information and frequently exaggerated depictions of people's lives on social media. People should use caution when using social media because it may have a damaging impact on their mental health. The negative effects of social media on mental health can be lessened by setting boundaries, such as limiting the amount of time spent on social media and creating a welcoming and encouraging online community.

Mentor(s): Arianna Schuler-Scott (Pamplin College of Business)

Emma Copening
Virginia Tech/Biological Systems Engineering

Development of Vaginal Dilation Device for In Vivo Mechanical Testing in Murine Models

Vaginal stenosis (VS) is a condition that affects approximately 88% of cancer patients after undergoing pelvic radiation treatment, causing scarring of the vaginal canal. VS negatively impacts the patient's quality of life, causing pain, decreased vaginal function, and vaginal dryness. Vaginal dilation therapy is the standard treatment for VS, but its efficacy and optimal regimen remain uncertain, prompting many women to endure the condition rather than seek treatment. This study aims to develop a more standardized, effective, and patient-specific dilation process for VS by developing a device for animal testing that provides real-time data on the pressure, radius, and stiffness of the vaginal canal during treatment. The proposed device measures electrical impedance via a saline-inflated latex balloon surrounding a catheter with four electrodes that facilitate data collection. When the balloon is inflated, an alternating current passes through the excitation electrodes, travels through the solution, and is detected through each sensing electrode to measure three radii along the length of the vagina and approximate the stiffness of the tissue. The device connects to a digital interface which interprets these measurements and allows users to control inflation and deflation while displaying real-time pressure and radius data. This approach can provide clinicians with the necessary data to track patient progress and to determine the appropriate frequency and duration of dilation without causing further injury. This research can lead to the development of an evidence-based, user-friendly dilator to significantly increase patient adherence and ultimately improve the quality of life for women suffering from VS.

Mentor(s): Raffaella De Vita (Mechanical Engineering)

Micah Craine
Virginia Tech/Computational Modeling and Data Analytics
Aashish Aryal
Virginia Tech/Computer Science

Evaluating the Accuracy of the U.S. EPA's MOVES4 Model in Estimating Particulate Matter Emissions from Electric Vehicles

Non-exhaust particulate matter (PM) emissions have gained attention due to stricter exhaust emission policies and the growing global vehicle fleet becoming increasingly electric. PM exhaust emissions are virtually eliminated, and non-exhaust brake wear PM emissions are considerably reduced due to electric vehicles' regenerative braking systems. However, the increased weight of electric vehicles leads to higher PM emissions, underscoring the importance of accurately quantifying and reducing PM emissions.

Despite the importance of quantifying particulate matter, the algorithm to estimate TWPs in the latest version of the U.S. EPA's MOtor Vehicle Emission Simulator (MOVES4) uses outdated studies from the early 2000s.

To assess the validity of this model, we underwent many MOVES4 runs, while changing various quantities in the database used. From this testing, we found out that MOVES4 uses a fixed ratio for PM10 to PM2.5 to estimate emissions, and that the model does not take into account the weights of any vehicles, only the quantity of tires when calculating tire emissions.

In addition to modeling, we also helped test the current system for the collection of airborne tire particles. With this system, we were able to test the true ratio of PM10 to PM2.5, and prepare for on-road tests.

From this research on the MOVES4 model and comparing it to more modern studies as well as actual tests, we can conclude that the MOVES4 model has numerous oversimplifications and that the increasing electrification of cars will significantly increase both PM2.5 and PM10 emissions from their tires.

Mentor(s): Hosein Foroutan (VT)

Hannah Crook
Virginia Tech/Environmental Data Science

Potential Sources and Interannual Variability of Atmospheric Microplastics Deposited in South Central Appalachia

The presence of microplastics in the atmosphere is a growing environmental concern due to their impact on the environment and human health. These tiny plastic particles can be ingested by living organisms, affect climate patterns, and be deposited in our oceans and ecosystems. Understanding atmospheric movement and deposition of microplastics is crucial for developing effective mitigation strategies to reduce pollution. This study aims to find and explain trajectories, deposition patterns, and potential sources of atmospheric microplastics to better comprehend their distribution in the South Central Appalachia (SCA) region. Utilizing the Hybrid Single-Particle Lagrangian Integrated Trajectory (HYSPLIT) model of the National Oceanic and Atmospheric Administration, atmospheric pathways were traced for 35 microplastics sampled in the SCA region in previous research. A heatmap was generated showing the frequency of trajectories across the area. In addition to modeling, new trials of the previous research protocol are being conducted to compare with the earlier study and understand interannual variability of microplastic deposition. From the model outputs, it was found that microplastics collected in the SCA region travelled in the atmosphere most commonly within the region and throughout Virginia, but also came from North Carolina, West Virginia, Tennessee, Georgia, Maryland, Delaware, and New Jersey. Microplastics that were collected often travelled at lower altitudes, but some reached as high as 1500m before deposition. With these findings, a better understanding of the origins and release of these microplastics can be achieved, through further research. This can allow action to be taken to minimize microplastic pollution.

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

Victoria Cross
Virginia Tech/Experimental Neuroscience

neuroSURF

Retrospectively analyzing children with CASK-related disability undergoing Global Developmental Delay Intensive Therapies

Background: CASK-related disability is rare but requires further exploration in order to develop reliable and repeatable testing and treatment. This project sought to explore the increase in cognitive-processing and development that children with CASK-related disability display while receiving global developmental delay intensive therapy. Further, we aimed to determine the effects that intensive therapy has on this group of children's attention, cognitive engagement as proxies for executive functioning. Children with CASK mutation often display delays in participatory actions that is thought to be disorders of cognition, attention, and executive functioning.
Methods: The methods of this project included retrospectively analyzing treatment video of 4 children with CASK mutations of varying ages, mean X=51.75, range between 12-120 months. Children were receiving intensive therapy services that were 4 weeks in length. Cognitive-processes was measured by the number of seconds between a request and the child's execution of the request. Cognitive-engagement was measured by the number of child-initiated actions in the first 5 minutes without any new request or direction.
Hypotheses: We hypothesize that cognitive processing will decrease across time with continued therapy and that cognitive engagement will increase across therapy time.
Results: All children's processing time decreased across days of therapy by a mean=3.30 seconds (s.d.=0.954). Cognitive-engagement was increased by a mean=3.50 count of child-initiated tasks (s.d.=2.598). For two children there was a correlation between these two variables (R2=0.9118, 0.8564).
Conclusions: These findings are proof-of-principle that cognitive–processing and cognitive-engagement can be measured via retrospective video recordings of therapy sessions.

Mentor(s): Stephanie DeLuca (Fralin Biomedical Research Institute at VTC)

Morgan Crum
Virginia Tech/Wildlife Conservation

Weller's Wannabe? Investigating Possible Mimicry between *Desmognathus orestes* and *Plethodon welleri*

Batesian mimicry occurs when a model species displays warning coloration to signal an unfavorable trait to predators, and a mimic species possesses the same coloration, but no such trait. This phenomenon has been observed in salamander species such as *Plethodon jordani*, the model, and *Desmognathus imitator*, the mimic. In this case, *P. jordani* produces a noxious, unpalatable secretion that is very sticky and acts as a deterrent to predators while *D. imitator* does not. I hypothesize a mimetic relationship between two species found in the Mount Rogers National Recreation Area: *Plethodon welleri* (model with noxious secretion) and *Desmognathus orestes* (mimic with no secretion). In this study, we surveyed sites separated by 30m in elevation, in Virginia's Smyth, Grayson, and Washington counties. Bidirectional transects of 100m by 5m were completed at each site. We searched under leaf litter, rocks, and logs, and put each salamander in a bag until we began processing them for data collection. For each *P. welleri* and *D. orestes*, we matched their color to a swatch in the Herpeton *Color Catalogue for Field Biologists*. We then found the proportions of overlapping colors for *D. orestes* and *P. welleri* for each elevation.

Mentor(s): Charlie Holguin (Fish and Wildlife Department, Virginia Tech)
Holly Kindsvater (Fish and Wildlife Department, Virginia Tech)
Kevin Hamed (Fish and Wildlife Department, Virginia Tech)

Sterling Cullinane
Hollins University/Theater
Mary Zaengle
Hollins University/Theater

Community Speaks: Queer Roanoke and Verbatim Theater

Community Speaks is a verbatim theatre project exploring the queer community in Roanoke. This research phase lays the foundation for a larger performance piece, addressing the need for a connection between Hollins University's queer community and the broader Roanoke LGBTQ+ population. Verbatim theatre is a powerful form of social justice advocacy that uses the exact words of interviewees to authentically represent marginalized voices.

Our methodology combines oral history techniques, community engagement—including attendance at local LGBTQ+ events and strategic networking—and archival research drawing from the Southwest Virginia LGBTQ+ History Project. Through these methods, we capture the diverse experiences and perspectives within Roanoke's queer community, both past and present.

The ultimate goal of our research is to develop a fully realized verbatim script for performance at Hollins University and potentially at Ursula's Cafe in Downtown Roanoke, creating greater understanding and connection between campus and city LGBTQ+ communities.

Mentor(s): Dr. Wendy-Marie Martin (Theater, Hollins University)

Immanuel Cutler
Virginia Tech/General Engineering

Effects of Concentration of PEGDA and Exposure Time on Mechanical Properties of 4D Biomaterials

4D Biomaterials is an emerging field combining smart polymers and 3D printing focusing on the creation of biocompatible materials that can change properties over time as a response to stimuli such as pH, light, and chemical cues. This dynamic behavior presents opportunities for pioneering advancements in biomedicine, particularly in tissue engineering, drug delivery systems, and biosensing applications. Through photopolymerization, varying levels of ultraviolet (UV) light exposure and polymer concentrations in the resin can significantly impact the mechanical characteristics of the resulting structures. By measuring the thickness of composite resins with varying concentrations of PEGDA (Polyethylene glycol diacrylate) we can determine the polymers effect on the polymerization as well as the mechanical properties of the resin as a function of concentration of PEGDA and exposure time to UV light.

Mentor(s): Abby Whittington (Chemical Engineering and Material Science and Engineering)

Janelle Davis
Virginia Tech/Aerospace Engineering

CEED

The Impact of Water-to-Cement Ratios on the Durability and Performance of Concrete Repair-Substrate Interfaces

This study investigates the impact of different water-to-cement (w/c) ratios in repair mixtures on the overlay transition zone (OTZ), analogous to the interfacial transition zone (ITZ) and considered the weakest area in cement-based concrete pavement repairs. Repair materials were prepared against a substrate with a fixed moisture condition (RH-98%) and a w/c ratio of 0.45. Three different repair mixtures with w/c ratios of 0.38, 0.40, and 0.45 were used to prepare repair-substrate specimens. The mechanical properties, fracture properties, water absorption, rapid chloride penetration (RCPT), dynamic modulus of elasticity, chloride diffusion characteristics, and other performance metrics of the OTZ were examined following different ASTM, ACI, and RILEM standards. Additionally, the effect of freeze/thaw (F-T) cycling, a common environmental condition for concrete pavements, was explored. A novel technique, transmission X-ray microscopy (TXM), was employed to quantify the time-dependent chloride diffusion coefficient within the OTZ. The results indicate that the w/c ratio of repair materials significantly affects the interfacial bond and the overall performance of the repair-substrate composite. These findings contribute to a more informed approach to pavement repair practices, with potential implications for enhancing the longevity and performance of repaired concrete pavements.

Mentor(s): Alex Brand (Civil and Environmental Engineering)

Emma Davis
Hollins University/Psychology

Public Causal Beliefs about Binge Eating Disorder

While public awareness of mental health has increased in recent years, stigma remains for many disorders and can be a deterrent to treatment. Furthermore, awareness that conditions exist is just the first step in a larger process of mental health literacy, which would include accurate information about illnesses and their treatment. To improve mental health literacy, researchers seek to understand public assumptions about mental illnesses, including causal beliefs. Causal beliefs refer to the often-implicit theories people hold regarding the determining factors in creating a condition (i.e. daily stress, genetics, moral failing). There is a need for further research on public casual beliefs and how they interact with other stigma measures, especially for less-studied conditions like Binge Eating Disorder (BED). In the current online study, 196 participants responded to a vignette describing a person with clinical symptoms of Binge Eating Disorder; participants then completed a Causal Beliefs Scale where they rated (on a 5point Likert scale) the perceived importance of different factors (current stressors, past experiences, biology, or moral forces) in causing the character's Binge Eating Disorder. Results will be evaluated to determine which causal beliefs are most prominent and how these compare to previous research and beliefs about other disorders. We will also examine potential relationships between causal beliefs, personal variables, and other stigma measures.

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

Sophia Deal
Virginia Tech/Packaging Systems and Design

Inclusion Complex Optimization Process of Amorphous Polyhydroxyalkanoates and Beta-Cyclodextrin

The evolution of regulations and the importance of sustainability in the packaging industry have prompted a need for bioplastics as an alternative solution to traditional petroleum-based plastics. Bioplastics such as amorphous polyhydroxyalkanoate (aPHA), a natural bioplastic derived from the bacterial fermentation of food waste, have many advantages in terms of an improved environmental impact on account of its biodegradability in diverse conditions, including the ocean. Unfortunately, aPHA has disadvantages related to its low thermal resistance. This study aims to be a concept experiment and optimization process to build on previous research on the inclusion complex created from the combination of aPHA and beta-cyclodextrin (B-CD). The hydrophobic center cavity of the B-CD allows the aPHA to thread through the cyclic oligosaccharide, creating an inclusion complex and higher temperature stability. Six experiments were conducted to examine the changes in inclusion complex yield and molecular structure based on various temperatures and times, with 60°C for 4 hours being the control. The first three experiments, focused on temperature, were conducted by reacting aPHA and B-CD at 50°C, 60°C, and 70°C. The next three, focused on time, were conducted at 2 hours, 4 hours, and 8 hours. After the inclusion complex produced was subject to Fourier Transform Infrared Spectroscopy (FTIR) analysis. The results suggest that 70°C and 8 hours produce the optimal yield. These results aim to influence an increased use of aPHA in bioplastic packaging products such as films.

Mentor(s): Young-Teck Kim (Sustainable Biomaterials)

Arushi Deb
Virginia Tech/Physics

Independent Research

Tunable Transport In Topological Metal Mn2Au For Spintronics Applications

Antiferromagnetic materials are actively being explored for spintronic applications due to their zero net magnetic moment, insensitivity to magnetic fields, and novel magneto-electronic properties, including giant magnetoresistance and spin-orbit torque. Coincidentally, antiferromagnetism also breaks time reversal symmetry, which is a necessary prerequisite for a compound to be a topological Weyl material. Antiferromagnetic Mn2Au is a well-studied spintronics material, exhibiting a high spin-orbit torque efficiency, and an exceptionally high Néel temperature of over 1500K. Here we compute the electronic structure of Mn2Au and for the first time, identify it as a candidate Weyl metal. We study the dependence of Weyl point positions on the orientation of magnetic moments and compute the resulting anomalous Hall effect. Our prediction of Weyl physics in Mn2Au can lead to potential new functionalities in this antiferromagnetic spintronics material.

Mentor(s): Seva Ivanov (Physics)

Emelia Delaporte
Virginia Tech/Professional & Technical Writing; Multimedia Journalism

Independent Research

Does an association exist between retention rates and senses of belonging and care in the field of ornithology?

Though professional societies are meant to provide career-affirming benefits, studies have shown that members of marginalized communities often experience barriers and challenges that can lead to poorer rates of retention in their field. DEI efforts, aimed at undoing these challenges, are important in building a sense of belonging and providing care to members.. We surveyed members of three major ornithological societies in North America, completed by a total of 1163 individuals, to better understand their experiences within the field. As part of this survey we gathered data regarding the likelihood of individuals to leave the field in the next five years. We observed associations between the likelihood of individuals to be retained in the field of ornithology across five years and broader senses of care and belonging. We found that the lower an individual's sense of belonging or being cared for, the more likely they are to seek a career outside of ornithology in the next five years, and vice versa. Retention is important to ornithology because it boosts diversity, which allows for research that may not have otherwise been considered. We studied expected retention rates in historically marginalized groups, such as women, LGBTQ+ and BIPOC populations, and found that they are less likely to be retained than cisgendered, heterosexual and White populations. Our analysis suggests that societies need to focus attention on care and belonging as areas for improvement, in order to maintain and retain diversity. The development of affinity groups can be an aid in this process.

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

Riley DeLoatch
Morehouse College/Physics

Determining the extinction coefficient of RAFT agents for monitoring polymerizations

Controlled radical polymerizations (CRPs) enable the synthesis of polymers with well-defined molecular weights, and subsequently well-defined properties. Further, CRPs generally allow for the synthesis of block copolymers. Reversible addition fragmentation chain-transfer (RAFT) is a CRP technique that is mediated by a trithiocarbonate motif, which reversibly caps and uncaps the growing polymer chain to prevent undesired polymer termination. The trithiocarbonate has unique absorptions at 309 and 449 nm which can be monitored by UV/Vis spectroscopy to quantify its abundance in solution. We are determining the extinction coefficients of different RAFT agents using UV/Vis. We deliberately vary the concentration of each RAFT agent in DMSO or DMAc to monitor both of the characteristic absorptions. We determine the extinction coefficients using the slope as a function of concentration, consistent with Beer's Law. With this information we can accurately determine the abundance of trithiocarbonates in polymerization reaction aliquots to help determine how "living" and controlled it is.

Mentor(s): Koehler Stephen (Chemistry)

Jocelyne Dempsey
Old Dominion University/Biochemistry

Examining the relationship between amygdala volume and fear response in 3-month-old infants

The amygdala is a small, almond-shaped, bilaterally paired structure in the brain's temporal lobe. It is part of the limbic system and is heavily involved in the fear response. Previous evidence suggests that a larger amygdala is associated with behavioral disorders, whereas a smaller amygdala is associated with increased physiological reactivity to stress. We know amygdala volume has a strong positive relationship with response to fear throughout childhood and adolescence, however, little is known about the relationship between amygdala volume and response to fear in early infancy. This study aims to determine if there is a significant relationship between amygdala volume and concurrent fear response in infancy. This proposed investigation will examine this question using data from 15 participants at 3 months old, seven males and eight females. Fearful temperament was determined using the fear subscale score of the Infant Behavioral Questionnaire (IBQ) reported by mothers (N=15). The infant's amygdala volumes were measured using the software FreeSurfer from their collected T1 weighted structural magnetic resonance images (MRI), acquired during non-sedated natural sleep. Relationship significance was determined using Pearson's correlations to examine how right, left, and total amygdala volume relates to IBQ subscale fear scores. We hypothesized the results of the analysis will show a significant positive relationship between amygdala volume and fear temperament in 3-month-olds. Knowing if the amygdala's volume relates to fearful temperament creates knowledge that supports children, families, and clinicians in understanding potential markers for behavioral or stress response abnormalities.

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

Paris Dessert
Virginia Tech/Cognitive and Behavioral Neuroscience

Independent Research

A Narrative Review of Interventions Addressing Stimming Behaviors in Autistic Individuals

This narrative review sought to summarize intervention research conducted with autistic youth targeting self-stimulation ("stimming"). Treatments involved behavioral, neurological, pharmacological, and alternative or naturalistic approaches. The majority of studies have involved small sample sizes or case studies (i.e., 1-50 participants), with only one study having over 100 participants. Studies from the 1970s utilized physical punishment (e.g., slap, physical restraint), whereas newer studies have turned away from physical punishment yet some still use physicality (e.g., holding hands down during overcorrection). Four studies specified the target behaviors as affecting functioning in distressing ways; others simply targeted behaviors that were deemed socially inappropriate. With regard to behavioral interventions, Overcorrection and Parent-Child Interaction Therapy were found to be effective regardless of stimming type, whereas Conditioning was most effective for motor stereotypy and Response Interruption and Redirection was most effective for vocal stereotypy. Other behavioral interventions (time out, Differential Reinforcement of Other Behaviors, and parent interventions not involving the child) were found to be non-significant. Both neurological interventions, theta-bust stimulation and repetitive transcranial magnetic stimulation, were found to reduce stimming. With regard to pharmacological interventions, Oxytocin and Clomipramine were effective, whereas Fluoxetine and Citalopram showed no effect. Finally, all three alternative/naturalistic approaches (exercise, reduction in screentime, and music therapy) were all found helpful in reducing stimming. Future research is encouraged to more thoroughly describe samples to give readers a sense of the range of severity of participants, and to focus on stimming that negatively affects the autistic person's life rather than just being socially inappropriate.

Mentor(s): Rosanna Breaux (Department of Psychology)

Abigail Detloff
Virginia Tech/Microbiology

Identifying Protein-Protein Interactions on the Bacterial Spore Membrane Surface

Bacterial spores can be dormant for many years, and, through spore germination, can become metabolically active again within minutes. Some spore-forming species have toxic properties that make them disease-causing. Spores are difficult to kill due to their resistance to heat, chemicals, and physical assault, contributing to disease spread. One key component of spores' layered structure is the inner membrane, separating the spore core and cortex, which limits permeability of chemicals to enter the core. A lipoprotein complex exposed on the membrane's outer surface has been shown to stabilize the inner membrane. We now look to determine any interactions between these lipoproteins and other germination-active proteins that contribute to the stabilization of the membrane and germination ability. This was accomplished by the construction of bacterial two-hybrid plasmids, followed by cotransformation of these new plasmids into E. coli. Both qualitative and quantitative assays of strain phenotypes were performed to identify any protein-protein interactions. The qualitative assay results have not produced apparent indications of protein-protein interactions. However, results from quantitative analysis demonstrate possible weak interactions between the lipoproteins and between specific domains of each protein. To test these interactions further, we will carry out repetitions for the most hopeful results and assay of results at extended time points. In future studies, additional methods of identifying protein interactions, such as protein crosslinking, will be used to verify specific protein interactions. Work accomplished throughout this project can be used to understand more about spore resistance and germination. When the cell goes through germination, it becomes weakened and much easier to attack, and figuring out what types of interactions allow the most efficient germination will point to possible means of attack on the weakened cells and further prevention of infection/disease.

Mentor(s): David Popham (Department of Biological Sciences)

Moyo Dinakin
Cave Spring High School

CHBR

Comparing the Labeled Magnitude Scale Trainings to Flavor Ratings

Perceived sweetness has an impact on metabolic, perceptual, and brain response. Determining sweet taste for across-group-comparisons is significant to understanding absolute intensities. Thus, measurements are based on Labeled Magnitude Matching. However, the scale must be used correctly to allow for across-group comparisons. Here we examine how the generalized LMS (gLMS) and labeled hedonic scale (LHS) trainings correlate to real flavor ratings made by participants. To investigate this question, participants will be trained on how to rate flavors based on a labeled magnitude scale during consent sessions. This training includes ratings of real and remembered sensations, indicating where they lie on the hedonic scale, using common terms like “moderately” and “very much". Following this training, various non-caloric beverages with differing flavors will be given to participants for ratings. To complete this investigation, two researchers will first independently determine “correct” answers to training prompts. Responses will then be compared, and any disagreement greater than 10% of the scale will require reconciliation by a third researcher. Participant ratings will then be evaluated against the “correct” score that should be contingent to the training. We expect that on average participants scoring 10% outside of the “correct” range on LHS scale training are more likely to be excluded based on flavor rating criteria. The results from this study can demonstrate the accuracy of the gLMS and LHS trainings. Further, results from this analysis could be used to develop a process to better normalize flavor ratings for group comparisons.

Mentor(s): Alexandra DiFeliceantonio (Center for Health Behavior Research, Virginia Tech)
Mary Elizabeth Baugh (Center for Health Behavior Research, Virginia Tech)

Claudia Disbrow
Roanoke College/Health and Exercise Science

PDE9 Inhibition as a Therapeutic Target for Mitochondrial Quality Control in Cardiometabolic Disorders

Heart failure with preserved ejection fracture (HFpEF) poses a momentous clinical challenge as its complexity and lack of therapeutic interventions leave over 50% of all heart failure patients underserved and in opposition to adequate medical care. This research investigates the uncharted interplay between Phosphodiesterase 9 (PDE9) and autophagy. Central to HFpEF progression is mitochondrial quality control, pivotal in understanding the occurrence of suboptimal cardiomyocyte energetics and impaired mitochondrial functions in this unique cardiometabolic condition. We aim to elucidate the therapeutic efficacy of PDE9 through a dual approach combining mouse models and cellular assays. We quantified mitochondrial respiration, examined structural dynamics in cardiac tissue, and evaluated autophagic and mitophagic responses to delineate the molecular and functional modifications induced by altering PDE9 activity within the context of HFpEF pathology. PDE9 inhibition significantly improved diastolic function and mitochondrial bioenergetics in our model, providing compelling evidence for novel therapeutic drug development. In vitro analysis demonstrated accelerated autophagic and mitophagic fluxes, resulting in the rectification of mitochondrial dysfunctions and enhancement of cellular resilience against their induced stressors. These insights present paramount importance in improving clinical management strategies, with PDE9 inhibition offering a viable therapeutic pathway for the multitude of patients affected by the phenomenon of HFpEF.

Mentor(s): Sumita Mishra (Center for Exercise Medicine, FBRI)
Vivek Chander (Center of Exercise Medicine, FBRI)

Theodore Docev
Virginia Tech/Geosciences
Allison Montgomery
Virginia Tech/Ecological Restoration

Independent Research

20th Century Microplastic Accumulation and Storage in Bayside Salt Marshes of the Eastern Shore, Virginia.

Salt marshes are important carbon sinks, provide ecosystem services, and offer a buffer from storm surges. Salt marsh vegetation and sediment can also filter and absorb pollutants, making their sedimentary sequences good recorders of pollution through time. Some of these pollutants include: microplastics, tireware particles (TWRPs), pharmaceuticals, and heavy metals. Our main focus, microplastics (particles <5 mm) are major pollutants found in sediment, groundwater, and aquatic animals. How can we predict the ability of salt marshes to trap and store microplastics through time and what kind of microplastics can we expect to find in sedimentary sequences? To answer this question we took sediment cores from Saxis Marsh in Accomack County, Virginia, along the Chesapeake Bay from a depth of 0 to 50 cm. Cs137 and Pd210 analysis suggests the sediment record below 25 cm pre-dates the introduction of plastics in the mid 20th century. We extracted microplastics from our sediment cores and found 76% fibers, 24% fragments, and less than 1% beads or pellets, though there is no apparent pattern in concentration through the 0-50 cm analyzed. Common polymers are expected to include polystyrene (PS) and polyethylene terephthalate (PETE). The presence of microplastics downcore prior to the introduction of plastics in the mid 20th century suggests that microplastics have migrated downcore. This shows that salt marshes may be important microplastic sinks, trapping the pollutants in their porous substrate. Future work will focus on characterizing polymers and understanding the mechanism for downcore plastic migration.

Mentor(s): Tina Dura (Geosciences, Virginia Tech)
Austin Gray (Biological Sciences, Virginia Tech)

Fiona Dreesbach
Virginia Tech/Microbiology

VT-REEL

The effect of secondary metabolite diversity on pathogen evolution

Plants produce an array of chemicals called secondary metabolites. Although these metabolites are known to serve many functions, such as pathogen defense, it's still unknown why plants produce a diverse set of chemicals rather than a few more potent chemicals. One hypothesis is that the complexity of multiple compounds may be more effective in slowing the evolution of pathogens to individual metabolites with only a single mode of action. To test this hypothesis, Penicillium expansum, a fungal pathogen that impacts apples post-harvest, was grown over generations to examine the impact of secondary metabolites on the evolution of the pathogen. The fungus was grown in 96 well plates containing mycological broth with different solutions of metabolites common in apples, including 14 single compounds and 45 solutions containing combinations of the individual metabolites. The growth was measured over five days by a plate reader at 8 am and 8 pm daily. After each generation, the spores from each well were counted then diluted to a constant of 120 spores per 1 microliter of solution, and transferred to sterile plates for the next generation. To test the evolution of the pathogen, this process was repeated for three generations and will be continued until reaching 10. Preliminary results suggest a relationship between increased structural diversity of secondary metabolites and preventing rapid evolution of pathogens. These results inform our understanding of the origins of secondary metabolite diversity and can be applied to improve the management of plant pathogens.

Mentor(s): Susan Whitehead (Department of Biological Sciences, Virginia Tech)
Dr. Monica Ponder (Department of Food Science and Technology, Virginia Tech)

Khaled Dulli
Virginia Tech/Mechanical Engineering

CEED

Enhancing Resilience of Low-Rise Large Volume Structures Against Extreme Winds

This research aims to bolster the resilience of low-rise large volume structures, such as big-box stores and pre-engineered buildings, against extreme wind events. Historical damage data is first collected to understand the prevalent failure modes in these structures. The focus is on modeling the roof system and the critical roof-to-wall connections, often the weakest link during high wind events. The objective is to enhance structural redundancy by strengthening these connections, thereby preventing disproportionate collapse and minimizing asset losses.

The study employs finite element modeling validated through wind tunnel testing. My contributions included optimizing existing Python code to generate community and structural impact summaries based on STEER and FEMA reports of actual natural disasters involving high-speed winds. I also executed the Python code on Google Colab to enhance processing speed and efficiency, enabling us to handle large datasets effectively. Additionally, I created detailed CAD models using SolidWorks to support the structural analysis.

The research addresses key questions: How can roof-to-wall connections be strengthened to ensure a continuous load path? What becomes the next weakest link once these connections are improved? Will addressing this new failure mode enhance life safety, prevent asset loss, and reduce downtime?

By simulating extreme wind conditions, we aim to identify vulnerabilities and evaluate the effectiveness of proposed solutions. This research integrates stakeholder input to ensure alignment with community needs, striving to develop solutions that effectively mitigate risks and enhance structural resilience. The goal is to safeguard lives and assets through improved structural engineering practices.

Mentor(s): Monica Arul (Civil and Environmental Engineering)

Zacarya Elbash
Virginia Tech/Neuroscience

A-lab SURF

Chronic Pain and Delay Discounting: The Cognitive Struggle of Substance Use Disorders Recovery

Background: Chronic pain is associated with substance use disorders (SUD). Research shows that those recovering from SUD with chronic pain have a shorter temporal window. However, little research has been done on whether the cognitive intrusion of pain (i.e., the extent to which people experience pain that interrupts their thinking) plays a role in this relationship.
Objective: This study aims to (1) investigate the relationship between chronic pain and delay discounting (DD; a measure of one's temporal window) and (2) examine whether the cognitive intrusion of pain is associated with chronic pain and DD among individuals in recovery from SUD.
Methods: Participants (n = 209) were recruited from the International Quit & Recovery Registry and completed a monetary DD task, demographics questionnaire, chronic pain questions, and the Experience of Cognitive Intrusion of Pain. Linear regressions with model selection were used to test the aforementioned associations. The models with the lowest BIC were used.
Results: No differences were observed in DD rates between those who have chronic pain and those who do not ($p = .469$). Those who have chronic pain reported having higher cognitive intrusion of pain ($p < .001$). Additionally, cognitive intrusion of pain was not associated with DD rates ($p = .178$).
Conclusion: The study did not find associations between chronic pain with DD, and between cognitive intrusion and DD. We found that chronic pain was associated with higher scores on the cognitive intrusion scale. This may potentially lead to attempts to stop thinking about the pain, which might lead to relapse.

Mentor(s): Daniel Cabral (Post Doc, FBRI)
Tony Nist (Post Doc, FBRI)
Warren Bickel (Principal Investigator, FBRI)

Aziza Ergasheva
University of Virginia/Computer Science
Nitya Ganta
Virginia Tech/Computer Science

Leveraging AI to analyze centrosome and chromosome numbers in tetraploid cells

Tetraploidy, possessing four sets of chromosomes, is a common genomic change among cancer cells. When cells become tetraploid, they often acquire extra centrosomes, an organelle essential for chromosome division. Previous studies have shown a correlation between tetraploidy, supernumerary centrosomes, and tumor progression *in vivo*. Nevertheless, *in vitro*, newly formed tetraploid cells lose their extra centrosomes while maintaining a near-tetraploid chromosome number. This indicates that the tumor microenvironment may influence the evolution of chromosome and centrosome numbers in tetraploid cells, which would explain the discrepancy between the *in vivo* and *in vitro* observations. Testing this hypothesis requires analyzing centrosome and chromosome numbers in numerous cells during the population's progression under varying culture conditions that mimic the tumor microenvironment. The centrosomes' minute size (250x450nm) and the resolution constraints of the confocal microscope (250x-500-600nm) make a manual analysis of cells tedious, potentially inaccurate, and susceptible to human bias. Therefore, the goal of this project was to develop and optimize an automated pipeline for centrosome and chromosome counting. The pipeline consisted of three distinct AI models that specialized in categorizing cells by their cell cycle stage, estimating chromosome numbers, and segmenting and counting centrioles. All models had an 80:20 training and testing ratio split, respectively. The pipeline successfully differentiated whether cells were mitotic, G1, or G2. Moreover, centrosome counting accuracy was 96%, and the chromosome count consistently and accurately estimated whether the cells were diploid or tetraploid. The pipeline is currently being used to collect data from experimental samples.

Mentor(s): Daniela Cimini (Biological Sciences and Fralin Life Sciences Institute, VT)
Nicholas Keen (Biological Sciences and Fralin Life Sciences Institute, VT)

Saipranav Evani
Virginia Tech/Aerospace Engineering

CEED

Characterizing the Flow Field of Virginia Tech's Hypersonic Wind Tunnel

The hypersonic wind tunnel at Virginia Tech, originally acquired from the Russian Academy of Sciences, is critical infrastructure for advancing high-speed aerodynamics research at the university. Hypersonic flow, characterized by speeds of Mach 5 and higher, introduces complex physical and chemical phenomena that significantly impact the design and testing of aerospace vehicles. Although there has been very limited experimentation with humans flying aircraft at hypersonic speeds, some practical examples include atmospheric re-entry and military weaponry. This study aims to meticulously characterize the flow field within the hypersonic wind tunnel. A primary objective is to identify regions of clean flow, which are essential for accurate and safe testing of aerospace components under hypersonic conditions; even minor imperfections can lead to unrefined data or unintended shocks. Pressure transducers were calibrated and were strategically placed in the test chamber of the tunnel to discern areas of turbulence and clean flow. Temperature probes were also placed throughout the testing rig to ensure there was clean flow through the nozzles. Data was collected and analyzed and CFD was performed to validate the results obtained. Temperature data helped to verify that there was a volume of clean air coming through the test chamber due to a decrease in temperature inside the plenum where air is ejected. While this test was mainly to identify clean flow in the test chamber of the tunnel, it shows promise for the future of hypersonic testing at Virginia Tech as the program receives more funding.

Mentor(s): Liselle Joseph (Kevin T. Crofton Department of Aerospace and Ocean Engineering)

Mohammed Fares

Virginia Tech/Computational Modeling Data Analytics; Computer Science minor

Systematic Approach for Cluster Detection of Countable Applets in Quantitative Data

Developing a method to cluster fruitlet detection with the aim of providing an accurate measure of the number of applets employing precise coding and an annotation-vision model to achieve human-like accuracy. The aim of the project is using the computer software, YOLOV8 or YOLOV5 to identify the object (the applet) while uploading several images. Afterwards, the user would write the code in Python or another programming language and run it via a command-line interface (CLI) to obtain the necessary results. Applet detection leverages machine learning and vision detection to predict the number of applets by highlighting photographs and inspecting multiple images to confirm their presence by using the proper dataset. Examining up to 30 images revealed changes in the amount, scattering, and placement of applets. This has been integral since the computer-vision model detects objects based on their appearance matching the software's criteria. For instance, a light green applet is more likely to meet the system’s image requirements than a darker green applet. In conclusion, different methods have been developed primarily for fruit size estimation in 2D images and 3D point clouds with the computer-human error difference ranging from 5 to 10 percent, except for certain images with distinct applets, proving the analysis that the model detects objects matching the software's standard.

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

Joshua Farnsworth
Virginia Tech/Psychology

Independent Research

Does Gender Impact the Association Between Mindfulness and IPV Perpetration?

Intimate partner violence (IPV; psychological, physical, and sexual partner-directed aggression) is a health hazard, especially for those in college. Experts find college-aged adults between 18-25 are significantly more likely to experience and perpetrate IPV. Therefore, it's important to examine risk factors for physical, psychological, and sexual IPV within this population. Research suggests that greater mindfulness skills (e.g., having awareness of, observing, describing, and approaching internal and external experiences without judgement or reactivity) may circumvent IPV perpetration; however, it's unknown whether this association varies as a function of gender. Identifying gender differences in associations between mindfulness and IPV perpetration among college students will inform whether gender-specific intervention refinement is needed. We hypothesized that mindfulness facets (Observing, Describing, Non-Judgement, Acting with Awareness, Non-Reactivity) and IPV perpetration (psychological, physical, or sexual) would vary as a function of gender. Data were drawn from an archival cross-sectional dataset of N = 236 college students who reported drinking in the past month. Data were analyzed using three logistic regression models, one for each form of IPV perpetration of interest. For each model, IPV was regressed onto all five facets of the Five Factor Mindfulness Questionnaire (FFMQ), gender, and the interaction term between each FFMQ facet and gender. No significant interactions emerged, suggesting that the associations among mindfulness components and IPV perpetration are comparable across genders.

Mentor(s): Meagan Brem (Psychology)

Elizabeth Fearer
University of South Carolina/Psychology
Briana Ermanni
Virginia Tech/Psychology

Independent Research

Examining relations between maternal intrusiveness and ADHD symptoms in children with low inhibitory control

Intrusive maternal behaviors influence the development of their child's ADHD symptoms, as these behaviors often impede their ability to learn self-regulation and attention control (Kostyrka et al., 2023; Silverman & Ragusa, 1992). Specifically, more intrusive behaviors when working on a task together impedes children's inhibitory control (IC) (Geeraerts et al., 2021), suggesting IC may moderate the relation between maternal intrusiveness (MI) and later ADHD symptoms. Therefore, the current study assessed the relation between MI and children's IC at age 3 and how they predict ADHD symptoms at age 4.

At their 3-year visit, MI behaviors during a challenging puzzle task were coded for using a 4-point scale, where 1 meant no intrusive behavior and 4 meant high intrusive behavior. Children's IC was assessed using the Tongue Task, where children were tasked with holding a goldfish snack on their tongue for a period of time. Prior to their 4-year visit, mothers reported on children's ADHD symptoms using the Child Behavior Checklist (CBCL; Achenbach & Edelbrock, 1983).

In a regression analysis, MI, IC, and the interaction term were entered as predictors of 4-year ADHD symptoms (N = 176). The model [$R^2 = .05$, $F(3,172) = 3.15$, $p = .03$] and interaction ($p = .02$; $b = -4.52$) were significant. Simple slopes analysis at one SD above and below the mean for inhibitory control reveal that MI predicts ADHD symptoms in 4-year-olds, but only for children who have low IC. Results suggest having low IC becomes increasingly problematic as intrusiveness increases.

Mentor(s): Martha Ann Bell (Psychology)

Shannon Fisher
Virginia Tech/Environmental Resource Managment

MASBio

Using Hemp Lime in Building Materials for Carbon Sequestration

At a time where CO2 emissions are at an all-time high, incorporating plant material, like hemp, into building materials is a way to naturally store carbon without creating new waste. Hemp lime, also known as Hempcrete, is made from the shredded hurd of the hemp plant mixed with hydraulic lime and water. It is a building material predominantly used for its insulative properties as it has good thermal insulation and poor compressive strength compared to standard building materials. Hempcrete is typically slow drying which limits the optimization of building time when assembling hemp lime on site. The goal of this research is to create hemp lime blocks that can be transported well, in hopes that the hempcrete can be assembled off site and shipped to the building location. The experiments consist of a block made up of 2 parts binder (lime) to 1-part plant material (Hemp) and an array of additives including sand, Portland cement, and other biomass inclusions. The objective of the experimental trials was to mimic the block when transported. Each trial consisted of taking the initial weight of the block and rotating and dropping the block from a one-inch surface and measuring the weight lost after every 5 rotations. This process was continued for either 10 trials or until the block lost its structure. While this experiment is not yet completed the anticipated result is that the blocks with 66%-75% cement in proportion to hemp will perform best.

Mentor(s): Daniel Hindman (Sustainable Biomaterials)
Scott Barrett (Forest Resources and Environmental Conservation)

Sofia Forbes
Virginia Tech/Microbiology

Interactions of Flagellotropic Bacteriophages with Various Agrobacterium Species

Flagellotropic bacteriophages (phages) depend on rotating host flagellar filaments for infection. This study investigates the interactions between flagellotropic phages and their Agrobacterium hosts. We focused on three phage-host pairs: phage Milano and host Agrobacterium tumefaciens strain C58, phage 7-7-1 and host Agrobacterium sp. H13-3, and phage OLIVR4 and host Agrobacterium tumefaciens strain 15.13/040. Although phages are typically highly host-specific, we did observe cross-infectivity among certain Agrobacterium species and phages in spot assays. We used swim ring assays to test whether flagellins from different Agrobacterium species can complement across species. Understanding these interactions is crucial for developing phage-based biocontrol strategies, providing significant information for clinical and agricultural applications.

Mentor(s): Abigail Horton (Microbiology)

Andrea Galvan
The University of Texas at El Paso/Aerospace and Aeronautical Engineering

Teaching Systems Engineering Fundamentals to K-12 Students through a Robotics Educational Bootcamp

This poster shows a curriculum to teach the basics of Systems Engineering to K-12 students through a hands-on robotic bootcamp using VEX EXP robots. The portfolio is created to involve students in a team-based competition, and the methodology includes a series of challenges. The challenge guides the students through designing, building, and testing their robot. The students code and iterate through the VEX block interface to optimize it and complete the assigned challenge. This educational approach demonstrates an example of exposing and teaching students how to solve engineering problems and find an optimal solution according to the given requirements, which essentially provides a scope of the basics of Systems Engineering.

Mentor(s): Taylan Topcu (Grado Department of Industrial & Systems Engineering)

Nathan Gannon
University of Texas at Austin/Chemistry

Investigating the effects of casting method and ionic liquid composition on the structural and chemical properties of molecular ionic composites.

Developing electrolytes for batteries involves many factors, such as the salt acting as the carrier of one electrode's surface ions to the other and the substance in which the electrolyte is contained. These factors are the primary considerations of research involving solid polymer electrolytes, which are a solid gel structure comprised of long polymer chains and ionic liquids. Lou Madsen's group focuses their research on a specific kind of solid polymer gel called a molecular ionic composite (MIC). The MICs are made of an ionic polymer called poly(2,2′-disulfonyl-4,4′-benzidine terephthalamide) (PBDT) that acts as an additive to the ionic liquid matrix which solidifies the solution after preparing a film. These MIC films have a few advantages over liquid electrolytes, including reduction of dendritic growth that causes loss of battery life and a decrease in flammability over common organic solvents. Our research involved testing the efficiency of different ionic liquids in the MIC films, specifically to determine the impact of these ionic liquids on the structural and chemical integrity of the films. To accomplish this, we made use of dynamic mechanical analysis (DMA) and side-by-side comparison of dissolution in water. The two ionic liquids being compared were EMIM Triflate and Pyr14 TFSI, the latter of which not forming a gel in the liquid phase of the solution. Given Pyr14 TFSI's poor ability to gel, the expectation was that it did not form strong interactions with the PBDT rods, making for a less stable film. However, we learned that the method of forming the gels was also important, and the stability of the EMIM triflate films depended on the temperature at which it was prepared. More experimentation will be required to fully characterize the behavior of the films, but for now, the results are inconclusive.

Mentor(s): Lou Madsen (Chemistry)

Ariana Garrastegui Segarra
Virginia Polytechnic Institute and State University/Animal and Poultry Science

Independent Research

Ubiquitination in the prefrontal cortex as a sex-specific mechanism of fear memory formation

Post-traumatic stress disorder (PTSD) is 2-3 times more common in women than men, though the reasons for this sex bias remain unknown. The ubiquitin-proteasome system (UPS) plays a crucial role in the formation of fear memories that underlie PTSD. In this system, proteins can be marked by a single (mono) or many (poly) ubiquitin proteins, the latter of which has many different forms and leads to a diverse range of fates for the target protein. Recently, our group has reported sex differences in different forms of mono- and polyubiquitination in the amygdala during fear memory formation. However, little is known about how ubiquitin regulates sex differences in the molecular mechanisms of fear memory formation in other brain regions. The anterior cingulate cortex (ACC) is part of the prefrontal cortex, a sexually dimorphic brain region, and has been implicated in fear memory formation. Despite this, to date, no study has examined changes in ubiquitin signaling in the ACC during fear memory formation. Here, we found that training rats in contextual fear conditioning selectively increases linear (M1) polyubiquitination in the ACC region of males, but not females. This occurred without any significant changes in K27, K48 or K63 polyubiquitination. Further, we did not observe any changes in the most conform forms of monoubiquitination (at histone H2A and H2B). Together, these data suggest that sex-specific changes in linear polyubiquitination in the ACC could be contributing to fear memory formation. Current experiments are investigating behavioral changes following fear conditioning by inhibiting linear polyubiquitination in the ACC using CRISPR-dCas9.

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

Alexander Gioia
Virginia Tech/Mechanical Engineering

Independent Research

Variable Gearing In Jumping

The human foot is capable of adjusting gearing ratios between ground reaction force and muscle moments that can enhance muscle mechanics during walking and running, but this has never been studied in counter movement jumps (CMJ) which encompass rapid changes of direction and force.
PURPOSE: To investigate differences between variable and constant gearing on Achilles muscle tendon velocity (AMTV) during jumping. METHODS: 40 active young adults participated in this study (20 M (21.7 ± 2.2 yrs) and 20 F (23.2 ± 4.3 yrs)). 3D motion capture and force plates recorded foot and ankle motion and ground reaction forces (GRF) during CMJ. The gear ratio was determined as the GRF gear divided by the triceps surae gear. The variable gear ratio was calculated continuously throughout the task and a constant gear ratio was taken at the midpoint of each landing. AMTV was defined as the triceps surae gear multiplied by the ankle angular velocity. A one-way repeated measures ANOVA (α=0.05) was conducted through statistical parametric mapping to assess differences in AMTV throughout ground contact between variable and constant gearing.
RESULTS: Gear ratios in the first 15% were less than or close to 1 and in the last quarter were between 1.5 and 2. The eccentric portion of the movement resulted in negative AMTV values, thus stretching the muscles, and the concentric portion with positive AMTV values, thus shortening the muscles. Compared to constant gearing, variable gearing resulted in higher AMTV during the first 2-3% of contact (avg 21.83% higher, max 22.91% higher), and lower AMTV during the first 7-11% (avg 21.90% lower, max 24.84% lower) and 62% and later of ground contact (avg 37.35% lower, max 166.34% lower) (Fig 1).
CONCLUSION: These results show that variable gearing in jumping allows for increased muscle stretch during landing and higher triceps surae force production during propulsion. Variable gearing allows humans to propel themselves more efficiently with precise musculature response.

Mentor(s): Robin Queen (Biomedical Engineering and Mechanics)
Daniel Schmitt (Evolutionary Anthropology, Duke University)

Chloe Green
Virginia Tech/Civil Engineering
Celia McDermott
Virginia Tech/Civil Engineering

Fiber Reinforced Polymer Diaphragm Retrofits For Earthquake Resilience

Diaphragms are a key element of the horizontal lateral force resisting system (hLFRS) of a structure. Their design allows for the transfer of lateral forces generated by wind and seismic events to the vertical lateral force resisting system (vLFRS).

As knowledge of diaphragm behavior has grown, significant structural deficiencies in old reinforced concrete structures have been identified, specifically in high-seismic areas. For the past few decades, externally bonded fiber reinforced polymer (FRP) retrofits have been a common practice to extend the life of these structures by strengthening the floor against in-plane loads, such as those created by lateral forces. The extended life of structures will allow for the continued occupancy and potential repurposing of older structures, avoiding the large carbon footprint associated with demolition and new building construction.

However, there is a lack of experimental data to support existing externally bonded FRP retrofit schemes. This experimental program aimed to quantify the effect of varying FRP configurations on strength, stiffness, and ductility. 10 half-scale reinforced concrete diaphragm specimens were tested under reversed cyclic loading, with one non-retrofitted specimen serving as the control, and 9 retrofitted specimens with varying FRP types, configurations, and steel reinforcement layouts.

Experimental data showed that externally bonded FRP retrofits increased in-plane shear strength and initial stiffness of the strengthened diaphragms. Additionally, FRP plies oriented perpendicular to applied shear were found to increase ductility. In all but one specimen, failure was governed by the debonding of FRP near diagonal shear cracks in the diaphragm field.

Mentor(s): Eric Jacques (Civil & Environmental Engineering, VT)
Matthew Eatherton (SEM, VT)

Mariano Guerrero Perez
Virginia Tech/Physics

Independent Research

First Principles Simulation of Color-Center Defects in Lithium Fluoride for Sensing Low-Energy Nuclear Recoils

Despite mounting evidence from gravitational anomalies in astronomical measurements of stars, galaxies, and the cosmic microwave background suggesting dark matter accounts for 85% of matter in the universe, dark matter particles have yet to be observed directly. The current data is in favor of low-velocity “cold” dark matter which weakly interacts with conventional matter, resulting in nuclear recoils that produce scintillation light or phonons detectable using large quantities of cryogenic crystals or liquefied noble gasses. As an alternative sensing method, it has been suggested that next-generation dark matter experiments might instead look for photons emitted from color-center defects generated by nuclear recoils. Materials used for this kind of approach would need to be cost effective, optically transparent, and readily generate bright color center defects from nuclear recoils. Here we use first principles methods to model one such candidate material, lithium fluoride, and predict the properties of simple color center defects. We consider lithium and fluorine interstitials and vacancies, computing formation energies, charge states. emission frequencies, brightness, and radiative lifetimes, and discuss the potential of using lithium fluoride crystals for directional detection of dark matter and other particles.

Mentor(s): Vsevolod Ivanov (Virginia Tech Physics Department, Hume Center for National Security and Technology)

Semhar Habte-Mariam
Virginia Tech/Biochemistry

Novel Combinational Therapies for Melanoma

Melanoma is the deadliest form of skin cancer. Immunotherapies harness the body's immune system to fight melanoma and show promising clinical benefits for melanoma; yet resistance to immunotherapies still develops. We have recently revealed that PIK3CB, encoding PI3Kβ, outcompetes the other homologous PI3K kinases (PI3K$\alpha/\delta/\gamma$) in promoting the survival of melanoma cells. Given the vital role of PI3K signaling in establishing immunosuppressive tumor microenvironment, dysregulation of PI3Kβ signaling could cause resistance to immunotherapies, making selectively targeting PI3Kβ a viable therapeutic approach for overcoming immunotherapy resistance in melanoma. Our goal is to develop effective therapies for melanoma. To achieve this, we will first establish a cell system to determine the efficacy of immunotherapies. Our first aim is to test if melanoma cell lines respond to PI3Kβ inhibitors so that we will be able to test them for the combination of immunotherapies and PI3Kβ inhibitors. Our second aim is to label mouse melanoma cells to differentiate them from immune cells when testing drug combinations. Murine YUMM1.7 (PI3Kβ-responding) and YUMM5.2 (non-PI3Kβ-responding) cells were treated with PI3K inhibitors and subject to the MTS viability assay. YUMM1.7 cells were transfected with plasmids encoding dsRed or GFP and imaged using a fluorescence microscope. We found that: (1) PI3K-β inhibitors preferentially inhibited the viability of YUMM1.7 cells; (2) PI3K-β inhibitors had the strongest cytotoxicity; and (3) YUMM1.7 cells were labeled with dsRed and GFP. Hence, we will use YUMM1.7 cells to test combinational immunotherapies in the future.

Mentor(s): Zhi Sheng (Fralin Biomedical Research Institute at VTC)
Maegan Gabby (Fralin Biomedical Research Institute at VTC)
Sara Schroder (Fralin Biomedical Research Institute at VTC)

Megan Hahn
University of Arizona/Chemistry

Use of Zirconium Metal Organic Frameworks for Photon-Upconversion in Solar Cells

The focus of this research is on using metal-organic frameworks (MOFs) to improve solar cell efficiency by upconverting low-energy photons. Modern silicon-based photovoltaic cells typically convert only 25% of the energy received into electricity and operate best using high-energy photons in the blue-violet range, with absorbance completely cutting off after 1000nm. Photon upconversion through triplet-triplet annihilation allows for the combination of two low-energy photons into a singular high-energy one which can be used by the solar cell. Photon upconversion is based on donor and acceptor molecules; the donor uptakes two photons through electron excitation, and the acceptor, returns to the ground state doubling the energy of the other, increasing the energy of the emitted photon. Previous studies have shown that this process works in solution, but orientation and distance between the two were diffusion-limited. Research within the Morris group uses MOFs as both the donor and acceptor molecules. MOFs are porous structures with an inorganic component joined together by coordinating organic molecules. This creates a 3D structure that can be likened to scaffolding or a skeleton. The porous nature of the MOF allows many of these interactions to happen simultaneously. Coordinating the acceptor to the donor molecule in a MOFs creates a singular structure capable of absorbing, upconverting, and emitting photons without the limiting factors of distance and orientation.

Mentor(s): Amanda Morris (Chemistry)

Vania Halvonik
Franklin and Marshall College/Neuroscience

Pioneering a c-FOS Staining Approach to Map Motor Circuits

Nursing behavior depends upon the activation of multiple cranial motor nuclei in concert. Transsynaptic viral tracers have already been used to map brainstem motor circuits for adult chewing/swallowing behaviors but parallel connections and patterns of motor nuclei activation during infant nursing remain unknown. In this project, we piloted c-FOS immunofluorescence staining to identify motor neuron activation in the facial nucleus in neonatal mice to determine if the method can be used to map brainstem motor circuits during nursing. We expected more c-FOS positive motor neurons in the facial nucleus in mice who nursed compared to those who did not because c-FOS is expressed when neurons are active, and the facial nucleus contains motor neurons that innervate many of the muscles required for nursing. Neonatal mice brainstems were sectioned from neonatal mice in the following nursing conditions: continuous nursing, return to nursing after 2 hours of deprivation, and deprivation with no return. Mice were bred with a genetically encoded choline acetyltransferase (ChAT) eGFP reporter. Sections were stained for identification of the facial nucleus based upon GFP expression and active neurons based upon c-FOS labeling. We found larger numbers of c-FOS expressing neurons in mice who continuously nursed compared to mice in the two deprivation conditions. Our results indicate that c-FOS staining could accurately identify recently active motor neurons in the brainstem during nursing, potentially allowing mapping of multiple cranial motor nuclei that in concert control nursing.

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

William Hanger
Virginia Tech/Biological Sciences

David Lyerly Foundation Undergraduate Microbiology Research Fellowship

Isolation of Pantoea spp. Jumbo Phages from Soil Samples

Bacteriophages, viruses that infect bacteria, are ubiquitous in the environment. Jumbo phages, with large genomes > 200 kilobase pairs, often have a broad host range compared to smaller phages that may be host-specific. Currently, ~27,000 phages have had their genomes sequenced, and only 614 are jumbo phages (~2.3 %). This low representation may be partly because 0.2 µm filters are frequently used to sterilize phage samples, and during this process, jumbo phages are removed. In this study, we sought to develop a protocol for phage isolation that was more permissive to jumbo phage recovery. Agricultural soil samples were incubated in a rich medium with nine different strains of Pantoea spp. to enrich phages. After centrifugation, the supernatant was sterilized using chloroform rather than filtration. Spot tests looking for zones of clearing were performed with the sterilized soil sample against each strain, showing whether any phage was present in the soil sample. All four soil samples tested showed at least one positive spot test; an apple tree soil sample showed a positive spot test for five of the nine strains, indicating it may contain a jumbo phage with a broad host range. Plaque assays were subsequently performed to quantify the phage, and webbed plates were used to make high-titer stocks. These stocks are a source for phage genomic DNA purification, used for genomic sequencing, and for the preparation of transmission electron microscopy samples. The isolated phages have potential therapeutic applications for preventing or treating plant diseases caused by Pantoea spp.

Mentor(s): Ann Stevens (Biological Sciences, Virginia Tech)
Frank Alyward (Biological Sciences, Virginia Tech)

Jaden Harris
Virginia Commonwealth University/Biology

Age Impacts Synchronous Network Activity in Mouse Model of Childhood Genetic Epilepsy

Synchronous network activity (SNA) is a phenomenon prevalent in the early development of mice where large groups of neurons in a local region fire action potentials or are quiescent at the same time. SNA is present in many brain regions, both in vivo and in vitro, and is known to play an important role in promoting proper neural connectivity and normal brain function later in life. In humans, SNA is present until around birth. Humans with developmental epileptic encephalopathies (DEE) often develop epilepsy around birth. Thus, we hypothesized that a mouse model of DEE would show altered SNA. To test this, we performed calcium imaging in brain slices from mice expressing the calcium indicator, GCaMP, at P6-8 and P8-11 time points. Regions of interest where joint events occurred were identified and compared. We found that younger slices had more events in regions of interest than older slices, indicating a decrease in SNAs as mice grow older. The difference between the DEE model and the control was unclear, with both showing decreased events in older slices. Future studies will further examine the impact of DEE on SNA and development.

Mentor(s): Matthew Weston (Fralin Biomedical Research Institute, Center for Neurobiology Research)

Antonio Harvey
Longwood University/Chemistry

Post-Modification of Polymer Networks for Metal Binding

Metallopolymers, a class of materials created from incorporating metal ions into polymer networks, have been shown to have desirable characteristics for applications like luminescent materials and drug delivery. Synthesizing metallopolymers is one approach for creating new materials that have the potential to replace or improve common materials used in industry. However, metal ions must bind strongly to polymer ligands to make these new materials. A proper site for metal ion binding is required, which implies that the polymer side chains must be modified. A synthetic strategy is needed to install these binding site ligands on the polymer side chains. Upon successfully synthesizing these materials, the goal would be to determine their physical characteristics and investigate their applicative uses.

Mentor(s): Guoliang Liu (Chemistry)

Baker Hasan
Virginia Tech/Computer Science

Exploring Data to Support Evidence-Based Tech Hiring for GitMeter

The traditional hiring process for software engineers involves submitting resumes, going through technical interviews, and then making hiring decisions. However, this method often doesn't show an individual's true skills and potential. Technical interviews, in particular, can be biased and stressful, which may affect the results. To solve these problems, we created GitMeter, a software tool that evaluates a candidate's technical skills based on their GitHub profile. GitMeter looks at things like the number of projects, repositories, and code comments to give a grade to the resume, providing a better picture of the candidate's abilities and achievements. We developed GitMeter by first conducting a survey with hiring firms to find out what features they needed. The feedback helped us improve GitMeter to be useful for both hiring managers and candidates. Some key features include automatic analysis of code quality and project diversity, giving a full view of technical skills. Initial survey results show that hiring firms prefer objective and measurable ways to assess skills. GitMeter addresses this need by reducing biases and making evaluations fairer, offering a strong alternative to traditional methods. In short, GitMeter improves the hiring process for software engineers by offering a more accurate and complete evaluation of candidates' skills. This leads to fairer and better hiring decisions.

Mentor(s): Chris Brown (Computer Science, Virginia Tech)

Thomas Hausler
Virginia Tech/Biological Science

Role of Dipeptide Permease Transporters in Metabolism of Peptides by Sinorhizobium meliloti

Sinorhizobium meliloti (S. meliloti) is a soil-dwelling bacterium that forms a symbiotic relationship with alfalfa plants. In this mutually beneficial relationship, alfalfa plants provide nutritious substances such as amino acids and sugars for S. meliloti and in return, the bacterium fixes nitrogen for the plant. S. meliloti possesses chemoreceptors that enable them to perceive signals such as nutrients and toxic compounds in the environment. In addition, bacteria can use extracellular peptides as a source of nutrient and metabolic activity and their utilization may differ from one bacterium to another. In S. meliloti, dipeptide transporters, DppA1 and DppA2, necessary for the uptake of dipeptides from the environment, have been characterized. Previous data from the Scharf lab has shown that S. meliloti (WT) is able to utilize 55% of 268 dipeptides screened. This study sought to determine the contribution of DppA1 and DppA2 transporters in facilitating dipeptide metabolism in S. meliloti. We therefore assayed ΔdppA1 and ΔdppA2 double-deletion-mutant strains of S. meliloti for peptide metabolism using the Biolog growth assay. A high-throughput screening using Biolog plates confirmed that this mutant strain can use peptides as a sole nitrogen source but at a decreased utilization rate of 29%, compared to the WT strain of S. meliloti.

Mentor(s): Foster Agyei (Department of Biological Sciences Virginia Tech)

Deija Hawkins
Virginia Tech/Medicinal Chemistry

Modification of Spns2 Inhibitors to Treat Multiple Sclerosis

Sphingosine-1-Phosphate (S1P) is a ubiquitous cellular signaling molecule that interacts with G-protein-coupled receptors (S1P1-5) to regulate numerous cellular processes. S1P export is regulated by extracellular transporters spinster homolog 2 (Spns2) and Mfsd2b, which are embedded in the cell membrane. Currently, five FDA-approved drugs (Fingolimod, Siponimod, Ozanimod, Etrasimod, and Ponesimod) are on the market to treat multiple sclerosis, ulcerative colitis, and obesity by targeting the G-coupled receptors in the S1P pathway. Due to the on-target side-effects of targeting S1P1, these drugs have a wide range of adverse effects including bradycardia, hypertension, and reduced pulmonary function. We intend to avoid these adverse effects by targeting a transporter upstream in the S1P pathway, Spns2. Previous research studies determined that Spns2-deficient mice displayed no significant blood S1P level reductions which implies that targeting Spns2 should mitigate the cardiovascular effects. Targeting Spns2 disrupts the blood to tissue S1P gradient necessary for lymphocyte trafficking. Previously, we have reported first-generation Spns2 inhibitors with an oxadiazole core (SLF1081851), a benzoxazole core (SLB1122168), and a phenyl urea core (SLF80821178). In this present study, we have designed and synthesized three compounds with benzimidazole cores and will be evaluating them in preliminary “In vitro” assays using HeLa cells to determine their ability to inhibit Spns2.

Mentor(s): Shikha Kumari (Chemistry)

Grace Hawkinson
Virginia Tech/Computational and Systems Neuroscience

Investigating Mosquito Flight Behavior Using Virtual Reality Tools to Enhance Control Strategies

Mosquitoes are the deadliest animals in the world, killing over a million people each year due to mosquito-borne pathogens. Despite efforts to eradicate them, the development of new control methods to limit mosquito populations is hindered by our lack of understanding of their biology, such as how mosquitoes fly. Mosquito flight is a complicated behavior that requires the coordination of multiple muscles to move the wings while also navigating. Flight is essential to mosquito dispersal, reproduction, and host feeding. Thus, new knowledge about mosquito flight behavior could be used to disrupt their ability to transmit diseases.
To this end, we have developed a virtual reality tool that uses an LED-based display to replay visual stimuli to tethered, flying mosquitoes. Simultaneously, we used machine-vision based approaches (Kinefly) to track the movements of the mosquitoes' wings. As a result, we can expose mosquitoes to a variety of visual stimuli and measure the responses of their flight system.
We used this virtual reality tool in the context of two different experiments. The goal of the first experiment was to determine whether lab-reared mutant mosquitoes can fly with similar levels of fitness as wildtype mosquitoes. We compared the flight and object-tracking ability of mutant mosquitoes to that of control wild-type mosquitoes. The goal of the second experiment was to test whether mosquitoes avoid looming visual threats while in flight. We measured mosquitoes' flight orientation and the movements of their wings when presented with looming stimuli.
Altogether, our initial experiments demonstrate that such virtual reality flight arenas are useful systems for measuring mosquito performance and fitness. This comprehensive analysis will help advance our understanding of mosquito flight and contribute to developing more effective population control strategies.

Mentor(s): Sweta Agrawal (School of Neuroscience Virginia Tech)
Clement Vinauger (Biochemistry, Virginia Tech)

Joshua Hayes
Virginia Tech/Mechanical Engineering

CEED

Development of Mechanical Engineering Related Labs for Applied Electrical Theory

Applied Electrical Theory (ECE 2054) for Mechanical Engineering students requires the completion of labs to supplement the course material. The current labs have little relation to the Mechanical Engineering major and do not prepare students adequately for future classes. New labs can be developed to better prepare students for future classes by using knowledge of higher-level Mechanical Engineering courses while keeping the core content of ECE 2054 meaningful. The first lab uses a humidity sensor that acts as a variable resistor. Students will create a circuit that will generate an output based on the changes in the humidity sensor. The second lab addresses the concepts of stress and strain. Students will use theoretical calculations to find the stress under different loads. To measure strain, students will use a strain gauge attached to an unknown material. The strain gauge will be attached to a circuit that will change in output due to the strain gauge. The stress and strain data are then used to identify the material based on its properties. The third lab is still being designed and tested. It engages students with university resources by requiring them to use a 3D printer to build a DC motor from scratch. The students will print the casing and wind the motor. These three labs will enable students to learn the key principles of devices they will use throughout their future classes and careers.

Mentor(s): Peter Han (Electrical and Computer Engineering)

Cassidy Henderson
Hollins University/Biochemistry

Comparison of Babel Brain and k-WAVE for brain modeling

Ultrasound is a sound wave with a frequency that exceeds the range of human hearing. Focusing ultrasound through the skull to the brain can temporarily alter brain activity. Computational modeling is used to estimate the location of the focal zone and intensity at the focal point during ultrasound delivery. Babel brain and k-WAVE are two computational modeling software used to calculate the properties of ultrasound by creating models of subjects' heads during a simulated ultrasound delivery. How comparable these computational modeling applications are remains unclear. To address this gap, we compared Babel Brain and k-WAVE to determine differences in modeling outcomes. Then, we hypothesized that Babel Brain would be comparable to k-WAVE and be a reliable modeling software to give accurate and realistic data and models. This was accomplished by co-registering MRI and CT scans, computing acoustic fields within brain tissue accounting for skull and tissue-induced distortions, and evaluating thermal impacts based on relevant ultrasound parameters. After an exploration investigation in the beam profiles, as well as Isppa values, and maximum temperatures of the skull, brain, and skin between Babel Brain and k-WAVE, it was found that Babel Brain has modest to moderate agreement with k-WAVE. As we continue to analyze these results, a method that numerically scores the comparability between Babel Brain and k-WAVE will be formulated, as well as a specific breakdown of the "modest to moderate agreement" between Babel Brain and k-WAVE.

Mentor(s): Wynn Legon (Non-invasive Ultrasound Lab)

Aldo Hernandez-Mendez
Virginia Tech/Ocean Engineering

Mapping and Sensor Fusions

This project aims to develop and evaluate urgent landing software and a Kalman filter for a small Unmanned Aerial System (sUAS). The primary research questions focus on the accuracy of the urgent landing software in mapping environments and identifying optimal landing spots, and the effectiveness of the Kalman filter in improving UAV state estimation using IMU and pose data. This study contributes to the broader field of UAV autonomy and safety, enhancing capabilities in safely landing during an emergency in crowded city areas. The urgent landing software operated on a Single Board Computer (SBC), mapped the environment, and identified landing spots, while a motion capture room provided ground truth data. The Kalman filter, developed in MATLAB, post-processed IMU data using a linearized state-space model of the UAVs dynamics around its hover position. Although testing was not completed, anticipated outcomes include significant improvements in state estimation accuracy, as measured by Root Mean Square Error (RMSE) and Mean Absolute Error (MAE) relative to the ground truth data. Additional anticipated outcomes would include testing the urgent landing softwares ability to map the environment using Intersection of Union (IOU).

Mentor(s): Ella Atkins (Aerospace and Ocean Engineering)

Trinity Hopson
Patrick Henry High School

CHBR

Evaluating Human Milk Composition Fluctuations Over the First 6-Months of an Infants Life.

Human breast milk is a complex biofluid that changes based on infant needs which makes it the optimum source of infant nutrition. Human milk composition contains 3-5% fat, 0.8-0.9% protein, 6.9-7.2% carbohydrates, and 0.2% mineral constituents. Human milk composition fluctuates based on maternal diet. Currently, there are not many human milk alternatives that fulfill infant needs. Mothers typically breastfeed for the first 6-months of the baby's life and the World Health Organization (WHO) recommends that mothers breastfeed up to 24-months of the infant's life. We hypothesize average fat composition and average total energy in human milk will increase from 4-weeks to 6-months post-birth. The methods used to conduct this experiment included obtaining human milk samples at 4-weeks, 8-weeks, 3-months and 6-months from the 10 participants of the INEIND (Impact of Nutrition and Experience on Infant Neurodevelopment) study. The milk samples were then processed using a Miris Human Milk Analyzer including a Miris heat bath and sonicator to thaw and homogenize the samples. The samples were previously separated by maturity of the milk and analyzed based on the macronutrients the milk contained. Based on our findings, we conclude that fat composition and total energy varied heavily from 4-weeks to 6-months. The results do not support our hypothesis and inform how human milk alternatives may attempt to replicate the fat and energy levels fluctuations in human milk. Over time, we hope to gain knowledge on how to aid in improving human milk alternatives by understanding the changes in milk at different timepoints.

Mentor(s): Brittany Howell (Fralin Biomedical Research Institute)

Jordan Horrall
Virginia Tech/Computer Science

Monitoring Biological Aerosol Particles (BAPs) in Spruce Forest in Mauerbach, Austria

Biological aerosol particles (BAPs) are small airborne particles released by biological systems. The movement of BAPs throughout the atmosphere impacts plant health and reproduction, such as the spread of pathogens and pollen. BAPs also have important implications for climate change, as seen with the spread of ice nucleating particles, which can influence precipitation. Little research has been conducted to compare the transport of biological particles in spruce forests. We hypothesized that concentrations of BAPs vary within and above spruce forests. To test this hypothesis, we used multiple sensor packages (including an Optical Particle Counter, a meteorological sensor, and an impinger) at a unique spruce forest field site in Mauerbach, Austria (GPS 48.2573889, 16.1991667). Ground-based sensor packages were deployed both in an open field and inside the forest, running for 40-minute intervals. A drone with a similar sensor package was flown above the tree canopy or over the open field, and this sensor package was run for 10-minute intervals, overlapping with the sensors on the ground. In general, the smallest particle sizes observed (0.3µm - 0.5µm) decreased throughout the day, likely the result of atmospheric mixing. We are currently exploring trends in particle concentrations related to temperature, wind speed/direction, humidity, time of day, and weather conditions. We are also working to characterize the type and size of BAPs captured in the impingers. Our work has important implications for monitoring the health of spruce forests around world.

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

Syeda Hossain
Virginia Tech/Computer Science

CEED

Understanding User and Developer Perceptions of Dark Patterns in Software

Dark patterns are user interface designs that manipulate users into actions benefiting designers, often at the user's expense. These designs exploit cognitive biases and are prevalent in digital interfaces. While many studies have examined dark patterns from an end-user perspective, little research has explored software developers' views. This study aims to understand perceptions of dark patterns from both end-users and software engineers, providing insights to help stakeholders reduce their use and foster more equitable user experiences. The goal of the project is to investigate deceptive designs to find solutions that protect users and foster more equitable user experiences with technologies impacting everyday life.

RQ1: How do dark patterns influence users' perception of software?
RQ2: How do software developers implement and perceive dark patterns in software?
RQ3: How do software developers perceive dark patterns in development contexts?
RQ4: How can Large Language Models be used to detect dark patterns in code?

This mixed-methods research includes surveys for end-users and software developers, and GitHub data mining to analyze developer comments on dark patterns. Qualitative and quantitative data will be analyzed to provide insights into perceptions of dark patterns. AI tools, such as ChatGPT, will assist in detecting dark pattern-related coding.

Our project investigates the societal impact and implementation of dark patterns in software. Findings will inspire technical solutions, like automated detection tools, and non-technical solutions, such as design guidelines, to prevent dark patterns. This research aims to protect users, foster equitable user experiences, and provide actionable insights for stakeholders in the digital interface design community.

Mentor(s): Chris Brown

Albert Hu
Virginia Tech/Computer Science

CEED

Utilization of Persona Creation through LLMs to Enhance Human Storytelling

Storytelling often poses challenges for creatives, especially in conceptualizing characters and their interactions within a narrative. To address this, a web application was developed that leverages GPT-3.5 Turbo to assist storytellers. Users can create personas, representing their story's characters, by inputting details such as name, age, personality traits, and significant life events. The LLM further enhances these personas by suggesting additional life events that align with the character's background. Through prompt engineering, the LLM assumes the roles of these characters, using its logical and spatial-temporal reasoning, along with narrative context, to predict their actions in response to story events described by the user. This persona management system aims to provide valuable insights into characters and elevate the narrative creation process for anyone.

Mentor(s): Pinar Yanardag (Department of Computer Science)

Basem Huneidi
Virginia Tech/Neuroscience

Patient Pain and Quality of Life Outcomes after Histotripsy Treatment for Canine Osteosarcoma

Introduction: Osteosarcoma (OS) is a type of bone cancer that usually occurs in the long bones of canines and humans alike. OS is an aggressive cancer – the primary tumor causes severe pain and dysfunction while potentially metastasizing, typically to the lungs. Surgical removal of the primary tumor is associated with morbidity and decreased functionality. OS survival has not improved in dogs and people for decades. Histotripsy is a non-invasive, non-thermal ablation technique that uses focused ultrasound to destroy a tumor. Histotripsy spares the patient the need for surgical tumor resection while potentially fostering immune system recognition of osteosarcoma since the lack of heat generation throughout the histotripsy procedure prevents the denaturation of OS proteins.
Methods: Canines with appendicular OS were recruited for a clinical trial evaluating the effects of histotripsy OS ablation on pain relief. The OS tumors were ablated with histotripsy, and gait analyses were performed before and after histotripsy.
Results: Gait analysis on one patient revealed the patient's gait gradually improved until it returned to pre-treatment levels twenty one weeks after histotripsy treatment. Certain aspects of the patient's gait surpassed pre-treatment levels, while others fell slightly below, with an overall positive trend of improved gait. As a result of the physiological similarities, the implications of treatment in canines is translatable to humans.
Conclusion: The positive long-term improvement in gait highlights the viability of histotripsy as an alternative method of treatment for OS in patients. Future work includes combining histotripsy with immunotherapy strategies to further enhance the immune response.

Mentor(s): Joanne Tuohy (Veterinarian Medicine)

Aariq Huq
Virginia Tech/Biological Sciences

Investigating effects of media and surface hydrophilicity on type IV pilus-dependent biofilm formation

Type IV pili (T4P) are bacterial appendages involved in motility, attachment, and biofilm development. Biofilms are surface-attached complexes composed of bacterial cells surrounded by a self-produced matrix of exopolysaccharides. These complexes are critical for bacterial colonization and persistence on biotic and abiotic surfaces. We previously determined that biofilm formation of Acinetobacter nosocomialis M2 is a T4P-dependent process in MacConkey (MC) media on hydrophilic, TC-treated plates. Additionally, we showed bile salts (BSs) in MC media promote T4P-mediated motility by increasing surface hydrophilicity. As MC media contains inhibitory levels of bile salts (BSs), which impacts both surface hydrophilicity and bacterial growth, we aimed to uncover the specific mechanism(s) in which BSs may be promoting T4P-dependent biofilm. Here, we performed biofilm assays with 30%, 35%, and 40% Luria-Bertani (LB) and MC media on both non-treated and TC-treated plates. We found that M2 WT and ΔpilA formed more biofilm in 30% LB than in MC media on both non-treated and TC-treated plates. Additionally, there was no significant difference in biofilm formation for M2 WT and ΔpilA on non-treated vs TC-treated plates. Lastly, there was no significant difference in biofilm formation between M2 WT and ΔpilA under all treatments. These results indicate that BSs are unlikely inhibiting biofilm formation through bacterial growth inhibition. However, In contrast to previous results, we were unable to confirm that T4P are critical for M2 biofilm formation. Further optimization of the biofilm assay is needed before examining the physicochemical effects of BSs and hydrophilicity on cellular attachment and biofilm formation.

Mentor(s): Zhaomin Yang (Biological Sciences)

Marcus Huynh
Virginia Tech/Computer Science

CEED

Persona-Based AI Web Automation: Tailored Automation of Online Tasks

Web automation traditionally relies on scripted simulations of user actions, often failing to accurately reflect real user behavior or handle complex, context-dependent tasks. Our research introduces a novel approach to address these limitations: persona-based AI web automation. This method integrates artificial intelligence with user personas, automating tasks in a way that closely resembles the user's own behavior and intent. To achieve this, our implementation strategy combines conventional web scraping techniques with advanced large language models to generate incremental steps and actions. By employing an AI agent that adopts the user's persona, our approach streamlines the web automation process with step-based actions and real-time user feedback, offering a more efficient and user-friendly solution. With this method, we hope to enhance the adaptability of automated web interactions, potentially transforming how we approach web-based tasks.

Mentor(s): Yan Chen (Computer Science)

Njeri Jackson
Virginia Tech/Human Development
Jessica Douthit
Berea College/Computer and Information Science
Ben Rosner
Virginia Tech/Economics and Geography

Estimating the Effect of a Utility-Scale Solar Facility on House Prices: A Case Study in Prince George County

Despite a global economic shift towards renewable energy, many local communities across the United States remain resistant to solar facilities in their neighborhood. Common concerns include potential negative environmental impacts, visual degradation of the landscape, and a possible reduction in the value of nearby residential properties. The citizens of Prince George County, Virginia, are no exception. Using the House Price Hedonic Model and applying a Difference-in-Differences Estimator, we investigate whether there is a causal relationship between the proximity of a utility-scale solar facility and the value of residential properties in Prince George County. Our results show that the presence of a utility-scale solar facility has no statistically significant impact on property values.

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

Bless Jah
Virginia Tech/Computer Engineering

CEED

How Do Visually Impaired Users Navigate Privacy Risks in an Ad-Driven Web?

Websites play a crucial role in daily life, with millions available and billions of users depending on them. These sites offer free services by generating revenue through targeted advertisements. However, users with visual impairments and cognitive disabilities often experience these ads and web content differently. They may be deceived into interacting with ads, causing privacy violations through third-party information leakage. Visually impaired users rely on on-hover activities for screen readers to process information. We analyzed network traffic from 50 popular news websites based on on-load, on-hover, and on-click interactions. Alarmingly, 46 websites have third-party tracking triggered by on-hover interactions with ads, with 81% transmitting unique user identifiers to third-party URLs. This practice compromises the privacy of disabled users, subjecting them to involuntary tracking to access the content. This significant privacy invasion highlights a critical gap in equitable web accessibility and security. Addressing this issue is crucial to ensure all users can access web content without sacrificing privacy.

Mentor(s): Muhammad A. Gulzar (Department of Computer Science, Virginia Tech)
Hadi Amjad (Department of Computer Science, Virginia Tech)

Noor Janjua
Virginia Tech/CMDA

Where There's Smoke, There's AI: Advanced techniques in Smoke Plume Analysis

Smoke: elusive, translucent, and notoriously difficult to quantify. In image processing, segmenting smoke is a unique challenge that pushes the limits of current computer vision techniques. This research investigates deep learning methods to segment and estimate smoke plume concentrations from videos and images of field experiments. This has applications in agriculture, wildfire management, and pollutant localization. The study explores a combination of unsupervised machine learning and image processing tools, such as K-means clustering and HSV/LAB color space processing, alongside a more adaptive approach using a fine-tuned Detectron2 model with pre-trained smoke masks. Results demonstrated that the Detectron2 model successfully segmented most smoke plumes and performance could be enhanced with more datasets. The Detectron2 model utilizes the COCO-Instance Segmentation configuration, and was trained and validated on smoke images from a previous field experiment. The segmentation process involved reading images, predicting smoke masks, and applying a custom function to highlight smoke concentration. However, estimating smoke plume concentration remains challenging due to the semi-transparency of smoke and the influence of image backgrounds on pixel color—our primary indicator of smoke concentration as of right now. These findings suggest potential improvements in the model for better smoke plume segmentation, but further research is needed to develop reliable methods for estimating smoke particle concentrations. Overall, the implications of this project show that objects as non confirmative such as smoke can be properly segmented and even further analyzed, allowing for possible application in air quality monitoring, atmospheric studies and more.

Mentor(s): Shane Ross (Aerospace & Ocean Engineering, VT)
Nimmala, Bhargavi

Jaela Jernigan
Virginia Tech/Medicinal Chemistry

Bioassay-guided Isolation of Antibiofilm Compounds from Marine Egg Mass Microbiota

Biofilms are surface-adhered assemblages of bacteria embedded in a matrix of self-produced extracellular polymeric substances. Resistant pathogens form biofilms as a protective barrier against antibiotics and the host's immune system, making it difficult to treat persistent infections in immunocompromised patients. The goal of targeting biofilms is currently focused on developing therapeutics that inhibit the formation of biofilms or disrupt already-existing biofilms. This project aims to leverage natural products from the microbiota of marine egg masses, an underexplored ecosystem, for biofilm inhibition against Staphylococcus aureus. These microbial symbionts have been hypothesized to produce small molecules that chemically defend the eggs. Isolating the biologically relevant compounds could lead to the discovery of potent novel biofilm-inhibiting compounds. A chemical fraction library of >700 bacterial fractions from moon snail egg collars was previously screened and several crude fractions capable of inhibiting S. aureus biofilms were identified. Bioassay-guided isolation is being performed on crude fraction EM7-3C, produced by a Flavobacteria of the genus Arenibacter sp. to isolate the active metabolite responsible for the observed activity. Thus far, EM7-3C has been fractionated using High Performance Liquid Chromatography (HPLC) to yield 5 sub-fractions that will be tested for activity against S. aureus. The structure of the active metabolite will be determined using Nuclear Magnetic Resonance (NMR) and Mass Spectrometry (MS).

Mentor(s): Emily Mevers (Chemistry)

Taj Johnson
Cornell College/Physics

Independent Research

Time Delay due to Scattering of High Energy Supernova Neutrinos with Dark Matter

This paper compiles research on dark matter and neutrino scattering to produce bounds for a future experiment to test. Dark matter is a particle that has no known interactions. Assuming dark matter behaves like a fermion and interacts through the weak force, it is possible through interactions with neutrinos to find its mass and other useful information. To do so, highly energetic neutrinos are required. This paper focuses on highly energetic neutrino created through a supernova. This paper relates the dark matter mass, the mediator mass, and the dark matter and neutrino interaction to each other. Code was created to simulate the many unknowns in this interaction using supernova SN1987a as a baseline. Supernova neutrinos are energetic enough to potentially interact with dark matter and still have energy left to be detected. This makes supernova neutrinos very important for detecting the relatively slow and weakly interacting dark matter. Based on the analysis, the results of a future neutrino detection experiment on a supernova should be able to determine the properties of dark matter.

Mentor(s): Ian Shoemaker (Neutrino Physics)

Gaurav Jones
Virginia Tech/Experimental Neuroscience
Austin Swallow
Virginia Tech

The flavor enhancer Maltol potentiates RXR/Thyroid Hormone-mediated Mechanisms of Neural Development in Xenopus laevis larvae.

Thyroid hormone (TH) plays a crucial role in brain development, and disruptors of TH are known to result in brain malformation and cognitive impairment. Maltol is used ubiquitously by the food industry as a caramel-like flavor enhancer, and some data suggests that it binds to retinoid X receptors (RXRs), which form a complex with TH receptors (TRs) to regulate expression of TH-sensitive genes, particularly in the developing brain. Given maltol's widespread usage, understanding these mechanisms is essential. We determined if maltol interferes with TH-mediated changes in brain development using Xenopus laevis larvae by exposing them to a range of maltol concentrations under control, T4 (Thyroxine) 1.5µg/L, UVI (RXR antagonist) 600nM, and T4+UVI conditions. Using phosphohistone H3 (pH3) immunostaining, we counted proliferating neural progenitor cells (NPCs) in the optic tectum, yielding inconclusive results due to uncontrolled variables, but suggesting that maltol acts similarly to T4 under control conditions by increasing proliferation. We found that maltol agonizes TH-induced changes in tectal width:length (W:L) ratio in a dose-dependent manner, which UVI blocked. Lastly, using quantitative polymerase chain reaction (qPCR) analysis, we found that maltol likewise potentiated TH-mediated changes in expression of some TH-sensitive genes, which UVI blocked. Our data is consistent with the hypothesis that maltol has the capacity to influence TH mechanisms of brain development via RXR agonism. Future directions are to find and control for confounding variables while increasing statistical power by focusing on a smaller set of maltol concentrations.

Mentor(s): Christopher Thompson (Department of Neuroscience)

Mia Jones
University of Massachusetts Lowell/Business Administration
Nicholas Hamilton
Berea College/Computer Science
Emily Gard
Virginia Tech/Political Science

Projecting Food Insecurity in Southwest Virginia

Food insecurity is a socioeconomic condition in which a household does not have access to enough nutritious food to sustain a healthy lifestyle for all its members. In Virginia, food insecurity rates are highest in the southwest region of the state. This project aims to support food banks, including Feeding Southwest Virginia, by simulating food insecurity rates through 2027 in Southwest Virginia. Drawing from the literature on food insecurity, we selected relevant variables related to food insecurity from the American Community Survey and Bureau of Labor Statistics data. These variables were then forecasted at the county level using a time series forecasting model. The historical data was used to train a machine learning model which utilizes these factors to predict food insecurity rates. The forecasted data was then fed into the machine learning model to create projected food insecurity rates across Southwest Virginia. In addition to projecting food insecurity rates, we simulated future scenarios by altering the values for key factors individually. We displayed these findings on an online interactive map that allows the user to compare the food insecurity rates for each county or city by year and see the changes between years. The user can also see the locations of farmers markets, grocery and dollar stores, and food distribution centers in the area to consider their potential impact. This map will serve as a tool for Feeding Southwest Virginia in determining their resource allocation and to demonstrate the need for more aid in particular areas.

Mentor(s): Michael Cary (Department of Agricultural and Applied Economics)
Susan Chen (Department of Agricultural and Applied Economics, Virginia Tech)
Eric Kaufman (Department of Agricultural, Leadership, and Community Education, Virginia Tech)

Erik Judy
Virginia Tech/Aerospace Engineering

Independent Research

Dispersion of Aluminum Particles using Pressurized Air

Aluminum particles increase the energy released by an explosive, generating a significantly higher pressure and impulse. Aluminized explosives have been tested on a large-scale, but these tests are costly and time intensive. These drawbacks are overcome by reducing the testing scale. The objective of this research is to determine if small-scale testing results in pressure trends similarly to large-scale testing. A 96mL pressure vessel served as the containment for aluminum particle combustion. Following powder dispersal, a heated tungsten wire ignited the aluminum powder. The reduction of aluminum particle clumps to single particles was essential for accurately testing particle size effects. Current work on this project includes developing a method for uniformly distributing aluminum particles with mean diameters of 1µm-95µm in concentrations between 100-400g/m3. The dispersal method used pressurized air to disperse aluminum particles within the pressure vessel. The dispersal uniformity was evaluated using videos of powder dispersed within the pressure vessel. It was determined that a pressure of less than 7000Pa uniformly distributed the aluminum particles. It was essential that the air pressure did not cool the ignition wire below the temperature required for aluminum combustion. Aluminum particles were successfully combusted, confirming the dispersal method's viability for future combustion testing in the pressure vessel.

Mentor(s): Eric Jacques (Civil and Environmental Engineering, Virginia Tech)
Molly Kamide (Aerospace Engineering, Virginia Tech)

Brian Kane
Virginia Tech/Aerospace Engineer

Quantum key distribution protocol without using classical channel communication

Classical cryptography depends on exchanging a secret key (a long sequence of numbers). Currently, mostly asymmetric schemes, are used where a public key is used for encryption and a private key is used for decryption. Data security using classical cryptography depends on the fact that factoring large integer numbers into their prime factors is a difficult task for classical computers. Thus, classical cryptography secret keys can be decoded by powerful quantum computers. The purpose of this research is to find a new QKD (quantum key distribution), a protocol that does not interfere with a classic channel i.e. (text, call, email), this would help to achieve higher security by using the GHZ (Greenberger-Horne-Zeilinger State method) which is devised for the single 3-spin state on which a single measurement is sufficient to test the local hidden variables. We assume that the two sides who want to communicate are Alice and Bob. Eve, another one, intends to eavesdrop (take the information). If Alice wants to communicate with Bob, they do the following steps. First, Alice creates a GHZ state and for each last qubit that she has in that state she sends it to bob, next bob randomly chooses to do a unitary operation or not if he does is '1' and if he does not is '0', this new string we will call it k after this he sent it back to Alice where the other two qubits that she did not send she added the single one that bob send, after this, she does a CNOT (control not) in the first as the target and the second one as the control she measures each one of the CNOT and if k' (which is her string) = to k the key has already been established. As we just see in the following steps we manage to provide the QKD (quantum key distribution), without using any classical communication. In comparison with other protocols of this subject, it doesn't need an external channel to complete this function. So, this system may be useful when the classical channel is unavailable. Just one of the disadvantages of this protocol is the use of operations on this qubit such as the unitary operation and the CNO (control not), this adds an extra layer of difficulties to carry out.

Mentor(s): Jamie Sikora (Computer Science, Virginia Tech)
Wayne Scales (ECE, Virginia Tech)

Genelia Kang
Addiction Recovery Research Center at the Fralin Biomedical Research Institute/Biomedical Sciences

Exploring the Efficacy of Nicotine Replacement Therapy Interventions

Smoking is a leading cause of preventable death in the United States, impacting hundreds of thousands of lives each year. Quitting smoking presents significant challenges, but nicotine replacement therapy (NRT) aids in alleviating cravings and withdrawal symptoms through alternative nicotine sources. Studies indicate significant increases in cessation rates with NRT, ranging from 50% to 70%.

Our study aimed to assess the effect of narratives on the relative risks of combustible products and/or benefits of NRT on intention to quit and nicotine/tobacco purchasing decisions and explore the role of socioeconomic status (SES) as a moderator.

Participants were recruited via mTurk and randomly assigned to different interventions determined by a 2 x 2 factorial design: control (no intervention), relative risks of combustible products, relative benefits of NRT, and both risks of combustible products and benefits of NRT. Each group viewed a 60-second video intervention including a testimony from someone who had quit smoking. Following the videos, participants were directed to the Electronic Tobacco Marketplace (ETM) to make hypothetical purchases of NRT products, cigarettes, or other tobacco items and asked about their intention to quit.

We hypothesize that: 1) individuals educated on smoking risks and NRT benefits will be more likely to switch to NRT compared to control, and 2) individuals with lower SES may be less inclined to opt for NRT products. This study is expected to highlight the potential of health communication in the form of narratives to increase the substitutability of NRT products and ultimately promote smoking cessation.

Mentor(s): Roberta Freitas Lemos (Addiction Recovery Research Center at Fralin Biomedical Research Institute)

Sophia Kelly
Virginia Tech/Psychology

Examining the relationship between the goal setting behaviors of individuals with ADHD and their substance use habits

Current literature shows that individuals with ADHD are more susceptible to developing substance use disorders (SUD) than individuals without; often, usage begins at a younger age, manifests more severely, and treatment is less effective. Various reasons for this have been explored, including desires to fit in, self-medication, and genetic predisposition (Nehlin, C., Nyberg, F., & Öster, C. 2014). However, multiple other possible factors have been overlooked due to their presumed irrelevance; goal-setting being one. For many, setting goals is related to increased achievement and overall quality of life (King, I. 1994). However, the effect of goal-setting on individuals with ADHD has been ignored due to their challenges with executing long-term goals (Becker, S. P., & Barkley, R. A. 2020). This study was conducted to explore the relationship between individuals with ADHD's goal-setting habits and their likelihood of developing SUDs. 55 high-schoolers with ADHD answered questions about goals and steps being taken to achieve those goals. Responses were then qualitatively coded for specificity. Additionally, participants completed the Alcohol Use Disorders Identification Test (AUDIT) and Drug Use Disorders Identification Test (DUDIT) to gauge substance use habits. Statistical tests were used to compare AUDIT and DUDIT results to the scores their goals received. It is anticipated that there will be a negative correlation between the specificity of goals and SUD prevalence. This research is relevant for the community to better understand how different factors influence individuals with ADHD's susceptibility to SUDs and life successes, as well as to guide possible treatments.

Mentor(s): Sam Kempker Margherio (Psychology)

Anum Khan
Virginia Tech/Smart and Sustainable Cities

Seeing the Unseen: New Tools to Measure Hidden Volatile Organic Compounds (VOC) in the Air

Although invisible, air impacts us far more than we think. Air can be a cause of different climates as well as a conduit for viruses/bacteria (as the 2020 pandemic taught us). Hazardous Air Pollutant (HAP) found in unclean air can also be detrimental. There are approximately 200 regulated compounds in the air that consists of thousands of chemically identical molecules, so it is difficult to measure each unique target chemical separately without the help of laboratory equipment. Our research focused on the development of a sensor that would be capable of detecting these harmful elements in the atmosphere. Although such technology exists, it is inaccessible, expensive, and awkward to handle on the field. Therefore, the main purpose of this study was to use relatively cheaper equipment parts to construct a portable device. By combining a few more economical components such as gas chromatography column, photoionization detector, microcontroller, and pump, we were able to identify individual target HAPs in air sample in novel, quick and cheap way. Our current data includes clear GC signals at concentrations of 100-500 ppm for specific HAPs such as benzene. We are currently in the process of testing at lower concentrations and evaluating our ability to resolve identical and detrimental chemicals like benzene and toluene.

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

Asfandiyar Khan
Virginia Tech/Computer Science

CEED

Cross-Omics Integration in Foundation Models: Bridging Single-Cell and Bulk RNA-Seq, Proteomics, and Spatial Data

This research aims to develop an advanced foundation model for single-cell omics data analysis by integrating multi-omics datasets, including single-cell RNA-seq & single-cell proteomics, bulk RNA-seq & bulk proteomics, and spatial omics data. Existing single-cell RNA-seq models are extended to incorporate diverse data types, therefore enhancing model performance and interpretability through advanced pretraining and integration techniques. Using a unified tokenizer, we preprocess varied datasets for streamlined integration and pretrain the model with masked learning objectives on large-scale unlabelled data to obtain common patterns and unique interactions. The model leverages a Transformer-based architecture with multi-head self-attention and gene2vec embeddings, all inspired by scBERT, scGPT, Geneformer, and TOSICA features. Fine-tuning is performed on specific datasets for tasks such as cell type annotation, gene perturbation prediction, and gene network inference, with data enhancement techniques to boost robustness. Additionally, a co-training framework incorporating Graph Neural Networks and gene regulatory networks enriches the model's understanding of gene interactions. The expected outcome is a flexible, efficient model that far surpasses current methods in accuracy and reliability. The new model would allow for better and wider exploration of cell type variability, pathological development, and treatment targets, as well as facilitate more comprehensive and precise integration of multi-omics data. This work greatly advances single-cell and bulk omics integration of many types, ultimately aiding in biomedical research by offering a reliable tool for multi-omics data analysis in a greater range of use-cases.

Mentor(s): Dr. BevLee Waford (Engineering Education)

Hallie Knorr
Bowling Green State University/Physics

CNP REU

Gamma Ray Spectroscopy for Neutrino Experiments

When studying neutrinos and dark matter, researchers must minimize background events coming from unrelated processes. One source of background comes from naturally occurring long-lived radioisotopes in experiment materials. To address this, High Purity Germanium (HPGe) detectors are used to screen materials for neutrino experiments using gamma ray spectroscopy. HPGe detectors are excellent radiation detection devices, due to their high energy resolution and intrinsic purity. The data from these detectors provide detailed information about the energy and intensity of gamma rays, allowing us to quantify different radioactive sources present in samples. In this poster I will discuss the performance of two HPGe detectors I operated as part of my research experience at Virginia Tech. In particular, I will discuss the experimental setup, calibration of the detector energy response, and measurement of detection efficiency with point calibration sources.

Mentor(s): Thomas O'Donnell (Virginia Tech Center for Neutrino Physics)

David Kuhtenia
Case Western Reserve University/Physics

CNP REU

Finding Neutrons in MiniCHANDLER

MiniCHANDLER is an antineutrino detector that uses an 8x8x5 array of plastic scintillating cubes that capture gamma rays with lithium-doped ZnS sheets between each layer to capture neutrons. On two sides of the detector are forty photomultiplier tubes (PMTs) that detect photons generated by gamma waves entering the detector and neutrons captured in the lithiated sheets. Gamma waves and neutron captures create different waveforms on the PMT output so it is possible to distinguish between them. Previously, this classification was done by creating templates that represent the ideal waveform of each type and calculating chi-square values for each template with each measured waveform. Updated electronics for MiniCHANDLER now include a capacitor on the output of the PMT which changes the shape of the waveforms. The original shape can be recovered via a method that resembles a discrete derivative. With the integrating effect of the capacitor the signature of a neutron capture event changes such that it may be possible to detect them without the use of a chi-square value and instead by counting how many increases in signal amplitude happen in a short time. This Mostly Increasing method is efficient and pure.

Mentor(s): Jonathan Link (Physics)

Sarah Lathrop
Washington and Lee University/Mathematics
Jackie Gregasavitch
Virginia Tech/Systems Biology
Genevieve Jean-Pierre
Duke University/Computer Science

CUBE SURF

GLP-1s Beyond Weight Loss: Social Media Insights on Discussion, Taste, and Mental Health

Background: Glucagon-like peptide-1 receptor agonists (GLP-1s), initially approved for treating Type II diabetes (T2D), are increasingly utilized for weight loss. While the weight loss results are notable, changes in taste perception remain underreported. Additionally, recent studies have found a link between GLP-1 use and reduced alcohol consumption, with emerging evidence of other associations. Using social media discussions, this study aims to: (1) examine the frequency of GLP-1 mentions for weight loss over time; (2) compare descriptors of frequently mentioned foods in general food discussions versus GLP-1 discussions; and (3) compare mental health mentions related to GLP-1s with those related to metformin, a traditional T2D medication.

Methods: Relevant data on GLP-1s were extracted from Reddit using the web-scraping tool Apify. User interactions (posts and comments) were analyzed to characterize GLP-1 agonist discussions over time in relation to market entry and current events (Aim 1). Natural language processing compared descriptors and sentiments of foods in GLP-1 discussions versus general food discussions (Aim 2). Proportions and chi-square statistics were used to compare the frequencies of mental health terms in the context of GLP-1s versus metformin (Aim 3).

Results: Significant increases in user activity corresponded to major news events. Statistically significant differences were found in the adjectives used to describe common foods in GLP-1 discussions versus general food discussions. Additionally, mental health keywords differed significantly between the metformin and GLP-1 subreddits.

Conclusion: These results suggest that future studies using other online platforms and experimental methods could further elucidate taste profile changes among GLP-1 users.

Mentor(s): Alex Hanlon (Statistics)
Alex DiFeliceantonio (Human, Nutrition, Food, and Exercise)
Chris Grubb (Statistics)
Tanner Barbour (Statistics)

Ellyott Lawson
Virginia Tech/Animal and Poultry Sciences

Examining Home-Prepared Diets for Companion Dogs Using Data from the Dog Aging Project

With the rising distrust of big commercial dog food companies, many owners are starting to home-prepare their dog's food. Proper diets are more complex in preparation than most people realize, leading to dogs with this diet type to be at risk for nutritional imbalances. The data in this study was collected from the Dog Aging Project, a nationwide research study that collects data on companion dogs. Each diet was sorted under one or more applicable codes, based on the feed components listed in the diet (e.g. kibble, cooked meat, raw meat, vegetables). Additionally, all diets were categorized as being completely balanced, partially balanced, or unbalanced. This study found that over 85% of diets were not completely balanced. 25% of owners included raw meat in their dog's food. There was a correlation present between diets containing raw meat and unbalanced diets. Raw meat-based diets carry the risk of bacterial infection, so it is important that owners consult a veterinarian and be aware of the risks of possibly feeding an unbalanced or raw diet to their pet. Veterinarians should ask the specifics of what clients are feeding their dogs if they mention feeding a home-prepared diet.

Mentor(s): Audrey Ruple (Virginia-Maryland College of Veterinary Medicine, Department of Population Health Sciences)

Han Lee
Virginia Tech/Biological Sciences
Kiera Long
FBRI /Highschool Student

A-Lab SURF (Presenter 1), CHBR (Presenter 2)

Differential brain morphology after UPF diet compared to nonUPF diet using voxel based morphology

Ultra-processed foods (UPF), characterized by their high degree of chemical and industrial processing, make up 58% of calories consumed in the average US diet. UPF consumption is associated with higher BMI and obesity, and multiple studies have looked into the correlation of obesity and obesity-related comorbidities with changes in brain anatomy; many studies show a relationship with neurodegenerative disorders, brain atrophy, and lower brain volume. Few studies have examined the relationship between diet quality and brain morphology in children and mice, which show a correlation between a lower quality diet and lower hippocampal volume, but none have examined the relationship between UPF consumption and brain morphology in young adults (ages 18-25). We hypothesize the total intracranial volume in young adults will be smaller after a UPF diet compared to nonUPF. In our on-going randomized control trial, participants are provided with two nutritionally equivalent diets in random order, one UPF diet (81% kcals UPF) and nonUPF diet (0% kcals UPF), separated by a 4 week washout. T1w images are captured before and after each diet period using a Magnetom Prisma whole-body 3.0 T Prisma scanner with a 64-channel head coil (Siemens AG, Medical Solutions, Erlandgen, Germany). These data are analyzed using SPM12 voxel based morphometry (VBM) to identify differences in brain morphology after a UPF diet compared to a nonUPF diet. Results of this analysis will be informative of how a UPF diet impacts brain structure compared to a nonUPF diet and could have implications for dietary guidelines in the US.

Mentor(s): Alexandra DiFeliceantonio (HNFE/FBRI)

Aaron Lin
Virginia Tech/Mechanical Engineering

CEED

Improving Vat Polymerization through Rheological Analysis of Novum Glass Particles in Photoresin

Additive Manufacturing, sometimes referred to as 3D printing, involves the creation of 3D objects from a variety of materials such as polymers, metals, composites, and ceramics. It has applications in many fields, including but not limited to dentistry, medicine, jewelry, and molding prototypes. One example is Vat Polymerization (VP). VP involves the use of UV light to activate the polymerization of photopolymers, which are resins that are activated by light. The UV light wavelength enables the resin to mold together and cure into a solid state. The process creates solid layers which are then added together to form objects. VP is beneficial due to its ability to create detailed, precise, and high-quality products. It has disadvantages, including cost, poor strength, and poor durability, the latter two due to its need for low viscosity resins. Viscosity is a material property which is defined by resistance to deformation. In this study the effects of particle size, particle concentration, and gap height were analyzed in the ARES-G2 Rheometer with 25mm and 50mm parallel plates to determine viscoelastic properties in photoresin at different parameters. Specifically, three different Novum Glass size particles were used: 3-6 μm, 38-45 μm, and 212-250 μm. The glass was mixed with the photoresin in a Flacktek mixer to form 1% and 25% concentration samples. Frequency and strain sweeps were performed along with Thixotropy tests to determine viscoelastic properties at different gap heights between the rheometer and sample. These findings may be used to further improve photoresins in vat polymerization.

Mentor(s): Michael Bortner (Macromolecules Innovation Institute)

Emelia Linkous
Virginia Tech/Environmental Resources Management

MASBio

Transpiration drying and associated leaf physiology of common Appalachian hardwood species used in biofuel production

The drying of intact, felled trees (left on the ground with foliage intact) is called transpiration drying. Transpiration drying is not a new idea and has been explored in the past as a way to lower wood drying costs as the leaves pull water from the stems. To date, the amount and length of transpiration, as well as how long leaves stay viable following cutting, have not been studied.
This study serves to measure transpiration, stomatal conductance, and chlorophyll fluorescence following felling of white oak (Quercus alba), black oak (Quercus velutina), pignut hickory (Carya glabra), and red maple (Acer rubrum), and to determine the change in wood moisture content in all four species following felling. Leaf physiology was measured immediately 1, 3, 6, 8, 10, and 13 days following felling. Sapwood moisture content was measured immediately 1, 3, 6,10, 21, and 31 days following felling. Trees stopped transpiring 1-2 days after felling, and leaf fluorescence (a measure of leaf viability) continually declined until ~1 week following felling. Moisture content continued to decline even when leaf transpiration was minimal. The trees continued to dry throughout the project length, but very little was a result of actual leaf transpiration through stomata since transpiration ceased very quickly following felling. An additional and similar study is actively being conducted to determine the results of transpiration drying by measuring moisture content of felled trees with crown intact versus crown removed.

Mentor(s): John Seiler (Forest Resources & Environmental Conservation, Virginia Tech)
Scott Barrett (Forest Resources & Environmental Conservation, Virginia Tech)

Andrew Linville
Virginia Tech/Mechanical Engineering

What's Wrong With my Motor? Utilizing Instantaneous Frequency to Extract Motor Component Signatures

Induction motors are the drivers of industry and are one of the most common electrical machines, thus it is vital for the industrial economy to efficiently keep these machines operational. Induction motors operate on AC electricity; therefore, the current is a sinusoid with a frequency of 60 Hz, and information about components in the motor such as bearings, rotor, stator, etc. appear as noise on the 60 Hz current signal. Many technologies currently exist to track the motor current to determine the condition of individual components by analyzing this noise.

In this research, a novel system was developed to increase the resolution of the extracted motor component noise. If the sensor signal is directly captured by a data acquisition system (DAQ), then a large portion of the bit-resolution is required just to follow the 60 Hz carrying frequency leaving only a few bits to capture the component information causing higher quantization error and lower resolution. To increase the resolution of the component information, an algorithm was developed that calculates the instantaneous frequency, amplitude and phase of the sensor signal which then is used to recreate a smooth output signal utilized to subtract out the 60 Hz carrying frequency leaving only the component noise information.

This allows a DAQ with a smaller range to be chosen which greatly increases the resolution and decreases quantization errors. The proposed algorithm was able to almost entirely remove the 60 Hz signal decreasing the quantization error and improving the resolution of the component information. This allows for more accurate insights into the machine's health helping to prevent failures.

Mentor(s): Shane Ross (Aerospace and Ocean Engineering, Virginia Tech)
Alfred Wicks (Mechanical Engineering, Virginia Tech)

Sydney Luff
Virginia Tech/Biochemistry

Feeding Behavior of Male and Female Mosquitoes of Different Species with Respect to Different Sucrose Concentrations

Female mosquitoes are notorious for their blood-feeding habits, which results in the transmission of diseases to humans. However, both sexes of mosquitoes require nutrients found in plants' nectar to sustain their metabolism, and males are exclusively sugar feeders. Different species of mosquitoes feed on different animal and plant hosts that vary in the physical and chemical properties of the fluid (blood or nectar) offered. However, whether mosquito species that are adapted to feeding on specific blood viscosities are constrained to feeding on specific nectar sources remains unknown. To answer this, we performed restrained-feeding assays on males and females of two species of mosquitoes: the human-feeding Aedes aegypti, and the bird-biting Culex quinquefasciatus. Individuals were fed various concentrations of sucrose to quantify the proportion of mosquitoes feeding and the ingested volume. Results showed that females of both species fed on the solution with the highest concentration, or the most nutritious solution. The males of both species, however, predominantly fed on the solution with an intermediate concentration of sugar within our tested range- suggesting that males may have morphological constraints limiting their ability to drink higher-viscosity fluids. Overall, the difference between male and female feeding patterns correlates with their distinct diet, but the lack of differences between species might reflect an older, more conserved evolutionary relationship between plants and mosquitoes. In the future these results may aid in exploring the development of mosquito sexual dimorphism from an evolutionary standpoint, as well as give insight to the relationship between host preference and morphology.

Mentor(s): Clement Vinauger (Biochemistry)

Alan Mach
Brown University/Biomedical Engineering

Does water loss or blood pumping explain mass loss in cicada wings during adult wing development?

Complete wing development is necessary for winged insects to perform tasks including locomotion, mating, and foraging. Some insects inflate their wings by pumping hemolymph (insect blood) into them to induce expansion. Recent work on cicada nymphs has shown that as their wings expand, their mass decreases by a factor of three, suggesting the hemolymph is pumped out. However, how much mass loss is attributed to hemolymph replacement? We collected approximately 250 Magicicada septendecim nymphs. We dissected their wings at three stages of development (immediately after emergence from shell, full expansion, ~1.5 hours after emergence). Immediately after dissection, the dissected end of the wing base was glued to prevent loss of wing hemolymph. The wings were then weighed in five-minute intervals for an hour using a digital mass balance, and mass loss was calculated by subtracting recorded wing masses from the original wing mass. In separate trials, we performed microscopic video imaging on cicada nymphs to determine the presence of expanding air-filled tracheal tubes present in their wings. Accounting for vapor pressure and surface area, only ~5-15% of the previous study's mass loss was observed ($p < 0.001$) when the wing was sealed, supporting the hypothesis of circulatory flow of hemolymph out of the wings. Furthermore, image analysis reveals that in a four-minute period, tracheal tubes doubled their size after full expansion. Both observations support our hypothesis that wing expansion includes the outward pumping of hemolymph and its replacement with air.

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

Noah Mann
Virginia Tech/Biomedical engineering

CEED

Identifying the Effects of Stress and Sex on Unique Pathology in Blast TBI

Mild traumatic brain injury (mTBI) stands as one of the most prevalent injuries among military personnel. Blast-induced neurotrauma is a significant contributor to mTBI cases during active service, particularly in combat zones where explosive devices pose a constant threat. Combat operational stress (COS) significantly increases the risk of mental health disorders like anxiety, depression, and PTSD in soldiers. Those who experience head trauma are even more likely to develop these conditions. To better understand how COS and TBI may interact, the VandeVord Lab uses a rodent model of acute unpredictable stress (AUS) combined with blast induced neurotrauma (BINT). In this model, male and female rats were exposed to 3 days of unpredictable stress followed by 3 days of 1 blast per day. The goal of the AUS treatment is to simulate the stress that military personnel experience from combat. At 1 and 3 months post injury, the rats were assessed for anxiety-like behavior through the use of elevated plus maze (EPM) test. EPM is a behavioral test with a plus shaped arena that has two enclosed arms and two open arms. This test allows us to assess anxiety and risk-taking behavior of the rats through the analysis of time spent in each arm. Increased time in the enclosed arm represents increased anxiety-like behavior. Based on our results, both sex and stress have significant effects on EPM behavioral outcomes after a BINT.

Mentor(s): Jessica Strickler (Biomedical Engineering and Mechanics)

Allyn Matheson
UC Berkeley/Geography

Disparities in Leadership and Sense of Belonging Between White and BIPOC Members of Ornithological Societies

Marginalized communities face challenges and barriers (ex. discrimination, access to opportunities, and representation) in professional societies, particularly in the sciences. Addressing these challenges requires fundamental change in the professional and academic structures that are oppressive and exclusionary towards underrepresented communities. This research focuses on the underrepresentation of the BIPOC (Black, Indigenous, and People of Colour) community among leadership and their sense of belonging in three ornithological societies. Belonging helps to understand peoples' emotions, attitudes, and relationship with a larger group and.is an essential aspect of improving DEIB. These results are based on a quantitative analysis of survey responses from 1,163 members of three ornithological societies. BIPOC members (including members who are mixed race) are underrepresented in ornithological societies' leadership. BIPOC members make up 14% of total survey respondents, but only 7% of respondents involved in leadership. We also found that BIPOC members of ornithological societies have a lower sense of belonging when compared to white members. BIPOC members also have a greater range for sense of belonging responses when compared to white members. Improving representation in leadership and sense of belonging for BIPOC members is an essential component to addressing the challenges marginalized communities face in ornithological societies and creating fundamental change.

Mentor(s): Nathan Thayer (Department of Fish And Wildlife Conservation, Virginia Tech)
Ashley Dayer (Department of Fish and Wildlife Conservation, Virginia Tech)

Cameron Mathis-Ehlers
Hollins University/Studio Art

Art & Hunger: An Empty Bowls Project

Empty Bowls is a movement by ceramic artists in cities and towns around the world to raise money for local organizations fighting hunger. It's one of the many ways artists can help fight world-wide issues on a local level. It's done differently everywhere but the general concept is that artists and craft makers create bowls to be sold and all the proceeds go to the charity they're representing. Empty Bowls events are usually set up like a soup kitchen, where you can purchase a bowl and fill it with soup. I'm working at the Floyd Center for the Arts to create bowls to be donated to the Empty Bowls association in Floyd, VA. I'm using a hand building method that uses bisque molds to achieve consistent shapes and form. This mold method is when you form the clay around an object, the mold, to create a desired shape. I'm using bowl shaped molds that were created by clay and fired to bisque temperatures around 1800 degrees. This process is very repetitive but has helped me to gain speed when making the bowls. I have also improved on my time management skills because studio space is limited, and time is very valuable. When I'm done with the wet work process I will glaze and fire to a high temperature of 2300 degrees, which is best for functional pottery. Most of the bowls will be donated but some will be put into an exit exhibition at the Floyd Center for the Arts.

Sources: "Empty Bowls." CDCAC, 7 Mar. 2024, cdcac.org/empty-bowls/.

Mentor(s): Joshua Manning (Studio Art, Hollins University)

Megan McCarley
College of William & Mary/Psychology

Independent Research

Electrophysiological and Behavioral Factors as Predictors of Negative Emotion in Infancy and Toddlerhood

Previous research indicates that behavioral and emotional regulation strategies each require some form of attentional control to be properly executed (Posner et al, 2014). Additionally, prior studies found that decreased heart rate (HR) and increased EEG coherence in the frontal-parietal alpha band (6-9Hz) indicate increased attention. Electrophysiological data paired with measures of behavioral regulation could therefore indicate neural attentional activity related to emotion regulation and allow for negative affect to be predicted physiologically and behaviorally. Attentional control and emotion regulation begin to develop at 10 months, providing an initial time point for analysis (Gartstein et al., 2014).

Our study used frontal-parietal EEG coherence and HR during a frustration task, as well as baseline EEG and HR, behavioral distraction during the task, and maternal report of infant behavioral distress and soothability at 10 months to concurrently predict negative affect. Results from multiple regression indicate that HR, EEG, and distraction during the task predict negative affect, with the equation accounting for 48% of variance of negative affect. There were no significant findings for maternal report distress or soothability, nor baseline HR and EEG. Predicting negative affect concurrently at 10 months using electrophysiological measures and behavioral regulation may suggest that a greater ability to regulate negative emotion necessitates both physiological and behavioral regulation as early as the first year.

Further analysis to investigate if these regulation predictors at 10 months extend to predict negative affect at 24 and 36 months will also be performed to see if these findings are similar longitudinally.

Mentor(s): Martha Ann Bell (Psychology)

Joseph Medeck
Tusculum University/Chemistry

Optoelectrical properties of chiral quasi-2D Halide Perovskites

Several unique optoelectronic properties of Chiral Quasi-2D halide perovskites including tunable bandgap, high color purity, and high photoluminescence quantum yields have demonstrated perovskite materials as having great potential for future light-emitting diode (LEDs) technology. Chiral organic ligands are used to introduce light polarization through chiral-induced spin selectivity (CISS). Spin transfer from 2D to 3D perovskite generates circularly polarized light. Light polarization is necessary for use in display technologies, and future technologies including 3D displays, quantum computing and sensing, and information processing. By eliminating energy loss induced by circularly polarized filters, the need for ferromagnetism, and low temperatures, Chiral Quasi-2D halide perovskites are a promising alternative to traditional methods of controlling spin polarization in electronics. The focus of this research was to investigate the optoelectronic properties including circularly polarized luminescence of Chiral Quasi-2D halide perovskites based on differing ratios of lead halides and chiral organic ligand cations. Ruddlesden-Popper perovskite samples spin-coated on thin films were investigated, represented by the formula C2An-1MnX3n+1, where C is the chiral organic spacer Cation, A is the cesium anion (A = Cs), M is lead (M = Pb) and X is the halides (X = Br, I). Using Transient absorption spectroscopy (TAS) it was confirmed that Chiral Quasi-2D halide perovskites display circular light polarization.

Mentor(s): Lina Quan (Chemistry)

Richard Melia
Virginia Tech/Biological Systems Engineering

Independent Research

Denitrifying bioreactors for legacy nitrate removal from springs in the Chesapeake Bay watershed

The release of excessive nutrients, including nitrogen (N), from agriculture has become a great concern over the last few decades. The discharge of legacy N from springs in the Chesapeake Bay watershed contributes to eutrophication and hypoxic aquatic zones. Denitrifying bioreactors have been implemented primarily in tile-drained agricultural fields to mitigate excess nitrate in drainage water. The goal of this research is to determine if bioreactors may be a suitable option for mitigating groundwater derived legacy N from spring water. Specifically, we will explore the impacts of bioreactor substrate type and temperature on nitrate (NO3-N) removal. Spring water maintains a cooler temperature year-round (10 °C) and a constant flow, both of which are hypothesized to impact N removal performance. To test for N removal, we will conduct a laboratory-based bioreactor column study. Each bioreactor column (12 total) will receive local groundwater amended to achieve a concentration of around 20 mg NO3-N/L at hydraulic retention times (HRTs) of 2, 5, or 8 hours. Treatment factors include a medium of woodchips or bark and influent water temperature – room temperature (~20 °C) or groundwater (10 °C) – in triplicate. Water quality parameters, including NO3-N, pH, dissolved oxygen, conductivity, temperature, and oxidation reduction potential will be routinely measured from the influent and column effluent. Our preliminary results showed that the room temperature water and bark combination was the most effective in N removal, while cold temperature and woodchip had lower removal. Results from this study will inform future design and recommended operation of spring bioreactors.

Mentor(s): Natasha Bell (Biological Systems Engineering, Virginia Tech)
Zachary Easton (Biological Systems Engineering, Virginia Tech)

Ashley Merritt
Hollins University/International Studies
Milo Pacheco
Hollins University/International Studies

Studying Abroad: Continuity and Change in Study Abroad Programing and Experiences at Hollins University

Studying Abroad for many has defined their college experience, but no two programs or locations are equal. While most experiences remain unique to the individual, there are still collective aspects that define the years that one has traveled. Global events, academic and everyday accessibility, as well as support from the institution are all able to be researched and complied to compare the continuity and changes in the student experience abroad utilizing the Hollins University Abroad Program as a case study. Data was primarily collected through oral histories from Alumna and current students, as well as archival material such as diaries, photographs, and university published material.

Mentor(s): Ashleigh Breske (International Studies, Hollins University)

Julian Miller
Virginia Tech/Cybersecurity Management and Analytics

Machine Learning-based Cybersecurity for Invertor Based Resources

Communication is widely used in the power system for monitoring and controlling the power system. The number of renewable inverter-based resources (IBR) in the grid is increasing, and their operation relies on communication, exposing the power system to cyberattacks. Cyberattacks can cause power outages and damage the installed devices; however, cyberattacks can be detected using machine learning (ML)--based techniques. Attackers use different types of attacks, such as denial of service (DoS) and false data injection (FDI) attacks. Moreover, the grid can undergo different transients, and the detection algorithm needs to be able to differentiate between the transient and the cyberattacks. This project uses various ML algorithms, including support vector machines (SVM), decision trees (DT), random forests (RF) , multilayer perceptron (MLP) neural networks, and long short-term memory (LSTM) for developing detection algorithm for FDI cyberattacks for three different IBR units installed in IEEE 39-bus system. The performance of all five algorithms is compared to find the best algorithm for cyberattack detection.

Mentor(s): Ali Mehrizi-Sani (Bradley Department of Electrical and Computer Engineering, Virginia Tech)
Milad Beikbabaei (Bradley Department of Electrical and Computer Engineering, Virginia Tech)

Jaden Minnivk
Virginia Tech/Chemical Engineering

Independent Research

Small Angle Monitor for The Moller Experiment

The Measurement of a Lepton-Lepton Electroweak Reaction (MOLLER) experiment proposes to measure the parity-violating asymmetry in electron-electron (Møller) scattering, thus offering a precise determination of the weak mixing angle at low energies. This precision will surpass any planned experiments in the next decade and offer a unique way to explore new physics at different energy scales, complementing searches at high-energy colliders like the Large Hadron Collider (LHC). Achieving precise controls is critical to meet the experiment's ultra-precise measurements.This endeavor demands comprehensive understanding of systematic uncertainties and understanding photoelectron (PE) yields. The Small Angle Monitors (SAMs) play a pivotal role in this context and are analyzed by PE lightguide testing of various materials. When positioned strategically to minimize expected physics asymmetries relative to main detectors, SAMs provide sensitive monitoring of false asymmetries. This presentation provides an overview of SAMs within the MOLLER setup, emphasizing their design considerations and operational contributions. Experimental outcomes showcased are PE lightguide testing, single PE calibrations (SPE), and Photomultiplier Tube (PMT) characterizations, thereby illustrating their role in enhancing precision within the experiment.

Mentor(s): Mark Pitt (Physics)

Naisha Mistry
Northeastern University/Data Science
Dasol Lee
Duke University/Computer Science & Psychology

Development of surface-enhanced Raman spectroscopy (SERS)-based nanoprobes and machine learning models for predicting droplet pH

Many viruses are sensitive to changes in pH with certain pH levels either inactivating them or reducing their infectivity. Virus transmission often occurs through respiratory aerosols ranging from 0.1 to 10 µm in diameter. Conventional pH measurement methods are ineffective for these droplets since they require bulk solutions and cannot be measured at micro/nanoscale. Our research aims to address this gap by developing surface-enhanced Raman spectroscopy (SERS)-based pH nanoprobes. We created nanoprobes by functionalizing gold nanoparticles with a pH-responsive reporter and analyzed its SERS spectra in various pH environments. A Boltzmann fit calibration curve was developed based on spectral peaks resulting from structural changes in the pH reporter. We employed Principal Component Analysis (PCA) and K-Means clustering to identify patterns in SERS spectra across different pH levels. Machine learning models were then utilized to predict droplet pH since such models can incorporate multiple spectral peaks for greater accuracy. Our findings revealed three major spectral clusters: one for highly acidic, one for highly basic, and one for spectra influenced by both acidic and basic peaks. The Gaussian Process Regression (GPR) model with a 1/2 Matérn Kernel demonstrated the highest accuracy in predicting droplet pH, with a root mean squared error (RMSE) of 0.51 and an R2 of 0.97. This approach allows for precise pH prediction in droplets, providing valuable insights for droplet research and developing strategies for virus transmission and mitigation.

Mentor(s): Peter Vikesland (Department of Civil & Environmental Engineering)

Allie Mitchem
Hollins University/Psychology

Parental Perceptions on Their Children's Technology Use

Technology has become essential in today's world. One recent survey found that 97% of people own a cellphone in the U.S. (Pew Research Center 2024). With this increase in technology, apprehension has increased about the risks related to technology use. During the COVID-19 pandemic screen time among adolescents increased around 52% (Madigan et al., 2022). Another study found mental health issues began to increase, such as anxiety and depression, as screen time use increased during COVID-19 (Li et al., 2021). Physical side effects have also been found from excess technology. One study found that children using screens before bedtime were found with negative physical side effects such as obesity and poor sleep quality (Dube, et al., 2017).

Adults and parents are also facing similar distress when it comes to technology use. Studies focusing on parent technology use have discovered results that affect the technology use of their children as well as their emotional behavior. One study found that parents' problematic cellphone use leads to worse child behavior such as emotional outbursts and anxiety (Dolev-Cohen, & Ricon, 2024). Another study found that parents' excessive screen time use may hinder the child's socialization skills (Uzundağ, et al., 2022).

With this previous research in mind, the goal of this current study is to gain information about the parent's perspective on their child's technology use. The results may enlighten parents about their technology use as well as their children's, and redirect technology use and its side effects.

Mentor(s): Richard Michalski (Psychology, Hollins University)

Evan Molinares Hess
Virginia Tech/Computer Engineering

Foveated Side-Channel Attacks on VR Rendering

Virtual reality (VR) technologies require high-fidelity, high-resolution images and low latency to be useful in both the entertainment and productivity sectors. These technical demands necessitate techniques such as eye-tracked foveated rendering, which utilizes the focal point of the user's vision to determine where to most effectively utilize rendering resources. While computational cost-saving measures like foveated rendering enable more smooth and satisfactory user experiences, they also pose novel security concerns for users' eye-tracking data when using VR applications. This study aims to explore attack vectors that reveal the user's gaze position. We assume the role of a developer using a game engine creating a VR application without any elevated application permissions to demonstrate the scope of this vulnerability. The attack vector consists of 3D game objects which function as "trapdoors" in a rendered scene which performance counters reflect. These performance counters, such as frame rate and render pass execution time, could reveal the user's gaze position when correlated with timing data. Performance counters are available to unprivileged applications and, in some cases, belong to the application itself. Preliminary results show that this attack is feasible and motivates further work to identify and mitigate this novel vulnerability, as it bypasses previous work to preserve user privacy. This work contributes to the understanding of novel security vulnerabilities unique to VR systems.

Mentor(s): Brendan David-John (Computer Science)
Dr. Bo Ji (Computer Science, Virginia Tech)
Paul Maynard, PhD Student (Computer Science, Virginia Tech)

Hector Montemayor
Virginia Tech/Neuroscience

Independent Research

Drosophila melanogaster larvae integrate tonicity into temperature preference

Drosophila melanogaster larvae possess two dorsal organ ganglions (DOGs) in their anterior region, containing thermosensory neurons. These ganglions utilize three dorsal organ cool cells (DOCCs), including two A-type and one B-type, to respond to cooling. Previous research in our lab have shown that under hypertonic conditions, B-type DOCCs exhibit reduced or no calcium response to cool temperatures, while A-type DOCCs remain unaffected. To explore the behavioral consequences of hypertonic influence on B-type DOCCs, we investigated the behavior of early third instar larvae after three hours of hypertonic stress using steep and shallow temperature gradients on agar gels. In a two-choice assay, a steep temperature variation between 18ºC and 25ºC was established. A gradient assay was used to create a shallow temperature gradient from 13ºC to 31ºC where larvae were free to move for ten minutes. Under normal conditions, wild type larvae encountering a steep temperature change prefer 18°C, however, hypertonic stress abolished this cool preference. In the shallow gradient assay, wild type larvae chose 24 ºC as their preferred temperature with no significant impact from hypotonic conditions. These results imply that Drosophila larvae integrate tonicity into temperature preferences, particularly in steep temperature changes, suggesting a possible role of B-type DOCCs in temperature attraction behavior under hypertonic conditions.

Mentor(s): Hua Bai (Neuroscience, Virginia Tech)
Lina Ni (Neuroscience, Virginia Tech)

Tyler Moore
Virginia Tech/Biochemistry

Histotripsy: Using Focused Ultrasound to Target and Treat Pancreatic Cancer

Despite only comprising 3% of all cancer diagnoses, pancreatic cancer is responsible for 7% of all cancer deaths due to the inability to detect cancer development until stage IV or metastasis. Current techniques for treating cancers include radiation, surgical, and thermal treatments which each have well-known side effects that can hinder the recovery of a patient. Histotripsy is a novel cancer therapeutic technique that uses focused ultrasound to mechanically ablate (damage) tumorous regions. Our aim is to identify immunological responses to focused ultrasound within physiological conditions. Current in vitro studies involve the quantification of cell ablation and proliferation at and after the time of treatment. Our studies show various increases in cellular response to these treatments, and we look to see how this can help our knowledge of future human clinical trials. Understanding patterns and cell responses is a crucial and fundamental step in learning how histotripsy could better our current strategies to boost the devastatingly low survival rate.

Mentor(s): Coy Allen (Immunology, Virginia Tech)
Eli Vlaisavljevich (Biomedical Engineering and Mechanics, Virginia Tech)

Jake Moore
William Byrd High School

Low-intensity Focused Ultrasound is a Promising Noninvasive Procedure Which May Potentially Reduce Anxiety

Anxiety disorders are one of the most prevalent mental disorders with 33.7% of the population experiencing an anxiety disorder in their lifetime. The dACC and dAI are associated with reward-based decision making and task-level control. There is an increase in the function in the dACC and dAI in people with high levels of anxiety. Despite the observed hyperactivity in the dAI and dACC, this is merely a correlation, not a causation between the pathology of these brain regions and anxiety. Low intensity focused ultrasound (LIFU) is a promising noninvasive procedure which can be used to target areas of the brain to either inhibit or excite the targeted area. With LIFU, a causal relationship can be established, specifically, in our experiment with the three conditions: LIFU to the dACC, LIFU to the dAI, and an active sham. 15 healthy participants were subjected to a behavioral test in which they were exposed to either no shock, predictable shock, or unpredictable shock afterward, they rated their anxiety on a scale from 0-10. The data showed that in the unpredictable shock, when LIFU was delivered to the dACC (pvalue = 0.0129) and dAI (p-value = 0.0127) subjects rated their anxiety on a lower level than with the active sham. There was no difference in the predictable shock condition with the dACC (p-value = 0.478) and dAI (p-value = 0.382) with the active sham. Ultimately, LIFU elicits promising results as there is evidence to show that LIFU could potentially reduce a person's anxiety.

Mentor(s): Wynn Legon (Legon Lab)

Julia Neres
Florida State University/Public health
Maggie Brooks
St. Olaf College/Religion
Genevieve Brunner
Virginia Tech/Statistics

CUBE SURF

Examining the Effect of Price, User Type, and Nicotine Strength on E-Cigarette Demand among Smoking Adults

Electronic cigarettes (e-cigarettes) are becoming increasingly popular among Americans and are known to expose users to short-term toxicants and mutagens. However, their long-term health risks are still unknown. To inform tobacco regulatory science and produce effective public health policies for e-cigarette use, this study aims to understand the effects of nicotine strength (NS), price, and user type (exclusive cigarette vs. dual cigarette/e-cigarette) on behavioral economic demand of e-cigarettes in 85 smoking adults from the Roanoke area. Data are from hypothetical purchase tasks completed by each participant for e-liquid at four NS (3, 6, 12, 24 mg/mL) and seven price levels ($0.12, $0.25, $0.50, $1.00, $2.00, $4.00, $8.00). Linear mixed effects modeling was used to examine the two- and three-way interactions between NS, price, and user type on the primary outcome of e-cigarette demand (as measured by log-transformed quantity of purchasing), adjusting for age. Participants were mostly male (60%) and white (67%), with a mean age of 39 (SD=9.6). Dual users were significantly younger than exclusive users (means: 36.3 vs 41.7, p=0.008). No differences in other demographics were found between user types. A two-way interaction between price and user type was observed (p=0.0278). Specifically, dual users, on average, purchased a higher quantity of e-cigarette liquid than exclusive users at every price point. No additional two- or three-way interactions were found between NS, price, and user type. These findings suggest that price and NS play a role in purchasing behavior and should be considered in the development of effective public health policies.

Mentor(s): Alexandra Hanlon (Statistics, Virginia Tech)
Alicia Lozano (Statistics, Virginia Tech)
Muyao (Jenny) Lin (Statistics, Virginia Tech)

Jenny Nguyen
College of William and Mary/Neuroscience

CHBR

Examining the Association between Familial Relationships, Unhealthy Eating Habits, and Delay Discounting in Individuals in Recovery from Substance Use Disorder

Background: Familial relationships (FR) can impact the recovery journey of individuals with substance use disorders (SUD). For example, having difficult FR may lead to engagement in unhealthy behaviors, such as poor eating (e.g., ultra-processed foods). Unhealthy eating behaviors may in turn lead to poor executive functioning and decision-making. Objectives: This study aims to examine the association between (1) FR with poor eating and delay discounting (DD; preference for smaller sooner rewards, over delayed, larger ones), as well as (2) between poor eating and DD among individuals recovering from SUD. Methods: Individuals in recovery from SUD (N = 129 [93 female]) completed a monetary DD task, the Brief Family Relationship Scale (higher scores indicate better FR), and the Health Behaviors Questionnaire (only the food domain was extracted). Demographics were also collected using a standardized questionnaire. Linear regressions with model selection were used to analyze the associations aforementioned. Covariates were included based on the model selection (the model with the lowest BIC was selected). Results: Regression analyses revealed significant positive associations between FR and poor eating ($p < .001$) and between poor eating and DD ($p = .004$). Conclusion: These research findings highlight the significance of FR impacting dietary practices in individuals in recovery from SUD and suggest that weaker FR may lead to poor eating, which in turn may shorten participants' temporal window. This study addresses holistic approaches to examine SUD recovery and suggests that having healthy FR and dietary practices may be important for decision-making and their recovery journey.

Mentor(s): Daniel Cabral (Addiction Recovery Research Center)
Warren K. Bickel (Addiction Recovery Research Center, Fralin Biomedical Research Institute)
Anthony Nist (Addiction Recovery Research Center, Fralin Biomedical Research Institute)

Nevin O'Dowd
Virginia Tech/Biomedical Engineering

Independent Research

Evaluating the Effects of Traumatic Brain Injury on Cognition and Memory using the Novel Object Recognition Test

Mild traumatic brain injury (mTBI) is a growing health concern that accounts for over 75% of all TBI cases. In veterans, it is estimated that between 15.2% and 22.8% of returning personnel suffer from an mTBI, with blast exposure as the leading cause of injury. Increasing evidence shows that mTBI can cause major acute and chronic cognitive and neurological deficits. To understand the physiological effects of mTBI, male Sprague-Dawley rats were split randomly into five distinct groups: mild repeated closed-head impact, repeated primary blast, repeated blast plus single impact, single impact, and sham. Repeated impact and blast groups received three injuries, one hour apart. Learning and recognition memory was evaluated at 2 days, 14 days, and 30 days post-mTBI using the novel object recognition test (NOR). Rats were tracked using Ethovision XT to measure distance traveled and average velocity. Each rat's interaction with novel and familiar objects was quantified through novel investigation percentage, discrimination index, frequency, cumulative duration, and latency to first. Behavioral data was statistically analyzed using GraphPad and JMP software. Since rodents have an innate tendency to investigate novelty, a rodent with an intact memory of a familiar object will spend more time exploring the novel object. Previous studies have shown that discrimination between novel and familiar objects decreases following mTBI, indicating deficits in memory and recall. Similarly, we expect decreased performance in the NOR test among mTBI groups. The anticipated findings will enhance understanding of mTBI-related consequences within veteran populations.

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

Brandon Ordoobadi
Virginia Tech/Electrical Engineering

CEED

The Effectiveness of Data Sonification on Wind Speed during Thunderstorms

Thunderstorms are frequently occurring natural disasters that can cause significant wind damage, with intensity occasionally comparable to hurricanes. While hurricanes have an accurate model to predict when they will occur, thunderstorms are more brief and complex, leading to difficulties in analyzing thunderstorm wind data and the lack of an accurate prediction model. By utilizing data sonification, patterns in wind data could be potentially discovered, creating a breakthrough in our current understanding of thunderstorms.

In order to test if sonification could be a potent tool in thunderstorm modeling, our research team gathered wind speed data from European ports over multiple years. Utilizing MATLAB, this data has been parsed for points where thunderstorms occur and datasets containing six hours of wind speed data have been created. An issue with these datasets is that they contain multiple instances of noise, which are irregular and unwanted data points in a signal. To clean this noise, a filter algorithm was created to clean this noise while retaining the integrity of the original signal. After testing multiple different data smoothing methods, it was found that utilizing a median filter and a moving average was the most effective method in reducing noise. There are currently 131 datasets that contain a clean signal with six hours of data to be analyzed. This data will be sent through a sonification program and tested to see if trends can be found. If trends are discovered, the validity of sonification would be proven, successfully completing this project's goals.

Mentor(s): Monica Arul (Civil and Environmental Engineering)

Bolawole Orenuga
Virginia Commonwealth University/Mechanical Engineering

Low-Cost, Rapidly Deployable Drone Detector to Protect Airports from Denial of Service

The rise in drone use allows for impactful security and operational obstacles for airports, causing prospective air obstructions and safety risks. Rapidly deployable drone detectors are necessary to minimize these troubles. Utilizing radiofrequency detection technologies and multiuse platforms like the Raspberry Pi, solar power, and software defined radios, these systems provide a cost-efficient solution for real-time drone monitoring and detection. The project's goal is to aid in the benefit of airport security by enabling quick and easy designs of these detection systems, available to be operated by people with little to no technical specific skills required. The method involves a Raspberry Pi connected to an Adalm-Pluto to detect drone radiofrequency signals, using specific softwares for signal decodes and analytics. An alert mechanism will notify security once a drone is detected. The system can be moved around the airport with ease, since the design focuses on portability. The design is eco-friendly as well, with solar energy being the source of power for the contraption. Through thorough testing and trial and error analysis, the detector will have maximal functionality and be in its most reliable form while in use.

Mentor(s): Carl Dietrich (Bradley Department of Electrical and Computer Engineering)

Nissi Otoo
Virginia Tech/Computer Engineering

Technology Use in the Black Church: Perspectives of Black Church Leaders

Historically, the Black Church has played a pivotal role in civic engagement and social justice, and continues to do so today. Yet, few researchers have explored how decisions around technology use are made in the church. To address this gap, we conducted semi-structured interviews with five Black Church leaders to understand how church leaders interact with digital technologies, both in general and specifically with the communities that they serve. We found that while Black Church leaders are eager to engage with technology, most of the engagement with outside communities is through in-person contact; opportunities to give online have a financial penalty in comparison to traditional methods of tithing and donating; lastly, technology use within outreach and ministries is highly dependent by ministry leaders - many who volunteer their time. We contribute to research that focuses on technology use in religious organizations and community engagement of community-based organizations.

Mentor(s): Ihudiya Finda Ogbonnaya-Ogburu (Department of Computer Science)

Jasmine Palmer
Concord University/Chemistry

Independent Research

Comparative Synthesis of NaGdF4 Nanoparticles Using Acetic Acid and Oleates as Precursors

This study investigates the comparative synthesis and emissive properties of NaGdF4-containing nanoparticles, doped with cerium (Ce) and europium (Eu) ions, using acetic acid and oleates as precursors. The research aims to compare different precursors and their influence on the optical characteristics of the nanoparticles. By understanding each precursor's optical characteristics on the nanoparticle and determining which one yields higher emission, the nanoparticle synthesis can be optimized for applications that require high optical performance, such as medical imaging.

Optimizing nanoparticles for medical imaging is a significant advancement in the progression of nanotechnology, facilitating easier identification of malignant tissues. For this synthesis, the microwave-assisted decomposition approach was taken, which utilizes degassing, purging, and microwaving the nanoparticles. Characterization methods include UV-Vis spectroscopy and FT-IR spectroscopy, and the emission data was collected using fluorescence spectroscopy. Preliminary findings indicate that nanoparticles using acetic acid as a precursor show higher emission opposed to nanoparticles using oleates.

Mentor(s): Rodney Tigaa (Department of Physical and Environmental Sciences, Concord University)

Rutha Patel
Virginia Tech /Biological Science

Exploring the complex relationship between aggression and testosterone in urban and rural song sparrows (Melospiza melodia)

Urban songbirds often exhibit elevated aggression in response to a simulated territorial intrusion (STI) when compared to rural birds, although the endocrine mechanisms driving this behavioral difference remain unclear. Testosterone (T) is often implicated in the regulation of aggression, with elevated T associated with increased aggression. Despite differences in aggression between urban and rural birds, previous studies have shown that male songbirds in urban and rural habitats have similar levels of T at baseline and following STI. However, rural birds show higher levels of T after injection with gonadotropin-releasing hormone (GnRH), which stimulates endogenous T release. This suggests that urban males may be more behaviorally sensitive to surges in T. To resolve the relationship between T and aggression in the context of urbanization, we compared the aggressive responses of urban and rural male song sparrows (Melospiza melodia) to STI before and after GnRH injection. If urban males are more behaviorally sensitive to T, we would expect them to be more aggressive both at baseline and following a GnRH-induced surge in T. Consistent with previous findings, our data revealed that urban males are significantly more aggressive than rural males at baseline. However, all males, regardless of habitat type, showed significantly reduced aggression after GnRH injection when compared to their own baseline aggression levels. These findings join other recent research suggesting that mechanisms other than surges in T are a response to challenge and other mechanisms contribute to the regulation of aggression.

Mentor(s): Kendra Sewall (Biological Science)

Hannah Patton
Virginia Tech/Cognitive and Behavioral Neuroscience

Urbanization and behavior: Does Neuropeptide Y mediate behavioral shifts among urban and rural song sparrow (Melospiza melodia) populations?

Urbanization presents animals with novel environmental conditions in which behavioral flexibility is imperative for survival. Resource limitation, like lower food abundance, is one of many novel stressors. In territorial songbirds, males use aggression for resource defense necessary for survival. Urban song sparrows (Melospiza melodia) face lower resource availability and are more aggressive than their rural counterparts. However, the neural mechanisms underpinning behavioral differences in response to resource availability are understudied. Neuropeptide Y (NPY) increases feeding when food intake is low and is associated with aggression in certain contexts. NPY is also abundant in nodes of the brain's social behavior network. Given its role in feeding and aggression, NPY may mediate behavioral flexibility of aggression in urban song sparrows facing food limitation. To explore the relationship between aggression, resource availability, and NPY, we compared NPY protein abundance in the paraventricular nucleus (PVN) and infundibular nucleus (IN) of the hypothalamus between rural and urban male song sparrows near baseline and in response to a sustained simulated challenge by another male. Rural males had higher NPY protein abundance in the PVN, but not the IN, when compared to urban males. Baseline levels of NPY in urban and rural males were higher than males exposed to simulated challenge. We found no correlation between aggression and NPY. Our results suggest that the NPY system is affected by urbanization but also responds to social competition. Future work will examine how the NPY system interacts with other signaling molecules such as the glucocorticoid stress response system.

Mentor(s): Kendra Sewall (Department of Biological Sciences, Virginia Tech)
Casey Mclaughlin (Department of Biological Sciences, Virginia Tech)
Taylor Fossett (Department of Biological Sciences, Virginia Tech)

Rebecca Peppers
Virginia Tech/Nanomedicine

Independent Research

Functional Analysis of HA-Tagged GR28B(D) Warmth Receptor in Drosophila

In fruit flies, GR28B(D), a warm receptor essential for avoiding high temperatures, is not well understood. One approach to understanding this receptor is to disrupt its function by swapping portions of the genome from a Gr28b isoform. Ectopically expressing the Gr28b.d gene allows us to test the function of the GR28B(D) receptor. With each swap, we must verify the location of the receptor. Therefore, an HA tag was added to the C-terminal of the Gr28B(D) to facilitate its detection, purification, and characterization. Two experiments were conducted to evaluate whether the HA tag disrupts the function of the Gr28b) gene. In the first experiment, termed "warmth-triggered knockdown," flies expressing Gr28b.d under the control of tubulin-Gal4 exhibited knockdown behavior when heated to 37°C, demonstrating warmth-responsive neuronal activation. To assess the impact of the HA tag, the tubulin-Gal4 system was tested with a 3xHA-tagged Gr28B(D), yielding similar knockdown results, indicating that the HA tag did not impair its function. In the second experiment, the proboscis extension response (PER) was measured, showing that flies expressing Gr28B(D) in sweet-responsive chemosensory neurons extended their proboscis at approximately 32°C, unlike control flies. This response confirmed Gr28B(D) as a warmth sensor. Further validation using Gr5a-Gal4 x UAS-Gr28B(D)-3xHA demonstrated that the HA tag did not disrupt Gr28B(D)'s function, as the tagged protein maintained its warmth sensitivity. These findings collectively affirm the functional integrity of the HA-tagged Gr28B(D) in both experiments.

Mentor(s): Lina Ni (Neuroscience)
Ainul Huda (Neuroscience, Virginia Tech)

Ryan Pho
Virginia Tech/Biochemistry

Adrenergic Receptor Antagonists Reduce Herpes Simplex Virus 1 Recurrences with The Presence of Epinephrine

Stress causes herpes simplex virus 1 (HSV1) recurrences. We previously showed epinephrine, the "fight or flight" stress hormone, reactivates HSV1 by activating certain adrenergic receptors. HSV1 establishes latency in sensory and sympathetic neurons, but epinephrine (EPI) selectively reactivates HSV1 in sympathetic neurons by activating at least two adrenergic receptors (AR), including any combination of alpha-2 (AR-α2), beta-1 (AR-β1), or beta-2 (AR-β2). We hypothesized that AR inhibitors would decrease HSV1 viral reactivation while epinephrine is present in the cells. In guinea pigs, atipamezole (a specific α2-AR inhibitor), propranolol (a nonspecific β-AR inhibitor), or a combination of both decreased HSV1 recurrences. After infecting cultured primary adult sensory neurons with HSV1 and establishing latency for 7 days, neurons were treated with atipamezole and EPI, propranolol and EPI, and a combination of both with EPI; Separate treatments also only included atipamezole, propranolol, and a combination of both without EPI. After 24 hours, neurons were collected, DNA was extracted, and HSV1 DNA was quantified by qPCR. In sensory neurons, there was little significance in reactivation of HSV-1. Since these AR antagonists proved to have reduced HSV1 recurrence in primary neuronal cultures, our results suggest that the medications acted on sympathetic neurons in response to EPI will have a positive effect. Future studies will test these treatments in latently infected sympathetic neuronal cultures to determine if AR antagonists inhibit HSV1 reactivation in these neurons. These adrenergic receptor inhibitors may lead to potential clinical solutions for individuals susceptible to frequent viral recurrences of HSV1.

Mentor(s): Andrea Bertke (Department of Population Health Sciences)
Jillian Green (Biomedical and Veterinary Science - Virginia Tech)
Greyson Moore (Biomedical and Veterinary Science - Virginia Tech)

Corabeth Pierce
Hollins University/International Studies & French

The Impact of the Russia-Ukraine War on Central Asian Republics

When Russia annexed Crimea in 2014, the international relations community held its breath. This was particularly true of the former Soviet Republics of Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, and Uzbekistan, who had a legitimate fear that their territory might be Vladimir Putin's next target. Concerns for the security of the Central Asian Republics (CARs) increased when the Russian-Ukrainian War broke out in February of 2022. At the same time, the CARs maintain close economic, financial and political ties with Moscow. This project's focus will examine the impact of the war in Ukraine on the Central Asian states, with a focus on changes to foreign policy, alliances, trade, migration, and economy. Research data includes official statements presented by governments and states, media articles, academic journals, as well as migration, economic, and trade statistics. The anticipated findings will either be that (a) the war has had a large impact on the Central Asian Republics causing them to rethink their foreign policy and seek relations with states other than Russia, or (b) that there has been little to no change in foreign policy within the CARs, thus leading them to continue close ties to Russia. Thus far, the former option has the highest likelihood of being correct as research points toward there being modifications in how CARs interact with other states.

Mentor(s): Edward Lynch (Political Science, Hollins University)

Cameron Portis
George Mason University/Cybersecurity Engineering
Sriram Narlapati
Virginia Tech/Computer Science
Uday Talasila
Virginia Tech/Computer Science

Large Language Models for Alert Investigation

Security analysts play a crucial role in protecting organizations from cyber threats, meticulously reviewing log data from diverse sources to identify potential breaches. However, the overwhelming number of alerts generated by various security tools often leads to a mental state known as alert fatigue. Alert fatigue refers to the desensitization to security alerts due to their overwhelming volume. Organizations often receive thousands of alerts daily, each requiring extensive analysis to resolve. As a result, human analysts are prone to overlooking crucial details while conducting extensive analysis. As such, the presence of alert fatigue presents a significant risk to organizations, compromising the effectiveness of security monitoring and response.

This paper introduces a novel program designed to mitigate alert fatigue by analyzing log data to detect malicious attack sequences. By leveraging the capabilities of modern large language models, our program minimizes the data intake and provides a comprehensive analysis of its findings. With this program, analysts can query specific information, understand the context and severity of alerts, and receive prioritized response recommendations. The interface allows for conversational communication which eases the mental strain on analysts.

Initial testing on a dataset of over 5,000 log entries demonstrated a 95% confidence level in identifying log data as an attack attempt when analyzing a simulation of known attack sequences. More extensive testing must be done to identify the extent of the program's capabilities. As of now, however, this tool offers a promising solution to enhance the efficiency and accuracy of cybersecurity operations.

Mentor(s): Peng Gao (Department of Computer Science)

Aaron Pozo-Aranda
Virginia Tech/Clinical Neuroscience

A-Lab SURF

Identifying native NMDA receptor diversity in the mouse thalamus

N-methyl-D-aspartate receptors (NMDARs) are ionotropic glutamate receptors that are crucial for neuronal communication including synapses. They're also important for maintenance, development, and plasticity. NMDARs are exceptionally diverse tetrameric complexes with the assembly being comprised of two GluN1 and two GluN2 subunits (GluN2A – 2D) or GluN3 subunits (GluN3A or 3B) that allow for variation in biophysical, pharmacological, and signaling properties. NMDARs subtypes with distinct subunit composition contribute and lead to distinct brain functions. Disappointingly, we have very limited knowledge of native NMDAR subunit composition and how they're coupled with other proteins, limiting our ability to target specific NMDAR populations. We study NMDAR organization and synapse diversity in the thalamus due to its diverse glutamatergic input and gene expression. The objective of this project is to investigate the mechanisms that lead to synaptic diversity by identifying the specificity of NMDAR subunit assembly. We hypothesize that GluN2 subunits assemble preferentially in tetramers and have subunit specific interactions with other macromolecular complexes that lead to distinct subcellular organization in the brain. To determine the composition of NMDAR tetramers, immunoprecipitation was performed on solubilized mouse thalamus to isolate crude synaptoneurosomes containing pre- and postsynaptic compartments, followed by western blotting. Our preliminary results have qualitatively shown varying prevalence of NMDAR assemblies including a novel NMDAR complex including the GluN2B and GluN2C subunits. Outcomes of this project will guide treatment strategies in ongoing studies with mouse disease models and the development of sub-type selective NMDAR modulators.

Mentor(s): Sharon Swanger (Fralin Biomedical Research Institute)

Tiandra Prather
Virginia State University/Manufacturing Engineering
Lamarre Joyner
Virginia State University/Computer Engineering

Classical vs. Quantum RNG in the BB84 Protocol

Abstract (Lamarre J. and Tiandra P.)

Ensuring secure communication in today's digital world is crucial, and generating genuinely random numbers is essential for keeping information safe. Classical random number generators (RNGs) can be predictable and show patterns, making them less secure. In contrast, quantum random number generators (QRNGs) use the natural randomness of quantum mechanics to create more secure random numbers. This study compares classical and quantum RNGs using the BB84 protocol, which securely allows two people to share a secret key using light particles called photons.

We analyzed 912 random numbers generated using both classical and quantum methods for patterns (biases), mistakes (error rates), and randomness (entropy). The classical RNG showed a noticeable initial bias of about 47%, and reduced datasets showed biases of 50% and 52% for Alice and Bob. The classical data also had a high error rate of 50% and an entropy value of 0.301, indicating less randomness.

In contrast, using the BB84 protocol, the quantum RNG produced data with biases of 60% for Alice and 49% for Bob, with insufficient error rates starting at 0%. The entropy values for the quantum-generated data were 0.292 for Alice and 0.301 for Bob, indicating higher randomness.

Our results unequivocally demonstrate the superiority of QRNGs over classical methods for the BB84 protocol. QRNGs have lower biases, fewer mistakes, and higher randomness, making them ideal for sharing secret keys and ensuring secure and dependable communication.

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

Harbalbeen Rai
Virginia Tech/Biological Sciences

A-Lab SURF

Development of Glutamatergic Synapse in Somatosensory Thalamus Decrease in Number in Dravet Syndrome Mice Model

Dravet Syndrome (DS) is an epileptic disorder which has a 20% mortality rate. DS is connected to a gene mutation, Scn1a, that encodes the voltage-gated sodium channel NaV1.1, which is highly expressed in GABAergic reticular thalamus (nRT) neurons. However, a recent study conducted in the Swanger lab, showed reduced excitability of nRT neurons and thalamocortical neurons in the ventral posterolateral (VPL) thalamus, while thalamocortical ventral posteromedial (VPM) neurons exhibited enhanced excitability in DS mice. The results from the electrophysiology showed that the removal of NaV1.1 reduced glutamatergic sensory synaptic input to VPL neurons, but not VPM neurons. Altered excitability is likely to cause activity-dependent changes in synapse development or formation, which may contribute to seizures early in the disease and/or behavioral deficits through adulthood. Based on this study, we hypothesized that through DS mouse brain development, the number of sensory synapses will decrease after the point of highest seizure burden. This experiment used 3 age groups: 2 weeks old, before seizure burden, 4 week old, after highest seizure burden, and 8 week old, adult. Immunohistochemistry and super resolution imaging were utilized on wildtype (WT) and Scn1a heterozygous (DS) mice in each age group to detect and quantify sensory synapses, which are specifically labeled by VGLUT2 . Our preliminary research suggests that VGLUT2 synapse number is decreased at both 4 weeks and 8 weeks in DS mice compared to WT. This suggests that sensory synapse number decreases after seizure onset and could contribute to ongoing behavioral deficits through adulthood.

Mentor(s): Sharon Swanger (Fralin Biomedical Research Institute; Vet Med)

Bhumika Rai
Hollins University/Psychology
Madison Brousseau
Hollins University /Psychology

The impact of perpetrator race, identification procedures, and encoding time on eyewitness identification.

Eyewitness misidentification is the leading cause of DNA exonerations (Innocence Project, 2024). There are various factors that can influence eyewitness identification (ID) accuracy such as how long the witness viewed the perpetrator (encoding time), the race of the perpetrator (i.e., the cross-race effect [CRE]), and the identification procedure (showup or lineup) used by police. The purpose of this study is to investigate how these variables interact with one another, and to better understand under which conditions provide the most accurate ID decisions. To do so, we plan to conduct a large online study using Prolific using a within-subjects factorial design. In the study, White participants will view a Black (cross-race) or White (same-race) perpetrator for either a short or long amount of time. Later, participants will be given a showup (1-person) or a six-person lineup that will either contain a guilty or innocent suspect. Lastly, confidence ratings will be obtained.

Mentor(s): Alex Wooten (Psychology, Hollins University)

Javier Ralat
Virginia Tech/Computer Engineer

AskAResearcher: Transforming Research to Practice

The present state of computer science has grown quickly, and as technology advances, interaction between researchers and practitioners has diminished. We developed "Ask A Researcher" to bridge this communication gap with a user-friendly website. By fostering the sharing of questions and research findings, the site creates an engaging atmosphere that promotes professional and research progress. New users register with their full name and expertise, stored securely using Flask and Python. Upon signing in, they access features designed to promote effective collaboration. The home page displays questions with options to comment and react, allowing feedback and engagement. Users can also post their own questions, specifying their role as a researcher or practitioner. The expert blogs tab, which I contributed to, allows users to post and view blogs, providing a space for topic-specific discussions. The user list tab offers a directory of active users, displaying their name, contact information, expertise, and an option to request specific content, facilitating peer connections. The paper discussion tab allows users to upload, view, and download research papers, enhancing discussions on recent findings. Users can annotate and comment on papers, providing direct feedback on specific sections. This complements the feedback tab, enabling more in-depth discussions. By connecting researchers and practitioners, “Ask A Researcher” enhances the practical application of research and promotes continuous growth and professional development in computer science. Looking forward, we plan to incorporate messaging features within the site to further facilitate user communication and growth.

Mentor(s): Chris Brown (Department of Computer Science)

Jennifer Rechani
Virginia Tech/Biomedical Engineering

Motor Characterization Of A Wearable Device To Manage Upper Extremity Lymphedema

Lymphedema, affecting 140 to 200 million people globally, is an incurable, progressive condition characterized by painful swelling. The primary treatment involves manual lymphatic drainage (MLD) massage and compression garments, limiting patient independence due to the need for certified therapists. To address this, we developed a wearable device using vibration to mimic MLD patterns, aiming for at-home maintenance therapy. This study compared the acceleration and frequency of our device's motors to clinically-used handheld massagers. An accelerometer placed in an arm-mimicking tissue phantom collected data at varying voltages and motor configurations. Data analysis in MATLAB revealed that our device's acceleration ranged from 0.5 to 2 g, and frequency from 70 to 180 Hz, comparable to small clinical vibration tools. These findings support the potential of our device in providing effective at-home lymphedema treatment

Mentor(s): Christopher Arena (BEAM)

Maryam Rehmatulla
Virginia Tech/Computational Modeling and Data Analytics
Andres Sanchez
Virginia Tech/Aerospace engineering

Identifying Spring Dead Spot in Bermuda Grass Using Aerial Imagery and Machine Learning

Spring dead spot (Ophiosphaerella spp.) is a terrible disease that affects turfgrasses in the spring, specifically bermudagrass. The disease is caused by species of the Ophiosphaerella fungus, which infect in the fall and are circular patches of dead grass in the spring. It is necessary to frequently apply fungicide applications to manage the disease, which can be costly and labor-intensive. Therefore, the need to predict the growth of spring dead spot and only treat infected areas arose. This project focused on developing a machine-learning model that would utilize images of spring dead spot to detect the disease automatically. A U-Net model was created using aerial imagery of turf fields on a Mavic two and three Enterprise Advanced. Image masks were then created from the labeling software LabelBox which allowed the disease to be manually identified. These masks and the original images are then used to train the machine-learning model to identify and predict the growth of spring dead spot. The model was then tested using a series of validation images and masks containing ground validation points of spring dead spot to ensure the model's accuracy. Moving forward, this model will help advance turfgrass pathology by saving time, energy, and resources when it comes to spraying spring dead spot on turf fields. Furthermore, machine learning models could be implemented in the future for all diseases and significantly help advance the field of turfgrass pathology.

Mentor(s): David McCall (VT Turfgrass Pathology and Precision Management)

Myles Reid
Virginia Tech/Electrical Engineering

Enhancing Interactive Learning through Wireless Communication Simulations

This research investigates enhancing interactive learning in wireless communications by integrating a game controller into existing Wireless @ Virginia Tech coded simulations. The main objective is to enhance user interactivity and facilitate task completion within the simulations. By incorporating a game controller, users can interact more intuitively with the simulation environment, creating a more engaging learning experience. Data collected from users before and after the integration show increased interactivity and decreased task completion time. These findings demonstrate the controller's effectiveness, leading to future incorporation into additional Wireless @ Virginia Tech simulations. The results highlight the potential for enhanced user experiences and improved learning outcomes in wireless communication education. Future work will explore additional methods to increase interactivity in the simulations. This study underscores the value of interactive tools in technical education and the potential for improved user experiences and learning outcomes in wireless communication education.

Mentor(s): Carl Dietrich (Bradley Department of Electrical Engineering, Wireless @ Virginia Tech)

Ian Rhudy
University of Michigan/Engineering Physics
Nathan Dressler
Virginia Tech/Physics

Mechanical Properties of 304-Steel Springs in Cryogenic Environments

The Darkside-20k liquid argon time-projection chamber (LAr TPC) is planned to use 2472 spring-tempered 304 stainless steel extension springs to support a wire grid consisting of 1236 electrically charged wires. Liquid argon has a boiling point of 87 K, and acts as a scintillator in the detection of dark matter. Exposure to these cryogenic temperatures influences the spring constant (k) and pretension (Tp) of the springs due to 304 stainless steel's Young's Modulus. Compared to the ambient temperature value of k = 78.19 ± 0.12 N/m, the new value was measured to increase to k = 82.45 ± 0.12 N/m (5.4 ± 0.2 % increase) using liquid nitrogen (LN2) boil off to reach temperatures at 87 K. The pretension was also qualitatively measured to increase, while the length of the spring was qualitatively measured to decrease. The experimental apparatus consisted of a 0.848 in clear T-shaped pvc in which the spring was housed, allowing chilled N2 gas/liquid to be blown normally to the direction of oscillation. Using a temperature probe in this encasing, oscillations were videoed over a range of temperatures with which the spring constant could be determined. Measurement of these parameters minimizes the uncertainty involved in building such a nuanced and complicated detector.

Mentor(s): Bruce Vogelaar (Physics)

Morgan Roadman
Concord University/Computer Science

CNP REU

Neutrino Emissions from Plutonium-241 and Spent Nuclear Fuel

This project examines the emissions of neutrinos from plutonium-241 and spent nuclear fuel. By analyzing these signals, we aim to improve our understanding of the behavior of neutrinos in different storage environments for used nuclear material. The study evaluates the characteristics of these emissions, concentrating on detection and measurement, and the potential use of plutonium-241 in experimental applications.

Mentor(s): Patrick Huber (Department of Physics)

Gwendolyn Robbins
Virginia Tech/Biochemistry

Using Feeding Experimentation Device (FED3) to Evaluate Non-Motor Symptoms of Parkinson's Disease in Mice

Parkinson's Disease (PD) is a neurodegenerative disorder effecting over 10 million people worldwide. It is characterized by motor symptoms such as shaking and weakened muscles with current FDA-approved therapeutics (MAO inhibitors, carbidopa infusions, and dopamine agonists) effectively slowing the decline of motor function. However, over 90% of patients experience non-motor symptoms such as cognitive impairment, depression, anxiety, and sleep disorders. Cognitive and other non-motor symptoms of PD are under researched in the field, and as a result, there are limited treatment options addressing these symptoms. To address this gap in our understanding of PD, we plan to implement the Feeding Experimental Device version 3 (FED3) to comprehensively evaluate cognitive deficits in a mouse model of PD. To validate that the FED3 can be used for testing cognitive function, we first needed to establish that PD mice do not differ from control mice in the following three ways: (1) PD mice can use the operandum to obtain food pellets, (2) PD mice have the same ability to retrieve food pellets, and (3) PD mice have the same motivation to consume pellets. Because mice in our PD model experience motor symptoms, this experiment was designed using a three-test cognitive battery to validate that the mice can operate the device with the same ability and motivation as the control. This study will allow us to perform future experiments testing cognitive non-motor symptoms in our mouse model of PD.

Mentor(s): Matthew Buczynski (Neuroscience)

Tyler Roberts
Lafayette College/Biochemistry

Alterations in Excitatory Corticothalamic Synapses in a Dravet Syndrome Mouse Model

Dravet syndrome (DS) is an infantile epileptic disorder characterized by dysfunction across brain circuits, resulting in a broad phenotypic profile including cognitive impairment, convulsive and non-convulsive seizures, and sleep disruption. Seizure activity in the cortex is carried to the thalamus by glutamatergic corticothalamic (CT) neurons, where it propagates to the entire brain. Prior studies found physiological evidence of altered CT input to the reticular thalamus (nRT) in a DS mouse model at 4 weeks of age. These observed changes are likely due to a decrease in number of synapses or a reduced probability of synaptic glutamate release. Utilizing immunohistochemical staining, we can determine if the number of synapses changes, contributing to the decreased excitatory synaptic transmission. By labeling pre and postsynaptic markers and colocalizing them with VGLUT1, a CT synapse-specific marker, we can precisely quantify if there are any alterations to glutamatergic CT input caused by DS. We investigated these differences in mice aged 2 weeks (prior to seizure onset), 4 weeks (after peak seizure burden), and 8 weeks (after seizure activity subsides) to elucidate the role of altered synaptic connectivity in disease progression. Preliminary results indicate that VGLUT1 synapses to the nRT are reduced in 8-week-old DS mice compared to WT mice, but not at 2 or 4 weeks. Our interpretation is that a change in synapse number is not likely contributing to the observed physiology at 4 weeks, and that the loss of synapses at 8 weeks may be due to prolonged CT synapse dysfunction in the nRT.

Mentor(s): Sharon Swanger (Assistant Professor, Fralin Biomedical Research Institute at VTC)

Michael Roberts-Tsoukkas
Virginia Tech/Aerospace Engineering

Earth-Moon Cycler Orbits with a Stable Subfamily

A family of periodic trajectories in the circular restricted three-body problem was studied, that, when viewed in the co-rotating frame, revolve around the Earth three times and the Moon two times per 74-day period. Several of the trajectories considered were determined to be stable, which would substantially reduce the amount of maneuvering required to maintain them. Furthermore, the period and coverage of key regions of cislunar space make these trajectories ideal for uncrewed cargo transportation and reconnaissance missions involving constellations of satellites. The trajectories were located precisely using a differential correction algorithm and stability analyses were performed using Poincaré maps. It is believed that other such stable 'Earth-Moon cyclers' exist and can be found systematically, based on an underlying theory of mechanisms of transport between the Earth and Moon in the circular restricted three body system.

Mentor(s): Shane Ross (Aerospace Engineering)

Stefan Robinson
Virginia State University/Computer Engineering

Polarizer changes affecting local and non-local interferometry

The Michelson Interferometer can be applied to many fields for various results including finding the precise position of objects, testing optical components, finding wind and temperature patterns, and in the application of quantum computer engineering it can be used to measure the interference of two photons to find out if the wave produced from the measurement is constructive or destructive. While there are many applications that the Michelson interferometer can be used for, the test of adjusting the polarizers during local and non-local measurements can lead to very idiosyncratic results when compared to a standard control measurement. During a measurement of local and non-local photon interference the user will adjust the H, V- and 45-degree polarizer to see the drastic changes of the interference when compared to the standard measurement whilst also comparing the two and comparing the differences of an entangled(non-local) and non-entangled photon pair. The results show that the polarizations decrease the photon count overall but applying certain polarizations certain distinct interference patterns with some being constructive patterns and some being destructive patterns. Other results caused less to now interference with the results looking distinctly different from the control when looking at the comparison of measurements with none of the overlapping. This experiment leads to communications being improved and signals being boosted with the polarization settings increasing the interference patterns of the photons.

Mentor(s): Wayne Scales (Quantum Engineering, Virginia Tech)
Shi Guannan Quantum (Engineering Virginia Tech)

Janae Robinson
Virginia Tech/Clinical Neuroscience

Visual Spectral Sensitivity of Jamaican Fruit-eating bat (Artibeus jamaicensis)

Bats rely on echolocation to navigate and detect food in their habitats. Because of their nocturnal cycle, it is commonly believed that bats rely on their hearing over any other sense. However, recent studies have questioned the extent that bats use their vision along with echolocation. In this study, we aimed to examine the spectral sensitivity of the bat species Artibeus jamaicensis by measuring the average inter-call interval length for different light conditions. We used eight different wavelengths ranging from 365 – 623 nm, corresponding to colors red, orange, yellow, green, blue, violet, and ultraviolet, paired with three different light intensities (1.5 lux, 6.6 lux, 10.0 lux) produced by two LED studio lights. In addition, we used a completely dark (0 lux) condition as the control. Eight randomized bats were flown, one at a time, in a flight room with each of the conditions and two ultrasound sensitive microphones. Our analyses showed that with higher intensity of light, the inter-call interval would slightly lengthen. This suggests that bats extract information about their surroundings using audio-visual integration sensory strategy. With visual wavelength we did not find any major differences in inter-call interval length.

Mentor(s): Silvio Macias (School of Neuroscience)

Simidele Rogers
Bennett College/Psychology with Biology minor

Recombinant Protein Expression and Purification: The Isolation of Glutathione S-Transferase

Glutathione S transferase (GST) is a protein involved in the detoxification of endogenous compounds and breaks down molecules through conjugation with reduced glutathione. Saccharomyces cerevisine GST is commonly used as a strategy for isolation of recombinant proteins from Escherichia coli fused with GST. In this work, a protocol for the isolation of GST from E.coli was performed. Bacterial cells were transformed with PGEX4T1, a plasmid that encodes GST. Protein expression was induced in the bacterium by the addition of isopropyl. B-D-1 thiogalactopyranoside, and incubated for 3 h at 25C. The purification procedure involved extracting GST using lysozyme, which breaks down the bacterial cell wall, and Triton X°100, which helps to extract the protein from membrane debris. A sonication step further increased protein recovery. GST was isolated from the total extract using affinity chromatography followed by size exclusion chromatography. The purity of GST was evaluated using SDS PAGE, which indicated that GST appeared as a single band of 26 kDa, consistent with the expected size. Overall, this procedure represents a conventional approach that can be used for the isolation of any recombinant protein fused with GST.

Mentor(s): Daniel Capelluto (Department of Biological Sciences)

Anna Rubley
Virginia Tech/Neuroscience

Monoubiquitination of Histone H2B decreases in the amygdala of male and female rats during fear memory formation

The ubiquitin-proteasome system (UPS) plays a crucial role in the formation of fear memories, primarily through protein degradation. This degradation process involves polyubiquitination, where multiple ubiquitin molecules attach to a single protein which often targets it for degradation by the proteasome. However, proteins can also be tagged by a single ubiquitin, termed monoubiquitin, which leads to functions independent of protein degradation, though monoubiquitination has not been well studied in the brain. Recently, our lab found that monoubiquitination of the H2B histone (H2Bubi) is a master regulator of the transcriptome necessary for contextual fear memory formation in the hippocampus. Despite this, it remains unknown if H2Bubi functions as a master transcriptional regulator for memory formation in other brain regions, particularly the amygdala that is essential for the formation of all fear-based memories. This experiment examines H2Bubi in the amygdala by comparing H2Bubi levels in naive versus fear conditioned male and female rats. Results indicate a significant decrease in H2Bubi levels in fear conditioned rats compared to naive animals with no observed sex differences, though females exhibited a slightly larger decrease than males. Current experiments are investigating behavioral changes following fear conditioning by upregulating RNF20, the ligase essential for H2Bubi, using CRISPR-dCas9.

Mentor(s): Timothy Jarome (School of Animal Sciences)

Irelin Ruppel
Hollins University/International Relations

"A Push for Democracy:" The United States' Democracy Promotion in Chile, Peru, Bolivia, and Ecuador

Extensive research was undertaken to investigate the United States' role in regards to democracy promotion and decisions in the countries Chile, Peru, Bolivia, and Ecuador. Decisions about U.S foreign policy in these regions are left to the bureaucracy of US foreign policy establishment. This research project tests whether there is institutional continuity and policy making when elected officials and political appointees are not involved. This research specifically focuses on countries that are separate from the core interests and vital concerns of the United States reflecting the influence and motivation the US government may have. This study recovers evidence that supports the idea that the United States plays a major role in influencing these countries' ideology on democracy with an extensive amount of evidence from journal articles, journalistic analyses, congressional hearings, and administration statements. An analysis of these sources yields the explanation that the US has heavily influenced these countries' democracy decisions through money, support, and persuasion. The evidence adds nuance to our understanding of the role that the United States government plays to influence countries on the promotion of democracy. While very little attention from scholars on this crucial area has been done, the research conducted opens up entirely new knowledge to the field. This project will contribute to future research on similar topics and encourage more studies to be conducted with the role of the US government in their promotion of democracy and other decision making.

Mentor(s): Edward Lynch (Global Politics and Societies; Hollins University)

William Ryder
Randolph-Macon College/Chemistry

Tuning Catalytic Efficiency of Synthetic Enzyme Kemp Eliminase 15 by Attaching a DNA Fragment

The synthetic enzyme Kemp Eliminase 15 (KE 15) catalyzes the formation of 2-Hydroxy-5-nitrobenzonitrile from 5-Nitrobenzisozazole. However, KE 15 and other synthetic enzymes are less efficient than natural enzymes. The most popular method for improving synthetic enzymes is introducing mutations. However, mutations do not guarantee a better enzyme and risk breaking the structure. Instead of using mutations, an attempt to tune the efficiency of KE 15 was made using a histidine tag and tris-nitrilotriacetic acid to attach DNA. The rationale behind this is preorganization theory. It argues that the major reason enzymes work is by providing a better electrostatic environment for the reaction than the solvent. Using Groningen Machine for Chemical Simulation (GROMACS) a DNA strand was put in a box under vacuum with sodium ions to balance the charge. This pdb file was converted to tinker xyz. The tinker file mass was recentered and the lowest energy conformation of the DNA was found using Tinker software functions. A molecular dynamic simulation was performed to determine the stability of the DNA. This process was repeated using the lowest energy conformation of the isolated DNA strand, but with a box solvated with water. The lowest energy conformation of the DNA from the solvated simulation was attached to the enzyme where the process was repeated. After the molecular dynamics simulations of the enzyme and DNA system an electric field calculation used to determine the electrostatics of the system. Through this methodology the electrostatic impacts of DNA attached to KE 15 can be explored.

Mentor(s): Valerie Welborn (Department of Chemistry)

Robine Saintile
Delaware State University/Biochemistry

Synthesis and electrochemical performance optimization of P2 (prismatic crystal structure) layered NaxMn0.8Fe0.1Ti0.1O2

Sodium-ion batteries have attracted the attention of the economy due to their electrochemical performance, inexpensive cost, and abundance of sodium. Sodium ion batteries contain three components: cathodes, anodes, and electrolytes. We work in synthesizing and measuring electrochemical performance of P2-type layered oxides. A unique feature of sodium layered oxides is their ability to crystalize into thermodynamically stable P2 layered structures with under-stoichiometric Na content. Despite the instinct advantages of P2-type layered oxides, these oxides still face critical challenges inclusive of structural deformation, and Na deficiency. Our experimental plan consists of coprecipitation of Mn0.8Fe0.1Ti0.1(OH)2, observing the morphology of sodium based layered oxides. Calcination parameter optimization, which incorporates temperature, duration, and sodium content. Rechecking morphology, checking phase purity, stoichiometry of the calcines materials, and electrochemical characterization. This study highlights the overall process in creating P2-layered oxides.

Mentor(s): Lin Feng (Chemistry)

Rupabali Samanta
Virginia Tech/Clinical Neuroscience

Investigating the Effect of Peripheral CSF Overexpression and Psychological Stress on Macrophage Function in Ovarian Tissue

Psychological stress contributes to various mood disorders, including depression. These disorders are twice as likely to occur in females compared to males, with this sex difference emerging at puberty and diminishing at menopause. This pattern suggests that ovarian hormones play a role in the higher rate of mood disorders in females. There is a strong relationship between ovarian hormones, stress, and the immune system. Colony-stimulating factor 1 (CSF1) is a cytokine that increases circulating levels of innate immune cells and signaling proteins associated with immune activation. CSF1 is necessary for the onset of normal ovarian cycling in female mice. In the periphery, CSF1 and estrogen are oppositely regulated such that decreasing estrogen would increase CSF1 levels.

In this project, we investigated how stress and CSF1 overexpression impact CSF1 receptor expression in ovarian macrophages of female mice. Ovaries were collected after genetic modification of the CSF1 gene using jet-PEI, a non-viral CRISPR-Cas9 gene editing system, or after completing the SCVS protocol. The ovaries were cut at a thickness of 30 microns via cryostat microtome. Immunohistochemistry was performed on these tissues for the ligand CSF1, the receptor CSF1R, and the macrophage marker Iba1. Imaging was obtained using a Nikon A1 confocal microscope and a Keyence BZ-X Series Fluorescence Microscope. Image analysis was conducted using Imaris software (v9.8.2). This project highlights the utility of jet-PEI agents for peripheral gene manipulation and could reveal the effects of CSF1 overexpression and the SCVS paradigm on CSF1/CSF1R binding in ovarian tissue.

Mentor(s): Georgia Hodes (School of Neuroscience, Virginia Tech)
Dr. Tim Jarome (Animal and Poultry Science, Virgina Tech)

Connor Sandberg
Virginia Tech/Aerospace Engineering

Independent Research

Small Scale Aluminum Combustion Ignition System

The goal of this project is to carry out small-scale testing and decide if parallels can be drawn between small-scale and large-scale testing. Current work on this project includes determining an effective aluminum powder ignition mechanism. Aluminum powder is an additive to fuels and energetics due to its high volumetric and gravimetric heat of combustion. Before aluminum can combust, the particle's outer layer must be removed through melting or cracking. Large-scale testing is time-intensive and costly, making small-scale testing a more sustainable option. Hot wire ignition was selected as the combustion mechanism. Its low energy contribution minimizes energy and pressure input not resulting from aluminum combustion. Our experiment consists of testing particle sizes 1µm - 95µm with a concentration of 100-400 g/m3 in a 96 mL vessel pressurized at 1 atm. Because the vessel is pressurized, pressure differences are also measured. For combustion, a temperature of ~2000K is needed and the ignition temperature for the hot wire is 3695K. Tungsten (125µm diameter) and platinum (75µm diameter) wire were chosen for their high melting points and conductivity. During testing, the platinum wire did not combust the aluminum due to lack of heat generated. The tungsten wire can be used to combust 1µm, 10µm, and 30µm aluminum particles. It is uncertain if 95µm powder was combusting during preliminary testing. It melted to the tungsten wire but the characteristic white light from aluminum combustion was not seen. Future work includes creating pressure concentration curves generated during aluminum combustion for comparison with large-scale testing.

Mentor(s): Eric Jaques (Dept. of Civil & Environmental Engineering, Virginia Tech)
Molly Kamide (Dept. of Civil & Environmental Engineering, Virginia Tech)

Claudia Sanna
Virginia Tech/Mechanical Engineering

CEED

Developing Pneumatic Air Muscles to be used in a Robotic Snake

Pneumatic air muscles have been used in soft robotics to mimic biological muscles. The muscle being used for this prototype are called the McKibben air muscles. These muscles are manufactured by inserting a silicone tube into a braided mesh sleeve with plugs which are secured by a hose clamp. Previous iterations of these muscles used 3-D printed barbed fittings for each end of the tube. To better imitate real-life muscles, the plugs must be replaced with a flexible material. Then to evaluate these muscles, two muscles must be attached to a flexible backbone on separate sides so that we see to what extent the muscles are able to bend the backbone. Silicone was used to cast a backbone and to create soft plugs for the ends of the muscle. These new muscles take longer to manufacture but perform as well as their earlier versions. The main improvement is that these muscles are not as bulky, which will help once more muscles are attached to the backbone. In the future, resin printing pneumatic air muscles could be beneficial since it can allow us to create smaller muscles which can help with making a more compact final prototype.

Mentor(s): Noel Naughton (Mechanical Engineering)

Ivan Savelyev
Virginia Tech/Psychology

BRIDGE summer undergraduate research grant

Phone Use and Gratitude Expression: Naturalistic observations of pedestrian-driver interactions

Within the domain of positive psychology, it's been demonstrated that expressions of gratitude boost subjective wellbeing for both parties involved—the benefactor and the beneficiary of an expression of gratitude. Student researchers from the VT Center for Applied Behavior Systems have systematically observed pedestrians using VT crosswalks for eight semesters and found that less than 15% of over 1,500 pedestrians using marked crosswalks on campus waved a sign of gratitude to the drivers of vehicles who had stopped for them. he current field study was designed to determine factors that influence people's likelihood to thank the drivers of vehicles who had stopped for them at a crosswalk in downtown Blacksburg. We have been observing and recording various human dynamics occurring before and after a vehicle stops for a pedestrian, including the pedestrian's facial expression (smiling/not smiling), social interaction (walking alone/walking with others), gratitude (gratitude expressed/not expressed), and phone use (using/not using phone). Gender and an approximation of age are also recorded per pedestrian, along with the number of vehicles that passed a pedestrian waiting to cross. Those who express gratitude are significantly more likely to smile afterwards; and those using their cellphone while crossing the street are significantly less likely to express gratitude. Also, pronounced differences in frequency of gratitude have been observed as a function of the pedestrian's age, with "50+" individuals being the most likely to express gratitude (62% of 297), and those "Under 18" being the least likely to do so (11% of 131).

Mentor(s): Scott Geller (Psychology)

Hugh Scarpa-Friemdan
Virginia Tech/Mechanical Engineering

CEED

Ultra-High Temperature Ceramics (UHTC) Test Rig Electronics Modification and Torch Replacement

This research involves modifying a torch test rig to test ultra-high-temperature ceramics under temperatures between 1000◦C - 3000◦C. Goal 1 is to reconfigure the motors' electronics and software so they can automatically move the torch in two directions and by predetermined distances. Goal 2 is to reconfigure the rig's assembly to accommodate a propylene-burning torch to replace the current oxyacetylene-burning torch for safety and usability, enabling future testing of a wider range of parameters. Ceramics tested using this rig will later be applied to extreme temperatures such as those generated by hypersonic travel and aerospace vehicles.

Several problems were discovered. For Goal 1, incorrect wiring of the circuit board sending movement instructions made the motors move in the wrong directions and was fixed by rewiring the circuit from the Arduino microcontroller to the motor drivers. Also, a motor wheel was not securely fastened, preventing that motor from pushing the rig with the expected force. A replacement fastener will be ordered. For Goal 2, the rig components were not correctly oriented to house the new larger propylene torch. The heating tip is 14 inches long and slanted at a 70-degree angle, and the paired torch handle is 7 inches long. This combination will fit the current rig structure if the components are reoriented to accommodate the slant.

Next steps are: (1) secure the motor wheel with new fasteners and ensure the motors can push the rig forward and backward, (2) modify the rig program to enable stopping at predetermined locations, and (3) adjust the rig structure to fit the new torch.

Mentor(s): Carolina Tallon (Materials Science and Engineering)

Reilly Sekyere
Hampton University/Chemistry

Microbes vs. Preservatives: Microbial Activity in Cosmetic Products and How Preservatives Affect Growth

The cosmetic industry is continually developing new ingredients, methods, and products, while working to ensure consumer safety. When it comes to microbial growth, preservatives are the front-line defense in cosmetic products. Several cosmetic products were qualitatively screened for bacteria through T-streaks on LB agar plates. Only 7.4% of the samples were contaminated. The Gram stain procedure and other biochemical tests were used to identify select characteristics of the isolated bacteria. To test the efficacy of their preservatives, a sample of Cover Girl foundation from the 1980s and a new 2024 sample were inoculated with high numbers of the common skin bacterium Staphylococcus epidermidis. Colony forming units (CFUs) of the bacteria were determined through the applications of serial dilutions in phosphate buffered saline (PBS) and spread plates on LB agar. Surprisingly, the preservatives in the older makeup worked immediately, decreasing CFUs by 1000X on the initial day that the bacteria were introduced. Overall, the 1980s makeup eliminated the bacteria at a faster rate than the 2024 sample, possibly due to chemical changes within the older makeup sample or a change in the formulation of preservatives throughout the years. Finally, two more cosmetic samples were analyzed containing essential oils or both natural and synthetic chemicals using the methods described above. After 24 hours, all samples had similar CFUs, but by 72 hours, the sample that used essential oils was eliminating bacteria at a faster rate. This study demonstrated that preservatives vary in their ability to safeguard cosmetics products against bacterial contamination.

Mentor(s): Ann Stevens (Department of Biological Sciences)

Kathryn Shannon
Loyola University Maryland/Biology

How Dogs Experience Loss: The Impacts of Permanent Disruption of Familial Social Structure on Age Related Decline in Canines

Due to the close relationship between dogs and humans, many factors that can affect health outcomes in people, such as aging, can be modeled by dogs. This study is focused on how dogs experience losing a family member (human or animal) and how such loss may impact their aging process. The data used was collected by The Dog Aging Project (DAP), a large-scale, longitudinal study engaging thousands of dog owners who share information about their dogs. Participants complete surveys about observed changes in behavioral and physical health of their dogs, as well as updates in life circumstances. The aim of this study was to analyze qualitative free response data collected in these surveys. Via Annual Follow-Up Survey (AFUS), 29781 dog-owners indicated an age-related change in their dog. Of these, 1578 respondents (5%) elected to give additional information in free-response, categorized by the owner as a quality of life change or age-related change. In examining free responses, we found that several themes emerged, including owners indicating that grief and loss was an explanation for changes in pet health. Of respondents who gave additional information about quality of life or age-related change, 8.37% indicated grief, loss, or other change to the dog's social structure/companionship. These changes were reported through comments categorized into behavioral and physical changes. This research topic and the subject of thanatology is important to caring for canine companions through periods of loss as well as evaluating the potential impacts of grief on human health.

Mentor(s): Audrey Ruple (Population Health Sciences Dept- Virginia-Maryland College of Veterinary Medicine)
Dr. Courtney Sexton (Population Health Sciences Dept- Virginia-Maryland College of Veterinary Medicine)

Isaac Shimozono
Virginia Tech/Biochemistry

The Effect of Hypoxia on Exercise Responsive Genes in Mouse Skeletal Muscle

Despite extensive research showing benefits of exercise on overall health, many bio-molecular mechanisms and pathways affected by exercise are not fully understood. One such pathway is induced by hypoxia, a condition in which there is a reduced amount of oxygen available to cells, as experienced in actively exercising skeletal muscle. Hypoxia triggers a cascade of changes in metabolic gene regulation that is not fully understood.

To shed light on skeletal muscle's response to hypoxia, C2C12 mouse skeletal muscle cells underwent cellular differentiation to transform from myocytes into myotubes and were subsequently exposed to hypoxia using both chemical and environmental induction. Initial investigations used increasing concentrations of cobalt chloride ($CoCl_2$) to induce hypoxia. Alternatively, additional C2C12 cultures were exposed to a 2% O_2 environment using a hypoxia-chamber for a time-course treatment. Cells were harvested, RNA isolated, and cDNA prepared from each experimental set. The relative expression of exercise-stress responsive genes Ho-1, Nrf1, Hk2, Sik1, and Pdk4 was measured using qPCR.

The results indicate that Ho-1 and Nrf1 are upregulated with 150 □M $CoCl_2$ treatment ($p < 0.05$), but there is no significant change in the expression of the other genes. Similar results are anticipated from the hypoxia-chamber group. Future work will explore how hydrogen peroxide, a reactive oxygen species generated during exercise in skeletal muscle, alters the expression of the aforementioned genes.

Mentor(s): Adele Addington (Human Nutrition Food and Exercise Sciences; HNFE)
Siobhan Craige (HNFE, Virginia Tech)

Matthew Si
Virginia Tech/Chemical Engineering

Purification of Molten Salt For Energy Storage Systems

To meet growing energy needs while reducing greenhouse gas emissions, nuclear energy production provides an optimistic solution. One promising approach to generating nuclear energy is with Molten Salt Reactor (MSR). MSR are safer to operate than traditional nuclear reactors because they can be operated at lower pressures, are more cost effective as the lower pressure allows for thinner vessels, and still allow for efficient energy transfer. However, an issue with MSR is that impurities- such as oxides, moisture, sulfides, and metals- can significantly impact the redox potential in molten salt environments and lead to corrosion of vessel walls. To purify the salt, a system was developed to reduce these impurities through thermal, chemical, and physical separation. Different parameters like varying hydrogen and argon flow rates were investigated to obtain the limits and efficacy of the system. Carbon-sulfur combustion analysis, oxygen-hydrogen inert gas fusion analysis, and Inductively Coupled Plasma Mass Spectrometry (ICP-MS) were the analytical methods used to quantify the impurity left in the purified salts. Though more tests need to be conducted to understand the full capability of the purification system, results seem to point toward the system being a successful method in purifying salts.

Mentor(s): Amanda Leong (Mechanical Engineering, Virginia Tech)
Jinsuo Zhang (Mechanical Engineering, Virginia Tech)

Marisa Sigrist
Virginia Western Community College to Radford University/Medical Lab Science

Purification of the MalE-McpWPR fusion protein using a pTEV cloning vector and characterization of its ligand spectrum.

Sinorhizobium meliloti is a Gram-negative alphaproteobacterium that senses chemoattractants exuded by alfalfa roots with the help of specific chemoreceptors. This behaviour enables S. meliloti to move towards plant roots and engage in symbiosis wherein it fixes atmospheric nitrogen into ammonia for alfalfa and receives carbon sources as nutrients in return. S. meliloti possesses eight chemoreceptors called methyl-accepting chemotaxis proteins (MCPs), McpT through McpZ, and one transducer protein, IcpA. Among these receptors the ligand profiles of McpW, McpY, McpZ, and IcpA remain undescribed. The present study involves the characterization of the periplasmic region (PR) of McpW fused to the maltose-binding protein MalE for identifying its potential ligand profile. For this, the part of the mcpW gene encoding for the PR of McpW (McpWPR)was cloned into plasmid pKLD66, resulting in its fusion to MalE with an N-terminal 6x-His affinity tag. Escherichia coli BL21/DE3 cells were transformed with the resulting plasmid pBS756. His6-MalE-McpWPR was purified from the cell-free soluble extract using Ni-NTA affinity chromatography followed by size exclusion chromatography (SEC). Quality of SEC fractions was analyzed via SDS-PAGE and quantified using a Bradford protein assay. His6-MalE-McpWPR was successfully purified as confirmed by a 60 -kDa band on an SDS-PAGE gel. More than 50 mg fusion protein per L of bacterial culture were obtained, which is being analyzed for its potential ligand profile using Differential Scanning Fluorimetry. The putative ligands of His6-MalE-McpWPR will be further validated using Isothermal Titration Calorimetry and chemotaxis capillary assays to analyze their physiological effect on chemotaxis in S. meliloti.

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

Cayden Smedley
Virginia Tech/Aerospace Engineering

Transport of Biological Particles in the Atmosphere

Studying the Movement of Biological Particles in the Atmosphere Within and Above Forests in Mauerbach, Austria

Trees are susceptible to a wide range of pests and diseases, which can lead to the decline or even destruction of the forests they inhabit. Understanding the movement of the increased emission of biological particles produced while a tree is under stress is one measure of the health of a forest. We hypothesized that the emission of biological particles varies within and above forest canopies. To test this hypothesis, we used three sensor packages, henceforth known as a sampler, equipped with an optical particle counter (OPC), an impinging device (ID), an ultrasonic anemometer (UA), and a suite of meteorological sensors. We strategically positioned one sampler above (on a drone, 40m above ground level, 10m above tree canopy), within, and just outside a spruce forest in Mauerbach, Austria. We observed similar trends in particle concentrations for in the 0.03-0.05µm range within and above the tree canopy. Preliminary results indicate these particle concentrations were also higher earlier in the day, possibly due to the cooler temperatures, increased humidity, and decreased atmospheric mixing. Our work provides important information on the emission of biological particles from spruce forests in Austria and could help provide information on the health of the forests in the future.

Mentor(s): David Schmale III (School of Plant and Environmental Sciences)
Reginia Hanlon, Research Associate, Virginia Tech

Kyle Smith
Virginia Tech/Mechanical Engineer
Gabriel Worsley
Virginia Tech/Computer Science

CEED

Sandponics: A new approach to traditional nitrification and solids removal processes in aquaponics systems

An aquaponics system is a closed system wherein fish, plants, and bacteria maintain a synergistic closed-loop system. Traditional aquaponics systems typically contain clay pebbles as the plant grow media and include auxiliary mechanical components for solids removal and nitrification. Sandponics is an innovative approach wherein the mechanical components are not necessary since solids removal and nitrification occur within the sand media itself, saving energy and costs. The objective of this experiment is to determine how three different sand media types (play sand, paving sand, and all-purpose sand) and clay pebble media may differ in terms of nitrifying and solids filtering capabilities within an aquaponics system. Water will be sampled and analyzed from the grow beds and fish tank, and impacts on fish and plant growth parameters will also be measured. Each of the four treatments (three sand types and 1 clay pebble type) is duplicated, for a total of eight different grow beds. The experiment is ongoing, but the expected result is that sand media will carry out denitrification and solids removal at a similar capacity as compared to the clay pebble media, with no significant detrimental impacts to fish or plant growth. If the research follows our expectations, this experiment will demonstrate the efficacy of sandponics systems, potentially leading to more widespread implementation of aquaponics systems due to the energy and cost savings of removal of auxiliary solids and nitrifying filters.

Mentor(s): Natasha Bell (Biological Systems Engineering)

Amanda Sobrado
William & Mary/Psychology

Internalizing Symptoms as a Protective Factor Against Drug and Alcohol Use for Highly Impulsive College Students

Drug and alcohol use in college students remains a critical concern, with approximately 20-25% of college students engaging with illicit substances and 79% engaging in alcohol use. There are high rates of comorbid substance use among individuals with anxiety, depression, and attention-deficit/hyperactivity disorder (ADHD). Impulsivity is a multifaceted marker that has been recognized as a risk factor for drug and alcohol abuse, and partially accounts for the high comorbidity between these diagnoses. Given this backdrop, the current study examines the role of impulsivity in the association between internalizing symptoms (depression, anxiety, and stress) and drug and alcohol use among college students. Participants included 143 college students (81.8% female; 42.7% freshman; 65.0% White; 14.7% Latine). To ensure variability in impulsivity, a subsample of students who self-reported having an ADHD diagnosis (n=63) were recruited. Participants self-reported on the Alcohol Use Disorders Identification Test; Drug Use Disorders Identification Test; Depression, Anxiety, Stress Scale-21 Item; and the Barkley Adult ADHD Rating Scale. Multiple regression analyses using the PROCESS macro in SPSS found significant interactions between internalizing symptoms and impulsivity in predicting both drug and alcohol use. Specifically, for people with low levels of impulsivity, there was a positive association between internalizing symptoms and drug use, but a non-significant association with alcohol use. In contrast, for people with high levels of impulsivity, the association between internalizing symptoms and drug and alcohol use was negative. Results suggest that internalizing symptoms are protective for highly impulsive college students.

Mentor(s): Rosanna Breaux (Psychology)

Carter Spillman
UNC-Greensboro/Biology

VT-REEL

Quantifying Differences in GHG Emissions in Biological-Treated Fertilizer and Untreated Fertilizer

Biologicals are agricultural products that aim to promote increased nutrient availability and uptake through symbiotic relationships with microorganisms. We investigated Biological A, a biofertilizer which utilizes living microbes to enhance plant nutrition by mobilizing or increasing nutrient availability in soils. Nitrogen (N) fertilization is known to influence greenhouse gas (GHG) emissions and this biological product is hypothesized to result GHG emissions. It is well documented that enhanced efficiency fertilizers applied as a coating to urea fertilizers reduce greenhouse gas emissions and rates of ammonia volatilization, though little data are available for agricultural biological products. This study aimed to compare the rate of greenhouse gas emissions and ammonia volatilization in plots where corn was treated with no N fertilizer (control), untreated granular urea, and biological treated granular urea. Gasmet measurements and static chamber measurements were taken weekly to monitor flux events in GHG emissions and ammonia volatilization over a period of three minutes (Gasmet) and forty-five minutes (static chamber). To monitor nutrient uptake and availability soil samples and tissue samples were collected throughout the growth cycle. Preliminary results suggest that rates of greenhouse gas emissions may be reduced with the use of biological, but that differences in nutrient uptake and availability are not statistically significant. Future research should aim to improve the consistency of results with biologicals by studying their interactions in different soils and rainfall conditions.

Mentor(s): Hunter Frame (Crop and Soil Environmental Sciences)

Luke Stanley
Virginia Tech/Biological Sciences

Transcriptional Activity of Per2AS is Dampened in the Presence of its Enhancers

Circadian rhythms are 24-hour rhythms in an organism's behavior and physiology. These rhythms are found in nearly all living organisms and provide evolutionary benefits to survival and fitness. In mammals, these rhythms are present within each cell and are generated by a genetic circuit comprising of a set of "clock genes" that control each other's expression in a 24-hour cycle. Our group recently found that the long non-coding RNA, Per2AS, is involved in the genetic circuit and plays an important role in regulating circadian rhythms. The overarching goal of this study is to understand the regulatory mechanisms of Per2AS transcription, as the transcriptional activity of Per2AS appears to be critical for its function. I hypothesized that three enhancer regions near the Per2AS promoter regulate the transcription activity of Per2AS. To test this, I used Per2AS promoter reporter genes with and without the three enhancer regions and performed luciferase reporter assays. I found that the expression of Per2AS was decreased in the presence of the enhancer regions. It was also found that the "clock genes", such as Nfil3, Rev-erb a, Rev-erb B, Bmal1 and Clock, and Dbp slightly recover the decrease in transcription activity caused by the enhancer regions. This data indicates that the enhancer regions of Per2AS contribute to its transcriptional activity. Future experiments can clarify the specific function of individual enhancer region.

Mentor(s): Shihoko Kojima (Biological Sciences)

Erika Strobel
Virginia Tech/Psychology

Fralin SURF

Social Cognition Deficits as a Transdiagnostic Risk Marker of General Psychopathology

The general psychopathology factor, or the "P-factor", captures the shared variance between mental disorders, accounting for comorbidity and severity of mental disorder symptoms. Deficits in social cognition, impairments in one's ability to consider their own or others' thoughts and feelings, are present in many mental disorders and are associated with greater symptom severity. No studies to date have investigated whether social cognition deficits are associated with general psychopathology. This project is the first to examine relations between multiple social cognitive processes and general psychopathology.

A sample of 310 Virginia Tech Psychology students (aged 18-25; 22.9% male) completed an online survey of social cognitive function and general psychopathology. We administered self-report questionnaires (Mentalization Scale and Perth Alexithymia Questionnaire) and behavioral tasks (Reading the Mind in the Eyes Test and Penn Emotion Recognition Test) measuring multiple social cognitive processes. Participants also completed the Adult Self Report (ASR) questionnaire as a measure of general psychopathology. Separate multiple linear regressions were conducted to examine relations between social cognition scores and the ASR Total Problems scores. Age and gender were included as covariates.

Higher ASR Total Problems scores were only significantly associated with worse alexithymia (Std. B=-0.404; $p<0.001$), poorer self-oriented mentalization (Std. B=-0.370; $p<0.001$), and greater accuracy on the Emotion Recognition Test (Std. B=0.134; $p=0.026$).

Social cognition impairments, specifically self-related mentalization deficits and worse alexithymia are present in young adults with high general psychopathology. Results suggest social cognitive deficits may be transdiagnostic risk markers for a range of mental disorder symptoms.

Mentor(s): Adrienne Romer (Psychology)

Cassandra Sturgill
Virginia Tech/Biochemistry

Quantifying Natural Antibody and Complement levels in House Finches through Hemolysis-Hemagglutination Assays

Constitutive innate humoral immunity comprises the first line of defense in many organisms, including House Finches (HOFI). This type of immunity describes a non-specific immune response that is present even without prior exposure to a pathogen. This immunity encompasses two components: Natural Antibodies (NAbs), and complement. NAbs exhibit less sensitivity than acquired antibody responses to short-term fluctuations in different conditions, such as the environment. Additionally, the production of NAbs represent a functionally distinct component of humoral immunity, as cells that produce NAbs are seemingly unaffected by experimental infection and initiation of specific antibody response. Studies considering the levels of NAbs existing in wild birds at different stages in an infection's lifespan are limited, and HOFIs pose as a model organism for expanding on this type of study due to their abundance and non-fatal reaction to a prevalent infection in HOFI caused by Mycoplasma gallisepticum, or MG. By conducting hemolysis-hemagglutination assays that utilized multiple different plasma samples from a population of HOFI birds present in varying temperatures, such as hot and cold, we were able to measure the levels of NAbs and complement present in the same sample population of HOFI twelve days pre-inoculation of MG, and eighteen days post-inoculation. This was done by scoring levels of lysis and agglutination in each sample's row, and it is expected that there will be not be varying levels of NAbs and complement between pre- and post-inoculation samples.

Mentor(s): Dana Hawley (Biological Sciences)

Birdie Suber
Hollins University/Film and English

Hope of Escape Research Archive (HERA)

The "Hope of Escape" Research Archive Project aims to document and preserve the historical artifacts used in producing the film "Hope of Escape" directed by Dr. Amy Gerber-Stroh of Hollins University. This archive includes a collection of original documents, letters, and photographs, each of which was used to help provide a thorough and accurate representation of the true story depicted in the film. The project seeks to ensure the accessibility of these valuable resources for future researchers, filmmakers, and those who wish to research their family tree. By digitizing these materials and creating a searchable database, the archive creates a deeper understanding of the historical events and personal narratives that inspired the film. This initiative supports the film's authenticity and educational value and contributes to the broader preservation of historical heritage. The "Hope of Escape" Research Archive is a testament to the dedication and rigorous research that inspired the film's creation, offering a lasting legacy that supports both historical scholarship and public engagement with history.

Mentor(s): Amy Gerber-Stroh (Hollins University, Film)

Martha-Patience Taah
Virginia Tech/Computer Science

Aligning EEG and EmotiBit Data: Development of Effective Synchronization Methods

Devices that capture physiological response signals such as Galvanic Skin Response (GSR) and heart rate are crucial for EEG studies. In sleep studies, this data can be monitored to expand understanding of sleep and memory by providing insights into the state of the body during different sleep stages. Accurate signal collection and alignment is crucial for ensuring the integrity of physiological data and its analysis. However, aligning signals across different devices can be challenging. While some research-grade products, like the Empatica E4, are available, they operate within closed ecosystems, are costly, and can be discontinued suddenly. In contrast, open-source devices like EmotiBit are more affordable and allow researchers to customize their data collection while still providing the necessary signals for research. We investigated two strategies to align EEG and EMG signals with EmotiBit data: using a Lab Streaming Layer (LSL) to send triggers to the devices and creating physical artifacts on both devices simultaneously. The LSL method involved using a Python script to send triggers over WiFi to coordinate the timing of the recorded data streams. Physical artifacts were generated by tapping the Emotibit and an EMG sensor together. Our findings indicate that the latency between triggers sent to the EmotiBit via LSL varied significantly, making alignment difficult. Conversely, we observed more consistent results using physical artifacts. The physical artifact method showed more effective synchronization of the EmotiBit and EEG data. The variance in latency with physical artifacts is less than a quarter of that from the LSL triggers. Refining this approach could facilitate broader access to EEG research while ensuring accurate synchronization of data timestamps, preventing misinterpretation of data.

Mentor(s): Sujith Vijayan (Neuroscience)

Mishael Taylor
Rice University/Biosciences

Innovative Phage-Based Strategies to Combat Virulence in Antibiotic-Resistant Salmonella Typhimurium (STm)

The rise of antibiotic-resistant Salmonella typhimurium (STm) strains requires innovative approaches to combat bacterial virulence. The primary aim of this research is to explore the use of bacteriophages to inhibit a gene responsible for virulence in STm. To achieve this goal, we aim to modify the bacteriophage P22 by inserting the dCas9 protein, a CRISPR-based tool for gene repression. Our preliminary experiments successfully show that the dCas9, bearing a guide-RNA complementary to the Red Fluorescent Protein (RFP) gene, expression into the P22 prophage of RFP and Green Fluorescent Protein (GFP)-expressing Escherichia coli (E. coli) lysogen, achieved a significant reduction in RFP expression without affecting the intensity of Green fluorescence. This outcome suggests that a similar approach could reduce the expression of virulence genes in STm. However, a challenge we faced was the low yield of phage production, critical for subsequent testing in mice models. To address this limitation, we are looking at an alternative strategy that targets the ATPase enzyme InvC in the Type 3 Secretion System in STm. By inserting a defective ATPase gene into the P22 phage, we hope to disrupt the ATPase function upon infection and reduce the overall virulence of STm. Future work will focus on optimizing phage production and testing dCas9 and ATPase disruption strategies to reduce STm virulence.

Mentor(s): Bryan Hsu (Biological Sciences)

Chloe Taylor
Virginia Tech/Sustainable Biomaterials

MASBio

Effect of Modified Cyclodextrin on Polylactic Acid Inclusion Complex Formation

Polylactic acid (PLA) is the most widely available bioplastic and has similar properties to traditional petroleum-based plastics such as polypropylene (PP) and polyethylene terephthalate (PET). It is used in many industries such as agriculture, automotive and packaging, but it has not been comprehensively employed due to poor thermal stability and other functional limitations. Previous literature has demonstrated improved thermal stability of PLA with formation of inclusion complex between beta-cyclodextrin and PLA. In this study, the technical diversity of inclusion complex formation is advanced using hydroxypropyl-beta-cyclodextrin. The high polarity due to the hydroxypropyl functional group may enable the advancement of thermal and physiochemical properties of PLA. Various analytical techniques, including thermogravimetric analysis (TGA), Fourier transform infrared spectroscopy (FTIR), and differential scanning calorimetry (DSC), were employed to characterize compounds formed at each step of the reaction and isolation process. Films incorporating the inclusion complex product were prepared and tested to evaluate mechanical, thermal, morphological and physical properties. These findings will advance bioplastic technology and allow for more widespread adoption of PLA in packaging applications.

Mentor(s): Young Kim (Sustainable Biomaterials)

Fern Thompson
Virginia Tech/Biochemistry

Itching for an Answer to the Late Enzymatic Steps in Poison Ivy Urushiol Biosynthesis

The late steps in poison ivy (Toxicodendron radicans) urushiol biosynthesis are hypothesized to be either anacardic acid or cardanol conversion to urushiol. The predicted enzyme activities are either an anacardic acid decarboxylase/2-hydroxylase, or a cardanol 2-hydroxylase enzyme activity. Potential enzyme families capable of these enzyme activities include: 2-oxoglutarate-dependent oxygenases (2ODO), Cytochrome P450 (CYP), nahG-like, or a flavin-containing monooxygenase (FMO), the three latter being the current target of this investigation because they all require NADPH as a cofactor. Cell free crude enzyme extracts from poison ivy drupes were assayed for concomitant NADPH-dependent and either anacardic acid- or cardanol-dependent urushiol formation using GC-MS-based urushiol detection. To date, no significant increases in urushiol levels over time from either anacardic acid or cardanol were observed. This could be due to improper or unoptimized enzyme assay conditions, and/or due to the inherent capacity of the urushiol to oxidize/polymerize over time making the urushiol product difficult to detect. Without significant evidence for a nahG-,CYP-, or FMO-like enzyme activity, the possibility of a 2ODO-like enzyme activity responsible for urushiol formation remains a valid hypothesis worthy of investigation.

Mentor(s): John Jelesko (School of Plant and Environmental Sciences)

Keegan Trubenbach
Virginia Tech/Civil Engineering

The Impact of Adsorption Materials for Passive Sampling of Aquifer Microbes

Technologies such as managed aquifer recharge (MAR) and bioremediation promise to play an influential role in addressing water storage and water quality concerns that come with the ever-increasing demand for water. Providing necessary risk assessment for MAR as it pertains to monitoring microbial community changes. There is a growing need to monitor the changes in microbial communities within aquifers as they play a crucial role in water quality and the overall health of groundwater ecosystems. Passive samplers are a promising tool to monitor microbes in a manner that represents their in-situ state within an area of study. Using a lab-scale continuous loop experiment, the objective of this experiment was to compare the effectiveness of adsorption materials (sediment, zirconia beads, and sand) in capturing and accurately reflecting the microbial communities present within an aqueous influent. Various media were studied to address the experiment's hypothesis that microbial abundance and diversity differ in the experimental recovery based on the adhesion media used. To test this hypothesis Qubit analysis along with Alpha and Beta Diversity Analysis will be done on extracted DNA from the samples taken. This research will play a key role in implementing a passive sampler in an aquifer environment.

Mentor(s): Jingqiu Liao (The Charles Edward Via, Jr. Department of Civil and Environmental Engineering)
Amy Pruden (The Charles Edward Via, Jr. Department of Civil and Environmental Engineering)
Mia Riddley (The Charles Edward Via, Jr. Department of Civil and Environmental Engineering)

Dhruv Varshney
Virginia Tech/Computer Science

Independent Research

AI-Enhanced Teaching Assistant: Bridging Professor Knowledge and Web Intelligence

The project aimed to develop an intelligent teaching assistant combining instructor-specific knowledge with internet-based information to enhance student learning. The main research question was: How can a software using AI technologies augment instructor expertise with broad online knowledge to provide personalized and comprehensive responses to student queries? The objective was to augment the student educational support by offering a scalable solution adaptable to various academic disciplines, improving student understanding and engagement. The project utilized vector embeddings for text representation and similarity search, alongside large language models for response generation. Instructor-provided materials were indexed and stored in a vector database. The AI-enhanced assistant used similarity search to retrieve relevant information from these vector embeddings and conducted a web search using the Tavily API, synthesizing these sources to generate a structured response. Anticipated outcomes include improved accuracy and relevance of responses, enhanced student understanding of complex topics, increased engagement through interactive learning formats, implementation of additional functions, enhanced user customization, addition of visualizations to text responses, and expansion of the dataset to cover various subjects. The project aims to create a versatile educational tool that can be tailored to different learning environments and needs, providing a comprehensive support system for both students and educators.

Mentor(s): Vinod Lohani (Engineering Education)

Dhruv Varshney
Virginia Tech/Computer Science

Independent Research

Development of AI-assisted Chatbot for Water Monitoring Environment Lab

The Learning Enhanced Watershed Assessment System (LEWAS) at Virginia Tech generated a vast repository of data through its high-resolution environmental monitoring and data presentation system and research publications over a decade, presenting challenges for efficient on-boarding of new students joining the lab. In an effort to help new students have a smooth onboarding experience, this project developed an AI-assisted chatbot that facilitated interactive and efficient access to information about LEWAS. The primary goal was to create a user-friendly interface that could efficiently retrieve and present relevant data from the lab's extensive resources. The research focused on implementing a Retrieval Augmented Generation (RAG) system, combining information retrieval with language generation to provide accurate and contextually appropriate responses. Key documents were converted into vector embeddings, stored in a vector database, and retrieved context using similarity search based on prompts given. The system then sent this context along with the user's question to a large language model to generate informative responses. The initial phase involved testing with a small set of documents, showing promising improvements in information accessibility. The chatbot successfully answered queries about LEWAS's operations, research outputs, and environmental data. Future work aims to expand the chatbot's knowledge base and capabilities, streamline knowledge transfer, support water sustainability research and education at Virginia Tech and beyond, expand the document set, integrate live lab data for real-time analysis, and add user interface features. The project anticipated creating a comprehensive tool for efficient information retrieval and interaction within the LEWAS framework.

Mentor(s): Vinod Lohani (Engineering Education)

Sophia Vikesland
Grinnell College/Biochemistry

VT-REEL

Transforming Cannabis sativa Leaf Discs and Meristem with Transcription Factor CsWoolly

With industrial hemp's recent legalization in Virginia, researchers look to explore the genetic regulation of cannabis with the long term goal of preventing economic losses for farmers, specifically when cannabinoid concentration is higher than the legal limit, 0.3% THC. Cannabinoids are highly profitable medicinal compounds with little current research about their biosynthetic pathways due to previous restrictions. Here, we attempt to transform different cannabis plant material with an overexpression vector containing the transcription factor CsWoolly, hypothesized to control trichome differentiation. Glandular trichomes are known to be the center for cannabinoid production. We aimed to both constitutively express and hormone induce CsWoolly in the pK2GW7 and pMDC7 vectors respectively. Successful assemblies were inserted into agrobacterium and transformed plant material such as leaf discs, meristems, and cell suspensions using sonication and vacuum infiltration. The sonicator specifically, when transforming leaf disks and meristems, was shown to aid in improving transformation in cannabis. The correlation has not yet been fully explored quantitatively with our experiments due to numerous variables that can cause a transformation to fail, although the sonication is theorized to increase agrobacterium infection by way of introducing minor tissue injuries. With our successfully transformed cannabis plant material, we will be able to conduct further experiments, measuring changes in cannabinoid concentration and gene expression. With this edited protocol to sonicate the cannabis plant material in agrobacterium solution, our improved transformation rates can increase efficiency in our investigation of CsWoolly and allow rapid transformation of various other transcription factors of interest.

Mentor(s): Bastiaan Bargmann (School of Plant and Environmental Sciences)

Kaylin Wallen
Hollins University/Biology and Public Health

Solid Waste Management and Infectious Diseases: Exploring Perceptions in Freetown, Sierra Leone

Solid waste management (SWM) is a crucial environmental health challenge facing African countries, including Sierra Leone. As a determinant of health, the physical environment significantly influences disease occurrence. Many studies indicate strong correlation between waste mismanagement and spread of infectious diseases. Improper disposal practices, such as open dumping on public streets and waterways serve as breeding grounds for vectors like flies, rats and mosquitoes, which facilitate the spread of vector-borne diseases such as malaria and dengue fever. Sierra Leone's garbage disposal system is poor, coupled with meagre infrastructure, low collection coverage, and inadequate budget. The literature primarily addresses the management of solid waste system, including the components crucial to their functioning. There is very limited research on public perception regarding the issue in Sierra Leone and sub-Saharan Africa as a whole. Using a qualitative research method, 26 people were interviewed in Makeni and Freetown (Sierra Leone) to examine individual perceptions on the relationship between SWM practices and infectious diseases. Using thematic content analysis, preliminary findings indicate moderate awareness of the positive link between SWM practices and infectious diseases in Makeni and Freetown. However, research participants overwhelming reported lack of resources (public garbage bins and collection services) to enable proper disposal of solid waste, thereby leading to garbage being dumped in unsanctioned areas within the community. By exploring individual awareness/perceptions, this study aims to provide insights into the public's understanding of SWM practices impact on health, which may help inform policy and community interventions to tackle the issue.

Mentor(s): Abubakarr Jalloh (Public Health)

Michael Wang
Washington and Lee University/Neuroscience

Mapping the functional pathways in Euchromatin-Disrupted Human Development Disorders

Disruption of euchromatin or heterochromatin occurs in various pathological conditions like human cancers and developmental disorders. Chromatin imbalances drive developmental disorders as they cause chromatin structure and function dysregulation, which alters gene expressions. While rigorous investigations are being undertaken in cancer research, developmental disorders have been largely understudied partially due to the rarity of these diseases. As a consequence, the vast majority of developmental disorders are currently untreatable. In mammals, NSD1 and NSD2 are major methyltransferases that catalyze di-methylation at Lysine 36 of histone H3 (H3K36me2). In humans, haploinsufficiency of NSD1 leads to a systematic tissue overgrowth phenotype known as Sotos Syndrome; contrarily, haploinsufficiency in NSD2 is linked to a tissue undergrowth phenotype, characterized as Rauch-Steindel syndrome. Given that NSD1 and NSD2 are paralogues, it is intriguing that their mutations result in opposite outcomes. We hypothesize that NSD1 and NSD2 deficiencies impair lineage differentiation programs at distinct developmental stages. To test this, we will adopt a neural differentiation model examining the transcriptional dysregulation in $NSD1^{+}/^{-}$ and $NSD2^{+}/^{-}$ cells at different developmental stages using single-cell RNA sequencing (scRNA-seq). Further, we will employ Perturb-seq for functional interrogation to dissect the transcriptional networks perturbed by these mutations. This ultimately allows for the identification of key regulatory genes that drive the divergent phenotypes observed in Sotos and Rauch-Steindel syndromes. Our aims to map the functional pathways will provide a foundation for a basic understanding of chromatin dysregulation and elucidate potential therapeutic interventions for the currently untreatable developmental disorders.

Mentor(s): Jia-ray Yu (CNRIC)

Elisabeth Wasserman
Virginia Tech/Statistics
Brynna Wert
Virginia Tech/Criminology
Filza Mutaal
Berea College/Economics

Deaths of Despair in Virginia: Analyzing Socioeconomic Factors and Demographics

"Deaths of despair," a term coined by Anne Case and Angus Deaton in 2015, refers to fatalities from suicide, drug overdose, and alcohol-related diseases. Over the past twenty years, the U.S. has seen a significant rise in deaths of despair (DOD). Reflecting this national trend, Virginia experienced a significant increase in these deaths in 2019, primarily driven by a rise in drug overdoses that disproportionately impacted economically disadvantaged areas. Our study examines the socioeconomic factors and demographics of DOD in Virginia from 2018 to 2022. We utilize county-level socioeconomic data from the 5-year American Community Survey (ACS) and death rates from the Centers for Disease Control and Prevention (CDC). We document gaps in DOD rates across different demographic groups, including sex, race, and age. Using ordinary least squares (OLS) regression, we analyze the relationship between education, income, and employment rates and the incidence of DOD. Our findings indicate that populations with lower educational attainment, higher poverty rates, and higher unemployment rates are most susceptible to DOD. Aligning with previous literature, our study suggests that middle-aged, White males represent highest rates of DOD, but in 2022, African Americans surpassed the White death rate in Virginia, representing a substantial demographic shift. By assessing correlates and demographics associated with DOD, we highlight the need for targeted interventions and suggest potential directions for future research.

Mentor(s): Michael Cary (Agricultural and Applied Economics, Virginia Tech)
Isabel Bradburn (Department of Human Development and Family Sciences, Virginia Tech)

Reagan Wcisel
Virginia Tech/Computer Science
Jacob Takeshita
Virginia Tech/Mechanical Engineering

Investigating an Accessible Multi-Agent Robotic System for Air Quality Monitoring in Construction Inspection

This research builds upon ARCADE's existing Multi-Robot Construction Inspection System (MRCIS). This project is a multidisciplinary undergraduate research on an ongoing research project on multi-agent construction robotics. This multi-robot system, a.k.a. MRCIS, consists of an unmanned aerial vehicle (UAV), a quadruped robot with a mounted robot arm and LiDAR, a wheeled robot, and an air quality sensing device to perform air quality monitoring. This research brings together perspectives from Computer Science (CS) and Mechanical Engineering (ME) to address the following research questions in two research thrusts:
Thrust 1: Computer Science
1A- How can the user interface (UI) be improved in the existing MRCIS?
1B-What air quality sensing can be added into MRCIS to be more accessible for people with disabilities?
Thrust 2: Mechanical Engineering
2A- How can the air quality module be physically mounted on MRCIS?
2B- What basics are needed for a LiDAR to be added to MRCIS?
This research exploration can potentially allow for construction inspectors and robots with multiple locomotions and capabilities to work collaboratively on identifying air quality issues in a manner that can be more accessible.

Mentor(s): Kereshmeh Afsari (Myers-Lawson School of Construction)

Emile Whittle-Hage
Virginia Tech/Biological Systems Engineering

Nanobody Protein Expression for use in a Nanosensor to detect a Pig Virus

Porcine Epidemic Diarrhea Virus (PEDV) is a common swine virus that causes watery diarrhea, depression, and anorexia in pigs. This virus has a near 100 percent fatality rate in newborn pigs and has numerous large economic repercussions on the farming industry. The current means of recognizing PEDV require extensive lab training and equipment which limits its accessibility for use by farm personnel and inhibits early detection of the virus. To combat this, we aim to create a nanosensor that can be easily used and deployed by farm personnel with little to no training for fast and early detection. The first steps in reaching this goal were carried out in this past year and summer, this included expressing three PEDV nanobodies from the membrane protein of PEDV; MC29, MC30, and MC37 as well as each of these PEDV nanobodies as a fusion protein with Horseradish Peroxidase (HRP). The membrane protein was chosen due to it being exposed on the surface of the virus. The main work this summer included attempting to express the fusion proteins which provided a bigger challenge since they are not easily purified and expressed as compared to the nanobodies. Multiple methods and changes to the protein expression protocol were implemented to attempt to achieve the desired results. SDS page was the main method used to view results with western blotting also being used. These proteins will be bonded to magnetic nanoparticles in the future to be utilized in the nanosensor.

Mentor(s): Mike Zhang (Department of Biological Systems Engineering)

Allison Wickman
Virginia Tech /Environmental Resources Management

MASBio

Assessing Regional Biomass Operations, Economics and Best Management Practices in Virginia

This study evaluates biomass and traditional timber harvesting operations, focusing on their operational characteristics, best management practice (BMP) implementation, and economic viability. A systematic review of secondary resources was conducted to compile metrics and data, informing the development of a conceptual model. This model characterizes the short-term operational economic viability of biomass harvesting, with the potential to predict hypothetical long-term economic impacts regarding nutrient loss. Concurrently, Virginia BMPs were evaluated within the context of biomass harvesting, with recommendations to ensure sustainability.

The literature indicates that both biomass and conventional harvests share fundamental operational similarities but differ in their approach to material extraction and final productization at the landing. A generalized case study was used to inform a comparative analysis, highlighting the trade-offs between operational costs and revenues, compared with potential negative economic implications due to loss of productivity in relation to the removal of biomass. Placed in parallel context, the two types of harvests showed no significant differences, despite the higher rate of residual removal in biomass harvests. For example, mountainous regions exhibited higher erosion rates due to steep slopes, regardless of the harvesting method.

This research indicates the importance of chipping costs and market pricing in the immediate economic viability of biomass harvesting. Long-term biomass extraction is viable only if future productivity losses are minimal. These results serve to guide ongoing sustainable forestry practices and policy development, while laying the groundwork for future research related to operational optimization, economic feasibility, and long-term sustainability.

Mentor(s): Michael Berry (FREC)
Scott Barrett (FREC)

Claire Wildermann
Virginia Tech/Clinical Neuroscience

Designing the Cold Pressor Task for Human Neuroimaging

The cold pressor test (CPT) is a method to induce pain and physiological stress, in order to study the responsiveness of the sympathetic nervous system in humans. Using fMRI (functional magnetic resonance imaging), a BOLD (blood oxygenation level dependent) response can detect changes in neuronal activity. However, the brain regions activated by CPT have not been characterized, especially in coordination with pain perception. This project aims to develop an efficient and reproducible method to conduct CPT in the fMRI. Different temperatures were tested to determine the ideal coldness to illicit physiological changes during the task, while not causing unbearable pain. 0-1ºC was selected for the study, generating ratings up to 7 or 8, on a scale from 0 to 10. The method of cold application is a sleeve-like ice pack, passively placed on the subjects' left hand. A program was made using PsychoPy that prompted subjects to rate their pain every ten seconds using a manual device. Heart and respiratory rate are recorded during the task. Five minutes of baseline scanning is performed prior to the task. The task consists of two minutes of cold application followed by two minutes of recovery. The subject rates their pain perception every 10 seconds throughout. The study was piloted and had minimal fMRI artifact and pain ratings ranging from 0 to 7.

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

Madison Wiley
Virginia Tech/Environmental Resource Management

Independent Research

Enterobacter spp. in Amended Hardwood and Softwood Biochar: Assessing the Survivability of Microbial Communities

Enterobacter spp. (301W) are plant growth-promoting, gram-negative, facultatively anaerobic rhizobacteria that are known for their diverse metabolic capabilities that allow them to thrive in various environments. They exhibit resistance to environmental stressors due to their versatile metabolic pathways and robust genetic adaptations, making them a good candidate for inoculation to nutrient-rich biochar. Biochar is a type of fine-grained charcoal that is produced through pyrolysis of organic materials, such as timber, and is studied as sustainable carbon sequestering fertilizer. As a soil amendment it can enhance water and nutrient retention, aid soil microbiome management, and sequester carbon. To test the suitability of hardwood and softwood biochar as a medium for 301W, we employed colony forming unit (CFU) extractions to monitor bacterial survival. It was expected that 301W could adapt and survive in biochar reasonably well, with over 5% recovery after 7 days. However, recovery was less than expected, which could be due to cell death or changes in the metabolic state of the bacteria, making them less viable for re-culture. Nevertheless, these findings could provide insight into optimizing biochar applications in agriculture, potentially enhancing its utility by leveraging beneficial microbes to improve soil health, as well as potentially improving agricultural sustainability by reducing the need for fertilizers and minimizing crop stress.

Mentor(s): Mark Williams (Plant and Environmental Sciences)

Devonte Wiley
Virginia Western Community College/Biochemistry

Analyzing effect of deactivation of various genes in Salmonella Typhimurium on susceptibility to bacteriophage χ

Bacteriophages are viruses that infect bacteria. Flagellotropic bacteriophages target the flagellum of the bacterium and utilize its counterclockwise movement to reach the base of the flagellum. It is proposed that it then binds to a secondary receptor to eject its DNA. The bacteriophage Chi (χ) has been proposed as a candidate in medicinal therapy for bacterial infection because it presents an exploitable evolutionary tradeoff, flagellar motility. To better understand how χ infects Salmonella enterica serovar Typhimurium, deletions were identified in a previous high throughput screen for various receptor genes to observe how the susceptibility of χ was affected when they was no longer expressed. Lambda red recombination was used to insert a kanamycin resistance cassette into the location where the gene was originally. Swimplate and efficiency of plating assays were conducted to observe the effects of gene deletion.
Gene deletion strains, ΔwzxE and ΔdsbA, both had 22.0% susceptibility with 37.0% and 41% motility, respectively, compared to the WT strain. It was found that the inactivation of two of the previously mentioned genes in S. Typhimurium resulted in reduction of susceptibility to χ phage, as well as reduction of motility. Deletion of damX increased susceptibility by 17.5% and significantly decreased motility. In future research, more gene deletion strains will be tested to determine how χ coinfection affects motility and how the gene inactivation affects susceptibility to χ. There will be future research conducted to attempt to incite recombination between multiple phages by coinfecting a single bacterial strain with them.

Mentor(s): Birgit Scharf (Biological Sciences, Virginia Tech)
Jackson Wood (Biological Sciences, Virginia Tech)

Maddi Williams
Virginia Tech/Geosciences
Andrew Allard
Virginia Tech/Geosciences
Piyali Roy
Virginia Tech/Biology

Independent Research

Microplastic Accumulation Since 1950 In Bayside and Seaside Salt Marshes of the Eastern Shore, Virginia.

Since the rise of plastic production and use in the early 1950s, microplastics (plastic particles and fragments smaller than 5 mm) have been accumulating in both onshore and offshore sediment sinks. Intertidal ecosystems, like salt marshes and estuaries, serve as significant sinks for microplastics due to their daily tidal inundation, natural sediment accumulation processes, and their inputs from both marine and freshwater sources that provide multiple pathways for microplastic introduction. Despite the documented presence of microplastics in coastal waters and sediments, quantitative studies that document the first appearance of microplastics in the sediment record and how their concentration and composition has varied through time, are scarce. This study addresses foundational questions to document the concentration and composition of microplastics in coastal marshes bordering the bayside and seaside of the Eastern Shore peninsula since their introduction in the mid-20th Century. Here, we extracted microplastics from sediment cores near Wallops Island, a seaside salt marsh. These samples had an 80:20 ratio of plastic fibers and fragments. While several different colors were observed, much of the degraded plastics were white synthetic fibers. These fibers displayed a distinct increase in concentration towards the top of the core. This correlates with increased urbanization of watersheds and plastic production in the past few decades. Compared to a core collected on the bayside of the Eastern Shore, our core has a lower overall concentration of microplastics, suggesting that Atlantic-facing marshes contain fewer microplastics. The data we have observed displays the role of salt marshes as microplastic sinks.

Mentor(s): Tina Dura (Geosciences)

Jenna Wilsher
Virginia Tech/Electrical Engineering

CEED

Developing a Field Programmable Gate Array (FPGA) Elevator Door Project for ECE 2804

The sophomore-level required course for Electrical and Computer Engineering majors, ECE 2804, challenges students to complete one of the preselected project choices over the course of a semester. Recently, these projects have contained a focus on analog electronics and signal modification such as signal inversion and amplification. Modern electronics such as data storage and chip integration, however, are predominantly digital requiring logic fluency. Unlike combinational circuits that require logic design before manufacturing, Field Programmable Gate Arrays (FPGAs) allow for a multitude of purposes determined by Hardware Description Languages (HDL). The purpose of this research was to design and build an FPGA controlled elevator door system and assess the difficulty of the project based on the knowledge earned from Virginia Tech's sophomore-level Electrical and Computer Engineering courses in the hopes of proposing a new ECE 2804 cornerstone project choice focused on digital design. This elevator system utilizes modular thinking along with significant comprehension of logic synthesis, circuit design, and digital signals to design a Mealy Finite State Machine that will change state based on inputs to the system along with submodules that control button debouncing, timers, and motor control. Considering the conducted research, Dr. Peter Han looks to finalize and release the FPGA elevator door project this upcoming Fall semester for student credit.

Mentor(s): Peter Han (Electrical and Computer Engineering)

Kaylia Wilson
Virginia Tech/Clinical Neuroscience

Investigating Phenotypic Differences of Drosophila melanogaster Ir21a Mutants

An essential trait in animals is their capacity to recognize, interpret and appropriately respond to fluctuations in environmental temperature. In Drosophila melanogaster it is known that IR21a and its co-receptors, IR25a and IR93a, play an integral role in thermosensation and are responsible for larval cool avoidance behavior. However, the molecular mechanisms underlying IR21a are poorly understood. Here, we show the behavioral effects on thermosensing in larvae when the DNA sequence encoding one of the four protein domains of the IR21a receptor is swapped. In normal D. melanogaster larvae, contact with a cool surface induces cool avoidance behaviors. Conversely, D. melanogaster larvae lacking the Ir21a gene exhibit increased tolerance to cooling, indicating a reduced innate avoidance of cool surfaces. To evaluate the larvae's behavior, a temperature gradient ranging from 13-31 degrees Celcius was designed. Approximately 30 larvae were placed at the centre, maintained at 21 degrees Celcius, and observed for 10 minutes to determine their temperature preferences based on their genotype. We found that swapping the C-terminal domain (CTD) of the Ir21a receptor gene with the CTD of Ir68a receptor gene, a warm receptor, significantly affected the thermosensing ability of the D. melanogaster larvae. Larvae with a disrupted CTD mirrored behaviors associated with the Ir21a mutant, demonstrating reduced responses to cool temperatures, as confirmed by t-tests and Analysis of Variances (ANOVA). The data suggests that the CTD is essential for mediating responses to temperature changes. This is significant for understanding the molecular dynamic of the IR21a receptor's four domains.

Mentor(s): Lina Ni (Neuroscience)

Justin Winberg
Virginia Tech/Mechanical Engineering

Spider-mite adaptability in their native fibrous environments

Spider mites are members of the Tetranychidae family that live on fibrous webs composed of varied alignments and diameters ranging from the micro to nanoscale. Measuring less than one millimeter in length, they are a ferocious species known for their ability to puncture plants and cause widespread havoc. Spider mites achieve this by migrating at high speeds (several body lengths per second) and applying forces. Here, we inquire how spider mites navigate their ever-changing environments, the critical fundamental knowledge that can help develop pest deterrent strategies. To understand how spider mites adapt to changes in their fibrous environment, we use our non-electrospinning spinneret-based tunable engineered parameter (STEP) technique to recreate the native fibrous environments with precise control over the fiber diameter and alignment as well as the interfiber spacing. Using high-speed imaging, first, we examine the migratory behavior of spider mites and quantify their gait. The spider mites switch from their normal tetrapod gait to a non-uniform gait with a change in fiber architectures. Second, we employed Nanonet Force Microscopy (NFM) to measure forces exerted by spider mites as they migrate on nanonets composed of small and large-diameter fibers. We quantify the forces exerted by each mite leg (tens of nanoNewton) and the total force (hundreds of nanoNewton) the organism exerts as they migrate. Overall, using fiber networks of varying configurations that match the native webbing of spider mites, we can capture and quantify the unique adaptabilities of these organisms to efficiently navigate in their fibrous environments.

Mentor(s): Amrinder Nain (Mechanical Engineering)

Amir Winfield
Virginia Tech/Computer Engineering

Correlation Curves and Descriptions of Quantum Entanglement

One of the various research areas in the quantum phenomenon is entanglement. Considering this area, entanglement between photons was explored to further dive into the unknowns many scientists still have today with this area to broaden the knowledge of quantum mechanics and how it relates to classical physics. Entanglement in engineering is a gateway for quantum cryptography, superdense coding, maybe faster than light speed communication, and even teleportation. Quantum This experiment involves the creation of entangled pairs using quantum lab experiments to learn how entanglement is detected by using the Clauser-Horne-Shimony-Holt (CHSH) test and to learn how to calculate the CHSH inequality to access the polarization entanglement of photons. To do this, the experimental set up included lasers, mirrors, polarizers, and a wave plate. There were two trials in which one had the wave plate present and the did not. The same procedure, however, was followed. Briefly, the laser was set to emit multiple photons. Following, we used CHSH to test the S value and the coincidences. Additionally, 16 manual experiments were done where 16 orthogonal angles (in sets of two) were put into Motor 1 and Motor 2 each. Our data showed that entanglement was created and conserved if S values were 2 or greater, thus deepening our understanding of entanglement by utilizing information between two photons given one directly impacted the other. With this, we can further explore testing over greater distances to test interference in areas such as cybersecurity where interference is a key challenge.

Mentor(s): Wayne Scales (Education and department of research; VT)
Jamie Sikora (Education; VT)

Hugh Young
Virginia Tech/Aerospace Engineering

CEED

A Study for determining the demand for Urban Air Mobility

The implementation of Urban air mobility services, and the success of said services, is dependent on the public views of UAM and the willingness of the public to use the services once they are provided. Because of this, before these services are implemented into a city, the demand for them and the manner in which they will be used must be determined in order to provide the most benefit to the communities and make the most profit. However, the demand for urban air mobility is difficult to predict as there is little to no history to base predictions on. As a result of this, most studies involved with determining the demand for Urban air mobility use surveys or focus groups to determine the public's views of UAM and their needs as a commuter. In this study, We will distribute a stated choice survey in the Houston area designed to gather data on commuters' views on urban air mobility and whether or not they would choose to use it instead of other options given different travel times, traffic conditions, and weather conditions. This data will be used to create a mathematical model to predict the demand for UAM. This model will help to provide various evidence-based policy recommendations for future smart and sustainable cities.

Mentor(s): Md Sami Hasnine (Civil and Environmental Engineering)
Daud Nabi Hridoy (Civil and Environmental Engineering)

Cora Youngs
Virginia Tech/Biochemistry

Focused Ultrasound Modifies Tumor Microenvironment and Improves Systemic Anti-Tumor Immunity During Ablation of Pancreatic Tumors

Histotripsy is a novel treatment modality utilizing focused ultrasound and acoustic cavitation to ablate tumor cells and generate acellular homogenate. The non-ionizing, non-thermal, non-invasive, and real time imaging properties make it a promising treatment for historically resistant malignancies such as pancreatic cancer. Our hypothesis is that the generation of acellular homogenate will activate the immune system and improve systemic anti-tumor immunity causing the recognition and abscopal like effects at metastasized sites. This study was conducted using C57Bl/6 mice with contralateral tumors developed in their flank. Only one tumor on each mouse was treated and tumor size and immune cell populations were measured for both tumors over several timepoints. Our data suggests that histotripsy generates an acute abscopal like effect in the treatment of pancreatic tumors through the reduction in treated and untreated tumor sizes and change in tumor microenvironments. Moving forward, we aim to evaluate the potential mechanisms of immune cell activation with the hope that these could be modified to create stronger abscopal like effects and offer a greater chance at remission.

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

Mary Zaengle
Hollins University/Theatre
Sterling Cullinane
Hollins University/Theatre

Community Speaks

Community Speaks is a verbatim theatre project exploring the queer community in Roanoke. This research phase lays the foundation for a larger performance piece, addressing the need for a connection between Hollins University's queer community and the broader Roanoke LGBTQ+ population. Verbatim theatre is a powerful form of social justice advocacy that uses the exact words of interviewees to authentically represent marginalized voices.

Our methodology combines oral history techniques, community engagement—including attendance at local LGBTQ+ events and strategic networking—and archival research drawing from the Southwest Virginia LGBTQ+ History Project. Through these methods, we capture the diverse experiences and perspectives within Roanoke's queer community, both past and present.

The ultimate goal of our research is to develop a fully realized verbatim script for performance at Hollins University and potentially at Ursula's Cafe in Downtown Roanoke, creating greater understanding and connection between campus and city LGBTQ+ communities.

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

Robert Zalenski
Virginia Tech/Biochemistry

Characterization of active site mutants for Acinetobacter baumannii siderophore biosynthesis enzyme FbsI

Acinetobacter baumannii is a pathogenic bacterium that largely affects immunocompromised individuals through nosocomial infections in the respiratory tract, bloodstream, urinary tract, and soft tissues.1,2 Siderophores are secreted by A. baumannii, which sequester iron from the host in iron-limited environments, allowing the bacteria to propagate while the host is disadvantaged. One of the siderophores of A. baumannii, Fimsbactin A, is a major virulence factor of the cell's system and is seen to be the most virulent of the bacterium's siderophore assortment.3 FbsI, an enzyme that catalyzes the rate-limiting step for the biosynthesis of Fimsbactin A, is a flavin-dependent monooxygenase. It is more specifically an N-hydroxylase that catalyzes the hydroxylation of terminal amines. FbsI favors the hydroxylation of two diamines: putrescine and cadaverine. This is done via redox chemistry with the bound flavin prosthetic group. With previous kinetic and structural characterizations of the wild-type FbsI, several unknowns remain regarding the enzyme's mechanism.4 This study proposes that the active site residues T240 and D390 are involved in substrate binding. The two mutant proteins, T240A and D390N, were expressed in E. coli through IPTG induction and purified using Ni-NTA IMAC. Using steady-state kinetic analysis, via oxygen consumption and product formation assays, the mutant T240A was shown to have a 1000-fold increase in its KM for putrescine and a substantial decrease in catalytic efficiency; the study into D390N is ongoing. With this being one of the first studies on FbsI's structure and function, this will hopefully guide future research regarding the enzyme's mechanism.

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

Riley Zeman
Virginia Tech/Biochemistry

Elucidating the Function of a Novel Electron Transferring Protein in Methanogenic Archaea

Microbial hydrogenotrophic sulfate reduction and methanogenesis, Earth's two of the oldest respiratory metabolisms, were originally believed to conflict with each other as sulfite inhibits methanogenesis, the sole energy source in methanogenic archaea or methanogens. Yet, some methanogens tolerate and assimilate sulfite, and it is due to a novel enzyme, F420-dependent sulfite reductase (Fsr), likely assembled from free-standing dissimilatory sulfite reductase (Dsr) like proteins (Dsr-LP), which is widespread in methanogens. Despite its close structural similarity to Dsr, genetic and enzymological studies show that Dsr-LP is a poor sulfite reductase. We hypothesized that Dsr-LP originally had a function that was not sulfite reduction and was leveraged to neutralize the toxicity of sulfite originating from sulfide oxidation after oxygen appeared. There are three classes of Dsr-LPs, each at different developmental stages in becoming Fsr, with Group III being the most advanced, with signatures for assembling siroheme and 2 iron-sulfur clusters. Methanocaldococcus jannaschii was chosen as a model for investigating Dsr-LP's function as it carries a Group III Dsr-LP and is an ancient organism living in deep-sea hydrothermal vents presenting an early Earth-like environment. From the cell extracts of a M. jannaschii strain that was engineered to express the protein with a streptavidin affinity tag, Dsr-LP was purified via Strep-Tactin® chromatography. UV-visible spectroscopy detected iron-sulfur clusters and a siroheme group in the purified protein. SDS-PAGE analysis showed that it contained additional polypeptides and their identities as revealed via upcoming mass spectrometric analysis will help to formulate sharper hypotheses and investigations on Dsr-LP's function.

Mentor(s): Biswarup Mukhopadhyay (Department of Biochemistry)

Elizabeth Zhang
Blacksburg High School/Biomedical Engineering

Independent Research

Quantification of 3D in vivo model of embryonic mice during late pregnancy

Computational models offer a powerful approach to unraveling the complexities of birth, which can be difficult to study experimentally in a safe and ethical manner. In order to create models that can simulate the complex process of pregnancy and birth, properties of both the mother and the baby, as well as their interactions, must be thoroughly characterized. While murine maternal tissues and embryos have been studied ex vivo, embryos in vivo, which are constrained by the mother's pelvic organs and other embryos in the same litter, have not been well characterized. To this end, we measured the geometric properties of embryonic mice in vivo during late pregnancy using high resolution magnetic resolution imaging (MRI). Collected images were analyzed using 3D Slicer (https://www.slicer.org/) where individual gestational sacs, including their components such as the placenta and embryo, were segmented, and their volumes calculated. Despite uneven distribution of embryos between the left and right uterine horns in some of the mice, there was no significant difference in the size of the embryos or gestational sacs between the left and right horn. While placental size was consistent across all three mice, Mouse 2 had much larger embryos and gestational sacs compared to the other mice. To our knowledge this is the first study to quantify the 3-dimensional geometries of the murine gestational sacs in vivo. The development of complex 3D models, like those presented here, is crucial to accurately simulate pregnancy and delivery. These models will serve as a springboard for future studies that aim to investigate human pregnancy-related complications such as maternal trauma, preterm births, and pelvic floor disorders.

Mentor(s): Raffaella De Vita (Biomedical Engineering and Mechanics)

Austin Zhang
Virginia Tech/Biochemistry

Investigating Chromatin Biology and Its Role In Cancers

Post-translational modifications on histones critically regulate the formation of euchromatin and heterochromatin, leading to activation and repression of gene expression, respectively. The lysine-to-methionine mutation at Lysine 27 of histone H3, H3K27M, is a primary driver in Diffuse Midline Glioma (DMG). DMG is the most aggressive pediatric brain cancer with a 5-year survival of 2%. H3K27M results in a global decrease in tri-methylation at Lysine 27 of histone H3 (H3K27me3), central to repressive chromatin formation. As a consequence, an antagonistic modification for active chromatin, H3K36me2, is aberrantly elevated, thus facilitating oncogenic transcription. Nuclear Receptor Binding Set Domain 1 (NSD1) is a lysine methyltransferase with a catalytic SET domain that catalyzes H3K36me2. NSD1 appears to be a promising therapeutic target in cancer, but little success has been made in pharmacological development. Our preliminary study uncovered that NSD1's catalytic activity is fully dependent on an allosteric activation site. We hypothesized that an interruption of NSD1's allosteric activation site could be an effective therapeutic strategy. We adopted a biochemical as well as cell-based approach to study NSD1 activity. Various modifications to the allosteric activation site were employed. The properties of this site were studied and its interaction with other chemicals can be mapped. NSD1 activity was also mapped in cells with cancerous properties, strengthening our understanding in a translational context. As we further understand the catalytic activity of this allosteric activation site, future drugs could be synthesized for cancer treatments.

Mentor(s): Jia-Ray Yu (FBRI at VTC - CNRIC Location)

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