OFFICE OF
UNDERGRADUATE
RESEARCH

2021 Dennis Dean Undergraduate Research & Creative Scholarship Conference

VIRTUAL

APRIL 30, 2021

RESEARCH.UNDERGRADUATE.VT.EDU/SYMPOSIUM

Contents

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

Welcome

Welcome to Virginia Tech's Spring Undergraduate Research and Creative Scholarship Virtual Symposium. This event is a celebration of the creative and scholarly accomplishments of undergraduate students campus- wide. Our program reflects the quality and diversity of undergraduate research at Virginia Tech. Many of the projects are the result of collaborations among several students.

Undergraduate research is recognized as one of the high impact practices in undergraduate education. Students who participate in undergraduate research are more likely to thrive and persist in their education. They become co-creators of knowledge, makers of objects that are useful and beautiful. At the heart and soul of these projects are collaborations between undergraduates and their mentors. Many thanks to the faculty, graduate students and others who commit to these scholarly endeavors with undergraduate students.

It is remarkable that we have near-record levels of presentations by students despite the challenges of conducting and presenting undergraduate research during a pandemic. This is credit to our amazing students and dedicated faculty and the resourcefulness of the Office of Undergraduate Research in creating the virtual symposium. I am most grateful to Keri Swaby, Director of the Office of Undergraduate Research, for her steadfast leadership and advocacy for undergraduate research regardless of the challenges.

Thanks to the Fralin Life Sciences Institute, and to Dr. Dennis Dean for continuous support and advocacy for undergraduate research and to the many colleagues who have contributed to building an endowment for this symposium.

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 annual Dennis Dean Undergraduate Research and Creative Scholarship conference at Virginia Tech hosted by the Office of Undergraduate Research (OUR). This year we convene virtually once again but hope that we can be together in person next year, as we celebrate the exceptional work of our undergraduates.

Despite the disruption to normal research and creative operations this year, our students have persevered and excelled, producing notable and impressive results that are on display today. Today's asynchronous event will showcase the breadth of research and creative scholarship taking place across campus every day at Virginia Tech and will demonstrate how broadly we define this impactful form of experiential learning.

Presenting results of a research or creative project is an important part of a student's overall journey because it provides them with the opportunity to learn to effectively communicate to a broad audience, defend their work, exchange ideas, and even be inspired for future directions in their work. I applaud our presenters for creating such compelling videos to share their work with you and I encourage you to engage these scholars with comments and questions on their "pages". Thank you for participating and helping our students to grow.

As with many other offices, the OUR shifted all operations virtually this year, but we are pleased that we were able to maintain the same level of support and programming to students and faculty as in the past, although perhaps with a little more creativity and added patience for technology. Critical to the success of the OUR this year has been the hard work of our Program Assistant, Nicole Bottass; the guidance of an active advisory board, comprised of faculty, administrators, and undergraduate and graduate students; and the 13 amazing Ambassadors who tirelessly work to help students navigate undergraduate research, particularly at this moment in time when so much is uncertain and has changed. Without these dedicated people, the operations of the OUR would not be possible.

I must recognize and specially thank the Fralin Life Sciences Institute, whose continued financial support allows us to celebrate undergraduate research and creative scholarship every day.

As always, I am humbled by the quality of work on show as part of this symposium and invite you to marvel at the wealth of research and creative scholarship the university has to offer. I invite you to engage, to explore, to connect, and to have fun… all from the comfort and safety of your own home!

Keri Swaby
Director of Undergraduate Research

ACC Meeting of the Minds

Due to the COVID-19 pandemic the 2021 ACC Meeting of the Minds (ACC MOM) at the University of North Carolina – Chapel Hill was held virtually. The scheduled conference dates were April 9-11, 2021. The Office of Undergraduate Research would like to recognize the students who presented.

Each year, 5-10 outstanding undergraduate researchers (accompanied by a faculty/ staff member) from each ACC university gather at a host institution to present their research, either orally or as a poster. Virginia Tech representatives are selected by a competitive refereed process. It is truly an honor to be invited to participate in this conference.
Student name, academic major, title of presentation, and faculty mentor listed below alphabetically.

Bella Brann (Physics)

ENGINEERING FASTER DOMAIN WALL MOTION IN MAGNETIC NANOSTRIPS
Dr. Satoru Emori

Christine Faunce (Experimental Neuroscience)

SINGLE NUCLEOTIDE P129T MUTATION SHOWS SUSCEPTIBILITY TO PROBLEMATIC DRUG USE IN MICE
Dr. Matthew Buczynski

Adam Luftglass (Materials Science and Engineering)

THE IMPACT OF STANDARDIZED FOOTWEAR ON LOAD AND LOAD SYMMETRY
Dr. Robin Queen

Victor Mukora (Computational Modeling and Data Analytics)

APPLYING MULTIPLE LINEAR REGRESSION TO PREDICTING SOLAR ENERGY
Dr. Anne Brown

Timothy Proudkii (Physics)

STAR FORMATION IN EARLY-TYPE GALAXIES: THE RELATIONSHIP BETWEEN H2/H1 SURFACE DENSITIES AND MEASURED HYDROSTATIC MIDPLANE PRESSURE
Dr. Danielle Lucero

Taylan Tunckanat (Biochemistry)

BIOCHEMICAL CHARACTERIZATION OF AMINOMUTASES INVOLVED IN SALT TOLERANCE IN METHANOGENIC ARCHAEA
Dr. Kylie Allen

NATIONAL CONFERENCE ON UNDERGRADUATE RESEARCH

Due to the COVID-19 pandemic the 2021 National Conference on Undergraduate Research (NCUR) was held virtually. The scheduled conference dates were April 12-14, 2021. The Office of Undergraduate Research would like to recognize the students who were selected to present.

The National Conference on Undergraduate Research (NCUR), established in 1987, is dedicated to promoting undergraduate research, scholarship and creative activity in all fields of study by sponsoring an annual conference for students. Unlike meetings of academic professional organizations, this gathering of young scholars welcomes presenters from all institutions of higher learning and from all corners of the academic curriculum. Through this annual conference, NCUR creates a unique environment for the celebration and promotion of undergraduate student achievement, provides models of exemplary research and scholarship, and helps to improve the state of undergraduate education.

Student name, academic major and title of presentation listed below alphabetically.

Neema Ahmadian (Engineering)

DRONE ULTRASOUND ACOUSTIC ENERGY TRANSFER

Samuel Browning (Psychology)

APPLYING POSITIVE PSYCHOLOGY DURING A QUARANTINE: HOW DOES A WEEKLY GRADITUDE LETTER AFFECT DAILY MOOD STATES?

Shruti Das (Mechanical Engineering)

SOUND MANIPULATION TECHNIQUES AND APPLICATIONS

Ryan D'Onofrio (Biology)

A STUTTERING ASSOCIATED MUTATION IN THE GENE GNPTAB ALTERS RAT PUP "ALTRASONICVOCALIZATIONS"

Lucas Feldkamp (Architecture)

CONTROL OF EXCESSIVE MOVEMENTS OF ARCHITECHURAL STRUCTURES

Michael Taylor (Biology)

SN OVEREXPRESSION OF A FOXP2 TRUNCATED VARIANT SHOWS BIOLOGICAL RELEVANCE ON THE DEVELOPMENT OF VOCALIZATIONS AND BEHAVIORS IN RATS

Taylan Tunckanat (Biochemistry)

BIOCHEMICAL CHARACTERIZATION OF AMINOMUTASES INVOLVED IN SALT TOLERANCE IN METHANOGENIC ARCHAEA

Sam Williams (Computer Science)

3D LEARNING ENVIRONMENTS IN PRACTICE-VIRTUAL MUSEUM AND VIRTUAL CLASSROOM CASE STUDIES

Travel Grant Awards 2020-2021

In these uncertain times, the VT Office of Undergraduate Research encourages studentsto present their research at virtual conferences. OUR travel support program will coverexpenses related to presenting at a virtual conference. This rolling review process is designed to assist undergraduate students who have had their research or creative scholarship accepted for presentation at a regional, national or international conference. This program will provide travel funding to students who, without this support, may not be able to attend a conference to present their work. Current undergraduates from any discipline are eligible to apply for travel support.

Samuel Browning (Psychology, College of Science)

Faculty Mentor: Dr. Scott Geller
MID-ATLANTIC UNDERGRADUATE RESEARCH CONFERENCE (MAURC)
March 25- 27, 2021

Mackenzie Davis (Psychology, College of Science)

Faculty Mentor: Dr. Scott Geller
MID-ATLANTIC UNDERGRADUATE RESEARCH CONFERENCE (MAURC)
March 25- 27, 2021

Logan Hanton (Real Estate, Pamplin College of Business)Faculty

Mentor: Dr. Jeff Robert
ARES VIRTUAL CONFERENCE - COLLABORATING WITH INDUSTRY TO IMPROVE UNDERGRADUATE REAL ESTATEEDUCATION
March 17-20, 2021

Lechuan Huang (Smart and Sustainable Cities, College of Architecture and Urban Studies)

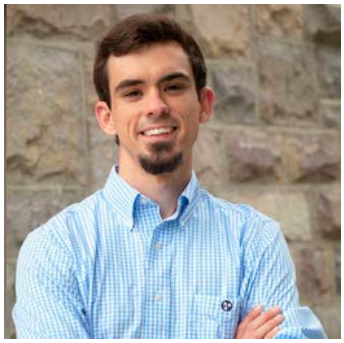
Faculty Mentor: Theodore Chao Lim
AMERICAN ASSOCIATION OF GEOGRAPHERS ANNUAL MEETING 2021 (AAG)
April 7-11, 2021

2021 Outstanding Undergraduate Research Mentor Award

An often overlooked, unrecognized and unrewarded mode of teaching is mentoring undergraduate students in research. Four years ago, the Office of Undergraduate Research launched the Outstanding Undergraduate Research Mentor Award- for a Faculty and a Graduate Student- to recognize the hard work, time, dedication, and guidance that research mentors provide to undergraduate students.

Undergraduates were asked to nominate one Virginia Tech faculty or graduate student research mentor from any discipline for this award. We received 15 nominations: 12 nominations for 8 faculty members and 3 nominations for 3 graduate students. It was extremely humbling and inspiring to review the thoughtful and passion-filled nominations. Many recognized the tireless and often unrewarded efforts of their mentors and indicated that their mentor made their VT experience unique and overwhelmingly had a positive impact on their future plans.

The recipient of this year's Outstanding Undergraduate Research FACULTY Mentor Award is Koeun Choi, PhD from Human Development, who received two nominations. Students described her as empathetic, informed, patient, supportive and passionate.



The recipient of this year's Outstanding Undergraduate Research GRADUATE STUDENT Mentor Award is William Singer, School of Plant and Environmental Sciences, who was described as patient, engaging and adaptable.

Thank you to all undergraduate research mentors. Without mentors, students could not engage in research and without exceptional mentors, students would not gain as much out of the research experience!

Office of Undergraduate Research Ambassadors

Julia Pimentel - Head Ambassador **(Graduation: Spring 2022)**

MATERIAL SCIENCE AND ENGINEERING

Danielle Alms (Graduation: Spring 2021)

BIOLOGICAL SCIENCES - OPTION IN ECOLOGY, EVOLUTION AND BEHAVIOR, minor: SOCIOLOGY

Maame-Owusua Boateng (Graduation: Spring 2021) *TRANSFER

STUDENT CLINICAL NEUROSCIENCE- ASTROCYTES, TRAUMATIC BRAIN INJURY, EPILEPSY, NEUROSCIENCE

Bethany Grocock (Graduation: Spring 2021)

HUMAN DEVELOPMENT - CHILD DEVELOPMENT, COGNITIVE DEVELOPMENT, EDUCATIONAL MEDIA

Cameron Hart (History; Professional and Technical Writing) (Graduation: Spring 2021)

BIOMEDICAL SCIENCES - BIOLOGY, CHEMISTRY, PUBLIC HEALTH BIOCHEMISTRY

Shivani Iyer (Graduation: Spring 2021)

BIOLOGY - SOCIAL ABILITY QUANTIFICATION SYNAPTOGENESIS

Srinidhi Jayakumar Narayanaswamy (Graduation: Spring 2022)

PSYSCHOLOGY, minors: ADAPTIVE BRAIN AND BEHAVIOR, INTEGRATED HEALTH AND WELLNESS

Hana Mir (Graduation: Fall 2022)

PHYSICS - DARK MATTER PHYSICS, NON-EQUILIBRIUM STATISTICAL MECHANICS + POPULATION DYNAMICS

Austin Murray (Graduation: Spring 2021)

BIOCHEMISTRY - PLANT VIROLOGY, PROTEOMICS STRUCTURAL BIOCHEMISTRY

Sofie Saunier (Graduation: Spring 2021)

BIOLOGICAL SYSTEMS ENGINEERING - BIOMECHANICS BIO-INSPIRED ENGINEERING, BIOLOGY/IMMUNOLOGY FOCUSED

Alexandra Soccio-Mallon (Graduation: Spring 2021)

SYSTEM BIOLOGY - INTEGRATED CELLULAR RESPONSES

Dylan Spedaliere (Graduation: Spring 2023)

BIOLOGY - SOCIAL INSECTS, SPECIFICALLY ANTS, HOW INSECTS AND HUMANS INTERACT WITH EACHOTHER

Taylan Tunckanat (Graduation: Spring 2021)

BIOCHEMISTRY, ENZYMOLOGY, METHANOGENIC ARCHAEA, COMPATIBLE SOLUTES

Emily Warwick (Graduation: Spring 2021)

INTERNATIONAL RELATIONS AND PUBLIC AND URBAN AFFAIRS

Rowan Wooldridge (Graduation: Fall 2020)

BIOCHEMISTRY - PLANT VIROLOGY, PROTEOMICS STRUCTURAL BIOCHEMISTRY

Informational Booths

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

TRANSLATIONAL BIOLOGY, MEDICINE AND HEALTH

OFFICE OF SCHOLARLY INTEGRITY AND RESEARCH COMPLIANCE

VIRGINIA TECH GRADUATE SCHOOL

UNIVERSITY LIBRARIES

PHILOLOGIA

MOLECULAR AND CELLULAR BIOLOGY GRADUATE PROGRAM

ONLINE MASTERS OF AGRICULTURE & APPLIED ECONOMICS

MASTER OF PUBLIC ADMINISTRATION + PH.D. IN PUBLIC ADMINISTRATION AND PUBLIC AFFAIRS

Abstract

Lucy Adamson
Virginia Tech/Crop and Soil Environmental Science
Mary Michael Lipford
Virginia Tech/Crop and Soil Environmental Science

1) The influence of mechanical leaf removal on growth, biomass, grain yield, and nutrient value of mung bean (Vigna radiata)

In Senegal, one of the biggest problems that livestock producers face is the gap in the availability of good quality forages between the wet and extended dry seasons. Virginia Tech, in collaboration with Counterpart International (an NGO) introduced mung bean to Senegal for food and feed. Two separate experiments were conducted at Kentland Farm, VA (1) to determine the effect of leaf harvest of mung bean leaves on mung bean yield , forage biomass and quality and (2) to evaluate effects of Rhizobium (RH) and Arbuscular Mycorrhizal Fungi (AMF) inoculation on yield of mung bean and soil fertility effects. Similar sampling methods were used for both experiments. Random plants by treatment replication were taken and separated by leaf, stem, and mature and immature seeds pods. Samples were dried and weighed for biomass yield. Subsamples were obtained from the biomass samples, dried in a forced air oven for 48 hours and ground. Neutral detergent fiber (NDF), acid detergent fiber (ADF) and crude protein (CP) values were predicted using near infrared spectroscopy (NIRS). For yield data on leaf harvest experiment an ANOVA test was run on leaf harvest frequency versus biomass. The P value of .4712 was high; therefore, failing to reject the null hypothesis that leaf harvest frequency has no significant impact on overall biomass. For inoculation results the AMF significantly increases pod dry weight of mung bean compared to the other treatments and inoculation of RH or application of N-fertilizer increases leaf dry weight of mung bean compared to the other treatments.

Mentor(s): Ozzie Abaye (Crop and Soil Science), Dr. Bo Zhang (Crop and Soil Science Dept.), Virginia Tech

Tess Alexander
Virginia Tech/Biological Sciences

Does big data bring opportunity, bias, or both for conservation? Exploring open access species occurrence data

Biodiversity describes the variety of species in a habitat and is important for the function and resilience of ecosystems to climate change. To measure biodiversity, we must understand where species occur. This is difficult with incomplete data, but a growing number of databases allow community scientists to upload observations, or occurrence data, of species which may help address this knowledge gap. Occurrence data record a species' exact location in space and time. It is used with environmental data to develop species distribution models (SDMs) that predict where a species likely occurs. However, data reported opportunistically can be spatially biased by being clustered where scientists frequent, rather than actual species occurrence, ultimately lowering the accuracy of associated SDMs. To identify potential bias in occurrence datasets, I addressed the question, is there a correlation between centers of high population density and the number of anuran, or frog and toad, occurrence points reported in two citizen scientist databases: the Global Biodiversity Information Facility and HerpMapper? I hypothesize occurrences are denser around urban and conservation centers because of the greater data collection initiatives and that occurrences will occur more often in developed and forested landscapes. To test this, I created density plots of occurrences for three anuran species to demonstrate clumping patterns across the species' range. I also calculated average percent land cover and land cover patchiness within 5 km of all occurrences. The results suggest occurrences from these databases are biased towards human collection efforts. SDMs using these data need to account for this bias to better predict and measure biodiversity.

Mentor(s): Meryl Mims (Biological Sciences), Chloe Moore, PhD student (Biological Sciences), Virginia Tech

Amara Alexander
Virginia Tech/Microbiology

Single Cell RNAseq Analysis Identifying Neurons in Response to Stress

Brain is known to be the essential tissue coordinating stress responses and neural pathways involving in hypothalamic-pituitary adrenal axis control the release of neurotransmitters during stress adaptation. However, the overlap of stress-dependent neurons with different circuitries in the brain has left the neurons responding to physiological stress largely unidentified. In this study, we explored a public available single-cell atlas to identify neurons involving in stress-dependent activation. This single-cell atlas was generated for zebrafish brains across 12 developmental stages. We first screened single cell expression data to identify cells expressing known stress-related genes, including pdyn, crhb, and a possibly related gene, avp. These cells were classified into 4 groups according to the combination of expression patterns of 3 genes. Fifteen differentially expressed genes were identified from pair-wise comparison of pdyn+crhb-avp+ vs pdyn+crhb-avp- cells. This list of differentially expressed genes identified in the present study may provide possible targets of stress-dependent neuron identification as well as the signaling pathways participating in stress-response.

Mentor(s): David Xie (Biomedical Sciences & Pathobiology), Virginia Tech

Johan Alfaro Carballo
Virginia Tech/Clinical Neuroscience

Covid-19 and Undocumented College Students: Challenges, Resources, and Recommendations

Undocumented college students face multiple challenges in the financial, academic, social, and emotional areas. During what would be a normal school year, undocumented students have many barriers and limitations to overcome. Challenges that in cases prevent students from succeeding or completing their degree. With Covid-19 impacting college campuses across the nation, it is expected that the hurdles have been impacted. The purpose of this research is to identify the way Covid-19 has altered the common challenge undocumented students face during a normal school year. Undocumented college students asked to share their experiences and how Covid-19 has played a role or impacted past challenges. With the goals of creating a list of resources, identifying challenges, and creating recommendations to aid undocumented students on campus. Methods of data collection that will be used are virtual focus groups and surveys. Other goals and outcomes of this research are to gain a deeper understanding of how a pandemic affects undocumented college students and identifying a pattern that could potentially be used to help in future crises. It is anticipated that the Covid-19 pandemic has increased challenges and limitations in the undocumented college student population. Areas expected to be impacted are financial, emotional, health, and academic areas.

Mentor(s): Natalie Cook (Department of Population Health Sciences), Virginia Tech

Danielle Alms
Virginia Tech/Biological Sciences

The effect of Mycoplasma gallisepticum infection on feather quality and maintenance in house finches (Haemorhous mexicanus)

When organisms, such as songbirds, are faced with an active pathogen infection, there can be pronounced energetic trade-offs. These tradeoffs may affect several systems within an organism, including behavioral maintenance of external structures. In songbirds, behavioral feather maintenance ("preening") is critically important to their survival and fitness. Mycoplasma gallisepticum (MG) is a common pathogen in a songbird species, the house finch, where it causes the disease mycoplasmal conjunctivitis. To date, no studies have looked at how preening behavior changes with MG infection and how these differences in preening may affect feather quality. To test this, 32 wild-caught, but captive-held house finches were given one of three treatments directly into the conjunctiva as part of a separate study: a high (10^4) dose of MG (n=11), a mid (10^3) dose of MG (n=11), or a sham control treatment of sterile media (n=10). Behavioral videos were recorded at two time points (pre-infection and peak-infection) to determine the proportion of time spent preening and the time spent inactive. Approximately one month post-inoculation, a secondary flight feather was clipped and examined under a microscope to score the amount of degradation of feather structures on a 1-4 scale. We found that birds infected with MG preened significantly less often and were also significantly less active than healthy controls. However, there was no difference in the feather quality scores between control and infected individuals, which may partly be due to the controlled environment our birds experience while in captivity. Our data suggests that infection strongly affects the behavior of house finches by decreasing their overall activity, including behaviors critical to survival such as preening. Further work is needed to determine whether house finches in the wild that are infected with MG experience a fitness cost due to this reduced feather maintenance.

Mentor(s): Dr. Dana Hawley (Biological Sciences), Marissa Langager (Biological Sciences), Chava Weitzman (Biological Sciences), Sara Teemer (Biological Sciences), Virginia Tech

Rachel Apple
Virginia Tech/Human Development

The Effect of Psychiatric Disability and Sibling Age Gap on Sibling Relationships

This study was conducted to determine if sibling age gap affects the sibling relationship, and to determine how sibling disability affects these findings. Data was collected through a one-time online survey which asked an array of questions about sibling relationship and disability. We measured sibling relationship with the Sibling Intimacy Scale (SIS) and the warmth scale of the Adult Sibling Relationship Questionnaire (ASRQ). Results indicate that siblings of individuals with a disability report less sibling intimacy and warmth compared to typically developing siblings. Age gap does not significantly affect the relationship of typically developing siblings. However, relationships for those who have a sibling with a disability are negatively impacted by a wide age gap. When closely examining sibling birth order and whether or not the sibling has a disability, we found that both interactively affect sibling warmth ($F=6.68$, $p=.01$). Specifically, when participants are younger, having a sibling without a disability does not affect their assessment of sibling warmth. When participants are older than the sibling, disability predicts significantly less warmth. However, the same interactive pattern was not presented using SIS. These results emphasize age gap and birth order of siblings in disability research, especially focusing on sibling closeness and warmth. Further exploration should be made in terms of different conditions of different types of disabilities.

Mentor(s): Carolyn Shivers (Human Development), Virginia Tech

Roshen Arun
Virginia Tech/Mechanical Engineering
Chase Dillard
Virginia Tech/Computer Engineering

Nest AI

The Nest Learning thermostat accounts for temperature set points based on user time input. This Nest AI project aims to develop a framework for an AI external to the Nest that will not only follow user's historical preferences, but will also factor in insulation heat loss and external weather conditions to maintain constant comfort to users while improving the energy efficiency of residential systems. A Raspberry Pi serves as the data processing component that communicates set temperatures to the Nest. It uses a Python script and temperature sensors to calculate heat loss and set the Nest thermostat accordingly. The communication and processing between the Raspberry Pi and the Nest have been established along with a heat loss reference table. Additionally, A thermal test chamber has been completed and can begin collecting data to teach the neural network. The current step is to relate heat loss to a Nest set temperature by using machine learning and data collection. Once this is complete, the system will be fully functional, but it will need to be refined with data before it can make accurate predictions.

Mentor(s): David Gray (Engineering), Virginia Tech

Amber Attreed

Virginia Tech/Cognitive and Behavioral Neuroscience

A Systematic Review of Interventions Targeting Irritability Among Depressed Children and Adolescents

Children with depressive disorders are significantly more likely to display irritability, relative to adults with depression. Irritability has been linked to depression severity, as well as functional outcomes (e.g., coping ability, sleep problems, social impairment). However, it remains unclear whether interventions for youth with depression can significantly reduce irritability. As such, the present study sought to conduct a systematic review of interventions targeting irritability among children and adolescents with depressive disorders. Only two studies were identified that examined changes in irritability from pre- to post-intervention, with one of these articles focusing on Omega-3 fatty acid supplements and one focusing on the antidepressant medication Fluoxetine. In the first study, adolescents receiving the Omega-3 fatty acid supplement for 10 weeks showed large improvements in irritability (d=1.01); however, this improvement was not larger than that experienced by adolescents who received a placebo (d=0.73), p=.70 (Gabbay et al., 2018). In contrast, adolescents who received Fluoxetine for 12 weeks showed decreased depression symptoms including irritability (d=2.71), with irritability being the second most common symptom at baseline and third most common 4-12 weeks into treatment. Unfortunately, 10.5% of adolescents continued to display irritability, even after their depression symptoms had remitted (Tao et al., 2010). Four additional studies were identified that examined irritability as an adverse event, with 2.23% of participants experiencing this side effect on average. This study highlights the critical importance of more intervention research examining the efficacy of medication, therapy, or both to improve irritability, and thus negative outcomes, among depressed children and adolescents.

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

Keely Beard
Virginia Tech/Biology

Callogenesis, rhizogenesis, and Agrobacterium-mediated transformation of Cannabis sativa L.

Cannabis sativa L. is a valuable, emerging crop with applications in feed, fiber, and pharmaceuticals. Unfortunately, due to recently lifted legal restrictions, cannabis research has been severely impacted and the molecular understanding of this crop is limited. The application of biotechnology for genome editing has significant potential in addressing species-specific deficiencies, but the lack of an efficient in vitro regeneration protocol continues to be a big hurdle that has yet to be conquered. Here, we present our progress towards the development of an efficient in vitro regeneration protocol with the ultimate goal of implementing new plant breeding technologies, such as CRISPR/Cas9. A series of treatments using various combinations of plant growth regulators are applied to tissue cultures to induce callus and attempt regeneration. Additionally, the introduction of inducible embryogenic transcription factors is mediated by Agrobacterium tumefaciens transformation with the goal of inducing somatic embryogenesis and/or shoot regeneration. We demonstrate callogenesis and rhizogenesis from leaf-disc explants using adaptations of published regeneration procedures. Furthermore, preliminary experiments using estradiol-inducible expression of green fluorescent protein show that we can use Agrobacterium to successfully transform cannabis. Our work has shown that there is merit in continuing to study and attempt regeneration in hemp.

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

Taylor Berkley
Virginia Tech/History

Bon Appetit!: How Julia Child Transformed American Culinary Culture

Julia Child, an internationally renowned chef, broke into the spotlight in 1963 with the premiere of her cooking show, "The French Chef." This show brought a new genre of television shows to American households. People loved Child instantly due to her simple and through cooking techniques as well as her one-of-a-kind personality. She shaped through her show how American cooking shows would prosper in the upcoming decades, as well as, bringing interest back into the kitchen for women. By using interviews, newspaper articles, and scholarly articles, I will show how Julia Child became well-known culinary star and helped transformed American culinary culture.

Mentor(s): Dr. Mark Barrow (History), Virginia Tech

Kaleb Bowinkle
Virginia Tech/Biochemistry

Investigating the Distribution and Biosynthesis of a modified cofactor F430 in Methanococcus maripaludis

Methanogenesis is the energy-generating pathway in methanogenic archaea (methanogens) that produces methane as an end product. Methanogens are abundant in anaerobic environments and are responsible for over 70% of global methane, a potent greenhouse gas and the main component of natural gas. Producing a methanogenic strain able to efficiently reverse methanogenesis could be used to convert methane to more useable liquid fuels. Before this can be realized, however, the chemistry of methanogenesis must be more fully understood. The final, rate-determining, methane-forming step of methanogenesis is catalyzed by methyl-coenzyme M reductase (MCR) and its essential prosthetic group, cofactor F430. Recently, variants of cofactor F430 have been discovered in several methanogens and the closely related anaerobic methanotrophs (ANME). The main variant we have observed in methanogens is mercaptopropionate-F430 (F430-3). Growth experiments with Methanococcus maripaludis show that F430-3 is most abundant in stationary phase of growth, but only when grown on hydrogen, suggesting that hydrogen deprivation induces the expression of F430-3. Bioinformatics and genetic manipulation suggest that BSM21210, from ANME-1, and its methanogenic homologs, catalyze the initial sulfur insertion step in the biosynthesis of F430-2 and F430-3. Future research will elucidate the biosynthesis and physiological roles these variants of an essential cofactor play in life.

Mentor(s): Kylie Allen (Biochemistry), Virginia Tech

Caroline Bradford
Virginia Tech/Biological Sciences

Harvest sustainability and practices of two Southern Appalachian medicinal species (Sanguinaria canadensis and Trillium erectum)

Sanguinaria canadensis (bloodroot) and Trillium erectum (red trillium) are native North American flowering plants that have been collected for generations. The medicinal properties contained within each species have continued to generate a vast interest in collectors. These species play an integral role within traditional medicinal practices as well as having modern pharmaceutical uses. Their rising popularity makes it important to better understand current harvest rates and practices along with potential threats these species may encounter from over-collecting or changing climates. Southern Appalachian residents were surveyed to determine any trend for the availability of both species. In addition, we produced estimates of the projected effects that anthropogenic climate change will have on Sanguinaria canadensis and Trillium erectum using our custom ecological niche modeling (ENM) script. Our preliminary results show a drastic decline in both populations as a result of both mild and severe warming scenarios. These results emphasize the need for more detailed harvest data due to the serious implications of declining habitat availability for both species. Each species holds a valuable cultural and medicinal role in many communities and our research will contribute to efforts to conserve their populations.

Mentor(s): Jordan Metzgar (Biological Sciences), Virginia Tech

Madeleine Byrns
Virginia Tech/Clinical Neuroscience
Jared Fyfe
Virginia Tech/Criminology
Elizabeth Iddings
Virginia Tech/Psychology
Madeleine Coury
Virginia Tech/Psychology

Utilizing the Virtual Premortem Focus Group Method to evaluate a Brief Emotion Regulation Training (BERT) for emerging adults

Dissemination and implementation science methods and measures were applied to ensure that a novel online brief emotion regulation training (BERT) program developed with "the end in mind." The first step was an online brainstorming pre-mortem to evaluate potential failures of the program. Feedback was collected in focus groups of undergraduate students (n = 12) and via 4 clinician individual interviews. Each undergraduate focus group had 2-4 participants who were guided to identify how the program might fail.

Focus group data were clustered into three emergent categories: compliments (Keep; n = 34), suggested program changes (Change; n = 113), and concerns about the current program (Concern; n = 97). Decisions were made on how to address these suggestions for the next program iteration. Codes were divided into change now (n = 30), change later (n = 33), change to be surveyed at the end of BERT's pilot (n=48) already in the program (n = 59), changes not to be made (n = 42), or compliments given (n = 22).

The brainstorming pre-mortem process allowed end-users to identify multiple challenges within the pre-implementation phase of BERT. Although the brainstorming pre-mortem was designed to address failures, a substantial amount of feedback pointed out compliments or content already in the program. Many suggested changes were easy to implement, though many were technological barriers that could not be addressed in this iteration. The modifications to BERT elicited feedback and steps to take before the pilot trial leading to confidence in the successful implementation of BERT.

Mentor(s): Samantha Harden (HNFE Department), Alyssa J. Gatto (Psychology Department), Julie C. Dunsmore (Psychology Department), Virginia Tech

Faith Carrick
Virginia Tech/Agriculture Technology
Cameron Lee
Virginia Tech/Agriculture Technology

Comparing effects of creep feeding vs. creep grazing on cow and calf weight gain

The beef cattle industry has had a standing debate on the long-term benefits and effects that creep feeding or creep grazing has on cattle weight gain. There are known benefits to both creep feeding your calves as well as creep grazing. This study aims to record the weight gains, and overall health of two different cow/calf groups to see the benefits of each creep feeding style. Ten cow calf pairs were divided at random into groups that would be creep fed and another that would creep grazing. Creed grazing is done by allowing the calves to graze free choice under temporary fencing. The temporary fencing was set high enough for the calves to easily pass underneath, to access the highest quality forages, but exclude the cows. The fence was moved every two to three days to give the cows ample grazing as well. The second group was creep fed. They have full access to unlimited feed. The creep feeders keep the feed dry and only allow the calves to access the feed. In addition, we have improved the diversity, palatability, and nutrient value of the pastures. We have done this by frost seeding the pastures with cool season legumes, and tall fescue. Both groups of cattle were weighed every two weeks. After a month, our recorded data showed the average daily rate of gain for both creep and grazing groups was 2.26 lbs./day. The cow's data also showed little difference. The grazing groups average daily gains were -0.96lbs and the creep group were -0.713lbs. The overall health of the cow and calf pairs did not seem to be affected by the difference in diet. The potential benefits to creep grazing vs. creep feeding we have observed thus far are: decreased time/labor (no hay feeding), increased profit (forages cost less than hay, feed, fuel for tractors), and the soil/overall pasture health (less treading damage, grass has ample time for regrowth, increased soil cover).

Mentor(s): Wesley Gwaltney (Agriculture Technology), Virginia Tech

Sara Carter
Virginia Tech/International Relations

America or America? A study of topic-based shifting in a US expat in London

Research shows that individuals who change geographic location for extended periods of time alter and adapt their speech because of second dialect acquisition (Nycz 2015). Speakers are also prone to topic-based shifting between their original dialect (D1) and their nonnative dialect (D2) (e.g., Walker 2019). I explore how a single migrant speaker changes pronunciation of a particular word depending on how she is positioning herself relative to both locations (Nycz 2018) in an attempts to understand how and why people change their speech.

This study examines an interview with a 41, female speaker who lived in America for 31 years, but moved, and resided at the time of recording, in London, England. The recording, part of the Transatlantic Corpus (Walker 2014), is approximately 40 minutes long and covers various American/English topics.

I focus on her pronunciation of the first vowel in the word "America(n)". Most studies looking at salient pronunciation differences focus on stressed vowels (Walker 2019), but the vowel of interest here is a schwa in both American and English dialects. However, the realization of schwa differs slightly, but audibly across dialects, including in this iconic word which she says a total of 39 times throughout the interview.

Sometimes when she says "America(n)," she includes herself as an American, while other times she appears to align herself as a British speaker and positions herself outside of the US. After acoustically measuring F1 and F2 of the midpoint of each vowel in Praat, it is apparent her pronunciation of schwa in these tokens changes throughout the interview but is better understood by a close reading of the stance she is taking in a given moment (Kiesling 2009).

Mentor(s): Abby Walker (English), Virginia Tech

Sounak Chakrabarti
Virginia Tech/Mechanical Engineering
Anh Le
Virginia Tech/Mechanical Engineering
Sanmeel Lagaad
Virginia Tech/Mechanical Engineering

Merging Soft-Robotics with Deep Learning in Replicating the Biosonar-Sensing Capabilities of Bats

Bats are highly accurate in echolocating their prey in various natural environments, a capability that remains out of reach for man-made sonar technology. One of the functionalities of bat biosonar that could contribute to this performance gap between bats and engineers, are the rapid ear movements of bats that are fast enough to create Doppler shifts. These Doppler shifts encode sensory information into the incoming biosonar signals that could help bats with understanding their environments in real time.

In order to emulate this behavior, prior research has replicated the dynamics of the bat pinna with fixed deformation patterns, e.g., due to a lever deforming a silicone replica of a bat pinna. However, these systems could not capture the variability (known and unknown) in the pinna motions of bats in their natural environments. To explore the utility of different motion patterns for different sonar tasks, reinforcement learning will be utilized to learn pinna motion sequences that can maximize sensory performance in natural environments.

To support this, biomimetic ears have been threaded with tendons allowing for very precise soft robotic actuation of localized areas. We hope to use these ears to create a small batch of data characterizing the relationship between incoming signals and ear deformations. However, reinforcement learning requires immense amounts of data, so we will need to use an FEA simulation model that will be capable of replicating ten to a hundred times the amount of data produced in real time. Afterwards, the produced data from the FEA simulation will be upsampled by being passed through an encoder.

After the specified steps, we will be able to gather enough data for reinforcement learning to train and optimize the pinna motions in the bat ear for processing incoming biosonar signals.

Mentor(s): Rolf Mueller (Mechanical Engineering), Ibrahim M. Eshera (ECE), Virginia Tech

Erin Collins
Virginia Tech/Biochemistry

Using Virtual Screening to Develop Predictive Models to Discover Novel Partial Agonists of PPARγ

Peroxisome Proliferator-Activated Receptor γ (PPARγ) is associated with a wide range of diseases, including type 2 diabetes (T2D). Thiazolidinediones (TZDs) are a class of drugs that are full agonists of PPARγ, which effectively treat T2D. However, TZDs cause negative side effects in patients, such as weight gain, edema, and heart failure. Partial agonists could be an alternative to TZD-based drugs. However, there is a lack of understanding of the types of PPARγ partial agonists and how they differ from full agonists. In silico techniques, like molecular docking and pharmacophore modeling, allow us to determine and characterize markers of varying levels of agonism. An extensive search of the RCSB Protein Data Bank found 62 partial agonists of PPARγ. Cross-docking was performed and found that 3TY0 and 5TWO would be effective as receptor structures for future docking. By grouping known partial agonists by common structural features, we found several unique groups of partial agonists. These groups allow us to predict if a ligand is a partial agonist of PPARγ, and which type it is, based on its structure and protein-ligand interactions. To determine the predictive power of the groups to detect partial agonists, active and decoy ligands of PPARγ from the DUD-E and NRLiSt databases were docked into 3TY0 and 5TWO. These groups will find distinguishing features between active and decoy ligands, which can lead to more targeted drug design. If successful, the groups can be used to find novel partial agonists of PPARγ, which could be used to treat T2D.

Mentor(s): Anne Brown (University Library), Stephanie Lewis (Honors College), Virginia Tech

Madeleine Coury
Virginia Tech/Psychology
Kimny Sysawang
Virginia Tech/Psychology
Madeleine Byrns
Virginia Tech/Clinical Neuroscience
Delaney Keller
Virginia Tech/Psychology

Considerations for Methodological Integrity and Participant Safety when Transitioning Qualitative Focus Group Method to a Virtual Platform

In 2020, the COVID-19 pandemic forced research operations to quickly mobilize to an online platform. This research examines how we strategically modified in-person focus groups to a virtual platform.

The Brainwriting Premortem Method (BPM) is the "silent sharing of written ideas about why an intervention failed". Nonverbal dialogue takes place through written conversation to address project shortcomings prior to launch. BPM facilitates an open environment, mitigating safety issues traditional focus groups face. The BPM was selected to evaluate a novel online Brief Emotion Regulation Training (BERT) program for undergraduate students.

Our BPM method utilized an anonymous GoogleDoc where participants built written conversation around specified questions regarding pre-implementation failures. Participants were asked to log out of their personal Google accounts for anonymity and logistical reasons (color-code; differentiate responses).

Extra precautions were taken to ensure sufficient security online with data collection and storage. The virtual BPM enabled participants to maintain true anonymity and gave reassurance towards participants' safety. It provided quick feedback and real-time decision making, producing a transcript and avoiding manual transcription. Virtual platforms can reduce financial, travel, and time costs.

The BPM moved to a virtual platform while functioning to promote a safe, inclusive conversation and efficiently collect data. Our virtual BPM fostered participant engagement and facilitated effective conversations in a setting where some may not feel that they can share their thoughts.

Mentor(s): Dr. Samantha M. Harden (Department of Human Nutrition, Foods, and Exercise), Alyssa J. Gatto (Department of Psychology), Virginia Tech. Dr. Julie C. Dunsmore (Department of Psychological, Health, and Learning Sciences), University of Houston. Dr. Lee Cooper, (Department of Psychology) Virginia Tech

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Anvitha Metpally
Virginia Tech/Clinical Neuroscience
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Virginia Tech/Biological Sciences
Bethany Grocock
Virginia Tech/Human Development
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Virginia Tech/Clinical Neuroscience
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Virginia Tech/Human Nutrition, Foods, and Exercise

How do we perceive and learn from robots?: Implications of the "Uncanny Valley" effect on learning

Robots are becoming increasingly commonplace in the modern-day, and have the potential to affect many aspects of our lives. This expansion highlights the importance of understanding how robots impact the cognitive development of future generations. While human-like robots can elicit positive emotions and support learning, they may also trigger the "Uncanny Valley" effect, which is the psychological difficulty in accepting artificial-but-human-like objects (Mori et al., 2012). This project examined how adults perceive and learn from human-like robots. First, adult participants (N = 137; 23-70 years) completed an online experiment to determine how they perceived morphed human-robot images. Next, participants watched videos of both a human and a robot and selected who they would prefer to learn from. Results indicated that participants accurately perceived human faces and preferred them over robot faces. Further, there was a decrease in participants' preference for human-like robot faces, suggesting the presence of the "Uncanny Valley" effect. Overall, adults were more likely to learn from a human as opposed to a robot, but adults' learning depended on their human-robot face perception. Adults who preferred a human face learned from a human while those who preferred a robot face learned from a robot. This research has implications for understanding how adults use new technology to seek information and could be used as a basis for further research on learning.

Mentor(s): Koeun Choi (Human Development and Family Science), Virginia Tech

Emma Covington
Virginia Tech/Clinical Neuroscience
Samantha Tollefson
Virginia Tech/Chemistry
Maya Elhachem
Virginia Tech/Cognitive and Behavioral Neuroscience
Lauren Duma
Virginia Tech/Clinical Neuroscience
Bridgett Burgos
Virginia Tech/Clinical Neuroscience

The Innovation of mRNA

Eterna is a citizen science based website where users can complete mRNA puzzles to construct molecular medicines. The data is then looked at and used by Stanford University to research and design new molecular medicines that can be used to help treat infections or be used in vaccines. COVID-19 is an infectious disease that has impacted the world greatly. It is an airborne virus that can be spread easily through close contact. The purpose of this study is to analyze the virtual creation of the various COVID-19 vaccines and link their design to the puzzles on the Eterna website. Many COVID-19 vaccines have been developed, but only a few have been approved. Pfizer and Moderna have been approved by the World Health Organization (WHO) and the Center for Disease Control (CDC). Johnson and Johnson recently this year got their vaccine approved. Oxford's AstraZeneca vaccine recently got its vaccine approved. The research on the COVID-19 vaccine demonstrates how fast a vaccine can be made and distributed among the population. Citizen science projects, such as Eterna, can help scientists in the future create new vaccines, as RNA vaccines have been shown to work against the COVID virus and.

Mentor(s): Victoria Corbin (Orion LLC), Virginia Tech

William Cox
Virginia Tech/Aerospace Engineering
Henry Forsyth
Virginia Tech/Computer Engineering
Enoch Cho
Virginia Tech/Electrical Engineering

Developing a Standalone Deep-Learning Enabled Bio-Mimetic Sonar Control System

Developing a sonar system that mimics a Rhinolophidae bat's echolocation requires an electrical system to actuate mechanical components, control audio emission and recording equipment, and perform signal processing. The Naval Engineering Education Consortium Bat Robot Electrical team was tasked with developing the hardware and software for this system. An onboard computer, the Nvidia Jetson Nano, was added to the Bat Robot to perform machine learning using its integrated GPU. Additionally, three open-source commercial-off-the-shelf microcontrollers were added to the robot to perform data acquisition and actuation. Tasks were split between the microcontrollers based on their available number of pins and clock frequencies. Use of the Jetson's GPU accelerated standard signal processing tasks by a factor of up to four. Splitting tasks between 3 microcontrollers allowed for simultaneous recording of ultrasonic echoes and movement of two servos, two stepper motors and sixteen valves. To enable high speed transmission of audio data between onboard systems, native USB protocol was used. Power distribution was achieved through the development of custom, modular PCBs. The system was designed to draw power from a lithium polymer battery, convert the input voltage to various useful output voltages using power cards, and distribute these voltages through a power network board. The selection of these boards coupled with the development of compact PCBs led to a lightweight, compact and highly capable system that was easy to integrate with the Bat Robot.

Mentor(s): Rolf Mueller (Mechanical Engineering), Virginia Tech

Danielle David
Virginia Tech/Biochemistry
Aurora Jensen
Virginia Tech/Biochemistry
Hannah Vincent
Virginia Tech/Biochemistry
Lauren Johnson
Virginia Tech/Biochemistry
Alyssa McCaffery
Virginia Tech/Biochemistry
Madison Payne
Virginia Tech/Biochemistry

Science of Wellbeing Project

The ultimate goal of this project is for each member of the team to find a wellness activity that can be incorporated into their daily life. This activity is used to bring an overall greater happiness and satisfaction level to the participants' life. One of the bigger goals for which the team is trying to bring awareness is the stigma associated with mental health; this is especially important for college students. The group is hoping to achieve these goals by participating in The Science of Wellbeing Course offered by Yale through Coursera. The course is designed to be completed in ten weeks, and it consists of readings, videos, and rewirement activities. In the last few weeks of the course, each participant chooses the rewirement activity and puts everything we learned into practice. For The Science of Wellbeing Project through Orion, each group member is required to complete a daily log in which the members outline what they did for each rewirement activity and complete a reflection on their experience. In addition, group members are responsible for submitting screenshots of each week's completed module to a google doc. The result of the project will be determined at the end of the ten-week period by comparing the results of the happiness quiz taken during week 1 to the results of the happiness quiz taken during week 10 of the project. The group is expecting to see positive results as group members have been successfully completing the same, one rewirement activity each day for the last two weeks.

Mentor(s): Victoria Corbin (Assistant Dean for Outreach and Student Engagement), Virginia Tech

Mackenzie Davis
Virginia Tech/Psychology

Universities vs. COVID-19: A Community- Wide Prevention Measure Analysis of At Risk vs. Non Risk Areas

Universities in five different states are collaborating on an original large-scale COVID-prevention effort by asking many of their students to complete an innovative survey that strategically asks them to identify areas on and around campus that are “hot spots” for spreading the coronavirus. These universities—Virginia Tech, Appalachian State, Western Michigan, University of Kansas, and University of Florida—are also observing mask wearing, social distancing, and other COVID prevention measures in their communities to analyze the risk management and wellness precautions taken by students, faculty, and the surrounding communities. Mapping hot-spot areas provides invaluable information for prevention and intervention creation.

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

Jaylen Day
Virginia Tech/Chemical Engineering

Cyberbiosecurity Factsheets for Middle School Educators

The goal of this research project was to investigate and create an academic resource about cyberbiosecurity for middle school educators. This academic resource is a series of fact sheets that explain entry level concepts and terms in the field of cyberbiosecurity. The overarching purpose of this project was to: '[Initiate] the Rural Cyberbiosecurity Workforce Pipeline through Empowering Agricultural Educators Supporting Middle School Girls'. This was the focus of my project because women in the cybersecurity sector only account for 20% of the workforce. Integration between cybersecurity and the life sciences is limited, so resources for educators will be beneficial for youth development in the cyberbiosecurity field.

The research project has been ongoing for 4 months, but I've been focused on cyberbiosecurity related research for 8 months now. In my research about cyberbiosecurity, I used academic databases such as the Agriculture Science Collection from ProQuest, Google Scholar, PubAg, etc. My greatest resource was a collaborative Google Drive between faculty and students focused on cyberbiosecurity.

From a creative standpoint, the fact sheets should follow the conventions of a technical document: appropriate use of white space, pictures to break long lines of texts, appropriate headings, etc. Also, I have to ensure the information presented is easy to understand and appropriate for the audience. This research project is in progress with 10 cyberbiosecurity fact sheets of 500-700 words.

Mentor(s): Tiffany Drape (Department of Agriculture and Leadership Education), Virginia Tech

Nicole DeFoor
Virginia Tech/Experimental Neuroscience

Under-expression of immune system genes in ovarian tumor samples with a rare mutation in FAM104A

During this pandemic, the word immunocompromised has been brought up in casual conversations more often than before. We have been told to protect those who are immunocompromised because they are more likely to be strongly affected by COVID-19 and will have a harder time recovering. These individuals are also more likely to have other health issues due to the weakened state of their immune system, this includes different types of cancer. This is mostly due to immune evasion of tumor cells, but could be due to immune system deficiency. In ovarian serous cystadenocarcinoma (OSC) samples, somatic mutations of lymphocytes have been found to be correlated with expression of certain immune system genes. Specifically, the Q90Pfs*6 variant in the FAM104A gene was found to occur in 19% of tumor cells, rather than only 0.0025% in control DNA samples. This was also found in both matched tumor and blood derived normal samples, suggesting that the mutation it causes is in lymphocytes instead of tumor cells. To validate these findings, we are using CRISPR/Cas9 gene editing to study the effect of knocking out FAM104A on gene expression. This data along with current genetic testing of the incidence of FAM104A in ovarian tumor cells might give way to one of the causes of and therapeutics for ovarian cell cancer.

Mentor(s): Ramu Anandakrishnan (VCOM - Biomedical Sciences, Biomedical Sciences and Pathobiology), Virginia Tech

Sophia DeSimone
Virginia Tech/Biochemistry
Anthony Briganti
Virginia Tech/Biochemistry

Combating Antibacterial Resistance: Characterizing Antibiotic Binding Pockets to Advance Bidentate Design

Antibiotic resistance is a growing problem in modern medicine and there is a need to find new antibiotics able to treat common diseases. As of 2019, the CDC reported over 2.8 million cases of antibiotic-resistant infections in the United States and there are approximately 35, 000 deaths annually.1 Medicine is quickly running out of tools to treat these resistant bacteria, and cases are expected to increase. A solution to this problem is the creation of novel bidentate antibiotics, which are two known antibiotics covalently linked to bind simultaneously into the ribosome. Molecular docking studies of antibiotics are used to characterize ribosomal binding sites and determine candidates for creating bidentate antibiotics to overcome antibiotic resistance. A docking protocol was created for ribosomes as the programs available were designed for amino acids rather than nucleic acids. The pleuromutilin class of antibiotics, consisting of Lefamulin and Tiamulin, has been successfully docked with RMSD values less than 2Å and have similar binding motifs. The antibiotics blasticidin S and spectinomycin are in the process of being characterized as well. This successful docking protocol will be applied to other classes of antibiotics and can be further combined with other computational tools such as interaction fingerprinting and surface mapping to further enhance the understanding of bidentate candidates.

Mentor(s): Anne Brown (Biochemistry), Virginia Tech

Walter Dickey
Virginia Tech/Clinical Neuroscience
Colleen Hammer
Virginia Tech/Explore Science
Alex Miller
Virginia Tech/Explore Science
Calla Serrano
Virginia Tech/Biological Sciences
Bri Woodall
Virginia Tech/Clinical Neuroscience

Genetics and Biotechnology: JELL-O-lectrophoresis

As a result of the pandemic, many schools moved to remote learning, which resulted in students losing interactive aspects of their science classes. Therefore, one of the main goals of this project is to reinforce what freshman students are learning in their biology classes. Another goal of this project is to encourage students to step away from their computers and engage in a lab activity that can be conducted easily at home. Furthermore, an additional goal is to encourage students to explore different aspects of genetics and become more enthusiastic about biology. To achieve an understanding of DNA and the basics of genetics, students are recommended to interact with the PowerPoint attached to the lesson plan. Afterward, they can complete an interactive worksheet that includes a scenario presenting multiple diseases. Tied with another interactive activity, students will identify the specific disease using a lab that simulates gel electrophoresis. In order to be sufficiently prepared to conduct a lesson on this topic, research has been conducted on specific genetic topics including genetic mutation, pedigrees, and topics regarding ethics in genetics. Additional research has been conducted on DNA structure and the role of DNA in protein synthesis to provide a substantial foundation for the students. Upon completing the activity, students should receive a thorough understanding of DNA structure, genetic variation, cell division, and ethics of genetics.

Mentor(s): Victoria Corbin (Orion LLC), Virginia Tech

Shawn Ding
Virginia Tech/Statistics
Rhett Sargent
Virginia Tech/Statistics
Clare Hinds
Virginia Tech/Math
Rachel Suchman
Virginia Tech/Biological Sciences
Aden Liu
Virginia Tech/CMDA

The Effects of Coding and Technological Advancements on the Professional Lives of Modern Society versus the People of the Past

Coding and programming have become desired job skills for numerous professions over the last century. Originally, these skills were used only in STEM-related disciplines, but now they can be applied to many different aspects of society. Students that have taken coding classes have found in many cases that these skills have been helpful even though they may not have initially thought that they would be in their field of study. Therefore, this research is meant to inform students of any field about the benefits of learning coding skills. Here we show the impact coding has on the professional lives of people in our society. Examples of this may be found in fashion, entertainment, agriculture, and more. Learning computer programming will enhance someone's logical thinking, abstract thinking, and problem-solving skills, increasing their skill set and the variety of opportunities they can take on. For example, social science has been greatly impacted by coding especially with regards to communication and efficiency in different workplaces. Students who take the time to learn these skills may find that being proficient in different computing skills will lead to more job offers with higher salaries. Our findings are meant to inspire students to learn some of these computing skills since we have found that it does have benefits regarding personal and professional development.

Mentor(s): Victoria Corbin (Orion LLC), Virginia Tech

Mitch Dolby
Virginia Tech/Geography
Christina Tran
Virginia Tech/Physics
Emily Warwick
Virginia Tech/International Relations

Effects of Redlining on the 1983 Chicago Mayoral Election

Redlining in American cities has had various long-standing impacts. The repercussions of redlining towards marginalized groups are well-documented and include a multitude socioeconomic issues. This research focuses on redlining in the city of Chicago and its effects on the Chicago 1983 mayoral race, which saw the election of the city's first black mayor. The purpose of this research was to better understand the extent to which redlining practices shaped election results within Chicago. To answer this question, we visualized datasets from the 1980 census, the 1983 election, and the Home Owners Loan Corporation (HOLC) neighborhood grades. Specifically, we used racial data and votes by candidate from each election precinct. Using ArcGIS Pro and R programming, we created a comprehensive dashboard displaying a map of HOLC grades from the year 1940, and a spatial distribution of race and election results in each ward of the city. We simplified race to a normalized bivariate coloration of white and nonwhite populations to allow for a more intelligible view, and we overlaid this with pie charts representing votes by candidate in each ward. Chicago saw a definite split in candidate preferences by race, with white voters primarily supporting the Republican candidate and nonwhite voters supporting the Democratic candidate. From these results, we concluded that redlining played a role, albeit indirect, in the outcome of the 1983 election. This practice was a major factor in the de facto segregation of the city by race, hence geographically influencing its politics and voting patterns.

Mentor(s): Anne Brown (Biochemistry), Virginia Tech

Brock Duma
Virginia Tech/Blacksburg High School

Whitewater Helmet STAR: Evaluating the Biomechanical Performance and Risk of Head Injury for Whitewater Helmets

There are more than 6 million people who participate in whitewater kayaking and rafting in the United States each year. Of these 6 million participants, there are over 50 whitewater related deaths each year, with the primary cause of death being serious head trauma. The objective of this study was to create a rating system for whitewater helmets by evaluating the biomechanical performance and risk of head injury of whitewater helmets using the Summation of Tests for the Analysis of Risk (STAR) system. A total of 21 helmets were selected, and 2 models of each helmet were tested. A pendulum impactor was used to test the helmets under conditions which are known to be associated with the highest risk of head injury and death. The struck head consisted of a NOCSAE head form and Hybrid III 50th percentile neck, with the head form instrumented with three linear accelerometers, and a triaxial angular rate sensor. For this study, 126 tests were performed at six different configurations. The helmets were tested at 3.1 m/s and 4.9 m/s with impacts to the front, rear, and side for each speed. Each helmet's STAR value was calculated using the combination of exposure and injury risk that was determined by the linear and rotational accelerations. The resulting head impact accelerations predicted a very high risk of concussion for all impact locations with the 4.9 m/s impact speed. The STAR values varied between helmets, indicating that some helmets provide better protection than others. Overall, the results illustrated a clear need for improvement in whitewater helmets, and the methodologies developed in this research project should provide manufacturers a clear path to improving their products.

Mentor(s): Stefan Duma (Institute for Critical Technology and Applied Science - ICTAS), Virginia Tech

Lauren Duma
Virginia Tech/Clinical Neuroscience

Proposed Injury Threshold for Drone Blade Lacerations

As the use of drones becomes increasingly popular and more widespread, the number of drone related injuries is increasing. Drone accidents have caused a variety of injuries, including head injuries with loss of consciousness, open globe eye lacerations, and skin lacerations. The objective of this study was to determine the different properties of various drone propellers that cause laceration injuries, and to propose an injury threshold that can be used to reduce the risk of skin lacerations.

A total of seventeen experiments were performed using nine different toy drones. For each drone, the blade tip thickness, blade length, and angular velocity (rpm) were recorded. Each experiment had full contact with the skin surrogate, second trimester fetal bovine skin. The observed injury caused by the drone was then assigned a level of injury severity: 0 for no injury, 1 for a minor abrasion, and 2 for a minor laceration.

Minor abrasions were only observed at blade tip speeds higher than 80 ft/s, and minor lacerations were only observed at blade tip speeds higher than 200 ft/s. Overall, injury severity had the strongest correlation to tip speed ($r^2=0.79$). However, injury severity did not correlate as strongly to angular velocity ($r^2=0.56$), blade length ($r^2=0.034$), and blade tip thickness ($r^2=0.00008$).

Blade tip speed proved to contribute the most to laceration injuries caused by drone blades, with speeds above 80 ft/s causing minor abrasions and speeds above 200 ft/s causing lacerations. In order to avoid severe injuries caused by drone propellers, maximum blade tip speed should stay below the threshold of 200 ft/s, especially for drones designed for toy use.

Mentor(s): Stefan Duma (ICTAS), Virginia Tech

Elizabeth Duncan
Virginia Tech/Statistics

Differential Expression Analysis and Modeling of T Cell Differentiation Pathways

Our immune system consists of physical and cellular mechanisms that work to identify, defend against, and attack foreign invaders, called pathogens, that pose a threat to our health. T cells and their specific, differentiated lineages play an important role in adaptive immune responses by destroying infected cells in addition to signaling other cell types in the immune system. Thus, it is critical to understand the precise mechanism by which these cells operate and the results of their interactions. We implement differential expression analysis in R to analyze the effects of the polarizing concentrations of the protein Eos on the regulation of a T cell sub-lineage, T helper 1 cells. Eos was hypothesized to play a role in T helper 1 cell differentiation. Additionally, we develop a system of nonlinear ordinary differential equations that describes the relationships between Eos and other associated genes and proteins in the T helper 1 cell differentiation pathway. Our analysis shows that high concentrations of Eos positively regulates T helper 1 cell genes such as Prdm1. Conversely, selective deletion of Eos results in significant decreased expression of T helper 1 cells' associated factors. With this information, we position ourselves to better understand the complexities of immune responses. This insight may allow us to predict and intervene in the immune system to manage our bodies' responses to pathogens as well as furthering our knowledge of the effects of immunological mutations.

Mentor(s): Lauren Childs (Mathematics), Virginia Tech

Nicholas Dunn
Virginia Tech/Psychology

ADHD Status and Biological Sex as Predictors of Change in Adolescent Executive Functioning

Executive functioning (EF) is the set of cognitive processes that develop through early-adulthood and allow for goal-directed behavior and self-regulation. Certain individual factors may convey risk for EF difficulties, including attention-deficit/hyperactivity disorder (ADHD) status, with ADHD being characterized by significant delays in EF development, and biological sex, with males being more likely to display EF deficits. The present study explored how EF abilities changed during adolescence without intervention, and if this development was influence by ADHD status and biological sex. Participants were 302 adolescents (55.3% males, 53.6% with ADHD) ages 12-14 years old in 8th grade and 14-17 years old in 10th grade. EF was measured based on parent ratings on the Behavioral Rating Inventory of Executive Function, Second Edition. Repeated measures ANOVAs were run in SPSS with ADHD status and biological sex entered as between-subjects factors and medication and therapy status included as covariates. Adolescents with ADHD had greater difficulties in behavior, emotion, and cognitive regulation on average (Fs=17.03-65.98; ps<.001). Significant interactions between time and ADHD status were found for all outcomes (Fs=15.59-49.63; ps<.001), with adolescents with ADHD displaying parent-reported improvements in behavior, emotion, and cognitive regulation from 8th to 10th grade. In contrast, adolescents without ADHD experienced worse behavior, emotion, and cognitive regulation in 10th grade compared to 8th grade. Findings suggest that even though adolescents with ADHD are significantly more likely to exhibit EF difficulties, they experience improvements in these abilities from early- to mid-adolescence, controlling for any effects of medication or therapy.

Mentor(s): Rosanna Breaux (Department of Psychology), Martha Ann Bell (Department of Psychology), Virginia Tech

Diego Elias
Blacksburg High School Student

Use It or Lose It: An Analysis of Unnecessary Spending in Flexible Spending Accounts

Americans are spending more than ever on health care. In fact, the Kaiser Family Foundation calculates that the typical family in the U.S. spends around 11% of their income on health services - almost $8,200 per year. One way Americans prepare for these medical expenses is by registering for flexible spending accounts(FSAs). FSAs are a complement to health insurance and are funded by the user's income. They also come with a "Use it or Lose It" policy in which all leftover money at the end of the account life is forfeited. This research attempts to answer the question: How much, if any, unnecessary spending - spending that is driven by the risk of forfeiture primarily, not the medical benefit - occurs in FSAs? With data from 250 Montgomery County Public Schools FSA owners from 2018-2019 and from 2019-2020, the results show that in the last 3 months of the account life, total spending increases significantly. Furthermore, the proportion of spending that occurs on the weekends increases significantly in the final months of the account period - suggesting that the extra spending in those months is less urgent than previous spending.

Mentor(s): Alec Smith (Economics), Virginia Tech, Katharine Davis (Blacksburg High School)

Truitt Elliott
Virginia Tech/Biochemistry

Using Molecular Dynamics to Determine Influence of HIV-gp41 Cytoplasmic Tail Region Length on Protein-Membrane Stability

HIV-1 is a virus that infiltrates immune cells and uses them to replicate itself to the detriment of the cell and host body. HIV-1 infects a cell by fusing the viral membrane with the host cell membrane, thus releasing a cascade of proteins and genetic material into the cell, which drives viral replication. Understanding the mechanisms of viral fusion could provide one route to developing small molecule or antibody-based treatment attenuating viral infection. The primary driver of viral fusion is envelope glycoproteins (gp41) as part of an envelope protein complex on the outside HIV-1 membrane. Gp41 is comprised of a three-helix structure which lies within the membrane (R660-R683), a conserved membrane proximal external region (MPER) (R684-R710), and a cytoplasmic tail (CT) (R710-856). The structures of these regions have only recently been determined and little is known regarding their dynamics. Molecular dynamics (MD) simulations were performed on different novel structures of gp41 to determine its dynamics, with particular attention to the variable lengths of the baseplate-CT region. It has been theorized that the CT region has a greater effect on gp41 and viral membrane stability than previously anticipated. The preliminary outputs from the simulations support this, as the CT region causes a perturbation of the membrane. An ongoing simulation which contains only a fraction of the CT region seems to show markedly less stability. By better understanding the dynamics of different regions of gp41, a more wholistic comprehension of the protein can be determined, contributing to the development of novel therapeutics.

Mentor(s): Anne Brown (Biochemistry), Virginia Tech

Tia Farese
Virginia Tech/Industrial and Systems Engineering
Richard Parks
Virginia Tech/Industrial and Systems Engineering

Impact of Automated Vehicle External Communication on Other Road User Behavior

This study is evaluating Highly Automated Vehicles (HAV) external communication design parameters in dynamic settings and from a vehicle passenger and pedestrian road user perspective. This research will examine how HAV can best communicate with drivers and pedestrians about their intentions (e.g., turning, stopping, yielding, etc.). Precisely, the efforts will determine the most effective location for a communication system (i.e., windshield and grill) to be located on the HAV and the most effective color to use for signaling (i.e., turquoise and white) when communicating with other drivers and pedestrians. This study will collect both subjective and objective road user performance data to better assess how road users may respond to two HAVs interacting in roadway scenarios where AVs may have difficulty (i.e., a four-way stop, construction zone).
The subjective tech savviness scale, designed by Lextant, was collected from participants. This data separated the participants into “base”, “average”, and “power” groups determined by their quantified responses. This research analyzed participants through observing participant crossing decisions, hesitation, and subjective responses. This study is still in the process of data collection. Researchers hypothesize that “power” participants will be more likely to cross the street without hesitation and correctly identify the different lighting displays whereas “base” participants will be less likely to cross the street without hesitation and not correctly identify the different lighting displays.

Mentor(s): Charlie Klauer (Industrial and Systems Engineering), Alexandria Rossi-Alvarez, (Industrial and Systems Engineering, Ph.D. student), Virginia Tech

Yasmin Farzan
Virginia Tech/Chemical Engineering
Alexander Davis
Virginia Tech/Chemical Engineering

Synthesis of Oxygen-Based Ligands for C-H Bond Activation Catalysts

In this project, we seek to find alternative methods for cleaving C-H bonds in order to make more useful compounds. The problem is that C-H bonds are very nonpolar, very stable, and tend not to react via traditional methodologies. Typical methods used in pharmaceutics and industry employ lengthy syntheses or require high temperatures or expensive metal catalysts (e.g., platinum) to bypass some of these issues, which is costly and not sustainable in the long term. The focus of our research is to use first-row transition metals (which are abundant and cheap) as catalysts that could more efficiently cleave specific C-H bonds. We borrow inspiration from nature to design oxygen-based ligands that we hypothesize will provide the metal center the properties needed to break unreactive C-H bonds without the need for extreme conditions. These ligands are meant to support stable, yet highly reactive metal complexes. Efforts towards the syntheses of these ligands will be presented.

Mentor(s): Diana Iovan (Chemistry), Virginia Tech

Christine Faunce
Virginia Tech/Experimental Neuroscience

Single Nucleotide P129T Mutation Shows Susceptibility to Problematic Substance Use in Mice

A single nucleotide polymorphism (proline 129 to threonine) of the fatty acid amide hydrolase (FAAH) gene has been identified. This missense mutation has been associated with an increased susceptibility to problematic drug use in humans. However, it remains unclear whether the P129T mutation plays a causative, mechanistic role in maladaptive drug use behaviors. Using heterozygous P129T humanized knock-in mice on a C57Bl/6 background as breeding pairs, wildtype (WT) and P129T knock-in (KI) littermates were produced and used to evaluate the behavioral and biochemical changes that result from the P129T polymorphism. To evaluate behavioral effects of the P129T polymorphism, conditioned place preference (CPP) assessed reward-like behavior. Both WT and KI mice were given acute injections of saline or nicotine (0.1 – 1.0 mg/kg, s.c.) in separate sides of the chamber for three sessions. One final session (no injection) quantified the time spent in either chamber. To evaluate the biochemical effects of the P129T polymorphism, activity-based protein profiling (ABPP) was used to measure significant differences of active enzyme levels in WT and KI mice in whole brain tissue samples as well as specific brain areas involved in drug reward and dependence. These results bring new knowledge to the field's understanding of this genetic mutation while utilizing both behavioral and molecular techniques. Further investigations to continue this research will evaluate the gene expression differences and behavioral profile of these genetically modified animals when administered different drugs. Additionally, further investigation of the mechanism by which this susceptibility is caused is of great interest.

Mentor(s): Matthew Buczynski (Neuroscience), Virginia Tech

Mindolay Fike
Blacksburg High School

Antithrombin Medicine Methods Effectiveness

The transgenic anticoagulant medication known as ATryn was rejected approximately a decade ago due to immunogenicity concerns from goat proteins considering it's produced by transplanting a human gene into a goat to synthesize an antithrombotic protein. By researching previous experiments utilizing recent technologies that remove animal proteins, the possibility that ATryn could reduce immunogenicity concerns and be available for public use has increased significantly. The new procedure occurs through a double sided albumin impregnated high-flux polysulfone dialyzer which removes proteins and toxins from drugs. The meta-analysis conducted this past year confirms that high-flux dialyzers have been effective in research, such as in a study concerning hemodialysis and post dilution hemodiafiltration. High-flux dialyzers have been previously utilized successfully in former studies, which prompts a fair potentiality that, when used on this transgenic, goat produced anticoagulant, the current immunogenicity concerns that prevent it from being formally accepted, would be reduced greatly. This would provide significant help to patients lacking an antithrombin protein under the particular reason that the current anticoagulant medications which are nontransgenic, have been proven to be extremely dangerous in several previous studies. The most commonly used oral anticoagulant medication is in fact the top third medicine at cause for patient hospitalizations. The use of such types of medicine have been known to cause severe and occasionally fatal bleeding. The suggested dosages also vary over time and by patient, however it is a tedious and extremely difficult task to measure specific dosages at times for each individual, which naturally increases the risk of using such medication. By reducing the immunogenicity concerns of ATryn, which contains a nonartificial antithrombin protein, the risks of anticoagulant medication would most likely decrease, providing a safer, more effective antithrombin medication method available to the public.

Mentor(s): Katharine Davis (Education), Blacksburg High School

Lia Fontanella
Virginia Tech/Biology
Kathryn Athanasaw
Virginia Tech/Psychology
Abby Decker
Virginia Tech/Psychology, Sports Media Analytics
Ben Yost
Virginia Tech/Systems Biology
Kareisa Nix
Virginia Tech/Biology

Fossils and Phylogenies: The Evolution of Darwin, the Very Scary Monster!

The COVID-19 pandemic has caused major problems regarding education in schools across the world. Students during the pandemic feel online education has had a negative effect on their learning and has limited the social skills and experiences an actual classroom has to offer. Science classes in particular face many challenges educating students without proper laboratory settings. The Stay-at-Home Sciences citizen science project aims to educate students in different fields of science while following Virginia's Science Standards of Learning (SSOL). Our goal is to educate middle school students on the study of evolution in a fun, interactive way through the website UnCamp! Our students will complete a phylogenetic tree of an imaginary monster species to display the mutations and adaptations the species endures over time. Furthermore, the interactive portion of the project includes creating a fossil of the monster made out of the household materials to represent the effect fossilization has on evolution. The activity introduces students into a biology field and material covered in the SSOLs. After completing our activities, we anticipate our students will gain a better understanding of evolution and specific concepts of evolution including descent with modification, natural selection, and mutation. In addition to this, we anticipate our students will have a greater understanding of SSOL LS.13

Mentor(s): Jack Hopson (Orion LLC), Virginia Tech

Rebecca Fregoso
Virginia Tech/Psychology

College Sibling Relationship Closeness

This current study examined how relationship closeness between two siblings is affected when one, both, or no sibling having a mental illness. It also examines how the effects change with age, gender, and the severity of a sibling's mental illness. The study further investigated if the closeness of the relationship between siblings, where one or both has a mental illness, causes one sibling to take on a caregiver role or if the relationship feels more like a burden.

A correlational test was run in order to find and analyze the differences in relationship closeness between different siblings. The findings of this analysis indicate that there is a significant difference in the strength of the relationship between sibling closeness and sibling age, depending on whether or not the sibling has a mental illness ($z = 1.99$ $p = .02$). Specifically, if a sibling has a mental illness, there is a negative relationship between age and sibling closeness, but there is no such relationship when the sibling does not have mental illness. Furthering this study's findings, the analysis found that the severity of a sibling's mental illness is not related to the closeness of their relationship to one another ($r = .04$).

More research should be conducted in the future in order to get a better understanding about how the closeness between siblings with any type of mental illness may be affected due to race, ethnicity, sibling order, and if the relationship closeness changes due to other disabilities.

Mentor(s): Carolyn Shivers (Human Development and Family Science), Virginia Tech

Natasha Gaito
Virginia Tech/Clinical Neuroscience

In Silico Analysis of POMC and NPY promoters: The Role of Methylation in Environmental Triggers of Obesity

Obesity has reached epidemic proportions globally with its prevalence nearly tripling between 1975 and 2016. At least 2.8 million deaths each year are a result of being overweight or obese. Although there is data to suggest that the environment and genetics each play a large role in an individual developing a metabolic disorder, such as obesity, there is a missing link between the two. This relationship is thought to be regulated by epigenetic changes, which can mark the DNA in response to environmental stimuli. The purpose of this study is to better examine these epigenetic modifications, specifically DNA methylation of genes important in appetite regulation, to allow us to better understand the connection between environment and genetics. In the present study, we utilized in silico genomic analysis with the NCBI, Methbank, promo, and WashU EpiGenome browser databases to characterize the methylation pattern in the promoter region of POMC and NPY, which are satiety and appetite stimulate genes, respectively, that have been implicated in human obesity. Phylogenetic analysis was used to analyze both gene promoters to look for conserved regions across species and characterize transcription factor binding sites within the methylated regions. Transcription factor binding sites for c-MYB, USF, and CREB, all methylation-sensitive, were identified in the promoter region of POMC. Bisulfite sequencing identified a differentially methylated CG site in the NPY promoter which appears to be part of the binding site for RC2/HAP1. Plasmid promoter constructs are being created to assess differential methylation in these transcription factor binding sites, which could help us understand the role of epigenetic changes in the expression of POMC and NPY.

Mentor(s): Deborah Good (Human Nutrition Food and Exercise), Dr. Timothy Jarome (Animal and Poultry Science/Neuroscience), Virginia Tech

Timothy Gillen
Virginia Tech/Explore Scinece
Gabriel Black-Planas
Virginia Tech/Explore Scinece
Ethan Fellman
Virginia Tech/Medicinal Chemistry
Nathan Peters
Virginia Tech/Physics
Matthew Levy
Virginia Tech/Mathematics

The Effects of the 1986 Space Shuttle Challenger Disaster on the Economic and Safety Aspects of Spacecrafts and Space Exploration.

The Space Shuttle Challenger disaster was a fatal incident in the United States' space program that occurred on January 28, 1986, when the Space Shuttle Challenger broke apart 73 seconds into its flight, killing all seven crew members aboard. The loss of the seven astronauts sparked an investigation that would ultimately result in widespread policy changes in both safety and communication for NASA and future private space companies. By using multiple directories with a careful selection of keywords, then carefully reading and analyzing multiple research articles, investigative reports, websites, and informative videos, we investigated the cause of the disaster and the effect it had on the space exploration industry as a whole, including in the present with SpaceX and Sierra Nevada Corporation. From research and the Roger Commission Report, the cause of the Challenger disaster were O-ring failures and a lack of communication. From this, our research then focused on how these failures led to policy changes to avoid similar situations in the future. Strict guidelines for O-ring designs allowed the space shuttle's to fly without the worry of fuel leaking while other guidelines restricted launching when there were safety issues. These new guidelines improved team and management communication to ensure the success of future flights and missions. The Challenger disaster spurred updated safety and communication practices at NASA and other space programs as a whole.

Mentor(s): Victoria Corbin (Orion LLC), Katlyn Morales (Orion LLC), Olivia Evans (Orion LLC)
Nick Russell (Orion LLC), Virginia Tech

Cameron Gilmore
Blacksburg High School

Organizational Safety Culture: Exploring Differences Between English & Spanish Speaking Workers

Historically, production and efficiency has been prioritized over workplace safety in high risk industries such as mining and construction. One phenomena introduced to address safety concerns is the concept of safety culture. Safety culture can be broadly defined as an organization's values and ideals regarding safety. A robust safety culture has been shown to reduce workplace injury. In companies with large portions of non-English speaking laborers, effectively inculcating a positive safety culture can be challenging. Training materials, policies, guidelines, and other tools are often only delivered in English. This study investigates the difference in how safety culture is perceived between Spanish speaking workers and their English speaking counterparts. The data analyzed for this project came from a safety culture survey administered to a mid-sized construction company based in California. Analysis of the pre-existing data consisted of separating responses by language (Spanish & English) and looking for significant differences in their responses to the survey items. Of the 87 items, 26 of them were significantly different, and in all but two cases, the English speaking employees rated the safety culture more favorably. First, it appears as though the 4 years of safety initiatives undergone by the company prior to the survey were not equally effective for both language groups. Second, these results demand more information. Further studies should be conducted to look for this trend across multiple industries, and multiple types of organizations.

Mentor(s): Katharine Davis, Blacksburg High School

Juan Gonzalez
Virginia Tech/Environmental Horticulture
Joseph Taylor
Virginia Tech/

Enhancing Regeneration Efficiency Using Inducible Expression of Modified Auxin

By 2050, food production will need to increase up to 50% in order to meet the increasing global demand facilitated by affluence, population growth, and a growing bioeconomy. Precision gene editing allows plant scientists to introduce novel traits to crop varieties to combat these growing demands. However, complete organism regeneration is often a bottleneck in the application of new genetic technologies as many critical crop plants are recalcitrant to regeneration techniques. Regeneration of plants using in vitro culture takes place through embryogenesis, which allows the regeneration of complete organisms from small explants of plant tissue. Tweaking auxin signaling specificity may play a pivotal role in regeneration efficiency. This project compares the regeneration efficiency in explants inducibly expressing hyperactive versions of auxin response factors (ARF5, ARF7). The application of the hormone estradiol at different developmental stages was used to activate an inducible construct, driving the expression of these hyperactive ARFs. Plants from each line were grown on MS medium for one week and the roots were cut to remove meristematic regions. The sectioned roots were then transferred to a callus inducing medium (CIM) for 6 days and then a shoot inducing medium (SIM) for 22 days, each with or without the addition of estradiol. Preliminary results suggest that the inducibe expression hyperactive ARF5 does improve regeneration efficiency. The hyperactive variant of ARF5 showcased a higher regeneration frequency with the presence of estradiol compared to plants not expressing the hyperactive constructs, especially when the estradiol is given only during the SIM stage. However, ARF7 showcased a negative regenerative response to estradiol, with the best response under normal CIM and SIM plates. Additional experimental repeats and quantitative data analysis is necessary to verify the induced expression of these hyperactive ARFs. Inducible expression of ARF proteins during key developmental stages of regeneration may help mitigate a substantial bottleneck in further crop development research while also elucidating the nuances of auxin signaling specificity.

Mentor(s): Bastiaan Bargmann, Joseph Taylor, Virginia Tech

Paige Greenberg
Virginia Tech/Materials Science and Engineering
Brian Parker
Virginia Tech/Materials Science and Engineering
Elise Kingry
Virginia Tech/Mechanical Engineering

Heat Switch

Heat switches are devices that allow for manual or autonomous control of the amount of heat going into or out of a system. These systems are typically used in conjunction with a cooling system to remove heat from systems that have energy and heat sensitivities. The switch varies between being opened and closed to manage heat within the system. Current heat switches are typically made of state-changing material (like paraffin wax), bimetal materials, or actuating solenoids. Applications for the heat switch range from fluid pumps to opening and closing circuits. These systems can be applied to magnets as well as ferro-fluids. The goal of this project is to determine the thermomagnetic material properties of gadolinium near its second-order phase transition temperature and to use these data in a custom-written multi-physics model to guide the design of an autonomous magnetothermal heat switch. In this project, we have developed the magnetic and thermal components of a multi-physics model using Finite Element Method Magnetics (FEMM) and OctaveFEMM. We have also designed and built a custom temperature control system to indirectly characterize the intrinsic magnetic properties of the material, and have developed approximate expressions for the parameters for use in our multi-physics model.

Mentor(s): David Gray (Engineering Education), Virginia Tech

Jill Grzelak
Virginia Tech/Biological Systems Engineering

Future Climate Change Projections in Virginia

Virginia is likely to see an increase in sea level, flooding, and temperature, and possibly a decrease in water availability, due to climate change. Therefore, weather data from the past and projections of climate change in the future are critical in finding trends and projecting how severe these climate conditions will be so that we can better prepare for the future. This research aims to answer questions about how daily and extreme temperature and precipitation amounts are going to change in the mid-century under different climate change scenarios. It also demonstrates the variability between different climate models. Boxplots modeling the change in temperature and precipitation averages for each season were generated. The spread of these boxes demonstrates the range of results from different climate models. Additionally, a probability density curve of temperatures from one climate model was created to show the days per year that extreme temperatures, such as above 90°F, are expected to occur in the mid-century. The results from this figure show that days with an average temperature of about 90°F will occur twice as often in comparison to historic data. A data table of predicted average and extreme temperatures for the mid-century from three models was also made to demonstrate the variability of predictions between different global climate models. The overall result of this research shows that, despite the evident variation in the data of the different climate models, they all demonstrate an increase in average and extreme temperature and precipitation amounts in the next 20-40 years.

Mentor(s): Julie Shortridge (Biological Systems Engineering), Virginia Tech

Sule Guner
Virginia Tech/Biological Sciences

Call for Improved Equity and Inclusion in College of Agriculture and Life Sciences

Inclusive educational environments provide space for all students to feel supported and feel that they belong regardless of their identity. These environments entail effective relationships where there is mutual respect, understanding, tolerance and clear communication. Prior research has found that undergraduate students in college of life sciences felt or witnessed marginalization and mistreatment by faculty and graduate students (Drape et al.). This finding calls for a more inclusive educational experience that enables participation, allows everyone to freely express their points of views, and respects diversity. Qualitative data collected from CALS Equity and Inclusion student survey to evaluate the inclusive behaviors of faculty and graduate students revealed major themes relating to inclusion, communication, and engagement in classrooms. The two survey questions that focused on inclusive and un-inclusive behaviors were as follows: “What behaviors or actions do faculty/graduate students display to make those spaces feel inclusive?” and “What behaviors or actions do faculty/graduate students display to make those spaces feel un-inclusive?”. The results of the survey revealed common inclusive behaviors displayed. These included: interactive communication, inclusive language, effective engagement, and being open to questions and discussions. The common un-inclusive behaviors displayed included: non-inclusive language, lack of communication, poor student engagement, and egoistical behaviors such as belittling students or being judgmental towards them. The findings demonstrate the need for additional training in inclusive pedagogy for faculty and graduate students.

Mentor(s): Tiffany Drape (Agriculture and Life Sciences), Virginia Tech

Tanvi Haldankar
Virginia Tech/Computer Science
Lalitha Kuppa
Virginia Tech/Computer Science

A Walk Down Memory Lane: Analysis of Memory and Computer Systems From 1995 to Present-Day

Since the dawn of computing, the world has tracked system performance. Yet, computer system performance data is still primarily siloed by benchmark, system, or system component. The mission of the Computer Systems Genome Project (CSGenome) is to draw together this data to analyze the evolution of system architecture and performance. This work aims to discuss how memory in particular has evolved, both theoretically and in practice from the mid-1990s to present-day, and how that has impacted overall performance.

Firstly, we analyzed the growth of memory in a broader context by studying its development in major computing systems over the past three decades. In particular, we investigated different generations of synchronous dynamic random access memory (SDRAM) technologies, Rambus DRAM, and several asynchronous DRAM modules.

To quantitatively assess the evolution of memory, we standardized data from the CSGenome repository, previously scraped from the Standard Performance Evaluation Corporation (SPEC) Benchmarking Suite, to extract memory attributes, such as RAM generation, bandwidth, and latency. We also standardized benchmark performance over the four generations of SPEC Benchmarks (CPU95, CPU2000, CPU2006, and CPU2017) to determine trends across systems. Beyond this, we validated the accuracy of results by analyzing data against known memory trends.

The addition of standardized memory data to the CSGenome repository provides a way to observe trends across multiple components in computer systems. As CPU-intensive benchmarks, such as the SPEC Suite, generally emphasize a system's processor, memory subsystem, and compiler, this repository provides a way to isolate trends related to individual system components.

Mentor(s): Margaret Ellis (Computer Science), Dr. Godmar Back, (Computer Science), Dr. Kirk Cameron (Computer Science), Virginia Tech

Noor Hameed
Virginia Tech/Food Science and Technology

The Local Food Hub Food Safety Outreach Program (FSOP) 2019

The importance of food safety is stressed in agriculture because it reinforces good practice and ensures the livelihoods of consumers. The goal of this project is to generate new knowledge about the experience of growing, selling, and buying produce in Virginia; and this is through producer participation in focus groups. Approximately thirty-five participants took part by responding to surveys and citing experiences regarding barriers and successes to farming and selling, as well as resources that may be needed to enhance local production. The project team created a series of nine modules as a workshop for producers to better understand The Produce Safety Rule (PSR), and how factors such as worker training, animal risk management, cleaning, and sanitizing are highlighted in the PSR. Pre/Post quizzes were created in accordance to the contents of the modules to demonstrate understanding of the PSR. The anticipated result of this project is to inform future project work for The Local Food Hub, a non-profit organization who works with agriculture producers to infuse local produce into the community.

Mentor(s): Tiffany Drape (Agriculture, Community, and Leadership Education), Virginia Tech

Emily Hammond
Virginia Tech/Human Nutrition, Foods and Exercise

The Impact of Comorbid Depression on Self-Concept in Anxious Youth

Self-concept, or perception about one's self-competence and positive self-worth, predicts successful social relationships, work performance, and overall wellness; however, self-concept can be negatively impacted by symptoms of anxiety and depression in adolescence. The current study aimed to evaluate (1) the impact of depression on self-esteem in anxious youth, and (2) the impact of self-concept on social outcomes. Seventy-five youth (ages 7-17yrs, Mage=11.42, SD=2.73, 24 females) with anxiety disorders participated in a comprehensive psychological evaluation. Youth completed measures of self-concept, IQ, and academic achievement with caregiver reports of coping and social skills, and teacher reports of depressive symptoms and social skills. Youth were split into high and low depression groups based on teacher-reported T-scores (low=50-62, high=62-79). To evaluate group differences in self-esteem, a 2 (depression level) x 2 (biological sex) MANCOVA was conducted controlling for age and anxiety subtype. Depression level was marginally significant, $F(1, 55)= 3.56$, $p=.066$, and biological sex was statistically significant, $F(1, 55)= 5.51$, $p= .024$. Anxious youth with low depression (M=47.74, SD=8.90) reported better self-concept than anxious youth with high depression (M=43.48, SD=9.90). Females (M=42.37, SD=7.34) reported lower self-concept than males (M=47.64, SD=9.85). Regression results suggested that self-concept was a marginally significant predictor of coping skills, ß=.241, p=.081, but not a significant predictor of parent-reported or teacher-reported social skills or academic achievement. Other significant predictors of coping skills included IQ, ß=.344, p=.020, and depression level, ß=-.252, p=.074 (marginally). These results implicate self-concept as a potential socioemotional coping intervention target for anxious youth with co-occurring depression symptoms.

Mentor(s): Tyler McFayden (Psychology), Rosanna Breaux (Psychology Department), Thomas Ollendick (Psychology Department), Virginia Tech

Mariam Hasan
Virginia Tech/Biomedical Engineering

COVID-19 as Social Murder: An Investigation of Racialized Bodies in America

The goal of this project is to explore the concept of social murder against the Black community by evaluating COVID-19 pandemic impacts on this portion of the United States population. The COVID-19 pandemic has shown a disproportionate amount of deaths in racialized minorities. Arguments of “bad biology” or “poor decision-making” in Black Americans in combination with the problematic persistence of biological essentialism in medical research all fail to highlight the social conditions that have caused the disparities we see today. Through artistic data visualizations, images, videos, and text, the project walks the audience through racial inequities that have been exasperated by the COVID-19 pandemic and the social conditions which have caused them. The topics discussed include intersectionality, racialized bodies, social murder, the wealth gap, environmental and structural racism, syndemic theory, and racial bias in an attempt to shift the blame of health disparities from black and brown communities to political neglect and systemic inequities. The information will be displayed on a publically accessible website and is intended to raise awareness of these issues and engage an audience who may have no background knowledge on the subject.

Mentor(s): Nikki Lewis (Honors College), Virginia Tech

Brett Heatwole
Virginia Tech/Environmental Conservation and Society
Jonathan Florence
Virginia Tech/Environmental Conservation and Society
Jacob Robinson
Virginia Tech/Fish Conservation
Alexander Newton
Virginia Tech/Exploring Natural Resources
Luna Fulgueiro-Fuchs
Virginia Tech/Water Management Resources and Policy

Analyzing Stroubles Creek Water Quality Through Macroinvertebrate Identification in Blacksburg, Virginia

The goal of this project is to analyze benthic macroinvertebrates from Stroubles Creek in Blacksburg, VA to assess water quality. Benthic macroinvertebrates are an aquatic indicator species that provide information about impairment within the stream.
The purpose of this research is to assist the Virginia Tech Stream Team and VT StREAM Lab in their efforts to monitor and restore impaired Stroubles Creek, by identifying macroinvertebrates in samples collected by both us and the team to determine water quality along the stream.
In order to identify the macroinvertebrates, we used a microscope to closely examine those found in the collected samples. We then recorded the family of the identified macroinvertebrate in our data table. In addition to identifying and recording these organisms, we will use other analytical methods to determine the water quality.
The results so far indicate better-than-expected water quality in Stroubles Creek. Water quality in the sites closer to the Virginia Tech Duck Pond was anticipated to be very poor but had better than anticipated diversity. Although the first site shows better than expected results the sites further down the stream have not been as diverse as anticipated. However, we still found more sensitive species farther down the stream. All of the sites had a lot of species that are very tolerant of poor water quality. As more samples are sorted, it is expected that the current trend will continue, and the downstream sites will be more diverse and have higher numbers of sensitive macroinvertebrates.

Mentor(s): Bryan Brown (Biological Sciences), Victoria Corbin (Orion LLC), Virginia Tech

Robert Hodge
Virginia Tech/Industrial and Systems Engineering
Henry Claesson
Virginia Tech/Mechanical Engineering

Kicking Assets

Collaboration has been a cornerstone of engineering and has driven technology and innovation for decades. The undergraduate research team, Kicking Assets, has posed the question "Is Microsoft Teams a viable solution for an environment for engineering students to work and collaborate in?" During the fall of 2020, Kicking Assets researched many different packages of before-mentioned tools and materials. Implementation of these materials and resources are applied to select GE-1216 courses in the spring 2021 semester. Microsoft Forms was used to collect data about first-year engineering students' experiences working in group settings at the beginning and the end of the semester. For our study, we will compare sections taught by different instructors – one curriculum that includes a mandate to use MS Teams, and the other where the choice of teamworking tools is left open for the students to determine themselves. Through statistical analysis, we examine the effects of a structured team collaboration tool suite on aspects of student collaboration such as task management, communication, and file sharing.

Mentor(s): David Gray (Engineering Education), Virginia Tech

Makayla Honaker
Virginia Tech/Psychology

The association between intolerance of uncertainty and mental health outcomes during the COVID-19 pandemic in children and adolescents with neurodevelopmental disorders in rural Appalachia

Intolerance of uncertainty (IU) is "a dispositional characteristic that results from a set of negative beliefs about uncertainty and its implications" (Buhr & Dugas, 2009). Traditionally, IU is related to anxiety and depression symptoms (Dar et al., 2017). During the COVID-19 pandemic, a time of high uncertainty, IU has been a risk factor for poor psychological well-being (e.g., Satici et al., 2020); however, most of the COVID-19 literature has focused on adults. As such, this study examined the association between IU and mental health during the pandemic in a sample of children and adolescents.

Participants included 34 children (n=17; ages 8-12) and adolescents (n=17; ages 13-17) from rural Appalachia, previously diagnosed with a neurodevelopmental disorder. Youth completed the Intolerance of Uncertainty Scale for Children, Screen for Child Anxiety Related Disorders, and Mood and Feelings Questionnaire during spring 2020. Independent sample t-tests and multiple regression analyses were run in SPSS-26.

Children had significantly higher IU than adolescents, t=2.39, p=.023. IU predicted anxiety symptoms for children and adolescents, b=0.36, p=.002. A significant interaction of age and IU in predicting depression symptoms was observed, b=-0.53, p=.010. Higher IU predicted less depressive symptoms in adolescents, b=-0.38, p=.021, but was unrelated to depression in children, b=0.14, p=.200.

Overall, children had a higher level of IU, which predicted greater anxiety symptoms. For adolescents, IU predicted more anxiety, but less depressive symptoms. Future research should seek to replicate these findings in a broader demographic region and assess possible differences for youth with versus without a neurodevelopmental disorder.

Mentor(s): Rosanna Breaux (Psychology), Thomas Ollendick (Psychology), Virginia Tech

Andrew Hynes
Virginia Tech/Biological Sciences

Quantifying co-infection of Mycoplasma gallisepticum and coccidia in wild house finches

Emerging infectious diseases are an ever-present threat to wild bird populations, but pathogens do not act alone within hosts. When multiple pathogens co-infect a host, they can directly and indirectly interact to affect the growth and host response to both diseases. For instance, a laboratory experiment on house finches found that a greater burden of one pathogen, coccidial Isospora sp., caused worse disease from a second pathogen, Mycoplasma gallisepticum (MG.) Here, we examine the interaction between these two pathogens in wild house finch populations to determine if interactions observed in a laboratory setting cross over into wild populations. Because MG causes population declines in house finches, understanding its co-infection dynamics with other pathogens is important as we try to understand patterns of disease. In order to study this interaction, we collect fecal samples and eye swabs from wild house finches in Montgomery County, Virginia. These samples are then used to quantify coccidial load by performing a fecal float, and to quantify MG by first extracting DNA from conjunctival swab samples with the Qiagen DNeasy Blood and Tissue kit. Then, quantitative PCR is used to quantify MG in the samples. We anticipate that the synergistic effect between the two pathogens found in the lab will be reflected in the wild, though the prevalence of coccidia is much lower in wild house finch populations than in captivity.

Mentor(s): Dana Hawley (Biological Sciences), Dr. Chava L Weitzman (Biological Sciences), Virginia Tech

Reshyra Jadooram
Virginia Tech/Psychology

Exploring the Role of Parent Psychopathology and Parenting Behaviors in Children's Reading and Writing Abilities

Parent psychopathology and parenting behaviors have been shown to influence children's language development. However, prior research has predominantly examined these constructs independently, and focused largely on mothers. Given this backdrop, the present study aimed to explore the joint role of parental psychopathology (depression, anxiety) and parenting behaviors (involvement, positive parenting, poor monitoring, inconsistent discipline) in children's reading and writing abilities. Additionally, analyses explored if these relations differ for mothers versus fathers. Participants were 138 children (71 females) ages 6-12 years (M = 9.64) and their parents (109 mothers, 79 fathers). Parent psychopathology and parenting behaviors were measured using parent self-report on the Alabama Parenting Questionnaire and Brief Symptoms Inventory; children's reading and writing abilities were assessed using the Woodcock-Johnson Tests of Achievement. Multiple regression analyses were run in SPSS. Surprisingly, mothers with higher levels of depression symptoms had children with significantly better reading abilities. As expected, mothers who used more inconsistent discipline practices had children with significantly poorer reading and written expression abilities; whereas, mothers who were more involved with their child, had children with marginally better reading and written expression abilities. Overall, paternal psychopathology and parenting behaviors were found to be unrelated to children's reading and writing abilities. The findings of this study suggest that the psychopathology and parenting behaviors of mothers play a more significant role in language development of children than that of fathers. Future research should investigate other factors that may shape children's language development, such as parental education level and relationships with teachers and peers.

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

Lindsay Jarvis
Virginia Tech/Psychology

The Role of Pet Ownership in the Mental Health of Children and Adolescents During the COVID-19 Pandemic

Prior research correlates pet ownership with reduced self-reported loneliness, with greater benefits in mental health wellbeing for males than females. Studies of the benefits of pet ownership throughout the COVID-19 pandemic have focused primarily on adult populations and largely on dog ownership, with female participants predominating these studies. These studies reported females living alone with dogs described less loneliness during the pandemic. Given this backdrop, the present study examined the role of new pet ownership on changes in anxiety and depression symptoms in children and adolescents and whether biological sex moderates these relations. Participants were parents of 50 youth ages 6-17 years (M = 12.22; 45% female) who completed ratings during spring 2020 stay-at-home orders and again during fall 2020 upon the return to school. Among participants, 68.3% owned a dog, 55.0% owned a cat, and 21.7% owned a small animal (e.g., fish, reptile). Anxiety and depression symptoms were measured using T-scores on the parent-reported Revised Children's Anxiety and Depression Scale. Results suggest getting any new pet during the pandemic significantly interacted with biological sex in predicting changes in anxiety and depression symptoms. Specifically, males who got a pet during the pandemic experienced a moderate decrease in both anxiety and depression symptoms from spring to fall 2020 (d = 0.32 and 0.38). Results highlight potential benefits of pet ownership on reducing anxiety and depression symptoms during chronic stressors for male youth. For children without pets, examining whether pet therapy in schools could provide similar benefits is an important next step.

Mentor(s): Rosanna Breaux (Psychology), Thomas Ollendick (Psychology), Virginia Tech

Elise Jensen
Virginia Tech/Psychology

An Investigation of Associations between Adverse Childhood Experiences and Quality of Life in Autistic and Non-Autistic youth

Research suggests that autism spectrum disorder (ASD) and adverse childhood experiences (ACEs) may each be negatively associated with childhood quality of life (QOL). However, little is known regarding how ACES may relate to QOL in autistic and non-autistic youth. It is critical to understand these patterns in order to maximize QOL across diagnostic groups.

Therefore, this study examines differences in parent-reported QOL between autistic and non-autistic children, as well as the association between ACEs and QOL for both groups. Parents of children ages 2-17 (n= 242; 117 ASD, 125 non-ASD) were administered questionnaires regarding ACEs and QOL.

T-test and MANOVA analyses showed a main effect of diagnosis on overall QOL and each QOL subscale (school, emotional, physical, social), with the ASD group reporting worse QOL than their non-ASD counterparts. Pearson's correlations for the ASD and non-ASD groups showed that ACEs and QOL were correlated for both groups across most subscales, with stronger magnitude in the ASD group. For autistic children, there was a significantly stronger association between ACES and emotional QOL than for non-autistic children (ASD r= -.45, p <.001; non-ASD r=-.14, p=.12; Fisher's r-to-z transformation p<.001).

Results suggest that while parents of autistic youth report lower QOL than their non-ASD counterparts, ACEs may have a particularly strong association with emotional QOL in ASD.

Mentor(s): Christina McDonnell (Psychology), Elizabeth DeLucia (Psychology), Theresa Andrzejewski (Psychology), Virginia Tech

Jeamin Jung
Virginia Tech/Biological Sciences

Assessing and Evaluating the Atomistic Interaction differences between Sphingosine and Inhibitors for Sphingosine Kinase Druggability

Sphingosine 1-phospate (S1P) is a lipid signaling molecule whose generation is catalyzed by Sphingosine Kinases (SphK). SphKs, S1P, and its receptors are all known to be involved with numerous biological pathways, immunological disease, and disease mechanisms. However, despite this knowledge, the research effort towards SphKs as targets for therapeutics has been relatively limited. The effective development of SphK specific drugs is difficult as well due to the highly similar active site composition that all kinases share. This work utilizes molecular dynamics (MD) simulations and other computational drug discovery techniques and methods to further understand the parallels and disparities between the SphK isoforms by their structure-function relationship and dynamics when in complex with sphingosine, ATP+Mg, and apo. By evaluating the dynamic and structural similarities and differences across complexes, we gained expanded knowledge of the exploitable structural features for isoform specific inhibitor design. Consequently, this work also investigated the influence of 3 potential protein-specific ligands for both isoforms using the same computational techniques and simulation methods. By comparing the 3 ligand-bound SphK complex interactions with the sphingosine- bound SphK interactions, this work confirms key shared residues like Val304 and Asp178, as well as other exploitable features between kinase isoforms. Future research should continue analysis on the simulated inhibitor systems for more distinct shared interactions or differences and conclude which ligands are the best suited isoform-selective inhibitors for oncogenic and other disease type drug development.

Mentor(s): Anne Brown (Biochemistry), Amanda K. Sharp (Genetics, Bioinformatics, and Computational Biology), Virginia Tech

Julia Kawas
Virginia Tech/Physics

Modeling the pathogenesis of adenoviral myocarditis

Myocarditis accounts for 42% of sudden cardiac death in young adults. Cardiac intercellular junctions encompass connexin43 (Cx43) gap junctions intimately associated with sodium channels that together facilitate the electrical coupling between cells to facilitate each heartbeat. Alterations in Cx43 function occur in almost all forms of heart disease, and can affect sodium channel localization. Adenovirus is a leading cause of myocarditis but the impact of adenoviral infection on Cx43 and/or ion channel function is essentially unexplored. Gap junctions also propagate antiviral immune responses, leading us to hypothesize that adenovirus targets Cx43 to facilitate viral replication leading to arrhythmias. Species specificity of adenovirus has hindered development of an animal model but the advent of human induced-pluripotent stem cell (HiPSC) technology now provides a source of human cardiomyocyte-like cells in which to model viral infection in human heart muscle. In addition, a recently identified mouse adenovirus (MAdV-3) was reported to be cardiotropic. Using iPSC-derived cardiomyocytes we performed fixed cell confocal microscopy and western blotting over a 72-hour time course following human adenoviral infection. Preliminary data indicate suppression of Cx43 expression in infected cells, with significant remodeling of ion channel localization and expression. Mice were infected with MAdV-3 for 7 days prior to sectioning and immunostaining of heart tissue and cardiotropism was confirmed by qPCR. Together our findings confirm human iPSC-derived cardiomyocytes as a useful model of human viral infection of the heart and MAdV-3 as a novel model system in which to study mechanisms of myocarditis.

Mentor(s): James Smyth (Biology), Virginia Tech

Delaney Keller
Virginia Tech/Psychology
Katie Murray
Virginia Tech/Psychology
Olivia Shaw
Virginia Tech/Clinical Neuroscience

Exploring treatment outcomes for low-income patients in a rural community-based clinic

Socioeconomic status often has an impact on the quality of mental health treatment that patients from low-income backgrounds receive (Hodgkinson et al., 2017). Barriers (cost, childcare, transportation) complicate treatment access for these individuals (Thompson & Nitzarim, 2012). This study uses measurement-based care (MBC) to explore the relationship between income and treatment outcomes. 105 clients in a rural, community-based clinic were seen from 2015-2020 with a MBC protocol (Cooper et al., 2019). The scales utilized included: Brief Adjustment Scale-6 (BASE-6) for general psychological adjustment; Depression Anxiety Stress Subscales (DASS-21); and Working Alliance Inventory-Short Form Revised (WAI-SR). Participants were divided into low ($0k-$24; n = 50), medium ($25k-$49k; n = 20), and high ($50k+; n = 35) income groups. Income was correlated with intake BASE-6 ($r = -0.4$; $p < .01$) scores, and discharge BASE-6 ($r = -0.3$; $p < .05$), DASS-21 Anxiety ($r = -0.3$; $p < .05$) and Stress ($r = -0.3$; $p < .05$) scores. ANOVAs reveal a significant effect of time, but not income, on the WAI-SR [$F(43) = 10.389$; $p < .01$], and the DASS-21 Depression [$F(41) = 12.184$; $p < .01$], Anxiety [$F(41) = 6.023$; $p < .02$], and Stress [$F(41) = 14.424$; $p < .01$] scales. Both time and income were significant for the BASE-6 [$F(44) = 15.624$; $p < .01$; $F(44) = 4.608$; $p < .02$]. Findings indicate that low-income patients improve with treatment, yet at higher rates of psychological distress than other patients. Effective treatments must address the needs of people who are low-income.

Mentor(s): Lee Cooper (Psychology), Alyssa J. Gatto (Psychology), Ha-Young Ko (Psychology), Sydney B. Jones (Psychology) Virginia Tech

Sanmeel Vijay Lagad
Virginia Tech/Mechanical Engineering
Varish Devarashetty
Virginia Tech/Mechanical Engineering
Matthew Chitre
Virginia Tech/Mechanical Engineering
Brian Scurlock
Virginia Tech/Mechanical Engineering

Development of Soft Robotic Actuation System for Biomimetic Dynamic Sonar Head

Actuation systems play an important role in biomimetic emulations of bat biosonar since the animals deform their noseleaves and ears during biosonar emission/reception. Initial stages included traditional actuation, performed by a set of servo motors driving a piston mechanism for actuating the baffles in a linear direction. With the evolution of soft robotic actuation (SRA) methods, there's a wide range of possibilities for non-linear motion for pinnae and noseleaf. Using a pneumatically controlled SRA, a wide range of motion has been achieved in recent biomimetic sonar head. This study evaluates the progress in the actuation system over the time in biomimicry of Batbot. Through this study, an attempt is also made to investigate the possibilities of further modifications in SRA, specifically a tendon actuation system. Based on the investigation of possible methods, this study also extends to extrapolation of uses of soft robotics and actuation methods. These systems have proven highly energy efficient and cost-effective due to the lesser number of required components. Investigation of these properties can help in identification of an optimal system for biomimetic and traditional robotics. This examination can provide a fruitful overview of current requirements to achieve a better actuation system, not only for robotics but also for traditional machine operations.

Mentor(s): Rolf Mueller (Mechanical Engineering), Virginia Tech

Anh Le
Virginia Tech/Mechanical Engineering
Tianyu Gong
Virginia Tech/Mechanical Engineering
Joe Grygotis
Virginia Tech/Mechanical Engineering
Ryan MacLeod
Virginia Tech/Mechanical Engineering
Jason Weaver
Virginia Tech/Mechanical Engineering

Tendon Actuation System for a Soft-Robotic Bat Head

Horseshoe bats have highly accurate sonar detection in dense vegetation to capture prey in low visibility. Replicating this capability has eluded engineers up to now. The goal of our project is to implement this technology so that a drone can fly autonomously through dense vegetation. Horseshoe bats, specifically, Old-World horseshoe bats (Rhinolophidae) and the New-World leaf-nosed bats (Phyllostomidae), do this by emitting biosonar pulses that are diffracted by biological baffles called noseleafs. Horseshoe bats can move their ears, called pinnae, to deform for biosonar reception. The pinnae in horseshoe bats have more than 20 muscles related to complex motions to improve sensing and navigation performance. The emitter, noseleaf, and receiver, pinna, motions create Doppler shifts. These Doppler shifts allow horseshoe bats to identify prey in dense foliage with active biosonar. Horseshoe bat pinnae can create many distinct pulse sequences to create Doppler shifts.
To replicate these muscles and Doppler effects biomimetic ears have been manufactured with tendons to allow for precise soft robotic actuation of localized areas. The current model is manufactured with a silicone skin, rigid hexagonal core, and tendon sheaths routed between the silicone skin and rigid core to guide the tendon and protect the silicone and rigid core from the friction of tendon movement. The silicone skin provides a smooth surface similar to that of the front skin of the bat pinna so that biosonar signals can be processed (emitted and received) without interference from the shape of the rigid core. The tendons replicate the muscle movements in the pinnae and noseleaf to deform the structures. The rigid core provides stiffness and control to the pinnae and noseleaf. Our tendon actuated system replicates how horseshoe bats move their muscles but with 5 degrees of freedom in each pinna and 3 degrees of freedom in the noseleaf.

Mentor(s): Rolf Mueller (Mechanical Engineering), Virginia Tech

Dasol Lee
Blacksburg High School

Evaluating Loneliness Scales to Assess Loneliness During the COVID-19 Pandemic

Loneliness, the feeling of distress one receives when they perceive their social relationships are less in quantity and quality than desired, is connected to many short and long term physical and psychological issues (Luhmann & Hawkley, 2016). Due to their synergistic effect, loneliness and depression are especially harmful to humans (Cacioppo et al., 2006). During the COVID-19 pandemic, loneliness and depression has risen due to the forced physical isolation and are amplified by the mass panic and anxiety associated with the pandemic (Banerjee & Rai, 2020; Jia et al., 2020; Killgore et al., 2020). While there are existing scales to measure loneliness, most of them were specifically created for use in research or clinical settings. Since there was a lack of tools for public use, this research determined the loneliness scale best suited for individuals to use during the COVID-19 pandemic. By evaluating the prominent loneliness scales in existence based on the factors chosen (Accuracy, Language, Loneliness, Answer Options), the best scale for each category of length was decided. From longest to shortest, these include the Version 3 UCLA Loneliness Scale, UCLA 10-item scale, and the single-item question. By establishing a scale for usage by people during the pandemic, people can easily and accurately determine if they are lonely. Mitigating the effects of loneliness and proactively stopping it will result in healthier and happier people, benefiting the greater society. This scale could also be helpful in making the research done during the pandemic efficient and uniform.

Mentor(s): Katharine Davis, Blacksburg High School

Katerina Leedy
Blacksburg High School

Differential expression of genes associated with innate immunity in individuals with and without Alpha-gal Syndrome

Alpha-gal Syndrome (AGS) is a novel IgE-mediated allergy to the alpha-gal glycan found in red meat and is associated with bites from the Lone Star Tick. Little is known about the immune mechanisms that cause AGS. Recent research at UNC found differential gene expression relating to the adaptive immune response between subjects with AGS and control subjects. However, investigation of gene expression relating to innate immune response has not been performed. I analyzed existing data from this recent research to determine the transcriptional differences relating to cytotoxicity and Natural Killer (NK) cells, two parts of the innate immune response. 4 genes relating to NK cell function showed statistically significant differences in gene expression between the AGS and control groups when compared through 1-way ANOVA and t-test. AGS subjects demonstrated upregulated expression of genes associated with the production of interferon-gamma (IL18, IFNG) which plays a role in stimulation of both innate and adaptive immune responses. AGS subjects also demonstrated a downregulation of genes coding for receptor proteins involved in stimulation of NK cell cytotoxicity and amplification of T cell activation (KLRK1, CD2). No statistically significant differential gene expression associated with cytotoxicity pathways were found between the AGS and control groups. Subjects with AGS did not show distinct differences in gene expression primarily characteristic of the innate immune response.

Mentor(s): Katharine Davis, Blacksburg High School, Dr. Onyinye Iweala (Department of Medicine), University of North Carolina (Chapel Hill)

Kathlynn Lewis
Virginia Tech/Environmental Science

Carbon Storage in Northern Virginia Grasslands: Effects of Land Management and Plant Diversity

Subtropical grasslands are the most threatened biome on Earth and an underappreciated carbon sink, especially when compared to land used for agricultural production. Southeastern grasslands are particularly threatened. One of the many things not yet understood about native Virginia grasslands is the role they play in the global carbon cycle. We aimed to quantify the carbon stored in the soils of northern Virginia grasslands under three land-use conditions: reference (high-quality native grassland), restored (post-agricultural fields seeded with native plants), and degraded (fields dominated by tall fescue). We sampled soil at 45 sites including at 30 reference sites with a plant diversity survey to determine the impact that plant composition has on soil carbon.

Remnant and restored grasslands stored 1.2-1.6x more carbon than degraded fescue fields, with restored sites storing 1.3x more total carbon than reference sites. Restored sites averaged .0189g/cm3 of carbon ±0.0011; remnant sites averaged .0145g/cm3 ±0.00105 and degraded sites averaged .0119g/cm3 of carbon ±0.0012 Neither plant species diversity nor species richness in any major guild (e.g., grasses, forbs, legumes,) had any impact on soil carbon. We suspect that greater carbon storage in restored versus reference grasslands comes from more prescribed burning in restorations and bias towards poor soils being left undisturbed for longer periods in reference sites (allowing these sites to host native grassland vegetation in small areas like powerline rights-of-way). These findings support the use of grassland restoration for carbon sequestration, with carbon being within the low end of the range observed in regional forests.

Mentor(s): Leighton Reid (SPES), J. Leighton Reid (SPES), Ryan Stewart (SPES), Virginia Tech

Gwyneth Martin
Virginia Tech/Marine Fish Conservation

Microplastic Ingestion Frequency Analysis on Freshwater Fish Trophic Levels in the New River Valley

Plastic pollution has been a growing global concern in both marine and freshwater environments, especially during the last decade. In the United States, 18 billion pounds of plastic waste flows into the oceans every year, which not only affects ocean chemistry and ecosystems but breaks down the plastics into fragmented particles which affect the entire marine food web. These fragmented particles are microplastics and are classified as plastic particles smaller than 5mm. Extraction of microplastics from exposed fish reveal a significant presence of plastic particles inside fish tissues. Although many studies have quantified microplastic concentrations in marine fish, little is known about how microplastics are transferred among elements of food webs and whether they biomagnify in food chains as other pollutants are known to do in freshwater systems. Therefore, throughout September and October of 2020, 250 fish were sampled from Toms Creek and Stroubles Creek. 50 individuals of 5 different species with different eating habits were sampled using electroshocking. In the lab, microplastic extraction from the fish gastrointestinal tracts followed the methods described by Avio et al. (2015) with consideration of Horton et al. (2018). The samples were diluted with 10% KOH in a dry oven for 12 hours. The remaining material and microplastics were weighed and identified according to size class and abundance. Currently, the analysis of the correlation between weight and frequency of the plastics and the weight of the gastrointestinal tract, the frequency distribution of each species, and the average weight of plastic per fish will continue to be conducted throughout the spring 2021 with finalization of the project and publication in summer 2021.

Mentor(s): Dr. Leandro Castello (Fish and Wildlife Conservation), Virginia Tech

Anvitha Metpally
Virginia Tech/Clinical Neuroscience

Using a mindful lifestyle intervention to help improve maternal and infant outcomes in obese pregnant women

Maternal obesity has been correlated to increased risk of developing physical health complications during pregnancy including gestational diabetes mellitus, preeclampsia and hypertension, increased rate of caesarean section, and enhanced surgical site infections, among others. Additionally, the offspring of obese mothers have a higher risk of being obese themselves, which creates an interminable cycle of multi-generational obesity and the continuation of poor health behaviors. However, a gap exists in our understanding of ways to optimize health behaviors in obese pregnant women to improve both maternal and infant outcomes. Through a two-pronged data collection strategy, we are recruiting obese pregnant participants through Amazon mTURK and through primary care physician referrals in Roanoke, VA and the surrounding areas, the latter of which will serve as our clinical trial population. During each trimester, the pregnant women will be completing self-reported questionnaires and neurocognitive assessments that quantify eating and exercise habits and motivations, delay discounting (a measure of future valuation), body image, affective state, and executive function. By implementing an educational lifestyle intervention in the clinical trial participants, we hypothesize that episodic future thinking and healthy lifestyle changes will lead to an improvement in the mother's physical and mental health, as well as enhance infant outcomes, therefore suspending the aforementioned deleterious cycle. From our preliminary analysis, we predict to find a significant relationship between BMI, delay discounting, and mental health during the peripartum period. Currently, we are gathering data through mTURK and completing case manager training to implement the intervention in the clinical trial participants.

Mentor(s): Julia Basso (HNFE), Virginia Tech

Victoria Midkiff
Blacksburg High School

Finding a Correlation Between Temperature and Melt Pool Size in Laser Additive Manufacturing

Laser additive manufacturing is a technique that has the capability to build three-dimensional components using metal. The process is done by using a laser to melt and fuse powdered metal. The laser melts the solid, powdered, metal in a particular pattern, and the technique has the potential to produce any three-dimensional shape. During the process, the melted metal forms a melt pool in the powder bed. The melt pool formed has several measurable characteristics. One of these characteristics is the average temperature of the melt pool at a given time. This is found using thermal imaging, which captures the thermal profile of the melt pool during the manufacturing process. Simultaneously, the exact shape of the melt pool can be examined using synchrotron X-ray imaging. During the additive manufacturing process, the melt pool first enlarges, then shrinks. In this study, the depth and width and varying depths of a melt pool were compared to the temperature at the same time. In order to find these dimensions, the X-ray video frames were examined using the software ImageJ, which allowed for accurate measuring of the melt pools. The resulting analysis indicates that a positive, linear, correlation exists between the average temperature and size over time. Based on these findings, the laser additive manufacturing process can be observed with more detail when X-ray imaging is not available, using the prediction of the melt pool shape based on the average temperature and that temperature's correlation to shape.

Mentor(s): Katherine Davis, Blacksburg High School, Rongxuan Wang (Industrial and Systems Engineering), Virginia Tech

Sajan Mistry
Virginia Tech/Mechanical Engineering

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Brain Computer Interfaced Prosthetics

The purpose of this project was to configure an open source brain computer interface to be paired with a prosthetic to improve the financial accessibility of neuroprosthetics. There were two parallel design paths for this project, the brain computer interface, and artificial muscles. The brain computer interface was powered by the OpenBCI hardware, and an Arduino UNO, where the Open BCI sends a serial data stream to the Arduino, which then actuates movement based on the numeric value of the serial data stream. The artificial muscles serve the purpose of streamlining the internal workings of the prosthetic hand, reducing weight, and allowing for more fluid movements than a motor. Each artificial muscle is made of supercoiled nylon filament with a NiChrome heating element wire embedded in the coil. The majority of this project has progressed using an iterative design process. This project will culminate with actuating an artificial muscle using input from the brain computer interface.

Mentor(s): David Gray (Engineering Education), Virginia Tech

Fahd Mohamed
Virginia Tech/Biochemistry

Expression and Characterization of Plasmodium falciparum Protein Depalmitoylase ABHD17A

In host cell invasion by the Plasmodium falciparum parasite, rhoptry organelles secrete their bulb contents which contain an array of lipids and proteins that contribute to the formation of the parasitophoros vacuole. In this study, we are interested in N-terminal α/β hydrolase domain-containing ABHD17 ortholog (PfABHD17A) because of sequence homology to protein depalmitoylases and hypothesize that it may play a role in the proper functioning of the rhoptry organelles by allowing for the cycling of palmitoyl groups that remodel the rhoptry membrane palmitoylome for constructive invasion. To investigate catalytic properties of this enzyme, we attempted to express the full-length protein sequence, including the catalytic α/β hydrolase domain. Unfortunately, the protein was not expressed – likely due to C-terminal intrinsically disordered region. However, by truncating the full-length sequence, and selecting only the α/β hydrolase region for expression, we successfully expressed ABHD17A, which was purified using IMAC and gel filtration chromatography. Subsequent assays with fluorogenic substrate DPP-5 illustrated clear depalmitoylase activity. Additionally, we attempted to express a series of four 20 amino acid truncations in preparation for x-ray crystallography. Of the truncations, we find that one having a deletion of 40 residues retained activity, thus defining a minimal active sequence. Lastly, using various serine hydrolase inhibitors, we constructed an inhibitor profile for ABHD17A. We found high potency for inhibitors IDFP and ML-211 (a lysophospholipase inhibitor). We hope to eventually conduct X-ray crystallography to better understand substrate interactions in the active site and to aid in developing a potentially useful antimalarial drug.

Mentor(s): Michael Klemba (Biochemistry), Katie Fike (Biochemistry), Jiapeng Liu (Biochemistry), Virginia Tech

Victor Mukora
Virginia Tech/Computational Modeling and Data Analytics

Applying Predictive Modeling to Enhancing Solar Energy Efficiency

Analysis has been provided on how factors like temperature or humidity impact panel efficiency, but there has been little to no research conducted on how various environmental conditions relate with each other to affect solar energy output real-time. Having a model that correlates several environmental predictor variables known to impact solar energy can help determine what adjustments need to be made to optimize solar panel performance (like adjusting cooling). In this project, multiple linear regression (MLR) and other predictive modeling techniques like ridge regression or neural networks were used for relating environmental variables like high temperature, outside humidity, or rain rate to the total solar energy output produced. Data containing thirty-three different weather measurements and their respective solar energy outputs was obtained from the United Kingdom Power Networks and will be used as the principal dataset for the model. To check general predictive model assumptions like normality of residuals or heteroscedasticity, several functions provided from a model performance package in R verified whether the assumptions for the corresponding model were met. Model selection will be based on Root Mean Squared Error.

Mentor(s): Anne Brown (Biochemistry), Mr. Briganti, Virginia Tech

Gillian Mundt
Virginia Tech/Biological Sciences

Stopping the Stigma: Ethnobotanical Research on Southern Appalachian Species as Gynecological Aids

Gynecology and proper women's health have been taboo for centuries. Euphemisms have been used such as "the change" for menopause and "troubles" for menstruation. Childbirth and pediatric health were often lumped in with women's health and included a majority of documented women's health herbal remedies. Other remedies for women's health concerns are poorly documented including treatments for cramps, heavy menstruation, STIs/STDs, menopause, and abortions. Some medicinal plants that are commonly used as gynecological aids are Actaea racemosa (Black Cohosh, menstrual cramps), Viburnum prunifolium (Black Haw, uterine relaxant), Vitex agnus-castus (Chaste Tree, premenstrual syndrome), Mitchella repens (Partridgeberry, infertility, and cramps), and Dioscorea villosa (Wild Yam, cramps, and morning sickness). We will distribute a Qualtrics survey to several southern Appalachian herbalist online discussion boards to document uses and preparations for these species and others. The survey will also gather demographic information to determine which age groups have greater experience and knowledge of medicinal plants as gynecological aids. We expect to see a more developed understanding of knowledge and treatment of gynecological ailments in younger generations.

Mentor(s): Jordan Metzgar (Biological Sciences), Virginia Tech

Austin Murray
Virginia Tech/Biochemistry

Understanding the Roles of Amphipathic Alpha-Helices in Membrane Association and Viral Genomic Replication of Brome Mosaic Virus Protein 1a

Brome mosaic virus (BMV) is a well-studied positive-strand RNA [(+)RNA] virus that belongs to the alphavirus-like superfamily comprised of important plant, animal and human pathogens. BMV encodes for replication proteins 1a (BMV 1a) and 2apol as well as movement and coat proteins. BMV replicates inside viral replication complexes (VRCs) that are localized at endoplasmic reticulum (ER) membranes, which are remodeled by BMV 1a to form VRCs. Two previously- identified amphipathic α-helices within BMV 1a, dubbed Helix A and B, were thought to be responsible for "anchoring" BMV 1a to ER membranes. Several plasmid constructs were made to express various mCherry-tagged BMV 1a fragments that contained Helix A and/or B to determine if either of the two helices are sufficient to target the perinuclear ER. Fluorescence microscopy visualization showed various dominant localization patterns of different BMV 1a fragments. Intriguingly, any of the BMV 1a fragments containing Helix B consistently displayed localization patterns akin to wild-type BMV 1a. This suggests that Helix B is sufficient to target proteins, be it BMV 1a or mCherry, to ER membranes. Future studies will determine whether Helix B is sufficient to target other proteins to ER membranes, what amino acid(s) in Helix B is critical in ER targeting, and the possible effect of overexpression of the aforementioned fragments on interfering with the ER membrane association of BMV 1a and BMV replication.

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

Emma Nguyen
Virginia Tech/Biomedical Engineering
Anthony Spinetta
Virginia Tech/Aerospace Engineering
Lalit Adhikari
Virginia Tech/Physics
Julie Truong
Virginia Tech/Aerospace Engineering
Karl Wolf
Virginia Tech/Aerospace Engineering

Surface Autonomous Vehicle Emergency Response (SAVER)

The goal of the project is to create a Surface Autonomous Vehicle for Emergency Rescue (SAVER) capable of withstanding drops from an altitude of 15 feet into a maritime environment. The SAVER will navigate to astronauts in distress via an ANGEL beacon signal with necessary rescue supplies. The purpose of our work is to compete in NASA's Micro-g NExT competition and have our vehicle tested at NASA's Neutral Buoyancy Lab. The autonomous surface vehicle consists of a fiberglass hull, a foam upper cover, and two external motors set up for a differential-based steering system, thus allowing the SAVER to maneuver efficiently. The hull is a modified-V boat design, with a volume of approximately 7 cubic feet. The three internal storage compartments, separated by two braces, are capable of carrying 2.5 liters of water, a spare life raft, a survival radio, an Orion medical kit, a Contingency/Spare 406 MHz Second-Generation Beacon, and a spare life preserver unit. A polycarbonate plate, lined with a rubber gasket and covered with buoyant foam, is attached to the top of the hull, enabling the SAVER to self-orient independent of initial drop conditions. The electronics include a single-board microcontroller, a GPS Module, a 3-axis accelerometer, a radio receiver, and a gyroscope, to efficiently and safely navigate to astronauts in distress. The anticipated results are that once in the water, the vehicle will run a fully-autonomous path-finding algorithm and successfully deliver rescue supplies to an astronaut in distress.

Mentor(s): David Gray (Engineering), Virginia Tech

Kaavya Nimmakayala
Virginia Tech/Materials Science and Engineering

De-Icing of Composite Beams under Pure Bending

Historically, de-icing techniques have employed low-adhesion coatings or antifreeze chemicals that can be expensive and harmful to the environment. Current approaches mainly focus on developing advanced surface coatings or using pure shear or pure tensile loads instead of the mode of mechanical loading to remove ice. Using high-speed imaging, we elucidated critical bending, the curvature at which ice fractures, of composite aluminum beams loaded with ice of varying sizes on a linear translation stage setup in a walk-in freezer. Experiments and simple scaling analysis have demonstrated that the critical bending of the aluminum beam is a function of the ice thickness, the elastic modulus of the composite beam, and the radius of curvature of the beam. Future work includes understanding the ice fracture from the composite beam under different loading conditions.

Mentor(s): Jonathan Boreyko (Mechanical Engineering), Virginia Tech

Megan O'Hara
Virginia Tech/Biological Sciences
Emilie Applebach
Virginia Tech/Biological Sciences
Sarah Munford
Virginia Tech/Explore Science
Logan Chavarro
Virginia Tech/Biological Sciences
Luming Zhao
Virginia Tech/Explore Science

Engaging Students in Science through Distance Learning

The COVID-19 pandemic has affected students globally as education of all levels transitioned to an online environment. Teaching and learning science subjects from a distance in high schools has proven to be particularly challenging as materials to aid class, such as lab and experimentation supplies, are not available to most students at home. Further, rural areas, such as the Blacksburg community, have even less accessibility to these materials than wealthier counties. Our research focused on developing an at-home supplementary aid for the Blacksburg community to learn high school biology Virginia Science Standards of Learning (SSOLs) in an engaging way, by creating an interactive story centered around pollination and ecosystems. This activity puts the student in the position of a researcher working for a local scientist, in which the student must identify the cause for the decline in two species: Pieris virginiensis and Cardamine concatenata. Throughout the story, the student will be taught about various aspects of pollination and ecosystems, asked inferential questions regarding the material, as well as participate in an experiment, where they will dissect a flower local to them and identify its anatomy. We anticipate students will gain a greater understanding of SSOL BIO.8, pollination, plants and pollinators' roles in ecosystems, and be able to identify different flower structures associated with pollination, all in effort to aid their studies in school.

Mentor(s): Victoria Corbin (Orion LLC), Virginia Tech

Myriam Oliver
Virginia Tech/Psychology

A Systematic Observations of Facemask Wearing and Interpersonal Distancing: Risk Compensation vs. Response Generalization

Facemask-wearing and social distancing are effective at preventing the spread of COVID-19, these behaviors do not occur simultaneously in many situations. In fact, it is possible that people feel an unwarranted sense of safety when performing one of these behaviors, and thus do not perform both. Our research assessed both of these behaviors among individuals to determine whether risk compensation is occurring. The theory of risk compensation presumes individuals take more risks when they feel more protected. For example, someone wearing a facemask may feel safer and subsequently stand closer to others. To test this theory, research students observed facemask wearing and social distancing in various indoor and outdoor locations. These students recorded three different observations on a Qualtrics survey: an individual's gender, his/her mask-wearing behavior (wearing a mask, wearing a mask incorrectly, or not wearing a mask), and the estimated distance between the individual and the nearest person within a six-foot radius. Our observations of individuals suggest the opposite of risk compensation—response generalization, or a spillover effect. Specifically, individuals wearing a facemask maintained significantly greater social distances (i.e., 3.09 feet) than those not wearing a facemask or wearing a facemask incorrectly (i.e., 2.13 and 2.10 feet, respectively), suggesting a spillover effect from one COVID-prevention behavior to another COVID-prevention behavior. In other words, those who were not wearing a COVID-prevention facemask were maintaining significantly ($p < .001$) closer distances to other persons.

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

Javier Ortiz Alvarado
Virginia Tech/Chemistry

Sequestration of Chemotherapy agents Using Bioinspired Polymers

In the treatment of liver cancer, chemotherapeutics are introduced in a number of ways. One such way is through a transarterial chemoablation (TACE) procedure. This procedure involves targeted drug delivery to the tumor, utilizing fluoroscopic guidance. The TACE procedure improves upon traditional chemotherapy by trapping approximately 50% of the chemotherapy drug in the tumor site. However, the remaining drug circulates throughout the body, affects healthy cells, and leads to the side effects we associate with chemotherapy. Previous studies show that the excess chemotherapy can be absorbed onto a chemofilter, placed beyond the tumor, before entering systemic circulation. However, these filters are prohibitively expensive due to the use of genomic DNA as a capture agent. This project aims to develop a polymer for incorporation into a chemofilter that captures the chemotherapy agent. These polymers are synthesized using free radical polymerization and characterized using 1H NMR and SEC analysis.

Mentor(s): Michael Schulz (Chemistry), Virginia Tech

Kathryn Paasch
Virginia Tech/Biochemistry
Elina Thompson
Virginia Tech/Biochemistry
Jackson Walsh
Virginia Tech/Public Health
Annie Webster
Virginia Tech/Biochemistry
Ali Presby
Virginia Tech/Forestry
Isabella Filippone
Virginia Tech/Human Nutrition, Food and Exercise

Dog Behavior Project

The purpose of this study is to identify the signs of stress in dogs. Some of the known stress signs in dogs are lip licking, showing the whites of their eyes (whale eye), tucking their tail, avoiding eye contact, crouching, stress yawning, excessive panting and raising their paws. Our team collected videos of dogs from dog owners and our own pets. We then analyzed the videos, looking to identify different stress behaviors the dogs were displaying and recorded the exact time point within the video when they displayed that behavior. Through our group's analysis of the videos, we found that the most common behaviors shown in the dogs in our study were excessive panting, whale eye and lip licking. We found that lip licking and excessive panting usually accompany each other and whale eye is usually seen as one of the first signs of stress. One goal of our study is to be able to teach dog owners the different stress signals of dogs so that they can recognize when their pet is under stress. From this study, we can now educate others on identifying whale eye as one of the first stress behaviors so that pet owners can observe that behavior and de-escalate the situation putting their dog under stress.

Mentor(s): Victoria Corbin (College of Science), Virginia Tech

Daniela Pereira
Virginia Tech/Clinical Neuroscience
Meg Kenny
Virginia Tech/Biology
Makenzie Grann
Virginia Tech/Biology
Shivani Verma
Virginia Tech/Biology
Natalia Bowyer
Virginia Tech/ Clinical Neuroscience

Virtual vs. Physical Company: The Effect on Mood

Socialization is necessary for people's mental health. It sets the foundation for meaningful relationships, shown to be a core element of happiness. However, the nature of socialization has been changing with the development and accessibility of online social media platforms. The use of technology as a social tool has increased with the pandemic forcing people to self-quarantine and resort to virtual forms of interaction. Given this rapid change and socialization's importance in influencing happiness, we conducted a literature review on the effect of nonverbal virtual interaction (SMS texting, online chatting, etc.) versus physical interaction (face-to-face) on mood. We read three different studies on the subject, with three more readings on the psychological theory behind the results. All three studies showed that physical interaction resulted in more positive mood compared to virtual interactions, although virtual interaction did offer some help in improving overall mood. This comparison helped us conclude that physical interaction was the optimal form of communication to improve mood as virtual interaction deprives people of physical cues important for social satisfaction. These results have various applications; e.g, since physical social cues were important for the communication of friendliness, people should utilize functions of technology that allow those cues to be seen, such as webcams to communicate facial expressions.

Mentor(s): Victoria Corbin (Orion LLC), Virginia Tech

Julia Pimentel
Virginia Tech/Materials Science and Engineering
Kaley Foulks
Virginia Tech/Mechanical Engineering
Parker Meltvedt
Virginia Tech/Aerospace Engineering
Gabriel Brenza
Virginia Tech/Aerospace Engineering
Cora Meno
Virginia Tech/General Engineering

Investigating the influence of embedded copper defects on tensile strength of quasi-isotropic fiberglass epoxy composites

Unidirectional fiber-reinforced lamina are anisotropic materials that consist of fibers and a resin matrix. These materials are anisotropic because they are stronger in the fiber direction than in the transverse direction, which is orthogonal to the longitudinal fiber direction. In contrast, isotropic materials have properties that are consistent in all directions. Multiple unidirectional lamina can be stacked to make a laminate. Quasi-isotropic laminates can be manufactured by stacking lamina with alternating fiber directions in 0 degree and 90 degree orientations while maintaining stacking symmetry. Such configurations enhance mechanical strength in more than a single direction. It is important to note that introducing any midplane defects to the quasi-isotropic laminate will reduce mechanical strength due to incomplete adhesion of the layers, which serves as a source of delamination. An investigation was conducted to analyze the influence of 3 different types of conductive copper defects at variable sizes within 8 layer quasi-isotropic fiberglass composites. The 3 types of defects were copper fabric, copper tape, and copper foil. 2 sizes of defects were evaluated: 1 cm^2 x 1 cm^2 squares and whole midplane layers. Tensile testing was the primary method of quantifying mechanical strength. It was hypothesized that the tensile specimens containing fabric defects, which had the largest inherent surface area of the defects, would have the highest tensile strength. Such findings may be valuable in aerospace or defense applications towards understanding change in mechanical strength due to embedding conductive materials or electronics with varying geometries within composites.

Mentor(s): Bradley Davis (MEEP Program at Hume Center for National Security and Technology), Jacob Viar (Materials Science and Engineering, Hume Center for National Security and Technology), Virginia Tech

Tyler Pugh
Virginia Tech/Industrial and Systems Engineering

Sexual Violence: Impact on Academic Success and Financial Stability

The objective of this systematic review is to understand the impact of sexual violence on the academic performance and financial stability of college students. Each year, approximately 26% of college women and 7% of college men report experiencing some form of sexual violence (Cantor, 2020), yet little research has been done on how these issues impact college students academically and financially. Knowing more about the outcomes of sexual violence survivors could improve campus resources and policies (e.g., Title IX). For this research paper, a systematic review of published literature was conducted. Relevant studies were identified through Google Scholar, WorldCat, ArticleFirst, and Education Research Complete. My search included studies from 1996-2020. 400+ articles were flagged using keywords such as sexual assault, sexual violence, rape, academic success, financial stability, and college students. After the preliminary evaluation of the abstract and results, 12 were used to inform this research. Results illuminated that college sexual violence survivors tend to have the following negative academic consequences: lower grade point average, less classroom participation, and less focus while attending class. However, there were no known studies that investigated the economic impact of college sexual violence survivors, which differs from national research findings. The lack of evidence for the latter points to a need for more research in this area. Future research should investigate financial barriers for college sexual violence survivors. Additionally, campus leaders should advance programs and support systems that address results about academic outcomes identified through this review.

Mentor(s): Tonisha Lane (Higher Education), Virginia Tech

Katherine Quion
Virginia Tech/Biological Systems Engineering

Evaluating Future Climate Change Impacts in Virginia

With the onset of climate change, more frequent and intense storms, longer droughts, higher temperatures, and sea level rise will affect the work of engineers, planners, and impact everyone's lives. Research organizations around the world have created highly complex Global Climate Models (GCMs) that simulate Earth's physical properties. This project aims to look into the impacts that climate change will have on Virginia in the next 50 years and assess the accuracy of GCMs. The accuracy of these models can be assessed by comparing model simulations of past years, called hindcast projections to historically observed data. Hindcast (1981-2005) and Mid-Century (2041-2060) temperature and precipitation projections are averaged across 21 GCMs, creating an ensemble average for annual temperature, number of days with maximum temperature above 90°F, annual precipitation, and number of days with rainfall greater than 2 inches. These Hindcast and Mid-Century projection variables were mapped across Virginia, displaying various increases in temperatures and precipitation across the state. To analyze the accuracy of the models for extreme weather events, the hindcast projections of extreme weather events were compared to the observed historical average for three different regions in Virginia (Arlington, Norfolk, and Roanoke). Extreme weather events like the number of days annually with heavy rain, the maximum number of consecutive days with no rainfall (drought period), and the maximum 5-day rainfall, were compared to the observed historical amount. This analysis found that models have a tendency to underestimate extreme weather events and may underestimate these changes in the future.

Mentor(s): Julie Shortridge (Biological Systems Engineering), Virginia Tech

Amanda Ramirez
Virginia Tech/Biochemistry

Functional Analysis of Mutated N-terminal Serine Residues in Amino Acid Permease I (AAPI) from Arabidopsis thaliana

Amino Acid Permease 1 (AAP1) from Arabidopsis is a transmembrane protein that transports amino acids. Several other plant nutrient transporters are shown to be regulated (AMT1;3, IRT1, and NRT1;1) based on the phosphorylation status of amino acid residues in the protein. Recent evidence from the Pilot Lab suggests that AAP1 may have roles in sensing and signaling the presence of amino acids, in addition to those already defined in transport. The mechanism for signaling and regulation by and of AAP1 is not well understood. To explore this hypothesis, we identified two Ser residues in the cytosolic-facing N-terminus of AAP1 that have been shown to be phosphorylated and mutated these to either Asp or Ala – to mimic constitutively phosphorylated or dephosphorylated states of the protein, respectively. To determine if the phosphorylation status of the N-terminus changes the sub-cellular localization of AAP1 in plants, we expressed the mutant AAP1 proteins fused to the fluorescent reporter protein mCherry in Nicotiana benthamiana and visualized with fluorescence microscopy. We determined the transport properties of the AAP1 phosphorylation mutants by complementing yeast strain 22Δ10α with the mutant proteins and measuring the growth on medium containing amino acids as the only nitrogen source.

Mentor(s): Guillaume Pilot (Plant and Environmental Sciences), Brett Shelley (Plant Molecular Biology, PhD student), Virginia Tech

Alexa Reed
Virginia Tech/Biological Systems Engineering

Spatial Analysis of Salinity in Stroubles Creek, Blacksburg, VA

Anthropogenic salt pollution is a serious ecological threat affecting freshwater ecosystems through water quality degradation. The long-term patterns of salt loading and transport via streams throughout mixed-use urban watersheds has yet to be thoroughly investigated. My project expanded on research conducted by a group of Interface of Global Change (IGC) fellows by evaluating potential point and nonpoint sources of anthropogenic salt usage by monitoring conductivity spatially throughout the Stroubles Creek watershed. Previous research utilized a single monitoring station at the Virginia Tech StREAM Lab to look at 8 years of conductivity and flow data during storm events. Results indicated that the effects of salt use in the watershed are complex and require higher spatial resolution to account for landscape heterogeneity and multiple salt sources. Therefore, we expanded spatial monitoring of water quality throughout the watershed at an additional four sites along Stroubles Creek upstream and downstream of the StREAM Lab to collect stage (i.e., water level), dissolved oxygen, and conductivity data to further address the spatial complexity of salt movement within the watershed. The monitoring period from August 2020 to April 2021 included six road brining events. I analyzed these six days of high-frequency specific conductance and stage data to evaluate spatial variability, downstream dampening, and hysteresis during storm events. I will present the results that show changes in salinity moving downstream in Stroubles Creek, and how salt concentrations vary due to time since brining and within specific storm events.

Mentor(s): W. Cully Hession (Biological Systems Engineering), Virginia Tech

Tyler Rodriguez Rodriguez
Virginia Tech/Engineering Science and Mechanics
Demi Poulos
Virginia Tech/Engineering Science and Mechanics
Jamie Brennan
Virginia Tech/Engineering Science and Mechanics

InsulPatch: Insect-inspired powerless drug delivery

The InsulPatch is a wearable patch powered by the user's arterial pulse to continuously deliver insulin transdermally to diabetes patients. Diabetes is a metabolic disorder affecting over 460 million people. The current methods of insulin delivery are syringe injections, and insulin pumps such the OmniPod or MiniMed. Common self-reported barriers for adherence to insulin regimes include pain (90.2%), time consumption (63.2%), interference with physical activity (61.6%), concerns about insulin injections or wearable insulin pumps interfering with daily activities, and embarrassment related to bulky wearable pumps. There are no treatment options that address all of the above complaints in one device, which is the aim of the InsulPatch device. The geometry and mechanics of the device was inspired by the thoracic tracheal network and respiratory system of insects. The user's pulse creates a pressure on the fluid channel and causes a flow. The insulin flows from the fluid channel to the microneedle array where it is delivered transdermally to the patient. A PDMS prototype of this device has been created for experimental testing purposes. A benchtop setup was created to replicate the pulse produced by the radial artery on the device. Through this experimental setup, flow rate measurements were taken at arterial pressure. As a proof of concept, a modified version of the prototype was placed on the radial artery and a flow driven by an active arterial pulse was observed. The goal of future testing is to successfully pump transdermally. This includes experimental testing with a custom microneedle array and porcine skin.

Mentor(s): Anne Staples (Biomedical Engineering and Mechanics), Virginia Tech

Christopher Rosser
Virginia Tech/Medicinal Chemistry

Mentorship in a Sustainability project for first-generation and underrepresented undergraduates

The study identifies the strategies and factors associated with the retention of underrepresented students as described by Rodgers and Summers's previous research and uses it as the framework for addressing minority/underrepresented undergraduates' need for career exploration and mentorship in higher education. Academic and professional development opportunities such as mentoring, research, and internships can help guide undergraduate students to discover their career goals and possible graduate degrees. In higher education, students who identify as an underrepresented population lack access to faculty who share similar identity traits, which causes difficulty in developing relationships between students and possible faculty mentors. This program for underrepresented and first-generation undergraduate students is centered around students and faculty mentors working together to develop a research topic on sustainability in the food, agricultural, natural resources, and human sciences (FANH). Students and mentors (8 mentors and 13 undergraduate students) were interviewed before and after the program to understand the expectations of each participant, and the impact of the program. Findings suggest that students were in need of developing their skill sets as researchers, leaders, and guidance in career exploration. Mentors wanted to grow as researchers just as the students but mentors want to gain more experience in mentoring and advising and to help their students gain experiences necessary for their development in academia and the professional world.

Mentor(s): TIffany Drape (Agricultural, Leadership, & Community Education), Virginia Tech

Rupabali Samanta
Blacksburg High School

A Renewal of Hope: Proposed Glial Cell Treatment for Alzheimer’s Disease

Each year, there are nearly three million new cases of Alzheimer's Disease in America. This neurodegenerative disease also affects ten percent of those ages 65 and older and one-third of those ages 85 and over. Despite its prevalence, there is currently no cure for Alzheimer's Disease. However, recent research has found evidence that glial cells enhance symptoms of Alzheimer’s, such as brain inflammation and neurotoxicity. Exploring how glial cells influence symptoms of Alzheimer's may allow us to find a new, better treatment or even cure for this disease. Presently, there is widespread debate within the scientific community as to whether or not glial cells can be manipulated to treat Alzheimer's and how to go about doing this. Thus, this research sought to determine which glial cell function is the best candidate for future treatments for Alzheimer's. To do so, a meta-analysis was conducted with five datasets that analyzed how glial cells influence Alzheimer’s symptoms, and the resulting effect sizes, calculated using Pearson's R, were compared. The analysis showed that the TREM2 and TYROBP proteins had the largest effect size, so this research concluded that these proteins' role in precipitating Alzheimer's pathology and neurodegeneration makes them the most likely targets for future glial cell treatments for Alzheimer's Disease.

Mentor(s): Michelle Olsen (School of Neuroscience), Virginia Tech, Katharine Davis, Blacksburg High School

Gwyneth Schloer
Virginia Tech/Mechanical Engineering
Hannah Franklin
Virginia Tech/Mechanical Engineering

Acousto-Optic Nondestructive Inspection (AONDI)

Residual strain significantly influences material performance, and further, the anisotropic nature of composite materials complicates the development of models to predict the behavior and strain residuals of these materials. Thus, a better method to rapidly determine the strain state of as-manufactured composite components is needed. The novel acousto-optic nondestructive inspection (AONDI) system will function by categorizing the scattering of acoustic waves via an interferometric scan in order to create a map of subsurface flaws and defects in a test specimen. This system has the ability to transform post-production testing of various materials due to its large area non-intrusive scanning mechanism. This semester's efforts were focused on the demonstration of a DC interferometric scan, which included inducing surface waves into a material, observing the wave diffraction patterns with an interferometric probe system, and transforming and postprocessing the captured data. This demonstration serves as a proof of concept for the AC acousto-optic nondestructive inspection system that is to be built in future semesters. Overall, the acousto-optic nondestructive inspection system is relevant to engineers and scholars alike due to its potential to alter the way that post-production materials testing is performed.

Mentor(s): David Gray (Engineering Education), Virginia Tech

Caroline Schumacher
Virginia Tech/Clinical Neuroscience

Spinster 2 (SPNS2) Transport Protein: Visualizing and Observing Solvent Flow, Ion Transportation, Interacting Residues, and Protein Structure Stability

Sphingosine Kinase phosphorylates a signaling molecule called sphingosine kinase 1-phosphate (S1P). High levels of S1P have been linked to cancers and various diseases. A transmembrane protein called Spinster 2 (SPNS2) is known to transport S1P into the extracellular region. This project observed solvent flow, ion transportation, interacting residues, and protein structure stability to provide insight for potential inhibitors of the SPNS2 protein to affect the S1P levels and attenuate downstream effects. Molecular dynamics simulations (mds) were used to probe the dynamics of SPNS2. SPNS2 was then visualized at each snapshot with four replicates per timescale and 13 timescales that progressed through time. Simulations were run for 1 microsecond and analyzed in 100-200 timeframes. SPNS2 was visualized within the membrane in two different ways, SPNS2 within the membrane and SPNS2 within the membrane, with the solvent, and with the interacting ions. The solvent and ions selected were within 3.5 Å of the SPNS2 protein and the interacting residues selected were within 5 Å of the interacting ions. Each replicate of SPNS2 was visualized and aligned and the associated RMSD values were recorded. After analyzing the data, potassium ions were observed on the exofacial leaflet, inside the channel, and on the cytofacial leaflet. Chloride ions were observed on the exofacial leaflet and the cytofacial leaflet but not inside the channel. The GLU433 and THR370 residues were observed to interact with potassium ions in at least one replicate per timescale and ASP472 was observed in at least one replicate per timescale except the 400-500 ns timescale. GLU433 and ASP472 residues formed electrostatic interactions with the potassium ions. The RMSD values from aligning each timescale to the previous timescale per replicate were relatively low ranging from 0.811 to 1.636 suggesting a stable structure of SPNS2. The visualizations of each alignment were examined and slight movement of the SPNS2 protein was noted in the carboxy terminus. These observations have the potential to contribute to a better understanding of the function, structure, and transport mechanism of the SPNS2 protein as well as influence future drug discoveries.

Mentor(s): Anne Brown (Biochemistry), Virginia Tech

Lauren Seeley
Virginia Tech/Environmental Science

Increasing Methionine Content in Soybean Seed through a Genomic Prediction Model

Soybean is an important US crop critical to livestock health and production as it is high in protein, but lacks sufficient levels of methionine, an essential amino acid. Often, methionine must be supplemented, raising the cost of the feed and slowing feed processing. Genomic prediction can help breed a soybean that naturally contains high methionine. A diverse germplasm of 398 accessions with two maturity groups were grown in Blacksburg and Warsaw, Virginia during 2019. All accessions across environments were phenotyped for protein-bound methionine content using two methods: high-performance liquid chromatography (HPLC) with a standard curve, and near infrared spectroscopy (NIR) with a manufacturer calibration. Their genotypic data of single nucleotide polymorphisms (SNP) were collected from www.soybase.org. A package rrBLUP was used in R to determine the heritability of methionine and to perform cross validation for a prediction model. There was very little genetic signal for methionine quantified through the HPLC method (heritability = 1e-09) but there was some genetic signal measured by the NIR method (heritability = 0.37). A complete cross validation process will be completed to identified prediction accuracy of both phenotype datasets. The results indicate that the relationship between SNPs and methionine in soybean is complicated , and different quantification techniques can potentially lead to variable prediction models.

Mentor(s): Bo Zhang (School of Plant and Environmental Sciences), Virginia Tech

Christine Segnari
Virginia Tech/Wildlife Conservation
Dhruv Dharamshi
Virginia Tech/Wildlife Conservation
Rachel Morse
Virginia Tech/Wildlife Conservation
Jessica Nguyen
Virginia Tech/Chemistry

Benthic Macroinvertebrates as Stroubles Creek Water Quality Indicators

The goal of our research is to assess the water quality of impaired Stroubles Creek in Blacksburg, VA, and to aid both the Virginia Tech Stream Team and VT StREAM Lab in their continued efforts to improve the stream's water quality by helping them identify benthic macroinvertebrate species present in samples collected by both us and the Stream Team. Macroinvertebrates are aquatic indicator species, so the types of macroinvertebrates present in samples can indicate water quality and ecosystem health in the stream. Specifically, our research focuses on the sampling of sites along the stream and the identification and analysis of macroinvertebrates at those sites.

The purpose of our study is to determine if water quality improves along Stroubles Creek. To conduct this research, our team sorted and identified macroinvertebrate samples from this year and previous years at different sites along the creek using microscopes. These organisms were identified to family level and recorded into a datasheet and organized by sample. Due to proximity to campus, we expect water quality near the VT Duck Pond to be worse than water quality further downstream near ongoing stream restoration efforts. Because of this water quality gradient, we have found more pollution tolerant macroinvertebrates closer to the Duck Pond and more sensitive macroinvertebrates downstream. As we continue our research, we expect these trends to continue.

Mentor(s): Bryan Brown (Biological Sciences), Victoria Corbin (Orion LLC), Virginia Tech

Caroline Smith
Virginia Tech/Smart and Sustainable Cities

COVID-19 and its Impact on Technology use and Social Interactions within College Students

COVID-19 forced the majority of American colleges and universities to switch to online learning during the Fall 2020 semester. As a result, social interactions among students were abruptly and severely limited. This research aims to uncover COVID-19 and online learning's impact on a college student's technology use and how their social interactions may have shifted as a result. Additionally, the findings expand on what a college student may desire from a social setting in an online environment. The undergraduate students interviewed participated in at least one virtual extracurricular activity during the Fall 2020 semester. The performed interviews used a semi-structured format and asked questions regarding technology use and social interactions. Interviews were coded and analyzed using Microsoft Excel to find correlations between participants. Overall, students were missing day-to-day conversations and the ability to make new connections. Furthermore, students tend to prefer a relaxed and social environment when it comes to online interactions. Findings from this project will benefit future administrators when planning for future online learning platforms and will provide insight into a college student's social needs during online learning. The data collected will also be beneficial to policy makers when it comes to regulation surrounding the implementation and practice of additional online learning and distant learning platforms.

Mentor(s): Theodore Lim (School of Public and International Affairs), Virginia Tech

Delaney Snead
Virginia Tech/Civil Engineering

Assessing Microbial Wastewater Community Composition and Antibiotic Resistance in the Presence of Hospital Sewage

Hospital wastewater, or effluent, is an important vehicle for the spread of antibiotic resistance and antibiotic resistant pathogens (ARPs). It typically contains higher concentrations of antibiotics and ARPs compared to most other sewage sources; however, questions linger over whether it is a major source of antibiotic resistance during wastewater treatment. Here, we report culture-based analyses demonstrating the persistence of hospital-derived multidrug resistant bacteria in sequencing batch reactors (SBRs), a model for the activated sludge process, that contain stabilized domestic wastewater combined with either 0, 1, or 10% hospital effluent. Over three weeks, the SBRs were sampled for carbapenemase producing organisms (CPOs) in addition to cefotaxime resistant Escherichia coli and Klebsiella pneumoniae. From these samples, 466 strains of antibiotic resistant bacteria were isolated, 119 isolates of E. coli and K. pneumoniae were PCR confirmed, and 76 CPOs underwent Sanger sequencing. Kirby-Bauer susceptibility testing was then used to analyze 85 of these target organisms to determine any changes in their resistance profiles over time. A deferred growth inhibition assay will later be used to assess the presence of microbial competitive exclusion. Collectively these tests show that hospital effluent can potentially shift the activated sludge microbiome and allow hospital-derived ARGs to persist in the environment.

Mentor(s): Amy Pruden (The Charles Edward Via, Jr., Civil and Environmental Engineering Department), Virginia Tech

Martha Soscia
Virginia Tech/Animal & Poultry Science
Dollie Gravley
Virginia Tech/Dairy Science
Maggie Moon
Virginia Tech/Animal & Poultry Science

SARS-CoV-2 infected laboratory mice and their impact on transmissibility between bedding and infected species

In the past year, SARS-CoV-2 has risen to the forefront of research from the profound effect this coronavirus has had on humans. However, our overall understanding of this virus is limited. The constant transmission and susceptibility of SARS-CoV-2 has also increased demand for treatment options and information about this virus. Our research aims to answer the question of how transmissible SAR-CoV-2 is between animals, as there is limited research on this subject thus far. Our methods included different groups of mice placed in SARS-CoV-2 contaminated bedding and also placement of healthy mice in with infected mice. The mice were monitored for symptoms and data was collected to determine if transmission occurred. To confirm that a mouse had been infected, blood samples were collected and analyzed to test for positive RNA strands. The positive blood tests from the previously healthy mice in the contaminated bedding confirmed transmission of SARS-CoV-2. In addition, the infected mice were able to transmit the SARS-CoV-2 virus to non-infected mice. Results showed that the SARS-CoV-2 virus was transmittable through air and by touch. In conclusion, veterinarians can improve isolation protocols, treatment, and restrainment of this virus. Future researchers can relate to these findings and aid further research on the spread and response of SARS-CoV-2.

Mentor(s): Amanda MacDonald (Librarian), Virginia Tech

Regan Spetch
Virginia Tech/Physics
Canon Zeidan
Virginia Tech/Physics
Keith Weed
Virginia Tech/Physics
Justin Higgins
Virginia Tech/Physics
Colin Scharff
Virginia Tech/Physics

Molecular Docking

The Orion LLC at Virginia Tech is a group of like-minded students who have a passion for the sciences. Orion provides an opportunity for its members to collaborate on long-term citizen-science projects, such as our project, molecular docking, which involves the ways that molecular structures fit together. We specifically analyze the enzyme sphingosine kinase and attempt to find how the Adenosine Diphosphate molecule best fits in its binding cavity. Sphingosine kinase produces S1P, which will alter cell signaling, contributing to cell proliferation in the body. There are two known isoforms of sphingosine kinase, SphK1 and SphK2, the latter of which has not been as extensively studied. By making an effective inhibitor for SphK, we can slow it before it produces sphingosine-1-phosphate, rather than try to eliminate S1P from the body after it is made. When creating the inhibitor, we will need to take into consideration the shape, bonding, and structure of SphK. We use virtual environments such as pyMOL and Marvin Sketch to achieve this. This research has several crucial implications in the pharmaceutical field, because we are creating a new drug to target SphK.. The affinity is the amount of energy released when the inhibitor binds to the binding site of sphingosine kinase; the more negative the affinity, the more energy is released, thus showing the efficacy of the inhibitor. Our inhibitor had an affinity of -9.0, which is high, meaning that our inhibitor is quite effective.

Mentor(s): Victoria Corbin (Orion LLC), Virginia Tech

Justin Stafford
Virginia Tech/Horticulture
Matt Fedorko
Virginia Tech/Environmental Science
Garren Snow
Virginia Tech/Biochemistry
Gurleen Singh
Virginia Tech/CMDA

The Impact of Glyphosate on Human Health

Herbicides are chemicals commonly used in agricultural processes. They function to kill undesired plants or weeds that can harm agricultural developments and yields. One specific example of an herbicide that has been used for many years is glyphosate. As this chemical is often used during the growing of food, it is important to explore its effects on human health. Therefore, the question of this research project will be determining how glyphosate exposure affects human health. The goals of the study will be achieved through collecting blood samples from people who have had regular exposure to glyphosate, and then analyzing these samples with Gas Chromatography and Mass Spectroscopy. This will allow for identification and quantification of glyphosate in the bloodstream. Additionally, data about any known health conditions of the participants of the study will be collected, and used for statistical analysis to determine any potential correlation between glyphosate exposure and negative health effects. It is expected that the results of the study will indicate that there is a correlation between glyphosate exposure and negative health impacts. This hypothetical outcome could have implications on the field of agriculture, including the necessity of a new, more human-friendly herbicide alternative.

Mentor(s): Amanda MacDonald (ALS), Virginia Tech

Xavier Starks
Virginia Tech/Physics

Can Dark Matter Heat Up the Earth?

Dark matter is a type of matter that cannot be detected by using electromagnetic radiation but may interact weakly with the particles around it. Dark matter can get captured by celestial bodies and accumulate inside it. As a result of dark matter capture from Earth, dark matter can collide with nuclei on Earth. When dark matter collides with nuclei on Earth it will release a small amount of heat. We will make a model of capture rates of a range of dark matter masses and the use that information to make an estimation on the amount of heat the dark matter collisions will release. The estimated heat release will be referenced with the accepted value of Earth's heat budget to find any discrepancies. From estimating the capture and then using it to estimate the amount of heat released, it would provide context to how dark matter interacts and effects the matter around it. The model of the dark matter capture rate and the estimation of the heat released will be done by utilizing Python and Mathematica. The anticipated results of the project is to create a usable model for the capture rates of dark matter captured by Earth and to use that information to estimate the heat contribution due to the dark matter collisions.

Mentor(s): Ian Shoemaker (Physics), Virginia Tech

Alice Stitzer
Virginia Tech/Wildlife Conservation

Analysis of Jaguar Home Ranges Via a Novel Application of Spatially Explicit Capture-Recapture

Telemetry can be an expensive and invasive method used by biologists to infer movement and space-use of wildlife species. Understanding these dynamics is critical for making conservation and management decisions, like determining the size of wildlife reserves or designing wildlife movement corridors. These questions are especially important for large, elusive carnivores, like jaguars (Panthera onca), which move long distances and require extensive habitats. Using non-invasive camera traps coupled with statistical analysis to estimate home ranges is cheaper than telemetry and may support more robust population level inferences. Although telemetry provides many more observations per individual, often relatively few individual animals in a population are telemetered. Camera traps collect data on a much broader cross-section of the population and analyzing these data using spatially explicit capture-recapture (SECR) models may offer unique insight into large carnivores' space-use at a population level. SECR models are typically used to analyze wildlife population dynamics, but because they explicitly incorporate animal movements, we adapted the models to estimate home ranges. We examined camera trap data from a 9-year period (2010-2018) and estimated the home range sizes of 73 individual jaguars, 27 females and 46 males, in northwestern Belize. We found the average home range area to be 287.9 km2 for females and 937.4 km2 for males. We also examined turnover and shifts in recurring individuals' locations over time. These results demonstrate a novel application of SECR models that may enable researchers to derive additional information about space-use not previously available from camera trap data.

Mentor(s): Marcella Kelly (Fish and Wildlife Conservation), Robert Nipko (Fish and Wildlife Conservation), Virginia Tech

Allison Sweeney
Virginia Tech/Human, Nutrition, Foods & Exercise
Sofia Ayala Rodriguez
Virginia Tech/Biochemistry

Life Satisfaction in Individuals of Siblings with Physical or Psychiatric Disabilities

This study aims to investigate the difference in life satisfaction of siblings for those who have a physical disability compared to those who have a psychiatric disability. Individuals with a physically disabled sibling tend to have positive feelings and characteristics, such as increased maturity, tolerance, self-confidence, humanitarian concerns, etc., towards their siblings and life, meanwhile, minimal research has been done specifically for siblings of those with a psychiatric disability (Pit-Ten Cate, I. M., & Loots, G.M.P, 2000). The research team selected a subgroup of n = 8 people who have a sibling with a physical disability, and n = 36 people who have a sibling with a psychiatric disability. A t-test was conducted on this secondary data set to investigate the differences in life satisfaction. The findings indicate that there were statistically significant differences in distress ($t = 3.22$, $p = 0.003$) and overall life satisfaction ($t = -2.112$, $p = 0.041$) whereas there was no statistically significant difference in other categories of life satisfaction. Furthermore, while some categories may not have had statistical significance, they had clinical significance as indicated by large differences in means. The results of this study indicate that siblings of those with a physical disability may have a higher life satisfaction score. Future research should be conducted to understand the relationship among individuals with a physically disabled sibling and an individual with a sibling with a psychiatric disability.

Mentor(s): Carolyn Shivers (Human Development and Family Science), Virginia Tech

Jessica Taylor
Virginia Tech/Experimental Neuroscience
Molly Purtill
Virginia Tech/International Studies
Jessie Yu
Virginia Tech/Psychology
Emma Saunders
Virginia Tech/Human Development
Lily Carroll
Virginia Tech/Cognitive Behavioral Neuroscience
Nicole DeFoor
Virginia Tech/Psychology
Julia Greenman
Virginia Tech/International Studies
Joe Harrison
Virginia Tech/Statistics
Charlotte Koogle
Virginia Tech/Human Development
Leilani Laung
Virginia Tech/Human Development

Diners, Drive-Ins, and Dialects

Open subtitles are used by media productions when they anticipate non-caption-using viewers may have difficulty understanding speech. When these subtitles are used to transcribe dialects instead of translating languages (Liu 2014), they can reveal common ideologies about what accents are considered unintelligible.

We are examining open subtitle use in the television show Diners, Drive-Ins and Dives (DDD). Episodes follow host Guy Fieri as he interviews 3 different chefs. While these interviews are typically conducted in English, the chefs speak a variety of regional dialects of English or have native languages other than English.

We are systematically documenting the first language/dialect of each chef and whether they are subtitled. Subtitling occurs in 36 of 183 observed restaurant encounters so far. 10 of these instances are from encounters abroad, where the show uses subtitles both for non-native (L2) English speakers and to translate Spanish. For the remaining 26 subtitled encounters in the U.S., early analyses show that 20 chefs are exclusively L2-English speakers.

While there are a variety of moments where intelligibility could be compromised (mumbling, regional dialects, etc.), the editors' choices suggest that an intelligibility threshold is only crossed by L2-English. However, the show never entirely subtitles a speaker, which suggests a stance that it is certain L2-English utterances, not L2-English speakers, that are being marked as unintelligible.

Mentor(s): Abby Walker (English), Virginia Tech

Prisha Thapar
Virginia Tech/Cognitive and Behavioral Neuroscience
Alyssa Tsui
Virginia Tech/Psychology
Mikaley Bolden
Virginia Tech/Psychology

How (Skin) Deep is Your Love? Touch Types Used to Communicate Distinct Emotions

Previous studies have demonstrated people can communicate distinct emotions via touch. The current study sought to replicate Hertenstein et al. (2006), which described the frequencies of various touch-types used to communicate emotions. Sixty-two dyads (59 with usable data) participated in the current study. Each participant was randomly assigned as the initial receiver or communicator and could not see or hear the other participant. Two rounds of 12 emotions were communicated to the receiver via touch to the forearm and hand; after the first round, participants switched roles. These communications were independently coded for touch type by two coders, with final codes decided by consensus. As in Hertenstein et al. (2006) Study 2, the current study excluded self-focused emotions that were unreliably communicated via touch and focused on Ekman's and three prosocial emotions. Neutral was communicated three times to reduce the potential effect of process of elimination on accuracy. Overall, the results partially replicated the types of touches most frequently used by participants to communicate specific emotions. In direct comparison, the results for love were most consistent with Hertenstein et al. (2006)—the two most frequent touch-types in both studies were stroking and finger interlocking. For all emotions communicated, besides surprise, at least one of the top three touch-types was consistent across studies, indicating some standardization in touch communications.

Mentor(s): Bruce Friedman (Psychology), Heather Kissel (Psychology, graduate school), Virginia Tech

Deandra Thoms
Virginia Tech/Psychology
Lydia Endale
Virginia Tech/Biology
Rishitha Cherukuri
Virginia Tech/CMDA

Assessing Dog Behavior and the Ability of Owners to Identify Stressors

This project's main purpose is to educate dog owners on the more difficult to notice signs of dog stressors and to encourage them to build more positive relationships with their pets. This was accomplished through the analysis of several aspects in videos of dogs donated through crowdsourcing for our project. For example, dogs often start pacing, look away or lick their lips when stressed. If dog owners can understand the different behaviors dogs might exhibit, for example, potential stressors or danger signs, we can protect dogs from mean, unfair treatment and create better conditions for our dogs. With the videos that we have collected to use as our data, we can analyze the dogs in the videos to note down any signs of stress, anxiety, or fear. We can also use our data to help others look for abuse of dogs and to inform them so they know what to look for. The goal of this citizen science research project is to pile up crowdsourced videos dog owners can use to identify certain signs that these dogs can exhibit. This way we can understand or be full of knowledge about the different signs dogs might show and what they mean. Therefore, owners in their dog to prevent dog overstress and worry and depression.

Mentor(s): Erica Feuerbacher (Animal Behavior and Welfare), Virginia Tech

Alexandra Tucker
Virginia Tech/Psychology

The Effects of Social Media Use on Social Connectedness, Mental Health, and Risk Taking Behaviors During COVID-19 Stay-At-Home Orders in Adolescents with and without ADHD

The COVID-19 pandemic is a global health emergency that has been shown to have serious impacts on mental health. Adolescents in particular have been experiencing negative mental health outcomes associated with social distancing orders, including increased feelings of loneliness, depression, and anxiety. These relations may differ for adolescents with versus without attention-deficit/hyperactivity disorder (ADHD) due to the higher levels of social difficulties, risk taking behaviors, and mental health difficulties experienced by youth with ADHD. With this project, we examined associations between social media use and feelings of social connectedness, and whether these variables were associated with depression and anxiety symptoms. Second, we explored whether these variables and relations differed for adolescents with ADHD when compared to neurotypical adolescents. Participants were 238 adolescents between the ages of 15 and 17 (55.7% male, 49.6% Diagnosed with ADHD) in sociodemographically homogeneous families (80.3% White) with a mean income of $94,789. Results indicated that adolescents who reported more social media use were more likely to feel socially connected during COVID-19 stay-at-home orders. Adolescents with ADHD were less likely to take risks in order to meet their social needs, but did not differ in social media use, technology use, or feelings of social connectedness. Feeling socially connected was associated with lower levels of depression and anxiety symptoms, whereas increased technology use was linked to higher levels of depression and anxiety symptoms. ADHD status did not moderate these relations. This presentation will discuss the clinical and social implications of these findings, and important future research directions.

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

Taylor Tuhy
Virginia Tech/Biochemistry
Madeleine Paulsen
Virginia Tech/Neuroscience
Nick Russell
Virginia Tech/Biochemistry

Meta-Analysis of the Formalin Pain Test

The formalin test is a pain test created in the 1970s that models different phases of acute pain in rodents. This test has high face validity and can determine the efficacy of drugs to treat pain in humans. Over time, this test has not been conducted uniformly; the versions conducted vary in the dose of formalin, location of injection, and the test's duration. With different versions of the formalin test being used throughout pain studies, there has not been an overall consensus on what controlled settings should be in place. We identified over 2,000 papers that used the formalin test to study pain. Papers were excluded from this study based on inconsistent labeling of pain phases, lack of complete data, lack of a control group, and not being available in English. We began conducting a meta-analysis of remaining papers and collected statistics on the protocols used by researchers in the field. As our analysis continues, we will extract data using Engauge Digitizer with the aim of converting figures into raw data. This data will be analyzed by a meta-analysis software known as PRISMA. After analyzing the data, we hope to determine factors that produce replicable results and to develop a protocol that controls for these factors in order to create a more rigorous formalin test.

Mentor(s): Matthew Buczynski (Neuroscience), Virginia Tech

Taylan Tunckanat
Virginia Tech/Biochemistry

Biochemical characterization of aminomutases involved in salt tolerance in methanogenic archaea

Lysine-2,3-aminomutase (LAM) catalyzes the conversion of L-α-lysine to L-β-lysine. This enzyme plays a role in combating salt stress in methanogenic archaea by carrying out the first step in the biosynthesis of Nε-acetyl-β-lysine, a well-studied osmolyte synthesized and accumulated in methanogens. LAM is of special interest as it belongs to the radical S-adenosyl-L-methionine (SAM) superfamily of enzymes which perform diverse and complex chemistry that produce essential biomolecules. Although the bacterial LAM involved in lysine degradation in Clostridium subterminale has been well-characterized, the archaeal LAM involved in osmolyte biosynthesis has never been studied in vitro.
Here, we report on the recombinant expression, purification, and enzymatic properties of LAM from Methanococcus maripaludis. The gene encoding LAM from M. maripaludis C7 (MmarC7_0106) was cloned and the his-tagged protein was overexpressed in Escherichia coli. After purification by metal-affinity chromatography under strictly anaerobic conditions, the kinetic parameters for the enzyme reaction in the presence of L-lysine, SAM, and dithionite at optimum conditions were established. In addition to the first biochemical characterization of an archaeal LAM, we have identified and confirmed the presence of a glutamate-2,3-aminomutase present in M. maripaludis C7 required for the biosynthesis of an alternative osmolyte through heterologous expression studies.

Mentor(s): Dr. Kylie Allen (Biochemistry), Virginia Tech

Meagan Turner
Virginia Tech/Biological Sciences
Jack Gosselin
Virginia Tech/Biological Sciences
Victoria Randall
Virginia Tech/Biological Sciences
Alexis Hackney
Virginia Tech/Clinical Neuroscience
Catherine Sams
Virginia Tech/Biological Sciences

Molecular Docking

Sphingosine kinases (SKs) are enzymes that add a phosphate group to sphingosine, creating sphingosine-1-phosphate (S1P). The structure of SK elicits the use of a gating mechanism to regulate binding of sphingosine to SKs, with ATP being the cofactor to contribute a phosphate group to create S1P (Adams, 2016). Different binding sites located on different points on the protein serve different functions, with the ATP or sphingosine binding sites being potential sites of drug discovery to influence the activity of SKs in disease states. Specifically, drug design relevant to SKs are important in cell proliferation, growth, and differentiation. In cancerous cells, SKs are overactive, resulting in an overproduction of S1P and uncontrolled cell proliferation. With drug design, if the process of sphingosine binding to SKs is inhibited, sphingosine will not be able to be phosphorylated and S1P will not be produced. We have used in silico techniques including molecular docking to probe the binding cavity and druggability of SKs. We have used current known inhibitors of SKs to confirm the method of docking to recreate experiential results and have begun to modify inhibitors with chemical groups to inhibit the sphingosine binding cavity. Ideally, our newly generated model compounds will have lower predicted binding free energy and more interactions in the binding pocket than sphingosine, indicating it might be a good inhibitor or drug candidate. Overall, we found that an edited ADP molecule could effectively block the docking point of sphingosine, and inhibit the formation of S1P by SK. After the formation of the inhibitor, RMSD and molecular affinity values indicated a successful docking and inhibiting of the edited ADP in SK.

Mentor(s): Victoria Corbin (Orion LLC), Virginia Tech

Emma Turton
Virginia Tech/Cognitive and Behavioral Neuroscience

The Impact of COVID-19 on Post Traumatic Stress Disorder Symptomatology in Adolescents with and without ADHD

The COVID-19 pandemic is a chronic stressor associated with widespread impact on physical and psychological health due to increased isolation, reduced routines, and increased sedentary behavior. Studies have found Post Traumatic Stress Disorder (PTSD) symptoms disproportionately impact youth compared to older generations during the pandemic. In general, individuals with ADHD are more likely to experience higher levels of PTSD following stressors or trauma; as such, youth with ADHD may be more vulnerable during COVID-19. The present study explored the impact of the COVID-19 pandemic on PTSD symptomology over three COVID-19 timepoints (spring, summer, fall 2020) in a sample of 238 adolescents (Mage=16.7 years) with and without ADHD (50% with ADHD; 56% male). PTSD symptoms were assessed using self-report on the Child and Adolescent Trauma Screen. PTSD symptoms significantly decreased on average from spring 2020 (M=9.93) to summer 2020 (M=7.95) and remained low in fall 2020 (M=7.63), $F=16.60$, $p<.001$. In spring 2020, 12% of adolescents had moderate trauma-related distress and 13% had probable PTSD; the rate of adolescents with moderate trauma-related distress and probable PTSD dropped in summer 2020 (9.0% and 8.9%) and fall 2020 (11.5% and 7.1%). ADHD status was unrelated to PTSD symptoms, whereas being female was associated with higher PTSD symptoms at each time point. In sum, stay-at-home orders were associated with adolescents experiencing high rates of PTSD symptoms; encouragingly, these symptoms decreased as restrictions were lifted in summer 2020. Despite this, interventions to support those with remaining elevations in trauma symptoms are needed as the pandemic persists.

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

Ashlynn VanWinkle
Virginia Tech/Biochemistry

Development of an attractive toxic sugar bait for the control of Aedes j. japonicus

The mosquito species Aedes japonicus japonicus is a cold tolerant, invasive species and active vector of the West Nile Virus with only limited methods of population control currently available. Attractive Toxic Sugar Baits (ATSBs) have recently emerged as an efficient mosquito control strategy that targets both male and female mosquitoes by exploiting sugar feeding behaviors. Previous ATSB research shows lethal effects on several mosquito species with minimal impact on the environment and non-target organisms. The goal of this work was thus to develop an ATSB to limit Ae. j. japonicus mosquito populations. We conducted feeding assays testing various solutions composed of sucrose and various fruit solutions mixed with 1% boric acid - which is lethal to mosquitoes. We compared survival rates in female and male mosquito groups fed with either the toxic solutions or a control solution (i.e., containing no boric acid) for 96 hours. We found that survivability was much lower when the mosquitoes were provided with the toxic solution compared to the control groups, proving the efficiency of our ATSBs in this invasive species. The next step consists in testing our ATSBs in the field to monitor its effects on the surrounding environment, off target species, and validate its efficacy in a natural setting.

Mentor(s): Chloe Lahondere (Biochemistry), Virginia Tech

Isaiah Varella
Virginia Tech/Clinical Neuroscience

Does a lower socioeconomic status (SES) score have an effect on the change of temporal window and alcohol valuation?

The focus of this research project is on decision-making in adults with alcohol use disorder, a major problem that causes disability, morbidity, and mortality. Reinforcer pathology, a novel framework for behavioral therapy and addiction, specifies that reinforcers such as alcohol, marijuana, etc. are integrated over the temporal window. The length of that window determines the relative value of different reinforcers, specifically self-administered alcohol. Because of reinforcer pathology, new interventions involving episodic future thinking (EFT), which involves inducing experiences that might occur in one's future, will be used in this experiment. The primary hypothesis for this experiment is that when an intervention involving EFT is tested, individuals with a lower socio-economic status (SES) score will experience less change in their temporal windows, which may be related to increased alcohol valuation compared to those who have a higher SES. Other measurements of the study are additional demographic variables such as age and alcohol use severity. We are also tracking study attrition and completion rates. Although the self-administration and EFT project data collection are just underway, early data indicate anywhere from 0 to 8 drinks during the self-administration session and as participants are added to the dataset, the effects of SES and EFT will be able to be examined.
This area of research is very important to me because too many of my peers in my age group, 20yrs.-30 yrs., have fallen short to substance use disorder and poor decision making. By pursuing this fellowship with the Bickel Lab, which specializes in health behaviors, addiction, and decision making, I am able to make a difference firsthand in understanding unhealthy decision making that will advance the field by improving the health and wellbeing of myself and others to come.

Mentor(s): Warren Bickel (Psychiatry/Psychology/Pharmacology), Virginia Tech, Kirstin Gatchalian (Program Manager, ARRC), Virginia Tech Carilion, Devin Tomlinson (ARRC - Ph.D Candidate), Virginia Tech Carilion

Eszter Varga
Virginia Tech/Aerospace Engineering

Implementing Numerical Solutions of ODEs to Aerospace Purposes to Highlight Engineering Multidisciplinarity

My research aims to showcase the age-old question by students: "Why do I learn this?". Often throughout our education, it may seem hard to find useful applications or purposes to our education, especially in areas of STEM. By working to highlight a possible implementation of a numerical solution to ordinary differential equations in the areas of aerospace engineering, I also gain the ability to answer this question. Hungary has the lowest number of females in engineering and STEM. Being the possible only current Hungarian female engineer at Virginia Tech means I have always fought for a greater voice. Felt responsible to show young girls the truly fascinating wonders of engineering. This combination of computation, design, and aerospace creates a unique opportunity for sharing the passion I hold for research and engineering. Not only is it a truly fascinating subject that utilizes many different and engaging ideas, introduced through classes often, but also a case of multidisciplinarity within engineering.
My research analyzed the carotid artery section and applied blood flow models on different original MRI scans and when blockages were to appear, in this section. I used different software to create my models, and turn those into meshes, which served as my boundary conditions for my flow model calculations. The different cases allowed me to extend my knowledge into different engineering fields, and create a real-life application for blood clot analysis, which can be used as a great medical tool. I also launched my blog, where I am able to tell my ever-growing audience about my findings, to fulfill the outreach goals of my project.

Mentor(s): Mayuresh Patil (AOE), Virginia Tech

Jacqueline Wang
Blacksburg High School

Investigating Trends in the Multiple Ligand Activation of PPAR Gamma

Peroxisome proliferator-activated receptors (PPARs) are ligand-activated transcription factors involved in the regulation of insulin. PPAR gamma (PPARγ) activates genes in muscle, fat, and liver. They regulate glucose metabolism and other functions in those parts. Currently, PPARγ agonists are used as Type 2 diabetes treatments such as Thiazolidinediones. While rather effective, fluid retention and increased intravascular volume from these treatments have made researchers look for another treatment, PPARγ partial agonists. These new ligands have reduced adverse effects. For this study, PPARγ was examined to find the residues are necessary for multi-ligand binding. The binding pocket interactions were analyzed using the software PyMOL. The models were taken from the RCSB PDB database. Models of PPARγ with 2 or 3 unique ligands were looked at so drugs can be developed to mimic the multi ligand binding feature/activation. All polar residues that were 5 angstroms or less away from the ligand were found. The process was repeated with other models, and similar residues were noted. The residues that were found in each model were deemed as "critical" in the binding of multiple ligands to PPARγ. The residues were all of the possible amino acids. From the data collected, tyrosine, serine, histidine, and arginine were present in over a third of the models. Finding these critical residues will help discover more treatments for Type 2 diabetes to decrease the number of side effects.

Mentor(s): Anne Brown (Biochemistry), Virginia Tech, Katharine Davis, Blacksburg High School

Omar West
Virginia Tech/Biological Sciences

The Effect of pH and symbiont density on outcomes in a cleaning symbiosis

Cleaning symbiosis between crayfish and worms known as ecosymbiotic branchiodellidan annelids have been studied very well in the past in various stress induced environments. The research that has been conducted on these organisms showed that the worms inhabiting the crayfish play a hygienic role for the crayfish that is mutualistic at low and intermediary levels. This relationship can shift to parasitic at high worm levels on the crayfish. This study that has been conducted focuses on the effect of how pH affects the symbiotic relationship between these two organisms. The treatments for this experiment were pH levels of 6,8, and 10, and the worm treatments were 0, 3, and 6. Each treatment had 4 replicants that were averaged together over the course of the study. The results of the study showed that both significantly higher percentage change in carapace length and blotted wet mass for the crayfish in the environments of a pH of 8 and a worm count of 6. This supports the hypothesis that the intermediary worm count of 6 and at a pH of 8 would result in these crayfish having a greater level of fitness. The relatively extreme pH's of 6 and 10 had a dramatic negative impact on the survivability of the crayfish and the overall fitness. This study will be conducted again in the future due to instances of random error throughout the study.

Mentor(s): Bryan Brown (Biological Sciences), Virginia Tech

Calvin Woehrle
Virginia Tech/Aerospace Engineering
Shivam Khullar
Virginia Tech/Aerospace Engineering
Joshua Crocker
Virginia Tech/Aerospace Engineering
Nathan Rand
Virginia Tech/General Engineering

Autonomous Drone Navigation and Mapping

Through the use of commercially available parts and open-source software, we have designed a low-budget autonomous drone system for use in surveying and 3D mapping.
The primary goal of this research project is the creation of a low-cost, autonomous, fixed-wing, drone designed for infrastructure inspection and ariel photography.
The drone system must be capable of manual and autonomous flight, as well as accommodate an interchangeable inspection payload. The craft is controlled by a microcontroller with various sensors, data loggers, and a communication system capable of linking to a ground station. Connections are redundant making use of Wi-Fi and software-defined radio.
Our research is focused on the integration of a complete system of hardware and software. Blender and other similar programs are used to combine and process images into a 3D model. ArduPilot, an open-source autopilot environment, is used to remotely monitor and control RC airframes. We have the ability to define various surveying patterns and automate sensor activation, allowing data points to be correlated with GPS coordinates. Additionally, ArduPilot allows emergency terrain avoidance and automatically returns to the launch site if communications are interrupted.
ArduPilot also allows us to run software in the loop simulations to test flight parameters without having physical access to flight hardware. This helps prevent expensive crashes while allowing remote development by team members.
We have successfully assembled our drone and validated our sensor payload. Flight tests will be conducted at Kentland Farm at the end of this semester.

Mentor(s): David Gray (Engineering Education), Virginia Tech

Mitch Woodhouse
Virginia Tech/Biological Systems Engineering

Investigating cell size regulation by inducing asymmetric division

Cell size homeostasis is an essential feature in all kingdoms of life where cells maintain a size that is optimal for their function. However, it is currently unknown how cells maintain their size. Two leading theories are the timer model, where cells divide after a certain time, and the sizer model, where cells divide after reaching a certain size. Importantly, the sizer model would require a molecular 'proxy' to measure cell size. Cdc13 (cyclin B) is a highly conserved activator of cell division that gets degraded during division and then accumulates in concentration with increasing cell size. To investigate whether Cdc13 concentration directly reflects cell size, I induced asymmetric division in fission yeast to compare Cdc13 protein accumulation rates in the large and small daughter cells. If Cdc13 accumulates faster in the larger daughter cell than in the smaller, then Cdc13 concentration may indeed directly reflect cell size. Surprisingly, I discovered that Cdc13 accumulation rates are equivalent in differently sized daughter cells. This suggests that Cdc13 accumulates not with size but with time. As such, if Cdc13 is involved in cell size homeostasis, it is most likely a 'timer', not a 'sizer'.

Mentor(s): Dr. Silke Hauf, (Biological Sciences), Virginia Tech

Eric Xie
Blacksburg High School

Classification of Neurons by Activation Stages using an Artificial Neural Network

Recent advancements in technology have allowed the gathering of single-cell RNA sequencing data (scRNA-seq). scRNA-seq provides expression profiles of individual cells that allow for the study of differences between gene expression on a cellular level. However, the unique nature of this dataset requires new methods of analysis to be developed in order to extract information from the data. By creating a feed-forward artificial neural network using scRNA-seq data, the activation stage of neurons could be accurately predicted using gene expression data. By comparing the impact of altering the learning rate and the number of neurons in the hidden layer on the overall area under the curve (AUC) of the receiver operating characteristic (ROC) curve, the performance of each program could be determined. The artificial neural network with the highest average AUC of 0.9 had two neurons and a learning rate of 0.01. The program could easily be adapted to analyze other characteristics of cells, such as cell development or type. Further optimizations are required to analyze larger and more complex datasets. Being able to gather information to this extent through analyzing gene expression data will greatly improve our ability to analyze cells of any type.

Mentor(s): Katharine Davis, Blacksburg High School

Joseph Zobel
Blacksburg High School

Determining Perceptions of Appalachian English among Non-Speakers Living in Appalachian Virginia

Appalachian English has been defined by a number of studies to be an independent dialect of American English (Wolfram, 1976a; Montgomery, 1991; Hazen, 2018). However, while there have been studies done regarding the perceptions of Appalachian English, there has not been a significant amount of research done regarding the perceptions of those who do not speak the dialect and reside in Appalachia, especially in Appalachian Virginia (Luhman, 1990; Cramer, 2018). Data regarding these perceptions were collected through a survey of a number of residents of Montgomery County, Virginia. This survey consisted of two parts: a map, upon which participants were asked to draw boundaries of dialects of American English, and a questionnaire to collect demographic data and data regarding perceptions of Appalachian English and other dialects. This study, therefore, defines and delves into the perspectives of these residents as they regard accents within the region, and compares the attitudes of those surveyed who do not speak Appalachian English with the attitudes of those who do. Furthermore, through statistical analysis of the data collected in the survey, this study identifies a number of statistically significant findings, especially regarding perceived beauty and correctness of Appalachian English, and suggests potential areas for future research to expand upon these findings.

Mentor(s): Katie Carmichael (English), Virginia Tech, Katharine Davis, Blacksburg High School