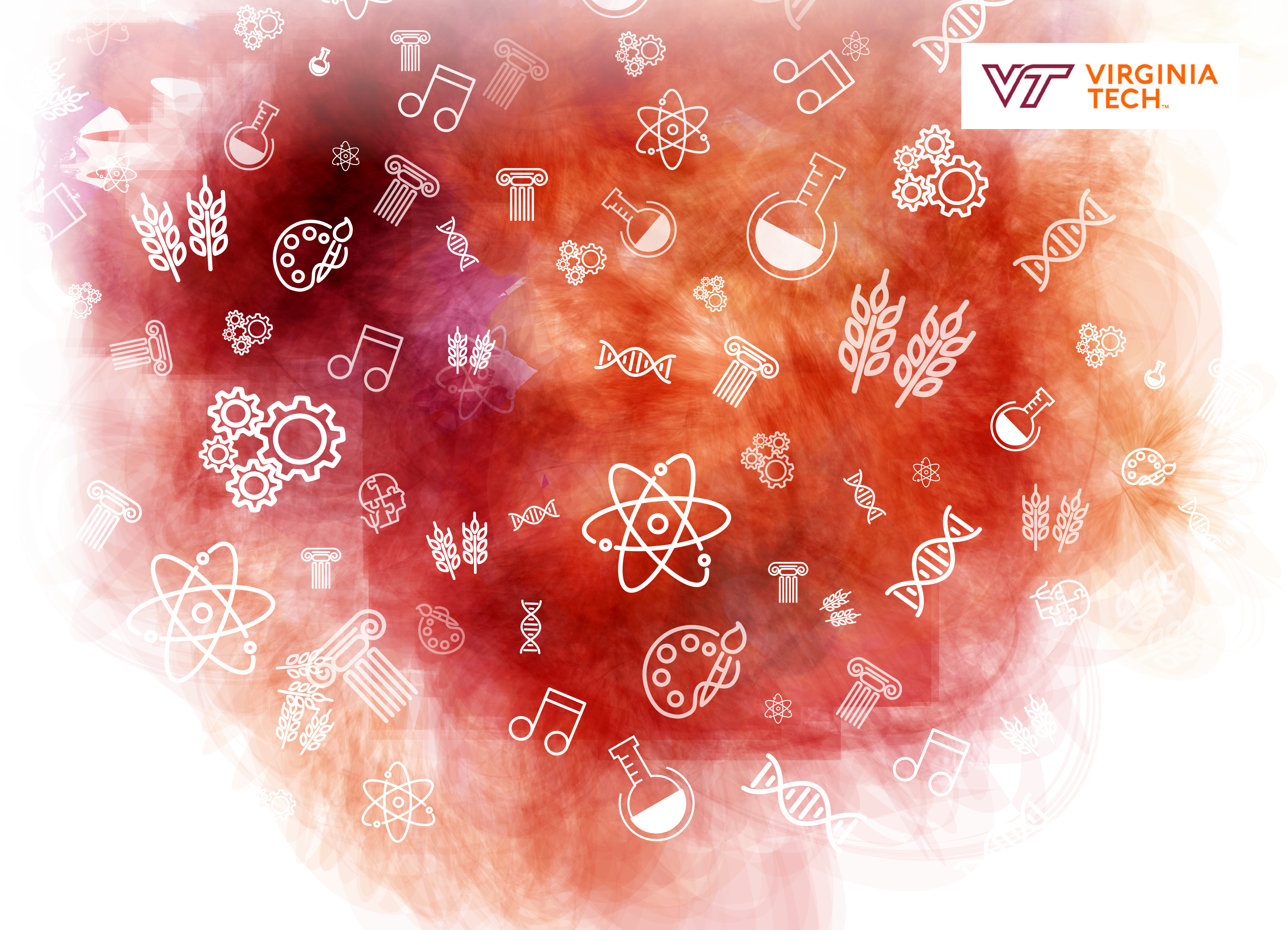


# VIRGINIA TECH'S OFFICE of UNDERGRADUATE RESEARCH SUMMER SYMPOSIUM

Goodwin Hall | July 26, 2018 | 9:00am - 4:30pm

ABSTRACTS

www.research.undergraduate.vt.edu

# Schedule at-a-glance

| | |
|---|---|
| 9:30-10:00am | Check-in<br>Goodwin Hall Atrium |
| 10:00-10:45am | Welcome + Keynote Address<br>Goodwin Hall Auditorium |
| | Welcome KERI SWABY<br>University Undergraduate Research Coordinator |
| | Introduction RYAN NASSER<br>Virginia Tech Junior: English and Neuroscience |
| | Keynote DR. WILLIAM (BILL) HOPKINS<br>Professor, Department of Fish and Wildlife Conservation<br>Director, Global Change Center at Virginia Tech |
| 10:45-11:00am | Break + Poster Session 1 set-up<br>Goodwin Hall Atrium |
| 11:00am-12:00pm | Poster Session 1<br>Goodwin Hall Atrium |
| 12:00-1:00pm | Lunch<br>Goodwin Hall Atrium |
| | Graduate School networking |
| | Poster Session 1 take-down |
| | Poster Session 2 set-up |
| 1:00-2:00pm | Poster Session 2<br>Goodwin Hall Atrium |
| 2:00-2:15pm | Break + Poster Session 2 take-down + Poster Session 3 set-up |
| 2:15-3:15pm | Poster Session 3<br>Goodwin Hall Atrium |
| 3:15-3:30pm | End of Symposium + Poster Session 3 take-down |

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

# Welcome

As part of Virginia Tech's Beyond Boundaries long-range visioning exercise, the concept of the VT-shaped education emerged. The VT-shaped student experience provides T-shaped learning: deep knowledge and skills in at least one field of study plus broader capacities including teamwork, problem solving, communication, and critical thinking to work across disciplines and in novel or complex situations. Beyond T-shaped learning, Virginia Tech seeks to engage the whole person through curricular and co-curricular learning experiences that are purpose-driven as a manifestation of our motto Ut Prosim, "That I may serve." The "V" in the VT-shaped experience is where students learn through participation in authentic work under the guidance of a mentor. I can think of no better experience than undergraduate research.

The Summer Undergraduate Research Conference is a high point of our summer at Virginia Tech. Most students presenting today have spent ten or more weeks immersed in a research project full-time. Summer affords undergraduates the opportunities to dedicate significant time and effort to the planning, execution and analysis of a research project. They have also had the chance to become authentic members of research teams by working side-by-side with faculty, graduate students, postdoctoral fellows and research staff.

Many thanks to all who have mentored undergraduates this summer. Virginia Tech is pleased to offer these summer experiences not only to our own students, but also to undergraduates from all over the country. We hope that you have enjoyed your time at Virginia Tech, and we appreciate the diversity of ideas and cultures that you have brought to our campus. Congratulations to all of our presenters!

A very special thank you to Keri Swaby, Janet Hilder, Nicole Easton, and our peer mentors for their tremendous work in making this symposium happen!

Enjoy!

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

# Office of Undergraduate Research

Keri Swaby
University
Undergraduate
Research Coordinator

Welcome to the annual Summer Research Conference at Virginia Tech! We are extremely excited to welcome 170 presenters from 18 organized research programs and many independent labs, who will give 157 poster presentations! Over the course of the past 10 weeks, undergraduate students from Virginia Tech and across the country, as well as Virginia public school teachers, have been engaged in a wide variety of projects tackling real world problems in many disciplines. I am extremely humbled by the quality of work on show today and welcome you to enjoy and marvel at the wealth of research that took place across VT this summer.

It has been a busy summer for the Office of Undergraduate Research (OUR). We have offered common programming to more than 170 researchers which included weekly professional development seminars on topics including handling data ethically, writing personal statements, abstracts and proposals, graduate school, and presenting research. Guest speakers came from University Libraries, the Honors College, the Graduate School, and faculty and graduate students from a variety of internal and external programs. We are extremely grateful for their time and for sharing their expertise.

This summer was not only about research and professional growth. Researchers were invited to weekly Friday field trips to visit VT labs and facilities including the TREC lab, DREAMS lab, VT Meat Center, Biocomplexity Institute Labs, the Drone Park, ICAT, Nonlinear Systems Lab, and the Kroehling Advanced Materials Foundry. A special thank you to these facilities for opening their doors and sharing the excitement of their research and work and thank you to Janet Hilder for coordinating each visit. In addition, our energetic peer mentors - Andrew, Lydia, Ryan, and Sophia - coordinated many social events including a Cascades hike, visit to Claytor Lake, Tubing on the New River, volunteering at the local animal shelter, and several cookouts and dinners out. Without our dedicated mentors, this summer would not have been a success. Thank you all for your incredibly hard work.

The operations of the OUR would not have been possible without generous financial support from the Fralin Life Science Institute. Thank you!

I hope you all enjoy the symposium. Researchers, I hope you have been inspired to continue exploring and growing. Good luck!

Sincerely,

Keri Swaby
University Undergraduate
Research Coordinator

# Keynote Address

## PROFESSOR, DEPARTMENT OF FISH AND WILDLIFE CONSERVATION
## DIRECTOR, GLOBAL CHANGE CENTER AT VIRGINIA TECH

## DR. WILLIAM (BILL) HOPKINS

Dr. Hopkins is a Professor in the Department of Fish and Wildlife Conservation in the College of Natural Resources and Environment at Virginia Tech. He is also the Director of the Global Change Center at Virginia Tech (within The Fralin Life Science Institute). He holds additional Adjunct Professor Appointments with the University of Georgia's prestigious Odum School of Ecology and the University of Tennessee's Department of Forestry, Wildlife, and Fisheries.

Dr. Hopkins' research focuses on physiological ecology and wildlife ecotoxicology. To date, he has published more than 185 peer-reviewed manuscripts and book chapters on subjects pertaining to environmental stressors, pollution, and the physiological ecology of amphibians, reptiles, birds, and bats. His work is heavily cited in the scientific literature and he frequently provides input on important environmental issues to the media (e.g., 60 minutes, NPR, etc.) and to decision makers in Richmond, VA and Washington D.C.

Dr. Hopkins serves (or previously served) on the editorial boards of three journals, as a member of four National Academy of Sciences (NAS) Committees dealing with water resource, pollution, and energy issues, and he currently chairs a NAS committee tasked with a National Review of > 300 U.S Geological Survey Laboratories. He has also served in advisory capacities at the local, state, national, and international level on issues pertaining to waste management, sustainability, and the global decline of biodiversity. He has been a key scientific contributor to five of the U.S. Department of Interior's Natural Resource Damage Assessment and Restoration (NRDAR) cases, including high profile cases such as the B.P. oil spill. His work on NRDAR cases includes ecological damage assessments, effective collaboration with diverse stakeholder groups, and development of practical, science-based restoration strategies and long-term monitoring plans.

Dr. Hopkins is an award-winning undergraduate teacher, twice receiving the College's Outstanding Faculty Award for undergraduate teaching and mentorship. Likewise, his contributions to graduate education were recently recognized by the Virginia Tech Graduate School when he was awarded the inaugural (2017) Graduate Student Mentorship Award for his college. Dr. Hopkins also received the 2015 Alumni Award for Research Excellence from Virginia Tech. In recent years much of Dr. Hopkins' focus has involved collaborating with colleagues to develop novel training opportunities for undergraduate and graduate students, to include a large (20 departments) Interdisciplinary Graduate Education Program, experiential learning requirements for his home department, a NSF-supported undergraduate senior thesis program, and a study abroad course on Tropical Ecology and Conservation in Ecuador.

*Dr. Bill Hopkins*

# 2018 ACC Creativity + Innovation Scholars

The ACC Creativity and Innovation program is funded by the Inter-Institutional Academic Collaborative of the Atlantic Coast Conference (ACCIAC). It supports current Virginia Tech undergraduate students who are involved in independent research projects or creative works under the mentorship of faculty. Selected Virginia Tech scholars receive a monetary award that can be used as a stipend and/or direct support of expenses such as travel, and use of specialized research services. Students from all academic disciplines are encouraged to apply to the program. This year's recipients and their projects are listed below.

## Lance DeKoninck (Engineering Science and Mechanics)

PASSIVELY RESISTING FROST AND ICE GROWTH ON CABLES

Faculty mentor: Jonathan Boreyko, Biomedical Engineering and Mechanics

## Brooke A. Kampney (Theatre Arts: General Theatre)

HEATHERS: THE MUSICAL

Faculty mentor: Joe Court, Theatre: Sound

## Wenting Shi (Chemical Engineering)

DEVELOPMENT OF DRUG-LOADED OPTICAL FIBERS FOR CANCER THERAPY

Faculty mentor: Dr. Rong Tong, Chemical Engineering

## Julia Tani (Environmental Science)

THE EFFECT OF ANTIBIOTIC CONCENTRATIONS IN THE CHOBE RIVER AND SEWAGE SETTLING PONDS ON THE PRESENCE OF ANTIBIOTIC RESISTANT ESCHERICHIA COLI IN NORTHERN BOTSWANA, AFRICA

Faculty mentor: Kathy Alexander, Fish and Wildlife Conservation

## Mattie T. Ten Kate (Neuroscience and Psychology)

ZEBRAFISH AS A MODEL FOR STUDYING GLIOMA

Faculty mentor: Robyn Umans, Neuroscience (College of Science)

## Eric D. Wuerfel (Physics)

GRAVITATIONAL WAVE SIGNAL FILTERING AND THE PHYSICS OF COMPACT BINARY COALESCENCES

Faculty mentor: Lydia Patton, Philosophy

# Thank you . . .

## PEER MENTORS

Andrew Biscardi
Ryan Nasser
Sophia Lee
Lydia Smith

## GRADUATE ASSISTANTS

Janet Hilder
Najla Mouchrek

## OFFICE OF UNDERGRADUATE EDUCATION

Nicole Easton

## PROGRAM DIRECTORS

### ASTROPHYSICS REU

Dr. Douglas Edmonds (Assistant Professor of Physics, Penn State, Hazleton)

### THE BIOCOMPLEXITY INSTITUTE'S RESEARCH EXPERIENCE FOR UNDERGRADUATES (BREU) PROGRAM

Dr. Kristy Collins (Biocomplexity Institute)

### BIOMECHANICS & BIOLOGICAL TRANSPORT REU

Dr. Shane Ross (BEAM)
Dr. David Schmale (PPWS)
Dr. Vincent Wang (BEAM)

### FRALIN SUMMER UNDERGRADUATE RESEARCH FELLOWSHIP (SURF)

Keri Swaby (Office of Undergraduate Research)

### INFORMATION BIOLOGY PROGRAM: PREDICTING, EXPLAINING, AND VISUALIZING COMPLEX SYSTEMS

Dr. Stanley Hefta (Biocomplexity Institute)

### IRES: US-CHINA COLLABORATION: BATS AS MODEL ORGANISMS FOR BIOINSPIRED ENGINEERING

Dr. Rolf Mueller (Mechanical Engineering)

### KAUST ICTAS REU

Dr. Vinod Lohani (Engineering Education + ICTAS)

### MACROMOLECULES INNOVATION INSTITUTE REU: MATERIALS INNOVATION AT THE INTERSECTION OF FOOD-ENERGY-WATER SYSTEMS (FEWS)

Dr. Timothy Long

### MULTICULTURAL ACADEMIC OPPORTUNITIES PROGRAM (MAOP)

Dr. Jody Thompson Marshall (MAOP Director)

# Thank you . . .

## PROGRAM DIRECTORS

### NSF/RET SITE: WATERECUBEG (ENGINEERING, ECOLOGY, ENVIRONMENT, + GEOSCIENCES)

Dr. Vinod Lohani (Engineering Education + ICTAS)

Dr. Randy Dymond (Ciivil & Environmental Engineering)

### NSF/REU SITE: INTERDISCIPLINARY WATER SCIENCE + ENGINEERING

Dr. Vinod Lohani (Engineering Education + ICTAS)

### PREP & IMSD (NIH)

Dr. Ed Smith (APSC)

### TRANSLATIONAL OBESITY UNDERGRADUATE RESEARCH SCHOLARS (TOUR)

Dr. Deborah Good (Department of Human Nutrition, Foods, and Exercise)

### USDA REEU: TRAINING FUTURE LEADERS TO SOLVE PROBLEMS AT THE CONFLUENCE OF WATER AND SOCIETY

Dr. Cully Hession (BSE)

Dr. Leigh-Anne Krometis (BSE)

Dr. Brian Badgley (CSES)

Dr. Amber Vallotton (Horticulture)

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

Dr. Glenda Gillaspy (Biochemistry)

Dr. W. Hunter Frame (Plant and Environmental Sciences)

### VIRGINIA TECH-VIRGINIA COMMUNITY COLLEGE SYSTEM BRIDGES TO THE BACCALAUREATE

Dr. Karen Eley Sanders (Associate Vice Provost for College Access)

Dr. Kristy Collins (Director: Education and Outreach Group, Biocomplexity Institute)

### VTCRI MOLECULAR VISUALIZATION SURF

Dr. James Smyth (VTCRI + VT Biological Sciences)

### VTCRI NEUROSURF

Dr. Michael Fox (VTCRI + VT Biological Sciences)

# 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.

## BIOMEDICAL ENGINEERING AND MECHANICS

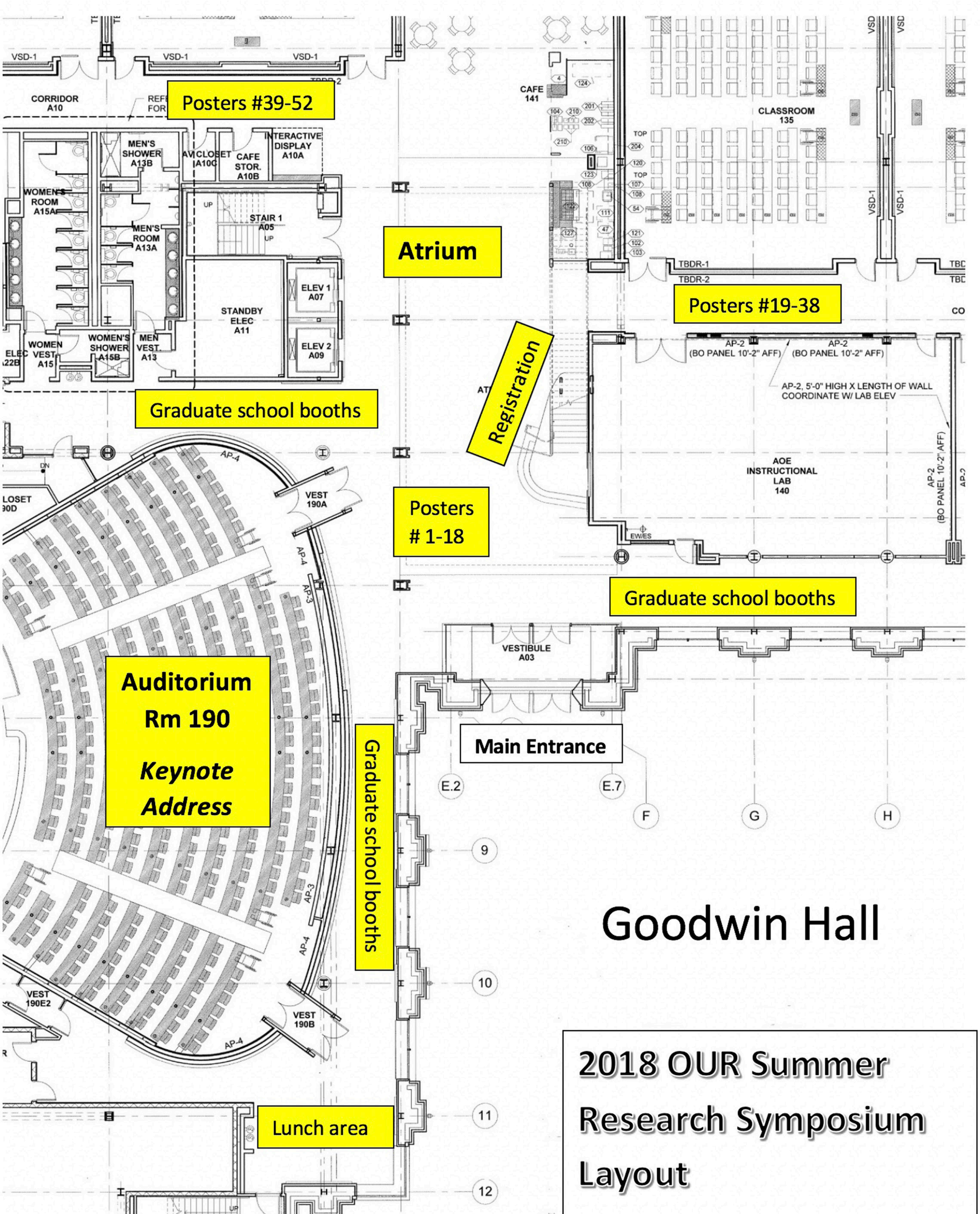
## GRADUATE SCHOOL

## MASTER OF PUBLIC HEALTH + BIOMEDICAL SCIENCES PHD & MASTERS PROGRAMS

## DEPARTMENT OF PHYSICS

## ISCHOLARS

## TRANSLATIONAL BIOLOGY, MEDICINE, + HEALTH




# 2018 OUR Summer Research Symposium Layout

July 26, 2018

# Contents

# Poster Presentations Session 1

11:00AM-12:00PM

1 **Abdulelah Qahtan** (Virginia Tech, Chemical Engineering)
Nanomaterial Enabled Sensors for Water Quality Monitoring
KAUST ICTAS REU

2 **Emily Hill** (Emory & Henry College, Biology and Chemistry)
The Distribution of Neutral Hydrogen in the Milky Way Galaxy
ASTROPHYSICS REU

3 **Madison Jackson** (Emory & Henry College, Physics)
Producing a Galactic Rotation Curve for the Milky Way Galaxy
ASTROPHYSICS REU

4 **Alana Hull** (Virginia Tech, Clinical Neuroscience)
The Role of Connexin 36 on Seizure-like Brain Activity
NEUROSURF

5 **Alondra Martinez** (University of Oklahoma, Chemical Engineering),
**Brianna Woolfolk** (University of Miami, Environmental Engineering)
The Presence of Antibiotic Resistance Genes in Waste Water Treatment Plants
INTERDISCIPLINARY WATER ENG & SCI REU

6 **Amanda Sharp** (Virginia Tech, Biochemistry)
Identifying Radical SAM Enzymes and Characterizing GRE-AEs in Methanocaldococcus jannaschii using Bioinformatic Tools
INDEPENDENT

7 **Arienne Roth** (Virginia Tech, Neuroscience)
Education Level Leads to Greater Monetary Strategy in Two-Party Fairness Game
NEUROSURF

8 **Arturo Roman Longoria** (Virginia Tech, Microbiology)
Effect of location on wheat seed microbiomes in Virginia
INDEPENDENT

9 **Aubrey Phares** (Virginia Tech, Cognitive and Behavioral Neuroscience)
Neighboring Astrocyte Response to Astrocyte Ablation
MOLECULAR VISUALIZATION SURF

10 **Ayman Alzomaili** (University of Wisconsin-Madison, Electrical Engineering)
Improving the durability of pneumatic actuators for Batbot
KAUST ICTAS REU

# Poster Presentations Session 1 *(continued)*

11:00AM-12:00PM

11 **Basem Eraqi** (University of California-Irvine, Mechanical Engineering)
Investigation of The Feasibility of Applying Artificial Neural Networks in Integrating Singular Functions
KAUST ICTAS REU

12 **Ben Clark** (Virginia Tech, Water: Resources, Policy & Management), **Ethan Boeding** (Virginia Tech, Nanoscience)
Quantifying nucleic acid association to nanoparticles
INDEPENDENT

13 **Benayas Dereje Begashaw** (Cornell University, Molecular Biology)
Functional analysis of vesicle trafficking in Optic Nerve Hypoplasia by the use of SynaptoTag AAV
NEUROSURF

14 **Brady Simpson** (James Madison University, Biology)
Identification of MEOX2 as a prognostic marker and a potential survival factor for glioblastoma
NEUROSURF

15 **Casey VanFossen** (Florida Gulf Coast University, Environmental Engineering)
Removal Efficiency of Pharmaceutical and Personal Care Products From Tap Water Using House-hold Water Filter Devices
INTERDISCIPLINARY WATER ENG & SCI REU

16 **Chase Amos** (University of Virginia, Chemistry with Specialization in Biochemistry)
Neuronal collagen XIX is essential for excitatory synapse formation in the accessory olfactory bulb
NEUROSURF

17 **Christian Lytle** (Case Western Reserve University, Chemical Engineering)
Evaluating the science behind shock chlorination in well systems
INTERDISCIPLINARY WATER ENG & SCI REU

18 **Claire Vavrus** (University of Wisconsin-Madison, Geological Engineering)
Effects of oxygenation on metals in a drinking water reservoir
INTERDISCIPLINARY WATER ENG & SCI REU

19 **Daniel Purcell** (Virginia Tech, Biomedical Sciences: Biomedical Option)
Adenovirus predisposes healthy cells to viral infection via intercellular signaling and junctional remodeling
MOLECULAR VISUALIZATION SURF

20 **Daniel Quintana** (University of California-Berkeley, Neurobiology)
Neuromuscular junction and spinal cord distribution of Argonaute 2 (Ago2) in Amyotrophic Lateral Sclerosis (ALS)
NEUROSURF

# Poster Presentations Session 1 *(continued)*

11:00AM-12:00PM

21 **Erin Milligan** (Ohio University, Civil Engineering)
Development of PCR Assays for the Investigation of Microbial Contaminants in Drinking Water Systems in Rural Puerto Rico after Hurricane Maria
INTERDISCIPLINARY WATER ENG & SCI REU

22 **Erin Spivey** (University of South Carolina-Aiken, Environmental Remediation Biology)
Invasive Crayfish Cleaning Habits and Removal of Ectosymbiont Worms
INTERDISCIPLINARY WATER ENG & SCI REU

23 **Faris Almohamed** (Penn State University, Material Science and Engineering)
Integrating synthetic polymers into Portland cement concrete to improve durability
KAUST ICTAS REU

24 **Harrison Andrew** (New College of Florida, Physics)
Two Temperature KLS Systems With Transverse Interface
PHYSICS USAEOP URAP

25 **Hassan Almohammedsaleh** (Virginia Tech, Electrical Engineering)
Solving Second Dgree Polynomials Using Artificial Neural Network
KAUST ICTAS REU

26 **Jaafar Al Hadab** (University of Rochester, Mechanical Engineering)
Developing an improved material model for rib cortical bone used in human finite element models
KAUST ICTAS REU

27 **Kayleigh Vance** (Virginia Tech, Biological Sciences)
Changes in Microglia Activation in the Spinal Cord
NEUROSURF

28 **Kevin He** (Virginia Tech, Biochemistry)
Identifying critical Connexin43 domains required for microtubule interaction
MOLECULAR VISUALIZATION SURF

29 **Kirsten Lydic** (Hampshire College, Cognitive Neuroscience)
Prospective thought, delay discounting, and metacognitive assessment in addiction and recovery
NEUROSURF

30 **Malikah Ajose** (Virginia Tech, Clinical Neuroscience)
Sex Differences Effect Astrocytic Response after TBI
NEUROSURF

# Poster Presentations Session 1 *(continued)*

11:00AM-12:00PM

31 **Matthew Svec, Richard Qiu** (Virginia Tech Carilion Research Institute)
Diabetes Mediates Dysfunction of the Blood-Brain Barrier
NEUROSURF

32 **Megan Harrigan** (Virginia Tech, Clinical Neuroscience)
Analysis of a Custom 3D-Printed Migration Chamber
NEUROSURF

33 **Mia Genuario** (Virginia Tech, Clinical Neuroscience)
Binocular and Class-Specific Retinal Input to Complex Retinogeniculate Synapses
NEUROSURF

34 **Mira Chaplin** (University of California-Berkeley, Civil and Environmental Engineering)
Spatial and temporal water quality patterns in a headwater stream impacted by surface mining
INTERDISCIPLINARY WATER ENG & SCI REU

35 **Naomi Carter** (Hampton University, Cellular and Molecular Biology)
Delocalization of GABAergic synapses after strain-specific Toxoplasma Gondii Infection
NEUROSURF

36 **Naser Alsubaiei** (Virginia Tech, Mechanical Engineering)
The ionic liquid gel polymer electrolytes for solid state lithium metal battery
KAUST ICTAS REU

37 **Nick Cramer** (Virginia Tech, Biochemistry)
Insight into Islet Amyloid Polypeptide (IAPP) and Amyloid-Î² Peptide Interactions Using Molecular Dynamics Simulations
INDEPENDENT

38 **Rachael Ward** (Virginia Tech, Experimental Neuroscience)
Ultrastructural Characterization of Types III and IV Collagen within the Vascular Basement Membrane of Brain Blood Vessels
NEUROSURF

39 **Rafe Hagee** (Emory & Henry College, Chemistry)
Turbidity and Suspended Sediment Sampling to Estimate Storm-Event Sediment Loads in Stroubles Creek
EMORY AND HENRY COLLEGE FRIENDS OF THE SCIENCES FELLOW

40 **Samuel Dickerson** (Virginia Tech, Biological Sciences)
Investigating Novel Roles for a Lymphocyte-associated Transcriptional Complex in Metastatic Breast Cancer Using Super-resolution Microscopy
MOLECULAR VISUALIZATION SURF

# Poster Presentations Session 1 *(continued)*

11:00AM-12:00PM

41 **Sara Eghtessadi** (University of Florida, Environmental Engineering)
Enhanced Resource Recovery from Secondary Wastewater by Integrating Algae in a Submerged Forward Osmosis System
INTERDISCIPLINARY WATER ENG & SCI REU

42 **Sean Collier** (Emory & Henry College, Mathematics),
**Sean Heston** (Virginia Tech, Physics) ,
**Jake Pighini** (Emory & Henry College, Physics)
Mining the Sloan Digital Sky Survey Database for Quasar Outflows with Possible Distance Indicators
ASTROPHYSICS REU

43 **Shayom Debopadhaya** (Virginia Tech Carilion Research Institute)
The role of QSOX1 in the formation and maintenance of neuromuscular junctions and muscle fibers
NEUROSURF

44 **Shericia Campbell** (Virginia State University, Biology)
Targeting the integrated stress response in cardiac hypertrophy to preserve electrical coupling
MOLECULAR VISUALIZATION SURF

45 CANCELED

46 **Sonali Dabhi** (The College of William and Mary, Neuroscience)
Astrocyte Ablation Causes Proliferation of Neighboring Astrocytes
NEUROSURF

47 **Tippavon Morrow** (Virginia Tech; Human Nutrition, Foods, and Exercise)
The Learning Process as Individuals Interact with Brain-Computer Interface
MOLECULAR VISUALIZATION SURF

48 **Tracey Myers** (Virginia Tech, Experimental Neuroscience)
The Effects of Acetylcholine and Agrin on C2C12 Cells
NEUROSURF

49 **Trevor Jones** (Virginia Tech, Computer Science)
Investigating the effects of interaction and display fidelity for Teaching Hydrology Concepts within an Interactive Immersive Virtual Environment
INTERDISCIPLINARY WATER ENG & SCI REU

50 **Victoria Buskey** (Virginia State University, Biology)
Identification of MYCN as a potential survival factor for leukemia
NEUROSURF

# Poster Presentations Session 1 *(continued)*

11:00AM-12:00PM

51 **Yasmeen Alsaihati** (University of California-Irvine, Checmical Engineering)
Fluorescent-Labeled cellulose derivatives for ASD
KAUST ICTAS REU

52 **Zachary Yorke** (Virginia Tech, Biochemistry)
Preparation of plasmids encoding fluorescent PI3K isoforms that enable a detection of protein-protein interactions
MOLECULAR VISUALIZATION SURF

# Poster Presentations Session 2

1:00-2:00PM

1 **Zachary Wilson** (Virginia Tech, Biological Sciences)
High Resolution Respirometry of Heart Mitochondria in Healthy and Diseased States
TRANSLATIONAL OBESITY (TOUR)

2 **Zachary Kozar** (Virginia Tech, Engineering Science and Mechanics)
Quantitative Analysis of Grayscale Tendon Ultrasound Images of Collegiate Basketball Players
INDEPENDENT

3 **Victoria Moore** (Mary Baldwin University, Biology)
Growth characteristics of HSV1 and HSV2 in primary adult neurons under various conditions
MAOP

4 **Uulen Batzul** (Virginia Tech, Biological Sciences)
Testing the effect of DNA methylation on nuclear volume scaling in tetraploid cells
VT IMSD

5 **Srikanth Jakkampudi** (Virginia Tech, Computational Modeling & Data Analytics)
Neural Networks for Protein Domain Recognition
INFORMATION BIOLOGY SUMMER PROGRAM

6 **Shreya Dayal** (Virginia Tech, Physics)
Self-Assembly of Actin Like Filaments
INDEPENDENT

7 **Richard Kline** (Northern Virginia Community College, Biotechnology)
Analyzing the Varied Chemotherapeutic Response of Breast Cancer Brain Metastases in Different Matrices
VT-VCCS B2B

8 **Naila Sayani** (Virginia Tech, Biological Systems Engineering)
High-speed Video Array Recordings of Bats Drinking on the Wing
IRES: US-CHINA COLLABORATION: BATS AS MODEL ORGANISMS FOR BIOINSPIRED ENGINEERING

9 **Michael Galeski** (Creighton, Sustainability),
**Sarah Abrahams** (Auburn University, Quantitative Economics),
**Elise Malvicini** (Mount Holyoke College, Environmental Studies)
Public Perceptions of the Mountain Valley Pipeline: A Content Analysis of Media Commentary
USDA REEU - CONFLUENCE OF WATER AND SOCIETY

10 **Meagan Todd** (Virginia Tech, Systems Biology)
Bioinformatic Analysis of Uncultivated Microbial Dark Matter: A Closer Look at Marinimicrobia
INDEPENDENT

# Poster Presentations Session 2 *(continued)*

1:00-2:00PM

11 **Maxwell Baum** (Virginia Tech, Mechanical Engineering)
Investigation of Biophysical Interactions in Microbial Communities
INDEPENDENT

12 **Maria Borjas** (University of Houston, Psychology)
Examining the Relationship Between Language Proficiency and Executive Function for Monolingual and Bilingual Children
MAOP

13 **Madison Bardot** (Virginia Tech, Chemistry)
Synthesis of Polymers with Pendant Adenine and Cytosine for Doxorubicin Sequestration during Chemotherapy Treatment
MAOP

14 **Maame-Owusua Boateng** (Northern Virginia Community College, Neuroscience)
An Antagonist Against a Retinoid X Receptor Reduces Neurogenesis in the Developing Tadpole Brain
VT-VCCS B2B

15 **Lazarus Arnau** (Virginia Tech, Physics)
Boundary Effects in Stochastic Cyclic Competition Models on a Two-Dimensional Lattice
ARMY EDUCATION OUTREACH PROGRAM UNDERGRADUATE RESEARCH APPRENTICESHIP PROGRAM

16 **Karen Huang** (Southwest Virginia Community College, Biochemistry)
Cloning and Expression of Fmr1 Functional Domains
VT-VCCS B2B

17 **Julian Mory** (Kennesaw State University, Chemistry)
The design of a flow cell reactor for investigating catalytic oxidation and chemical warfare agent breakthrough on high surface area materials
MAOP

18 **John Migliore** (Bethel University, Chemistry)
Synthesis and Characterization of Biologically-Sourced Polyureas for Controlled Ammonia Release
FOOD ENERGY WATER SSYSTEMS REU (FEWS)

19 **Jessica Voyack** (Virginia Tech, Psychology)
Greater Adaptive Functioning Impairment in Teens with Autism compared to Social Anxiety and Typically Developing Controls
INDEPENDENT

20 **James Alatis** (Virginia Tech, Chemistry)
Incorporation of Corrole and Porphyrin Based Ligands into Metal-Organic Frameworks
INDEPENDENT

# Poster Presentations Session 2 *(continued)*

1:00-2:00PM

21 **Jacob Kravits** (University of Massachusetts Amherst, Civil Engineering), **Alexa Bracale** (University of Delaware, Geological Sciences)
Close-Range Imagery for Quantifying Increased Turbidity in Small Appalachian Streams
USDA REEU - CONFLUENCE OF WATER AND SOCIETY

22 **Huy Ngo** (Virginia Tech, Fine Arts)
Photogrammetry Approach to Capturing the 3D Morphology of Bat Specimens
IRES: US-CHINA COLLABORATION: BATS AS MODEL ORGANISMS FOR BIOINSPIRED ENGINEERING

23 **Hope Geiger** (Southwest Virginia Community College, Engineering)
Characterization of Neutrophil Interactions with Nanoscale Bacteria-Enabled Drug Delivery System (NanoBEADS)
VT-VCCS B2B

24 **Hannah Comstock** (Virginia Tech, Creative Technologies)
Polygonal Models of Bat Specimens that are Scientifically Accurate as well as Aesthetically Pleasing
IRES: US-CHINA COLLABORATION: BATS AS MODEL ORGANISMS FOR BIOINSPIRED ENGINEERING

25 **Hannah Beard** (Virginia Tech, Animal and Poultry Science)
Global Characterization of Metabolic Responses by Dendritic Cells in Response to A. fumigatus viable Conidia
INFORMATION BIOLOGY SUMMER PROGRAM

26 **Freddie Xu** (Duke University, Biology)
Physalis angulata pollination after herbivory: the effects of herbivore damage on pollinator preference
MAOP

27 **Emily Smith** (Southwest Community College, Systems Biologyr)
Inducible Nitric Oxide Synthase is Needed for a Robust Defense Response Towards Aspergillus fumigatus
VT-VCCS B2B

28 **Emerald Greene** (Virginia Tech, Chemistry)
Atmospheric Stability of Zirconium Based Metal-Organic Frameworks
MAOP

29 **Dominic LoPinto** (Virginia Tech, Mechanical Engineering)
Automated Solutions to the Correspondence Problem in High-Speed Video Recordings of Bats
IRES: US-CHINA COLLABORATION: BATS AS MODEL ORGANISMS FOR BIOINSPIRED ENGINEERING

30 **Dillon Cutaiar** (Virginia Tech, Computer Science)
Shakespeare's Garden - Virtual Reality: An Immersive Virtual Sound Stroll
INDEPENDENT

# Poster Presentations Session 2 *(continued)*

1:00-2:00PM

31 **Desiree Velez** (Virginia Tech, Microbiology)
Gut Microbiota-Generated Trimethylamine N-oxide and Glucose Tolerance
TRANSLATIONAL OBESITY (TOUR)

32 **Dean Conte** (Virginia Tech, Mechanical Engineering)
Taking a Biomimetic Sonar System into the Habitats of Bats
IRES: US-CHINA COLLABORATION: BATS AS MODEL ORGANISMS FOR BIOINSPIRED ENGINEERING

33 **Darren Dougharty** (Virginia Tech, Biochemistry)
Aggregation of Tau Proteins in Alzheimer's Disease: I. Human Tau Isoforms
TRANSLATIONAL OBESITY (TOUR)

34 **Danielle Hugney** (Virginia Tech, Biomedical Sciences)
Forensic Microbiology: Can microbiome data be used to differentiate among individuals
INFORMATION BIOLOGY SUMMER PROGRAM

35 **Christopher Baires** (Northern Virginia Community College, Biomedical Engineering)
Interaction of Fluids on Solid Surfaces; in Traction of the Cleansing Effect of Bubbles
MAOP, VT-VCCS B2B

36 **Charles Ellis** (North Carolina State University, Mechanical Engineering)
A Comprehensive Study on the Effect of Acetaminophen in the Binding Fluid Versus the Powder in Powder Bed Jet Printing
FOOD ENERGY WATER SSYSTEMS REU (FEWS)

37 **Catherine Hayes** (Virginia Tech, Biochemistry)
Data Management and Feasibility of Validity Testing of the Market Basket Assessment Tool (MBAT)
TRANSLATIONAL OBESITY (TOUR)

38 **Caleb Ring** (Colorado School of Mines, Geological Engineering),
**Jessica Barthel** (Roanoke College, Environmental Science),
**Amir Barnett** (North Carolina A&T State University, Biological Engineering)
Pipeline Construction impacts on small mountain streams: evaluating stream geomorphology, water quality, and benthic macroinvertebrate diversity
USDA REEU - CONFLUENCE OF WATER AND SOCIETY

39 **Brittany Anderson** (Fayetteville State University, Biology)
Solubility in Clarithromycin enhancement by Amorphous Solid Dispersions with CCAB and PVP
FOOD ENERGY WATER SSYSTEMS REU (FEWS)

40 **Bridget Kastelberg** (Virginia Tech, Systems Biology)
Global Characterization of Immune Responses by Bone Marrow Derived Dendritic Cells in Response to A. fumigatus Viable Conidia
INFORMATION BIOLOGY SUMMER PROGRAM

# Poster Presentations Session 2 *(continued)*

1:00-2:00PM

41 **Brian Ratnasinghe** (Virginia Tech, Biochemistry)
Influence of Electronic Polarization on RNA and DNA G-quadruplex Structure and Dynamics
INDEPENDENT

42 **Brandi Thomas** (Virginia Tech, Microbiology)
Analyzing the Role of Pantoea stewartii subsp. stewartii Genes during in planta Growth via Reverse Genetics
VT-VCCS B2B

43 **Blake Sharp** (Virginia Tech, Computational Modeling and Data Analytics)
Building Social Media Backed Systems for Crisis-Informatics
BIOCOMPLEXITY REU

44 **Bhanu Chadalawada** (Virginia Tech, Biochemistry)
Optimal time to treat Non-metastatic melanoma
INFORMATION BIOLOGY SUMMER PROGRAM

45 **Avery Sebolt** (Virginia Tech, Aerospace Engineering)
Forward Motion Generation Using Standing Waves
INDEPENDENT

46 **Ann May** (Virginia Tech, Chemistry)
Host-Guest Encapsulation of Alkali Metals by Al-based Molecular Cage
MAOP

47 **Andrea Yu-Shan** (Virginia Tech, Psychology)
If I wanted to walk the walk, could I? Perceptions of access and availability of community resources while participating in a statewide walking program
TRANSLATIONAL OBESITY (TOUR)

48 **Ami Patel** (University of North Carolina-Charlotte, Chemistry)
Synthesizing Tapered (Cone-Shaped) Bottlebrush Polymers by Sequential Addition of Macromonomers
FOOD ENERGY WATER SYSTEMS REU (FEWS)

49 **Amanda Ward** (Virginia Tech, Biological Sciences)
Network Analysis of Co-expression in Cancer Genes
INDEPENDENT

50 **Alice Chen** (Virginia Tech, Computer Science)
Gene Co-Expression Network Analysis of Cancer Using Mice RNA-Seq
INDEPENDENT

# Poster Presentations Session 2 *(continued)*

1:00-2:00PM

51 **Alexandra Tucker** (New River Community College, Psychology)
Heart Rate Variability and Emotion Regulation in Middle Childhood
VT-VCCS B2B

52 **Abigail Workmeister** (Virginia Tech, Biochemistry)
Deregulation of circadian rhythms impacts cell cycle progression and tumorigenesis in vivo
INFORMATION BIOLOGY SUMMER PROGRAM

# Poster Presentations Session 3

2:15-3:15PM

1 **Alexander Varaksa** (Norfolk State, Biology)
Quantification of Fusarium verticillioides Transmission to Corn via Stink Bug Feeding using Species-specific, Real-time PCR
VT REEL/SURF (SECURING OUR FOOD)

2 **Ava Lakmazaheri** (Olin College, Mechanical Engineering), **Alex Moran** (Virginia Tech, Computer Engineering)
Cross-Robot Core Software Architecture for Real-Time Humanoid Control
INDEPENDENT

3 **Benjamin Heidebrecht** (Virginia Tech, Systems Biology)
Alleviation of parametric constraints in circadian timekeeping models through kinetic modification
INDEPENDENT

4 **Beulah Dadala** (University of California-Berkeley, Bioengineering)
Investigating Varied Response of Glioma Invasion to Changes in Cell Heterogeneity of Neural Tumor Microenvironments
BIOMECHANICS REU

5 **Cameron Bermand** (Virginia Tech, Environmental Science)
Soil Microbial Response to Integrated Plant Nutrition Systems during Production of Zea mays
FRALIN SURF

6 **Caroline Hickam** (Teacher: Radford High School, Earth & Space Science)
A Comparison of Anthropogenic Runoff Verses Physiographic Runoff and Their Effects on Insect Communities
WATER ECUBEG RET

7 **Casey Gregory** (Penn State, Biology)
Molecular and Physiological Responses to Nitrogen Stress in Seteria viridis and Sorghum bicolor
VT REEL/SURF (SECURING OUR FOOD)

8 **Cassandra Bush** (Norfolk State University, Biology)
Genome-Wide Association Study on Kunitz trypsin inhibitor in soybean seed and Supplemental Foliar Nutrients Effects on Fruit Quality and Yield of Two New Primocane Blackberry Cultivars
VT REEL/SURF (SECURING OUR FOOD)

9 **Catherine Twyman** (New River Community College, Engineering)
Something pH-ishy at LEWAS: Investigation of Sensor Accuracy and Possible Stream Pollutants
WATER ECUBEG RET

10 **Charlotte Brown** (Virginia Tech, Psychology)
Lower Parent-Child Agreement of Social Anxiety Symptoms in Teens with Autism versus Social Anxiety and Typically Developing Controls
INDEPENDENT

# Poster Presentations Session 3 *(continued)*

2:15-3:15PM

11 **Chase Mullins** (Virginia Tech, Microbiolgy)
Utilization of Reverse Genetics and Fungicide Sensitivity Assays to Study Pathogens of Two Agronomic Crops
VT REEL/SURF (SECURING OUR FOOD)

12 **Christopher Tan** (Virginia Tech, Biochemistry),
**Sid Madhavan** (Virginia Tech, Neuroscience)
Aggregation of Tau Proteins in Alzheimer's Disease: II. A Truncation Mutagenesis Approach
FRALIN SURF

13 **Connor Herron** (Virginia Tech, Mechanical Engineering)
3D Printed Robotic Arm based on Backwards Differential Two Axis Shoulder Joint
INDEPENDENT

14 **Dawn Hakkenberg** (Teacher: Patrick Henry High School, Mathematics)
Local Anaerobic Co-Digestion: A Feasibility Study
WATER ECUBEG RET

15 **Deirdre Conroy** (Virginia Tech, Wildlife Conservation)
An assessment on the influence of sustainable logging on jaguar density in Belize, Central America
FRALIN SURF

16 **Elle Cornman** (Virginia Tech, Clinical Neuroscience)
Microbes: Friend and Foe (Two separate experiments, one investigating the AAP1 amino acid transporter using yeast as a tool and the other the effect of nitrogen fertilizer on the growth and survival of escherichia coli on leafy greens)
VT REEL/SURF (SECURING OUR FOOD)

17 **Emily Reasor** (Virginia Tech, Wildlife Conservation)
Hormonal response of male tree swallows paired to females with experimentally manipulated sexual behavior
FRALIN SURF

18 **Emma Fralin** (Virginia Tech, Biology)
Temporal relationship of leptospirosis carriage in banded mongooses (Mungos mungo) in northern Botswana
FRALIN SURF

19 **Erod Keaton Baybay** (Virginia Tech, Physics)
An Enzymatic Tug of War: Deubiquitinating Enzymes Counteracting the Anaphase Promoting Complex
INDEPENDENT

20 **Ethan Winckler** (Virginia Tech, Biochemistry)
A Persulfide Releasing Prodrug Specific to Alkaline Phosphatase
FRALIN SURF

# Poster Presentations Session 3 *(continued)*

2:15-3:15PM

21 **Fiona Harris** (Virginia Tech, Biochemistry)
Characterization of the amino acid transporter AAP1
INDEPENDENT

22 **Gabryel Conley Natividad** (University of Idaho, Biological Engineering)
Invasion of GL261 Glioma Cells under Variable Flow Conditions in a Microfluidic Device
BIOMECHANICS REU

23 **Hannah Ridings** (Virginia Tech, Biochemistry)
Access to Collegiate Mental Healthcare Services: Virginia Tech
FRALIN SURF

24 **Hunter Aliff** (West Virginia State University, Chemistry)
VT-REEL Experience in Agricultural Sciences: Gene mapping of Soybeans and Biochemical Responses to Stress in Potato
VT REEL/SURF (SECURING OUR FOOD)

25 **Ira Moore** (Morehouse College, Applied Physics)
Relationship between landing trajectory and body position at impact
BIOMECHANICS REU

26 **James Benson** (Virginia Tech, Biology)
Analysis of Bacterial Abundance and Diversity in Freshwater Lake Systems based on Distance from Shore using a Small Unmanned Aircraft System
INDEPENDENT

27 **Jocelyn Brown** (Virginia Tech, Biology)
When SAM plays JAZ; a study of the interaction between parasitic plant and host
FRALIN SURF

28 **Katherine Vaughn** (Virginia Tech, Chemistry)
The effects of inhibiting estrogen synthesis on stress susceptibility in females
FRALIN SURF

29 **Katie Holcomb** (Teacher: Patrick Henry High School, Pe-AP Biology, Biology, Anatomy & Physiology
Does sediment pollution affect stream insect community structure?
WATER ECUBEG RET

30 **Kayla Airaghi** (Virginia Tech, Human Nutrition, Foods, and Exercise)
Assessment of Habitual Beverage Intake and Hydration Status in Collegiate Athletes
FRALIN SURF

# Poster Presentations Session 3 *(continued)*

2:15-3:15PM

31 **Kenrick Cameron JR** (Virginia Tech, Clinical Neuroscience)
Cdc48: The Unsung Hero of Anaphase
INDEPENDENT

32 **Lydia Ashburn** (North Carolina State University, Biomedical Engineering)
Splashing of Harmful Algal Blooms in Freshwater Systems
BIOMECHANICS REU

33 **Malia Bauder** (Oregon State University, Biochemistry and Molecular Biology)
Can We Create a Plant to Remove Excess Phosphate from Soil and Water?
VT REEL/SURF (SECURING OUR FOOD)

34 **Maria Sherman** (Teacher: Hidden Valley High School, AP Chemistry, College Bound Chemistry)
Energy Recovery from Wastewater Via Microbial Fuel Cell 3D Printed Platform
WATER ECUBEG RET

35 **Marieke van Haaren** (George Washington University, Biomedical Engineering)
Development of a methodology for strain gage array calibration and crosstalk compensation between axial force and anterior-posterior bending
BIOMECHANICS REU

36 **Mika Pagani** (Virginia Tech, Environmental Science)
Efficacy of Apritone Repellent Solution on Halyomorpha halys
INDEPENDENT

37 **Morgan Herrera** (Virginia Tech, Biological Systems Engineering)
The Development of a Murine Injury Model to Investigate the Effects of Eccentric Muscle Loading on Achilles Tendon Adaptations
BIOMECHANICS REU

38 **Nathanael Clark** (Virginia Tech, Biological Sciences)
Activity of Amino Acid Transport Protein Promoters in Arabidopsis During Infection with Hpa
INDEPENDENT

39 **Nathaniel Esteves** (Virginia Tech, Microbiology)
Investigation of factors influencing flagellotropic bacteriophage lysis patterns
FRALIN SURF

40 **Noah Wax** (Virginia Tech, Biological Sciences)
Decontamination of Raw Cucumbers using Microbubbles
FRALIN SURF

# Poster Presentations Session 3 *(continued)*

2:15-3:15PM

41 **Parker Broadnax** (Morehouse college, Mechanical Engineering)
Understanding how flying snakes land on a perch using physical modeling
BIOMECHANICS REU

42 **Philip Hancock, Alex Fuge** (Virginia Tech, Mechanical Engineering)
Design of a Six DOF 3D-Printable Leg for a Humanoid Robot
INDEPENDENT

43 **Russell Jeffery** (University of Central Arkansas, Applied Physics)
Autorotating Samara-Like Packages
BIOMECHANICS REU

44 **Sarah Rothstein** (Virginia Tech, Biochemistry)
Homologous Overexpression of an Unusual Thioredoxin from Clostridium acetobutylicum, a Solvent-producing Anaerobic Bacterium
FRALIN SURF

45 **Schuyler van Montfrans** (Teacher: Decatur High School, Physics and Chemistry),
Nutrient limitation and whole-ecosystem metabolism in a dynamic urban stream
WATER ECUBEG RET

46 **Shaunna Young** (Teacher: Roanoke City Public Schools, Earth Science)
Spatial and Temporal Drivers of Water Quality in Mountaintop Coal Mining Headwaters
WATER ECUBEG RET

47 **Steve Ahn** (Teacher: Holston High School, Biology, Environmental Science, Anatomy & Physiology)
A Study of Karst and Surface Water Nitrate Levels in Damascus, VA
WATER ECUBEG RET

48 **Timothy Bushman** (Virginia Tech, Microbiology)
Impact of the micronutrient selenoneine on the microbiome of rainbow trout (Oncorhynchus mykiss)
FRALIN SURF

49 **Troy Kaase** (Teacher: Franklin County High School, Biology and Physics)
Effect of Multiple Advanced Potable Water Reuse Treatment Barriers on Microbial Community Structure and the Occurrence of Antibiotic Resistance Genes
WATER ECUBEG RET

50 **Zahria Duncan** (Tuskegee University, Environmental Science)
Alfalfa Production Recommendations; Intertwining Sinorhiobium meliloti inoculation with Phosphorus Nutrient requirements provided by Poultry Litter Ash
VT REEL/SURF (SECURING OUR FOOD)

# Poster Presentations Session 3 *(continued)*

2:15-3:15PM

51 **Zeyu Yuan** (Virginia Tech, Biological Sciences)
The effect of plant growth promoting bacteria on Sinorhizobium meliloti and its host
INDEPENDENT

52 **Zoe Pelly** (Virginia Tech, Biochemistry)
Creating Dex-Inducible Arabidopsis to Analyze Split GFP Refolding and Ribosome Association
INDEPENDENT

# Abstracts

# *Astrophysics REU*

## PROGRAM COORDINATOR

Dr. Douglas Edmonds, Associate Professor of Physics; Penn State, Hazleton

## PROGRAM PARTICIPANTS

### Sean Collier

EMORY & HENRY COLLEGE, Mathematics
Faculty Mentor: Dr. Nahum Arav

### Sean Heston

VIRGINIA TECH, Physics
Faculty Mentor: Dr. Nahum Arav

### Emily Hill

EMORY & HENRY COLLEGE, Biology and Chemistry
Faculty Mentor: Dr. Douglas Edmonds

### Madison Jackson

EMORY & HENRY COLLEGE, Physics
Faculty Mentor: Dr. Douglas Edmonds

### Jake Pighini

EMORY & HENRY COLLEGE, Physics
Faculty Mentor: Dr. Nahum Arav

SEAN COLLIER
EMORY & HENRY COLLEGE / MATHEMATICS
SEAN HESTON
VIRGINIA TECH / PHYSICS
JAKE PIGHINI
EMORY & HENRY COLLEGE / PHYSICS

## Mining the Sloan Digital Sky Survey Database for Quasar Outflows with Possible Distance Indicators

The focus of our project is to identify outflows within quasar spectra from the Sloan Digital Sky Survey (SDSS) that exhibit key characteristics and warrant follow-up observations. Quasars are the most energetic objects in the universe and are connected with the supermassive black holes in the center of galaxies. These objects emit powerful outflows that influence the formation and evolution of the host galaxy. The research goal is to find outflows with specific characteristics that allow us to calculate number density and determine the distance of the outflow from the source, thus forming implications for quasar feedback. Currently, our project director Dr. Nahum Arav is looking for quasars with discernable S IV, N III and P V absorption troughs. These troughs are identified with software developed using the Interactive Data Language (IDL). The IDL software is used in conjunction with Java programs to find the velocity of the outflow relative to the quasar rest frame and its velocity spread. Moreover, it is used to check identifications of excited states and compare outflow troughs. Following our analysis, Dr. Arav then sorts through the proposed candidates to find viable follow-up targets. After mining through 2,187 objects in the SDSS database, we found 55 objects that justified a follow-up. With our total being 10,218 objects over a 1,000 hour period, we expect 245 to qualify as interesting. These may be added to proposals for observation time using larger telescopes such as the Hubble Space Telescope (HST) within the coming year.

**Mentors:** Dr. Nahum Arav (Virginia Tech, Physics), Douglas Edmonds (Penn State-Hazleton, Physics)

EMILY HILL
EMORY & HENRY COLLEGE / BIOLOGY AND CHEMISTRY

## The Distribution of Neutral Hydrogen in the Milky Way Galaxy

The Milky Way is a spiral galaxy composed of neutral hydrogen (HI) gas. Although the Milky Way's structure cannot be observed visually due to the Earth's location inside the galaxy, it can be represented by plotting blue-shifted and red-shifted neutral HI gas which is concentrated in four spiral arms. To locate HI in the galaxy, data was collected along the 21 cm hydrogen line using a small radio telescope (SRT) at Virginia Tech. In the laboratory, the 21 cm line occurs at a frequency of 1420.4 Mhz. Red-shifted gas moving away from the Sun displayed frequencies lower than the HI emission line while blue shifted displayed higher frequencies. These frequencies were then utilized to calculate the radial velocities of the gas. These calculations assumed that the orbital velocity of HI gas beyond the orbit of the Sun was equivalent to that of the Sun. This assumption was based on evidence from galactic rotation curve data (see poster by Madison Jackson et al.). The distance from the HI clumps to the Sun were then calculated utilizing trigonometric equations. This, along with the galactic longitude at which the data were taken, represented the galactic coordinates of the gas. When the HI gas was plotted, the data appeared to reveal spiral arms, indicating that the Milky Way is a spiral galaxy. These results were in general agreement with those determined previously by high-resolution data.

**Mentor:** Dr. Douglas Edmonds (Penn State, Physics)

MADISON JACKSON
EMORY & HENRY COLLEGE / PHYSICS

## Producing a Galactic Rotation Curve for the Milky Way Galaxy

A galactic rotation curve is used to graph the distance and velocity of intergalactic objects from the center of the galaxy. When plotted, the data resembles a curve that can be used to understand the relationship of velocity and mass in a galaxy. In this study, a galactic rotation curve was created for the Milky Way galaxy. The 21 cm Neutral Hydrogen Line is a fundamental instrument used in creating a rotation curve for the Milky Way. When neutral hydrogen's electron has an antiparallel spin the energy level is lower than the hydrogen with a parallel spin, causing radiation on the 21 cm line. This radiation was detected with a small radio telescope (SRT) at a frequency of 1420.42 MHz. The SRT took samples every two degrees from 20?¯- 260?¯ for a duration of 300 seconds then produced output files which could be analyzed using excel. The points 20?¯- 90?¯ were used for this rotation curve because the geometry of objects inside the orbit of the sun created right triangles. The remaining data was used later for mapping of the neutral hydrogen clouds throughout the galaxy. Trigonometric equations were applied to the triangles to calculate the distance of the hydrogen cloud from the galactic center. Then, by assessing the doppler shift of the cloud orbital velocity was calculated. The distance and orbital velocity were graphed to result in a low resolution galactic rotation curve.

**Mentor:** Douglas Edmonds (Penn State, Physics)

# *Biocomplexity Institute's Research Experience for Undergraduates (BREU) Program*

## PROGRAM DESCRIPTION

The Biocomplexity Institute's Research Experience for Undergraduates (BREU) prepares students for professional careers in science and technology fields through hands-on training opportunities. The in-depth training seeks to develop students across demographic areas and to foster innovation and collaboration with researchers and professionals. BREU will provide students with the opportunity to engage alongside cutting-edge research groups at the Institute, and thus engage in active learning at a level that classroom learning alone does not provide. By participating in hands-on research experiences, students will have the opportunity to contribute to creative problem solving; be involved in projects that elicit both engagement and intellectual curiosity; encourage innovation; reward success; and to transform both their curiosity and potential into academic achievement.

## PROGRAM COORDINATOR

Dr. Kristy Collins, Biocomplexity Institute

## PROGRAM PARTICIPANT

### Blake Sharp

VIRGINIA TECH, Computational Modeling & Data Analytics
Faculty Mentor: Dr. Anil Vullikanti

BLAKE SHARP
VIRGINIA TECH / COMPUTATIONAL MODELING AND DATA ANALYTICS

## Building Social Media Backed Systems for Crisis-Informatics

The area of crisis-informatics focuses on gathering accurate and actionable information, largely from on-line social media, for helping in disaster preparedness, response, and recovery. On-line social media has allowed the common masses to quickly and easily share information and opinions with the rest of the world. This frictionless and novel mode of communication has led to many social media users to share disaster related information in real time. However, due to the noisy, unstructured, and often unverifiable nature of content posted on on-line social media, a lot of crisis-informatics related research has focused on building systems that extract structured data from the social media platforms that can be easily summarized, comprehended, and verified. The current project also focuses on building information dashboards that extract structured data from on-line social media, primarily Twitter, and visualizing them. In particular, we intend to build systems for extracting and visualizing key disaster related information such as; for earthquakes: location of epicenter and regions damaged; for wildfires: spread of fire and regions damaged. Additionally, we would also like build event detection systems that for identifying events as they happen from social media posts. At this moment we have obtained high-dimensional vectors for each individual social media post including the content, time, and location of the tweet. Future steps will include filtering based on the topic, clustering these objects based on the event, and then investigating the centroids of these clusters, hoping to extract the event time, location, and description.

**Mentors:** Dr. Anil Vullikanti (Biocomplexity Institute at Virginia Tech, Computer Science), Parantapa Bhattacharya (Virginia Tech Biocomplexity Institute)

# *Biomechanics & Biological Transport REU Site*

## PROGRAM DESCRIPTION

This REU program is a nine-week summer research program for undergraduates interested in exploring research in biomechanics and biological transport that integrates fundamental biological processes in health, injury, and disease as well as fluid-based biological transport in the environment – from combined engineering and biological perspectives. Students are fully integrated into participating research groups and experience hands-on lab research, group meetings, and close collaboration with other members of related research groups. Students have the opportunity to perform basic research in multiple areas, including human health, injury, and disease; animal locomotion; plant diseases; biological transport in the environment; and bio-inspired technologies. In addition, career development components contribute to improving written and oral presentation skills.

## PROGRAM COORDINATOR

Amanda Covey, BEAM

## PROGRAM PARTICIPANTS

### Lydia Ashburn

NC STATE UNIVERSITY, Biomedical Engineering
Faculty Mentor: Dr. David Schmale

### Parker Broadnax

MOREHOUSE COLLEGE, Mechanical Engineering
Faculty Mentor: Dr. Jake Socha

### Gabryel Conley Natividad

UNIVERSITY OF IDAHO, Biological Engineering
Faculty Mentor: Dr. Jennifer Munson

### Beulah Dadala

UNIVERSITY OF CALIFORNIA-BERKELEY, Bioengineering
Faculty Mentor: Dr. Jennifer Munson

### Morgan Herrera

VIRGINIA TECH, Biological Systems Engineering
Faculty Mentor: Dr. Vincent Wang

### Russell Jeffery

UNIVERSITY OF CENTRAL ARKANSAS, Applied Physics
Faculty Mentor: Dr. Shane Ross

### Ira Moore

MOREHOUSE COLLEGE, Applied Physics
Faculty Mentor: Dr. Jake Socha

### Marieke van Haaren

GEORGE WASHINGTON UNIVERSITY, Biomedical Engineering
Faculty Mentor: Andrew Kemper

LYDIA ASHBURN
NORTH CAROLINA STATE UNIVERSITY / BIOMEDICAL ENGINEERING

## Splashing of Harmful Algal Blooms in Freshwater Systems

Harmful algal blooms (HABs) are of increasing public health concern in freshwater systems used for recreation, fishing, and drinking. Tools to track the spread of HABs are limited, in part due to a myriad of natural and industrial factors. We designed a high-speed camera system to record cultures of Anabaena (a surrogate HAB) spread following the impact of simulated raindrops. The high-speed camera was used to film drops of different sizes impacting clusters of algal cells, and the spread of satellite drops, as well as their velocities, were analyzed for each scenario. Our work will help to elucidate the spread of HABs in freshwater systems, with the aim of reducing their impact on human health in the surrounding areas.

**Mentors:** Dr. David Schmale (Virginia Tech, School of Plant and Environmental Sciences),
Dr. Sunny Jung (Virginia Tech, Department of Biomedical Engineering and Mechanics)

PARKER BROADNAX
MOREHOUSE COLLEGE / MECHANICAL ENGINEERING

## Understanding how flying snakes land on a perch using physical modeling

Flying snakes (Chrysopelea) are capable of executing complex landing maneuvers from great heights and speeds. They land without the mechanisms used by other flying animals (e.g., grasping with feet) and instead use their rope-like bodies to crash land onto their target substrate. Despite the potential for injury, their landings succeed without any observable bodily harm. What properties of the landing are due to active muscular activation by the snake, and which result from the passive properties of the flexible body? To address this question, we are probing the passive properties of a falling flexible object. Specifically, we dropped ropes (length, 1 m) onto a pvc pipe using a landing simulator to test for passive capture success. We varied the rope diameter and the height from which it was dropped, and varied the position at which the rope lands on the bar by 5 cm increments. This simulation will shed light on how the flying snakes' unique morphology affects their landing success.

**Mentors:** Dr. Jake Socha (Virginia Tech, Biomedical Engineering and Mechanics),
Hojat Pendar

GABRYEL CONLEY NATIVIDAD
UNIVERSITY OF IDAHO / BIOLOGICAL ENGINEERING

## Invasion of GL261 Glioma Cells under Variable Flow Conditions in a Microfluidic Device

Cancer affects over 15 million people each year and while in the past decade the survival rate for many cancer types has dramatically increased, brain cancers, specifically glioblastoma has remained relatively low, around 8%. One reason for this is their ability to invade into the surrounding brain. Glioblastoma cells have been shown to invade more when flow is applied than when they are cultured under static conditions. However, flow in the brain is variable and ever-present, not simply on or off. Understanding how different fluid flow rates affect the movement of Gl261 cells, can lead to a better understanding of how these cells invade into the brain. Using a microfluidic device, we incorporated hyaluronic acid gels seeded with Gl261 cells. We applied a variety flow rates which were measured using fluorescent recovery after photobleaching techniques to precisely determine the average interstitial flow velocity. Using live imaging wide field microscopy, we observed cellular migration within the gel over a 24 hour period. We also developed tracking software to track the cells over time and determine their migration parameters.

**Mentor:** Dr. Jennifer Munson (Virginia Tech, Biomedical Engineering and Mechanics)

BEULAH DADALA
UNIVERSITY OF CALIFORNIA, BERKELEY / BIOENGINEERING

## Investigating Varied Response of Glioma Invasion to Changes in Cell Heterogeneity of Neural Tumor Microenvironments

With 23,880 people diagnosed annually and 16,830 resultant deaths in the US alone, Glioma is an aggressive cancer about which little of its interactions with neighboring cells is known. Currently, treatment plans include rigorous rounds of both chemotherapy and radiation but show little efficacy in staving off tumor recurrence. Part of this treatment inefficacy is a result of poor characterization of the glioma Tumor Microenvironment (TME) and how it influences drug response and invasion. Knowing more about how TMEs differ between patients and how varied cell heterogeneity impacts therapeutic response would aid in creating better informed treatment plans that would optimize the mitigation of glioblastoma stemness, unchecked proliferation, and metastasis. Using a 3D multicellular Static/Flow Assay to optimize both ease of experimentation and accuracy to in vivo conditions, we focused on the two cell types that have been shown to most heavily influence glioma invasion, astrocytes and microglia, and seed them in hyaluronic acid gels to better replicate in vivo conditions. From there, we applied flow to the cell-seeded gels, then tracked cumulative and cell type specific invasion to look for differences in invasion depending on the cell types present. We imaged the membranes that the gels were cast atop of to track invasion as well as the gels on an inverted fluorescent microscope and confocal microscope respectively. To quantify cell invasion, we used ImageJ's cell counting features. This project's results can aid future studies on chemotherapeutic delivery and efficacy to help build treatment plans specific to a patient's TME and cell type populations.

**Mentors:** Dr. Jennifer Munson (Virginia Tech, Biomedical Engineering and Mechanics), Dr. Chase Cornelison (Virginia Tech, Biomedical Engineering and Mechanics)

MORGAN HERRERA
VIRGINIA TECH / BIOLOGICAL SYSTEMS ENGINEERING

## The Development of a Murine Injury Model to Investigate the Effects of Eccentric Muscle Loading on Achilles Tendon Adaptations

Rehabilitative exercise, specifically eccentric loading (e.g, heel drop exercise) to lengthen the muscle-tendon unit, is currently the most effective therapy for treating chronic Achilles tendon injuries. While mechanical loading shows efficacy in treating symptomatic tendinopathy, the mechanisms underlying the presumed healing process remain unclear. Therefore, our lab seeks to develop a pre-clinical (in vivo animal) model to systematically examine changes in muscle/tendon properties following eccentric loading.
In this initial study, a heel drop exercise (common in human treatment) was performed on uninjured 12-week male mice over a 3-week period. Heel drop exercises on the right limb were achieved using a Dual Mode Muscle Lever System (Aurora Scientific, Ontario) capable of controlling the ankle joint range of motion (+18?¯). The gastrocnemius complex was stimulated by an electrode inserted into the plantar flexors. The heel drop exercise was performed twice per week over a 3-week period. At the conclusion of the in vivo loading protocol, mice were sacrificed, and Achilles tendons prepared for either ex vivo tensile biomechanical testing.
Mice tolerated the loading protocols well and exhibited no signs of limb weakness or pain. Eccentrically loaded Achilles tendons showed no significant differences in their biomechanical properties relative to either the contralateral limb or the sham group.
DISCUSSION The novel model and protocol developed herein forms an important experimental foundation for investigating musculotendinous responses to eccentric loading following induction of a tendon injury.

**Mentors:** Vincent Wang (Virginia Tech, Biomedical Engineering and Mechanics), Sabah Rezvani (Virginia Tech, Biomedical Engineering and Mechanics)

RUSSELL JEFFERY
UNIVERSITY OF CENTRAL ARKANSAS / APPLIED PHYSICS

## Autorotating Samara-Like Packages

Samaras are seeds with one or more wings. Generally the function of the wing is to generate lift which increases the time it takes for the seeds to fall from the tree to the ground, thus allowing them to be spread farther by the wind than non-samaras (Planchuelo et al., 2016). The samaras with the best performance are maple seeds, which automatically enter an auto-rotation mode (spin) as they fall. Samara designs are of interest because (1) they slow their descent passively--there are no moving parts--so they are very robust against failure and (2) they tend to carry much more weight per unit of wing area than standard airfoils designed for aircraft (Lentink et al., 2009). As such, understanding the mechanisms by which samaras generate lift, and thereby slow their descent, has many potential applications in several industries. Natural autorotating samaras are typically in the 3 to 7 centimeter and 0.1 g mass scale, with descent speeds of around 1 m/s. In this project, the goal was to explore the possibility of designing a scaled-up version of a samara, on a scale of 50 cm and 300 g, to slow the descent of a small payload to speeds close to those of natural samaras. Data was collected using a small, onboard computer, a GPS unit, and a barometric altimeter. This platform could be developed for applications such as package delivery or meteorological studies, or it could be used as a research tool for further study.

**Mentor:** Dr. Shane Ross (Virginia Tech, Biomedical Engineering and Mechanics)

IRA MOORE
MOREHOUSE COLLEGE / APPLIED PHYSICS

## Relationship between landing trajectory and body position at impact

How birds land on a perch has been investigated previously, but how they land on water has not. To investigate this question we are examining the landing behavior of mallard ducks (Anas platyrhynchos). Previous work has shown that mallards land at a variety of velocities and trajectory angles, but it is unclear if the body position at impact stays the same or changes relative to velocity or trajectory angle. To examine this question, we are using 3-dimensional photogrammetric techniques in the field in Blacksburg, VA. Two different camera arrays are used to collect information on the full trajectories and body position at the point of impact. Three GoPro cameras recording at 4k resolution and 30 fps record the full trajectories. A NIkon D850 filming at 1080p resolution and 120 fps with mirrors form a rotational stereo videography( RSV) array to record the body position. Both camera arrays are calibrated using wand calibrations and the resulting videos are manually digitized using Argus 3D tracking software. Using these data, we measured change in body position and foot placement of mallards as they land on water and compared it with the velocity and angle of the full trajectory. Preliminary results suggest that landing mallards use a stereotyped impact position that extends head and neck so the bill is at a 120-110?¯ angle to the tail of the bird.

**Mentors:** Jake Socha (Virginia Tech, Biomechanics), John Whitehead (Virginia Tech, Biology)

MARIEKE VAN HAAREN
GEORGE WASHINGTON UNIVERSITY / BIOMEDICAL ENGINEERING

## Development of a methodology for strain gage array calibration and crosstalk compensation between axial force and anterior-posterior bending

In frontal motor vehicle collisions, the lower extremity is the most frequently injured region. While previous researchers have attempted to measure femur and tibia forces by implanting load cells in post-mortem human surrogates (PMHSs), this approach is invasive and could alter the responses of the lower extremity. In a prior study, the femurs of eight PMHSs were instrumented with strain gage arrays (SGAs) wired in Wheatstone bridge configurations to measure axial force and anterior-posterior (A-P) bending moment. Frontal sled tests were then performed using the eight PMHSs, the Hybrid III, and the THOR-M under three restraint conditions. However, the outputs of the SGAs require calibration factors, i.e. sensitivities, and crosstalk compensation matrices to validate the results, and make direct comparisons to the load cells in the dummies. Therefore, the purpose of this study was to develop a new procedure for calibrating the SGAs and compensating for crosstalk. To accomplish this, the femurs were removed from the previously tested PMHSs. The mid-diaphysis was aligned with the center of proximal and distal circular aluminum cups, with the use of two laser line levels, and then fixed to the cups with potting compound. The femurs were then loaded in pure bending and pure compression using two experimental setups. The outputs of the force and A-P moment SGAs were recorded in conjunction with the forces and moments from a three-axis load cell. These data were used to develop force sensitivities, moment sensitivities, and crosstalk compensation matrices for the axial force and A-P moment SGAs.

**Mentor:** Andrew Kemper (Virginia Tech, Biomedical Engineering and Mechanics)

# *Fralin Summer Undergraduate Research Fellowship (Fralin SURF)*

## PROGRAM DESCRIPTION

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

## PROGRAM COORDINATOR

Keri Swaby, Coordinator of the Office of Undergraduate Research

## PROGRAM PARTICIPANTS

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### Deirdre Conroy
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# *Fralin Summer Undergraduate Research Fellowship (Fralin SURF)*

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Faculty Mentor: John Matson

KAYLA AIRAGHI
VIRGINIA TECH / HUMAN NUTRITION, FOODS, AND EXERCISE

## Assessment of Habitual Beverage Intake and Hydration Status in Collegiate Athletes

To investigate the validity of the BEVQ-15 in assessing habitual beverage intake in Division 1 (D1) collegiate athletes and to validate urine color (UC) as a hydration biomarker in D1 collegiate athletes Division 1 athletes undergo an immense amount of stress juggling their sport, academic work, and overall health, while being held to high performance expectations. Dehydrated athletes experience increased perceived exertion and gastrointestinal temperature, along with decreased vigilance attention. Therefore, D1 athletes must have dietary and fluid intake habits to prevent dehydration and support optimal athletic performance, recovery, and health. D1 collegiate athletes (n= 72, 56% female, aged 18-23, body mass index; BMI= 23 ?Ò 2 kg/m2) from Virginia Tech and Radford University participated in three study sessions. Visit 1 included completion of a health/demographic questionnaire, a 24-hr dietary recall, the BEVQ-15 and a urine sample within 30 minutes of exercise. Visit 2 only included a 24-hr recall. Visit 3 was the same as visit 1, excluding the health/demographic questionnaire. Urine Specific gravity (USG) was measured using a refractometer, and urine color was assessed using a urine color chart. The mean USG was 1.016 ?Ò .0074 signifying that most athletes were dehydrated. Males consumed more fluid ounces total (138 ?Ò 26) than females (103 ?Ò 6) and also had a higher intake of sugar sweetened beverages (SSB), resulting in a higher amount of total calories coming from fluids. Total beverage intake (fl. oz. and kcals) were significantly associated (r=.36-.42, p < 0.01) supporting the validity of the BEVQ-15.

**Mentor:** Dr. Brenda Davy (Virginia Tech, Human Nutrition, Foods, and Exercise)

CAMERON BERMAND
VIRGINIA TECH / ENVIRONMENTAL SCIENCE

## Soil Microbial Response to Integrated Plant Nutrition Systems during Production of Zea mays

Overburdening agricultural practices have had detrimental effects to the health and fertility of cultivated soils. Integrated nutrient management systems attempt to address this problem by using fertilization with synthetic, organic, and biological nutrient sources to enhance crop production and diversify nutrient inputs in conventional agriculture. The rationale is that agroecosystems can be made more sustainable and resilient by reducing the demand for any one nutrient source. Within these systems, organic and bio-fertilizers have been identified as alternatives to synthetic products. Organic compounds and the diverse microorganisms that colonize these products can be important contributors to soil health. Direct measurements of changes in soil microorganisms following applications of these products are limited, but understanding the role of microorganisms in soil health is necessary to be able to promote sustainable crop production. The goal of this project was to evaluate soil microbial responses to the use of various nutrient management systems applied during production of Zea mays. The work was conducted at Kentland Farm in Blacksburg, VA and at Cloverfield Farm in Tappahannock, VA, two sites that represent differences in climate, geology, and soil type. Twelve fertilization treatments included the integration of synthetic fertilizers with organic fertilizers, bio-fertilizers, or each in unison. Microbial biomass was measured via substrate induced respiration, which serves as a general indicator of active microbial biomass. Following a single growing season, no significant differences across treatments were detected in the field trials. In future research, however, more specific metabolic shifts within the soil microbial community in response to fertilizer inputs will be measured using catabolic response profiling.

**Mentor:** Dr Brian Badgley (Virginia Tech, Crop Soil and Environmental Science)

JOCELYN BROWN
VIRGINIA TECH / BIOLOGY

## When SAM plays JAZ; a study of the interaction between parasitic plant and host

Mobile mRNAs move throughout a plant to perform a role independent of its cell of origin, and some have been found to move between the parasitic plant Cuscuta campestris and its hosts such as Arabidopsis thaliana. Our lab has found high expression of certain mobile mRNAs in the host-parasite interaction, leading to the hypothesis that both parasite and host use mobile mRNAs to manipulate the defense processes of the opposing plant. The goal of my research is to overexpress mobile Cuscuta and Arabidopsis mRNAs in Arabidopsis to analyze how they impact host development and defense response to Cuscuta attachment. Two genes that we selected for detailed study are A. thaliana Jasmonate-Zim-Domain Protein 1 (AtJAZ1) and C. campestris S-adenosylmethionine synthetase (CcSAMs). AtJAZ1 has a tRNA-like structure that can allow for greater movement of the mRNA, and encodes a protein that is involved in plant defense regulation. CcSAMs was found to be highly expressed in the interface region connecting the parasite and host and the mRNA showed a high transfer rate into the host. To date I have cloned these genes and generated transgenic Arabidopsis plants overexpressing AtJAZ1 and CcSAMs using Agrobacterium-mediated transformation. T1 Arabidopsis plants overexpressing AtJAZ1 and T0 Arabidopsis plants overexpressing CcSAMs have been grown for selection and phenotyping. The ultimate purpose of the study is to better understand the role of mobile mRNAs in interactions between Cuscuta and its hosts in order to help reduce crop losses due to Cuscuta.

**Mentors:** Dr. Jim Westwood (Virginia Tech, School of Plant and Environmental Sciences), Dr. Soyon Park (Virginia Tech, School of Plant and Environmental Sciences)

TIMOTHY BUSHMAN
VIRGINIA TECH / MICROBIOLOGY

## Impact of the micronutrient selenoneine on the microbiome of rainbow trout (Oncorhynchus mykiss)

**Mentors:** Ann M. Stevens (Virginia Tech, Microbiology), David D. Kuhn (Virginia Tech, Department of Food Science and Technology)

DEIRDRE CONROY
VIRGINIA TECH / WILDLIFE CONSERVATION

## An assessment on the influence of sustainable logging on jaguar density in Belize, Central America

A large majority of potential habitat for wild cats in Central America is being used for production forests with timber extraction and these forests may have much to offer wildlife. This makes it vitally important to understand the impact of human activities such as logging on top predator conservation. While sustainability from the perspective of continued timber harvest has been studied extensively, research on sustainability from a wildlife perspective is lacking. My overall research goal was to determine the impacts of sustainable logging on the density of jaguars across a rainforest landscape of Belize using remotely-triggered camera techniques. My research component fits into a comprehensive project on logging impacts on overall tropical biodiversity. Cameras (30-40 per site) were systematically spaced at 2-3km intervals across 4 study sites exhibiting a gradient from completely unlogged to sustainably logged forests, and varying human usage including a small cattle ranch and coffee plantation. After collecting data for 6 weeks in-country, I used past project data to estimate wildcat densities to compare across sites. I have used knowledge gained from coursework on mark-recapture estimation to build capture histories for jaguars since individuals can be identified by unique spot patterns in photographs. I have learned newer spatially explicit mark-recapture methods to estimate jaguar density in logged vs. unlogged sites. Preliminary results indicate that sustainable logging may be compatible with predator conservation. The knowledge gained in this study will be used to inform management objectives for conserving jaguars and overall tropical rainforest biodiversity.

**Mentor:** Dr. Marcella Kelly (Virginia Tech, Fish and Wildlife Conservation)

NATHANIEL ESTEVES
VIRGINIA TECH / MICROBIOLOGY

## Investigation of factors influencing flagellotropic bacteriophage lysis patterns

Bacteriophages, viruses that attack bacteria, are found in many different niches including human intestinal flora. Bacteriophages have varying degrees of specificity. Flagellotropic bacteriophages are phages that infect only motile bacteria and do so by binding to rotating flagellar filaments. In this study, we used phage drop assays to investigate factors influencing the pattern of phage-mediated bacterial lysis. The low agar concentration in swim plates allows for the formation of a swim ring, corresponding to motile bacteria swimming through the medium. For each experiment, Salmonella enterica subsp. enterica serovar Typhimurium strain 14028s bacteria were inoculated with flagellotropic bacteriophage ?? on swim plates. Various factors hypothesized to impact the lysis pattern were altered in separate trials. It was determined that virus titer, nutrient concentration, multiplicity of infection, configuration of phage inoculation, and deletions of bacterial chemoreceptor genes all play a role in determining the pattern of lysis. These results help elucidate the poorly understood dispersal mechanism of bacteriophage viruses in various microbiological environments.

**Mentor:** Dr. Birgit Scharf (Virginia Tech, Biological Sciences)

EMMA FRALIN
VIRGINIA TECH / BIOLOGY

## Temporal relationship of leptospirosis carriage in banded mongooses (Mungos mungo) in northern Botswana

Leptospira interrogans is a pathogenic spirochete that causes the zoonotic disease, leptospirosis. The disease has been isolated from many animals, wild and domestic, and is often considered to be a reservoir in peridomestic rodents. If untreated, leptospirosis can induce renal failure due to concentration in the kidneys, and subsequently cause fatality. In Kasane, Botswana, leptospirosis has been identified in banded mongoose, but only in determining presence as opposed to a temporal relationship between troupes. The objective of this study was to understand the transmission dynamics of leptospirosis by collecting urine from free-living, habituated banded mongooses along with kidneys from deceased banded mongoose and screening these samples for the presence of leptospirosis using polymerase chain reaction (PCR). Additionally, a protocol to culture L. interrogans from urine and kidney samples of infected banded mongooses for subsequent genetic analyses was created. 27 samples were screened for L. interrogans ranging over the previous 2 years, and were all negative for leptospirosis. In a previous study conducted in 2012 by Dr. Kathleen Alexander, 41% of kidney samples tested positive for leptospirosis. These temporal dynamics suggest that pathogen transmission and troupe susceptibility have changed over the past six years. While these results are small in comparison to the total population of mongoose residing in Kasane, conclusions are important in determining public health susceptibility and further studies should be conducted. In addition, six samples were allocated for culturing in preparation for creating a culture protocol using EMJH media.

**Mentor:** Dr. Kathleen Alexander (Virginia Tech, Fish and Wildlife Conservation)

EMILY REASOR
VIRGINIA TECH / WILDLIFE CONSERVATION

## Hormonal response of male tree swallows paired to females with experimentally manipulated sexual behavior

Levels of testosterone, the main male sex hormone in vertebrates, are known to change in response to male-male conflicts (e.g., fighting over a resource or mate). However, there is little research looking into how male testosterone levels change in response to female sexual receptivity. To test male responsiveness to female sexual receptivity, we manipulated female sexual behavior and measured the partnered male's hormonal responses. Female tree swallows (Tachycineta bicolor) were implanted with either androstatrienedione (ATD), estradiol (E2), or a blank implant to artificially manipulate their sexual behavior (e.g., solicitations, copulations) during the breeding season; another group of females were not implanted. Blank and non-implanted females served as controls; meanwhile, we predicted that ATD implants would lower and E2 implants would increase female sexual behavior. These implanted females were later identified when nesting at the field site. Blood from breeding male tree swallows socially paired with an implanted female was drawn at the field site. Plasma testosterone levels were later quantified through radioimmunoassay (RIA) in the lab. A Kruskal-Wallis test was used to statistically compare the testosterone levels of experimental groups. Overall, there was no statistical difference between the experimental groups. Given the data we collected, it does not appear that manipulated hormonal levels in females leads to differences in partnered male testosterone levels. However, future studies with larger sample sizes might lead us to more definitive results.

**Mentors:** Ignacio Moore (Virginia Tech, Biological Sciences), Jessica Hernandez (Virginia Tech, Biological Sciences)

SARAH ROTHSTEIN
VIRGINIA TECH / BIOCHEMISTRY

## Homologous Overexpression of an Unusual Thioredoxin from Clostridium acetobutylicum, a Solvent-producing Anaerobic Bacterium

Clostridium acetobutylicum (Ca), an obligate anaerobe, is an industrially important bacterium. It produces the gasoline-additive butanol and ethanol, as well as acetone during the second step of its biphasic growth. The solventogenesis process is thought to be regulated by thioredoxin (Trx) which maintains cellular redox homeostasis. Trx is a small redox protein that reduces disulfide bonds in target proteins via its Cys-X-X-Cys active site (X, a variable amino acid residue) changing their biochemical activities and physical properties. Trx is oxidized in this process and reduced Trx is regenerated by Trx Reductase (TrxR) with NADPH or ferredoxin. Ca carries two pairs of Trx and TrxR: Trx1-TrxR1 and Trx2-TrxR2, and in addition carries Trx3, and TrxR3. Trx3 is of our interest as it contains a non-canonical active site motif, Ser-X-X-Cys. Our goal is to determine the effect of Trx3's unique active site on its disulfide reductase activity, and if it is reduced by TrxR3. Accordingly, Trx3 is being overexpressed and characterized. Our results showed that heterologous overexpression in E. coli generated Trx3 in inclusion bodies. For this reason, we are attempting to overexpress Trx3 in Ca. We have constructed an E. coli-Ca shuttle vector carrying trx3 under the control of a Ca hydrogenase promoter (PhydA) which is strong and induced during early acidogenic growth phase. The plasmid was transformed into Ca and the resulting strain was analyzed for the overproduction of Trx3. Then, Trx3 will be purified and characterized for its disulfide reductase activity and redox properties.

**Mentor:** Biswarup Mukhopadhyay (Virginia Tech, Biochemistry)

CHRISTOPHER TAN
VIRGINIA TECH / BIOCHEMISTRY
SID MADHAVAN
VIRGINIA TECH / NEUROSCIENCE

## Aggregation of Tau Proteins in Alzheimer's Disease: II. A Truncation Mutagenesis Approach

Alzheimer's disease is the most common type of dementia that interferes with one's memory and behavior. It is a neurodegenerative disorder caused by the toxicity of insoluble aggregated proteins in the brain and is currently absent of a cure. One of the most prominent proteins contributing to cytotoxicity in the brain is the human tau protein. There are six isoforms of tau with the largest being tau 2N4R, genetically consisting of two insert segments in the N-terminal (2N) and four repeat regions in the C-terminal (4R). This project serves to highlight the importance of the repeat region, specifically the R2 region, for the aggregation and toxicity of amyloidogenic tau. Different mutants of 2N4R tau each with deletions of regions in the N-terminal or C-terminal were cloned and then the recombinant proteins were expressed and purified using molecular biology and biochemical techniques. The rate of aggregation of the different mutants were then analyzed using ThT fluorescence based assays and compared to highlight the effects of specific regions on tau aggregation. Consistent with the aggregation kinetics results of human tau isoforms, our truncation mutagenesis results showed that the R2 region is essential for the rapid aggregation of 2N4R tau as the mutants lacking the R2 region failed to aggregate. Our work may contribute to the understanding of the importance of specific regions of human tau proteins and to the future development of tau amyloid inhibitors that target these regions. Tackling the toxic aggregation of amyloids can ultimately lead to a cure for Alzheimer's and other neurodegenerative diseases of the brain.

**Mentor:** Bin Xu (Virginia Tech, Biochemistry)

KATHERINE VAUGHN
VIRGINIA TECH / CHEMISTRY

## The effects of inhibiting estrogen synthesis on stress susceptibility in females

Women are twice as likely to be diagnosed with mood disorder compared to men. The first episode of depression usually occurs during puberty. We used a 6-day variable stress paradigm, which induces depression- and anxiety-like behaviors in the female mice but not males. We examined whether estrogen synthesis was necessary for the behavior expressed by females. We hypothesized that blocking estrogen synthesis during puberty would stop the onset of stress related behavior. Female C57BL/6J mice (n= 40) were given Letrozole, an aromatase inhibitor, or vehicle in the drinking water, starting at 4 weeks of age to block the aromatization of estrogens. All mice were single housed throughout the experiment to measure Letrozole intake. After 2.5 weeks of treatment, mice were given 6 days of variable stress This was immediately followed by three behavioral tests; splash test, novelty suppressed feeding (NSF), forced swim test (FST). The effectiveness of letrozole treatment was confirmed by an increase in body weight, and a decrease in uterine weight in treated animals. No effect of stress in the vehicle or letrozole groups in the splash test or FST was observed, which appears to be due to unusually high baseline levels of stress in the control animals. The results from NSF, an anxiety associated test, showed susceptibility to stress among the vehicle groups, however, the effect was lost in the letrozole group. These data suggest that estrogen may contribute to anxiety-associated behavior in female mice, and that reducing estrogen levels may increase resilience.

**Mentor:** Dr. Georgia Hodes (Virginia Tech, School of Neuroscience)

NOAH WAX
VIRGINIA TECH / BIOLOGICAL SCIENCES

## Decontamination of Raw Cucumbers using Microbubbles

Raw produce can often be contaminated with pathogens such as Salmonella during harvesting, packaging or transport. Contaminated produce can pose a greater risk of causing foodborne illness if not properly decontaminated due to these foods being consumed raw. A cavitation process was studied to determine the efficacy of microbubbles at reducing the amount of Salmonella on the surface of raw cucumbers.

Cucumbers were inoculated with Salmonella Newport and exposed to microbubbles (1 or 3 mm) with an air flow of 0, 7 or 14 liters per minute (LPM)) for either 30 or 120 seconds. After treatment, rinse samples were taken from the cucumber and the treatment tank water and plated onto XLT4 agar and allowed to incubate for 24 hours before being counted. Cucumbers treated with microbubbles at 14 LPM showed the greatest reduction in Salmonella regardless of bubble size (either 1 or 3 mm) with a log reduction of 3.4 and 3.34 CFU/cucumber, respectively. Cucumbers treated with water alone showed the greatest recovery of Salmonella from the tank water (mean log 6.7 CFU/tank). Recovery of Salmonella from cucumbers and water represented a 0.96 log reduction in bacteria from the inocula. This suggests that the bubbles not only remove Salmonella from cucumbers but also inactivate the bacteria thus preventing their recovery from the water.

While further testing is needed, microbubbles appear to be a viable decontamination method for produce as it can be scaled up and requires no harsh chemicals that could alter the texture or flavor of the produce.

**Mentor:** Dr. Joe Eifert (Virginia Tech, Food Science and Technology)

ETHAN WINCKLER
VIRGINIA TECH / BIOCHEMISTRY

## A Persulfide Releasing Prodrug Specific to Alkaline Phosphatase

**Mentor:** John Matson (Virginia Tech, Chemistry)

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JAMES ALATIS
VIRGINIA TECH / CHEMISTRY

## Incorporation of Corrole and Porphyrin Based Ligands into Metal-Organic Frameworks

Metal-organic frameworks (MOFs) are multidimensional structures comprised of metal nodes connected by organic ligands forming highly ordered multidimensional arrays. These materials were investigated for a wide variety of applications including electrocatalysis and solar cell, among others. Corrole is a nitrogen based macrocycle that is known to form complexes with a variety of metals, and has intrinsic catalytic properties that are dependent on the metal center and the substituents around the corrole core.1 The goal of this study is to design and synthesize a Zr based MOF using either porphyrin or corrole based ligands to generate novel MOF structures and test their properties. Of particular interest is electrocatalytic activity of corroles towards oxygen and carbon dioxide reduction, as well as water oxidation. First, the corrole functionalized with benzoate groups capable of coordinating to Zr was synthesized using a standard condensation reaction between pyrrole and an aldehyde and its purity confirmed by 1H NMR spectroscopy and mass spectrometry. In the next step, a synthesis of MOFs was attempted using the free base ligand, and its linear analogue from which several powders were obtained. Powder X-ray diffraction (PXRD) analysis revealed that these powders had poor crystallinity and therefore their structure could not be determined at this stage. Known porphyrin MOFs were synthesized using a variety of modulators. The crystallinity of these MOFs was confirmed using PXRD.

Future work includes further optimization of the MOF synthesis with the goal of obtaining crystalline materials that could be used for structure elucidation. Testing the electrocatalytic and light absorption capability of porphyrin based MOFs and how they differ depending on which modulator is used is also of interest. Furthermore, different metals will be incorporated inside the corrole core which will then be used to synthesize electrocatalytically active MOFs.

**Mentor:** Amanda Morris (Virginia Tech, Chemistry)

HARRISON ANDREW
NEW COLLEGE OF FLORIDA / PHYSICS

## Two Temperature KLS Systems With Transverse Interface

We employ Monte Carlo computer simulations to study the critical dynamics of a combination of two driven diffusive systems held at different temperatures, with the goal to further advance the fundamental theoretical understanding of systems driven far away from thermal equilibrium. Specifically, we explore a spatially inhomogeneous Katz-Lebowitz-Spohn (KLS) lattice gas subject to nearest-neighbor attractive interactions. As its equilibrium counterpart, the Ising model, it has a continuous transition in two dimensions at a critical temperature that separates a disordered configuration from a phase-ordered state. Its universal dynamic behavior is governed by exactly known critical exponents. In the disordered phase at higher temperatures, the KLS model displays generic scale invariance, with the dynamic scaling exponents of the (Totally) Asymmetric Exclusion Process or (T)ASEP, for which biased hopping along one spatial direction sets up a non-equilibrium steady state with non-zero particle current. We construct a system with periodic boundary conditions where one region is held at the critical temperature, while the other one is defined by hopping rates set by higher temperatures, with the domain boundary oriented perpendicular to the drive. Our simulations show that in the steady state, the particle flux becomes constant across the entire system; while a characteristic stationary sharp density shock emerges in the TASEP domain, its reach into the KLS domain is governed by slow power law decay. We describe these spatial profiles quantitatively and discuss their dependence on the temperature difference in both regions.

**Mentor:** Uwe Tauber (Virginia Tech, Physics)

LAZARUS ARNAU
VIRGINIA TECH / PHYSICS

## Boundary Effects in Stochastic Cyclic Competition Models on a Two-Dimensional Lattice

We study noise-induced and -stabilized spatial patterns in two distinct stochastic population model variants for cyclic competition of three species, namely the Rock-Paper-Scissors (RPS) and the May-Leonard (ML) models. In two dimensions, it is well established that the ML model can display (quasi-)stable spiral structures, in contrast to simple species clustering in the RPS system. Our ultimate goal is to impose control over such competing structures in systems where both RPS and ML reactions are implemented. To this end, we have employed Monte Carlo computer simulations to investigate how changing the microscopic rules in a subsection of a two-dimensional lattice influences the macroscopic behavior in the rest of the lattice. Specifically, we implement the ML reaction scheme on a torus, except on a ring-shaped patch, which is set to follow the cyclic Lotka-Volterra predation rules of the RPS model. There, we observe a marked disruption of the usual spiral patterns in the form of plane waves emanating from the RPS region, up to a characteristic distance that is set by the diffusion rate in the RPS patch. Furthermore, the overall population density drops considerably in the vicinity of the interface between both regions.

**Mentors:** Uwe C. Tauber (Virginia Tech, Physics), Shannon Serrao (Virginia Tech, Physics)

This project is part of the Army Education Outreach Program Undergraduate Research Apprenticeship Program.

UULEN BATZUL
VIRGINIA TECH / BIOLOGICAL SCIENCES

## Testing the effect of DNA methylation on nuclear volume scaling in tetraploid cells

Tetraploid cells (with twice the chromosome number of a normal, diploid cell) are typically assumed to have twice the nuclear volume as their diploid counterparts. Preliminary evidence from the lab shows that this is not always the case. We have previously seen that non-transformed epithelial tetraploid cells typically show near-doubling of the nuclear volume (as expected) while transformed colorectal cancer cells show nuclear volume increases ranging from 10% - 65% over the diploid. We hypothesized that the colorectal cancer cells showing the least increase in volume will show higher levels of DNA methylation, as methylation makes the DNA more compact. Therefore, we reasoned it could alter nuclear size as well. To test our hypothesis, we turned to quantitative fluorescence microscopy and optimized a protocol for immunostaining with an antibody that recognizes 5-methylcytosine. We developed an analysis pipeline for image analysis and used these methods to analyze the amount of 5-methylcytosine in DLD-1 diploid cells and two DLD-1 tetraploid clones. We found that the DLD-1 tetraploid clone with the least increase in nuclear volume showed only a modest increase in DNA methylation compared to the diploid. Another DLD-1 tetraploid clone that showed greater nuclear volume increase demonstrated higher levels of DNA methylation. These preliminary results indicate that our hypothesis may not be valid and that DNA methylation differences may not explain the differences we see in nuclear scaling. Future experiments will seek to confirm this result and test additional mechanisms that may explain the pattern observed in the nuclear volume measurements.

**Mentor:** Daniela Cimini (Virginia Tech, Biological Sciences)

MAXWELL BAUM
VIRGINIA TECH / MECHANICAL ENGINEERING

## Investigation of Biophysical Interactions in Microbial Communities

In nature, microbes live in heterogeneous communities with complex biophysical and biochemical interactions. These interactions dictate the structure and function of the communities. In this study, we examined the role of flagellar motility and cell size in interactions and spatial organization between the motile and non-motile subpopulations of binary microbial communities. To help elucidate the biophysical mechanisms underpinning the community structure, we characterized the swimming speed and chemotaxis (i.e., biased migration in response to chemical gradients) of uropathogenic and highly motile Escherichia coli UMN 308 in the presence of quasi-steady linear gradients of L-aspartic acid established in a microfluidic device. We created synthetic binary microbial communities by combining this strain with non-motile E. coli CFT073, Candida albicans, or Staphylococcus aureus. Under optimal chemotactic conditions, we have observed a distinct separation between the motile and non-motile phases of the microbial communities. We quantified phase displacement at various ratios and overall cell densities. At a 1:1 ratio, the separation occurred at an overall density as low as 2.5x10^8 cell/mL. This phase separation was robustly observed across a wide range of cell densities (as high as 10^9 cell/mL) and several different ratios (1:1, 2:1, 4:1) of non-motile-to-motile subpopulations. Characterization of the biophysical interactions in microbial communities will advance the current understanding of microbial spatial organization in nature and in infectious disease pathogenesis, such as urinary tract infections, which are often caused when otherwise commensal microbes reach the urinary tract.

**Mentor:** Bahareh Behkam (Virginia Tech, Mechanical Engineering, Biomedical Engineering & Sciences, Macromolecules Innovation Institute)

EROD KEATON BAYBAY
VIRGINIA TECH / PHYSICS

## An Enzymatic Tug of War: Deubiquitinating Enzymes Counteracting the Anaphase Promoting Complex

In all eukaryotes, mitosis is the central mechanism by which genetic information is partitioned equally into daughter cells. Progression through mitosis is tightly regulated, which is essential to prevent chromosome missegregation and aneuploidy. The Anaphase Promoting Complex or Cyclosome (APC/C) is crucial to mitosis, due to its role in regulating the segregation of chromosomes and exit from mitosis. The APC/C acts by covalently attaching ubiquitin to key substrates, thereby tagging them for degradation. Deubiquitinating enzymes (DUBs) catalyze the removal of substrate-bound ubiquitin and could play an important role in regulating APC/C substrate levels. Previous studies deleted individual DUBs to characterize their function. These studies, however, failed to identify antagonists to the APC/C, likely due to functional redundancy. As a possible solution, we overexpress individual DUBs to screen for potential APC/C antagonists. To accomplish this, we amplify the open reading frames of select DUBs from genomic DNA and exogenously insert them into the leu1 locus of S. pombe together with a conditional promoter designed to overexpress the gene of interest. Overexpression may provide insights into the function of specific DUBs as well as their potential as antagonists to the APC/C.

**Mentors:** Silke Hauf (Virginia Tech, Biological Sciences), Varun Krishna and Drisya Vijayakumari (Virginia Tech, Biological Sciences)

JAMES BENSON
VIRGINIA TECH / BIOLOGY

## Analysis of Bacterial Abundance and Diversity in Freshwater Lake Systems based on Distance from Shore using a Small Unmanned Aircraft System

Aquatic ecosystems have a diverse collection of microorganism species, the concentration of these microorganisms within an aquatic ecosystem, and between aquatic systems in the same area, vary depending on a variety of environmental factors. Previous studies on the distribution of microorganisms and their concentrations within aquatic systems have traditionally focused on waterbodies facing some abnormal factor thought to be affecting the organisms. In addition, seasonal differences and depth of collection have been studied. Several lakes in the Austrian regions of Upper Austria and Styria were sampled in a grid beginning at the shore, 25 meters from shore, and 50 meters from shore with a Small Unmanned Aircraft Vehicle (sUAV) in an attempt to characterize the distribution of the microbial communities without disturbing the sampling area. Bathymetric data of the lakes was collected as well to investigate any connection between microbial concentration and the water temperature and depth of the lake bottom at the sample site. Analysis of the CFU/mL based on whole lakes and distance from shore showed that proximity to other lakes had little effect on the average CFU/mL and that much of relative microbial abundance occurred at either 1 meter from shore or at 50 meters from shore. The eight lakes together had a mean CFU/mL of 7.59x10^4. Future works aim to characterize other factors that could affect the dispersal of microbial populations through analysis with a flow meter and a more sensitive water temperature sensor to detect currents that may transport microbes and populations around the system.

**Mentor:** David Schmale (Virginia Tech, School of Plant and Environmental Sciences)

CHARLOTTE BROWN
VIRGINIA TECH / PSYCHOLOGY

## Lower Parent-Child Agreement of Social Anxiety Symptoms in Teens with Autism versus Social Anxiety and Typically Developing Controls

**Mentors:** John Richey (Virginia Tech, Psychology), Marika Coffman and Ligia Antezana (Virginia Tech, Psychology)

KENRICK CAMERON JR
VIRGINIA TECH / CLINICAL NEUROSCIENCE



## Cdc48: The Unsung Hero of Anaphase

Cell reproduction is fundamental to the development and function of all life. The series of events leading to eukaryotic cell reproduction is called the cell cycle. Cell cycle events need to be executed with high fidelity for cells to survive and reproduce. For example, the accurate replication and segregation of chromosomes during mitosis is key to maintain genome stability. Errors lead to chromosome missegregation and aneuploidy, which may cause cell death or cancer development. Chromosome separation is triggered by the Anaphase-promoting complex which ubiquitinates target proteins, marking them for degradation. An important APC/C substrate is securin, whose degradation releases its binding partner, separase, a protease which triggers chromosome separation. Cell division cycle protein 48 (Cdc48) is an AAA-ATPase implicated in the cell cycle where it acts in concert with ubiquitinases or deubiquitinases to modify the ubiquitination status of target proteins. It also functions to extract ubiquitinated proteins from their binding partners. Cdc48 is required for the stability of separase in mitosis, which has led to the hypothesis that Cdc48 may extract securin from separase, protecting separase from co-degradation with securin. However, the mechanistic basis of securin and separase regulation by Cdc48 remains to be understood. To probe further, we are modifying fission yeast to express a version of Cdc48 tagged at the endogenous locus with a fluorescent protein. Not only can this reveal the localization of Cdc48 relative to securin and separase as cells undergo mitosis, but also identify Cdc48-interacting partners and their consequence on chromosome separation.

**Mentor:** Dr. Silke Hauf (Virginia Tech, Biolgoy)

ALICE CHEN
VIRGINIA TECH / COMPUTER SCIENCE

Independent

## Gene Co-Expression Network Analysis of Cancer Using Mice RNA-Seq

The study of causes of cancer, whether genetic or environmental, is at the forefront of modern oncology research. Knowing which genes may be correlated with or indicate risk of cancer is useful in understanding what steps to take in future cancer treatment and prevention. In addition, we can predict the biological functions of unknown genes and their relationships to known genes. We attempted this with a gene coexpression network, a graph consisting of nodes representing genes and edges connecting genes co-expressed within a sample above a threshold multiple of their mean. Our goal was to uncover such relationships related to cancer by looking at large datasets of RNA-seq, a reliable measure of gene expression, collected from experiments of mice with and without cancer. We collected data from the Sequence Read Archive from the National Institute of Health by searching for datasets of mice RNA seq labelled with 'cancer' or terms ending in '-oma.' Whole-genome expression levels for over 20,000 genes and 1,700 samples were normalized using R, and then filtered by selecting only those with normalized expression values above a threshold measured in standard deviations above the mean. From these high-scoring gene-sample pairs, we created a gene co-expression network in which multiple genes in clusters linked with the same samples are treated as correlated. We utilized Cytoscape to visualize the network in the context of its metadata. We analyzed this gene co-expression network for unknown genes clustered with genes of known functions to infer the functions of the unknowns.

**Mentor:** Allan Dickerman (Virginia Tech, Biocomplexity Institute)

BEN CLARK
VIRGINIA TECH / WATER: RESOURCES, POLICY & MANAGEMENT
ETHAN BOEDING
VIRGINIA TECH / NANOSCIENCE

## Quantifying nucleic acid association to nanoparticles

**Mentors:** Peter J. Vikesland (Virginia Tech, The Charles E. Via Jr. Department of Civil and Environmental Engineering), Matt Y. Chan (Virginia Tech, The Charles E. Via Jr. Department of Civil and Environmental Engineering)

NATHANAEL CLARK
VIRGINIA TECH / BIOLOGICAL SCIENCES

Independent

## Activity of Amino Acid Transport Protein Promoters in Arabidopsis During Infection with Hpa

Hyaloperonospora arabidopsidis (Hpa) is a pathogen known to cause downy mildew in the plant Arabidopsis thaliana. Closely related to other oomycete pathogens such as Phytophthora, Hpa is an obligate biotroph; it is unable to utilize inorganic matter to form organic nutrients, which it must steal from its host. Hpa is believed to acquire nitrogen from its host in the form of amino acids. It is believed to do this by utilizing its host's amino acid transport proteins. Preliminary data has shown that infection with Hpa leads to increased promoter activity of several amino acid transport proteins; repeats of these experiments, as described here, continue to support this. Using the beta-glucuronidase (GUS) gene reporting system, the promoter activity of four amino acid transport proteins were determined in both infected and non-infected Arabidopsis plants. By fusing GUS to a gene's promoter, the localization of that gene's promoter can be determined through histochemical staining, and a quantitative measure of promoter activity can be determined using fluorometric enzyme activity assays. By doing this, we hope to continue to identify genes which can be targeted to genetically engineer disease resistance in crop plants.

**Mentor:** Guillaume Pilot (Virginia Tech; Plant Pathology, Physiology, and Weed Science)

NICK CRAMER
VIRGINIA TECH / BIOCHEMISTRY

## Insight into Islet Amyloid Polypeptide (IAPP) and Amyloid-?˝ Peptide Interactions Using Molecular Dynamics Simulations

Amyloid-beta (A?˝) and islet amyloid polypeptide (IAPP) are small peptide fragments that have the potential to self-assemble and form cytotoxic species, such as small soluble oligomers and large insoluble fibrils. The formation of A?˝ aggregates facilitates the development of neurodegenerative disease, most notably Alzheimer's disease (AD), while IAPP aggregates induce pancreatic b-cell apoptosis, leading to exacerbation of type 2 diabetes (T2D). Cross-amyloid interactions between A?˝ and IAPP have been described both in vivo and in vitro, implying the role of A?˝ or IAPP as modulators of cytotoxic self-aggregation of each species, and suggesting that A?˝-IAPP interactions are the potential molecular link between AD and T2D. Using molecular dynamics simulations, 'hot spot' segments of the two peptides were studied to understand the formation of hexamers in a heterogenous and homogenous environment. Control replicates of homogeneous A?˝(16-22) peptides formed stacked, perpendicular antiparallel beta sheets. Control replicates of IAPP(20-29) peptides formed stacked, parallel beta sheets and had relatively unstable aggregation structures. Replicate systems containing A?˝ and IAPP showed little evidence of A?˝ self-aggregation and demonstrated stability in a staggered arrangement of A?˝(16-22) and IAPP(20-29). Simulations suggest that if IAPP(20-29) is present in a system with A?˝(16-22), then it could slow A?˝(16-22) self-aggregation, possibly through interactions between IAPP(20-29)'s polar terminal residues and A?˝(16-22)'s charged polar terminal residues.

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

DILLON CUTAIAR
VIRGINIA TECH / COMPUTER SCIENCE

## Shakespeare's Garden - Virtual Reality: An Immersive Virtual Sound Stroll

While educational, professional, and gaming environments in virtual reality are common, little has been done to explore virtual reality's potential application in theatre and performance art. Shakespeare's Garden - Virtual Reality (SG-VR) is an immersive audio-visual experience based on a previously exhibited physical installation called Shakespeare's Garden. It is an attempt to replicate, augment, and further develop the original experience. Virtual reality allows the artists' original intent and new visions to shine through in interesting ways that are not possible in a physical space. Using a VR headset, the user is immersed in a spatialized ambient audio soundscape of natural sounds, surrounded by visual projections of sonnet texts, and encouraged to explore the space, occasionally wandering into target areas where they are able to hear selected Shakespeare sonnets and dramatic scenes recited by recorded actors. SG-VR represents an inquiry into the question, 'Can we create an aesthetic, artistic, and meaningful experience in VR?' Based on user feedback and the opinions of the original artists, the answer is 'yes'.

**Mentor:** Chris Miller (Virginia Tech, Digital Humanities)

SHREYA DAYAL
VIRGINIA TECH / PHYSICS

## Self-Assembly of Actin Like Filaments

**Mentor:** Dr. Shengfeng Cheng (Virginia Tech, Physics)

RAFE HAGEE
EMORY & HENRY COLLEGE / CHEMISTRY

## Turbidity and Suspended Sediment Sampling to Estimate Storm-Event Sediment Loads in Stroubles Creek

Sediment is one of the leading causes of stream impairment in the United States. During storm events, sediment particles can be transported by storm runoff into nearby streams. At the Virginia Tech StREAM Lab, we continuously measure flow and turbidity, but it is too costly and difficult to continuously measure sediment within the stream channel during high flow events. In order to predict the amount of sediment entering Stroubles Creek, we measured the total suspended sediment (TSS) by deploying an automatic sampler (ISCO) for a single storm event in June 2018. The ISCO collected water samples every 30 minutes and the YSI water quality sonde continuously measured turbidity every 15 minutes during a six-hour storm event. Utilizing the resulting TSS concentrations with existing turbidity measurements, we developed a predictive equation to relate turbidity to sediment concentration. Next, we utilized this relationship along with flow rate to estimate sediment loads during a single storm event. The YSI and ISCO measurements can make a direct comparison between water quality and sediment movement during a storm event. It is apparent that a site-specific, linear relationship between water turbidity and sediment can be established. Once established, we will be able to utilize StREAM Lab data from the last six months to estimate sediment loads in Stroubles Creek.

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

This project is part of the Emory and Henry College Friends of the Sciences Fellow program.

PHILIP HANCOCK
VIRGINIA TECH / MECHANICAL ENGINEERING
ALEX FUGE
VIRGINIA TECH / MECHANICAL ENGINEERING

## Design of a Six DOF 3D-Printable Leg for a Humanoid Robot

The main goal of this project is to investigate the feasibility of the design and manufacture of a full sized humanoid robot with 3D printing as the main method of fabrication. Specific requirements for this robot include the ability to walk across uneven terrain and to climb stairs. Each leg must have six degrees of freedom (two in the ankle, one in the knee, three in the hip) and a minimum knee rotation of 90 degrees. With recent advances in 3D printing, parts with complex geometry can be produced quickly with relatively inexpensive equipment. This study explores the capabilities of additive manufacturing, demonstrating that 3D printing structural components is a viable manufacturing process powerful enough to produce a full sized humanoid robot. This project required extensive use of Computer-Aided Design (CAD) for visualization, assembly, stress analysis, and manufacturing purposes. We were able to verify the motion of the constrained assembly and determine principal stresses before manufacturing the physical model by running simple kinematic simulations and through Finite Element Analysis (FEA). This greatly reduced the number of prototypes required to be built and subsequently the amount of material used. As of now, we have completed the construction of three full-sized prototypes. The model is still undergoing experimental testing, however we expect that each leg should be able to support a load of 150 lbf while actuating at the knee at a rate of 0.1 m/s. Each plastic leg is estimated to be at least 30% lighter than the previous robots' metal counterparts while still retaining comparable movement capabilities.

**Mentor:** Alex Leonessa (Virginia Tech, Mechanical Engineering)

FIONA HARRIS
VIRGINIA TECH / BIOCHEMISTRY

Independent

## Characterization of the amino acid transporter AAP1

Amino acids are the source of organic nitrogen available for biosynthesis in plant cells. The ability of plants to sense and translocate amino acids is essential for the uptake of nitrogen, and subsequent production of proteins and other cell nutrients. This project focuses on the characterization of the enzyme AAP1, which has been shown in previous literature to act as an amino acid transporter in Arabidopsis. However, lines of Arabidopsis have been obtained that display abnormal degregulation of amino acid metabolism associated with mutations in the AAP1 gene. One mutation of the AAP1 gene, aap1-6, abolishes the transport function of the enzyme, however the phenotype of the plant is not identical to the line lacking the AAP1 gene, as would be expected if AAP1 functions solely as a transporter. Another AAP1 mutant, aap1-9, maintains transport function, however produces a stunted phenotype. This indicates a role for AAP1 beyond that of just a transporter, possibly acting simultaneously as an amino acid sensor, or a transceptor. Given below are is a study of the uptake of amino acids by AAP1 and variants expressed in yeast.

**Mentor:** Guillaume Pilot (Virginia Tech, School of Plant and Environmental Sciences)

BENJAMIN HEIDEBRECHT
VIRGINIA TECH / SYSTEMS BIOLOGY

## Alleviation of parametric constraints in circadian timekeeping models through kinetic modification

Many organisms spanning every biological kingdom possess endogenous circadian rhythms (CR, ~24 h period) which are used to coordinate a myriad of physiological functions with the day-night cycle. In this study, I use bifurcation theory to explore the properties of three mathematical models of the CR in eukaryotes. The models, originally proposed by Kim and Forger (Molecular Systems Biology, 2012), are based on a simple negative feedback (SNF) loop between a regulatory protein PER and its transcriptional activator (BMAL), optionally supplemented with a second negative feedback loop (NNF) and/or a positive feedback loop (PNF) based on regulated transcription of BMAL by REV-ERB and/or ROR, respectively. In my work, each of these Kim-Forger models was modified with a Michaelis-Menten rate law for the degradation of PER in the nucleus. This simple modification of the Kim-Forger differential equations significantly increases the robustness of oscillations (i.e., increases the size of the oscillatory domain in parameter space) in each of the models, especially so in the PNF model. Of particular interest is the observation that oscillations in my model persist for values of the binding constant of PER to BMAL that are 100-fold smaller than the required value in Kim-Forger's original model. This change circumvents a rather strict parametric constraint on oscillations in the Kim-Forger model. The new model will be used in the future to explore the effects on CR of 'PER-antisense' RNA expression and of DNA damage.

**Mentors:** John Tyson (Virginia Tech, Biological Sciences), Jing Chen (Virginia Tech, Biological Sciences)

CONNOR HERRON
VIRGINIA TECH / MECHANICAL ENGINEERING

Independent

## 3D Printed Robotic Arm based on Backwards Differential Two Axis Shoulder Joint

The purpose of this project is to design the most efficient, lightweight arm for a humanoid robot. This project is focused on using lightweight elements which provide similar mobility to TREC's previous humanoid designs THOR and ESCHER. The arms have three main linkages: a shoulder joint, a bicep, and a forearm. Its shoulder joint uses two motors to generate movement in the two degrees of freedom separately or simultaneously. The original design for the shoulder joint was inspired by an automobile's differential, where a drive shaft torque is used to drive two synchronized wheels. In this case, the wheels of the car would be powering and controlling the drive shaft output. The shoulder joint's rotary encoder is kept within the shaft of the T-joint for protection, a major improvement from the previous design. The structural components of the arm are 3D printed using ABS filament, lowering the overall weight while still maintaining appropriate rigidity. Design for manufacturing is essential for ease of assembly and appropriate tolerance compliance. The project heavily relied on Computer-Aided Design (CAD) for visualization and manufacturing, and Finite Element Analysis (FEA) for stress and strain simulations. Kinematic simulations were used to verify correct motion and help identify points of failure in our model prior to assembly. Several components are undergoing toolpath development to begin machining to meet acceptable stress requirements. A full-sized prototype has been developed and will begin undergoing testing soon.

**Mentor:** Alex Leonessa (Virginia Tech, Mechanical Engineering)

ZACHARY KOZAR
VIRGINIA TECH / ENGINEERING SCIENCE AND MECHANICS

## Quantitative Analysis of Grayscale Tendon Ultrasound Images of Collegiate Basketball Players

Physicians generally diagnose injuries in a qualitative manner, relying on physically and visually identifying diseased tissue using ultrasound (US). The current study aims to use quantitative analysis of grayscale US images to detect potential differences in athletes' patellar tendons over the course of a demanding college basketball season. Under a VCOM IRB-approved protocol, members of the Virginia Tech Women's Basketball Team were subject to two imaging sessions of the patella tendon. Using a GE LOGIQ S8 US machine (General Electric, USA), tendons were images once prior to and once following the season. A custom Matlab program was written to allow the researcher to hand-select a region of interest (ROI) that covered the entire central region of the tendon. Grayscale intensity, variance, skewness, kurtosis and entropy [1] were determined over the ROI. Kurtosis of the post-season images was significantly (p<0.05) increased relative to that of the pre-season. Variance, entropy, and intensity decreased significantly following the season. Decreased variance is indicative of a more homogeneous grayscale intensity of the tendon on B-mode images. The skew of the pixel intensities was positive for 99% of all images, denoting that pixel intensity was trended towards higher values. The increase in kurtosis represents a closer distribution of pixels from the mean, consistent with the decreased variance. Decreased entropy reflects a decrease in the number of separate grayscale levels in the ROI. Together, these data points suggest a potential compromise of tendon integrity attributable to the demands of a college basketball season.

**Mentor:** Vincent Wang (Virginia Tech, Biomedical Engineering and Mechanics)

AVA LAKMAZAHERI
OLIN COLLEGE / MECHANICAL ENGINEERING
ALEX MORAN
VIRGINIA TECH / COMPUTER ENGINEERING

## Cross-Robot Core Software Architecture for Real-Time Humanoid Control

In the broad mission to improve quality of life, humanoid robots have a unique niche. Their potential for dexterity and intelligence enables them to perform life-critical tasks such as disaster search-and-rescue and assisting people with severe motor impairment. In this project, we explore the high-level software architecture needed to control a humanoid robot for these applications. To maximally support any such robot, we are interested in a universal system that decouples high-level logic from low-level hardware control. A cross-robot framework will broadly enable the field to bypass infrastructure-level programming and invest more in research-level efforts. We began by evaluating a range of open-source humanoid control applications for functionality, modularity, and simplicity. As a result of this process, we identified a platform called Cross-Robot Core (XBotCore) that satisfies these requirements and further allows modelling abstract behaviors using finite state machines, multi-tasking via a whole-body inverse kinematics engine, and simplifying complex structures into a universal robot description format. This system has a plug-in based architecture, allowing computationally intensive tasks (e.g. simulation and visualization) to run concurrently with 1 kHz control processes. The result is a generalized software platform for executing advanced locomotion and manipulation tasks in real time. Currently, we are working towards a full-scale robot simulation with implemented semi-autonomous whole-body control. Our next step is to enable the TREC Lab's humanoid robots to effectively perform their envisioned tasks using XBotCore.

**Mentor:** Alex Leonessa (Virginia Tech, Mechanical Engineering)

MIKA PAGANI
VIRGINIA TECH / ENVIRONMENTAL SCIENCE

## Efficacy of Apritone Repellent Solution on Halyomorpha halys

After the initial introduction to the United States in the late 1990s, the invasive brown marmorated stink bug (BMSB), Halyomorpha Halys (St?ùl), maintains its high risk pest status. Presently, there is no commercialized repellent for BMSB, leaving management solutions limited for the agricultural industry and homeowners to control the structural nuisance of BMSB. Prior work found geranyl cyclopentanone (apritone) to effectively repel overwintering BMSB. As a continuation, this research evaluated the effectiveness of apritone at different concentrations, as well as determining the residual efficacy after application. The repellent was applied to kraft paper which was then exposed to growth light overtime to determine its longevity. A four-choice cage experiment was then designed to examine the efficacy of apritone at 0%, 1%, 2.5%, and 5% active ingredient concentrations. BMSB were released in the center of a cage to then enter one of four shelters that incorporated one entry point surrounded by the repellent-applied kraft paper. Each structure covered a bell pepper food stimulus which was used to measure the amount of BMSB that entered a week from initial release, as well as counts of feeding wounds to the pepper fruit. After the four-week study, no significant differences were seen in shelter entry counts between treatments. There was an increased number of feedings wounds in the more concentrated applications. The volatility between the chemical and food may have impeded the repellency, therefore future studies will remove the food source from the experiment. (Supported by: Bedoukian Research Inc.). Author contact: mika396@vt.edu.

**Mentor:** Thomas Kuhar (Virginia Tech, Entomology)

ZOE PELLY
VIRGINIA TECH / BIOCHEMISTRY

## Creating Dex-Inducible Arabidopsis to Analyze Split GFP Refolding and Ribosome Association

Food security is the broad focus of this project. Little is known about how pathogens acquire nutrients from plants. We want to investigate nutrient transport genes from plants that pathogens depend on, using the model organism Arabidopsis and its obligate pathogen Hyaloperonospora arabidopsidis (Hpa). Ultimately, we can engineer genes into food crops so that they cannot be used by pathogens, to make resistant plants.

In order to study how pathogens interact with their host on a cellular level, we will utilize a modified technology, the translating ribosome affinity purification (TRAP). TRAP technology enables analysis of mRNAs that are being currently translated, which can be used to characterize expression of the nutrient transport genes. Our modified TRAP system uses a split green fluorescence protein (GFP), and pathogen-inducible or tissue-specific promoters. One half of the GFP is fused to a purification tag and the other to a ribosomal protein. GFP is the 'linker' between these two components so that expression of the purification tag and ribosomal protein can be controlled based on the promoter associated with it.

My research will focus on analyzing the refolding of the split GFP, an essential step towards proving the feasibility of the system: we need to understand the time frame within which we can purify tagged ribosomes during pathogen infection when split GFP is under control of the pathogen-inducible promoter. We have transformed Arabidopsis with inducible constructs, from which homozygous lines were selected. Fluorescence microscopy and GUS staining will be used to analyze induction of GFP. I will examine how different fragment combinations might affect refolding of the GFP with the ribosome. I will also measure refolding of GFP as a function of time through western blot and modified TRAP methods. This will confirm association of split GFP with the ribosome.

**Mentor: Guillaume Pilot** (Virginia Tech; Plant Pathology, Physiology, and Weed Science)

BRIAN RATNASINGHE
VIRGINIA TECH / BIOCHEMISTRY

## Influence of Electronic Polarization on RNA and DNA G-quadruplex Structure and Dynamics

A G-quadruplex(GQ) is a noncanonical nucleic acid structure that forms in guanine-rich regions of nucleic acids. The guanine bases are arranged in square planar configuration via Hoogsteen hydrogen bonding, facilitating the coordination of ions like K+. Atypical GQ conformation can lead to improper regulation of gene expression potentially resulting in cancer or mental disorders such as autism. Here, we preformed molecular dynamics simulations to gain insight into factors contributing to GQ stability. Two GQs are studied, the sc1 RNA GQ, which binds to the Fragile-X Mental Retardation Protein (FMRP) and the bcl-2 DNA GQ, which is in the promoter region of the B-cell CLL/lymphoma 2 (bcl-2) oncogene. Simulations of FMRP-sc1 aim to compare the effect of ion type on stability of the FMRP-sc1 complex, whereas simulations of bcl-2 aim to compare polarizable and nonpolarizable force fields to further understand the role of electronic polarization on GQ stability. In polarizable simulations, we use the Drude oscillator model, which adds negatively charged particles to all heavy atoms instead of approximating polarization, as in the CHARMM force field. Our results point to structural differences in FMRP-sc1 with bound Li+ and K+, which can provide insight into the potential risks of lithium as treatment for mental disorders. Similarly, simulations of the bcl-2 GQ indicate polarization influences ion binding in the tetrad core and overall GQ stability. These results suggest that the Drude force field is well suited to model systems containing GQs and provide novel insights into their conformational ensembles.

**Mentor:** Dr. Lemkul (Virginia Tech, Biochemistry)

ARTURO ROMAN LONGORIA
VIRGINIA TECH / MICROBIOLOGY

## Effect of location on wheat seed microbiomes in Virginia

Wheat is a globally important crop that has several major fungal diseases that appear to be increasing in spread and virulence. Traditional wheat breeding can select disease resistant strains for planting, and this can also be based on genetic screening for the presence of disease resistant forms of genes. However, microbial endophyte communities, the plant 'microbiome' that resides in plant tissues, may also contribute to host disease resistance, and constitutes a relatively unexplored area for crop improvement. To begin to explore the potential for these endophytes to impact disease resistance, we completed a culture-independent analysis (based on the bacterial DNA present inside the seeds) of bacterial wheat endophytes from the seeds of three wheat varieties grown at three different sites in Virginia. We found that the bacterial taxa in these wheat varieties grown in Virginia are consistent with other published studies. For example, the most dominant bacteria we found was in the genus Pantoea, which has also been found in other studies of wheat seeds. Second, the amount of variation in the bacterial endophyte community within a wheat variety at a site (i.e. across our 3 subsamples) was substantial, and as great as the variation among varieties and among site. We hypothesize that it is the interaction between host genetics and bacterially-contributed genes that ultimately result in higher disease resistance.

**Mentor:** Dr. Lisa Belden (Virginia Tech, Biological sciences)

AVERY SEBOLT
VIRGINIA TECH / AEROSPACE ENGINEERING

## Forward Motion Generation Using Standing Waves

In this project we use the energy of water waves to produce forward motion for a small vessel. A wave generator was constructed using a servo motor connected to a linear motion generator mechanism (Scotch yoke mechanism). The motor operates with a constant frequency and force that strikes the water to produce almost stationary waves in a large tank. A small vessel with elastic fins attached to it is placed on the water surface. The goal is to generate forward motion for the vessel using the water waves and control the direction of motion. Design optimization is carried out on the quantity, shape, position, orientation, and elasticity of the fins through experiments to generate the fastest forward motion for a certain water wave.

**Mentor:** Sevak Tahmasian (Virginia Tech, Biomedical Engineering and Mechanics)

AMANDA SHARP
VIRGINIA TECH / BIOCHEMISTRY

## Identifying Radical SAM Enzymes and Characterizing GRE-AEs in Methanocaldococcus jannaschii using Bioinformatic Tools

Radical S-adenosyl-L-methionine (SAM) enzymes were first classified in 2001 and defined to be a superfamily with over 600 members. Since, the number of radical SAM enzymes have grown tremendously and many remain uncharacterized in their function. Characterized radical SAM enzymes are involved with a variety of biochemical reactions, including methylations, sulfur insertions, and protein radical formation. The active site of radical SAM enzymes contain a conserved cysteine binding motif, CX3CX2C plus others similar, that coordinate an iron-sulfur cluster [4Fe-4S] at the center. Understanding the function and evolution of these radical SAM enzymes can lead to further insight on ancient metabolism. Bioinformatic tools were used to identify and compile a dataset based on motif presence of potential radical SAM enzymes in various organisms, focusing on the relative identity to the ancient methanogenic archaeon, Methanocaldococcus jannaschii. Additionally, glycyl radical enzyme activating enzymes (GRE-AEs), one class of radical SAM enzymes, were investigated in M. jannaschii due to their role in anaerobic metabolism. This data provides insight into the reduced total of radical SAM enzymes in more complex organisms, demonstrating that these enzymes may have been essential for survival on early earth and have slowly been removed from genomes. Additionally, the potential GRE-AEs investigated showed the ability to bind the ligand SAM in the ideal orientation for the radical chemistry to result. Collectively, this work helps further our knowledge and predicted function of radical SAM enzymes as it related to the building blocks of modern metabolism.

**Mentors:** Anne Brown (Virginia Tech, Biochemistry), David Bevan and Bob White (Virginia Tech, Biochemistry)

MEAGAN TODD
VIRGINIA TECH / SYSTEMS BIOLOGY

## Bioinformatic Analysis of Uncultivated Microbial Dark Matter: A Closer Look at Marinimicrobia

The majority of biodiversity of life on Earth consists of poorly-understood groups of 'microbial dark matter' (MDM) that play important roles in regulating the climate and influencing the physiology of multicellular organisms (Rinke et al, Nature, 2012). Understanding ecosystem processes and global biogeochemical cycles requires a deeper knowledge of these organisms within their natural environments; however, their cryptic metabolisms make them difficult and at times impossible to study in the laboratory. In this project, we are using transcriptomic sequencing to analyze mRNA transcripts produced by members of the Marinimicrobia, an abundant group of MDM that lives in ocean waters around the globe and plays important roles in biogeochemical cycling (Hawley et al, Nat. Comm, 2017). We focus on monitoring gene expression of Marinimicrobia in both coastal and open ocean environments and analyzing the correlation between species within the phylum and how their interactions affect their surrounding ecosystems. On a global spectrum, it is vital that the mechanisms of microbial communities within the oceans are understood to know how the systems will react to climate change caused by human activities. Given the importance of MDM, this project will help advance our understanding of the role that the Marinimicrobia play in regulating these key global biogeochemical cycles. Thus far, I have analyzed mRNA transcripts from various time points sampled in the North Pacific Subtropical Gyre and found that there were transcripts present from 13 genomes which belong to 3 distinct clades of Marinimicrobia.

**Mentor:** Frank O. Aylward (Virginia Tech, Biological Sciences)

JESSICA VOYACK
VIRGINIA TECH / PSYCHOLOGY

## Greater Adaptive Functioning Impairment in Teens with Autism compared to Social Anxiety and Typically Developing Controls

Adaptive skills are practical, everyday skills needed to function and meet the demands of one's environment, including the skills necessary to take care of oneself and interact with other people (Sparrow, Cicchetti, & Saulnier, 2016). Adaptive skills are impaired in adolescents with Autism Spectrum Disorder (ASD) across areas of Communication (CS), Daily Living (DLS), and Social Skills (SS) (Fenton, et al. 2016). The goal of this project is to examine differences in adaptive skills in adolescents with ASD compared to Social Anxiety Disorder (SAD) and typically developing controls (TDC). To date, no studies have examined whether adaptive deficits are specific to ASD, or are impaired generally in those with social deficits. Thus, we predicted that adolescents with SAD and ASD will show specific impaired adaptive skills in areas of SS compared to TDC, but that SAD and TDC would not differ in other domains.
One-Way ANOVA with Tukeys Post-hoc tested the hypothesis that ASD would demonstrate more impairment across areas of CS and DLS compared to SAD and TDC and further that ASD would demonstrate the greatest impairment for SS than SAD, and that SAD would have more impairment that TDC. Groups differed on CS, DLS, and SS (p<.01). Post-hoc analyses revealed that SAD and TDC groups demonstrated similar CS and DLS, while ASD demonstrated significant impairment (ps<.01). Consistent with our hypothesis, we found that all groups were significantly different from each other on SS (ps<.01), such that ASD had the most impairment, followed by SAD and TDC.

**Mentors:** John A Richey, Marika Coffman, and Ligia Antezana (Virginia Tech, Psychology)

AMANDA WARD
VIRGINIA TECH / BIOLOGICAL SCIENCES

## Network Analysis of Co-expression in Cancer Genes

Similarities between metabolic and regulatory pathways of genes can be observed through co-expression networks where dense links among samples and genes may indicate similar biological functionalities. Co-expression of genes related to cancer were observed on a broad scale over the whole mouse genome to discover functionally related genes. RNA-seq, a modern measurement of gene expression through high-input sequencing, is one datatype publicly available from the Sequence Read Archive at NIH. We searched this archive for mouse RNA-Seq samples filtered for cancer-related terms, such as those ending in '-oma', resulting in over 1700 samples. Expression levels of known genes were measured by mapping reads to the reference mouse genome using an automated script. Once normalized, the large data-frame was filtered for standard deviations above a threshold to select high gene expression values to form the edges connecting genes and samples in a network. Networks based on a standard deviation of six yielded better results with some clusters having up to 99 genes with hundreds of genes in correlation, however, most clusters contained one sample. Network clusters were filtered for a minimum of ten samples present to find denser clusters possibly representing similarly functioning genes. We used the Panther database to perform gene function enrichment analysis. One cluster with 99 genes was initially analyzed and yielded overarching results related towards a broad spectrum of development, metabolic processes, and cell differentiation with metadata from sample clusters aiding in interpretation of gene functions.

**Mentor:** Allan Dickerman (Virginia Tech, Computational Biology)

ZEYU YUAN
VIRGINIA TECH / BIOLOGICAL SCIENCES

## The effect of plant growth promoting bacteria on Sinorhizobium meliloti and its host

Sinorhizobium meliloti is a rhizosphere bacterium that forms a symbiotic relationship with the legume alfalfa. Nitrogen is essential to all living organisms' biological processes, and it is abundant in the air in the form of dinitrogen (N2). However, dinitrogen is unusable for most plants and animals. Sinorhizobium meliloti will fix dinitrogen in root nodules of the legume for the benefit of the plant. Bacteroids also leave excess nitrogen in the soil that may reduce fertilizer usage. Other rhizosphere bacteria may have the ability to promote the activity of Sinorhizobium meliloti or enhance the survival of the plant. Two different species of bacteria have been isolated from inside the seed coat of alfalfa: Pantoea sp. and Curtobacterium flaccumfaciens. They were inoculated along with Bacillus simplex 30N-5 and Sinorhizobium meliloti in a hydroponic system to observe the potential beneficial effects they can provide to plants. Bacillus simplex is used in this experiment as a positive control because it has already been established as a plant growth promoting bacteria. Plants are harvested 5 weeks post inoculation. Factors such as number of nodules, length of root and shoots, dry/fresh weight will determine the effect of the bacteria on plant growth.

**Mentor:** Birgit Scharf (Virginia Tech, Biological science)

# *Information Biology Program: Predicting, Explaining, and Visualizing Complex Systems*

## PROGRAM DESCRIPTION

The Information Biology Program: Predicting, Explaining, and Visualizing Complex Systems launched in the summer of 2017 to introduce Virginia Tech undergraduates to innovative research through a collaboration with the Honors College and the Biocomplexity Institute of Virginia Tech. The goal of this program is to analyze complex datasets to understand interactions within and between biological systems and apply findings to modern genomics and bioinformatics sciences. Students receive twelve weeks of individualized instruction and independent research experience from faculty advisors in biological informatics. This collaborative learning environment provides excellent preparation for a future career in any scientific research organization.

## PROGRAM COORDINATORS

Dr. Allan Dickerman
Dr. Shiv Kale
Mr. Sai Karyala
Dr. Rebecca Wattam

## PROGRAM PARTICIPANTS

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### Bridget Kastelberg
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### Abigail Workmeister
VIRGINIA TECH, Biochemistry
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# HANNAH BEARD

VIRGINIA TECH / ANIMAL AND POULTRY SCIENCE


## Global Characterization of Metabolic Responses by Dendritic Cells in Response to A. fumigatus viable Conidia

**Mentor:** Shiv Kale (Virginia Tech, Biocomplexity Institute)

BHANU CHADALAWADA
VIRGINIA TECH / BIOCHEMISTRY

## Optimal time to treat Non-metastatic melanoma

The purpose of this project is to measure the growth of tumors when giving cancer drugs for non-metastasized melanoma and to see the optimal time to administer the medications. Previous research has indicated a link between disruption of the body's internal circadian clock and tumor size. The purpose of this project is to see when the most opportune time is to give cancer medication to limit the sizes of tumors. Using both a normal and disrupted circadian cycle, we will compare the growth of the tumors at different time points from the non-metastatic melanoma cell line. Then using protein extraction and immunoblotting, we will be able to analyze the levels of various clock proteins involved compared to the size of the melanoma tumor to identify any possible relationships. We should expect to see the sizes of the tumors shrink when given the cancer treatments and be able to identify what the optimal time is to take the medication. The goal of this project is to give an insight for patients to see maximum benefits when they are taking their various medications. This experiment will also show how the various proteins of the circadian clock are related to the size of the tumor.

**Mentor:** Carla Finkielstein (Virginia Tech; Integrated Cellular Responses Laboratory, Department of Biological Sciences)

DANIELLE HUGNEY
VIRGINIA TECH / BIOMEDICAL SCIENCES

## Forensic Microbiology: Can microbiome data be used to differentiate among individuals

With modern DNA sequencing capabilities, the field of genetics is evolving rapidly in ways that can benefit many other areas of science. The development of 16S amplicon sequencing to survey environmental biodiversity has allowed for a better understanding of the composition and diversity of the human microbiome. Metagenomics and next-gen sequencing may have a major impact on forensic science, distinguishing between individuals based on their specific microbial signature and match it to evidence found at the crime scene. A previous analysis showed that local biogeography and strong individuality define the skin microbiome.   Here, we tested microbiome data from multiple individual body sites to determine which could best differentiate between individuals. We examined the 16S variable regions 1-3 sequence data published by the Human Microbial Project samples from up to 100 different individual volunteers at up to 20 distinct body sites. We analyzed the published counts per Operational Taxonomic Unit (OTU) for those individuals that had repeat measures for a body site. We used a non-parametric correlation in OTU counts among samples and tested for differences between within-individual versus between-individual correlations using the T-test to score the strength by which microbial patterns can be used to distinguish between individual humans at each body site. All of the samples tested expressed significant data, meaning the human microbiome is indeed individualistic. The site that expressed the most significant data was Stool samples with a T-test statistic of 17.87. However, this would not be an ideal method to sample for forensic applications. The best site to use for forensic applications could be Anterior Nares or Saliva, with T-statistics of 11.19 and 11.21, respectively. However, these two sites might limit the forensic applicability. Regression analysis of the magnitude shift in rank-order of each OTU between same-individual vs different-individual comparisons enabled us to define which bacterial species provided the strongest support for individual recognition relevant to use in forensics.

**Mentors:** Rebecca Wattam (Virginia Tech, Bioinformatics), Allan Dickerman (Virginia Tech, Bioinformatics)

SRIKANTH JAKKAMPUDI
VIRGINIA TECH / COMPUTATIONAL MODELING & DATA ANALYTICS

## Neural Networks for Protein Domain Recognition

The proteins that DNA codes for are classified into domains based on conserved sequence patterns. Sequence domains are determinants of protein structure and resulting function. Therefore, recognition of the domains present in a given sequence helps give insight into what the function of that sequence or gene has. The existing technology to identify protein domains makes use of a chain of Hidden Markov Models trained on multiple sequence alignments. This approach gives high quality results making use of the existing knowledge, but having to use a chain of models can greatly increase the run-time on a sequence query. We are experimenting with a variety of neural network approaches that consolidate the identification algorithm to a single classifier. In this work we describe the evolution of our machine learning strategy from working with padded whole sequences as examples to one that uses embedded representations of amino acid words. We also contrast approaches of simple identification of presence/absence versus coordinate based domain finding and their algorithmic cost. Overall the deep learning approach to domain finding has the potential to significantly improve performance in terms of time and storage space.

**Mentor:** Andrew Warren (Virginia Tech, Bioinformatics)

BRIDGET KASTELBERG
VIRGINIA TECH / SYSTEMS BIOLOGY

## Global Characterization of Immune Responses by Bone Marrow Derived Dendritic Cells in Response to A. fumigatus Viable Conidia

**Mentor:** Shiv D. Kale (Virginia Tech, Biocomplexity Institute)

## ABIGAIL WORKMEISTER

VIRGINIA TECH / BIOCHEMISTRY


Information Biology Summer Program

### Deregulation of circadian rhythms impacts cell cycle progression and tumorigenesis in vivo


**Mentor:** Carla V. Finkielstein (Virginia Tech; Integrated Cellular Responses Laboratory, Department of Biological Sciences)

# *IRES: US-China Collaboration: Bats as Model Organisms for Bioinspired Engineering*

## PROGRAM DESCRIPTION

The IRES project is a collaborative effort among faculty members from six departments at VT and the Institute for Critical Technology and Applied Science (ICTAS). The international component of the program is conducted in the Shandong University - Virginia Tech International Laboratory in China, a facility dedicated to the engineering analysis of bat biosonar, flight, and related topics that has been in operation since 2010 and has made many pioneering discoveries on bat biosonar. Students in the IRES program work on interdisciplinary research projects that analyze the engineering principles that underlie bats' sophisticated sensing, locomotion, and navigation: How to the bats coordinate their sonar pulses with flight? What wing movements help them snatch prey in midair or drink while in flight? How do tiny adjustments of intricately sculpted ears and noseleaves modulate sonar emission and reception? And how do all these systems work together to make the bats the master of their natural habitats?

## PROGRAM DIRECTOR

Dr. Rolf Mueller, Mechanical Engineering

## PROGRAM PARTICIPANTS


### Hannah Comstock

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### Dean Conte

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### Dominic LoPinto

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### Huy Ngo

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### Naila Sayani

VIRGINIA TECH, Biological Systems Engineering
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HANNAH COMSTOCK
VIRGINIA TECH / CREATIVE TECHNOLOGIES

## Polygonal Models of Bat Specimens that are Scientifically Accurate as well as Aesthetically Pleasing

When bats maneuver and operate their biosonar systems on the wing, many fast shape changes occur in the wings, the noseleaves (ultrasonic megaphones). In order to understand the integration between these fast effects, a digital 3d model of an entire bat that can be animated according to quantitative data is essential. In the current work, multiple types of software have been used to create such a model. Beginning with a photogrammetry software (RealityCapture), hundreds of photographs of a specimen's body and head were processed, aligned, and turned into rough 3D models based on the photographs to create a proportionally accurate representation of a Hipposideros armiger specimen. 3D modeling programs (Maya, Zbrush) were then used to clean up the models and stitch the entire bat together. Once the model was ready, it was retopologized by hand in Zbrush to give it low geometry, making it easier to work with the model in other programs once it was time to animate and render it. After the retopologizing process was completed, the model was then worked on more in Zbrush at a high polygon count to add realistic details that could later be added to the low polygon model as a normal map. The final step was to then give the bat texture by polypainting in Zbrush, which could later be added to the low polygon model as a texture map. The outcome was a textured, detailed full body model of Hipposideros armiger that could be rigged and animated to visualize data.

**Mentors:** Rolf Mueller (Virginia Tech, Mechanical Engineering),
Thomas Tucker (Virginia Tech, Creative Technologies)

DEAN CONTE
VIRGINIA TECH / MECHANICAL ENGINEERING

## Taking a Biomimetic Sonar System into the Habitats of Bats

Horseshoe bats (Rhinolophidae) have the capability to hunt and navigate in dense environments with impressive speed and accuracy. To achieve such autonomy, bats have a developed a sophisticated biological sonar system. Bats infer information about their environment by analyzing echoes of ultrasonic pulses they produce. The Horseshoe bat's sonar system consists of one ultrasonic emitter (the nostrils), and two receivers (the ears). During the emission and reception of ultrasonic pulses, the Horseshoe bat actively deforms both the nose-leaf (nostrils) and ears. This dynamic motion has been shown to increase sensory information encoding, allowing for improved direction-finding accuracy of objects. The goal of this project is to build and improve a mobile sonar system that mimics the dynamics of a Horseshoe bat. With this device we have collected data in locations where bats fly to "see what a bat sees" during flight. A mechanical system has been built which utilizes DC motors to actuate geometrically similar models of the Horseshoe bat ears and nose-leaf. The actuation recreates the motion of the emitting and receiving baffles of a real bat to the best of our ability. An electrical system has been designed and built to emit high quality ultrasonic "chirps" and record high resolution echo response data. The software used to record and analyze data are Python (back-end) and Matlab (front end). This sonar system has been used to gather pilot "flight" data both in caves and in dense foliage by mounting the sonar system on a zip-line in Shandong, China.

**Mentor:** Dr. Rolf Mueller (Virginia Tech, Mechanical Engineering)

DOMINIC LOPINTO
VIRGINIA TECH / MECHANICAL ENGINEERING

## Automated Solutions to the Correspondence Problem in High-Speed Video Recordings of Bats

Capturing fast, complex animal motions requires high-speed video footage taken from many different directions. Here, we have analyzed recordings from arrays of high-speed video cameras to reconstruct the kinematics of noseleaf (i.e., a "megaphone" for ultrasonic emission), ear, and wing motions in bats (great roundleaf bat, Hipposideros armiger). These camera array recordings consisted of hundreds to tens of thousands of video images across which the positions of tens or hundreds of artificial landmarks (small white paint dots) must be tracked. This can only be accomplished if an automated method is available for identifying landmark points in each image and by establishing correspondences between the same landmark points across different images. Here, we have tested two-dimensional cross-correlation and pyramid optical flow for this purpose. Two-dimensional cross-correlation combined with Kalman and double exponential filters had already been implemented in an open-source code (T. Hedrick). A custom tracking code that combines pyramid optical flow tracking with centroid finding was written for this work. Both codes were integrated with a common GUI (graphical user interface) and tested using the following method: five samples of data were compiled with a known number of identification markers. The visible points were counted and recorded before tracking was attempted with each code. While pyramid optical flow yielded a greater potential for inaccurately tracked individual points, it increased overall tracking accuracy compared to two-dimensional cross-correlation. Optical flow was less computationally expensive and more user friendly. Hence, pyramid optical flow can be considered the better fit for bat kinematics capture.

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

HUY NGO
VIRGINIA TECH / FINE ARTS

## Photogrammetry Approach to Capturing the 3D Morphology of Bat Specimens

Creating accurate digital models of entire bat specimens post-mortem as well as in-vivo requires a non-invasive method for capturing the 3d geometry in detail. In addition, making comparisons across different bat species requires an efficient process for accomplishing this. Here, photogrammetry was utilized to meet these specifications. Photogrammetry is a process where a camera rapidly takes pictures of an object at three different heights: low, medium and high, while the object is slowly being turned on a turntable. This process usually requires between 400 to 800 high-resolution pictures in order to recreate an accurate model of the subject. For the great roundleaf bat (Hipposideros armiger) that has been modelled here, the focus of the research was on the motions of wing during flight as well as the fast deformations of the noseleaves (i.e., ultrasonic emission baffles) and the ears during the bats' biosonar behaviors. Hence, 800 photos were taken of the head and 400 photos were taken of the body to create the 3d model. Softwares like Maya, Zbrush and RealityCapture were integral to the process of creating a computer generated image (CGI) of the bat specimens based on the photogrammetry data. In order to recreate the flapping of the wings and the deformations of the noseleaves and ears seen in the bats, rigging and animating processes were used. For this portion, Maya was used due to its capabilities of doing complex cloth simulation with various properties that can be applied to the wing membranes of the bat.

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

NAILA SAYANI
VIRGINIA TECH / BIOLOGICAL SYSTEMS ENGINEERING

## High-speed Video Array Recordings of Bats Drinking on the Wing

Bats are the only mammals that drink water while in flight. For the past few years, Virginia Tech researchers have been studying the kinematics of bats during drinking flight and compared it to straight flight. This research can lead to a better understanding of how competing demands on locomotion can be reconciled and could benefit applications such as water sampling with drones. Specifically, the goal of this experiment has been to capture high-speed video footage of bat flight while drinking. The videos can then be analyzed to determine the body kinematics of bats. In this experiment, two Pratt's roundleaf bats (*Hipposideros pratti*) were studied. Three high speed cameras were placed along two adjacent sides of the water basin in the bats' flight room. The cameras were synchronized and triggered when the bats fly by a motion-detecting ion laser. Various environmental conditions, such as light color and intensity, duration of light exposure, duration of water removal, and frequency of experiments were changed to create an environment where the bats would fly to drink in front of the cameras. Denying the bats water for short periods of time was effective in getting the bats to fly in front of white lights that were bright enough to capture videos with high temporal resolution. This was contrasted with video recordings of straight flight taken of bat flying in a flight tunnel. In the future, the behavior of bats of different sizes can be studied to understand the limits and modifications of bat drinking flights.

**Mentors:** Rolf Mueller (Virginia Tech / Shandong University, Mechanical Engineering), Sunghwan Jung (Virginia Tech, Biomedical Engineering and Mechanics)

# *KAUST ICTAS REU*

## PROGRAM DIRECTOR

Dr. Vinod Lohani, Engineering Education + ICTAS

## PROGRAM PARTICIPANTS

### Jaafar Al Hadab

UNIVERSITY OF ROCHESTER, Mechanical Engineering
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### Abdulelah Qahtan

VIRGINIA TECH, Chemical Engineering
Faculty Mentor: Dr. Peter Vikesland

JAAFAR AL HADAB
UNIVERSITY OF ROCHESTER / MECHANICAL ENGINEERING

## Developing an improved material model for rib cortical bone used in human finite element models

The thorax is a frequently injured region in car crashes, and the properties of the ribs greatly influence the likelihood of thoracic injury. Understanding how a rib behaves in a car collision is therefore a major concern for car crash safety research. Rib behavior is guided by two factors: the rib geometry, and the material properties of the rib bone. To develop accurate models of the cortical bone layer in the human rib, tensile tests of cortical bone coupons were simulated in LS-DYNA, and the force-time histories of the finite element (FE) model were compared with data from experimental tests. The compressive material properties were defined based on biomechanics literature. The developed material models were then implemented in full rib FE models which were employed to simulate rib bending tests. The simulations and the experimental tests were compared in terms of global responses (force, displacement) and local responses (strain). The results showed that the FE models fit the experimental data globally and locally. Additionally, rib fracture was shown to occur on the tensile side of the rib (as seen in experimental tests) rather than the compressive side (as occurred with a material that is symmetric in tension and compression). These results show that the differences in compressive and tensile material properties should be considered when creating a model of injury to bone.

**Mentors:** Costin Untaroiu (Virginia Tech, Biomedical Engineering & Mechanics), Keegab Yates (Virginia Tech, Biomedical Engineering and Mechanics)

FARIS ALMOHAMED
PENN STATE UNIVERSITY / MATERIAL SCIENCE AND ENGINEERING

## Integrating synthetic polymers into Portland cement concrete to improve durability

The purpose of this study is to improve the durability and hydrophobicity of concrete. With the current state of concrete, it has to be replaced every now and then. The production of cement, which is a main component of concrete, requires a lot of energy and produces 8% of the world's carbon dioxide. The hypothesis is based on finding a cheap additive, usually a polymer, that could improve the targeted properties. We mixed different concentrations of PDMS-PEO into our concrete mix. Ultimately, we were able to improve the hydrophobicity of concrete but had no luck with improving its durability.

**Mentor:** Kristie Caddick (Virginia Tech, Geoscience)

HASSAN ALMOHAMMEDSALEH
VIRGINIA TECH / ELECTRICAL ENGINEERING

## Solving Second Dgree Polynomials Using Artificial Neural Network

In our project, we use artificial neural network (ANN) that mimics how a human brain acquires to categorizes and clusters information for subsequent use. We developed a software for root'finding for a number of algebraic and transcendental equations that one comes across in fluid mechanics, heat transfer, solid'mechanics and mechanical vibrations of continuous systems. The objective will be to develop artificial neural network that can provide an initial guess for root'finding that can lead to a rapid convergence to the desired root(s). Our initial research, funded by NASA, has shown that such a use of artificial intelligence is indeed possible. Our main focus was to solve second degree polynomials and storing the data using a program coded by MatLab, then we finalized the process using ANN. The results of the project were getting the software working and actually solving the polynomial, which is the first step on the way of using ANN for solving n degree polynomials.

**Mentor:** Dr. Rakesh Kapania (Virginia Tech, Aerospace & Ocean Engineering)

YASMEEN ALSAIHATI
UNIVERSITY OF CALIFORNIA, IRVINE / CHEMICAL ENGINEERING

## Fluorescent-Labeled cellulose derivatives for ASD

Hydrophobic drugs suffer from poor aqueous solubility, therefore, crystallizing and causing poor bioavailability. The Edgar group aims to synthesize amphiphilic cellulose derivatives, in order to rescue these drugs by inhibiting drug-crystallization as amorphous solid dispersion (ASD) polymers that promote drug/polymer interaction. We aim to attach fluorophores in order to monitor targeted delivery and controlled release of the drug into the small intestine, as well as determine key interactions. The ASD polymers will be characterized by using FTIR and 1H (proton) and 13C (carbon) NMR. Gastrointestinal conditions will later be simulated for drug release profile.

**Mentor:** Diana Novo (Virginia Tech, Chemistry)

NASER ALSUBAIEI
VIRGINIA TECH / MECHANICAL ENGINEERING

## The ionic liquid gel polymer electrolytes for solid state lithium metal battery

The lithium metal anode has specific capacity of 3,829 mAh g-1 and 2,061 mAh cm-3, electrochemical potential of -3.04 V vs the standard hydrogen electrode. Thus, solid state lithium metal battery is considered as a most potential development of battery future. However, the commercial battery usually used liquid electrolytes with organic solvents, which is flammable, volatile, and toxic. The battery will catch fire or explosion when overcharge or short circuit. To solve the safety of the battery, the polymer electrolyte was selected with an good conductivity and wide electrochemical stability window. In the study, we investigated the electrochemical properties of ionic liquid gel polymer electrolytes (ILGPEs), such as ionic conductivity, lithium ion transference number, and electrochemical stability window. The lithium symmetrical cell used ILGPE as electrolytes was tested at a current density of 0.05 mA cm-2. The symmetrical cell can cycle for 1000 cycles and over 600 h. The interfacial compatibility of lithium electrode with ILGPE was also investigated by testing the interfacial resistance of the lithium symmetrical cell with a longtime storage. Besides, the specific capacity and cycle life of LiFePO4|ILGPE|Li cell was investigated at a current density of C/10. The results show the have a good interfacial compatibility and conductivity.

**Mentor:** Xiaona Pan (Virginia Tech, Chemistry)

AYMAN ALZOMAILI
UNIVERSITY OF WISCONSIN-MADISON / ELECTRICAL ENGINEERING

## Improving the durability of pneumatic actuators for Batbot

This project aims to improve the durability of the current version pneumatic actuators for the BatBot. The Batbot is a bio-insoired project that aims to mimic the echolocation capability of the greator horseshoe bat. This could prove very useful as a compact and lightweight alternative sensor/sonar for current echolocation devices. The new actuators were designed using CAD software and made using silicone molds. They will be tested for durability using air compresors and compared to the previous actuators. Testing is still in progress.

**Mentors:** Joseph Sutlive (Virginia Tech, ICTAS II), Ruihao Wang (Virginia Tech, ICTAS II)

BASEM ERAQI
UNIVERSITY OF CALIFORNIA, IRVINE / MECHANICAL ENGINEERING

## Investigation of The Feasibility of Applying Artificial Neural Networks in Integrating Singular Functions

In this age of computer-driven scientific research, numerous challenges faced in mechanical and aerospace engineering research are code-based. Dr. Rakesh Kapania's lab is working on optimizing the aerodynamics of plane parts by using computer algorithms, these algorithms require solving and manipulating systems of equations that require significant computations that are both resource and time heavy-consuming. In an initial step to addressing this issue, Dr. Kapania's laboratory is researching the numerical integration of singular functions through non-mathematical methods of integration. Mathematical functions that were believed to have infinite integrals areas over certain intervals are now possible to have a definite integration areas, this finding was achieved through attempting to apply Artificial Neural Networks and Machine Learning techniques to estimate integrable areas of the previously mentioned singular functions.

**Mentors:** Dr. Rakesh Kapania (Virginia Tech, Aerospace and Ocean Engineering), Junhyeon Seo (Virginia Tech, Aerospace and Ocean Engineering)

ABDULELAH QAHTAN
VIRGINIA TECH / CHEMICAL ENGINEERING

## Nanomaterial Enabled Sensors for Water Quality Monitoring

The recent advances in nanotechnology have been used to solve environmental issues that can affect many people worldwide such as water pollution corresponding to the global industrial revolution. In this research, nano'enabled sensors are being designed to provide high efficiency, multiplex functionality, and high flexibility sensing applications. Gold nanoparticle-based sensor platforms will be utilized to detect organic and inorganic contaminants in both tap and surface waters. After making nano-particles, it was characterized using UV-VIS, and DLS, then all interactions between particles and different compounds that can be found in the environment were recorded to monitor how these particles can detect contamination. Besides, nano-plastic waste, generated from daily chemical products such as soap, interacts with surrounding after it gets disposed. These waste particles can be the best carrier of some types of harmful viruses that cause diseases. One of the main focuses of this research is to study how can these particles modify the construction of the DNA of water.

**Mentor:** Dr. Peter Vikesland (Virginia Tech, Civil & Environmental Engineering)

# *Macromolecules Innovation Institute REU: Materials Innovation at the Intersection of Food-Energy-Water Systems*

## PROGRAM DESCRIPTION

Future scientific leaders must effectively communicate across disciplinary boundaries relating to food, energy, and water, with a "molecules to manufacturing" perspective for recognizing commonly shared and unique challenges, discoveries, and solutions. Our primary objective is to nurture students to pursue graduate studies and academic and industrial careers in FEWS fields, establishing the pool of educated and energetic talent to fuel the competitiveness of our nation. REU MII-FEWS research will provide enabling polymeric materials for food distribution, water efficient crop production, real-time monitoring devices, advanced manufacturing concepts to print the next generation of membranes for water purification, and novel synthetic methods to understand predictable transport and diffusion through materials. Working in teams, effective communication across the population, and igniting passion for discovery remain cornerstones. REU publications will serve as a key indicator for our success. The REU students will emerge as scientific leaders in a critical area for our nation; the students will initiate an interdisciplinary network of scientists with a spirit of entrepreneurship and a passion for societal impact. Students will understand the social complexities of translating technologies to international communities.

## PROGRAM COORDINATOR

Kim Felix

## PROGRAM PARTICIPANTS

### Brittany Anderseon

FAYETTEVILLE STATE UNIVERSITY, Biology
Faculty Mentor: Dr. Edgar

### Charles Ellis

NC STATE UNIVERSITY, Mechanical Engineering
Faculty Mentor: Dr. Chris Williams

### John Migliore

BETHEL UNIVERSITY, Chemistry
Faculty Mentor: Dr. Tim Long

### Ami Patel

UNIVERSITY OF NORTH CAROLINA-CHARLOTTE, Chemistry
Faculty Mentor: John B. Matson

BRITTANY ANDERSON
FAYETTEVILLE STATE UNIVERSITY / BIOLOGY

## Solubility in Clarithromycin enhancement by Amorphous Solid Dispersions with CCAB and PVP

Clarithromycin (CLA) is an antimicrobial drug used orally to treat mild to moderate bacterial infections. However, CLA has low solubility at a neutral pH level but improved solubility under acidic pH levels. Amorphous solid dispersion (ASD) has been demonstrated to be an effective strategy to improve solubility of drugs and thus improve bioavailability. Cellulose is the most abundant polysaccharide that is found in nature and its derivatives are very important to pharmaceutical industries. Studies have shown that polyvinylpyrrolidone (PVP) is a promising hydrophilic polymer with diverse properties along with its high thermal and chemical resistance and its solubility in water. 6-carboxy-cellulose acetate butyrate (CCAB) is a highly new commercial cellulose derivative. Using cellulose derivatives can prevent recrystallization after the drug is released into the GI tract. Also, water soluble polymers allow stabilization against crystallization from a solution. The goal of this study is to enhance the solubility of CLA using amorphous solid dispersion (ASD) with two distinct polymers, CCAB and PVP. The ASD formulations were prepared by solvent casting and analyzed using high liquid performance chromatography (HPLC) to examine the solubility over a eight hour drug release study. Using both polymers together with CLA did not increase the solubility under acidic conditions.

**Mentors:** Dr. Edgar (Virginia Tech, Sustainable Biomaterials), Chengzhe Gao (Virginia Tech, Chemistry)

CHARLES ELLIS
NORTH CAROLINA STATE UNIVERSITY / MECHANICAL ENGINEERING

## A Comprehensive Study on the Effect of Acetaminophen in the Binding Fluid Versus the Powder in Powder Bed Jet Printing

**Mentor:** Dr Chris Williams (Virginia Tech, Mechanical Engineering)

JOHN MIGLIORE
BETHEL UNIVERSITY / CHEMISTRY

## Synthesis and Characterization of Biologically-Sourced Polyureas for Controlled Ammonia Release

The need for environmentally friendly materials continues to rise due to social, political, and environmental demand. This study incorporates a recently developed food-energy-water nexus based approach and green chemistry principles to generate polymeric sources featuring sustained ammonia release. The food-energy-water nexus based approach serves as a system to link complex interactions between three complementary disciplines. Isocyanate free synthesis of polyureas through melt polycondensation provides renewable and biologically-derived starting materials in synthetic processes. This allows for less reactive, nontoxic working conditions due to the absence of isocyanate exposure and storage. PTMO-based and segmented PTMO-based polyurea analysis provided chemical and physical property characterization. Film processing of both polyureas suggested high molecular weight. Thermomechanical analysis showed varying melting temperatures dependent on crystallinity and hydrogen bonding interactions. Tensile testing of segmented polyureas demonstrated high strain capabilities under moderate stress. These isocyanate-free and biologically-sourced polyureas reveal potential as controlled ammonia release vehicles for agricultural application in nitrogen-containing fertilizers.

**Mentor:** Dr. Tim Long (Virginia Tech, Macromolecules Innovation Institute)

AMI PATEL
THE UNIVERSITY OF NORTH CAROLINA, CHARLOTTE / CHEMISTRY

## Synthesizing Tapered (Cone-Shaped) Bottlebrush Polymers by Sequential Addition of Macromonomers

Bottlebrush polymers, or molecular brushes, are a type of graft polymer comprised of a linear backbone and polymeric side-chains. Moreover, bottlebrush polymers of different morphologies have been explored because of their unique properties and applications. In this work, tapered (cone-shaped) bottlebrush polymers were synthesized to study the physical and biological effects of morphology. A series of macromonomers with different molecular weights were synthesized by photoiniferter polymerization using norbornyl functionalized chain transfer agents. These macromonomers had molecular weights ranging from 1.5 to 7.5 kg mol-1 in 1.5 kg mol-1 intervals. Using ring-opening metathesis polymerization (ROMP), while also employing the sequential addition of macromonomers (SAM) approach, tapered bottlebrush polymers were synthesized. Further research will involve synthesizing bottlebrush polymers to use as templates to form gold nanoparticles in the shape of a cone to assess their plasmonic properties.

**Mentors:** John B. Matson (Virginia Tech, Chemistry), Mohammed Alaboalirat and Samantha Scannelli (Virginia Tech, Chemistry)

# *Multicultural Academic Opportunities Program (MAOP)*

## PROGRAM DESCRIPTION

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

Since many SRI participants eventually enroll in graduate school at Virginia Tech or elsewhere, this program has been an especially effective way to invest in and prepare a talented, diverse group of students for enrollment in graduate programs. Previous participants have been very successful in obtaining graduate degrees and in adding to the diversity of their institutions and within their professional fields.

## PROGRAM COORDINATOR

Dr. Jody Thompson Marshall

## PROGRAM PARTICIPANTS

### Madison Bardot

VIRGINIA TECH, Chemistry
Faculty Mentor: Michael Schulz

### Maria Borjas

UNIVERSITY OF HOUSTON, Psychology
Faculty Mentor: Dr. Vanessa Diaz

### Emerald Greene

VIRGINIA TECH, Chemistry
Faculty Mentor: Dr. John Morris

### Ann May

VIRGINIA TECH, Chemistry
Faculty Mentor: Amanda Morris

### Victoria Moore

MARY BALDWIN UNIVERSITY, Biology
Faculty Mentor: Andrea Bertke

### Julian Mory

KENNESAW STATE UNIVERSITY, Chemistry
Faculty Mentor: Dr. John Morris

### Freddie Xu

DUKE UNIVERSITY, Biology
Faculty Mentor: Dr. Susan R. Whitehead

### Christopher Baires

NORTHERN VIRGINIA CC, Biomedical Engineering
Faculty Mentor: Dr. Sunny Jung

MADISON BARDOT
VIRGINIA TECH / CHEMISTRY

## Synthesis of Polymers with Pendant Adenine and Cytosine for Doxorubicin Sequestration during Chemotherapy Treatment

Liver cancer is the third leading cause of cancer mortality in the United States.1 The most common treatment is chemotherapy, specifically doxorubicin (DOX) administered via transarterial chemoembolization (TACE).2 To minimize the side effects caused by the systemic circulation of DOX, this research seeks to develop a polymer film with pendant DNA bases for DOX sequestration after leaving the hepatic tumor. Nucleobase-containing polymers with adenine and cytosine were prepared via atom transfer radical polymerization (ATRP), conventional radical polymerization, and reversible addition-fragmentation chain-transfer (RAFT) polymerization of methacrylate and acrylamide analogs.3 Monomers and polymers were characterized by 1HNMR and 13CNMR. The binding efficiencies of the monomers, polymers, and DNA were determined via isothermal titration calorimetry. The polymers will be covalently bonded to a cotton surface in order to compare the DOX capture capabilities of the nucleobase-containing polymers with those of genomic DNA. The nucleobase containing polymer will also be attached to a polymer film for analysis of DOX capture. The polymers bound to the cotton and polymer film surfaces will be tested in water, buffer solution, and human serum. After the analysis of the cytosine and adenine polymers, guanine and thymine monomers will be synthesized and tested similarly. Finally, combinations of polymers will be tested.

**Mentor:** Michael Schulz (Vitginia Tech, Chemistry)

MARIA BORJAS
UNIVERSITY OF HOUSTON / PSYCHOLOGY

## Examining the Relationship Between Language Proficiency and Executive Function for Monolingual and Bilingual Children

The underlying mechanism of the reported executive functioning advantage in bilinguals has not been well examined. Theoretically, inhibiting and switching between their languages has been proposed as the driver behind bilinguals' executive functioning performance. In the current longitudinal study, we sought to identify the direction of the relationship between language proficiency and executive functioning, and differences therein between bilinguals and monolinguals. The sample was composed of 40 Spanish-English bilingual and 38 English monolingual preschool children. The children were administered tests assessing their receptive vocabulary, a measure of language proficiency, and executive functioning. Data was collected twice, one year apart. Results showed that while for monolingual children language proficiency at Time 1 predicted performance on executive functioning tasks at time 2, (Appropriately controlling for the effects of executive functioning at Time 2 and age at both times), this was not found for the bilingual group. In addition, we found that the reverse was not true for monolinguals, suggesting that language proficiency predicts executive functioning, but not vice versa. Importantly, this difference found between bilingual and monolingual children casts doubt on the suggestion that the executive functioning bilingual advantage is due to linguistic aspects, as the two were not related at either time point in our study. These results also shine light on the need for more research on the developmental differences between monolinguals and bilinguals.

**Mentor:** Dr. Vanessa Diaz (Virginia Tech, Psychology)

EMERALD GREENE
VIRGINIA TECH / CHEMISTRY

## Atmospheric Stability of Zirconium Based Metal-Organic Frameworks

Metal-organic frameworks (MOFs) are highly porous materials which have been used in a wide variety of applications including filtration of hazardous materials, gas storage, and energy conversion. The zirconium-based UiO-series MOFs are known to have excellent thermal and chemical stability; however, little is known about their long-term stability when used in atmospheric conditions. The objective of this work was to probe the effect that ozone (O3), sulfur dioxide (SO2), and nitrogen dioxide (NO2) exposure, which are present in the atmosphere, have on the zirconium-based MOFs: UiO-66 and NU-1000. Two separate techniques: infrared spectroscopy (IR) and attenuated total reflectance infrared spectroscopy (ATR-IR) were used to analyze possible changes in the MOF structures following exposure to high concentrations of O3, SO2, and NO2. In situ FTIR monitoring of ozone exposure to UiO-66 and NU-1000 revealed that the structures were completely altered based on the different positive and negative peaks that formed. UiO-66 and NU-1000 were then exposed, ex situ, to O3, SO2, and NO2 separately. ATR-IR studies of pre- and post-O3 exposed UiO-66 and NU-1000 indicated the formation of carbonyl-based species at the expense of the aromatic linkers. SO2 exposure had little to no effect on the structure of both UiO-66 and NU-1000. NO2 however resulted in the formation of amide-based species and nitro-containing compounds. Overall, UiO-66 and NU-1000 are degraded when exposed to high concentrations of O3 and NO2, but are not effected by high concentrations of SO2.

**Mentor:** Dr. John Morris (Virginia Tech, Chemistry)

ANN MAY
VIRGINIA TECH / CHEMISTRY

## Host-Guest Encapsulation of Alkali Metals by Al-based Molecular Cage

Since the discovery of crown ethers, a new field of alkali metal host-guest interactions has developed to improve modern environmental practices, such as Cs capture from nuclear runoff. Cs is a toxic, radioactive metal that poses harm to humans, aquatic life, and the environment. In this study, Cs+ and other alkali metals bind to a porous Al-based supramolecular cage, Al-pdc-AA, for use in environmental metal extractions. Al-pdc-AA consists of pyridine-2,5-dicarboxylic acid organic ligands and dimeric Al-aceto nodes. Chemical characterization was conducted using 1H nuclear magnetic resonance (NMR), 13C NMR, single crystal X-ray diffraction (SXRD), thermogravimetric analysis, and isothermal calorimetry (ITC). Titration studies utilizing 1H NMR and ITC were conducted to characterize the binding of various alkali metals to the Al-based cage. Larger cations, such as Cs+, bind most strongly, as shown by the decrease in the chemical shifts of the 1H NMR spectra. From these spectra, binding affinities were explored for the Al-pdc-AA cage. Preliminary findings show that the Al-based cage binds Cs in a 2:1 ratio. Future work will include the synthesis of analogous Al supramolecular cages and solid-state absorption of gases, such as carbon dioxide.

**Mentor:** Amanda Morris (Virginia Tech, Chemistry)

VICTORIA MOORE
MARY BALDWIN UNIVERSITY / BIOLOGY

## Growth characteristics of HSV1 and HSV2 in primary adult neurons under various conditions

**Mentor:** Andrea Bertke (Virginia Tech, Population Health Sciences)

JULIAN MORY
KENNESAW STATE UNIVERSITY / CHEMISTRY

## The design of a flow cell reactor for investigating catalytic oxidation and chemical warfare agent breakthrough on high surface area materials

Chemical warfare agents (CWAs) remain an important field of study due to their continued use of attacks on both military combatants and civilians. This motivates researchers to develop novel catalytically active materials for CWA decomposition. Polyoxometalates (POMs), metal organic frameworks (MOFs), and metal oxides are promising materials for the catalytic destruction of CWAs. Our approach to further shed light on this subject was to develop an atmospheric flow reactor, equipped with a set of Mass Flow Controllers (MCFs), a saturator cell, and a gas mixing chamber that can characterize compounds as they react with these materials in real time by mass spectrometry. Carbon monoxide oxidation and methanol oxidation are extremely well-studied systems. To test the validity of the flow reactor, we observed these reactions under an ultra-high vacuum chamber with a base pressure of 10-9 torr. We further tested the flow cell by studying dimethyl chlorophosphate (DMCP) oxidation over several Au/TiO2 catalysts. The results from the reactor reveal DMCP being degraded by the catalysts by high temperatures.

**Mentor:** Dr. John Morris (Virginia Tech, Chemistry)

FREDDIE XU
DUKE UNIVERSITY / BIOLOGY

## Physalis angulata pollination after herbivory: the effects of herbivore damage on pollinator preference

Pollination is arguably the pinnacle of a plant's life cycle. Progeny are generated to carry on paternal traits for higher fitness and survival while also preserving genetic diversity within/between populations. While some plant species such as Physalis angulata are able to undergo self-pollination ('selfing'), higher quality and number of seeds are still yielded by outcrossing with other plants via pollinators. Thus, the selection/avoidance of pollinators for certain plants is crucial in determining the health of future generations. This study examines pollinator preferences for plant flowers following herbivory. We created two groups of P. angulata, exposing one to Manduca sexta (a specialist herbivore of the Solanaceae family) and keeping the other as a control. Following substantial damage, the plants were introduced to the generalist pollinator Bombus impatiens, and interaction data were recorded for both groups of plants. Data analysis indicates no effect of herbivory on flower production or on pollinator preference in regard to number of flowers visited, number of unique bumblebee visitors, and average visit duration per flower. We therefore conclude that herbivory by M. sexta on P. angulata does not generate a significant effect on pollination success as mediated by B. impatiens. Running contrary to previous studies conducted on other plant-herbivore systems, this conclusion highlights an intriguing ecological relationship where herbivory does not ultimately alter plant reproductive success, potentially elucidating implementable methods for maintaining agricultural output during pest pressures without the need for intense and harmful pesticides.

**Mentor:** Dr. Susan R. Whitehead (Virginia Tech, Biological Sciences)

CHRISTOPHER BAIRES
NORTHERN VIRGINIA COMMUNITY COLLEGE / BIOMEDICAL ENGINEERING

## Interaction of Fluids on Solid Surfaces; in Traction of the Cleansing Effect of Bubbles

The study of interfacial dynamics such as liquid-solid interactions gives us an opportunity to research the complex behavior of fluids passing through a solid body. This research aids in the potential for medical uses such as artificial organs and blood transfusions. Our project involves passing bubbles in various liquids in order to understand the cleansing effect of moving bubbles. Experimentally, we manufactured millimeter-sized channels, then track the behavior of fluids through a solid channel. By studying this phenomenon, we will be able to construct a geometric principle for applying this liquid-on-solid interaction into medical practices as well as a further understanding of bio-fluid mechanisms within the human body. Additionally, we are investigating bubble cleansing in which bubbles formed from a pressurized pump are pelted upon the surface of a micro glass slide that has been brushed with protein soil to simulate bacterial substrate on surfaces. Then, the surface of the micro glass slide is analyzed to measure the effectiveness of these bubbles in removing bacteria. The goal of this project is to provide a healthier alternative to cleansing surfaces rather than using harsh chemicals. An application for this study would be the cleansing of produce surfaces via cavitation bubbles by its scrubbing nature influenced by its dimensions, velocity, and mass. This innovative method will allow for a progressive way of cleaning while being eco-friendly as well as beneficial to produce and people.

**Mentor:** Dr. Sunny Jung (Virginia Tech, Biomedical Engineering & Mechanics)

# *NSF/RET Site: WaterECubeG (Engineering, Ecology, Environment, + Geosciences)*

## PROGRAM DESCRIPTION

The MAOP Undergraduate Summer Research Internship (SRI) started in Summer 1993, and since This NSF-RET site on WaterECubeG is a collaborative effort among faculty members in the Colleges of Engineering, Science, and Agriculture and Life Sciences. The Institute for Critical Technology and Applied Science (ICTAS) hosts this site. First cohort of 10 teachers (RET scholars), 8 from High Schools and 2 from Community Colleges in SW Virginia, were recruited in summer 2017 for a 6-week program to work on various interdisciplinary water research projects. They also participated in a professional development program including field trips and learning module development activities.

These RET scholars will infuse their research experiences into their courses during academic year 2017-18. One key objective of the site is to establish a community of teachers mentored in interdisciplinary water research for support, collaboration, and dissemination of site activities to a larger group of teachers in Virginia. The site will continue in the summers of 2018 and 2019. The site activities are coordinated by the faculty and students in the Learning Enhanced Watershed Assessment System (LEWAS) lab.

## PROGRAM DIRECTORS

Dr. Vinod K Lohani, Engineering Education + ICTAS
Dr. Randy Dymond, Civil & Environmental Engineering

## PROGRAM PARTICIPANTS

### Steve Ahn

TEACHER: HOLSTON HIGH SCHOOL, Science
Faculty Mentor: Dr. Kang Xia

### Katie Holcomb

TEACHER: PATRICK HENRY HIGH SCHOOL, Science
Faculty Mentor: Dr. Brian Brown

### Dawn Hakkenberg

TEACHER: PATRICK HENRY HIGH SCHOOL, Mathematics
Faculty Mentor: Nicholas Benn

### Troy Kaase

TEACHER: FRANKLIN COUNTY HIGH SCHOOL, Science
Faculty Mentor: Amy Pruden

### Caroline Hickam

TEACHER: RADFORD HIGH SCHOOL, Science
Faculty Mentor: Dr. Brian Brown

### Maria Sherman

TEACHER: HIDDEN VALLY HIGH SCHOOL, Science
Faculty Mentor: Dr. Jason He

# *NSF/RET Site: WaterECubeG (Engineering, Ecology, Environment, + Geosciences)*

PARTICIPANTS continued

## Catherine Twyman

NEW RIVER COMMUNITY COLLEGE, Engineering
Faculty Mentor: Dr. Vinod Lohani

## Schuyler van Montfrans

TEACHER: DECATUR HIGH SCHOOL, Science
Faculty Mentor: Erin Hotchkiss

## Shaunna Young

TEACHER: ROANOKE COUNTY SCHOOLS, Science
Faculty Mentor: Dr. Daniel McLaughlin

STEVE AHN
TEACHER: HOLSTON HIGH SCHOOL / BIOLOGY, ENVIRONMENTAL SCIENCE, ANATOMY & PHYSIOLOGY

## A Study of Karst and Surface Water Nitrate Levels in Damascus, VA

Karst and surface water at the South Fork Holston River (SFH) near Damascus, VA was tested for nitrate to address: 1) does the local wastewater treatment plant affect nitrate levels downstream in SFH? 2) do local cave streams show elevated nitrate and could those levels affect SFH? The purpose of this study is to develop a long term project for local high school students to monitor nitrate levels in the river; to determine the connectivity between identified cave streams and river; to determine the source of nitrate levels in cave streams; and to determine the degree of influence that cave streams on SFH nitrate levels. Water samples along SFH and 2 unnamed caves were collected and analyzed using a cadmium reduction method. Our tests showed that the wastewater treatment plant has no influence on the nitrate levels downstream SFH, but nitrate levels in the cave stream were significantly higher compared to surface water. Nitrate in water of a sinking stream in the agricultural land above a sampled cave was as low as that of the local surface water, leading investigators to question the source of the nitrate in the cave stream. The karst area and identified caves are on the north side of the river and while 2 tributary streams were identified by map, none were found flowing into SFH, suggesting karst cave streams and seeps are the primary feeder water sources on the north side of SFH and would influence nitrate levels in the SFH.

**Mentor:** Dr. Kang Xia (Virginia Tech, Crop Soils & Environmental Science)

DAWN HAKKENBERG
TEACHER: PATRICK HENRY HIGH SCHOOL / MATHEMATICS

## Local Anaerobic Co-Digestion: A Feasibility Study

The goal of this project is to determine the feasibility of anaerobically co-digesting food waste from D2 with primary and secondary solids from the Christiansburg Wastewater Treatment Plant (CWTP) to produce a biogas that is 40-70% Methane. Virginia Tech currently ships its food waste 80 miles away for composting at an annual cost of over $100,000 to the institution. Would it be cheaper and more sustainable to process the food waste locally? It has been shown previously that anaerobic digestion has the following advantages in comparison to composting: conservation of energy (no aeration), energy generation (combustion biogas), lower biomass generation, a smaller footprint and less odor. To determine whether local co-digestion is feasible, we conducted a biochemical methane potential assay (BMP) at 35 ?ˉC with processed food waste, primary and secondary wastewater solids, and poly-lactic acid (PLA), a certified industrially compostable plastic commonly used for food packaging, with an inoculum from CWTP and a solution of micro and macronutrients. We also investigated how thermal hydrolysis pretreatment (THP) of each substrate would affect co-digestion. Solids analysis, chemical oxygen demand (COD), and volatile fatty acids production (VFA) were monitored before and after THP. Additionally, a specific methanogenic activity (SMA) assay was done before and after BMP assays to investigate how blending substrates and pretreatment of substrates affected methanogenic activity. We predict blending substrates will increase biogas production without adverse effects to the anaerobic digestion process and THP will increase both BMP and SMA.

**Mentor:** Nicholas Benn (Virginia Tech, Civil & Environmental Engineering)

CAROLINE HICKAM
TEACHER: RADFORD HIGH SCHOOL / EARTH AND SPACE SCIENCE, ENVIRONMENTAL SCIENCE

## A Comparison of Anthropogenic Runoff Verses Physiographic Runoff and Their Effects on Insect Communities

All streams visually appear to have the same clean, clear water and thriving insect communities. Stroubles in Blacksburg, Virginia and Spruce Run in Newport, Virginia both have organisms living in the benthic zone, the lowest level of a body of water. These organisms have a close relationship with the substrate bottom, which greatly influences the biological life residing there. Urbanization adversely affects a stream's ability to capture and reduce nutrients. This is markedly different compared to a stream in a forested area receiving mostly seasonal runoff. We collected benthic samples from cobblestone lined baskets designed to mimic the benthic layer in two streams to determine the effects of anthropogenic runoff(agricultural/urban) verses physiographic(overland flow/groundwater) runoff on the benthos. Colonization trays are placed vertically at 5 and 15 meters above and below the confluence in the mainstream. We used a D- net to collect benthic samples on days 4, 7, and 14 from the baskets in the mainstream, beside the baskets, and in each tributary. We sorted and identified insect samples to family. Measurements of stream velocity, temperature, conductivity, PH, width, and depth were also collected at each site on days 4, 7, and 14. We assessed habitat quality at each location to help establish visual parameters for each stream. The amount and type of macroinvertebrates collected in each stream will be indicative to effects of anthropogenic runoff verses physiographic runoff. Data collected will also determine water quality and how assembly processes affect the amount and type of stream macroinvertebrate communities.

**Mentors:** Dr. Brian Brown (Virginia Tech, Biologcal Sciences), Sara Cathey and Savannah Justus (Virginia Tech, Biological Sciences)

KATIE HOLCOMB

TEACHER: PATRICK HENRY HIGH SCHOOL / PRE-AP BIOLOGY, BIOLOGY, ANATOMY AND PHYSIOLOGY



## Does sediment pollution affect stream insect community structure?

Substrate size can affect the stream insect colonization; larger cobble may attract different organisms than smaller cobble or finer substrate. Sediment pollution reduces habitat availability for stream insects and thus affects macroinvertebrate community structure. Insect communities may also be influenced by the proximity to a potential source of colonists, such as insects that disperse from tributaries. Thus, insect communities close to a confluence may be more diverse if habitat quality is improved. This study looks at the effect of sediment pollution and tributary influence on community structure. Colonization trays with cobble were placed in the mainstream at 5 meters and 15 meters above and below a tributary. We placed cobble in baskets simulating benthic layers of the stream and collected samples from the colonization trays. Then we collected benthic samples using a D-net beside colonization trays and in the tributaries. Samples were sorted, identified to the family level, and counted. Each day we measured of the pH, temperature, conductivity, flow, and stream width for reference to compare the different locations. We assessed habitat quality of each site. Samples were collected from Stroubles Creek in Blacksburg, Virginia and Spruce Run in New Port, Virginia. We compared the community composition and biodiversity above and below the tributary, as well as between benthic and tray samples. Based on the comparison of macroinvertebrates in the trays and the benthic samples we predicted that the sediment pollution would adversely impact the insect communities. The findings of this study can be applied to stream restoration practices.

**Mentors:** Dr. Brian Brown (Virginia Tech, Biological Sciences), Sara Cathey and Savannah Justus (Virginia Tech, Biological Sciences)

TROY KAASE

TEACHER: FRANKLIN COUNTY HIGH SCHOOL / BIOLOGY AND PHYSICS



## Effect of Multiple Advanced Potable Water Reuse Treatment Barriers on Microbial Community Structure and the Occurrence of Antibiotic Resistance Genes

The work done in this project focuses on providing insight into a possible future of wastewater treatment processes; specifically, implementing O3/Biologically Active Filtration based advanced wastewater treatment (AWT). By taking advantage of the HRSD Sustainable Water Initiative for Tomorrow (SWIFT) project, this research analyzes the microbial community throughout a pilot scale AWT system using several molecular techniques, such as 16s Amplicon Sequencing, qPCR, Qubit, and shotgun metagenomics. These analytical methods illuminate the effects of AWT processes with regards to microbial contaminants of emerging concern and the development of different bacterial communities in the BAF system itself. Thus far, the project has been able to identify the ten most prevalent phyla and class of bacteria within the BAF treatment system. More samples are still in the process of analysis to gain a better picture of the AWT process in the SWIFT project.

**Mentors:** Amy Pruden (Virginia Tech, Civil & Environmental Engineering), Matthew Blair (Virginia Tech, Civil and Environmental Engineering)

MARIA SHERMAN
TEACHER: HIDDEN VALLEY HIGH SCHOOL / AP CHEMISTRY/COLLEGE BOUND CHEMISTRY

## Energy Recovery from Wastewater Via Microbial Fuel Cell 3D Printed Platform

A tremendous amount of wastewater is generated on a daily basis, and energy and other resources are required to purify and discharge the water to the environment. To reduce wastewater volume, water conservation is important and ongoing. It also would be beneficial to generate electricity while simultaneously aiding in the purification of wastewater. The purpose of this project is to construct a microbial fuel cell (MFC) using a 3D printed platform, monitor the voltage output, and calculate the maximum current obtained and coulombic efficiency of the cell. MFCs operate similarly to electrochemical cells (batteries), but use bacteria to liberate the electrons. MFCs are also continuously fed fuel, so are not depleted like batteries. Microbes oxidize the carbon in short-chain organic compounds present in wastewater, and oxygen is reduced at the cathode to complete the circuit. The fuel cell used in this project was modified from a template and 3D printed. The reactor was assembled with a carbon brush anode, a carbon cloth supported by a wire mesh cathode, and a cation exchange membrane separating the two chambers. Rubber gaskets and silicone caulk were used to seal the reactor. Anaerobic sludge from Christiansburg Wastewater Plant was introduced to culture the microbial community, and an acetate nutrient solution was used to support the colony's growth. The open circuit voltage was monitored until it reached ~0.7 V. A large resistor was then added and slowly reduced. The voltage was monitored throughout this process to determine energy production.

**Mentors:** Dr. Jason He (Virginia Tech, Civil & Environmental Engineering), Shiqiang Zou (Virginia Tech, Civil and Environmental Engineering)

CATHERINE TWYMAN
NEW RIVER COMMUNITY COLLEGE / ENGINEERING

## Something pH-ishy at LEWAS: Investigation of Sensor Accuracy and Possible Stream Pollutants

The Learning Enhanced Watershed Assessment System (LEWAS) site monitors Stroubles Creek within the Webb Branch watershed located in the northern part of the Town of Blacksburg. Recently, values reported by the LEWAS site for discharge and pH have been unreliable and concerning. Work has been done to replace the presently used method for estimating discharge with a stage-discharge relationship. Manual discharge estimates have been made using a handheld flowmeter at various stages to create a correlation between weir stage and stream discharge, however a lack of rainfall events has prevented data collection of high stage events. The pH sensor was also recently reporting values as high as 12 on July 11, 2018, compared to historic values of 8. Two possibilities were considered to explain these high values: the sensor is impaired or there is a source of alkalinity upstream of the site. After calibrating the sensor, the reported pH was still at least 1 unit higher than that measured by grab sampling with a pH tablet (9.8 and ~8 respectively). Therefore, further testing after cleaning the sensor casing will be completed and reported. The possibility of an upstream source of alkalinity is also being investigated by taking grab samples along Upper Stroubles Creek between LEWAS and the spring source, as well as collaboration with Virginia Tech Facilities Department. Results of these investigations will be presented as well as a learning module to teach engineering students about the importance of water monitoring.

**Mentors:** Vinod Lohani (Virginia Tech, Engineering Education, ICTAS), Randy Dymond (Virginia Tech, Civil and Environmental Engineering)

SCHUYLER VAN MONTFRANS
TEACHER: DECATUR HIGH SCHOOL, DECATUR, GA / PHYSICS, CHEMISTRY

## Nutrient limitation and whole-ecosystem metabolism in a dynamic urban stream

**Mentors:** Erin Hotchkiss (Virginia Tech, Biological Sciences),
Brynn O'Donnell (Virginia Tech, Biological Sciences)

SHAUNNA YOUNG
TEACHER: ROANOKE CITY PUBLIC SCHOOLS / EARTH SCIENCE

## Spatial and Temporal Drivers of Water Quality in Mountaintop Coal Mining Headwaters

Mountaintop removal mining is a process that allows miners to access coal in buried coal seams by removing the mountaintop using explosives. The excess material is deposited in a nearby valley, known as a valley fill. Headwater streams are buried underneath this excess material, potentially impacting water quality downstream. We will use long term data sets (2011-2018) to examine multiple drivers: spatial variation via geologic differences, variation in stream flow, and time since recovery.

**Mentor:** Dr. Daniel McLaughlin (Virginia Tech, Department of Forest Resources and Environmental Conservation)

# *NSF/REU Site: Interdisciplinary Water Science + Engineering*

## PROGRAM DESCRIPTION

This NSF-REU site on Interdisciplinary Water Science & Engineering at Virginia Tech was established in 2007. Three cycles (2007-09), (2011-13), and (2014-17) of this site have been completed. 85 excellent undergraduate researchers (55 women + 30 men) representing 55+ different institutions in the United States have graduated thus far. The fourth cycle of the site, hosted by the Institute for Critical Technology & Applied Science (ICTAS), began in summer 2017 and will continue until the summer of 2019. Faculty members and their graduate students from a number of departments including Engineering Education, Civil & Environmental Engineering, Geosciences, Biological Sciences, Forest Resources & Environmental Conservation, and Crop & Soil Environmental Sciences mentor REU scholars to conduct research on various interdisciplinary aspects of water science and engineering.

The REU scholars get opportunities to conduct independent research and improve their communication (written and verbal) skills. Field trips and weekly seminars are organized to develop professional skills. Weekly social interactions are facilitated to enhance personal and professional bonding among REU scholars and with faculty/ graduate students.The site activities are coordinated by the faculty and students in the Learning Enhanced Watershed Assessment System (LEWAS) lab.

## PROGRAM DIRECTOR

Dr. Vinod K Lohani, Engineering Education + ICTAS

## PROGRAM PARTICIPANTS

### Mira Chaplin

UC-BERKELEY, Civil & Environmental Engineering
Faculty Mentor: Daniel McLaughlin

### Sara Eghtessadi

UNIVERSITY OF FLORIDA, Environmental Engineering
Faculty Mentor: Dr. Zhen He

### Trevor Jones

VIRGINIA TECH, Computer Science
Faculty Mentor: Dr. Vinod Lohani

### Christian Lytle

CASE WESTERN RESERVE, Chemical Engineering
Faculty Mentor: Kelsey Pieper

### Alondra Martinez

UNIVERSITY OF OKLAHOMA, Chemical Engineering
Faculty Mentor: Amy Pruden

### Erin Milligan

OHIO UNIVERSITY, Civil Engineering
Faculty Mentor: Amy Pruden

# *NSF/REU Site: Interdisciplinary Water Science + Engineering*

PARTICIPANTS continued

## Erin Spivey
USC-AIKEN, Environmental Remediation Biology
Faculty Mentor: Dr. Bryan L. Brown

## Casey VanFossen
FGCU, Environmental Engineering
Faculty Mentor: Dr. Kang Xia

## Claire Vavrus
UNIVERSITY OF WISCONSIN, Geological Engineering
Faculty Mentor: Madeline Schreiber

## Brianna Woolfolk
UNIVERSITY OF MIAMI, Environmental Engineering
Faculty Mentor: Amy Pruden

MIRA CHAPLIN
UNIVERSITY OF CALIFORNIA, BERKELEY / CIVIL AND ENVIRONMENTAL ENGINEERING

## Spatial and temporal water quality patterns in a headwater stream impacted by surface mining

Surface mining has a documented ecological impact on Appalachian headwater streams, including increases in total dissolved solids, disturbance of hydrologic pathways, and decreases in the richness of macroinvertebrate populations. This study describes spatial patterns in concentrations of major ions and trace metals throughout a headwater stream impacted by surface mining in Southwestern Virginia. Synoptic samples were collected every 100 meters from the main stream and every 50 meters from the tributaries under low and high flow conditions. These samples were analyzed for specific conductance, major ions and trace metals. Specific conductance was higher under low flow conditions and decreased downstream from the source. Under low flow conditions, Magnesium (Mg), Calcium (Ca), and Potassium (K) exhibited decreasing concentrations downstream of the source, consistent with dilution of a point source. Barium (Ba) and Sodium (Na) showed constant concentrations downstream, consistent with a geogenic source. However, Manganese (Mn), Iron (Fe), and Arsenic (As) showed increased concentrations in a wet meadow located 900 meters from the source, consistent with increased solubility created by anaerobic conditions. Spatial patterns in Selenium (Se) suggested effects of both anaerobic conditions and possible bioaccumulation. Soil samples within, upstream, and downstream of the meadow were collected and analyzed for As and Se concentrations to further assess how these different flow conditions affect the form and fate of important water quality constituents.

**Mentor:** Daniel McLaughlin (Virginia Tech, Forest Resources and Environmental Conservation)

SARA EGHTESSADI
UNIVERSITY OF FLORIDA / ENVIRONMENTAL ENGINEERING



## Enhanced Resource Recovery from Secondary Wastewater by Integrating Algae in a Submerged Forward Osmosis System

An osmotic membrane photobioreactor (OMPBR) was designed and operated for the purpose of recovering resources, especially nutrients and water, from secondary wastewater. In this OMPBR, Diammonium Phosphate (DAP) and Monoammonium Phosphate (MAP) were selected as draw solutes to extract water towards direct fertigation. Autotrophic microalgae in the feed tank harnesses natural sunlight and converts remaining nutrients (e.g. phosphorus and nitrogen) in the wastewater into biofuel. The microalgae provides further control of the salinity buildup issue caused by reverse solute flux (RSF) in OMPB through reducing membrane fouling and enhancing biological assimilation. The efficiency of the proposed OMPBR was measured in the water flux across the membrane, which was calculated using this formula: (mass/1000 L)/(25/10000 m^2?? time) in the units of L m-2 h-1.

**Mentor:** Dr. Zhen He (Virginia Tech, Civil and Environmental Engineering)

TREVOR JONES
VIRGINIA TECH / COMPUTER SCIENCE

## Investigating the effects of interaction and display fidelity for Teaching Hydrology Concepts within an Interactive Immersive Virtual Environment

The usage of Interactive Virtual Environments (VEs) in today's society has grown significantly, as more and more powerful use cases for virtual immersion develop. When considering the effectiveness of a particular virtual environment, this study aims to investigate how interaction and display fidelity affect the user experience and sense of immersion. The goal of this study more concisely is to evaluate the effects of interaction and display fidelity on teaching hydrology concepts within a virtual environment. It is expected from previous research that the high fidelity VE will have the most positive effects on user experience and most profound results for conceptual learning, relative to the low interaction fidelity environment.

**Mentors:** Dr. Vinod Lohani (Virginia Tech, Engineering Education),
Jeremy Smith (Virginia Tech, Engineering Education)

CHRISTIAN LYTLE
CASE WESTERN RESERVE UNIVERSITY / CHEMICAL ENGINEERING



## Evaluating the science behind shock chlorination in well systems

During flooding emergencies, floodwater containing harmful constituents such as fecal pathogens can contaminate private wells. Shock chlorination is the primary method for disinfecting contaminated private wells via the addition of high concentrations of chlorine (up to 200 mg/L). However, there is no standard protocol or rigorous research investigating its effectiveness, and similar chlorination practices in other countries been proven to be ineffective. Thus, lacking research verification, this REU research conducted an in-depth evaluation of the disinfection method, with emphasis on validating its effectiveness and examining potential side effects. Specifically, the objectives are to (1) measure the chlorine demand of soluble iron and manganese, which may be found in well water, (2) examine the corrosion of common well plumbing components during shock chlorination, and (3) simulate the mixing of bleach in the well column.  We observed that high iron and manganese levels did impact chlorine levels, but not to a substantial amount (<1% of chlorine removed). Wire coupons of metals common in well systems were exposed to 200 mg/L of chlorine to evaluate the effects of bleach on corrosion. Elevated levels of leaching were observed for copper, iron, and zinc. We are beginning to examine the dispersion of bleach (liquid and granular) in a well column and the effectiveness of mixing using scaled well rigs. This research is important in validating shock chlorination as a reliable means of disinfecting private wells.

**Mentors:** Kelsey Pieper (Virginia Tech, Civil and Environmental Engineering), Rebecca Kriss (Virginia Tech, Civil and Environmental Engineering)

ALONDRA MARTINEZ
UNIVERSITY OF OKLAHOMA / CHEMICAL ENGINEERING
BRIANNA WOOLFOLK
UNIVERSITY OF MIAMI / ENVIRONMENTAL ENGINEERING

## The Presence of Antibiotic Resistance Genes in Waste Water Treatment Plants

Antibiotic resistant bacteria (ARB) have become increasingly common, now posing a health issue of global concern. Lack of clinical regulations in developing countries and the ability of antibiotics to select for ARB in wastewater may support the development of antibiotic resistance. Antibiotic resistance genes (ARG) were quantified in samples collected throughout treatment trains from two Indian and one U.S. wastewater treatment plant (WWTP). This approach, along with work conducted by an international team of researchers, aims to better understand the factors that contribute to the presence of ARGs in WWTPs and identify technologies that may mitigate ARGs in plant effluent.

**Mentor:** Amy Pruden (Virginia Tech, Civil and Environmental Engineering)

ERIN MILLIGAN
OHIO UNIVERSITY / CIVIL ENGINEERING

## Development of PCR Assays for the Investigation of Microbial Contaminants in Drinking Water Systems in Rural Puerto Rico

In the aftermath of Hurricane Maria, Puerto Rico experienced widespread flooding, prolonged power outages, and devastation to an already deficient water and wastewater infrastructure. The challenges associated with restoring access to safe drinking water in small community water systems were especially demanding as there is insufficient funding and there are few existing studies on flood-related contamination remediation. The Patillas region of Puerto Rico, in particular, has faced an outbreak of Leptospirosis, resulting in at least two fatalities after Hurricane Maria. With the expected increase in climate-related flood events, our profile of the microbial composition of seven rural drinking water systems provides valuable information for ongoing recovery efforts as well as future disaster response.
To determine the presence/absence of microbial contaminants in drinking water, we developed working polymerase chain reaction (PCR) assays for the analysis of four pathogens of concern: Leptospira spp., Salmonella spp., Giardia spp., and Cryptosporidium spp. These pathogens were chosen for their presence in fecal contaminated waters, a common occurrence after flooding. Additionally, we've refined a process for developing new assays in the Pruden lab with appropriate quality assurance/quality control (QA/QC).

**Mentors:** Amy Pruden (Virginia Tech, Civil and Environmental Engineering), Marc Edwards (Virginia Tech, Civil and Environmental Engineering)

ERIN SPIVEY
UNIVERISITY OF SOUTH CAROLINA AIKEN / ENVIRONMENTAL REMEDIATION BIOLOGY



## Invasive Crayfish Cleaning Habits and Removal of Ectosymbiont Worms

The symbiosis between crayfish and their branchiobdellidan symbionts varies with ontogeny. Smaller crayfish actively remove worms, while larger crayfish tolerate the worms, benefiting from a cleaning mutualism at low to moderate worm densities. Crayfish which are invasive to Virginia's ecosystems have few worms, if any, and are generally considered to be bad hosts which disrupt the vital exchange of symbionts between native hosts. However, little is known about what happens to worms once transferred to an invasive host, or the grooming habits of invasive crayfish species regarding the cleaner worms. We performed an experiment using Faxonius cristovarius, a common invasive crayfish in Virginia, to observe both crayfish and worm behavior when such an encounter occurs. Sixteen crayfish were divided into size categories, half of which had their dactyls ablated to hinder grooming. Once the crayfish were placed into individual observation tanks, ten C. ingens were placed onto the carapace of each crayfish. Behavior was monitored for six hours. Total worm counts were taken after six and twenty-four hours. At six hours, ablated and nonablated crayfish had small differences in worm counts. After 24 hours, regardless of ablation, medium crayfish had none or almost no worms, while large crayfish had two to three. No worms were observed abandoning the crayfish; absence of worms on F. cristovarius was determined to be caused by host removal.

**Mentor:** Dr. Bryan L. Brown (Virginia Tech, Biological Sciences)

CASEY VANFOSSEN
FLORIDA GULF COAST UNIVERSITY / ENVIRONMENTAL ENGINEERING



## Removal Efficiency of Pharmaceutical and Personal Care Products From Tap Water Using House-hold Water Filter Devices

Pharmaceuticals and personal care products (PPCPs) have been detected in ground water used for wells, and aquatic environments. PPCPs in surface water have been linked to negative impacts such as changes in hormone balance on aquatic organisms. The effects of PPCPs on human health have not be investigated long enough to prove negligible effects. PPCPs are not fully removed through conventional wastewater treatment processes and are released into aquatic environments, drinking water sources, and well water sources. According to the EPA, well water quality is the home owner's responsibility. An affordable solution for removing drinking water containments are Point-of-Use (POU) house-hold filtration devices. In this study, the POU brands under investigation were water filter pitchers with name brands of ZeroWater, EHM, BWT, and water filter bottles with name brands of Brita, and Bobble. The purpose of this study was to measure the efficiency of pharmaceutical removal of each filter. Sulfamethoxazole, carbamazepine, ibuprofen, and triclosan, were spiked to tap water before testing for their removal efficiency by POU for the recommended number of lifetime uses. The removal efficiency was measured in percent removal of each use. The analysis concluded that the POU filters' PPCP removal efficiency decreased by 26.1%-6.7% for the three tesed water pitchers and about x-y% for the two water filter bottles before the end of their recommended lifetime.

**Mentors:** Dr. Kang Xia (Virginia Tech, School of Plant and Environmental Sciences), Lucas Waller (Virginia Tech, School of Plant and Environmental Sciences)

CLAIRE VAVRUS
UNIVERSITY OF WISCONSIN-MADISON / GEOLOGICAL ENGINEERING



## Effects of oxygenation on metals in a drinking water reservoir

Elevated concentrations of iron (Fe) and manganese (Mn) in drinking water cause aesthetic concerns and adverse health impacts. During the summer, thermal stratification of freshwater bodies can lead to anoxic conditions (dissolved oxygen <2mg/L) in the bottom waters (hypolimnion), promoting release of soluble Fe and Mn from sediments into the water column. At the Falling Creek Reservoir (FCR) in Vinton VA, a hypolimnetic oxygenation (HOx) system was installed in 2013 to prevent release of metals to the water column. For my REU project, I conducted a time series analysis (2015-2017) on metals concentration data collected at FCR and a reference reservoir to evaluate the effects of the HOx system and to identify potential drivers (dissolved oxygen and temperature) on metal concentrations. Results indicate that the HOx system decreases hypolimnetic metal concentrations. However, the analysis was not able to determine if dissolved oxygen or temperature was the primary driver of metals concentrations.

**Mentors:** Madeline Schreiber (Virginia Tech, Geosciences), Cayelan Carey (Virginia Tech, Biological Sciences)

# *Translational Obesity Undergraduate Research Scholars (TOUR)*

## PROGRAM DESCRIPTION

The Translational Obesity Undergraduate Research Scholars (TOUR-Scholars) is a research- intensive summer experience, which prepares students for graduate and medical education in translation obesity research. Five undergraduate students from departments across Virginia Tech were chosen to participate in the 2018 summer program. Funding was obtained from the Department of Human Nutrition, Foods, and Exercise, the College of Agriculture and Life Sciences, The Obesity Interdisciplinary Graduate Education Program, and the Center for Transformative Research on Health Behaviors.

## PROGRAM DIRECTOR

Dr. Deborah Good, Department of Human Nutrition, Foods, and Exercise

## PROGRAM PARTICIPANTS

### Darren Dougharty

VIRGINIA TECH, Biochemistry
Faculty Mentor: Bin Xu

### Catherine Hayes

VIRGINIA TECH, Biochemistry
Faculty Mentor: Dr. Elena Serrano

### Desiree Velez

VIRGINIA TECH, Microbiology
Faculty Mentor: Kevin Davy

### Zachary Wilson

VIRGINIA TECH, Biological Sciences
Faculty Mentor: Dr. David Brown

### Andrea Yu-Shan

VIRGINIA TECH, Psychology
Faculty Mentor: Dr. Samantha M. Harden

DARREN DOUGHARTY
VIRGINIA TECH / BIOCHEMISTRY

## Aggregation of Tau Proteins in Alzheimer's Disease: I. Human Tau Isoforms

Alzheimer's disease (AD) is the sixth leading cause of death in the United States, the most common cause of dementia, and one of the most expensive diseases due to the intensive care needed for the patients and the lack of therapeutic drugs for treatment. A trademark of AD is the neurofibrillary tau protein tangles that damage neurons as they leave their native state to form the highly ordered tangles. To better understand the formation of these tangles, the six human isoforms of tau proteins were expressed using recombinant technologies and highly purified using biochemical procedures. We performed detailed analyses of the aggregation properties of the six human tau isoforms. The result of the Thioflavin-T (ThT) fluorescence based assay indicated that the isoforms that have the R2 region consistently took longer time to form amyloids than their counterpart lacking the R2 region. This may also suggest that the R2 region plays an important role in the aggregation of these tau isoforms. Going forward, the R2 region will be studied by seeding mature tau fibrils from one isoform into the other five isoforms and monitoring the aggregation kinetics. We will perform structural studies of key tau fragments with or without the R2 regions. Our work may provide useful insights into the mechanisms of tau aggregation and the discovery of inhibitors for the toxic tau amyloids.

**Mentor:** Bin Xu (Virginia Tech, Biochemistry)

CATHERINE HAYES
VIRGINIA TECH / BIOCHEMISTRY

## Data Management and Feasibility of Validity Testing of the Market Basket Assessment Tool (MBAT)

The Market Basket Assessment Tool (MBAT) is a survey that determines the availability of healthy food items including whole grains, fruits, vegetables, low-fat dairy products, lean meats, and beans, seeds, and nuts among Supplemental Nutrition Assistance Program (SNAP) -authorized retail environments (Misyak and co-workers, 2018). The goals of this study were to: assess the feasibility of proposed methodology for the validity testing of the MBAT; determine an appropriate form of data management for the validity testing of the MBAT; and ultimately suggest parameters through which the validity of the MBAT could be determined. A trained researcher conducted both the MBAT and the Nutrition Environment Measures Survey (NEMS) (Glanz, et al, 2007), the current gold-standard for retail assessments, in 12 SNAP-authorized retail environments (4 grocery stores, 4 pharmacies, and 4 dollar stores). Total scores for the MBAT and NEMS were compiled; higher scores indicated healthier retail environments for both retail measures. Total mean MBAT scores were 38.75, 14.5, and 16.75, and total mean NEMS scores were 33.25, 6.25, and 3.5 for grocery stores, pharmacies, and dollar stores, respectively, indicating that the measures roughly correlated between store types. Specific statistical tests to compare the two instruments were not possible given small sample sizes and the distinct purposes of each instrument. Future steps include further data collection from partners in Virginia, North Carolina, and Mississippi to reach a sufficient sample size for statistical testing of the validity of the MBAT and sub-coding of the NEMS to allow for better comparisons with the MBAT.

**Mentors:** Dr. Elena Serrano (Virginia Tech; Human Nutrition, Foods, & Exercise), Dr. Sarah Misyak (Human Nutrition, Foods, and Exercise)

DESIREE VELEZ
VIRGINIA TECH / MICROBIOLOGY

## Gut Microbiota-Generated Trimethylamine N-oxide and Glucose Tolerance

Type 2 diabetes (T2D) is the most common type of diabetes in the United States. Trimethylamine N-oxide (TMAO) is a metabolite produced from dietary choline metabolism by gut bacteria. TMAO is elevated in T2D. In addition, TMAO impairs glucose tolerance in rodents. Whether increases in TMAO impairs glucose tolerance in humans is unknown. The purpose of this study is to addresS this issue.
Our hypothesis is that gut microbiota-generated increase in plasma TMAO concentrations will impair glucose tolerance in healthy adults.
Twenty healthy men and women between 18-75 years old will be randomized to consume choline bitartrate (1000mg/d) or a placebo (empty capsule) A baseline blood sample is taken then the participant will be given an oral glucose tolerance test (75 mg Sundex??) and blood sampling will occur at baseline and every 30 minutes over two hours. Blood glucose will be analyzed by using Hemocue Glucose 201??.
We expect that individuals given choline bitartrate, to stimulate TMAO synthesis by gut microbiota will show impaired glucose tolerance, as compared to the placebo, in healthy adults.
This study may provide insight into understanding the role of the gut microbiota in etiology of T2D. Future studies, including possible dietary or pharmaceutical interventions for reducing available choline may inform new therapies for prevention and treatment of T2D.

**Mentor:** Kevin Davy (Virginia Tech; Human Nutrition, Foods, & Exercise)

ZACHARY WILSON
VIRGINIA TECH / BIOLOGICAL SCIENCES

## High Resolution Respirometry of Heart Mitochondria in Healthy and Diseased States

Heart disease remains the leading cause of death globally, claiming the lives of nearly 9 million people in 2016. Current standard-of-care therapies for heart disease patients reduce energy demands on the heart but do not treat underlying deficits in cellular energy production. Cardiac mitochondria are primarily responsible for the production of energy in the heart, and targeting dysfunctional mitochondria represents a promising solution to improving the prognosis of heart disease patients. Increased production of reactive oxygen species in heart disease damages mitochondrial function, ultimately decreasing cardiac energy supply. Isolated mitochondria exposed to hydrogen peroxide serves as a heart disease model where the reactive oxygen species damage the respiratory chain, a series of complexes responsible for the actual production of energy. N-acetylcysteine (NAC) is a drug precursor to glutathione, an endogenous antioxidant which reduces reactive oxygen species. In this project, isolated mitochondria are treated with hydrogen peroxide with or without NAC. If NAC is capable of rescuing the respiratory rate, that would suggest that NAC restores mitochondrial energy production in pathological states. If successful, these data would be the first step in determining if incorporation of NAC into heart disease treatment plans could begin to better treat the number of one cause of morbidity/mortality on the planet.

**Mentor:** Dr. David Brown (Virginia Tech; Human Nutrition, Foods, & Exercise)

ANDREA YU-SHAN
VIRGINIA TECH / PSYCHOLOGY

## If I wanted to walk the walk, could I? Perceptions of access and availability of community resources while participating in a statewide walking program

**Mentors:** Dr. Samantha M. Harden (Virginia Tech; Human Nutrition, Foods, & Exercise); Stephanie Breig, Thomas Strayer III, and Valisa Hedrick (Virginia Tech, Human Nutrition, Foods, and Exercise)

# *USDA REEU: Training Future Leaders to Solve Problems at the Confluence of Water & Society*

## PROGRAM DESCRIPTION

This Confluence-REEU catalyzes interactions between students from widely varying disciplines by focusing on research questions that require innovative approaches to scientific collaboration and data visualization, as well as communication to and engagement with an array of local stakeholders. This 9-week program aims to guide students in developing a nuanced understanding of the environmental and social complexity of different anthropogenic stresses on water resources; demonstrate the disciplinary diversity required to address water quality problems; provide opportunities for students to improve their scientific communication skills; and establish a lifelong professional network of professionals committed to work related to interactions between water quality and human communities.

In 2018, eight fellows were selected from eight colleges and universities across the country, with disciplinary foci ranging from Geological Engineering to Liberal Arts. Fellows worked in interdisciplinary teams of 2-3 students mentored by three or more faculty to address research topics related to the ecological and social impacts of the Mountain Valley Pipeline's construction in the New River Valley. In addition to their primary research topic, students participated in a wide range of field trips to engage with stakeholders and learn more about how extension works to link university research directly with community needs.

## PROGRAM DIRECTORS

Cully Hession (BSE)
Leigh-Anne Krometis (BSE)
Brian Badgley (CSES)
Amber Vallotton (HORT)

## PROGRAM PARTICIPANTS

### Sarah Abrahams

AUBURN UNIVERSITY, Quantitative Economics
Faculty Mentor: Leigh Anne Krometis

### Amir Barnett

NORTH CAROLINA A&T STATE, Biological Engineering
Faculty Mentor: Cully Hession

### Jessica Barthel

ROANOKE COLLEGE, Environmental Science
Faculty Mentor: Cully Hession

### Alexa Bracale

UNIVERSITY OF DELAWARE, Geological Sciences
Faculty Mentor: Cully Hession

# *USDA REEU: Training Future Leaders to Solve Problems at the Confluence of Water & Society*

PARTICIPANTS continued

## Michael Galeski

CREIGHTON, Sustainability
Faculty Mentor: Leigh Anne Krometis

## Jacob Kravits

MASSACHUSETTS-AMHERST, Civil Engineering
Faculty Mentor: Cully Hession

## Elisa Malvicini

MOUNT HOLYOKE COLLEGE, Environmental Studies
Faculty Mentor: Leigh Anne Krometis

## Caleb Ring

COLORADO SCHOOL OF MINES, Geological Engineering
Faculty Mentor: Cully Hession

MICHAEL GALESKI
CREIGHTON / SUSTAINABILITY
SARAH ABRAHAMS
AUBURN UNIVERSITY / QUANTITATIVE ECONOMICS
ELISE MALVICINI
MOUNT HOLYOKE COLLEGE / ENVIRONMENTAL STUDIES

## Public Perceptions of the Mountain Valley Pipeline: A Content Analysis of Media Commentary

This research study focuses on the Mountain Valley Pipeline (MVP), a 303 mile natural gas pipeline that runs from northern West Virginia to southern Virginia. The MVP, like many other pipeline developments in the United States, has sparked controversy amongst stakeholders directly and indirectly impacted by its construction. This project aims to gauge the perceptions surrounding the MVP through content analysis, a technique that quantitatively measures various forms of communication. In utilizing this method, it is possible to evaluate how those who support or oppose the pipeline dialogue differently about the topic and how public opinion changes in relation to time and geography. Three researchers each received a randomized sample set from the 1507 comments on The Roanoke Times articles regarding the MVP, spanning from August of 2014 to June of 2018. Each comment was categorized into specific subject groups representing key topics relating to the pipeline's development. After completing all comments from 2014, a reliability analysis was completed to ensure coder accuracy, and indicated a 94.4% reliability, which suggests these are repeatable results. This information can be used by policymakers, local community leaders, and landowners to understand how a diverse group of stakeholders perceive issues such as water quality, environmental degradation, land rights, and governmental relationships with private companies. These findings have been visually expressed through graphs and maps to convey a holistic understanding of the perceptions of the pipeline development and its effects on the social constructs of the Appalachian region.

**Mentors:** Leigh Anne Krometis (Virginia Tech, Biological Systems Engineering), James Ivory, Luke Juran, Erin Ling, Tiffany Drape, Amber Vallotton (Virginia Tech)

JACOB KRAVITS
UNIVERSITY OF MASSACHUSETTS AMHERST / CIVIL ENGINEERING
ALEXA BRACALE
UNIVERSITY OF DELAWARE / GEOLOGICAL SCIENCES

## Close-Range Imagery for Quantifying Increased Turbidity in Small Appalachian Streams

Close-range cameras were mounted upstream and downstream at a crossing of the Mountain Valley Pipeline to demonstrate that turbidity imaging is a viable alternative for isolating anthropogenic increases to turbidity. Since this pipeline, spanning from northwestern West Virginia to southern Virginia, required deforestation and extensive land disturbance, increased sedimentation in streams was expected. This increased sedimentation can pose a threat to both stream ecology and overall aesthetics. This analysis focused on a 1.4 sq. mile watershed of Mill Creek, located in Montgomery County, Virginia. Typically, turbidity is measured using costly in-situ monitoring equipment. However, in cases of extreme development, this precision is not required to detect large turbidity changes. Instead, the process of turbidity imaging with digital cameras was developed as a low cost alternative. First, a time-lapse digital camera pointed at the stream-bed and a traditional turbidity sensor recorded close-range images and turbidity measurements, respectively. Then, global image statistics were used to isolate potential image characteristics correlated with turbidity, which, for these sites was the standard deviation of blue pixel intensity. Then, four cameras were deployed to test sites upstream and downstream of the pipeline. Differences in the standard deviation, and therefore turbidity, were then quantified. Additionally, these images provide a means of visualizing anthropogenic effects on water quality. Not only is turbidity imaging an inexpensive means of monitoring, it offers a method to estimate turbidity in shallow streams where traditional methods may be infeasible. Although this research focused on Appalachian streams, further analysis is required to determine the efficacy of turbidity imaging in other regions.

**Mentors:** Cully Hession (Virginia Tech, Biological Systems Engineering),
Carl Zipper (Virginia Tech, Crop and Soil Environmental Sciences),
Peter Sforza (Virginia Tech, Geography)

CALEB RING
COLORADO SCHOOL OF MINES / GEOLOGICAL ENGINEERING
JESSICA BARTHEL
ROANOKE COLLEGE / ENVIRONMENTAL SCIENCE
AMIR BARNETT
NORTH CAROLINA A&T STATE UNIVERSITY / BIOLOGICAL ENGINEERING

## Pipeline Construction impacts on small mountain streams: evaluating stream geomorphology, water quality, and benthic macroinvertebrate diversity

The Mountain Valley Pipeline is a natural gas pipeline crossing through Appalachian karst geology and mountain streams posing environmental concerns. Deforestation and construction on mountain grades can increase erosion and release nutrients, which can affect small streams. By examining stream morphology, sediment deposition, water quality and benthic macroinvertebrate diversity we characterized four reaches in the Mill Creek watershed (Montgomery County, VA): two isolated from pipeline construction and one on each side of the pipeline right-of-way. To identify physical stream health and relative impairment, we measured stream geometries and classified stream substrate to calculate relative bed stability. We installed embedded sediment samplers above and below the pipeline right-of-way to capture fine sediments for a comparison of quantity and composition. In addition, we measured water quality using a hand-held water quality sonde (YSI) and grab samples. We determined benthic macroinvertebrate diversity using modified procedures from the EPA's Rapid Bioassessment Protocol. Samples from above and below the pipeline crossing, with varying distances, were quantified and aggregated. Study results provided quantitative and visual evidence that the below pipeline stream was physically altered compared to upstream or isolated sites. The downstream site had greater sediment loads, evident in our bed sediment sampling and pebble counts, along with an impairment rating utilizing relative bed stability methodology. However, ecologically, the benthic macroinvertebrate community showed minimal variation by site and longitudinal distances. This study sufficiently establishes baseline information; further monitoring should evaluate physical stream properties and ecosystem health as pipeline construction continues and reclamation plans are implemented.

**Mentors:** Cully Hession (Virginia Tech, Biological Systems Engineering),
Brian Badgley (Virginia Tech, Crop and Soil Environmental Sciences)

# *VT Research and Extension Experiential Learning program: Securing Our Food*

## PROGRAM DESCRIPTION

Virginia Tech's Research and Extension Experiential Learning (VT-REEL) program on Securing Our Food is a research-intensive 10-week summer experience, which engages undergraduate students in translational plant science research via a combination of hands- on laboratory and field-based experiences. VT-REEL fellows spend the first half of the program on-campus, working in molecular plant sciences labs, and spend the second half of the program at Agricultural Research and Extension Centers (AREC), working in applied plant science labs.

Eight undergraduate students from diverse academic institutions across the United States were chosen to participate in the 2018 summer program. Each VT-REEL fellow conducted a translational plant science project under the guidance of two faculty mentors: one on-campus mentor and one AREC-affiliated mentor. Students participating in the program were provided with research stipends, housing and an on-campus meal plan. Funding was obtained through the USDA-NIFA. This program will continue through 2020.

## PROGRAM COORDINATOR

Dr. Sasha Marine, Department of Biochemistry

## PROGRAM PARTICIPANTS

### Hunter Aliff

WEST VIRGINIA STATE UNIVERSITY, Chemistry
Faculty Mentor: Saghai Maroof

### Malia Bauder

OREGON STATE, Biochemistry & Molecular Biology
Faculty Mentor: Glenda Gillaspy

### Cassandra Bush

NORFOLK STATE UNIVERSITY, Biology
Faculty Mentor: Jayesh Samtani

### Elle Cornman

VIRGINIA TECH, Clinical Neuroscience
Faculty Mentor: Dr. Guillaume Pilot

### Zahria Duncan

TUSKEGEE UNIVERSITY, Environmental Science
Faculty Mentor: Dr. Birgit Scharf

### Casey Gregory

PENN STATE, Biology
Faculty Mentor: Dr. Dorothea Tholl

# *VT Research and Extension Experiential Learning program: Securing Our Food*

PARTICIPANTS continued

Chase Mullins
VIRGINIA TECH, Microbiology
Faculty Mentor: Ann M. Stevens

Alexander Varaksa
NORFOLK STATE UNIVERSITY, Biology
Faculty Mentor: John McDowell

HUNTER ALIFF
WEST VIRGINIA STATE UNIVERSITY / CHEMISTRY

## VT-REEL Experience in Agricultural Sciences: Gene mapping of Soybeans and Biochemical Responses to Stress in Potato

The goal of the first five weeks project was to identify simple sequence repeat (SSR) markers of disease resistance genes to Phytophthora sojae. We are looking for qualitative disease resistance (Rps) genes on chromosomes 3 and 13 using various primers on recombinant inbred lines (RILs) of soybeans. The microsatellites tested on chromosome 3 and chromosome 13 did not come within a close enough range (5-6 cM) to be effectively used as molecular tag but they will add to the map and more markers will be tested on these two chromosomes in the future. For chromosome 13 Satt362 is 2.2 cM away from the Rps gene which allows for it to be used as a molecular tag in marker assisted selection for determining if a plant is resistant or susceptible. This is no longer true, we reran the markers with Satt114 added and the missing data and the markers have rearranged. At the Eastern Shore AREC, the main objective was learn to determine differences in the response of two potato cultivar to environmental stresses. Conducted studies to associate membrane stability, phenolic content, and activity of enzymes in the Reactive Oxygen Species scavenging system with susceptibility/ resistance to internal heat necrosis. The experience gained by conducting this research was insightful into strengths and weakness of overall skills, which have prepared the scholar for graduate school. This research aided in the development of critical thinking skills to developing effective experiments and critical analysis from trouble shooting.

**Mentors:** Saghai Maroof (Virginia Tech, Plant and Enviromental Science), Ramon Arancibia (Virginia Tech, Plant and Enviromental Science)

MALIA BAUDER
OREGON STATE UNIVERSITY / BIOCHEMISTRY AND MOLECULAR BIOLOGY

## Can We Create a Plant to Remove Excess Phosphate from Soil and Water?

Phosphorus in non-point source runoff from agricultural systems is a contributing factor in surface waters where algal blooms form, leading to eutrophication and degradation of water quality. The two primary causes of this are overuse of fertilizer and farming of monogastric animals such as fish and pigs, which cannot digest the main source of phosphate in seeds and contribute to phosphate accumulation through their waste. A solution to this problem may lie in a central, conserved pathway in eukaryotes which is involved in phosphate uptake and signaling. Through manipulation of this pathway, we may be able to design a plant to absorb and store elevated levels of phosphate, where it could be extracted and reused to fertilize future agro-ecosystems. The primary gene of interest within this pathway is IPK1, which adds one phosphate to an inositol carbon ring resulting in inositol hexakisphosphate (IP6). Monogastric animals are unable to process IP6; when IP6 is complexed to cations, this is referred to as phytate. There are two mutations of IPK1 of interest. One is a knockout, which has altered phosphate sensing, leading to greater phosphate uptake and resulting plant toxicity. The other is an IPK1 overexpressor, which we are characterizing. We hypothesize that IPK1 overexpressors may be able to hyper-accumulate phosphate with no detrimental effect to the plant. This project has focused on characterizing both types of mutants, as a preliminary step towards a sustainable phosphorus solution that concurrently protects the environment.

**Mentors:** Glenda Gillaspy (Virginia Tech, Biochemistry), Jim Owen (Virginia Tech, Horticulture)

CASSANDRA BUSH
NORFOLK STATE UNIVERSITY / BIOLOGY



## Genome-Wide Association Study on Kunitz trypsin inhibitor in soybean seed and Supplemental Foliar Nutrients Effects on Fruit Quality and Yield of Two New Primocane Blackberry Cultivars

The following experiments exhibit the need of skills in multiple disciplines for 21st century problem-solving in plant sciences to secure food production. Soybean meal is widely used as feed for monogastric animals; however, it contains antinutritional factors like trypsin inhibitors (TI) which contribute to animal health problems. Soybean has two types of (TI), Bowman-Birk TI (BBTI) and Kunitz TI (KTI). KTI has a more substantial effect since it is present in higher amounts. This study explores the loci underlying low Kunitz trypsin inhibitor in soybean seeds using genome-wide association (GWAS) analysis. This will enhance breeding and lower the cost of production. 500 plant introductions (PIs) were collected and planted. Phenotypic and genotypic data showed several putative quantitative trait loci (QTL) on 19 chromosomes and a SNP linked to high KTI on Chromosome 8. An additional two years of testing will be conducted to compare first year findings.
Blackberries grow in US hardiness zones 6-9 which includes Virginia. This experiment aims to identify blackberry cultivars that can be effectively grown in the area. Six blackberry cultivars were grown; simultaneously, two varieties were treated with three supplementary foliar nutrient products in order to determine if these treatments improved their overall fruit quality. Preliminary data suggest that four of the six cultivars are viable and that use of foliar nutrient treatments does not improve fruit yield in one of the two studied cultivars. Data collection will continue until the end of the blackberry season to see if these trends are corroborated.

**Mentors:** Jayesh Samtani (Virginia Tech, Horticulture), Bo Zhang (Virginia Tech, Plant Breeding)

ELLE CORNMAN
VIRGINIA TECH / CLINICAL NEUROSCIENCE

## Microbes: Friend and Foe (Two separate experiments, one investigating the AAP1 amino acid transporter using yeast as a tool and the other the effect of nitrogen fertilizer on the growth and survival of Escherichia coli on leafy greens)

Amino acids are used by plants as transferable packages of nitrogen, an essential nutrient for plant growth. The transfer of amino acids throughout the plant is regulated at the molecular level by amino acid transporters. The first project investigated the interactions between the AAP1 transporter and various other proteins using a yeast-two-hybrid system, which is based on testing for growth of the yeast Saccharomyces cerevisiae on selective media in relation to the proteins expressed in the cells. One of the 44 tested proteins, a RAB GTPase, was found to interact with AAP1, revealing a potential relationship between amino acid transport and signaling. This project emphasized how microbes could be used as tools in the laboratory for discovering novel gene functions, which could be applied to crop improvement in the future, like manipulation of protein content in storage organs of plants. Escherichia coli can live in the intestines of humans and animals as a healthy part of the gut microbiome. However, some E. coli contain virulence genes (called shiga-toxin producing E. coli, STEC), which cause severe cases of food poisoning. STEC can survive for several weeks on the surface of leafy greens. Additionally, STEC are frequently associated with outbreaks and recalls associated with leafy greens. Therefore, this study aims to investigate the effect of different nitrogen fertilizer rates on the growth and survival of E. coli on the surface of leafy greens. Since nitrogen, a crucial nutrient for plant growth, can also be consumed by E. coli, it is hypothesized that increased nitrogen fertilizer rates applied to leafy greens will promote an increased survival (and or growth) of E. coli on leafy greens. The goal is to provide nitrogen fertilizer rates that limit the growth and survival of E. coli, while still producing leafy greens with optimal quality and yield.

**Mentors:** Dr. Guillaume Pilot (Virginia Tech; Plant Pathology, Physiology, and Weed Science), Dr. Laura Strawn (Virginia Tech, Food Science and Technology)

ZAHRIA DUNCAN
TUSKEGEE UNIVERSITY / ENVIRONMENTAL SCIENCE

## Alfalfa Production Recommendations; Intertwining Sinorhiobium meliloti inoculation with Phosphorus Nutrient requirements provided by Poultry Litter Ash

**Mentors:** Dr. Brigit Scharf (Virgina Tech, Life Sciences), Dr. Mark Reiter (Virgina Tech, Soil and Environmental Science)

CASEY GREGORY
PENN STATE / BIOLOGY

## Molecular and Physiological Responses to Nitrogen Stress in Seteria viridis and Sorghum bicolor

Project 1: Nitrogen is often a limiting resource for plant growth and development; therefore, nitrogen availability is a significant determinant of crop yield. In Setaria viridis, the TPS04 gene is responsible for the formation of the terpene alcohol borneol. SvTPS04 is highly expressed in plants under nitrate stress. This project aimed to evaluate SvTPS04 gene expression and borneol accumulation in Setaria viridis roots and leaves. The absolute concentrations of borneol were determined by extracting the volatile metabolites, analyzing the extractions using GC/MS, and comparing the results to a standard curve. An average of 41 ng of borneol was found in the roots; no detectable quantities were found in the leaves. RT-PCR was used to locate the site of SvTPS04 expression. SvTPS04 was expressed in the roots, but not the leaves. Project 2: Biomass Sorghum bicolor has potential as a feedstock for ethanol production due to its drought resistance, large biomass production, and suitability in established production systems. Nitrogen management aims to optimize crop yields while minimizing nitrogen losses to the environment through leaching, volatilization, and denitrification. Vegetation indices express the health and vigor of vegetation by assessing the vegetation's greenness. In this study, the vegetation indices NDVI, SPAD, GA, and GAA were used to assess the vigor of biomass sorghum exposed to varying nitrogen applications. Plant height was also used to assess crop vigor. NDVI, SPAD, GA, GAA, and plant height were all positively correlated with nitrogen availability.

**Mentors:** Dr. Dorothea Tholl (Virginia Tech, Biology), Dr. Maria Balota (Virginia Tech; Plant Pathology, Physiology, and Weed Science)

CHASE MULLINS
VIRGINIA TECH / MICROBIOLOGY

## Utilization of Reverse Genetics and Fungicide Sensitivity Assays to Study Pathogens of Two Agronomic Crops

Pantoea stewartii subsp. stewartii is a bacterial phytopathogen that causes Stewart's wilt in sweet corn. A putative transcriptional regulator, encoded by iscR, is thought to be involved with iron acquisition in P. stewartii. It is hypothesized that iscR is important for the growth and colonization of P. stewartii in planta based on a previous Tn-Seq study. This is being tested by generating a gene deletion to examine changes in phenotypes in planta. Overlap extension PCR was used to generate a fragment that was ligated into the pGEM cloning vector and sent for sequencing. If the sequencing results match the anticipated sequence, the next steps will be to complete the deletion construction via Gateway system protocol.

Parastagonospora nodorum is a fungus that causes leaf and glume blotch in wheat. Fungicides are used to control this disease, but we hypothesized that fungicide resistance may be developing in P. nodorum populations in Virginia. To test this hypothesis, 16 isolates were collected from infected winter wheat leaves from four different locations across Virginia. Fungicide sensitivity was tested by measuring radial growth of each isolate on fungicide amended media. Four different concentrations (100ppm, 10ppm, 1ppm, and 0.1ppm) and two different fungicides (pyraclostrobin and prothioconazole) were used. EC50 values were determined, and isolates varied in sensitivity to the fungicides. Next steps will be to sequence the cytochrome b and CYP51 genes for each isolate to identify mutations in fungicide target sites that may be contributing to the reduced fungicide sensitivity in P. nodorum populations.

**Mentors:** Ann M. Stevens (Virginia Tech, Microbiology), Hillary L. Mehl (Virginia Tech Tidewater AREC)

ALEXANDER VARAKSA
NORFOLK STATE / BIOLOGY

## Quantification of Fusarium verticillioides Transmission to Corn via Stink Bug Feeding using Species-specific, Real-time PCR

**Mentors:** John McDowell (Virginia Tech, Plant Pathology), Hillary Mehl (Virginia Tech Tidewatwer AREC, Plant Pathology)

# *Virginia Tech-Virginia Community College System Bridges to the Baccalaureate*

## PROGRAM DESCRIPTION

The Bridges to the Baccalaureate Program partners with existing programs on the Virginia Tech campus to provide experiential learning opportunities to students attending New River, Northern Virginia, or Southwest Virginia Community College. This program is funded by the National Institutes of Health (NIH) (grant number 5r25gm17749) as a means to promote diversity and inclusion in the biomedical and behavioral sciences. The program aims to increase the number of transfer students pursuing degrees and research opportunities in the biomedical and behavioral sciences. The summer research internship is a 10-week paid research experience where students work with a faculty member in a mentor/protégé relationship to conduct research and present their findings in a scholarly presentation at the end of summer. The interns also participate in academic and professional development activities and are encouraged to work towards presenting their research at a national conference.

## PROGRAM COORDINATOR

Denise Young

## PROGRAM PARTICIPANTS

### Maame-Owusua Boateng

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Faculty Mentor: Dr. Christopher K. Thompson

### Hope Geiger

SOUTHWEST VIRGINIA CC, Engineering
Faculty Mentor: Bahareh Behkam

### Karen Huang

SOUTHWEST VIRGINIA CC, Biochemistry
Faculty Mentor: Dr. Hehuang (David) Xie

### Richard Kline

NORTHERN VIRGINIA CC, Biotechnology
Faculty Mentor: Dr. Jennifer Munson

### Emily Smith

SOUTHWEST VIRGINIA CC, Systems Biology
Faculty Mentor: Dr. Shiv Kale

### Brandi Thomas

VIRGINIA TECH, Microbiology
Faculty Mentor: Ann M. Stevens

### Alexandra Tucker

NEW RIVER VALLEY CC, Psychology
Faculty Mentor: Martha Ann Bell

MAAME-OWUSUA BOATENG
NORTHERN VIRGINIA COMMUNITY COLLEGE / NEUROSCIENCE

## An Antagonist Against a Retinoid X Receptor Reduces Neurogenesis in the Developing Tadpole Brain

**Mentor:** Christopher K. Thompson, Ph.D. (Virginia Tech, School of Neuroscience and Department of Biological Sciences)

HOPE GEIGER
SOUTHWEST VIRGINIA COMMUNITY COLLEGE / ENGINEERIMG

VT-VCCS B2B

## Characterization of Neutrophil Interactions with Nanoscale Bacteria-Enabled Drug Delivery System (NanoBEADS)

**Mentor:** Bahareh Behkam (Virginia Tech, Mechanical Engineering Department)

KAREN HUANG
SOUTHWEST VIRGINIA COMMUNITY COLLEGE / BIOCHEMISTRY

## Cloning and Expression of Fmr1 Functional Domains

Fragile X syndrome (FXS) is the most common form of inherited intellectual disability caused by the loss of functional fragile X mental retardation protein (FMRP). FMRP is an RNA'binding protein encoded by the gene fragile X mental retardation 1 (FMR1) and highly expressed in neurons. The binding of FMRP regulates the translation efficiency of target mRNAs, in particular for the synaptic messages in neurons. In consequence, individuals with Fragile X syndrome usually have the characteristics of learning disabilities and cognitive impairment. Our recent study suggests that FMRP may participate in the regulation of RNA methylation via the interaction with TET1 protein, an RNA demethylation enzyme. To gain a fine map of the interactions between FMRP and TET1, we adopted the classic cloning strategy to express different domains of FMRP in vitro for the identification of the specific domain responsible for the FMRP-TET1 interaction. We anticipate this study will provide a novel mechanism in RNA regulation and gain a better understanding of the etiology underlying FXS. Despite extensive research efforts, it is still unclear how different functional domains of FMRP are coordinated to mediate the interaction with other protein partners and target mRNA.

**Mentors:** Dr. Hehuang (David) Xie (Virginia Tech Biocomplexity Institute), Xiguang Xu (Virginia Tech Biocomplexity Institute)

RICHARD KLINE
NORTHERN VIRGINIA COMMUNITY COLLEGE / BIOTECHNOLOGY

## Analyzing the Varied Chemotherapeutic Response of Breast Cancer Brain Metastases in Different Matrices

Breast cancer metastasis is the leading cause of death in patients with breast cancer, with metastases to the brain being the most deadly. Currently, no consensus has been reached on the optimal management of breast cancer metastases to the brain. Whole brain radiotherapy (WBRT) and surgical resection of brain metastases are commonly employed to reduce/remove the tumor bulk, but can pose a significant risk to patients. Systematic therapies like chemotherapy and targeted therapy, are however emerging as a means to mitigate disease progression with regards to metastasis and tumor growth. Despite the efforts to elucidate the efficacy of chemotherapeutics on breast metastases, the extent to which the matrices of the secondary cancer microenvironment affects drug delivery and response remains uncertain. Our lab has utilized tissue-engineered models to determine whether these matrices cause breast cancer brain metastases to react differently to systematic therapy relative to the primary tumor. Using multi-layered hydrogels, we have recreated the microenvironment of a human breast cancer brain metastasis to test the efficacy of chemotherapeutics without the need to sacrifice an animal model. Here, we have seeded Collagen Matrigel and Hyaluronan gel matrices with MDA-MB-231 breast cancer cells and introduced chemotherapeutics to assess the percentage of live/dead cells. Subsequent iterations of this model may lead to the elimination of costly animal models and insight toward more effective methods of systematic therapies.

**Mentor:** Dr. Jennifer Munson (Virginia Tech, Biomedical Engineering & Mechanics)

EMILY SMITH
SOUTHWEST COMMUNITY COLLEGE / SYSTEMS BIOLOGY

VT-VCCS B2B

# Inducible Nitric Oxide Synthase is Needed for a Robust Defense Response Towards Aspergillus fumigatus

**Mentor:** Dr. Shiv Kale (Virginia Tech Biocomplexity Institute)

BRANDI THOMAS
VIRGINIA TECH / MICROBIOLOGY

## Analyzing the Role of Pantoea stewartii subsp. stewartii Genes during in planta Growth via Reverse Genetics

**Mentor:** Ann M. Stevens (Virginia Tech, Biological Sciences)

ALEXANDRA TUCKER
NEW RIVER VALLEY COMMUNITY COLLEGE / PSYCHOLOGY

## Heart Rate Variability and Emotion Regulation in Middle Childhood

**Mentor:** Martha Ann Bell (Virginia Tech, Psychology)

# *VTCRI Molecular Visualization SURF (MolViz SURF)*

## PROGRAM DESCRIPTION

The VTCRI Molecular Visualization SURF program is a 10-week long multidisciplinary summer program at the Virginia Tech Carilion Research Institute in Roanoke, Virginia. Seven undergraduate students participate in hypothesis-driven independent research, each under the guidance of a VTCRI faculty mentor. Students participate in a weekly workshop series to provide hands-on experience in the cutting edge imaging technologies housed within VTCRI to understand appropriate application of each technology in understanding biological processes. Additionally, a weekly professional development seminar provides training in scientific ethics, communication, and career paths. The program encompasses a full-time, 40-hour work week schedule and supports Molecular Visualization SURF students with a stipend and housing.

## PROGRAM DIRECTOR

Dr. James W. Smyth, VTCRI + VT Biological Sciences

## PROGRAM PARTICIPANTS

### Shericia Campbell

VIRGINIA STATE UNIVERSITY, Biology
Faculty Mentor: James Smyth

### Samuel Dickerson

VIRGINIA TECH, Biological Sciences
Faculty Mentor: Dr. Kenneth J. Oestreich

### Kevin He

VIRGINIA TECH, Biochemistry
Faculty Mentor: Samy Lamouille

### Tippavon Morrow

VIRGINIA TECH, HNFE
Faculty Mentor: Stephen LaConte

### Aubrey Phares

VIRGINIA TECH, Cognitive and Behavioral Neuroscience
Faculty Mentor: Dr. Stefanie Robel

### Daniel Purcell

VIRGINIA TECH, Biological Sciences
Faculty Mentor: Dr. James Smyth

### Zachary Yorke

VIRGINIA TECH, Biochemistry
Faculty Mentor: Zhi Sheng

SHERICIA CAMPBELL
VIRGINIA STATE UNIVERSITY / BIOLOGY

## Targeting the integrated stress response in cardiac hypertrophy to preserve electrical coupling

Heart Disease is the leading cause of death in the United States, with cardiovascular disease accounting for 1 in 4 of all deaths. In order for each heartbeat to occur, billions of cardiac muscle cells must contract simultaneously. These synchronized contractions are made possible by a subcellular channel known as the gap junction, which propagates direct signals from one cell to another at intercalated discs between cells. The gap junction protein Connexin-43(Cx43) is expressed in the working myocardium. During heart disease, such as cardiac hypertrophy, our lab has found that cardiomyocytes initiate the integrated stress response (ISR) resulting in altered Cx43 expression and localization. Hypertrophic cardiomyocytes are enlarged and alterations in Cx43 regulation lead to arrhythmias. We hypothesized that blocking the ISR would rescue Cx43 gap junction formation and restore proper intercellular communication in diseased hearts. Hypertrophy was induced in the hearts of adult C57BL/6 mice over seven days by osmotic minipump delivered isoproterenol with or without the ISR inhibitor ISRIB. Hearts were snap frozen and cryosectioned for immunostaining and analysis by confocal microscopy. ImageJ software was employed to measure localization of Cx43 at the intercalated disc based on colocalization with N-cadherin and cell size. ISRIB treatment prevented pathological cell size increases while preserving more normal Cx43 expression. We are currently employing super-resolution microscopy to further define changes in cell junctions. Our data identify blocking the cellular stress response and preserving normal protein translation as a viable therapeutic avenue in preventing the arrhythmogenic pathological remodeling of cardiac gap junctions.

**Mentor:** James Smyth (Virginia Tech Carilion Research Institute)

SAMUEL DICKERSON
VIRGINIA TECH / BIOLOGICAL SCIENCES

## Investigating Novel Roles for a Lymphocyte-associated Transcriptional Complex in Metastatic Breast Cancer Using Super-resolution Microscopy

Leukocytes, including T helper cells, are capable of responding to extracellular signals to migrate throughout the body during the course of an immune response. Recent studies have revealed that metastatic cancer cells are capable of mimicking this process driven by cytokine and chemokine receptors on the cell surface. In immune cells, gene expression is regulated by specific transcription factors including Signal Transducer and Activator of Transcription (STAT) and Ikaros Zinc Finger (IkZF) transcription factors. Our lab recently established that a protein complex of STAT3 and the IkZF factor Aiolos regulates gene expression in T helper cell populations, including that of cytokine and chemokine receptors. Interestingly, irregular expression/activation of Aiolos and STAT3 have been separately linked to metastatic breast cancer. Therefore, we hypothesized that this Aiolos/STAT3 transcriptional complex may control the expression of cytokine and/or chemokine receptors in metastatic breast cancer cells. To test this hypothesis, we analyzed the expression of Aiolos and STAT3 in non-tumorigenic (HMEC), tumorigenic/non-metastatic (HCC-70), and metastatic breast cancer (MDA-MB-231) cell lines. Within the MDA-MB-231 cells, we found that Aiolos was upregulated at the transcript and protein level and that STAT3 was activated as well, correlating with increased expression of the chemokine receptors CXCR4 and CD22. Next, a 'nearest-neighbor analysis' was conducted using super resolution microscopy and showed significant association between STAT3 and Aiolos in the nucleus of metastatic breast cancer cells. Taken together, our data support a role for an Aiolos/STAT3 transcriptional complex in the regulation of chemokine receptor expression in metastatic breast cancer cells.

**Mentors:** Dr. Kenneth J. Oestreich (Virginia-Maryland Regional College of Veterinary Medicine, Department of Biomedical Sciences and Pathobiology), Dr. James W. Smyth (Virginia Tech, Department of Biological Sciences)

KEVIN HE
VIRGINIA TECH / BIOCHEMISTRY

## Identifying critical Connexin43 domains required for microtubule interaction

Connexins are transmembrane proteins which enable the formation of gap junctions, intercellular channels which connect the cytoplasms of adjacent cells. After translation at the rough endoplasmic reticulum, connexin proteins are transported through the Golgi apparatus where they oligomerize into hemichannels that traffic to the plasma membrane along the microtubules. Human Gap Junction Alpha 1 (hGJA1), or connexin 43 (Cx43), is the most ubiquitously expressed connexin and encompasses a tubulin binding domain in its carboxy terminus. We hypothesized that Cx43 can directly interact with microtubules in an independent manner to trafficking on microtubules by vesicular transport. Using site directed mutagenesis three mutant Cx43 constructs were generated with deletions in either or both previously defined c-terminal tubulin binding domains. Wild-type and mutant sequences were cloned into expression vectors and transfected into mouse mammary gland epithelial NMuMG Cx43 -/- knockout cells. We utilized super-resolution Stochastic Optical Reconstruction Microscopy (STORM) to analyze the interaction of Cx43 mutants with microtubules. Cross-pair analysis reveals Cx43 mutants present reduced complexing with microtubules in comparison to wildtype Cx43. Our future work includes analyzing the effect of Cx43 mutant expression on vesicular transport and gap junction formation at the plasma membrane. Defining the mechanism of Cx43/microtubule complexing will contribute to our understanding of cellular processes governing gap junction formation and junction-independent Cx43 roles in cytoskeletal regulation.

**Mentors:** Samy Lamouille (Virginia Tech, Biological Sciences), James Smyth (Virginia Tech, Biological Sciences)

TIPPAVON MORROW
VIRGINIA TECH / HUMAN NUTRITION, FOODS, AND EXERCISE

## The Learning Process as Individuals Interact with Brain-Computer Interface

There are many different approaches to understanding how individuals learn to interact with Brain-Computer Interfaces (BCIs), but the general mechanism and neurobiology for learning to using a BCI is unknown. We hypothesize that individuals that are learning to interact with BCIs will demonstrate the power law of practice in their ability control the BCI. To test this, a longitudinal self-study was conducted using fMRI to measure the brain signals associated with high and low Default Mode Network (DMN) activity. The participant performed a task that measured how accurately they could regulate their DMN. While multiple trials have been conducted, more data needs to be collected to provide accurate conclusions and confirm or deny our hypothesis. The results suggests a negative correlation of performance over time with feedback, while it suggests a positive correlation between tasks without feedback. We suspect that these results are specific to studying the DMN. Since it is known that DMN activity decreases with challenging tasks, neurofeedback may be interfering with the participant's ability to regulate this network. Though our current results are inconclusive, studies of this nature may be useful for understanding the learning process that is required to use BCIs and to understand the neurobiology of this unique type of skill learning.

**Mentors:** Stephen LaConte (Virginia Tech Carilion Research Institute), Jonathan Lisinski (Virginia Tech Carilion Research Institute)

AUBREY PHARES
VIRGINIA TECH / COGNITIVE AND BEHAVIORAL NEUROSCIENCE

## Neighboring Astrocyte Response to Astrocyte Ablation

Background Astrocytes three dimensionally tile the brain, creating non-overlapping domains, each harboring and supporting ~100,000 neuronal synapses. The relevance and mechanism of maintaining astrocytes in this tiled formation is unclear. One possibility is that contact inhibition might prevent an astrocyte from growing into a neighboring domain. To test this theory, a genetic model was employed to ablate some astrocytes in order to determine the response of adjacent astrocytes. Methods Astrocytes were ablated genetically using an inducible system expressing Diphtheria Toxin subunit A in some astrocytes, and the processes of astrocytes neighboring loss areas were measured. We also tested if astrocytes turned reactive by labeling them with the astrogliosis marker GFAP. Results Astrocyte processes extending into empty spaces nearest to them (3 days post ablation (dpa): 74.36 +/- 5.215; 11dpa: 75.86 +/- 3.703) were significantly longer than processes in control animals (3dpa: 53.3 +/- 2.48; 11dpa: 53.67 +/- 2.199), processes opposite the ones extending into loss areas (3dpa: 44.97 +/- 2.361; 11dpa: 52.74 +/- 3.258), and astrocyte processes further away from loss areas (11dpa: 61 +/- 2.019). In addition, GFAP was upregulated in astrocytes surrounding areas of loss. Conclusions Given the elongation of astrocyte processes into areas where astrocytes were ablated, we conclude that astrocytes may maintain their own distinct territories due to contact inhibition. The upregulation of GFAP around loss areas also indicates that an astrogliosis response was taking place.

**Mentor:** Dr. Stefanie Robel (Virginia Tech, Neuroscience)

DANIEL PURCELL
VIRGINIA TECH / BIOLOGICAL SCIENCES: BIOMEDICAL OPTION

## Adenovirus predisposes healthy cells to viral infection via intercellular signaling and junctional remodeling

Adenoviruses are nonenveloped, double-stranded DNA viruses with seven species and over 60 genotypes known to cause infection. Clinical manifestations can be severe and infection has been shown to cause respiratory failure, myocarditis, hemorrhagic cystitis, neurological disease, and death. Human adenovirus type 5 (Ad5) is the most common viral vector used in clinical studies worldwide and its mode of infection has been heavily studied over the years. Ad5's primary receptor is the coxsackie and adenovirus receptor (CAR); however, as a transmembrane component of tight junctions this molecule would be inaccessible to virions seeking to infect cells. While infection mechanisms are well documented, little is known about manipulation of intercellular communication following entry into the host cell. The purpose of this study is to determine how intercellular junctions between infected and uninfected cells are affected during Ad5 infection. We hypothesized that gap junction signaling precipitates junctional remodeling in healthy cells to predispose them to viral infection through up regulation of molecules such as CAR. Human epithelial cells were infected at low multiplicity of infection to enable visualization of neighboring infected and uninfected cells. Confocal immunofluorescence and super-resolution were used to identify and measure changes in junctional and cytoskeletal structures. We find stabilization of gap junctions and altered microtubule organization in infected cells, supporting our hypothesis. Future work will test predisposition of uninfected cells to infection using fluorescently activated flow sorting. These studies will provide novel insight into manipulation of cellular junctions in the direct cell to cell spread of viral progeny.

**Mentor:** Dr. James Smyth (Virginia Tech, Biological Sciences)

ZACHARY YORKE
VIRGINIA TECH / BIOCHEMISTRY

## Preparation of plasmids encoding fluorescent PI3K isoforms that enable a detection of protein-protein interactions

Glioblastoma (GBM) is the most aggressive cancer that develops in the brain. Recent research has revealed that Phosphatidylinositol-4,5-bisphosphate 3-kinase catalytic subunit beta (PI3KCB/p110?˝) is a selective survival factor for GBM, presenting itself as a strong candidate for therapeutic targeting. Further analysis shows that Connexin 43 (Cx43), a gap junction protein, may regulate activity of PI3KCB/p110?˝ through a direct binding. It is therefore important to understand how Cx43 selectively interacts with PI3KCB/p110?˝, given that PI3KCB/p110?˝ is homologous to its isoforms PIK3CA/p110, PIK3CD/p110, and PIK3CG/p110. Fluorescence microscopy presents significant advantages to monitor protein-protein interactions. We therefore hypothesize that a fluorophore conjugated with PI3K isoforms permits a visualization of the interaction of PI3K isoforms with Cx43. The Gateway LR Clonase Enzyme Mix was utilized to incorporate the cDNAs of PI3K (isoforms PIK3CA, PIK3CD, and PIK3CG) into the empty vector containing a gene encoding a fluorescent protein mCherry. Among three isoforms, PIK3CD cDNA was not fused with mCherry, which requires further work. The resulting plasmids containing cDNA of PIK3CA or PIK3CG were transformed into the bacteria and the plasmid DNA was extracted using a plasmid miniprep kit. Plasmids were further transfected into LN229 cells. Expression of fusion proteins was verified by western blotting using antibodies recognizing PIK3CA/p110 or PIK3CD/p110. We successfully inserted cDNAs of PIK3CA and PIK3CD into a mCherry-expressing vector to generate fluorescent fusion proteins, which will further the research that determines interactions between PI3K isoforms and Cx43.

**Mentors:** Zhi Sheng (Virginia Tech Carilion Research Institute), Kevin Pridham (Virginia Tech Carilion Research Institute)

# *VTCRI neuroSURF*

## PROGRAM DESCRIPTION

The VTCRI neuroSURF program is a 10-week long program that gives VT and non-VT undergraduate students the opportunity to participate in independent translational neurobiology research at the Virginia Tech Carilion Research Institute in Roanoke, VA. This year, program participants also included two high school students from the Roanoke Valley Governor's School. In addition to independent research, the program includes coursework in translational neurobiology, seminars from VT and Carilion faculty whose research focuses on translational neurobiology, and professional development activities. The 2018 VTCRI neuroSURF fellows came from VT, UC Berkeley, Cornell University, Hampton University, William and Mary, Hampshire College, University of Virginia, James Madison University and Virginia State University. The neuroSURF program is now funded by the National Institutes of Health for the next 5 years.

## PROGRAM DIRECTOR

Dr. Michael Fox, VTCRI & VT Biological Sciences

## PROGRAM PARTICIPANTS

### Malikah Ajose

VIRGINIA TECH, Clinical Neuroscience
Faculty Mentor: Dr. Stefanie Robel

### Chase Amos

UNIVERSITY OF VIRGINIA, Chemistry
Faculty Mentor: Dr. Michael Fox

### Benayas Dereje Begashaw

CORNELL UNIVERSITY, Molecular Biology
Faculty Mentor: Dr. Konark Mukherjee

### Victoria Buskey

VIRGINIA STATE UNIVERSITY, Biology
Faculty Mentor: Zhi Sheng

### Naomi Carter

HAMPTON UNIVERSITY, Ceullular and Molecular Biology
Faculty Mentor: Dr. Michael Fox

### Sonali Dabhi

WILLIAM & MARY, Neuroscience
Faculty Mentor: Stefanie Robel

### Shayom Debopadhaya

VTCRI
Faculty Mentor: Gregorio Valdez

### Mia Genuario

VIRGINIA TECH, Clinical Neuroscience
Faculty Mentor: Dr. Micharl Fox

# VTCRI neuroSURF

PARTICIPANTS continued

## Megan Harrigan
VIRGINIA TECH, Clinical Neuroscience
Faculty Mentor: Harald Sontheimer

## Alana Hull
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## Kirsten Lydic
HAMPSHIRE COLLEGE, Cognitive Neuroscience
Faculty Mentor: Warren K. Bickel

## Tracey Myers
VIRGINIA TECH, Experimental Neuroscience
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## Richard Qiu
VTCRI
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MALIKAH AJOSE
VIRGINIA TECH / CLINICAL NEUROSCIENCE

## Sex Differences Effect Astrocytic Response after TBI

Traumatic brain injury (TBI) affects the male and female brain differently. Yet for many decades, research on TBI has used male rodents exclusively while few studies included females. One of the differences in males and females are sexual hormones, females high estrogen levels have been suggested to be protective. These studies, however; have not used females with different hormone stages, which is typical in the human population. Instead, they experimentally modified the hormone status of males and females.
Here we used females during different stages of their cycle representing either high estrogen (proestrus) or low estrogen (non-proestrus) and compared them to each other and to males after repeated mild TBI (rmTBI). We assessed mortality rates, the duration of loss of consciousness and changes of the astrocytic glutamate transporter 1 (Glt-1), which is essential for neuronal health and function.
In low estrogen female mice, righting recovery times increased the most when injuries were repeated, compared to high estrogen female mice and males. In females, mortality rates were higher during non-proestrus than during proestrus. Western blot analysis showed no statistically significant differences in expression of Glt-1 between groups.
Increase mortality rates in non-proestrus female mice implies estrogen could act as a protective factor in recovery from rmTBI. The highest increase in righting time was seen in low estrogen females, suggesting low estrogen is associated with declined recovery after rmTBI. Future research will include a deeper analysis of the molecular basis producing this difference, focusing on the role of astrocytes in this process.

**Mentors:** Dr. Stefanie Robel (Virginia Tech, School of Neuroscience), Dr. Carmen Munoz Ballester (Virginia Tech Carilion Research Institute, Center for Glial Biology)

CHASE AMOS
UNIVERSITY OF VIRGINIA / CHEMISTRY WITH SPECIALIZATION IN BIOCHEMISTRY

## Neuronal collagen XIX is essential for excitatory synapse formation in the accessory olfactory bulb

Members of the collagen superfamily have been previously demonstrated to contribute to the formation and maintenance of synapses in worms, flies, fish, and mice. For example, collagen XIX, an unconventional collagen expressed by subsets of telencephalic interneurons, is essential for the formation of inhibitory axo-somatic synapses in the mammalian cerebral cortex and hippocampus. Here, we discovered that collagen XIX (which is encoded by the col19a1 gene) is robustly expressed in the mouse accessory olfactory bulb (AOB). Furthermore, in situ hybridization showed colocalization of col19a1 mRNAs with synaptotagmin-2 (Syt2)-expressing cells in the AOB, indicating neuronal expression of this collagen. As collagen XIX expression in other brain regions is developmentally regulated, with highest levels of expression coinciding with synaptogenesis, we performed quantitative PCR (qPCR) on RNA isolated from the developing olfactory bulb. Our results demonstrate that levels of col19a1 mRNA expression in the OB coincide with synaptogenesis, peaking at P7. These preliminary findings led us to hypothesize that collagen XIX may play an essential role in synaptogenesis in the developing mouse AOB. To test this hypothesis, we used targeted mouse mutants lacking collagen XIX globally (col19a1-/-) and mutants lacking collagen XIX conditionally from only neurons (col19a1fl/fl-Nestin-Cre+). Immunohistochemistry comparing collagen XIX knockouts with littermate controls indicated a statistically significant decrease in excitatory synapses in the mitral cell layer of both col19a1-/- and col19a1fl/fl-Nestin-Cre+ AOB. Thus, these data demonstrate a novel role for this unconventional collagen in excitatory synaptogenesis, which starkly contrasts previous published roles of collagen XIX at inhibitory synapses in the telencephalon.

**Mentors:** Dr. Michael Fox (Virginia Tech Carilion Research Institute, Developmental and Translational Neurobiology Center), Dr. Jianmin Su (Virginia Tech Carilion Research Institute, Developmental and Translational Neurobiology Center)

BENAYAS DEREJE BEGASHAW
CORNELL UNIVERSITY / MOLECULAR BIOLOGY

## Functional analysis of vesicle trafficking in Optic Nerve Hypoplasia by the use of SynaptoTag AAV

Optic nerve hypoplasia (ONH) is characterized by the thinning of the optic nerve. A recent finding suggests that cross-sectional area reduction of the optic nerve is associated to the axonal atrophy of individual retinal ganglion cells. We hypothesize that microtubule mediated anterograde transport will be reduced due to atrophy of RGC axons, leading to a decrease in fast axonal trafficking in optic nerves. We attempted to utilize the 'SynaptoTag' plasmid, which incorporates an mCherry red-fluorescent protein and the vesicle protein synaptobrevin-2 fused to an enhanced green-fluorescent protein (EGFP) that is localized to the presynaptic sites. We used this plasmid because of its ability to visualize anterograde trafficking in neurons. AAV-2 was selected as a viral vector for the SynaptoTag plasmid because of its transduction efficiency in neurons. We transfected of HEK 293 cells with SynaptoTag, AAV 2 and Helper plasmids, as well as optimized their transfection efficiency using glycerol shock. AAV virus was harvested and purified using polyethylene glycol (PEG) precipitation method. Fluorescent synaptobrevin vesicle formation were observed in HEK 293 and PC-12 cells, displaying the effectiveness of the SynaptoTag AAV as a tool; however, red fluorescence intended to mark entire neurons was not observed in PC-12 cells. Explanation for lack of mCherry rendering in PC-12 cells is still unclear. Future directions should aim for the optimization of AAV SynaptoTag in cultured neurons, as well as in vivo.

**Mentor:** Dr. Konark Mukherjee (Virginia Tech Carilion Research Institute)

VICTORIA BUSKEY
VIRGINIA STATE UNIVERSITY / BIOLOGY

## Identification of MYCN as a potential survival factor for leukemia

Global pediatric cancer levels continue to rise over the years, with leukemia's accounting for 30% of pediatric cancers (American Cancer Society). Relapse levels remains high for pediatric patients due to the ineffectiveness of current therapies (Adamson, Peter C., et al). Identification of novel therapeutic targets is therefore needed for leukemia including pediatric leukemia. Previously, RNA interference screening has been identified as an effective method to identify novel drug targets for a variety of cancers. Here, we used data from the Achilles Project done by the Broad Institute. Through analysis of more than 50,000 short-hairpin RNAs (shRNAs) that target human genome, we identified 10 candidate shRNAs that showed the lowest levels at the end point in leukemia cells suggesting that they are perhaps important for cell survival. We further analyzed gene expression of these ten candidate genes in leukemia using data from BioGPS and Oncomine. Our results showed that MYCN was highly enriched in leukemia cells compared to normal hematopoietic cells. Finally, we performed western blotting to verify the presence of MYCN in K562 leukemia cells. We found that MYCN was expressed in leukemia cells. Taken together, our results suggest that MYCN is important for the survival of leukemia cells and is highly expressed in leukemia. By identifying MYCN as a potential survival factor, we add a new perspective to our knowledge on leukemia. Of particular importance, identifying this novel survival factor may provide effective therapeutic target for both pediatric and adult leukemia patients.

**Mentor:** Zhi Sheng (Virginia Tech Carilion Research Institute)

NAOMI CARTER
HAMPTON UNIVERSITY / CELLULAR AND MOLECULAR BIOLOGY

## Delocalization of GABAergic synapses after strain-specific Toxoplasma Gondii Infection

Toxoplasma gondii is an obligate intracellular parasite that infects ~25% of the US population and can cause Toxoplasmosis in immunocompromised individuals. Healthy individuals infected by Toxoplasma gondii also exhibit a higher risk for developing neuropsychiatric diseases such as schizophrenia. Toxoplasma gondii specifically infects neurons in the brain and infected animals develop seizures suggesting alterations in brain circuitry. Previous studies from our laboratory have shown that certain strains of Toxoplasma gondii impair the distribution of the inhibitory neurotransmitter GABA. Here, we performed a blinded analysis of how various strains of Toxoplasma gondii contribute to the mislocalization of glutamic acid decarboxylase (GAD67), the essential enzyme that catalyzes GABA synthesis within inhibitory neurons. After cryosectioning brains infected with various hybrid strains of Toxoplasma gondii, immunohistochemistry was used to explore the distribution of GAD67 and vesicular glutamate transporter 2 (VGluT2), a marker of excitatory nerve terminals that served as a control in these experiments. We focused our attention on the CA1 region of the hippocampus, where excitatory and inhibitory synapses are restricted to different sublamina. Murine brains were imaged using epifluorescence and confocal microscopy and acquired images were analyzed according to their signal intensity using ImageJ software. Image analysis revealed similar ratios of GAD67 signal intensity between the stratum pyramidale and the surrounding tissues suggesting that the brains analyzed were infected with a more virulent strain of Toxoplasma gondii. The next step is to analyze whether these same strains of Toxoplasma gondii lead to increased seizure susceptibility or altered behaviors in mice.

**Mentors:** Micheal Fox (Virginia Tech Carilion Research Institute, Center for Developmental and Translational Neurobiology), Gabby Carrillo (Virginia Tech; Translational Biology, Medicine, and Health)

SONALI DABHI
THE COLLEGE OF WILLIAM AND MARY / NEUROSCIENCE

## Astrocyte Ablation Causes Proliferation of Neighboring Astrocytes.

Mature astrocytes do not proliferate in the healthy CNS but can regain proliferative capability as a consequence of disease and injury, as through astrocyte death, neighboring cells may proliferate to replace lost cells. We genetically ablated astrocytes to test whether astrocyte cell death was sufficient to induce proliferation of neighboring astrocytes. To test this hypothesis, astrocytes were ablated using a Cre-inducible system expressing Diphtheria Toxin subunit A in a subset of astrocytes. To assess astrocyte proliferation, we stained for the cell cycle protein Ki67 and the synthetic nucleotide BrdU and examined the colocalization of these markers with the astrocyte marker S100B in mouse cortex. The ratio of proliferating astrocytes compared to total astrocytes for each region of interest (ROI) was quantified. We found that astrocytes near areas of ablation had significantly higher ratios of proliferating cells at 3 and 11 days post ablation (dpa) compared to non-ablation controls. Areas of no astrocyte loss in ablation animals (that have loss) showed higher proliferation ratios at 11dpa compared to non-ablation controls. Preliminary imaging of BrdU stained slices show that BrdU is able to stain proliferating cells and is present in areas surrounding ablation at 3 dpa. We conclude that our genetic model of astrocyte ablation is sufficient to induce astrocyte proliferation at 3 and 11 dpa. Cell proliferation in ablated animals in areas where astrocytes did not die suggests that this response is not limited to areas directly adjacent to cell death.

**Mentor:** Stefanie Robel (Virginia Tech Carilion Research Institute)

SHAYOM DEBOPADHAYA
VIRGINIA TECH CARILION RESEARCH INSTITUTE

## The role of QSOX1 in the formation and maintenance of neuromuscular junctions and muscle fibers

The neuromuscular junction (NMJ) is the synapse formed between motor neurons and skeletal muscles. The specialized extracellular matrix between the motor axon terminal and muscle fiber, called the synaptic basal lamina, contains molecules critical for organizing the three-dimensional architecture of the NMJ. Unfortunately, the synaptic basal lamina undergoes deleterious changes prior to or as NMJs degenerate during aging and progression of diseases. Hence, the discovery of molecules that shape and maintain the structure of the synaptic basal lamina could have therapeutic benefits for preserving the NMJ and somatic motor function. In this study, I assessed the function of Quiescin Sulfhydryl Oxidase 1 (QSOX1) on NMJs and skeletal muscles. QSOX1 is a secreted enzyme shown to aid in the formation of laminin alpha-4 trimers, essential components of the synaptic basal lamina that functions to stabilize the NMJ. Expression analysis revealed that QSOX1 is induced while NMJs regenerate following injury to motor axons. It also showed that QSOX1 expression is highest at postnatal day 6, a time when NMJs are also undergoing dramatic morphological and functional changes. To examine the role of QSOX1 at the NMJ and in elsewhere in skeletal muscles, I have used immunohistochemistry and confocal microscopy to determine the morphology of NMJs and muscle fibers in mice lacking QSOX1 gene. I also used myotubes derived from C2C12 cells, a myogenic cell line, to determine if QSOX1 acts directly on muscle fibers and their postsynaptic sites.

**Mentors:** Gregorio Valdez (Virginia Tech Carilion Research Institute), Natalia Sutherland (Virginia Tech Carilion Research Institute)

MIA GENUARIO
VIRGINIA TECH / CLINICAL NEUROSCIENCE

## Binocular and Class-Specific Retinal Input to Complex Retinogeniculate Synapses

The subcortical visual system has served as a model for understanding sensory system developments, circuitry, and function. The neural pathway that connects the retina to the brain is generated by retinal ganglion cells (RGCs), the only projection neurons of the retina. RGCs axons carrying image-forming visual information synapse to thalamocortical (TC) relay cells in the dorsal lateral geniculate nucleus (dLGN) of the thalamus. Recent studies of retinogeniculate synapses, i.e. those synapses formed between RGCs and TC relay cells in the dLGN, have shown that retinal terminals from different RGCs can converge onto single relay cells forming 'complex retinogeniculate synapses'. By studying the presence of these complex retinogeniculate synapses, we can understand the potential role of TC relay cells in processing visual information. To do this we analyzed complex retinogeniculate synapses asking two questions: Do complex retinogeniculate synapses contain binocular inputs? Do different classes of RGCs converge at single complex retinogeniculate synapses? We explored the answers to these questions using anterograde tracing, viral (Brainbow) labeling, immunohistochemistry, and confocal microscopy. The results show that multiple RGC classes did converge on a single relay neuron in the dLGN and that RGCs from different eyes converge to form a complex retinogeniculate synapse. These findings contribute to the novel understanding that at these retinogeniculate synapses, visual information is processed as it is being transmitted to TC relay cells.

**Mentors:** Michael Fox (Virginia Tech Carilion Research Institute, Center for Developmental and Translational Neurobiology), Alicia Kerr (Virginia Tech Carilion Research Institute, Center for Developmental and Translational Neurobiology)

MEGAN HARRIGAN
VIRGINIA TECH / CLINICAL NEUROSCIENCE

## Analysis of a Custom 3D-Printed Migration Chamber

Cell migration is a fundamental characteristic of many biological processes, most notably wound healing, cancer metastasis, and development. Chemoattractants, such as growth factors, can influence multiple aspects of cellular migration. Understanding the role that chemoattractants play in migration remains an important question during normal and pathophysiological conditions. In the past, migration chambers have been used to answer this question, but current chambers either cannot mimic an accurate environment through the formation of a chemical gradient (Boyden chamber) or require upkeep to maintain the chemical gradient (Dunn chamber). In this project, we introduce and evaluate a custom 3D-printed migration chamber that utilizes a unique hydrogel matrix to establish a chemical gradient that is maintained for 48 hours without upkeep. Previous studies have demonstrated the use of this hydrogel matrix as an effective way to establish multiple magnitudes of chemoattractant concentrations during one given experiment. However, we moved forward in this project to determine ways to improve the experimental setup and demonstrate the effectiveness of this chamber across multiple cell types using known chemoattractants for each cell type. Based on these results, we believe that this custom 3D-printed migration chamber could be used as a means of identifying interactions between cells and potential growth factors, as well as to further understand the migratory behaviors of cells.

**Mentor:** Harald Sontheimer (Virginia Tech, School of Neuroscience)

ALANA HULL
VIRGINIA TECH / CLINICAL NEUROSCIENCE

## The role of Connexin 36 on seizure-like brain activity

Epilepsy is a neurological disorder affecting approximately 50 million people worldwide and is classified by recurrent seizures resulting from abnormal electrical activity in the brain. Juvenile myoclonic epilepsy (JME), the most common epilepsy syndrome in children, is associated with the Connexin 36 (Cx36) gene. Connexins are proteins that form gap junctions between cells to allow for direct intercellular communication. Connexin 36 (Cx36) is found predominantly in the brain and contributes to the rapid synchronous activity observed between neurons which may have implications in a seizure event. There is no consensus on the exact role of Cx36 on seizure activity or whether it contributes to regional activity differences in the brain. To address this gap in understanding, we used zebrafish larvae treated with Pentylenetetrazol (PTZ), a validated model of epilepsy, to assess the role of Cx36 in seizure-like activity. To quantify seizure-like activity, we performed whole-brain confocal imaging and measured the levels of phosphorylated-ERK (pERK), a cellular readout of neuronal activity. This technique, called MAP-map, allows us to compare brain-wide activity between wildtype and Cx36 knockout fish. In the presence of PTZ, Cx36 knock-out fish had statistically significant increases in activity levels in several discrete brain regions. These results suggest that Cx36 plays an anticonvulsive role in a region-specific manner. Future research is necessary to confirm and further quantify the anticonvulsive properties of Cx36 in the brain.

**Mentor:** Yuchin Albert Pan (Virginia Tech Carilion Research Institute, Developmental and Translational Neurobiology Center)

KIRSTEN LYDIC
HAMPSHIRE COLLEGE / COGNITIVE NEUROSCIENCE


## Prospective thought, delay discounting, and metacognitive assessment in addiction and recovery

Previous work in the literature on addiction has demonstrated delay discounting rate as a proxy measure of temporal span capacities in decision-making, and additionally as a predictor of addiction severity and treatment success across several substances. Episodic future thinking (EFT) has been shown to reduce discounting rates in substance dependents, indicating viability as a cost-effective treatment. The primary goal of the present studies was to isolate various domains of EFT to evaluate how its effect might be maximized. A semantic future thinking (SFT) task was developed to isolate the episodic basis, recent-thinking tasks were used to isolate temporal direction, and non-autographical tasks were derived for both EFT and SFT to isolate the first-person perspective. Preliminary results in alcohol dependents suggest a complex interaction of these domains, with contributing effects of autobiographical orientation being dependent on the semantic or episodic nature of future-oriented tasks. Recent-thinking tasks and non-autobiographical SFT showed no difference from the control. In this study and in a second population of recovering substance users, subjects also completed several assessments to evaluate mediating effects of metacognitive abilities on discounting rates and the effect of prospection tasks. Initial analyses suggest that some metacognitive assessments could be used as possible predictors of discounting and prospective thinking effects, though several scales showed inconsistent results across populations. As data collection is still ongoing, further analyses may show greater significance between prospection tasks and in the mediating effects of metacognitive abilities, which may offer direction in individualizing prospective thinking tasks to improve treatment success.

**Mentors:** Warren K. Bickel (Virginia Tech Carilion Research Institute, Addiction Recovery Research Center), Derek A. Pope (Virginia Tech Carilion Research Institute Addiction Recovery Research Center)

TRACEY MYERS
VIRGINIA TECH / EXPERIMENTAL NEUROSCIENCE

## The Effects of Acetylcholine and Agrin on C2C12 Cells

The activation of quiescent myogenic cells is a necessity for healthy muscle regeneration. When these cells are activated, they differentiate, proliferate, and fuse to either reinforce existing muscle fibers or to form new muscle fibers. This process occurs as the nerve reinnervates the muscle, suggesting that motor neurons play a part in activating quiescent myogenic cells. Two molecules commonly released by motor neurons are acetylcholine and neural agrin, both of which exhibit effects on nicotinic acetylcholine receptors (nAChRs). However, the roles of these molecules in muscle regeneration have not been well characterized. Here, the effects of neural agrin and an acetylcholine agonist, carbochol, have been evaluated in an in vitro model using C2C12 cells, an immortalized myoblast cell line. To examine the role of the innervating nerve in activating quiescent myoblasts, we observed the proliferation and fusion rates of C2C12 cells incubated in the presence of neural agrin or carbochol. Quantitative PCR was performed to confirm the presence of nAChRs. It was found that agrin had no effect on proliferation or fusion of muscle fibers, but did significantly increase the number of nAChRs in fused muscle fibers. In the presence of carbochol, the proliferation rate of C2C12 cells was increased. In addition, fusion rates appeared to be increased, with significantly larger myotubes in cells exposed to carbochol and significantly fewer individual myotubes. This suggests an important role for the nerve derived factors, agrin and acetylcholine, in the regeneration of muscle fibers.

**Mentor:** Dr. Greg Valdez (Virginia Tech Carilion Research Institute, Biological Sciences)

DANIEL QUINTANA
UNIVERSITY OF CALIFORNIA, BERKELEY / NEUROBIOLOGY

## Neuromuscular junction and spinal cord distribution of Argonaute 2 (Ago2) in Amyotrophic Lateral Sclerosis (ALS)

**Mentors:** Dr. Greg Valdez (Virginia Tech, Neuroscience), Dr. Thomas Taetzsch (Virginia Tech, Neuroscience)

ARIENNE ROTH
VIRGINIA TECH / NEUROSCIENCE

## Education Level Leads to Greater Monetary Strategy in Two-Party Fairness Game

**Mentors:** Dr. Montague (Virginia Tech, Physics), Dr. Lohrenz (Virginia Tech Carilion Research Institute, Neuroscience)

BRADY SIMPSON
JAMES MADISON UNIVERSITY / BIOLOGY

## Identification of MEOX2 as a prognostic marker and a potential survival factor for glioblastoma

Glioblastoma (GBM) is the most malignant form of brain cancer with a five-year survival rate of 4.7% in the United States. The lack of therapeutic targets significantly contributes to the poor prognosis of GBM. The aim of this study is to identify novel therapeutic targets for GBM through analysis of publicly available data of RNA interference screens, a technique that has successfully been used on cancer therapeutic developments. In this study, we analyzed data of a large scale RNA interference screen conducted by the Broad Institute. Among 56,000 short-hairpin RNA's (shRNA's) that target more than 20,000 genes in 25 GBM cell lines, 11 genes were identified as candidates for potential survival factors. Further gene expression analyses using BioGPS and Oncomine datasets revealed that MEOX2 was the candidate with the highest expression levels in GBM compared to astrocytes or normal brain tissues. Analysis of patient data using data from The Human Protein Atlas showed that high levels of MEOX2 correlated with short life span of GBM patients. Western blotting analysis showed that MEOX2 was detected in 10 of the 11 GBM cell lines with different protein levels, suggesting that this gene is ubiquitously expressed in GBM at different levels. Finally, we performed shRNA-mediated knockdown for MEOX2. Unfortunately, the MEOX2 shRNA we tested was not effective. In conclusion, our multiscale analysis has identified MEOX2 as a prognostic marker and a potential survival factor for GBM, presenting an important therapeutic potential of targeting MEOX2 in treating this deadly disease.

**Mentors:** Dr. Zhi Sheng (Virginia Tech Carilion Research Institute, Associate Professor), Dr. Kevin Pridham (Virginia Tech Carilion Research Institute)

MATTHEW SVEC
VIRGINIA TECH CARILION RESEARCH INSTITUTE
RICHARD QIU
VIRGINIA TECH CARILION RESEARCH INSTITUTE

## Diabetes Mediates Dysfunction of the Blood-Brain Barrier

Microvasculature consists of lumen-forming endothelial cells (ECs) and pericytes (PCs), cells embedded in surrounding basement membrane. Diabetic microvascular dysfunction is documented in multiple systems, but has not been investigated in brain. This study assessed microvascular health and dysfunction at the blood-brain barrier (BBB) via immunohistochemistry and computational modeling. Control and diabetic brain vasculature was characterized in vivo by immunostaining and confocal microscopy. Vascularization and PC coverage were analyzed, and a statistically significant decrease in PC coverage (p<0.01) and statistically significant increase in vascularization (p<0.01) were observed in diabetic brain. Basement membrane components collagen III (Col3) and collagen IV (Col4) were also investigated. A statistically significant increase in the standard deviation of Col4-to-vessel ratio was observed when compared to control (p<0.01), suggesting vascular remodeling and heterogeneity of Col4 coverage in diabetes. Phenotypic changes to glia were also investigated. Astrocyte reactivity and microglial activation were assessed by GFAP and IBA1 staining, respectively. At the time of the writing of this abstract, results are pending. Implications of BBB dysfunction were modeled in silico using a Green's function method. BBB degradation was modeled and changes to cerebral oxygen were quantified. Hyperoxia appeared in regions nearest to arterioles while hypoxia appeared in regions nearest the venules. Given our observations of microvascular dysfunction in brain, we propose a previously unexplored diabetic microvascular disease of the BBB that parallels progression of known diabetic microvascular diseases. This BBB disruption has significant implications for tightly controlled transport pathways and neurodegenerative disease.

**Mentor:** John Chappell (Virginia Tech Carilion Research Institute, Center for Heart and Regenerative Medicine Research)

KAYLEIGH VANCE
VIRGINIA TECH / BIOLOGICAL SCIENCES

## Changes in Microglia Activation in the Spinal Cord

Recent studies from our lab have shown that the number of synapses important for initiating and modulating voluntary movements decreases in the spinal cord with advancing age. Microglia are candidates for causing the loss of synapses in the spinal cord given their role in the brain, where they cause synaptic loss with advancing age and also during development. Here, I investigated this possibility by determining if the number of activated microglia increases with advancing age. Using confocal fluorescent microscopy, images were obtained from the lumbar, thoracic, and cervical regions of the spinal cords of mice expressing GFP in microglia at various ages. I determined the total number of microglia. I also examined cellular hallmarks of activated microglia, including increased cell body size and whether their extensions were short or thick extensions. In all three regions, I found a significant increase in the ratio of activated to inactivated microglia in aged mice. I also found a significant increase in cell body size in all three regions of the spinal cord of aged mice. These findings suggest that activated microglia may participate in synaptic degeneration in the spinal cord.

**Mentor:** Dr. Greg Valdez (Virginia Tech Carilion Research Institute, Biological Sciences)

RACHAEL WARD
VIRGINIA TECH / EXPERIMENTAL NEUROSCIENCE

## Ultrastructural Characterization of Types III and IV Collagen within the Vascular Basement Membrane of Brain Blood Vessels

Blood vessels consist primarily of endothelial cells and pericytes (in capillaries), with vascular smooth muscle cells present in arteries and veins, and in the brain, astrocytic end-feet are adjacent to the vessel wall. Endothelial cells form tight junctions, especially in the brain to maintain the blood-brain barrier (BBB). Cellular interactions between pericytes and astrocytes, as well as their respective contributions to the BBB, remain poorly understood. Col-III and Col-IV are present in the vascular basement membrane, though the relative amounts of these extracellular matrix (ECM) proteins can change in certain disease states. Relatively little is known about how these components are physically configured in the brain microvasculature. This project aims to more fully characterize the intercellular space of brain microvessels in adult wild-type mice. To that end, we used high-power confocal imaging, Serial Block Face-Scanning Electron Microscopy (SBF-SEM), and Super-Resolution Microscopy. First, analysis of SBF-SEM images facilitated characterization of physical aspects of the brain vasculature. We measured the intercellular thicknesses between different vascular and non-vascular cell types, and cataloged ultrastructural details of apparent cellular interactions. We used confocal microscopy to observe immunolabeled neurovascular cells as well as to verify staining procedures for the 10 micron-thick, cryo-sliced sections. We then utilized Super Resolution Microscopy to generate images capturing the relationship between various cell types at the neurovascular interface (endothelial cell, pericyte, astrocyte, vascular smooth muscle cell) in addition to Col-III or Col-IV. SBF-SEM in particular revealed cellular projections within the brain microvasculature, appearing to mediate contact points for direct cellular interaction.

**Mentor:** John Chappell (Virginia Tech Carilion Research Institute, Biomedical Engineering)