OFFICE OF UNDERGRADUATE RESEARCH

HARNESS THE POWER OF DISCOVERY

2016

SUMMER UNDERGRADUATE RESEARCH SYMPOSIUM

ABSTRACT BOOK

VirginiaTech

Invent the Future®

Welcome

The Summer Undergraduate Research Conference is a highpoint of our summer at Virginia Tech. Most students presnting today have spent ten or more weeks immersed in a research project full-time. Summer affords undergradutes the opportunities to dedicate significant time and effort 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 experience 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. Congraduatlations to all of our presenters!

A very special thank you to Keri Swaby and Aaron Burdette for their tremendous work in making this symposium happen!

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

Office of Undergraduate Research

Welcome to the annual Summer Undergraduate Research Conference at Virginia Tech! We are extremely excited to welcome 88 presenters from eight (8) organized research programs and independent labs, who will give 11 oral and 84 poster presentations. Over the course of the past 10 weeks, undergraduate students from Virginia Tech and across the country, as well as local teachers, have been engaged in a wide variety of projects tackling real world problems in all areas of STEM. I am extremely humbled by the quality of work on show as part of this symposium 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 research students on campus, serving about 130 students. Students participated in weekly professional development seminars that explored topics including handling data ethically, personal statements, graduate school, writing abstracts and proposals, communicating science, and presenting research. Guest speakers came from University Libraries, Fralin Life Science Institute, University Honors, the VT Graduate School, and faculty from a variety of internal and external programs including VCOM. We are extremely grateful for their time and for sharing their expertise.

But this summer was not only about research and professional growth. This summer, the OUR sought to make this "The Best Summer of Your Life" for student participants. The OUR planned weekly Friday field trips to labs and facilities in the area including the VT Foundry, Kentland Farms, TREC lab, Future House, ICAT, and the VT Food Pilot Processing Plant, as well as fun outings to pick berries, to eat at the Homeplace Restaurant, to tube on the New River, to hike, and to explore the area. These activities were facilitated by four amazing peer mentors- Allie, Bryce, Nick and Stacy- who tirelessly planned events and activities, offering their time and experience to ensure that a fun time would be had by all. Without these dedicated students and the expert direction and immeasurable effort of Aaron Burdette, jack of all trades and indispensable program support specialist for the OUR, this summer would not have been a success. I thank them for all of their incredibly hard work. I would also like to thank Jack, Najla, and Caleigh for their help with communication and marketing efforts of the Office this summer.

The operations of the OUR would not have been possible without generous financial support from the Fralin Life Science Institute, the Office of the VP for Research, and the Biomechanics REU program.

Thank you!

Sincerely,
Keri Swaby

University Undergraduate Research Coordinator

Thank you

PROGRAM DIRECTORS

- **A MULTISCALE APPROACH TO BIOMECHANICS REU** / Dr. Pamela VandeVord (Biomedical Engineering & Sciences)
- **INTERDISCIPLINARY WATER SCIENCES AND ENGINEERING REU** / Dr. Vinod Lohani (Engineering Education)
- **SPACE@VT REU**/ Dr. Robert Clauer (Electrical and Computer Engineering), Dr. Scott Baily (Electrical and Computer Engineering)
- **FRALIN SUMMER UNDERGRADUATE RESEARCH FELLOWSHIP** / Keri Swaby (Office of Undergraduate Research)
- **TRANSLATIONAL OBESITY UNDERGRADUATE RESEARCH PROGRAM** / Dr. Deborah Good (Human Nutrition, Foods and Exercise)
- **NIH BRIDGES TO BACCALAUREATE** / Dr. Karen Eleysanders (Assoc. Vice Provost for College Access), Dr. Kristy Collins (Biocomplexity Institute).
- **MAOP UNDERGRADUATE SUMMER RESEARCH INTERNSHIP** / Dr. Jody Thompson Marshall
- **RET: BIOMECHANICS FROM MOLECULAR TO ORGANISIMAL SCALES** / Dr. Jake Socha (BEAM)

UNDERGRADUATE PEER MENTORS

- **ALLIE GREENE** / (Biochemistry, 2017) Fralin SURF (2013)
- **NICK LORD**/ (Biochemistry/German, 2018)
- **ANASTASIA KARETNYI** / (Biochemistry/Psychology, 2018) Fralin SURF (2014)
- **BRYCE DUNN** / (Biological Systems Engineering, Human Development, 2016)

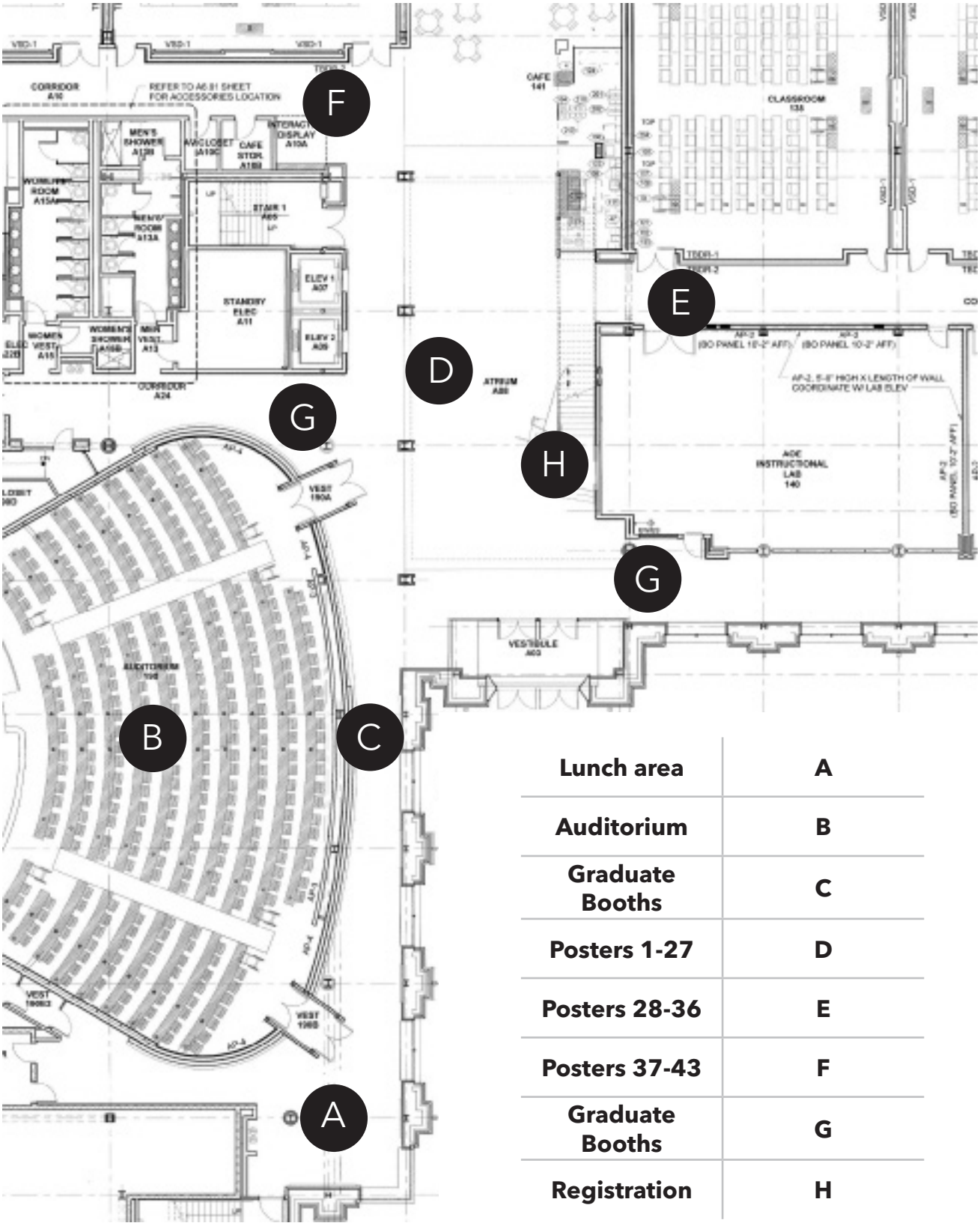
UNDERGRADUATE STUDENT ASSISTANTS

- **JACK HARTLEY** / (JMU Political Science, 2019)
- **CALEIGH SHAFFER** / (Journalism, 2017)

OUR SPONS0RS

- Virginia Tech Office of Undergraduate Studies
- Fralin Life Sciences Institute
- Virginia Tech Office of Research
- A Multiscale Approach to Biomechanics REU

Goodwin Hall



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2016 ACC CREATIVITY & INNOVATION SCHOLARS

This program funded by the Inter-Institutional Academic Collaborative of the Atlantic Coast Conference (ACCIAC) 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 supplies, travel, and use of specialized research services. Students from all academic disciplines were eligible to apply to the program. The seven selected students represent five of the seven undergraduate colleges at Virginia Tech.

Ge Zhou of Greenfield, Massachusetts, a senior majoring in architecture in the College of Architecture and Urban Studies. Project title: *"Probing medical architecture: A study of human-centered design."* Faculty mentor: Aki Ishida, assistant professor of architecture.

Rhiannon Hasenauer of Manahawkin, New Jersey, a junior majoring in human development in the College of Liberal Arts and Human Sciences. Project title: *"The future of Honduras."* Faculty mentor: Katherine Allen, professor of human development.

Allison Moser, a senior majoring in wildlife conservation in the College of Natural Resources and Environment. Project title: *"Habitat use of a rare rabbit species, Appalachian cottontail (Sylvilagus obscurus), in Roan, North Carolina."* Faculty mentor: W. Mark Ford, leader of Virginia Cooperative Fish and Wildlife Research Unit.

Kristen Long, a senior majoring in architecture in the College of Architecture and Urban Studies. Project title: *"The architectural role of a door."* Faculty mentor: Hans Rott, professor of architecture.

Hannah Parker of Emporia, Virginia, a senior majoring in animal and poultry sciences in the College of Agriculture and Life Sciences. Project title: *"The role of leptin as a mediator of placental development and function in cattle."* Faculty mentor: Alan Ealy, associate professor of animal and poultry sciences.

Amina Rahimi, a senior majoring in biochemistry in the College of Science. Project title: *"Development of an on-chip biosensor to quantify leukocyte phenotypes during sepsis."* Faculty mentor: Caroline Jones, assistant professor of biological sciences.

LEARN ABOUT GRADUATE PROGRAMS AT VIRGINIA TECH

The office of Graduate Recruitment and Diversity Initiatives (ORDI) seeks to promote a diverse and inclusive graduate community by acting as an enabler - assisting virtually every graduate program on campus to recruit, retain, and graduate a diverse student body. We follow the model of Inclusive Excellence as a way to improve the diversity of our student body, the success of all students at VT's Graduate School, and improve the climate for all staff, faculty and students involved in graduate education. We want to make Virginia Tech's Graduate School the number one choice for people of diverse backgrounds.

College of Engineering

The College of Engineering enables graduate students to accelerate their career achievements and explore their research interests through 16 Doctoral and 19 Masters programs available in 17 areas of study. Virginia Tech also offers a culturally diverse and vibrant community of students, faculty and administrators for connecting with, learning from, and exchanging thoughts and ideas.

JUMR

Journal of Undergraduate Materials Research

"The Voice of Future Scientists and Engineers"

JUMR is a scientific journal dedicated to research performed by undergraduate students in materials related fields. JUMR is a student-run endeavor. The editorial board is made up of graduate and undergraduate students from the Department of Materials Science and Engineering.

The primary goal of the journal is to provide a venue for undergraduates to publish research performed in materials related fields. The secondary goals are to provide opportunities for undergraduates to practice their communication skills and learn about reviewed publications, as well as providing opportunities for editorial board members to participate in the administration of creating the reviewed publication.

Virginia Tech Initiative for Maximizing Student Development (VT-IMSD, Undergraduate)

Curious about research in biomedical sciences, biomedical engineering, and behavioral sciences? The NIH-funded VT-IMSD is your opportunity! Our alumni have gone to: Stanford; Cal Tech; Brown; Duke; NC State, University of Pennsylvania. All this, while earning approximately $600/month, attending meetings at exotic places in the country, and being a part of a wonderful and supportive environment

Mission

To recruit and use developmental and experiential learning activities to support scholars from groups historically underrepresented in the behavioral and biomedical, sciences and engineering so they may succeed in obtaining a Ph.D. and pursuing a research career in these disciplines.

Program Support

The VT-IMSD is supported by the NIH through the National Institute of General Medical Sciences, which has a special commitment to preparing scholars from underrepresented groups for participation in careers in the biomedical and behavioral sciences.

Benefits for Undergraduate Scholars

Benefits provided scholars are in accordance with NIH guidelines:

- Hourly wage support (12 hours/week) from IMSD during two academic years.
- Travel support to attend a workshop and/or to make a presentation at ABRCMS biomedical conference, yearly.

Expectations for Scholars

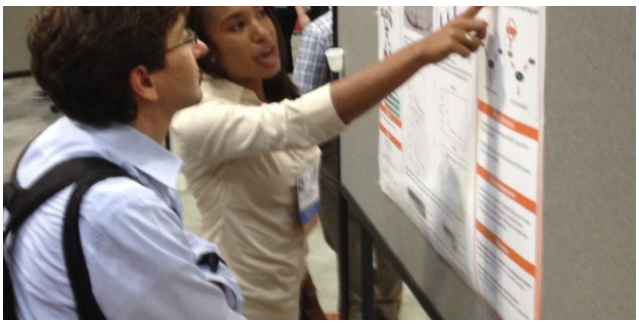
- Each scholar is expected to actively participate in research that offers the potential for scholar growth and development that prepares the scholar for entering a doctoral degree in behavioral or biomedical fields following the bachelor's degree.

Eligibility Requirements

- Underrepresented minorities, students with disabilities, first-generation college students and students with significant financial need

Interested in a Ph.D. and research career in biomedical and/or behavioral research in science or engineering

- Preference will be given to those with a 3.4 or higher GPA
- US Citizens or Permanent residents



Application for PRE-IMSD & IMSD Undergraduate Scholars Program To Apply:

Complete the VT-IMSD Undergraduate Application at http://www.imsd.apsc.vt.edu/?page_id=7616

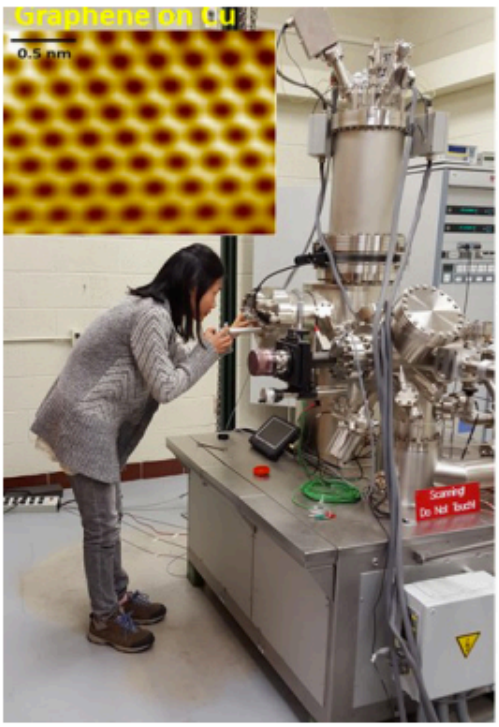
- Unofficial Transcripts
- Resume
- 100 word max description of your career interests
- 150 word max description of your research interests
- 200 word max description of what you hope to gain from participation in this program and how it contributes to your career plans and related decisions
- 100 word max explanation about what you think you can contribute to the program and why we should choose you as an IMSD Undergraduate Scholar
- Contact name and information for at least one, but no more than 2 people who have served as a mentor to you
- If you have had previous research experience, 200 word max description of what you learned from the experience

Please direct any questions to Dr. Ed Smith, VT-IMSD Undergraduate Director (540) 231-6849

Admissions:

You must have a B.S. in physics or a related field from an accredited institution. You should arrange to have your GRE general and physics scores (and your TOEFL score, if you are an international applicant) submitted with your application. You may qualify for a merit-based scholarship or assistantship (teaching or research). Submit your application online at **http://www.graduateschool.vt.edu**

Earn your doctorate or masters degree in PHYSICS



Contact us for more information!

Virginia Tech Department of Physics
222F Robeson Hall
Blacksburg VA 24061-0435 USA

http://www.phys.vt.edu

Betty J. Wilkins
Graduate Program Coordinator
1-540-231-8728
gradphys@vt.edu

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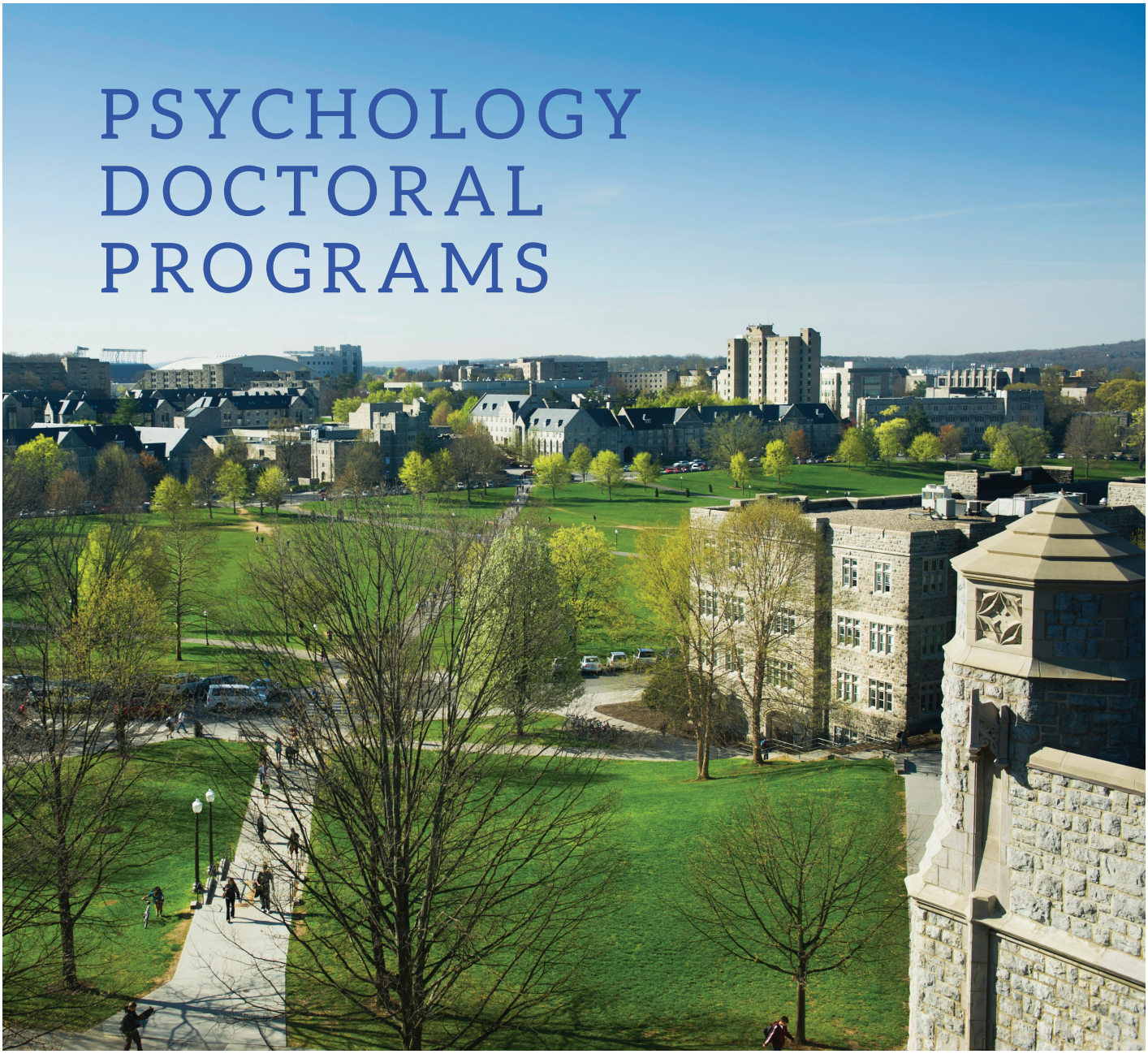
PSYCHOLOGY DOCTORAL PROGRAMS



Home to more than 30 faculty, 70 graduate students, and 900 undergraduate majors, the Department of Psychology at Virginia Tech is actively engaged in basic and applied research that is advancing knowledge in a variety of areas of psychology and health-related behavior.

NEUROSCIENCE AND BIOLOGICAL PSYCHOLOGY

INDUSTRIAL-ORGANIZATIONAL PSYCHOLOGY

DEVELOPMENTAL SCIENCE

CLINICAL SCIENCE

For more information, call us at 540.231.6582 or visit us on the Web at https://www.psyc.vt.edu.

VirginiaTech
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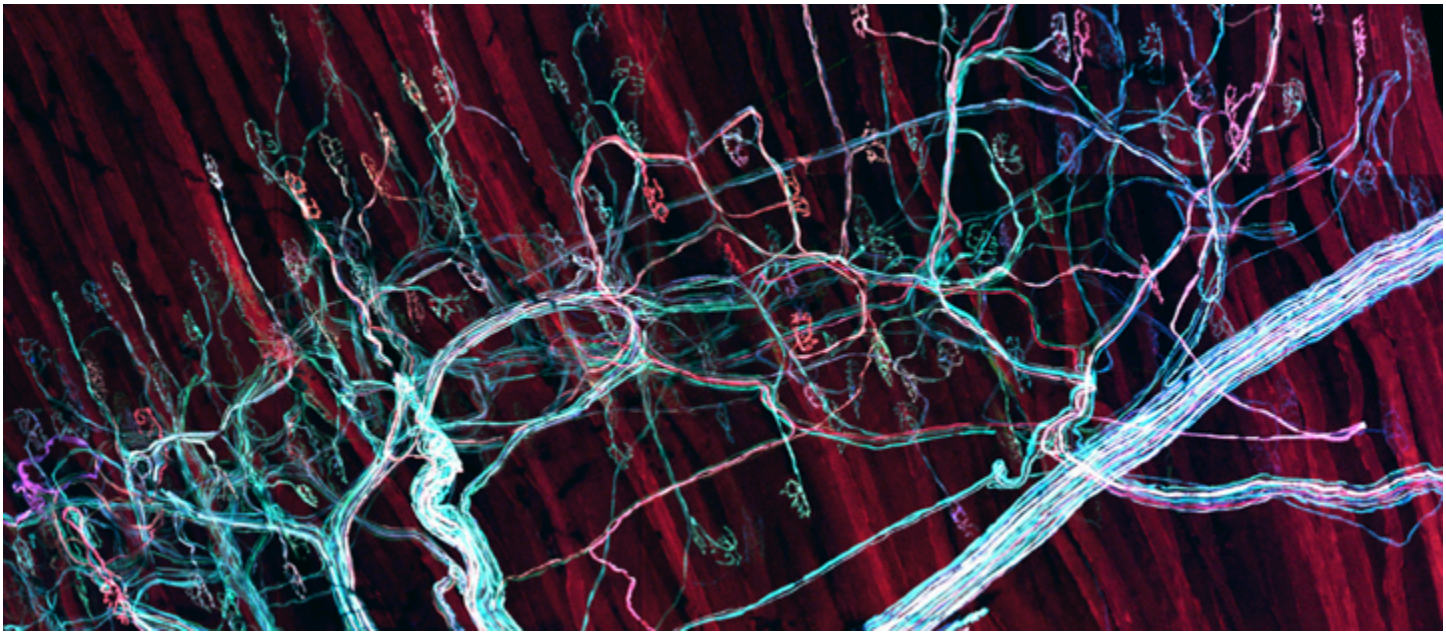
Virginia Tech is an equal opportunity/affirmative action institution.

Virginia Tech's Translational Biology, Medicine, and Health Program



Virginia Tech's Translational Biology, Medicine, and Health program is a research-intensive, multidisciplinary Ph.D. program in the biomedical and health sciences that emphasizes the concept of "translational science" across multiple levels of inquiry. It brings together students from the life, behavioral, physical, engineering, and computational sciences to consider today's major health challenges. Through an innovative interdisciplinary curriculum that is carefully designed to balance breadth and depth, this new program will prepare the next generation of scientific leaders to make and translate discoveries into preventions, diagnostics, treatments, cures and healthier behaviors. In contrast with traditional degree programs,the curriculum will not be delivered by a single department or college, but rather through a collaborative effort from faculty across 17 departments and seven colleges, located in both Blacksburg and Roanoke, Virginia. This "Faculty of Health Sciences," organized by the Associate Provost for Health Sciences, Dr. Michael Friedlander, is dedicated to advancing human health through basic and applied research. As such, many faculty also participate in centers committed to health-related research efforts, in diverse areas such as vector-borne disease, obesity, addiction, drug discovery and regenerative medicine.

How to apply
All applications are submitted online through the Graduate School at Virginia Tech.

For more information on admissions and timelines please send us an email at tbmh@vtc.vt.edu

Building on a Tradition of Success

If you are thinking about attending medical school, the Edward Via College of Osteopathic Medicine has been building on a tradition of success since opening its first campus in Blacksburg, Virginia, in 2003. Now, with three campuses across the southeast, VCOM has expanded not only in size and location, but has also grown in its ability to educate more medical students. VCOM will continue its successful history of educating physicians to serve in the areas where they are needed most, and providing collaborative medical research to benefit southwest Virginia, as well as advancing scientific research for our nation and around the globe.

Please visit our website to find out more about VCOM, where medical students learn to provide patient centered care as future physicians, from experiences extending far beyond the classroom.

www.vcom.edu

or like us on Facebook at **facebook.com/vcomvirginia**

Campuses in Blacksburg, VA • Spartanburg, SC • Auburn, AL

Visit www.vcom.edu/outcomes to view a copy of our Outcomes Report.

VCOM
Edward Via College of Osteopathic Medicine
VIRGINIA

Virginia-Maryland College of Veterinary Medicine

The Virginia-Maryland College of Veterinary Medicine is situated on the campus of Virginia Tech in Blacksburg, Virginia. Blacksburg is located in southwest Virginia between the Blue Ridge and Allegheny Mountains and is a distinct community with a population of about 40,000. Its residents enjoy a wide range of educational, social, recreational, and cultural opportunities. In addition to the main campus in Blacksburg, there are two other campuses, the Equine Medical Center, located in Leesburg, Virginia, and the Gudelsky Center, which is located on the campus of the University of Maryland, College Park.

There are opportunities for students within the Doctor of Veterinary Medicine who have an interest in research, to pursue graduate degrees in a variety of veterinary sciences, as well as a Masters of Public Health program.

The DVM program enables students to enter clinical training at the end of their second year. After spending time in a clinical setting, students will begin tracking in areas of interest within advanced courses. Students will then re-enter the clinics to complete their Doctor of Veterinary Medicine Degree. Areas of tracking include: small animal, equine, mixed animal, food animal, and public/corporate. The college has established the Center for Public and Corporate Veterinary Medicine, which is a national resource for training veterinarians in a variety of careers outside of clinical practice.

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9:00-10:00	Poster Session 1	Atrium
10:00-10:15	Break / Poster Take Down	Atrium
10:15-10:25	Welcome - Keri Swaby	Auditorium
10:25-10:55	Keynote Address - Dr. Paul Knox Dean of Honors College	Auditorium
11:00-12:15	Oral Showcase Session	Auditorium
12:15-1:15	Lunch Graduate school networking Poster Session 2 set up	Atrium
1:15-2:15	Poster Session 2	Atrium
2:15-2:30	Break / Poster Take Down	Atrium
2:30-4:00	Oral Session 2	Auditorium
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Session 1 / Poster presentations

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Oral Showcase

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11:15-11:30	Hana Chan (Biomed. Eng) *Development of a patellar tendon tensile testing methodology for assessment in knockout mice*	Biomechanics
11:30-11:45	Bridget C. Gile (Civil Eng.) *Hydrologic Influences on Surface Peat Characteristics at the Great Dismal Swamp: Implications for Carbon Storage and Fire Vulnerability*	Interdisciplinary Water
11:45-12:00	Schuyler G. van Montfrans (Biology) *The effects of incubation temperature on nest exodus performance within a social context in wood duck ducklings*	RET
12:00-12:15	Laura G. Wonilowicz (Biochemistry) *Structure-Activity Relationship Studies of (R)-Prolinol-Based Inhibitors of Sphingosine Kinase*	SURF

Session 2 / Poster presentations

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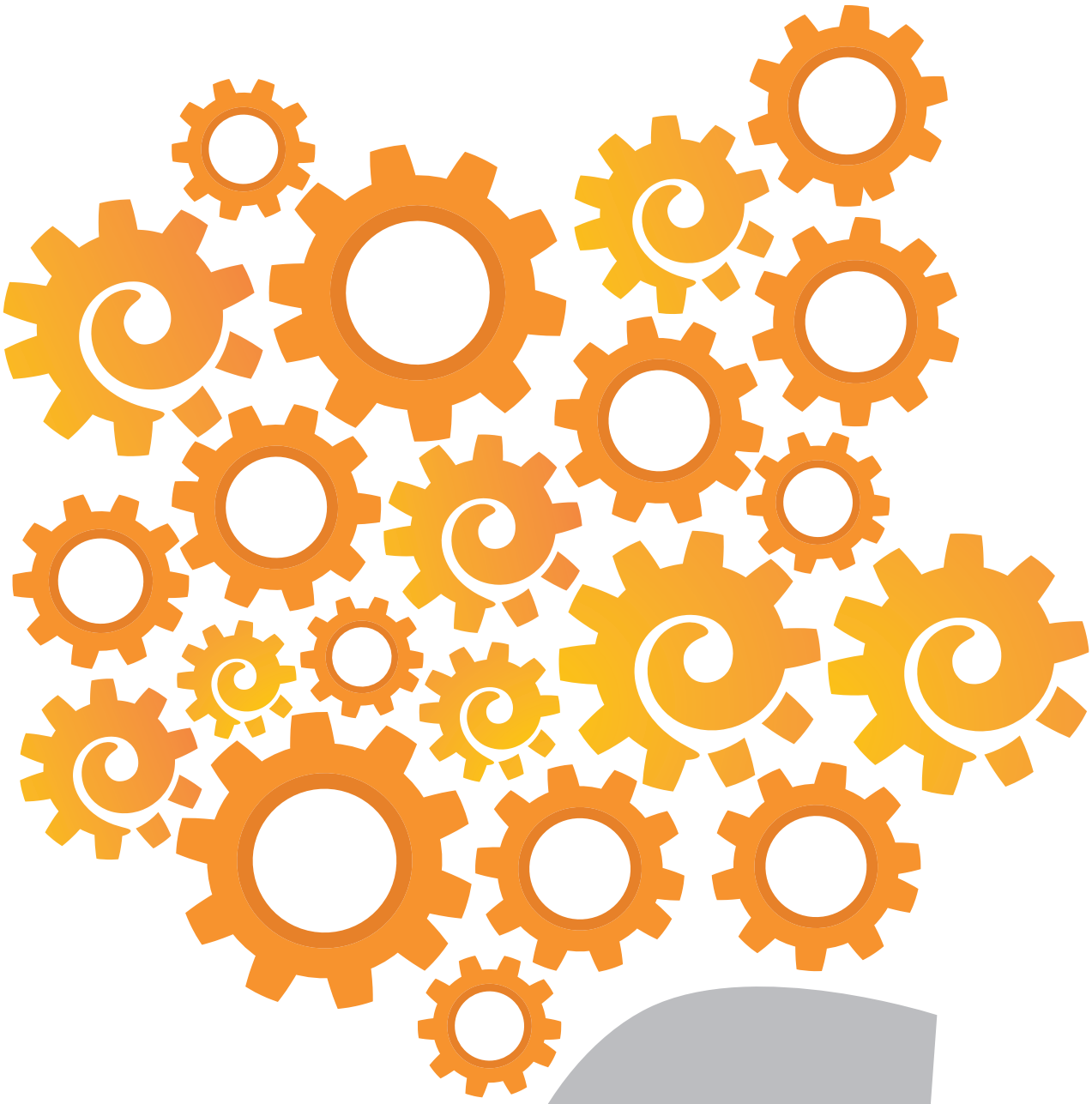
Oral Showcase

2:30-2:45	Emma M. Ramsis (HNFE) *A strategy to rescue LGMD2i using a lentivirus FKRP-GFP construct and muscle progenitors derived from miPSCs.*	TOUR
2:45-3:00	Michael L. Johnson (BSE) *A Novel Genome-Scale Model Architecture for Studying the Metabolic Consequences of Genetic Modification in Plants*	SURF
3:00-3:15	Daniel, P Marron (Chemistry) *Synthesis of Semi-rigid Linkers for Drug Delivery Scaffolds*	SURF
3:15-3:30	Austin C. Shapiro (Chem. Eng.) *The role of Dissimilatory Sulfite Reductase-Like Protein (Dsr-lp) in an methanogenic archaeon*	SURF
3:30-3:45	Tyler T Miller (Biological Sciences) *Evolution of Tetrodotoxin Resistant Sodium Channels (Nav1.8) in Snake Predators of Toxic Amphibian Prey*	SURF
3:45-4:00	Chelsea, N Cereghino BBiological Sciences) *Quantifying the nitrogen fixation of Rhizobium leguminosarum biovar trifolii with Trifolium repens, L. and Rhizobium leguminosarum biovar vicaea with Pisum sativum, L.*	SURF



Abstracts by Program

A MULTISCALE APPROACH TO BIOMECHANICS NSF REU

PROGRAM DESCRIPTION
This REU program allows students to experience a multiscale approach to biomechanical research. Students were fully integrated into participating research groups and experienced hands-on lab research, group meetings, and close collaboration with other members of related research groups. By conclusion of the program, students should understand the connection between biomechanical research and fundamental biological processes in health, injury, and disease.

PROGRAM DIRECTOR
Dr. Pamela VandeVord, Biomedical Engineering and Sciences

PROGRAM COORDINATOR
Amanda Covery

Chan, Hana
Case Western Reserve University
Biomedical Engineering
Mentor: Dr. Vincent Wang

Detwiller, Maya E.
Lafayette College
Mechanical Engineering
Mentor: Dr. Clay Gabler

Grewal, Arshpal S.
North Carolina State University
Mechanical Engineering
Mentor: Dr. Amrinder Nain

Stiansen, Nicholas S.
University of Pennsylvania
Bioengineering
Mentor: Dr. Steve Rowson

Tobin, Michael P.
University of Maryland- College Park
Bioengineering
Mentor: Dr. Costin Untaroiu

Weigand, Kellen N.
The University of Maryland
Bioengineering
Mentor: Dr. Bahareh Behkam

Wenrick, Mackenzie S.
Gannon University
Biomedical Engineering
Mentor: Dr. Robin Queen

Williams, Emily R.
Westmont College
Kinesiology
Mentor: Dr. Scott Verbridge

Winey, Nastasia E.
Johns Hopkins University
Mechanical Engineering
Dr. Andrew Kemper

Young, Shaunna D.
William Fleming High School (teacher)
Earth Science Education
Mentor: Dr. Vincent Wang

Zemitis, Catherine
Clemson University
Bioengineering
Mentor: Dr. Pam VandeVord

HANA CHAN,
CASE WESTERN RESERVE UNIVERSITY / BIOMEDICAL ENGINEERING

Development of a patellar tendon tensile testing methodology for assessment in knockout mice

Tendons ensure proper joint motion by transmitting forces from muscle to bone. Even though tendons exhibit the highest tensile strength among all connective tissues, they are prone to injury. Assessment of their biomechanical properties is critical to understanding the functional integrity of these tissues in their injured and uninjured states. Tendons consist of densely packed, organized collagen fibers embedded with noncollagenous material (predominantly proteoglycans). Proteoglycans (PGs) are composed of a core protein and glycosaminoglycan (GAG) side chains. Although proteoglycans constitute a minor percentage of tendon composition, they regulate collagen fibril growth and assembly, and their absence alters tissue mechanical properties. Hyaluronan (HA) is a hydrophilic GAG commonly found in the extracellular matrix of connective tissues and is produced by various hyaluronan synthases (Has). While the effects of HA on shear and compressive tissue properties are well documented, its influence on tensile tissue properties is presently unknown. The objective of this study is to develop a mouse patellar tendon tensile testing methodology and initially utilize this experimental model to quantify the effect of hyaluronan synthase ablation on mouse patellar tendon mechanical properties. Patellar tendon-bone complexes were harvested from three genotypes of 12 week male mice: wild type, Has1-knockout, and Has3-knockout. Following design and implementation of a custom experimental system, tensile testing was conducted using an MTS Insight materials testing system by loading tissue specimens in uniaxial tension until failure. We hypothesize that the knockout of hyaluronan synthase will increase the tensile properties of patellar tendons.

Mentor(s): Dr. Vincent Wang, Virginia Tech, Biomedical Engineering and Mechanics;

MAYA E. DETWILLER,
LAFAYETTE COLLEGE / MECHANICAL ENGINEERING

Pedestrian Crash Risk Mitigation by Autonomous Vehicles: Understanding the Efficacy of Perfect Active Safety

As autonomous vehicle research progresses, their influence on pedestrian safety continues to be questioned. The objective of this project was to determine the effect autonomous vehicles could have on pedestrian crash risk by characterizing the available time for an active safety system to respond to an unexpected pedestrian in the vehicle's path of travel. The current study is based on data collected in the Pedestrian Crash Data Study (PCDS) by the National Highway Traffic Safety Administration (NHTSA) from 1994 to 1998 consisting of a total 549 in-depth pedestrian crash reports. It was assumed autonomous vehicles would not violate traffic rules as well as recognize and proceed with caution in hazardous scenarios. Thus, crashes involving unlawful or careless driving behavior were assumed to be prevented by emergency braking. From the remaining 311 reports, available times for an autonomous vehicle to detect and avoid a pedestrian were calculated using the pedestrian's distance travelled in the roadway and their travel speed. These time estimates were then used to sort each crash into one of three categories: crashes mitigated by autonomous braking, crashes mitigated by a pedestrian airbag, or those solely dependent on a pedestrian safe car structure. The results concluded that out of the 311 crashes studied, only one case (0.3%) was deemed unavoidable as neither safety feature could be deployed and none of the vehicle's additional precautions would mitigate the severity of the crash. Regarding the entire dataset, it was predicted an autonomous vehicle could prevent 91-97% of the crashes studied. Note that a number of these scenarios were highly unusual. An autonomous vehicle design must consider these unique situations to avoid all crashes.

Mentor(s): Dr. Clay Gabler, Virginia Tech, Biomedical Engineering and Mechanics;

ARSHPAL S GREWAL,
NORTH CAROLINA STATE UNIVERSITY / MECHANICAL ENGINEERING

Design of Fiber Networks to Measure Forces in Cell Division

Despite vast research in the field of cell mechanics, methods to quantify mechanical behavior of cells in a 3D microenvironment mimicking the native extracellular matrix (ECM) are still in infancy. Quantitating cell force modulation to changes in cellular microenvironment promises to provide new mechanistic insights in a myriad of biophysical processes including division, differentiation, migration and apoptosis. Currently, these measurements are conducted using flat substrates (2D) or gels (3D) of different stiffness resembling soft or stiff cellular microenvironments. In vivo cells are surrounded by the fibrous ECM comprised of protein fibrils (30-70 nm in diameter), which are often bundled together to form larger diameter fibers (200-5000 nm). Thus, it is important to develop contextually relevant fibrous platforms to study cell mechanics. Here, using the non-electrospinning Spinneret based Tunable Engineered Parameters (STEP) fiber manufacturing platform, we are able to measure forces exerted by single cells attached to fused fiber nanonets. Nanonet Force Microscopy (NFM) uses nanonets composed of two layers of polystyrene fibers (220 and 2000 nm) deposited orthogonally to each other and fused at the intersections. The smaller and larger diameter fibers are spaced 20 and 300 microns apart, respectively. Cells cultured on fibers apply contractile forces causing the fibers to deflect, which is used to calculate the forces. We use this approach to demonstrate our ability to characterize division of Retinal Pigment Epithelial (RPE-1) cells attached to two fibers. Using timelapse microscopy, we record the mitotic cycle of single cells and describe their force modulation at high spatiotemporal resolution.

Mentor(s): Amrinder Nain, Virginia Tech, Mechanical Engineering; Abinash Padhi, Virginia Tech, Mechanical Engineering

NICHOLAS S STIANSEN,
UNIVERSITY OF PENNSYLVANIA / BIOENGINEERING

The Effect of Soft_——Shell Helmet Add-ons on Concussion Risk in Football

With up to 3.8 million sports-related concussions annually in the US and a potential correlation between head injury and long-term neurodegenerative diseases, minimizing concussion risk in athletes has become a priority. Companies such as Guardian are now creating helmet enhancements in the form of polyurethane-padded soft shell helmet covers designed to reduce head acceleration. However, the efficacy of the Guardian Cap has not been quantified and there is even some concern that a soft-shelled cap could increase injury risk due to greater friction. The objective of this study was to evaluate the Guardian Cap in its ability to reduce concussion risk. A total of 432 impact tests were performed using a pneumatic linear impactor to simulate head impacts in football. Three helmet types equipped with and without a Guardian Cap were struck with an impactor face simulating a football helmet with and without a Guardian Cap. Four impact locations were struck at 7, 8.5, and 9.5 m/s to represent a range of potentially concussive blows experienced by players. Helmets were fitted onto a dummy headform that was attached to a dummy neck and instrumented with three accelerometers and three angular rate sensors. Peak linear acceleration, peak rotational acceleration, and peak rotational velocity were calculated for each test condition and compared using a Two-Factor ANOVA. While differences due to the Guardian Cap were observed under specific conditions, differences were small and did not affect concussion risk greatly. These data are the first to quantify the Guardian Cap's effect on concussion risk.

Mentor(s): Steve Rowson, Virginia Tech, Center for Injury Biomechanics;

MICHAEL, P TOBIN,
UNIVERSITY OF MARYLAND- COLLEGE PARK / BIOENGINEERING

Development of a Biofidelic Finite Element Model of Human Rib Bone

Thoracic damage is the second-leading cause of severe and fatal automobile collision injury, ranking only below head injury. In adults, rib fractures are the most common form of thoracic injury resulting from moderate to severe motor vehicle accidents. Finite element (FE) human rib models could be utilized to improve the design of current automotive safety restraint systems. The purpose of this study was to identify the material properties of rib cortical bone using a FE simulation based optimization approach. Computerized Tomography (CT) scans of a human rib were segmented to reconstruct the interior and exterior surfaces of the cortical bone. These surfaces were aligned with FARO scan data recorded during prior rib bending tests to accurately model the pre-test configuration, including the potted ends. The time history of rib displacement recorded in testing was assigned at one rib end, while a kinematic joint was defined at the other rib end. The cortical parameters (the elastic modulus, tangent modulus, and yield stress) were considered as variables within ranges from literature. These bone parameters were identified by minimizing the difference between force-time histories recorded in the simulation and corresponding data recorded in testing using DOE (Design of Experiments)-based optimization algorithms. The cortical parameters derived in this study will be used to improve the human body FE models (i.e. GHBMC models), which could be used to design advanced automotive restraint systems.

Mentor(s): Dr. Costin Untaroiu, Virginia Tech, Center for Injury Biomechanics; Keegan Yates, Virginia Tech, Biomedical Engineering and Mechanics

MACKENZIE S. WENRICK,
GANNON UNIVERSITY / BIOMEDICAL ENGINEERING

Changes in Side-to-side Symmetry During a 2 Mile Run

Side-to-side asymmetry is known to increase injury risk during dynamic activities such as running. Despite the various reports pertaining to asymmetry in runners, the role that fatigue plays on side-to-side asymmetry has never been assessed. Therefore, this study investigated the impact of fatigue on loading symmetry during a 2 mile run on an outdoor course. Methods: 16 subjects (9 male, 7 female) ran on a predetermined course outside while wearing the single-sensor insoles (pedoped, Novel Electronics, St. Paul, MN) to measure vertical ground reaction forces throughout the run. The forces from twenty-step intervals were pulled for each limb at 25%, 50%, and 75% of the run to determine how limb symmetry changed throughout the run. The average and maximum peak ground reaction forces at each time point were determined and limb symmetry indices were calculated. A 1X3 repeated measures ANOVA was used to determine differences across time during the run ($p<0.05$). Results: No differences in side-to-side symmetry were observed across time during the run ($p=0.657$). The changes in average and maximum peak symmetry across the run appeared to be subject specific with high variability. Discussion: These results indicate that changes in symmetry may be subject specific and could be altered based on course location (running up hill or downhill) as well as potentially age and weekly running mileage. Further investigation is needed to determine the impact of these additional measures on loading symmetry as well as an expansion to a longer run in order to increase subject fatigue.

Mentor(s): Dr. Robin Queen, Virginia Tech, Biomedical Engineering and Mechanics;

KELLEN, N WEIGAND,
THE UNIVERSITY OF MARYLAND / BIOENGINEERING

Characterizing HL-60 - Salmonella Typhimurium Interactions for Improved Bacteria-Based Cancer Therapy

Engineered, facultative anaerobic bacteria such as Salmonella Typhimurium (ST) have been shown to safely accumulate in tumor tissue with high selectivity and to treat cancers unresponsive to conventional therapies. However, clinical success in immunocompetent hosts has been rare due to insufficient tumor colonization by bacteria. This is presently attributed to the host immune response, and bacteria-neutrophil interactions in particular have been implicated in in vivo studies. While the likelihood of tumor eradication by bacteria could be increased by systemic neutrophil-suppression, the risk of fatal infection is also increased. Thus, the objective of this project is to control intratumoral inflammation through localized modulation of neutrophil-bacteria interactions, thus enabling the bacteria to overcome the immunologic barrier and proliferate in vital tumor tissue. To this end, this work focused on characterizing the role of various genetic modifications on bacteria-neutrophil interactions in a microfluidic assay device. First, the motility and chemotaxis response of wild-type ST 14028 and tumor-targeting ST VNP20009 (Ô"msbB, Ô"purI) to a chemoattractant in our three channel, flow-free microfluidic chemotaxis assay device was characterized to validate experimental design and establish a baseline from which bacterial behavior was measured. Next, the responsive behavior of differentiated, neutrophil-like HL-60 cells to the presence of either ST 14028, ST VNP20009, or non-flagellated mutants (Ô"fliF) of both strains was quantified. The results of our HL-60 experiments are forthcoming. Using results from these experiments, optimized primary neutrophil-bacteria studies will be designed, the results from which can be used to devise strategies for improved bacteria-based tumor therapy.

Mentor(s): Dr. Bahareh Behkam, Virginia Tech, Mechanical Engineering;

EMILY, R WILLIAMS,
WESTMONT COLLEGE / KINESIOLOGY

Investigating the effects of a pulsed electric field on adherent cell structure and signaling

Despite developments in molecular drug immunotherapy for cancer treatment, remaining challenges render treatment difficult. Specifically, certain forms of cancer lack molecular targets, and can evade immune-surveillance. A potential solution to this is a multi-pronged attack on cancer that leverages physical mechanisms apart from molecular targeting. Recently, our lab reported down-regulation of a pro-tumor cell-signal in triple negative breast cancer (TNBC) cells exposed to short (order~ nano-microsecond) transient high-amplitude (order~ kV/cm) pulses typically used clinically via irreversible electroporation (IRE). From these observations, the lab hypothesized that the application of an electric field leads to changes in cell-signaling due to both electrophoretic forces on cell membrane receptors and shock to the internal structure of the cell. The aim of this project was to build an experimental platform to test this hypothesis. We sought to test the impact of pulsed and temporally uniform fields on cellular structure and signaling, while keeping total energy supplied constant. Fast Fourier Transform and numerical integration methods were used to determine the magnitude of a uniform field (corresponding to a pulsed field) that causes 50% mortality. Engineering design procedure for the experimental platform included: computer aided design, prototype testing using 3D printing fabrication, and a simulation of electric field distribution using finite element methods. IRE treatments on TNBC MDA-MB-231 cells were conducted inside 3D printed chambers to determine the lethality of electric field at differing voltages. Further, we stained cells to observe internal cellular structures and used cell supernatants to detect changes in cell-signals implicated in TNBC.

Mentor(s): Dr. Scott Verbridge, Virginia Tech, Biomedical Engineering; Ishan Goswami, Virginia Tech, Biomedical Engineering PhD Student

NASTASIA, E WINEY,
JOHNS HOPKINS UNIVERSITY / MECHANICAL ENGINEERING

Effect of Post Mortem Degradation on the Material Properties of Bovine Liver Parenchyma

Motor vehicle collisions (MVCs) are the second leading cause of accidental death in the United States, and the liver is one of the most frequently injured organs in MVCs. Although anthropomorphic test devices (ATDs) are used to assess the risk of injury from a MVC, none of the current regulatory ATDs are equipped with sensors that can be used to predict abdominal organ injury risk. Consequently, finite element models (FEMs) are becoming an integral tool for assessing abdominal organ injury risk. However, FEMs must be validated using biomechanical data, in order to make accurate assessments. Previous studies have conducted tension and compression coupon tests, on human and bovine liver parenchyma, to quantify the failure properties of the liver 36-48 hours after death. However, the effect of post mortem degradation on the material response has not been fully characterized. Therefore, the purpose of this study is to quantify how post mortem degradation effects the tensile material properties of bovine liver parenchyma. Fresh bovine livers were acquired within one hour of death. Multiple 5 mm thick, dog-bone shaped specimens were obtained from each liver, and then pulled in tension at 1 s-1 until failure, at various time points after death (~6, 24, and 48 hours). Motion tracking, load cells, accelerometers, and pre-test pictures were used to quantify failure stress, failure strain, and Poisson's ratio. Overall, this study will provide novel data that will improve the understanding of the effects of post mortem degradation on the material properties of liver parenchyma.

Mentor(s): Dr. Andrew Kemper, Virginia Tech, Biomedical Engineering; Kristin Dunford, Virginia Tech, Biomedical engineering

CATHERINE ZEMITIS,
CLEMSON UNIVERSITY / BIOENGINEERING

Understanding Blast-induced Traumatic Brain Injury Through the Use of a Novel Shock Wave Generator and High Speed Strain Analysis

Blast-induced traumatic brain injury (bTBI) affects over 25% of Veterans and service members. The increase of bTBI is hypothesized to be the result of blast overpressure (BOP) sustained by IEDs. Though it is known that TBI is linked to several clinical symptoms, there is still lack of understanding in disease mechanisms and therapeutic strategies. In this study, a custom shock wave generator (SWG) was optimized and used to better understand how different blast pressure profiles induce cell strain in 3D tissue during blast. To create this 3D structure, an astrocyte cell line was seeded in Matrigel (Corning). Astrocytes maintain homeostasis in the brain, and sense changes in neural activity and extracellular space composition. They respond by reactive astrogliosis, characterized by changes in gene expression, morphology, and proliferative capacity and function. The SWG, which utilizes a blast bridge circuit, simulates primary blast exposure. The device is instrumented with a piezoelectric sensor (Piezotronics) to record pressure profiles during blast. The test section of the chamber is optically clear for visualization of cells during shock wave exposure. Pressure magnitude was tested by various wires within the SWG. Optimization of test conditions to obtain suitable video analysis was accomplished. These parameters included the media (dye-free versus phenol red), slide fixation, and addition of microbeads. This technique provides novel insights into high-speed strain analysis of individual cells which can aid in understanding bTBI cell injury mechanisms which will lead to providing effective therapy and formulation of pathology-specific drugs to treat those afflicted with this injury. /

Mentor(s): Pam VandeVord, Vitginia Tech, Biomedical Engineering; Nora Hlavac, Virginia Tech, Biomedical Engineering

NIH BRIDGES TO THE BACCALAUREATE PROGRAM / MULTICULTURAL ACADEMIC OPPORTUNITIES PROGRAM (MAOP)

PROGRAM DESCRIPTION

The Bridges to the Baccalaureate Program partners with existing programs on the Virginia Tech campus to provide experiential learning opportunities to Virginia Community College System students. 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. There are several components to this program which includes outreach programs to our partner community colleges where faculty talk with students about career options and provide resources to lecture and lab instructors, invitations to students to "test drive" Virginia Tech as an option for transferring to a 4-year institution through campus visits and summer research programs, and a year of mentoring as a Bridges Scholar for those that do transfer to help with the transition to the Virginia Tech academic environment.

This summer, Bridges to Baccalaureate program participants were hosted by MAOP. MAOP is an academic success community founded upon the principles of self-help, mentoring and peer support. Central to the goal of MAOP is the promotion of diversification in the student body at Virginia Tech and on the post graduate level- particularly in the science, math, and technology areas. The summer research internship is a 10-week research experience where students work with a faculty member in a mentor/protégé relationship to design, conduct and present a scholarly research paper. Students learn to plan and conduct research in their field of interest, attend seminars, participate in field trips, use state-of-the-art equipment, prepare for the GRE, and attend a two and a half day exploratory retreat.

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CARLOS, M. APONTE,
NORTHERN VIRGINIA COMMUNITY COLLEGE / BIOLOGY

Chronic Circadian Disruptions and Mutations: The Destabilizing Effects in Per2:p53

Cells function in a daily 24-hour time frame. The internal clock is responsible for transitioning the cell onto the next stage of its cycle. An abnormal external stimulus exerted on the cell can create an opening for a damage-induced gene transcription mediated by the tumor suppressor protein p53. The p53 mediates the response to genotoxic stimuli by transcriptionally modulating the expression of genes involved in cell cycle arrest, repair, and death processes. The human Period 2 (hPer2) interacts with p53 to circumvent the ubiquitination that takes place when p53 and Mdm2 are linked while in the absence of hPer2. We hypothesize that alterations in residues located at the interface between p53 and Per2 should influence the strength of their interaction and we may be able to identify key residues required for the Per2:p53 complex stability. To test this, we made a transcription and translation reaction for the residues of both proteins to find the structure that binds specifically to the mutated p53. Then, we ran an immunoprecipitation to precipitate the proteins. We anticipate that this complex combination will stabilize and regulate the p53 reaction to genotoxic stress.

Mentor(s): Dr. Carla Finkielstein, Virginia Tech, Biological Sciences;

PAULA A CANO,
NORTHERN VIRGINIA COMMUNITY COLLEGE / BIOLOGY

Molecular insights into the circadian Period 2 factor_—Ès interaction with the tumor suppressor p53.

As pathways involved in regulating human circadian rhythm and cell cycle are found to crosstalk, questions arise regarding the role of circadian disruption and the increased incidence of proliferative disorders such as cancer. Evidence suggests that there are key proteins associated with this cycle which are critical in tumor regulation and cell apoptosis. These proteins are part of the circadian clock of the cell, a system that processes signals from the environment, such as light, and regulates the transcription and translation of proteins accordingly. Our studies focus on the Period 2 and p53 protein complex. It is particularly of interest due to the tumor suppressing role of p53, and its relationship with Per2, which prevents ubiquitination of p53. Our previous results show Per2 directly interacts within the C-terminus of p53 and controls p53's transcriptional activity. Accordingly, structural alterations within the p53:Per2 interface could potentially interfere with the essential binding of these two proteins. Various clinically relevant mutations located within the complex interface are being tested to determine their impact in binding patterns, and how this relates to the cell's ability to suppress tumors. We use immunoprecipitation and immunoblotting techniques to test and visualize the impact of structural mutations to evaluate their importance for complex formation.

Mentor(s): Carla Finkielstein, Virginia Tech, Biological Sciences;

MARIA L. CONTRERAS,
NORTHERN VIRGINIA COMMUNITY COLLEGE / ENGINEERING

Characterization of GFAP as a Serum Biomarker for Blast Induced Traumatic Brain Injury

About 1.7 million people suffer from mild traumatic brain injury (TBI) annually (Faul et al., 2010). TBI is a sudden hit to the head induced by an outside force which causes dysfunctions and abnormalities in the brain. This precipitates to psychological, social, and physical complications for patients in later stages after injury. TBI is clinically diagnosed through various screening test such as MRI, CT, and PET scans. However, these tests are often inefficient, inaccurate and costly. The lack of efficient TBI diagnostics represents a significant clinical need which has been addressed through the use of serum biomarkers. In this study, serum was collected from Yucatan mini-pigs at baseline and 72 hours after blast-induced TBI. Two assessment methods were used to determine and validate biomarker detection: Western blotting and enzyme-linked immunosorbent assay (ELISA). Automatic western techniques were used to measure glial fibrillary acidic protein (GFAP) levels in samples of both injured and control animals. GFAP is an intermediate filament found exclusively in astrocytes. Moreover, it has been shown that levels of GFAP within serum may be associated with TBI severity (Lei et al., 2015). Results from this study were derived from animals exposed to various blast levels. Evaluation of GFAP in the animal serum found no significant differences between groups when using Western blotting. Therefore, an ELISA, which is more sensitive, was used to validate these findings. We expect that once optimized, GFAP as a serum biomarker could enable physicians to run blood tests and accurately identify severity of TBI.

Mentor(s): Dr.VandeVord, Virginia Tech, Biomedical Engineering; Nora Hlavac, Virginia Tech, Biomedical Engineering

JUSTIN R. COX,
NORTHERN VIRGINIA COMMUNTIY COLLEGE / PSYCHOLOGY; MATHEMATICS

Effects of Major Depressive Disorder and smoking on cognitive interference and task adaptation

The effects of Major Depressive Disorder (MDD) and smoking on performance under conditions of cognitive interference, as well as task adaptation are not entirely understood. In this study, subjects with MDD (measured using the Beck Depression Inventory) and matched controls performed the Multiple Source Interference Task (MSIT), a task combining Stroop, Flanker and Simon interference to measure response time, accuracy, and adaptation rates. A main effect of interference was found, consistent with that previously reported in the literature. A main effect of smoking, but not for depression, was found, after controlling for age and intelligence.

Mentor(s): Brooks King-Casas, Virginia Tech, Virginia Tech Carilion Research Institute; Pearl Chiu, Virginia Tech, Virginia Tech Carilion Research Institute

RENEE S FAJARDIN,
NORTHERN VIRGINIA COMMUNITY COLLEGE / BIOLOGY

Differential Expression of PI3K Genes in Glioblastoma

Differential Expression of PI3K Genes in Glioblastoma / Renee Fajardin, Kevin Pridham, and Zhi Sheng / Glioblastoma (GBM) is the most aggressive tumor type with significantly poor prognosis. With no known cure or effective treatment to date, searching for new therapies is one of the top priorities in brain cancer research. Recent research from the Sheng laboratory shows that high levels of PIK3CB, a PI3K (Phosphoinositide 3-kinases) subunit, is correlated with decreased survival time in GBM patients and is therefore important for GBM progression. PI3K genes fall into three classes. Class 1 PI3K is comprised of four homologous catalytic subunits p110Ô±, p110Ô_, p110Ô,, and p110Ô_, encoded by four genes PIK3CA, PIK3CB, PIK3CD, and PIK3CG. PI3K pathway regulates the cell proliferation, and deregulated PI3K activity in GBM often causes an exponential increase in tumor growth and patient prognosis. However, previous studies have not yet analyzed the expression of PI3K isoforms in GBM, nor has it compared levels and correlations between PI3K isoforms and phosphorylated AKT (p-AKT, active form) in different GBM cell lines. I hypothesized that cells with high amounts of PIK3CB correlate with AKT activation. Here we measured the expression of p110Ô±, p110Ô_, p110Ô,, and p-AKT using western blotting in 9 GBM cell lines. I showed that two cell lines expressed low levels of p110Ô_ and p-akt, and another two lines had high levels of p110Ô_ and p-akt. These results suggest a possible correlation between PIK3CB levels and activation of AKT in GBM. My finding is of importance because it suggests a selective targeting of PI3K subunits in GBM to improve clinical efficacy for this deadly disease.

Mentor(s): Zhi Sheng, Virginia Tech Carilion School of Medicine;

NATALIA GUTIERREZ,
NORTHERN VIRGINIA COMMUNITY COLLEGE/GEORGE MASON UNIVERSITY / NEUROSCIENCE

Fibroblast Growth Factors Promote the Formation and Growth of Skeletal Muscles

Muscular dystrophy is a group of genetic diseases characterized by progressive degeneration of skeletal muscles, compromising mobility and health of affected individuals. Since skeletal muscles have the capacity to regenerate following activation of quiescent muscle satellite cells, much research has been focused on augmenting satellite cell proliferation and in maintaining the health status of already formed muscle fibers. In this study, we asked if fibroblast growth factors (FGFs) 1, 2, and the FGF binding protein 1 (FGFBP1) promote the proliferation of satellite cells and the formation of muscle fibers. We tested the effects of FGF1, FGF2, and FGFBP1 on C2C12 cells, an immortalized myoblast cell line capable of differentiating into mature muscles cells that fuses to form myotubes in vitro. To assess proliferation, C2C12 cells were plated at low density and treated for 2 days with FGFs. To assess differentiation, C2C12 cells were plated at high density and allowed to fuse to form myotubes. Myotube thickness was then compared between untreated and FGF-treated cells. These experiments reveled that while FGF1, FGF2, and FGFBP1 don't affect the proliferation of C2C12 cells, they increase myotube thickness. They also indicate that members of the FGF signaling pathway may be used to promote the formation of muscle fibers, and thus slow muscle degeneration caused by muscular dystrophy.

Mentor(s): Gregorio Valdez, Department of Biological Sciences;

HAGAR, M KENAWY,
LAFAYETTE COLLEGE / CHEMICAL ENGINEERING B.S.

Rolled PCL Meshes as Biocompatible Scaffolds

Treatments for anterior cruciate ligament injuries currently include the use of metal screws, autografts, and allografts for ACL reconstruction to take place. Unfortunately, such treatments have side effects such as low biocompatibility, donor site morbidity, and limited availability. Electrospinning can be used to fabricate strong, biocompatible fibers that are resilient and provide cell adhesion and guidance. However, electrospun meshes have small pores that inhibit cells from proliferating and the wrong shape to form connective 3D tissues. We propose that rolled composites can be made with the addition of collagen to the aligned fibers to improve the scaffold_–Ès potential for cells to infiltrate and to mimic the extracellular matrix. Rolled polycaprolactone (PCL) fibers were created which varied in rolling alignment, collagen to fiber ratio, and the electrospinning process. Monotonic testing was conducted to measure the composites_–È mechanical properties. This study confirms that fiber orientation, the relative ratio of collagen to micro-fibers, and heparin coated fibers vary the mechanical properties of cylindrical PCL meshes. If the rolled composites exhibit mechanical properties of an ACL, these meshes can move onto in vitro testing.

Mentor(s): Dr. Aaron Goldstein, Virginia Tech, Chemical Engineering; Dina Gadalla, Virginia Tech, Chemical Engineering; Patrick Thayer, Virginia Tech, Biomedical Engineering

LUCINDA LI,
CORNELL UNIVERSITY / ENVIRONMENTAL ENGINEERING

Microbial Deactivation Using Filter Paper Embedded With Fe3+-Modified Montmorillonite

While there are well established technologies to deactivate microbes in water, there is still an urgency to develop a more cost-effective and efficient approach to the issue. In our previous studies, Fe3+-modified Montmorillonite had demonstrated impressive deactivation of E. coli in test tube settings. However, to optimize this mineral treatment, the modified mineral must be immobilized into a readily accessible form. In this study, Fe3+-Montmorillonite was immobilized into filter paper and examined for its capability to deactivate E. coli when water was filtered through the paper. The mineral was embedded into the filter paper by incorporating it in the paper pulp during the paper making process. The formed paper was then used to filter a saline E. coli sample for four filtration runs. A sample of the effluent collected after each run was cultured on an LB agar plate before being filtered by the same piece of paper. It was determined that a paper embedded with 20 grams of wet Fe3+-Montmorillonite deactivated 99.9% of the initial E. coli sample. A paper embedded with eight grams of wet Fe3+-Montmorillonite deactivated 98.5% of the initial E. coli sample. In comparison, the Na+-Montmorillonite papers had little effect on the concentration of E. coli in the effluent and the blank filter paper resulted in a higher E. coli concentration after four filtration runs. These results indicate that immobilizing Fe3+-Montmorillonite into sheets of paper allow for an effective method to deactivate harmful microorganisms in water.

Mentor(s): Kang Xia, Virginia Tech, Crop and Soil Environmental Sciences;

NABILA, A MANGUM,

BENNETT COLLEGE / INTERDISCIPLINARY STUDIES MAJOR, CONCENTRATION IN AFRICANA WOMEN'S STUDIES

Anthropological Ethnography in Blacksburg, VA: Natural Occurring Interactions Involving Cultural Diversity

Sociocultural Anthropology is an academic discipline that has been crucial for understanding cross-cultural differences. It applies a holistic and organic approach through ethnographic fieldwork to understand the meaning systems motivating different groups of peoples' behaviors and values. In current society cross-cultural intersections are very commonplace and dominant as part of the globalized world. Every sociocultural anthropologist now has to learn how to research cultures in this culturally plural context. Fieldwork is very important because it helps us gain a better insight to why communities function the way that they do and the reasons that they operate a particular way. As an inspiring sociocultural anthropologist my project was to learn how to apply ethnographic methods to these current cross-cultural situations. Using anthropological approaches to ethnography, I therefore participated in and observed several local diverse events in the general area of Virginia Tech. Among them were Seeds of Resistance, The Coalition for Justice of Blacksburg &NAACP, the resistance activities against the construction of the Mountain Valley Pipeline, and other cross-cultural events. In addition I consulted with social media and websites on these topics to learn how to apply digital ethnographic methods. I also consulted with printed scholarly sources. This research lead to several insights regarding the significance and importance of anthropological fieldwork in addressing cross-cultural conflicts that is now occurring almost daily. I captured these insights into the richness and complexity of ethnographic research artistically in a set of paintings, each of which expresses a different theme.

Mentor(s): Dr.Anita Puckett, Virginia Tech, Religion and Culture; Virginia Tech, Mrs.Robin Boucher

JAI M MCCLEAN,
HAMPTON UNIVERSITY / BIOLOGY

LRRTM1 is a developmentally regulated, target-derived cue that drives retinal terminal differentiation in mouse visual thalamus

Retinal synapses onto relay cells in visual thalamus differ from retinal terminals in all other retino-recipient nuclei. Not only are retinal terminals significantly large in the dorsal lateral geniculate nucleus (dLGN), but they can be grouped into two distinct classes: simple retinogeniculate (RG) synapses which contain a single retinal terminal or complex RG synapses which contain numerous terminals on the same region of relay cell dendrite. This study aims to identify target-derived factors enriched in dLGN that could differentiate retinal terminals in this region. In mice, lrrtm1 mRNA shows a significant enrichment in dLGN during the development of retinogeniculate synapses. To test the role of LRRTM1 in RG synapse formation, retinal terminals in targeted mutant mice lacking LRRTM1 (lrrtm1-/-) were assessed. There was an increase in the proportion of smaller terminals in lrrtm1-/- mutant mice shown. These results could mean that each retinal terminal was smaller in mutants or that complex RG synapses were absent or impaired in their formation. The ultrastructural data in mutant and control dLGN indicate a reduced number of complex retinogeniculate synapses in the absence of LRRTM1. Thus, complex RG synapses require LRRTM1. This study provides the first insight into the role of a transynaptic adhesion molecule in regulating the assembly of complex, multi-bouton synapses. Further studies are needed to investigate the physiological consequences and behavioral impact of this defect in retinogeniculate synapses in the absence of LRRTM1.

Mentor(s): Michael Fox, Virginia Tech Carilion Research Institute;

MAYANNI, A MCCOURTY,
VIRGINIA WESLEYAN COLLEGE / EARTH AND ENVIRONMENTAL SCIENCE

Effects of incorporation and tillage on cover crop decomposition and soil respiration

Soil respiration is a natural process that releases carbon dioxide (CO2) into the atmosphere, contributing approximately 60 petagrams of carbon per year to the global carbon cycle. Agricultural soil management (e.g., tillage) and the inclusion of cover crops in agricultural ecosystems can alter soil respiration rates, though the specific effects of different tillage practices and different cover crop biomass incorporation depths are not well understood. The objective of this study was to quantify how depths of incorporation and tillage techniques can affect soil respiration rates during the decomposition of a cover crop mixture. Litter bags containing 10 g of crimson clover and barley were either placed on the surface or buried in a cornfield at three different depths (4 cm, 8 cm, 12 cm). One of two tillage techniques (conventional tillage; no-tillage) were applied to each cover crop bag. In half of the no-tillage locations, 1 cm diameter holes (artificial macropores) were created from the surface to the depth of the bag to examine the effects of macropores on respiration rates. Soil respiration rates were measured weekly using a Li-Cor IRGA 8100 auto-analyzer and the litter bags were recovered after 17 or 36 days to determine the decomposition of the cover crops. Preliminary results indicate that conventional tillage may cause an increase in soil respiration rates. Surface litter bags had a slower decomposition rate compared to bags that were buried. These results suggest that no-tillage practices and incorporating cover crops in agricultural ecosystems may reduce soil respiration and decomposition rates.

Mentor(s): Dr. Ryan Stewart, Virginia Tech, Crop and Soil Environmental Science;

MACKENZIE, C. MORRIS,
NORTHERN VIRGINIA COMMUNITY COLLEGE / PSYCHOLOGY

The Moderating Role of Perceived Stress in the Link between Household Chaos and Adolescent Delay Discounting

Adolescence is a period of heightened vulnerability to risky decision making, where environmental, social, and emotional factors can influence risk taking preferences and behaviors. Delay discounting, which measures an individual's preference for smaller more immediate rewards over larger rewards with a delay, is linked with impulsivity, substance use, and cigarette smoking. This preference for immediate gratification is relatively typical for adolescents, however, higher delay discounting indicates greater risk for addictive disorders and externalizing psychopathology. The purpose of this project was to examine the interaction between household chaos and stress, and their influence on adolescent delay discounting. A predominantly rural community sample was comprised of 150 adolescents (n = 150, 47% female), recruited for their participation in a longitudinal research study. Measures of household chaos, adolescent perceived stress, and adolescent delay discounting were collected. A moderated mediation model revealed that household chaos predicts adolescent delay discounting when perceived stress is low but not high. When chaos is low and perceived stress is low, delay discounting is also low. But when chaos is high and perceived stress is low, delay discounting is high. In conclusion, these results suggest that adolescent stress may play an important role in moderating the link between chaotic household environments and adolescent delay discounting. Understanding how stress and environment interact to predict delay discounting can help aide interventions and provide greater understanding of risk-taking and reward processing during adolescence.

Mentor(s): Dr. Jungmeen Kim-Spoon, Virginia Tech, Psychology; Kristin Peviani, Virginia Tech, Psychology

NEHA POTDAR,
VIRGINIA COMMONWEALTH UNIVERSITY / BIOMEDICAL ENGINEERING

Biodegradable Polymer Fibers for Drug Delivery in Brain Tumor Treatment

Photodynamic therapy is a cancer treatment used in which photosensitizers are injected into the bloodstream. After being exposed to a certain light wavelength, they produce a form of oxygen that kills nearby cells. However, the photosensitizers are not cell specific, so they can kill normal cells. The patient must remain in the dark for days since the treatment is light-sensitive. Silica fibers are used to guide the light in this treatment, but have created tissue damage since they are rigid. The purpose of this project was to examine if a more flexible, biodegradable, polymer fiber with a hollow channel could be created to alleviate tissue damage, utilize photodynamic therapy in order to localize the treatment, and perform drug delivery for brain tumor treatment. Experiments were conducted in which different types of fibers and coatings were used to see pore size using the Leo scanning electron microscope. Later, the Zeiss fluorescent microscope was used to see dye diffusion from the silica fibers in agarose gel which represented fake brain. Fiber insertions in mouse brains were performed to see the in vivo dye release and fluorescent images were taken from brain slices of the mouse. After measuring fluorescence intensity from the samples, we see that it decreased over time. The high performance liquid chromatography release study confirmed that all the dye released. We want to use the Femto Second Laser to cut a section of the fiber so light can be refracted at various locations in the brain and treat multiple areas.

Mentor(s): Dr. Tong, Virginia Tech, Chemical Engineering; Dr. Jia, Virginia Tech, Electrical Engineering

EMALEIGH, E RICHARDSON,
SOUTHWEST VIRGINIA COMMUNITY COLLEGE / BIOLOGICAL SCIENCES

Examining Type 4 Pili in Clostridium perfringens

Clostridium perfringens is a Gram-positive, spore-producing, anaerobic bacteria that causes myonecrosis in humans and animals (Reviewed by Uzal et al., 2015). C. perfringens has a type 4 pili system (T4PS) that is used by the bacterium for locomotion and host cell adherence (Reviewed by Melville and Craig, 2013). To examine T4PS protein expression and localization in vivo, we plan to use fluorescence microscopy to trace fluorescently tagged T4PS proteins. We fused a fluorescent reporter protein to the N-terminus of the T4PS protein PilM using overlapping PCR then ligated this into a plasmid. Currently, we have transformed this product into E.coli, with plans to transform the product into C. perfringens to use in conjunction with previously tagged T4PS proteins. Additionally, to identify genes involved in host cell attachment, we prepared to quantify the adherence of C. perfringens mutants. We used a previously developed assay where C2C12 mouse myoblasts are incubated with cultures of C. perfringens mutants, and adherence is quantified with agar plate counts (Rodgers et al., 2011). Both of these experiments are ongoing, as we continue toward the goal of characterizing the T4PS in C. perfringens.

Mentor(s): Dr. Steve Melville, Virginia Tech, Biological Sciences;

SYDNEY, A SMITH,
SOUTHWEST VIRGINIA COMMUNITY COLLEGE / ANIMAL & POULTRY SCIENCES

Differential expression of immunity genes in chickens on various dietary treatments

Coccidiosis is a devastating and costly parasitic disease to the poultry industry with multiple control methods being explored to reduce and ultimately eliminate its impact. The objective of this study was to determine and compare the effects of different prebiotics, alone or in combination with direct-fed microbials (DFM), on immune response of broilers challenged on day 15 with a 10X the recommended dose of the coccidiosis vaccine Advent. In total, 2,800 day-old Cobb 500 male broiler chicks were randomly assigned to 7 replicate pens (40 birds/ pen) of 10 treatments including one no-challenge control. Birds were placed in floor pens containing fresh bedding material topped with used litter but with no previous exposure to coccidia. Ileum samples were taken from 2 birds/pen at days 14 and 21 to assess expression of immune response genes. RNA was isolated and 2ug were taken to synthesize cDNA that is used as templates for qPCR measuring the six target genes IFN-Ô±, IL-1Ô_, IL-6, IL-4, IL-10, IFN-Ô_. This step is underway and data will be analyzed as qPCR is completed.

Mentor(s): Dr. Rami Dalloul, Virginia Tech, Animal & Poultry Sciences;

MORGAN, L VAUGHN; TIFFANY RADLE
NEW RIVER COMMUNITY COLLEGE / BIOCHEMISTRY; BIOCHEMISTRY

Distinct phosphatidylinositol 3-phosphate binding properties of EEA1 and Phafin2

Phafin2 and EEA1 are endosomal proteins with a FYVE domain on their C-termini. This domain is known to bind to a phosphoinositide known as phosphatidylinositol 3-phosphate (PI3P), which is enriched at the endosomal membranes. EEA1 is required for proper fusion of intracellular vesicles with endosomal membranes, whereas Phafin2 is involved with the regulation of epidermal growth factors and the process of autophagy. Working with transformed BL21 E. coli cells with pGEX4T3 plasmid, a glutathione S-transferase (GST) fused version of each protein domain was generated. The purification of the two domains began with over-expression by the addition of IPTG during logarithmic growth. Afterwards, reduced glutathione beads were used to separate the fusion protein from other bacterial proteins. In order to test the effectiveness of the beads, SDS-polyacrylamide gel electrophoresis was employed to observe the isolation of the proteins. The gel showed that the EEA1-FYVE domain attached to the beads and was successfully purified, whereas the Phafin2-FYVE did not. A lipid-protein overlay assay was used to test the binding of EEA1-FYVE domain to PI3P. It was found that a pH of 6.5 was optimal for binding in agreement with previous reports that used other methodologies. Despite the difficulty in isolating the Phafin2 FYVE domain, the pH dependency was tested using the full-length protein. Surprisingly, and opposed to that observed for EEA1 FYVE domain, Phafin2 bound PI3P at alkaline pH. We conclude that EEA1 binding to PI3P would be coupled to a H+ pump at the cytosolic side of the endosomal compartment whereas Phafin2 would not. These distinct functions may be associated to the unrelated EEA1 and Phafin2 functions in endosomes.

Mentor(s): Dr. Daniel Capelluto, Virginia Tech, Biological sciences;

CHRISTOPHER, T WOOTEN,
VIRGINIA TECH / CHEMICAL ENGINEERING

Size Control of Colloidal Pd Nanoparticles: Role of Ligand-Surface Binding Strength

Through a rapidly developing interest in nanotechnology, the application of Palladium nanoparticles has been realized in several areas such as catalysis for organic coupling reactions. To synthesize particles for reaction specific processes, the particles must often be stabilized by ligands. Studies have demonstrated that nanoparticle size is directly controlled by the type and concentration of ligand, but it is still unclear if they prevent nanoparticle agglomeration or have a role in controlling growth via blocking of surface sites. Our hypothesis is that surface growth is affected by the ligand-surface binding strength which can be controlled by the type of ligand and solvent. Additionally, for the same ligand, the binding strength could vary with the size of the nanoparticles. In this investigation, we aim to determine the effect of Pd nanoparticle size on the binding strength of phosphine ligands with different carbon chain length, trioctylphosphine (TOP) and tributylphosphine (TBP). We synthesized Pd nanoparticles (NPs) of different sizes -1nm and 3-4nm- capped with polyvinlypyrrolidone (PVP) in an ethanol-water solution, and then purified, concentrated, and re-dispersed them in pyridine. The size of the NPs was measured by transmission electron microscopy and small angle X-ray scattering, and the ligand-surface binding energy will be measured using isothermal titration calorimetry (ITC). The results will reveal how the type of type of ligand affects the binding strength with Pd NPs and if it is size dependent. Future work will focus on correlating the binding energy with the size of the NPs synthesized using the same ligands.

Mentor(s): Dr. Ayman Karim, Virginia Tech, Chemical Engineering; Wenhui Li, Virginia Tech, Chemical Engineering

RET: BIOMECHANICS FROM MOLECULAR TO ORGANISMAL SCALES

PROGRAM DESCRIPTION

This RET program involves in-service high school STEM teachers from the Appalachian region of southwestern Virginia and southern West Virginia, with an emphasis on serving underresourced schools and low income student populations. Each teacher is paired on a one-to-one basis with a biomechanics research laboratory, conducting research and developing new educational material over seven weeks in the summer. Teachers work alongside faculty and graduate students, developing new skills toward addressing specific biomechanics research questions using a hypothesis-driven approach. The partnership and interaction with the laboratory will continue throughout the following school year. Room, board, and stipend will be provided, with teachers housed on-site on the campus of Virginia Tech. During the summer research experience, teachers develop a novel standards-conforming educational module to bring back to their home school, enriching their curricular activities. Teachers will qualify for professional development points that can be used toward fulfilling the requirements for license renewal with the approval of their school systems.

PROGRAM DIRECTOR
Dr. Jake Socha, BEAM

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Biology
Mentor: Dr. Sunghwan Jung

Barnes, Amanda J.
Roanoke City Public Schools
Mentor: Dr. Jake Socha

England, Mark
Virginia Tech
Mentor: Dr. Rafael Davalos

Hakkenberg, Dawn
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Math
Mentor: Dr. Abaid

Hernandez, Philip A.
Virginia Tech
Biochemistry
Mentor: Dr. Robin Queen

John, Jewell M.
Virginia Tech
Mentor: Dr. Sunghwan Jung

Spivey, Cara R.
Franklin CO High School
HS Teacher
Mentor: Dr. Justin Barone

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William Fleming High School
Roanoke City Public Schools
Biology
Mentor: Dr. William Hopkins

Young, Shaunna D.
William Fleming High School
Teacher: Earth Science Education
Mentor: Dr. Vincent Wang

CHRIS, M BARNES,
WILLIAM FLEMING HIGH SCHOOL / BIOLOGY

Quantifying the structural limits of tree leaves in high wind events

The mechanics of how tree leaves are removed by high wind speed events, and how the lamina and petiole are structured to avoid such catastrophe are subjects of limited study. When wind blows around a leaf, the petiole or lamina surfaces can undergo tension, torsion, or bending forces until maximal withstanding forces yield and the structure fails, injuring the tree. The goal of this study was to investigate the structural limits of the petiole and lamina under tension similar to what would be experienced during a high wind speed storm, and determine whether there is a correlation between angle of the petiole to the branch, and yield strength of the connection. Tests for tensile strength of the petiole-branch interface were conducted using testing machinery by Instron and a branch holding fixture of our own design. In the course of this investigation, it was found that as the angle of the petiole to the branch was changed from its natural conformation, the average force required for separation increased.

Mentor(s): Sunghwan Jung, Virginia Tech, Biomedical Engineering and Mechanics;

AMANDA, J BARNES,
ROANOKE CITY PUBLIC SCHOOLS / ***

How does temperature affect insect hemolymph? A study of the larvae of Manduca sexta.

Microfluidic devices are limited by the differing behavior of fluids at the microscale, most notably, the increased viscous effects. Engineers have turned to insects as inspiration as they successfully circulate their blood (termed hemolymph) at the microscale. As cold-blooded animals, the hemolymph can change temperature with the environment as well, which would potentially alter the viscosity of the hemolymph. This project will determine the effect of temperature on the viscosity of hemolymph in larvae of Manduca sexta. To measure viscosity, a cone and plate viscometer within a nitrogen-filled sealed glove box was used to avoid coagulation. The viscometer was first calibrated using a standard solution as well as aqueous glycerol solutions to ensure the machine is within tolerance limitations. Hemolymph viscosity was then measured using both low and high humidity nitrogen gas to determine the effect of humidity on the samples. Then, using an attached circulating water bath, the viscosity of hemolymph was measured at 5C increments in order to determine how temperature can affect the viscosity. All data was analyzed using custom MATLAB codes that first finds when the viscosity is steady using a moving window standard deviation then determines the average viscosity with a 95% confidence interval. The results of these trials will help us to develop a better understanding of how insects are able to transport hemolymph at the micro scale which could help to improve fluid transport in micro technologies.

Mentor(s): Jake Socha, Biomedical engineering and mechanics;

MARK ENGLAND,
VIRGINIA TECH / ***

Correlation of Induced Osmotic Swelling and Susceptibility of a Cell to in vitro Electroporation

The ability to administer treatments locally at the site of a tumor is important to the success of modern cancer treatment. Targeted therapy is a newer type of treatment paradigm in which a local treatment maximally disrupts cancer cell propagation while as little collateral damage to normal cells as possible. Electroporation is a focal ablation technique in which an_intense electrical field_is applied to a cell in order to increase the permeability of the_cell membrane. Short electrical pulses on the order of a few hundred microseconds to milliseconds are delivered through electrodes placed around a cell to provide the free energy necessary to induce a structural rearrangements of membrane lipids, forming pores that bridge the intracellular environment with the extracellular environment.

The induced transmembrane voltage drives pore formation and is directly proportional to the cell radius and the electric field intensity. Here, we report the development of a protocol to reliably control cell size by modulating the osmolarity of the extracellular medium to enhance electroporation in vitro. We report the effect of induced transmembrane voltage on permeability by observing the evolution of fluorescence intensity in cells in a solution containing propidium iodide. These methods allow us to study the correlation between induced osmotic swelling and susceptibility of a cell to in vitro electroporation. This treatment could also provide a powerful adjuvant to clinical electroporation procedures to improve the targeted treatment of cancer and other diseases using lower-energy levels.

Mentor(s): Dr. Rafael Davalos, Virginia Tech, Biomedical Engineering and Mechanics; Dan Sweeney, PhD Candidate at Virginia Tech, Biomedical Engineering and Mechanics

DAWN HAKKENBERG,
ROANOKE CITY PUBLIC SCHOOLS / MATH

The Impact of Environmental Clutter on Acoustical Detection

Since White-Nose Syndrome has decimated bat populations, acoustical surveys have replaced mist-net capture as the most effect bat-survey tool in the Eastern U.S. However, failure to account for variability in detection probabilities among habitat types and conditions, i.e., structural clutter in the form of underbrush and trees, may bias inferences derived from acoustical occupancy modeling. Additionally, effective monitoring of the now threatened and endangered bat species requires more sophisticated detection probabilities than were previously necessary. Accordingly, we tested the impact of artificial environmental clutter, designed to simulate a range of relative clutter densities and basal area values, on acoustic call reception, call quality, and detection probability. We used a variety of detector placement designs and various detector types. We generated simulated bat echolocation pulses using a custom ultrasonic emitter, and the pulses were recorded using ultrasonic microphones in an anechoic chamber. The generated sounds were both frequency-modulated chirps and idealized calls from wild bats. Environmental clutter was simulated using various ensembles of wooden cylinders designed to mimic plant stems and tree trunks. Findings from our study will be used to refine acoustic sampling protocols and to parameterize bat occupancy modeling, thus producing more robust detection probability values.

Mentor(s): Dr. Abaid, Virginia Tech, 2Deparment of Biomedical Engineering & Mechanics;

PHILIP, A. HERNANDEZ,
VIRGINIA TECH / BIOCHEMISTRY

EFFECT OF ACHILLES TENDON ASSISTIVE TAPING ON PHYSICAL PERFORMANCE

Assistive taping of the Achilles tendon is completed in response to pain or injury. Taping consists of running elastic tape from the middle of the plantar aspect of the foot, around the heel to the middle of the gastrocnemius in order to assist with plantar flexion. The purpose of this study was to determine the effect of taping the dominant leg in healthy recreational athletes on physical performance measures. Methods: For this study, 18 (11 males, 7 females - 22.25 Î±2.35 years, 78.82 Î±15.09kg, 1.61 Î±0.095m) participants with no record of Achilles tendon injury or recent leg injury were recruited. Three trials each of vertical jump height and agility course speed were recorded during both a taped/non-taped condition. The order of testing was randomized to decrease the impact of fatigue. Jump height was measured with a Vertec or a Brower vertical jump indicator during a countermovement jump. Timing gates on a T-test agility course assessed the acceleration, left/right shuffling agility, back-pedal running. A paired t-test was completed to determine differences between the tape conditions with statistical significance being set at 0.05. Results: Subjects jumped higher (p=0.01) in the non-taped condition (17.69 Î± 4.51 cm) when compared to the taped condition (16.72 Î± 4.36 cm). Total time and course section times were not significantly different between conditions. Discussion: These results indicate that taping does not impact running agility, but does result in a decrease in jump performance indicating that prophylactic taping would be detrimental to performance.

Mentor(s): Robin Queen, Virginia Teach, BEAM- Biomedical Engineering and Mechanics; Evan McConnell

JEWELL, M JOHN,
*** / ***

Brush, Rub and Clean : A New Way to use Bubbles for Cleaner Fruits

Cleaning agricultural produce, especially perishable fruits or vegetables, is one of the biggest issues that impacts our society today. Once harvested they need to be cleaned and packed as fast as possible to reach the consumer market with their best taste and texture. To sanitize agricultural produce, companies typically use a big bath of water with chemicals (such as chlorine) to remove the majority of the bacteria. However this approach produces a lot of wasted water and alters the fruits/vegetables taste and texture. In this study we are going to investigate a new way to clean fruits, without using any chemicals. The idea is to use bubbles to brush the fruit/vegetable surface and remove the bacteria. To do so we are going to place a porous stone at the bottom of a water filled tank. This stone will be connected to a mini air compressor via rubber tubing. Once the air compressor is turned on, the air will pass through the pores in the stone creating bubbles in the water. The next step will be to place the fruit/vegetable in the middle of the stream of bubbles. The bubbles will brush up against the fruit/vegetable and presumably remove the pathogens that could be potentially harmful to humans. Using this method instead of chemicals will preserve the texture and the taste of the fruit/vegetable and reduce the amount of wasted water, leading to a reduction of costs for companies and consumers but also preserving our environment.

Mentor(s): Sunghwan Jung, Virginia Tech, Biomedical Engineering and Mechanics; Jean-Francois Louf, Virginia Tech, Biomedical Engineering and Mechanics

CARA, R SPIVEY,
HS TEACHER FRANKLIN CO HIGH SCHOOL / ***

Characterization of Biodegradable Protein-Filled Poly(vinyl alcohol) Composites

The purpose of the project is to characterize several biocomposite films composed of a biorenewable protein filler of trypsin hydrolyzed gliadin (THGd) or trypsin hydrolyzed wheat gluten (THWG) in a biodegradable polymer matrix of poly(vinyl alcohol) (PVA). It is thought that the protein can reinforce the polymer due to high Ô_-sheet content. The relationship between composite mechanical properties and Ô_-sheet content will be quantified via tensile testing and FT-IR spectroscopy, respectively. Conclusions on the effect of protein loading, protein type, and molecular weight of the polymer matrix can be made from the resulting data analysis. If time allows, an image of the protein aggregates within the composite films will be captured with either atomic force microscopy (AFM) and/or scanning electron microsopy (SEM). Creating a polymer composed of a biodegradable matrix and filler could improve current packaging processes.

Mentor(s): Justin Barone, Virginia Tech, Biological Systems Engineering;

SCHUYLER G. VAN MONTFRANS,
TEACHER AT WILLIAM FLEMING HIGH SCHOOL, ROANOKE CITY PUBLIC SCHOOLS, ROANOKE, VA / BIOLOGY

The effects of incubation temperature on nest exodus performance within a social context in wood duck ducklings

In oviparous species, incubation temperature affects many phenotypes in offspring that are critical for survival. -Previous studies on wood ducks (Aix sponsa) demonstrated that even subtle changes in incubation temperature (<1 Celcius) affect growth rate, immune function, thermoregulatory ability, and locomotor ability, as well as exploratory and boldness behaviors in offspring. Wood ducks nest in tree cavities and, shortly after hatching, ducklings must leave the nest by climbing out and jumping down to their mother (nest exodus). This behavior is critical because ducklings that fail to perform this behavior in the wild are likely to be abandoned by their mother and broodmates, which decreases their chances of survival. A previous study found that individual ducklings incubated at a lower temperature were less successful at leaving a nest box than those incubated at a higher temperature. However, nothing is known about how interactions between ducklings incubated at different temperatures may affect behaviors crucial to survival. This study examined whether incubation temperature affects behavior when ducklings incubated at two different temperatures perform a nest exodus simultaneously. In contrast to the findings on ducklings tested individually, we found that incubation temperature did not affect which duckling successfully exited the nest first. This suggests that social interactions between ducklings may affect nest exodus performance. This study has implications for the management of all avian species because parental nesting behavior, and thus incubation temperature, can be affected by a variety of anthropogenic factors such as extreme weather events, habitat degradation, pollution, and invasive species.

Mentor(s): Dr. William Hopkins, Virginia Tech, Fish and Wildlife Conservation; Sydney Hope, Virginia Tech, Fish and Wildlife Conservation

SHAUNNA D. YOUNG,
WILLIAM FLEMING HIGH SCHOOL (TEACHER) / EARTH SCIENCE EDUCATION

Quantifying the Passive Tensile Properties of the Mouse Soleus Muscle

Rehabilitative exercise, specifically eccentric loading (e.g. heel drop exercises) to lengthen the muscle-tendon unit, is currently the most effective long-term therapy for treating chronic Achilles tendon injuries. Further insights into the mechanisms by which eccentric muscle loading promotes tendon healing requires a detailed study of the mechanics of load transmission within the muscle-tendon unit. In both humans and mice, the soleus muscle originates at the posterior aspect of the knee and joins with the gastrocnemius (calf) to insert at the calcaneus (heel). Anatomically, the soleus and gastrocnemius are closely interrelated, and they are both recruited during active contraction or passive stretch. An improved understanding of the physiologic functioning of the calf complex requires examination of the isolated muscle/tendon structures. Physiologic muscle loading modes can be classified as active contraction or passive elongation. The purpose of this research project is to characterize the passive tensile properties of the soleus muscle of mice. This will be accomplished by developing a methodology for quantifying the tensile response of the muscle-tendon unit when loaded to failure. Experimentally, this will be achieved via materials testing combined with digital video analysis of tissue deformation. Results from this investigation will form an important foundation for subsequent studies assessing the relative physiologic contributions of the individual components of the gastrocnemius complex during eccentric loading. An improved understanding of how the muscle-tendon unit functions under loading in uninjured and injured conditions will facilitate the design of physiotherapy protocols for treatment of Achilles tendon injuries.

Mentor(s): Vincent Wang, Virginia Tech, Biomechanics;

SPACE@VT NSF REU

PROGRAM DESCRIPTION
The Center for Space Science and Engineering Research (Space@VT) resides in the Virginia Tech College of Engineering (CoE) with members from the Bradley Department of Electrical and Computer Engineering and the Aerospace and Ocean Engineering Department. Space@VT faculty lead research in both ground based, and satellite based measurements of the upper atmosphere and space weather phenomena, as well as theoretical and modeling research into space plasmas. The REU site exposes students to these various research programs and enables students to select a specific project for detailed focus. We provide undergraduate students an engaging high-quality learning experience over a period of 10 weeks. The program will elevates the students' exposure to space weather and plasma research, while preparing them for positions in academia, industry and government. We recruit talented, motivated and diverse students, and provide them education and orientation with a series of readings, seminars, laboratory work, communitybased outreach, and social and professional development activities.

PROGRAM DIRECTORS
Dr. Robert Clauer, Dr. Scott Bailey (Electrical and Computer Engineering)

PROGRAM COORDINATORS
Padma Carstens, Debbie Collins

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Aerospace Engineering
Mentor: Dr. Jonathan Black

Lloyd, William
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Aerospace Engineering
*Mentor: ****

Mercier, Mark R.
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Smoot, Josh
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Mentor: Dr. Greg Earle

Vogel, Andrew J.
Virginia Tech
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MentorDr. Greg Earle

IAN, L ELLIOTT,
VIRGINIA TECH / AEROSPACE

Optimal Constrained Relative Station Keeping for Small Satellites

The development of new technologies for use with cubesat micro-satellites has opened a new field of capabilities in space. Introducing hydrazine monopropellant to cubesats as small as six liters in volume allows them to maneuver at previously unachievable levels of control. This combination of small size and high maneuverability gives cubesats the potential for new in-orbit missions, but also creates new vulnerabilities for large satellites against cubesats controlled by operators with unknown intentions. Predicting the possible lifespan of a cubesat in relative station keeping may provide information on the capabilities of these new satellites and what should be done to maintain the security of high-value satellites. By using mixed integer linear programming (MILP) model predictive control (MPC), fuel optimal maneuvers can be estimated for a cubesat in proximity operations. When optimizing scenarios over long time spans, MPC breaks a problem down into finite horizons to create a closed feedback control loop that can develop optimal trajectories in real-time. This tool is already providing valuable information on the estimated total time a chosen cubesat model can remain in orbital proximity operations while constrained to certain performance criteria.

Mentor(s): Jonathan Black, Virginia Tech, Aerospace;

WILLIAM LLOYD,
VIRGINIA TECH / ***

NOAA Satellite Audio Capture for Imagery Generation

Software defined radio has allowed for an easy way to capture and record radio transmissions from satellites. The NOAA satellites provide a reliable source of signals. Captured by an antenna and fed through a TCP protocol to a software defined radio, the ability to record the audio as a wave file becomes possible. This wave file can then be passed through a decoder to generate an image of the area the satellite passed over.

*Mentor(s): ***, ;*

MARK R MERCIER,
VIRGINIA TECH / AEROSPACE ENGINEERING

CubeSat Attitude Control Simulator (CSACS)

Spacecraft attitude control three-axis simulators are commonly used to simulate attitude control conditions prior to flight due to the near frictionless environment that they provide. However, these attitude control simulators can be prohibitively expensive for smaller CubeSat class launches. As more universities, industries, and even high schools develop CubeSats to expand the horizons of human understanding, the demand for test platforms to test, verify, and validate systems has increased. Currently, very little if any public attitude control simulator exists that can support the new six and twelve unit CubeSats nor test all current CubeSat configurations. To solve these challenges, an economic alternative to traditional satellite attitude control system test platforms must be developed to meet the increasing needs of the CubeSat development field. A CubeSat attitude determination and control (ADACS) simulation has been designed and fabricated at Space@VT_—Ès Simulation Laboratory in order to meet this need. This inexpensive, next-generation platform will enable testing of any current and future CubeSat frame and ADACS system. The Virginia Tech CubeSat Attitude Control Simulator (CSACS) is a lightweight test platform with negligible inertia. Using commercial off the shelf (COTS) components, the system can dynamically balance and eliminate gravitational torque to provide a stable, realistic simulation system to test CubeSat ADACS. With an approximate platform cost of $2,500, this system can be built by any university or business to promote the advancement of small satellite technology and advanced space science research.

Mentor(s): Dr. Jonathan Black, Virginia Tech, Aerospace Engineering;

ANDREW J, VOGEL; JOSH SMOOT

VIRGINIA TECH / MECHANICAL ENGINEERING; VIRGINIA TECH/ AEROSPACE ENGINEERING

The Next Generation Retarding Potential Analyzer

Retarding Potential Analyzers (RPA) are scientific devices that have been used to measure ion energy distribution in earth's upper atmosphere. However, electrical requirements of RPA systems and size restrictions of CubeSat Satellites have made these scientific devices both structurally weak and difficult to assemble. Therefore, the RPAJ Project was created to strengthen the mechanical system, ease the assembly, and, if possible, widen the operational limitations of the RPA. These improvements would allow for the RPA instrument to be used more widely, allowing us to learn more about our atmosphere at a much quicker rate. / The main process involved in the redesign and development of the new experimental RPA was the engineering process. I implemented the circular loop of research, brainstorm, conceptualize, calculate, prototype and repeat. Research was composed of using the internet and formal documentation to learn about various factors that define an RPA's limitations. Brainstorming involved a collection of drafting paper and drawings. A massive amount of calculations went into ensuring thermal resistivity and structural security on the new design. I achieved effective prototyping using a 3D printer to give accurate representations of possible designs. The process repeated multiple times until the final design emerged. In the end, a new generation of RPA came out of the woodworks. The new design is stronger, more thermally tolerant, and easier to assemble. Overall the design is more reliable as well as simpler to handle.

Mentor(s): Dr. Greg Earle, Virginia Tech, Electrical and Computer Engineering; Dr. Jonathan Black, Virginia Tech, Aerospace and Ocean Engineering

Fralin Life Science Institute Summer Undergraduate Research Fellowship (SURF)

The Fralin SURF program is a 10-week training program designed to give motivated undergraduates the opportunity to engage in full time (approx. 40 hrs/wk) research 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. The program includes weekly research and professional development seminars, periodic social events, and a final symposium during which students will present their research.

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Keri Swaby, VT Office of Undergraduate Research

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TARIQ AYUBI,
VIRGINIA TECH / BIOCHEMISTRY

The Role of Epithelial and Macrophage NLRX1 in Response to Fungal Challenge.

Invasive pulmonary aspergillosis (IPA) is a high mortality fungal infection of the respiratory system affecting a diverse array of immunocompromised individuals. There is a pressing global need for the development of new antifungals due to growing incidences of resistant strains of fungi identified in clinical settings. The NLR (nucleotide-binding domain leucine-rich repeat containing) family of proteins are an essential component of the plant and animal immune response towards viruses, bacteria, and fungi. NLRX1 is a negative regulator of NF-kB signaling and plays an important role in human response to viruses and bacteria. Interestingly, NLRX1 was found to be upregulated in immune suppressed murine models of invasive pulmonary aspergillosis. Inoculation of nlrx1-/- deficient mice with Aspergillus fumigatus resulted in significantly higher fungal loads in comparison to wildtype C57/BL6 mice in immunosuppressed models. A survival study indicated NLRX1 deficient mice were more susceptible to mortality earlier on during infection as well as an overall increase in mortality in an immunosuppressed mouse model. We utilized wildtype and nlrx1-/- bone marrow derived macrophages (BMDM) and bronchial airway epithelial cells (BEAS-2B) to further determine changes in conidial processing, and chemokine/cytokine signaling. Our findings suggest a minor increase in conidial processing, and elevated levels of known and novel immune signaling molecules during invasive pulmonary aspergillosis. This study highlights the novel role of NLRX1 during IPA, identifies novel immune molecules that exacerbate inflammation during IPA, and a proof of concept for therapeutic development centered around NLRX1.

Mentor(s): Dr. Shiv Kale, Virginia Tech, Biocomplexity Institute;

NATALIE, M BALE,

VIRGINIA TECH / BIOLOGICAL SCIENCES

Differential leukocyte profiles of house finches (Haemorhous mexicanus) over the course of an experimental infection with a high or low virulent isolate of the bacterial pathogen, Mycoplasma gallisepticum

White blood cell differentials have proven to be a useful tool in assessing the immune response to stress and disease in an individual. By understanding the different ways the host immune system responds when infected with a pathogen, valuable predictions can be made regarding an individual's susceptibility to disease. However, few studies have explored how differences in pathogen virulence might affect this common hematological parameter in house finches. In the following study, house finches were experimentally infected with either a high or low virulent isolate of the bacterial pathogen, Mycoplasma gallisepticum (Mg). Blood smears were taken for each individual at 7 days pre-inoculation and 0, 3, 7, 14, 28, and 42 days post-inoculation in order to understand how the proportion of circulating leukocytes change over the entirety of the infection period. Finally, the changes in the leukocyte profiles were compared to an individual's infection severity (ie. pathogen load) and disease severity (ie. visible eye lesions) to determine if a correlation existed between these parameters. We found that when house finches were challenged with the high virulent isolate of Mg it caused a rise in the heterophil to lymphocyte (H/L) ratio and in the proportion of circulating monocytes. In contrast, the low virulent isolate of Mg caused no significant changes in the proportion of circulating leukocytes. These results suggest that the immune system of house finches show a markedly different response to Mg isolates of varying virulence.

Mentor(s): Dana Hawley, Virginia Tech, Biological Sciences; Ariel Leon, Virginia Tech, Biological Sciences

CHELSEA, N CEREGHINO,

VIRGINIA TECH / BIOLOGICAL SCIENCES

Quantifying the nitrogen fixation of Rhizobium leguminosarum biovar trifolii with Trifolium repens, L. and Rhizobium leguminosarum biovar vicaea with Pisum sativum, L.

To date, there have been many attempts to amplify the quantity of nitrogen fixed by the legume-rhizobia symbiosis in order to reduce the need for the agricultural application of fertilizer, which negatively impacts human and environmental health. Considering the destruction caused by nitrogen fertilizers, this project aimed to devise an alternative to fertilizer by determining rhizobia that can be used to induce the most efficient nitrogen-fixing relationship with legumes. Thus, the goal of this project was to determine a biovar of Rhizobium leguminosarum that is more fit for the symbiotic relationship with Trifolium repens, L. and Pisum sativum, L. based on its nitrogen productivity. T. repens, L. plants were inoculated with R. leguminosarum biovar trifolii, and P. sativum, L. plants were inoculated with R. leguminosarum biovar vicaea; both groups were grown in Thornton agar jars for 21 days. Control groups of uninoculated plants with and without nitrogen were also grown, in addition to T. repens, L. plants inoculated with R. leguminosarum biovar vicaea and P. sativum, L. plants inoculated with R. leguminosarum biovar trifolii. Mean dry mass and nodule count were measured to determine nitrogen fixation efficiency. Results of mean dry mass were inconclusive. Of the plants inoculated with rhizobia, P. sativum, L. plants were the only to be nodulated, with 4 plants nodulated by R. leguminosarum biovar vicaea and 5 plants nodulated by R. leguminosarum biovar trifolii. The results of the expanded host range of R. leguminosaum biovar trifolii indicate its potential as an alternative inoculant of P. sativum.

Mentor(s): Dr. Mark Williams, Virginia Tech, Horticulture;

NEIL T FESTE,
VIRGINIA TECH / BIOCHEMISTRY

Development of a turnip crinkle virus- yeast system to study viral replication mechanisms

Genome of class V viruses is composed of a positive-sense, single-stranded RNA [(+) RNA]. This class of viruses consist of clinically and agriculturally relevant pathogens including poliovirus, SARS-Coronavirus, brome mosaic virus (BMV), and foot and mouth disease virus. A critical and conserved step in the infection process of (+) RNA viruses is the modulation of host membranes to form viral replication complexes (VRC). Turnip crinkle virus (TCV) is (+)RNA virus and used as a model in plants to study the molecular viral replication mechanisms. The aim of this project is to construct an engineered yeast-TCV system to test how TCV replication proteins p28 and p88 rearrange cellular membranes and identify host proteins that are required for viral replication. Expression plasmids for Histine6-tagged p28 (p28-His6), FLAG-tagged p88 (FLAG-p88), and the full-length TCV genome will be constructed and verified by sequencing. These constructs will be introduced into yeast cells and the localization of p28-His6 and FLAG-p88 will be checked by immunofluorescence microscopy and viral replication will be checked by Northern hybridization. A better understanding of the mechanisms of these proteins will contribute to knowledge of VRC formation that may lead to the development of broad-spectrum antiviral therapies against (+) RNA viruses.

Mentor(s): Xiaofeng Wang, Virginia Tech, Plant Pathology, Physiology, and Weed Science;

ADAM, J. FORMELLA,
VIRGINIA TECH / MICROBIOLOGY

Creating a Breeding Colony of Corn Flea Beetles

The corn flea beetle, Chaetocnema pulicaria Melsheimer, is the vector for Pantoea stewartii, the bacterium that causes Stewartês wilt disease in corn. These beetles have never been successfully raised in captivity, which has limited studies on the association between P. stewartii and its insect host. Three approaches were employed to develop laboratory-rearing methods for corn flea beetles. First, two types of colony chambers used to rear beetles were compared: mesh and bottle cages. Each cage enclosed a pot of two corn plants and ten beetles. To test rearing environments, half of these cages were placed in a greenhouse with varying temperature while the remaining half were placed in a 25_ growth chamber. The second experiment was conducted to determine if population density in the beetle chambers affects fecundity. Bottle cages of ten, twenty, and fifty beetles matured for thirty days past F0 mortality to allow a complete life cycle to occur. Finally, the ovipositional success of corn flea beetles on three media: floral foam, agar, and wetted paper towels was examined. Each medium was placed at the base of 150 mL beakers, and 10 beetles were introduced per beaker. Experiments are still ongoing; however, the first set of experiments have already successfully demonstrated that a complete corn flea beetle life cycle can occur in cages located in 25_ growth chambers. These experiments lay the foundation for year-round-studies that will examine the role of select genes in P. stewartii in colonization of the beetle.

Mentor(s): Ann M. Stevens, Virginia Tech, Department of Biological Sciences; Thomas P. Kuhar, Virginia Tech, Department of Entomology

GINA, Q GASPAROTTO,
VIRGINIA TECH / FOOD SCIENCE AND TECHNOLOGY

Development of a Method for 3,3-dimethyl-1-butanol Analysis in Foods Using TQGCMS

Recent research has shown that 3,3-dimethyl-1-butanol (DMB) is a chemical analog to choline, which is a nutrient found in food products such as meat, egg yolk, and high-fat dairy products. DMB inhibits the formation of trimethylamine (TMA) into trimethylamine N-oxide (TMAO), which reduces the risks of atherosclerosis. Very little work has focused on levels of DMB in foods, but it has been reported in some extra virgin olive oils (EVOO), balsamic vinegars, red wines and grape seed oils at a maximum concentration of 25 mM (2550 ppm). The objective of our work was to develop a triple-quad, gas chromatography mass spectrometry method of analyzing DMB in foods. A Shimadzu GCMS-TQ8030 was fitted with a 60m ZB-Waxplus column. Q3 scans were conducted to pick ions for transitions using multiple reaction monitoring (MRM). We also evaluated whether Solid Phase Micro Extraction (SPME) was sensitive enough for DMB analysis in foods (extra virgin olive oil, balsamic vinegar, grapeseed oil) using a standard addition method. Very little molecular ion (M/Z 102) was observed in the Q3 scans. MRM transitions of 69_69 and 69_41 were selected for quantitative analysis. Collision energies of 4eV for the transition 69_69 and 9eV for 69_41 were chosen to maximize the sensitivity. Standard curves were used to determine the limit of quantification in liquid samples. The concentration of DMB was linear between 10ppb (~0.01-0.1mM) to 1000 ppb (~0.1-10mM) with a R2 value of 0.9952. We confirmed that we were unable to identify high concentrations of DMB (~25mM) using SPME.

Mentor(s): Sean O'Keefe, Virginia Tech, Food Science and Technology;

RICHARD, S HERRON,
VIRGINIA TECH / BIOLOGICAL SCIENCE

Transport of SWEET Proteins in Plants and Yeast

In yeast, sugar transporters such as Hxt3 and Hxt5 are transported to the plasma membrane in a manner of dependence on coat protein complex II (COPII) vesicles and cargo receptor Erv14. SWEET proteins are plant sugar transporters that function in yeast and are recruited by and required for plant bacteria and fungi pathogens. However, how SWEET proteins are transported to their final destination is not known. We hypothesize that the transportation of SWEET proteins is also dependent on COPII vesicles and Erv14. To test our hypothesis, SWEET genes from Arabidopsis thaliana (At) SWEET1 (AtS1) and SWEET11 (AtS11) were cloned, verified by sequencing, and tagged with a mCherry fluorescencent protein. AtS1- and AtS11-mCherry will be introduced into wild type yeast, the yeast mutant lacking the ERV14 gene , or various COPII temperature sensitive mutants. The localizations of AtS1/11-mCherry in yeast cells will be checked by using fluorescence microscopy. We expect to determine how SWEET proteins are transported in yeast and plants as well as whether we could control pathogen infections by manipulating SWEET protein targeting in plant.

Mentor(s): Dr. Xiaofeng Wang, Virginia Tech, Plant Pathology;

MICHAEL, LOWELL JOHNSON,
VIRGINIA TECH / BIOLOGICAL SYSTEMS ENGINEERING

A Novel Genome-Scale Model Architecture for Studying the Metabolic Consequences of Genetic Modification in Plants

A genome-scale metabolic model (GEM) is a large mathematical reconstruction of the network of biochemical pathways that make up an organism_—Ès metabolism. Such models are capable of providing meaningful insight into the high complexity of cellular metabolism and facilitate the prediction of genetic engineering targets. In plants, GEM_—Ès are useful for developing cell factories that can overproduce valuable commodity compounds, such as fuels and pharmaceuticals, naturally found in plant biomass. However, in order to engineer such cell factories, a comprehensive understanding of metabolic differences over growth and development is needed. Current GEM architecture is limited to representing plant metabolism at one developmental stage and additional steps are required to compare metabolisms of different plants. This project aims to address these limitations by creating the first GEM architecture capable of simultaneously describing the developmental transition and metabolic differences between two different plant types. We tested our model with wild type Arabidopsis thaliana and a transgenic plant overexpressing Sucrose non-Fermenting Related Kinase 1 (SnRK1.1). SnRK1 is of particular interest due to its up-regulation resulting in significantly increased leaf biomass. We modified and expanded a previously constructed Arabidopsis GEM, AraGEM, using high-quality pathway databases and incorporated experimentally measured data of the primary biomass components, including cell wall contents, protein, lipid, starch, gas exchange, and total biomass. Our model is able to accurately predict the differences in biomass growth rate between wild type and SnRK1 plants, thereby demonstrating the utility of our novel GEM architecture as a computational tool for metabolic engineering.

Mentor(s): Dr. Glenda Gillaspy, Dr. Ryan Senger, Biochemistry, Biological Systems Engineering; Jiun Yen

SUZANNE, R LALIBERTE,
VIRGINIA TECH / BIOLOGICAL SCIENCE

Elucidating the biochemistry of carrot aroma under global change

When carrots are grown in elevated temperatures, they become bitter and less palatable. A class of secondary metabolites known as terpenes, whose production can be induced by abiotic stress, may be responsible for this change. Enzymes known as terpene synthases catalyze terpene synthesis. However, the functions of the terpene synthases in carrots are largely unknown. This project focuses on characterizing one of these enzymes, terpene synthase 22, to help further the understanding of the terpene production in Daucus carrota. To do this, the gene was studied with computer software. cDNA was synthesized from RNA extracted from carrot roots, and it was then cloned into Escherichia coli vector pGEM-T before it will be into pET28a to amplify the enzyme. The enzyme will be purified with nickel affinity chromatography to perform an enzyme assay with terpene precursors, GPP, NPP, E,E-FPP, Z,Z-FPP, and GGPP as substrates. The products will be verified using gas chromatography and mass spectroscopy and compared to the volatile profile of Daucus carrota. In future experiments, this data could be used to study the expression levels of this gene in carrot roots to determine if it is affected by temperature stress. Collaborating labs will be able to establish whether or not these products are among those that are responsible for the change in carrot flavor associated with increasing temperature.

Mentor(s): Dorothea Tholl, Virginia Tech, Biological Science; Andrew Muchlinski, Virginia Tech, Biological Sciences

ZOYA MAHAJAN,
VIRGINIA TECH / MICROBIOLOGY

The Role of Wnt and TGF-beta Signaling in Primary Bronchial Smooth Muscle Cell Homeostasis

The Wnt family of secreted proteins, of which there are 19 in total for humans, are conserved across nearly all complex eukaryotic organisms, and are essential for organismal development and cellular homeostasis. Wnt proteins are known to signal through both the canonical ´Å¢-catenin signaling path and other non-canonical pathways. ´Å¢-catenin signaling occurs in part through the TCF/LEF transcription factor, which plays an important role as a negative regulator of inter-cellular junction homeostasis. There is growing evidence suggesting that perturbation of endogenous Wnt signaling in the respiratory system of young children may correlate with the development of a number of diseases including allergy and asthma. Approximately 10.5 million children and 29.5 million adults are diagnosed with asthma and total medical expenditures exceed $50 billion annually. We hypothesize that the misregulation of key Wnt proteins contributes to loss of cellular junctions between airway epithelial cells and results in increased fibronectin production by bronchial smooth muscle cells (BSMC_–Ès). Fibronectin is an emerging player of interest during allergy and asthma. An increase in the deposition of fibronectin into the subepithelial space of the airways has been observed in all forms of asthma. Standardized treatment of EMT cocktail mix on BSMC_–Ès resulted in the elevated expression of fibronectin and vimentin. Interestingly, treatment with cortisone acetate, an anti-inflammatory steroid, results in a reduction of both fibronectin and vimentin expression in the presence of the EMT cocktail. These initial findings suggest a mechanism in part for steroid treatment during an allergic pulmonary response or asthma symptoms.
/ / / / /

Mentor(s): Shiv Kale, Biocomplexity Institute; N/A

DANIEL, P MARRON,
VIRGINIA TECH / CHEMISTRY

Synthesis of Semi-rigid Linkers for Drug Delivery Scaffolds

The design of heteromultivalent drug scaffolds for highly specific drug delivery relies on linkers to mediate effective binding. Ideally, the molecular dynamics and kinetics of the overall structure will ensure payloads reach only their intended target. To effectively tune ligand density and binding efficiency, the scaffold utilized must be of the appropriate length and flexibility, as illustrated in Figure 1. Furthermore, the material used to synthesize the linker must be biocompatible and not readily proteolytically cleaved. As an example, the biopolymer collagen contains polyproline sequences that adopt semi-rigid helical conformations. These structures can be readily incorporated into peptidomimetic ligand scaffolds. / / In this study, decamers of polyproline, proline-glycine, and four proline analogues, namely 2-azetidine, 3-azetidine, pipecolic acid, isonipecotic acid were tested for length and secondary structure against a flexible PEG-based linker. Each of these linkers were synthesized as C-terminal amide and acetylated N-terminal for CD studies, and as Trp- and DNS/Trp pairs for FRET and fluorescence lifetime studies. The linkers were synthesized via solid phase peptide synthesis (SPPS) techniques. The peptide is then cleaved from the resin under acidic conditions, and were characterized and purified via HPLC-MS. / / The secondary structures of these linkers were investigated via circular dichroism (CD) spectroscopy, F'_rster resonance energy transfer (FRET) spectroscopy, fluorescence lifetime, and computational studies. In the near future, we will study proteolytic degradation of these linkers. These complimentary techniques will be useful in characterizing secondary structure of the ligands and evaluating them as biocompatible proteolytically-resistant linker candidates. /

Mentor(s): Jatinder Josan, Virginia Tech, Chemistry;

MARGARET, L MCCARTY,
VIRGINIA TECH / ANIMAL AND POULTRY SCIENCE

Evaluation of Thermoregulation in Beef Cows Consuming Tall Fescue Seed

Tall fescue is commonly recognized for containing a fungal endophyte that can be detrimental to the production of grazing cattle. The mycotoxins produced by this fungus can result in decreased weight gains, vasoconstriction and inability to disperse heat, poor reproductive performance, and failure to shed the winter hair coat. The possible decrease in performance among cattle grazing tall fescue can bring severe economic losses to cattle producers on the East Coast, where the cool season grass is highly prevalent. This study views how intake of the toxic endophyte derived from tall fescue impacts changes in body temperature over time, and how these differences affect overall performance in beef cows. In this design, 12 crossbred cows were randomly assigned to two different diet groups, with group one being fed high (HE) endophyte-infected seeds, and group two being fed low (LE) endophyte-infected seeds starting 38 days prior to the study. Body temperature measurements were initiated on d 0 and recorded every hour through d 32 using an indwelling vaginal temperature probe. Body weights and hair score assignments were measured on d 0, 7, 14, 21, and 28 with some changes over time but not by treatment. The cows showed significant difference in body temperature after 32 days based on P value. The increase in body temperature as a reaction to consumption of the toxic endophyte found in tall fescue can result in heat stress in cattle, decreasing weight gains and ultimately ending in economic loss for producers.

Mentor(s): Dr. Alan Ealy, Virginia Tech, Animal and Poultry Science;

LINDSEY, E. MCCLAIN,
VIRGINIA TECH / HUMAN NUTRITION, FOODS, AND EXERCISE

Modeling Rifapentine Solubility In Vitro

The aerobic bacteria, Mycobacterium tuberculosis, causes millions of cases of tuberculosis per year worldwide and is the leading cause of death due to infectious disease in developing countries. Rifapentine, an antibiotic commonly used in the treatment of tuberculosis infections, is favorable because of its long elimination half life. However, it is easily degradable in acidic environments and has poor solubility in water. For these reasons, after being processed by the stomach, Rifapentine has a very low bioavailability to humans. Using non-sink conditions, in vitro dissolutions of Rifapentine were carried out to simulate varying pHs of the gastric and small intestinal tracts. Dissolutions simulating the small intestines were also performed using bile to create a more accurate in vitro simulation. Using ultraviolet-visible spectroscopy, samples are currently being analyzed to determine the concentration of Rifapentine absorbed in these simulated conditions over time. As of now, results are inconclusive. However, higher concentrations of solubilized Rifapentine are expected in conditions simulating the acidic environment of the stomach. Trials including bile are also expected to have higher concentrations of Rifapentine because of the tendency of bile to form micelles, aiding in the absorption of hydrophobic compounds. /

Mentor(s): Andrew Neilson, Virginia Tech, Food Science and Technology;

ANNA, M MCCLUSKEY,
VIRGINIA TECH / BIOLOGICAL SCIENCES

The role of the pentapeptide-tether in Sinorhizobium meliloti amino acid and betaine sensing

Sinorhizobium meliloti is a gram-negative soil dwelling bacterium that is widely known for its symbiotic relationship with alfalfa. Alfalfa roots secrete a myriad of different metabolites into the soil, including sugars, amino acids, betaines, and flavonoids. Some of these compounds attract_S. meliloti_through a process known as chemotaxis. S. meliloti_ has eight chemoreceptors that bind to attractant molecules and signal the cell to swim in the direction of greater attractant concentrations. The Scharf lab has recently elucidated the function of two of these receptors. Specifically McpX, which senses betaines, and McpU, which senses amino acids. Our goal is to determine the role of a conserved C-terminal pentapeptide present in four of the eight chemoreceptors. In E. coli, this pentapeptide serves to tether receptor-modifying enzymes, CheR and CheB and the deletion of this motif hampers the cells adaptation to constant stimuli. McpX contains this motif at its C-terminus where McpU does not; the importance of this is unclear. To understand the role of the pentapeptide motif in S. meliloti, the cytosolic signaling domains of McpX and McpU were cloned, expressed, and purified so they can be used to perform chemical cross-linking assays with CheR and CheB to test for interaction. In the future, we hope to test the chemotaxis behavior of a strain that lacks the pentapeptide in McpX and another strain that encodes McpU with a C-terminal pentapeptide using swim plate assays. Results from this study will help determine the importance of the pentapeptide tether in S. meliloti chemotaxis.

Mentor(s): Birgit Scharf, Virginia Tech, Biological Sciences; Timofey Arapov (graduate student), Virginia Tech, Biological Sciences

TYLER T MILLER,
VIRGINIA TECH / BIOLOGICAL SCIENCES

Evolution of Tetrodotoxin Resistant Sodium Channels (Nav1.8) in Snake Predators of Toxic Amphibian Prey

Antipredator defenses such as toxins can lead to the evolution of resistance in predators, sometimes generating coevolutionary arms races. One excellent example of predator adaptation to prey defenses is tetrodotoxin (TTX) resistance in garter snakes that consume toxic newts. TTX binds to voltage-gated sodium channels (Nav), preventing the flow of sodium ions through the channels and causing paralysis and death. Six different tissue-specific sodium channels are known to be TTX-resistant in garter snakes and recent work has traced the evolutionary history of three of these channels. Here we focus on Nav1.8, a channel involved in pain sensation and expressed in the dorsal root ganglia as well as in small unmyelinated neurons of the sensory nervous system. A single amino acid substitution is known to confer toxin resistance in garter snake Nav1.8. We sequenced the gene encoding Nav1.8 in numerous species of snakes to determine its evolutionary history. Using a time-calibrated phylogeny, we establish that toxin resistance in Nav1.8 evolved between 18 and 40 million years ago (mya), shortly after the rise of TTX-bearing newts and around the same time as resistant Nav1.6, a related channel found in larger myelinated neurons. Our results provide an example of parallel evolution within gene families and, in combination with previous work, suggest that Nav1.8 may be crucial to triggering coevolutionary arms races between garter snakes and newts.

Mentor(s): Joel McGlothlin, Virginia Tech, Biological Sciences;

EDWARD, J A SCHULER,
VIRGINIA TECH / BIOLOGICAL SCIENCES

Coinfection Dynamics of Experimentally-inoculated Mycoplasma gallisepticum and Naturally-occurring Coccidia in House Finches, Haemorhous mexicanus

The emergence of Mycoplasma gallisepticum (Mg), a bacterial pathogen, in House Finches (Haemorhous mexicanus) in recent decades has created many opportunities for research, including the consequences of Mg infection in terms of house finch behavior, immunological response, and the balance of their natural microflora. This study focuses on understanding the dynamic interactions of house finches coinfected with Coccidia naturally found in the intestines and experimentally-inoculated Mg in the eyes. Fecal samples were collected from Mg-infected or non-infected birds and then examined using a standard fecal float technique. This technique allowed the coccidia oocysts to be counted on a microscope slide and the coccidia oocysts per gram of fecal matter was used as a standard to compare loads between birds. Whether or not a bird was actively infected with Mg significantly affected coccidia load. These immune-mediated effects indicate that a non-lethal infection, such as Mg, may trigger widespread disruption of the natural microflora. In addition, whether a bird is male or female had a significant effect on coccidia load as well, regardless if a bird was actively infected with Mg. This indicates the existence of distinct patterns of immunological response to infection that differs between the sexes which affect the natural microflora of the bird differently. While the correlation of Mg infection and coccidia load has been established through this experiment, there is still little known about the specific immune-mediated mechanisms causing these correlations.

Mentor(s): Dana Hawley, Virginia Tech, Biological Sciences; Courtney Thomason, Virginia Tech, Biological Sciences

AUSTIN C. SHAPIRO,
VIRGINIA TECH / CHEMICAL ENGINEERING

The role of Dissimilatory Sulfite Reductase-Like Protein (Dsr-lp) in an methanogenic archaeon

F420H2-dependent Sulfite Reductase (Fsr) is an enzyme that reduces sulfite, a toxic oxyanion, to sulfide. It's present mostly in thermophilic methanogens, a group of methane-producing microorganisms. Fsr is a chimera of two enzymes, F420H2-dehydrogenase and Dissimilatory Sulfite Reductase (Dsr). Our research focuses on the evolutionary development of Fsr, with the goal of elucidating how this protein evolved. Our bioinformatics analysis suggested that a group of proteins called Dissimilatory Sulfite Reductase-Like Proteins (DSR-LP) might be one of the precursors of Fsr. Unlike Fsr, Dsr-LPs exists in almost all methanogens. We are investigating the role of Dsr-LP, which could give insight into the evolutionary development of more complex system (Fsr). The study also has far-reaching implications in many areas such as bioenergy, waste treatment, and human health. We chose Methanococcus maripaludis as a model organism, as it only possesses a Dsr-LP homolog and lacks an Fsr homolog. Growth studies employed a variety of inducing agents on a M. maripaludis wild type strain and a strain lacking the gene encoding dsr-lp. The dsr-lp gene expression profiles were analyzed by the use of qRT-PCR and Western blot analysis. Our data suggested that cysteine, H2O2, and air induced the expression of Mm dsr-lp and the mutant strain experienced growth defects under all conditions. It seemed like Dsr-LP functioned either as a redox sensor or involved in oxidative stress response. Reactor-based growth, global gene expressions studies, and biochemical assay of the Dsr-lp will be performed to determine the role of Dsr-LP.

Mentor(s): Biswarup Mukhopadyay, Virginia Tech, Biochemistry; Dwi Susanti

ZOE M. WADDELL,
VIRGINIA TECH / PSYCHOLOGY

Parenting Stress and Autism: The Impact of Child Problem Behaviors on Maternal Stress

The demands of raising a child with Autism Spectrum Disorder (ASD) can significantly impact caregivers. Previous findings suggest that parents with children with ASD experience more stress than typically developing children (TD). Moreover, these problematic behaviors in children with ASD, such as hyperactivity, have been found to be associated with higher levels of parenting stress (McStay et. al., 2014). However, the majority of studies have utilized self-report measures of parent stress and problem behaviors, which can often be subjective and correlated. Accordingly, analyzing parent stress via physiological (e.g., heart rate (HR) and heart rate variability (HRV)) and self-report measures simultaneously may lead to the creation of bio-behavioral trajectories to better inform treatments and preventative measures. Previous studies have linked HR and HRV to stress; however, few have used it as a measure of parental stress (Thayer et. al., 2012). This study compares stress in parents of children with ASD and TD via physiological and self-report measures. Hypotheses included: 1) parents of children with ASD would self-report higher levels parenting stress as measured by the PSI-SF total score, 2) self-report more child problem behaviors as measured by the SDQ, 3) experience faster HR_—Ès and slower HRV, and 4) after controlling for age, level of severity (SRS-2), and problem behaviors (SDQ) the results would still be statistically significant. Results support the hypotheses that parents of children with ASD self-report higher levels of parenting stress and more child problem behaviors. Conversely, results reject the hypothesis that they experience faster HR_—Ès and slower HRV.

Mentor(s): Angela Scarpa, Virginia Tech, Psychology;

LINDSAY, M WENTZEL,
VIRGINIA TECH / WILDLIFE CONSERVATION

Assessment of Pseudopregnancy in Black Bears (Ursus americanus) Through Hormonal Analysis

The American black bear (Ursus americanus) exhibits several environmentally synchronized reproductive strategies to efficiently use its energy resources. It is believed that black bears experience pseudopregnancy, a physiological state in which a non-pregnant female exhibits progesterone (P4) levels similar to that of gravid bears in the absence of an actual pregnancy. However, this strategy may conflict with the overall efficient metabolism of black bears. Some studies have shown similar patterns in blood serum P4 profiles in parturient and non-parturient females, yet little focus was directed towards pregnancy diagnosis. Pregnant females experiencing in utero fetal death could display similar P4 levels to those that produced cubs, thereby creating false positives for pseudopregnancy. We aimed to test whether black bears exhibit pseudopregnancy by comparing P4 and estradiol (E2) of females diagnosed by ultrasound as: pregnant producing cubs (P+C), pregnant not producing cubs (P-C), or not pregnant (NP). We collected 370 blood samples from 29 adult females (10 P+C, 9 P-C, and 10 NP) for hormonal analysis. Contrary to previous studies, P4 concentrations of P+C, P-C, and NP females were significantly different. Pregnant bears showed a 5-fold increase in P4 after embryonic implantation, while NP females maintained low P4 levels. P+C and P-C females also exhibited lower E2 concentrations during pregnancy, while E2 of NP females did not change significantly. Our results suggest that black bears do not experience pseudopregnancy as a physiological reproductive strategy. This study increases our understanding of black bear reproduction and physiological requirements for non-pregnant females.

Mentor(s): Bernardo Mesa, Virginia Tech, Department of Fish and Wildlife Conservation; Marcella Kelly, Virginia Tech, Department of Fish and Wildlife Conservation

LAURA, G WONILOWICZ,
VIRGINIA TECH / BIOCHEMISTRY

Structure-Activity Relationship Studies of (R)-Prolinol-Based Inhibitors of Sphingosine Kinase

With implications in disease-promoting cellular activities, sphingosine kinase (SphK) presents a window for therapeutic discovery through inhibitor design and synthesis. It exists as two isoforms, SphK1 and SphK2, which modulate the phosphorylation of sphingosine (Sph) to the pro-inflammatory and proliferative sphingosine-1-phosphate (S1P). With elevated S1P levels observed in disease states including cancer and sickle cell disease, SphK inhibition provides an avenue for biological insight and therapeutic development.1 Accordingly, structure-activity relationship (SAR) studies of SphK inhibition have produced an array of small molecules. The need for inhibitors with greater potency and selectivity, however, remains prominent in this quest.1 Our previous SAR studies indicate the SphK1 inhibitory benefits of bulky or lipophilic tail regions and polar head group moieties. Thus, the compounds we introduce in this report feature a variety of substituted phenyl tails, benzyl linkers, and an (R)-prolinol head group. Specifically, our study investigates the inhibitory significance of electron withdrawing versus lipophilic tail substituents, optimal substituent placement, and effects of steric bulk near the head group region. Through modifications of this biologically active scaffold, we present a panel of molecules subjected to screening for S1P levels through a broken cell assay. This study extends our previous work and upholds the pairing of bulky, lipophilic tails with polar head groups for efficient SphK1 inhibition.

Mentor(s): Dr. Webster Santos, Virginia Tech, Chemistry;

DAWN, A WRIGHT,
VIRGINIA TECH / NEUROSCIENCE

Transcriptional regulation of CRISPR3 by sigma and anti-sigma in Myxococcus xanthus

The CRISPR-Cas system confers bacteria and archaea adaptive immunity against invading DNA and RNA elements such as bacteriophages and motile genetic elements. It has been used for genome editing in all organisms more recently. Interestingly, a previous study in the laboratory discovered that a transposon insertion in CRISPR3 (__æCRISPR3) reestablished EPS (exopolysaccharide) production to a pilA deletion (__æpilA) mutant in the bacterium Myxococcus xanthus. Transcriptomic analyses indicated that the transcription of CRISPR3, its Cas genes, and other neighboring genes are highly up-regulated in the __æpilA __æCRISPR3 strain. Among them is a pair of genes encoding the ECF-sigma factor and an anti-sigma factor. This project attempts to construct mutants in the sigma and anti-sigma genes to examine the hypothesis that this sigma and anti-sigma pair are involved in CRISPR3 regulation in M. xanthus. Two plasmids were constructed using E. coli as the host organism: one containing the deletion allele for both the sigma and anti-sigma genes, and another with a deletion allele for the anti-sigma factor. The plasmids were each used to delete these genes in M. xanthus wild-type and __æpilA strains. Mutants with the anti-sigma deletion have been constructed successfully and we are in the process of deleting both genes in the wild-type and __æpilA strains. Further examination of these mutants will reveal if the ECF-sigma is a positive transcriptional regulator of genes in the CRISPR3 region including itself, and whether the anti-sigma inhibits this ECF-sigma to maintain homeostasis under normal physiological condition.

Mentor(s): Zhaomin Yang, Virginia Tech, Biological Sciences;

TRANSLATIONAL OBESITY UNDERGRADUATE RESEARCH

PROGRAM DESCRIPTION

The Translational Obesity Undergraduate Research Scholars (TOUR-Scholars), under the umbrella of the Fralin Translational Obesity Center (Fralin-TORC) and its Interdisciplinary Graduate Education Program (IGEP), 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, along with one student from the State University of New York, College at Fredonia, were chosen to participate in the 2014 summer program. TOUR-Scholars were matched in a translational project with two faculty mentors, working across disciplines. Funding was obtained through faculty-mentor matching of funds, the Department of Human Nutrition, Foods, and Exercise, the College of Agriculture as well as contributions from the Fralin Translational Obesity Research Center, to provide a research stipend for each of the students, and some discretionary funds.

PROGRAM DIRECTOR

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

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Mentor: Dr. Robert Grange

WILL, A COFFEY,
VIRGINIA TECH / HUMAN NUTRITION, FOODS, AND EXERCISE

Effects of Dehydration Among Older Adults

Many older adults do not consume enough water and as a consequence, water loss dehydration is common among older adults. Dehydration is associated with disability and mortality. In addition, dehydration is associated with impaired cognitive, motor, and vascular function. However, whether increasing water intake improves cognitive, motor, or vascular function in older adults is not known. To test the hypothesis that increasing water intake to recommended levels would improve cognitive, motor, and vascular function in older adults, twenty-five older men and women (age __Ç60 years) will be randomized in a crossover manner to increase daily water intake to recommended levels (2.7 and 3.7L for 3 days for women and men, respectively) or to reduce daily water intake to 25% of recommended levels (0.675 and 0.925L/d for 3 days). All food and beverages will be prepared, packaged, and distributed through the HNFE metabolic kitchen in Wallace Hall. NIH toolbox, a multidimensional set of brief standardized measures using an iPad, will be used to assess the domains of cognition and motor function. The cognitive domain will be comprised of measures of executive function, working and episodic memory, processing speed, and attention. The motor function will be comprised of measures of strength, endurance, locomotion, dexterity, and balance. Brachial artery flow mediated dilation, our measure of vascular function, will be assessed using high resolution ultrasonography. Measurements will be performed before and following each intervention. There is a need to bring about awareness of the importance and benefits of adequate hydration status among older adults.

Mentor(s): Dr. Kevin Davy, Virginia Tech, Human Nutrition, Foods, and Exercise;

JOSEPH P GRIECO,
STATE UNIVERSITY OF NEW YORK AT FREDONIA / MOLECULAR GENETICS

Effects of a Short-Term High Fat Diet on Circulating Pro-Inflammatory Cytokines

The ability of skeletal muscle to adapt and respond to various nutrient states is important to maintaining healthy metabolic function. Inflammatory cytokines (IL-6, IL-15, IL-17a, and MCP-1) have been theorized to disrupt skeletal muscle metabolism and are highly integrated in the context of metabolic disease, such as obesity and diabetes. The purpose of this study was to assess circulating cytokine levels in response to a high fat meal challenge before and after 5 days of high fat feeding. Thirteen participants (age 22.2 ± 1. years, BMI 22.3 ± 2.8) were fed a control diet that was isocaloric to their habitual diet for two weeks, followed by 5 days of isocaloric high fat diet (HFD). Participants were subjected to a high fat meal challenge (kcal ~30% of daily energy intake, 64% fat. Blood draws were taken immediately after the meal challenge and each hour thereafter for 4 hours. Serum cytokine levels were detected using a Bio-Plex multiplex immunoassay kit instructions (Bio-Rad, Hercules CA). There were no differences in fasting serum cytokine levels (pre vs. post HFD) of IL-6, IL-15, IL-17a or MCP-1. In addition, 5 days HFD did not affect the cytokine response to a meal challenge. These findings suggest that a short-term HFD in young, non-obese humans doesnêt affect serum cytokine levels in either the fasted state or in transition to the fed state. Further studies are warranted to investigate possible mechanisms influencing skeletal muscle metabolic adaptations to an acute meal challenge that become disrupted by acute high fat feeding.

Mentor(s): Matthew Hulver, Virginia Tech, HNFE; Ryan McMillan, Virginia Tech, HNFE

DANIEL GIRALDO HERRERA,
VIRGINIA TECH / HUMAN NUTRITION, FOODS, AND EXERCISE

Master Food Volunteers Physical Activity Training

Cooperative Extension professionals (i.e., community-based health educators) can train and work with community members who undergo official training for certification as a Master Food Volunteer (MFV). MFVs work to disseminate health-related information to community members. Since its inception in 2011, 569 MFVs have been trained, spending over 20,000 hours in the community delivering programming to over 44,800 residents. MFVs have primarily worked with food (e.g., food and cooking demonstrations, nutrition basics). However, to address chronic disease prevention and management, physical activity outcomes are now included in the Extension mission. Therefore a redesign of the physical activity portion of the MFV program was needed. To address this need, the physical activity program manual chapter and training presentation were adapted based on the Physical Activity Guidelines for Americans (2008). Using current evidence, updates included moderate and vigorous physical activity weekly time guidelines and examples of exercises for each category. In order to best integrate physical activity into the work of MFVs, physical activity was presented as every-day tasks that can be incorporated to daily routine and within foodservice activities. These adaptations include desk exercises, brain breaks during training, stretches, decreasing sedentary time, and the Borg Test for measuring relative exercise intensity. The training program includes experiential learning steps_—"such as practicing the brain breaks during training_—"to build MFVs confidence in integrating physical activity in their programming. Next steps include determining a) perceptions of MFV on the programmatic updates and b) the degree to which MFV include physical activity in their programming.

Mentor(s): Samantha M. Harden, Virginia Tech: Human Nutrition, Foods and Exercise;

OLIVIA, F PRIVITERA,
VIRGINIA TECH / HUMAN NUTRITION, FOODS AND EXERCISE

Influence of a High-Fat Diet on Delayed Discounting and Reward Responses

People make food choices based on the motivation to consume foods that are reinforcing. High fat foods are energy dense and tasteful (i.e., reinforcing) and when consumed in excess, can result in positive energy balance and weight gain. Delayed discounting (DD) can be measured in the laboratory setting, and reflects a person's choice between immediate gratification of a small reward (e.g., small sum of money, high-fat snack food) or a larger, delayed reward given in the future. The objective of this study was to assess whether acute consumption of an isocaloric high-fat diet (HFD) causes a person's delayed discounting measures to change. Endurance trained (VO2max greater than 60 ml/kg/min) and sedentary males aged 21-28 years were studied (n=3, to date; 20 planned recruitment). At baseline, subjects completed the Three Factor Eating Questionnaire (T-FEQ) to assess dietary restraint followed by four discounting surveys (DD). These two assessments (T-FEQ and DD) were completed after an overnight fast. These assessments were repeated at two time points: after a 10-14 day isocaloric, lead-in diet (55% carbohydrate, 30% fat, 15% protein), and after five days of a HFD (55% fat, 30% carbohydrate, 15% protein). The study will test the hypothesis that consumption of a HFD will change a person's ability to delay discounting, and specifically, that they will prefer small, immediate rewards over delayed healthier rewards. The study will determine the influence of short-term HFD consumption on dietary cognitive restraint and will allow for implementation of effective reinforcing interventions used to change unhealthy eating behaviors.

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

EMMA, M RAMSIS,
VIRGINIA TECH / SCIENCE OF HNFE

A strategy to rescue LGMD2i using a lentivirus FKRP-GFP construct and muscle progenitors derived from miPSCs.

Limb girdle muscular dystrophy 2i (LGMD2i) is a degenerative skeletal muscle disease caused by the absence of fukutin-related protein (FKRP). The long-term goal of this project is to test a strategy whereby FKRP is reintroduced into muscle progenitor cells grown in vitro, and then engraft these rescued cells into skeletal muscle of FKRP-deficient mice. This strategy requires multiple steps; in this study we assessed two. First, the viability of a lentiviral vector carrying the FKRP-GFP gene construct was tested in human embryonic kidney 293 cells and in C2C12 skeletal muscle cells. Our data revealed a long lasting presence of GFP in both cell types after multiple passages suggesting the vector is viable and the GFP expression is stable. Second, to program mouse inducible pluripotent stem cells (miPSCs) into muscle progenitors, miPSCs were first derived from wild type (WT) and FKRP-deficient dermal fibroblasts. Then, we directed WT miPSCs down the myogenic lineage using specific supplements/inhibitors for 25+ days1. These cells show promising muscle progenitor morphology. Together, these data demonstrate that the lentiviral vectors can stably modify C2C12 muscle cells, and that muscle progenitors can be derived from miPSCs. Next we will genetically correct FKRP-deficient miPSCs, convert them into myogenic progenitors and explore the therapeutic potential of transplanting rescued cells into skeletal muscles of FKRP-deficient mice. Ultimately, this strategy could be used to obtain and rescue FKRP-deficient muscle cells from patients, engraft them in the same patient to reduce the immune response, and to explore the potential for a stem cell-based therapy.

Mentor(s): Robert Grange, Virginia Tech, HNFE; N/A

INTERDISCIPLINARY WATER SCIENCES AND ENGINEERING NSF REU

This NSF-REU Site on Interdisciplinary Water Sciences and Engineering at Virginia Tech was established in 2007. Two cycles (2007-09) and (2011-13) of this Site have been completed and 56 excellent undergraduate researchers (33 women + 23 men) (REU fellows) representing 45 different institutions in the United States have graduated thus far. Faculty members and their graduate students from a variety of disciplines including Engineering Education, Civil and Environmental Engineering, Geosciences, Biological Sciences, Industrial Design, and Crop and Soil Environmental Sciences mentor REU fellows to conduct research on various interdisciplinary aspects of water sciences and engineering. The REU fellows 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 fellows and with faculty/ graduate students. The site will continue until 2016.

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HANIYYAH, J CHAPMAN,
NORTH CAROLINA STATE UNIVERSITY / ENVIRONMENTAL ENGINEERING

Examination of the Microbiological Community and Redox Zones in Simulated Reclaimed Water Distribution Systems

Reclaimed water research has increased in recent years, as water reuse is an advancement to sustainability and more economical than current alternative treatment methods. This research project seeks to understand if potable water treatment regulations are directly applicable to reclaimed water treatment. Conditions of simulated reclaimed water distribution systems such as disinfectant type (free chlorine and chloramine), water age, and nutrient level (high or low assimilable organic carbon) have various affects on quality, assessed by redox zones and water biochemistry. It is hypothesized that distribution systems with high organic matter and rapid secondary disinfectant decay rates will attenuate the growth of microbes with increased water age.

Mentor(s): Dr. Amy Pruden, Virginia Tech, Civil and Environmental Engineering; Dr. Marc A. Edwards, Virginia Tech, Civil and Environmental Engineering

KENDALL, M FITZGERALD,
STATE UNIVERSITY OF NEW YORK AT GENESEO / GEOLOGICAL SCIENCES

Occurrence of Pharmaceuticals and Personal Care Products (PPCPs) in Various Water Sources

Pharmaceuticals and personal care products (PPCPs) are a class of emerging contaminants that includes prescription, over-the-counter, veterinary, and illicit drugs in addition to products intended to have primary effects on the human body, such as sunscreens and insect repellants. PPCPs have been studied in the U.S. since 1999, when a USGS study found such compounds in 80% of streams analyzed. Recently, a 2016 study by the USGS identified pharmaceuticals in all 59 streams sampled in the southeastern U.S., with only 17 streams having a point-source of pollution such as wastewater discharge. The objective of this study was to screen for the presence of forty PPCP compounds in various water sources including an urban-impacted stream, wastewater treatment influent and effluent, and private well water. Water samples were collected from the two inlets and one outlet of Duck Pond, a bioretention pond intended to manage stormwater runoff, and downstream of the pond where Stroubles Creek flows into the New River, a drinking water source for surrounding counties. Private well water samples were collected from two counties in Virginia based on their reported proximity to various contamination sources. Influent and effluent samples were collected from wastewater treatment plants across the U.S. The samples were extracted and cleaned up using solid phase extraction and screened for target PPCPs on an ultra performance liquid chromatography-tandem mass spectrometry (UPLC/MS/MS). In total, fifteen PPCPs were detected in Stroubles Creek, twenty in wastewater, and twelve in private well water at estimated concentrations from low ppt to low ppb.

Mentor(s): Dr. Kang Xia, Virginia Tech, Crop & Soil Environmental Sciences; Dr. Chaoqi Chen, Virginia Tech, Crop & Soil Environmental Sciences

BRIDGET C GILE,
VILLANOVA UNIVERSITY / CIVIL ENGINEERING

Hydrologic Influences on Surface Peat Characteristics at the Great Dismal Swamp: Implications for Carbon Storage and Fire Vulnerability

Peatland ecosystems are a critical environmental resource for biodiversity and global carbon sequestration; drainage of peatlands for agricultural, residential, and commercial development can severely impair these functions. The purpose of this research was to examine the influence of wetland hydrology on physical and chemical properties of surface peat that indicate its degree of decomposition and affect its vulnerability to fire. Peat cores were collected from the Great Dismal Swamp at 20 locations along a hydrologic gradient and analyzed for bulk density, organic matter content, and carbon/nitrogen concentrations. These soil properties were evaluated against mean water levels at each sampling location to assess hydrologic controls on peat characteristics. Excluding an outlier transect, peat bulk density was found to decrease significantly with increased wetness. Results indicated no significant correlation between hydrologic regime and organic content or carbon/nitrogen composition, although findings suggest that sampling across a more comprehensive hydrologic gradient may yield clearer trends. Evaluated soil parameters serve as important indicators of peat decomposition (thus C-storage), as well as influence the vulnerability to peat-consuming fires. Understanding the hydrologic controls on these parameters at the Great Dismal Swamp will not only aid in the assessment of current conditions, but also will serve to guide ongoing restoration efforts focused on rewetting the Swamp.

Mentor(s): Dr. Daniel McLaughlin, Virginia Tech, Forest Resources and Environmental Conservation;

ERIN, A HYNES,
THE UNIVERSITY OF TEXAS AT AUSTIN / CIVIL ENGINEERING

Ammonia Recovery using Microbial Electrolysis Cell

Removing Ammonia from wastewater is important because excessive ammonia in the water supply leads to blue baby syndrome and algae overgrowth. Recovering Ammonia is important because Ammonia is an important chemical for agricultural practice. For wastewater treatment, Osmotic Microbial Fuel Cells have several advantages over the common Activated Sludge process. An OsMEC doesn't produce extra greenhouse gasses but does recover energy and nutrients. In this study, we tried to see if an OsMEC could recover more ammonia from wastewater than a Microbial Electrolysis Cell (MEC). An OsMEC is different from an MEC in that it has a Forward Osmosis Membrane (FOM) between its anode and cathode instead of a Cation Exchange Membrane (CEM). Forward Osmosis Membranes are cheaper than CEMs, and can produce higher current and clean water at the cathode. We used a two-chamber OsMEC, with both anode and cathode in continuous mode. We used a simulated wastewater solution as anode influent and a NaCl draw solution and cathode influent. Preliminary data shows an ammonia recovery of 35.5% with a low current generation of 5 mA. Our results will improve when we increase current generation and control biofouling. We plan to recover at least 60% NH4+ from the anode to the cathode while also recovering Hydrogen (H2). We will test the effect of Aeration at the cathode, current generation, and draw solution concentration. We plan to use mathematical models to predict how much Ammonia and current our reactor would recover in MEC mode.

Mentor(s): Dr. Jason He, Virginia Tech, Department of Civil and Environmental Engineering; Mohan Qin, Virginia Tech, Department of Civil and Environmental Engineering

KATHRYN, M KRUEGER,
VIRGINIA TECH / GEOCHEMISTRY

Influence of Oxygenation on Metal Concentrations in a Drinking Water Reservoir

Iron (Fe) and manganese (Mn) cause water quality issues in drinking water reservoirs, especially during summer months when thermal stratification can lead to low dissolved oxygen (DO) conditions. Under these conditions, Fe and Mn can be released from the sediment into the water column. These metals are costly to treat; thus, efforts have been made to address the issue in situ before the water reaches the treatment plant. One in situ method, installed at a local drinking water reservoir in 2013, includes use of a side stream supersaturation (SSS) system to oxygenate the reservoir to prevent low DO. In past years (2013-2015), the SSS has been activated for different periods of time during the summer to evaluate the impact of oxygenation on metals and other water quality parameters. Results have shown that metals are released from sediment, regardless of the extent of oxygenation. However, increased oxygenation promoted Fe oxidation, with lesser impact on Mn oxidation. / In 2016, the SSS has been activated continuously since the start of thermal stratification. For this study, we are evaluating the impact of continuous oxygenation on metal release and cycling within the reservoir. Water samples were collected with depth over a ten week period from the oxygenated reservoir and also from a nearby reference reservoir that is not oxygenated. Results to date show that the SSS significantly lowers the amount of Mn and Fe in the oxygenated reservoir in comparison to the reference reservoir, which has elevated levels of Mn and Fe near the sediments.

Mentor(s): Madeline E. Schreiber, Virginia Tech, Geoscience;

ELENA LOPEZ,
UNIVERSITY OF SOUTHERN CALIFORNIA / ENVIRONMENTAL ENGINEERING

Nutrient Recovery of Nitrogen and Phosphorus as Struvite Using Microbial Desalination Cells

Nutrient pollution is a widespread environmental problem caused by the discharge of excess nutrients, i.e., nitrogen and phosphorus. In this study, we use bioelectrochemical systems to remove and recover nutrients from wastewater in the form of struvite and achieve multiple benefits. First, the recovery of nutrients will limit the adverse effects of eutrophication while producing a beneficial fertilizer product for the agricultural industry. Second, this approach enables the integration of bioelectrochemical technologies like microbial desalination cells (MDCs) with conventional wastewater treatment processes to improve its sustainability. A four-chamber MDC was constructed to test the feasibility of struvite precipitation from synthetic wastewater. Ammonia and phosphate would in theory migrate across the ion exchange membranes and be concentrated in the second chamber. After one month of start-up, the MDC produced a stable current of 25 mA. Influent and effluent carbon oxygen demand (COD), pH, ammonia and phosphate concentrations were monitored. The concentrated solution containing ammonia and phosphate would be transferred to an external bottle and precipitated by adding magnesium and adjusting the pH. The influent COD concentration and the hydraulic retention time are expected to exert strong influence to MDC performance and would be examined in the following studies. Based on high electrical current generation, theoretically, it is expected to have struvite precipitation, which would encourage further development to improve the potential within the MDC and wastewater treatment nexus.

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

MARIANA, G MARTINEZ,
ARIZONA STATE UNIVERSITY / CIVIL ENGINEERING

Evaluating Growth Potential of Legionella in Simulated Glass Water Heaters

Opportunistic pathogens (OPs) are now the leading cause of drinking water related disease outbreak. Residential hot water systems have been linked to disease occurrence and are likely the primary location for OPs growth. In previous studies, hydrogen evolved from corrosion of water heater sacrificial anode rods has been hypothesized to support growth of OPs; however, further understanding is needed about the mechanism(s) for OP growth. Bench-scale reactors were used to evaluate growth potential of Legionella in two different hot water system designs, standard water heater tanks and tanks with recirculation. Standard systems were simulated in reactors with no stirring while recirculating systems were simulated by continuous agitation. Conditions tested included a control reactor with breakpoint chlorinated and granular activated carbon filtered Blacksburg tap water with no other alterations and reactors dosed with 0.50 mg/L-N ammonia (with and without agitation), 20 mg/L hydrogen (with and without agitation), 5 ug/L copper, and ammonia and hydrogen together. Preliminary data showed that agitation resulted in increased microbial growth (279 more total cells/uL as measured by flow cytometry). In addition, while there were no additive impacts of the combination of hydrogen and ammonia nutrients with regard to total microbial growth (8790 total cells/uL), there were additive impacts with regard to fixation of total organic carbon (385-216 ug/L more organic carbon fixed in the condition with both ammonia and hydrogen than either hydrogen or ammonia alone). These data suggest there is variable microbial regrowth potential with respect to the nutrient available. Future tests will examine culture and molecular quantification of Legionella in these reactors.

Mentor(s): Marc Edwards, Virginia Tech, Civil and Environmental Engineering; William Rhoads, Virginia Tech, Civil and Environmental Engineering

AUBREY, L MCCUTCHAN,
OKLAHOMA STATE UNIVERSITY / CIVIL ENGINEERING

Natural Attenuation Of Groundwater Contaminant Plumes In The Hyporheic Zone

This project investigated the reaction of resazurin to resorufin to be used for laboratory simulations of the hyporheic zone, a zone where groundwater and surface water mix in areas such as a riverbed. The gap in knowledge we are working to fill is to quantify the amount of which a pollutant can be remediated in this zone. In the resazurin to resorufin reaction dissolved oxygen is consumed as well as an unstable oxygen atom on the resazurin resulting in the solution transforming from dark blue to pink. This makes the reaction useable as a tracer for laboratory experiments that replicate the hyporheic zone. Additionally, a mesocosm filled with sand was used to simulate the hyporheic zone. Here the upwelling water in the tank acting as groundwater did not contain resazurin but sodium sulfite, one of the other reactants. Water flowing into the sediment from the top acted as surface water and contained the resazurin. Here the two water sources had varying chemical properties, which would be a realistic occurrence in the hyporheic zone that can help facilitate attenuation of pollutants. Furthermore, computer models where used to understand flow paths and different chemical concentrations throughout the mesocosm at steady state. Results showed the reaction was useful as a tracer and future testing will be needed to determine accuracy of the computer models, if they can be used for other reactions that could take place in the hyporheic zone, and to quantify how much of a pollutant can being remediated.

Mentor(s): Erich Hester, Virginia Tech, Civil and Environmental Engineering; Mark Widdowson, Virginia Tech, Civil and Environmental Engineering

MATHEW VERGHESE,
VIRGINIA TECH / COMPUTER ENGINEERING

Implementation of Interactive Graphs to Facilitate Environmental Monitoring with a Cyberlearning System

The Learning Enhanced Watershed Assessment System (LEWAS) is a unique, high-frequency, real-time environmental monitoring lab on the campus of Virginia Tech. The LEWAS has the following four stages: 1) data inputs which consist of environmental instruments including an acoustic Doppler current profiler, a water quality Sonde and a weather transmitter taking measurements every 1-3 min., 2) data processing occurring locally on a Raspberry Pi, 3) data storage on a remote server and 4) data visualization through an Online Watershed Learning System (OWLS) (www.lewas.centers.vt.edu/dataviewer/) through which end users access the LEWAS data for research and education. This paper includes the interactive methods added to the OWLS graphs in order to facilitate the cyberlearning process. The current live data scatter plot in the OWLS was updated to include more interactive features through the use of D3 (Data-Driven Documents). Additionally, D3 was used to create a stacked bar and grouped bar graph representation of collected water quantity data over a user-specified number of days. The effects of adding these interactive and data visualization features was assessed with a survey of the improved system in use. Additional features for future work are also included.

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VIRGINIA TECH / NEUROSCIENCE; VIRGINIA TECH/ ELECTRICAL ENGINEERING

Preliminary Interest in Regular Cognitive Screening

A 2015 CDC Health Report ranked Alzheimer's disease, a subset of dementia, as the sixth highest ,cause of death in America, affecting 93,541 individuals. The rate of dementia, and it's symptoms of memory loss, confusion, and disorientation, doubles every decade after age 60. However, symptoms are not usually acknowledged until they significantly impact daily functioning and independence, meaning the disease is typically further progressed before screening occurs. One way to promote earlier detection is to administer screening before symptoms occur, building a cognitive baseline to compare future results against. A recent study reports that individuals between ages 55-64 have a high potential to display the beginnings of cognitive decline, making them a key demographic to begin regular screening. A survey was drafted to assess if individuals between ages 55-64 would utilize a smart device to test cognition if asked by a physician on a regular basis and how concerned they were about their cognitive health as they aged. Survey results indicate that 61% of respondents in the key demographic would utilize such an app if asked by their physician. 82% of survey respondents in the target age range were concerned with their future cognitive health. Such high percentages potentially support the acceptance and usage of regular cognitive testing through smart devices. Survey results indicate that preemptive mental care, through regular screening, could become a healthcare norm. Frequent screening has the potential to provide a detailed view of an individual's cognitive health, allowing for more patient-centered care in the future.

Mentor(s): Dr. Brown, Data and Informatics Consultant, Sciences;

MATHEW, C BUSHEY,
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Novel Nanovaccines Against Nicotine Addiction

The study of drug delivery using hybrid nanoparticles (HNP) made from lipids and poly(lactic-co-glycolic)acid (PLGA) is ongoing. These lipids are used to form liposomes around the PLGA and desired drug. The HNP formed are then used for the purpose of drug delivery, along with that it can be broken down within the body, is relatively nontoxic, and have been FDA approved for use in humans. Each component of the HNP taken separately, PLGA and the lipids, have there downside in the body such as degrade too quickly, or drugs leaking out. Together they form a sturdy vehicle that can overcome this degradation, and prevent the drugs from leaking out too early. With that and the proper the proper components, the HNP can be used to deliver drugs anywhere within the body. There are many methods in which nanoparticle preparation can be pursued, such as various emulsion techniques and microfluidics. In this study, an optimized method of single step double emulsion is used to make hybrid nanoparticles containing PLGA. This technique is tested with various solvents, sonication times, and stabilizers to determine the effects they have on nanoparticle formation. The charge and size of these nanoparticles are measured multiple times using a Zetasizer, with imaging done via transmission electron microscope (TEM). These nanoparticles were tested to quantify uptake of them in mammalian dendritic cells using fluorescence imaging.

Mentor(s): Dr. Yun Hu, Virginia Tech, Biological System Engineering; Virginia Tech, Biological System Engineering

REBECCA, C BUTTON,
THE COMMONWEALTH GOVERNOR'S SCHOOL / HIGH SCHOOL STUDENT

Three Dimensional Printing of Vascular Scaffold Systems

Understanding the vascular geometry of vascular tissue is the key to being able to understand their relevance for nutrient delivery and disease progression. Traditional methods of recreating the tumor vascular system have proven ineffective due to them being two dimensional. The advent of the three dimensional printer (3D printer), made fabricating these structures possible. Using a 3D printer modified to print with carbohydrate solution, scaffolds for vascular system can be fabricated. Once the carbohydrate scaffold has been fabricated, it can be placed in a cell media to be dissolved. After it is dissolved, endothelial cells are grown and polarized to facilitate the formation of basal membrane and true in vitro vascular system that resembles the basic features of in vivo structures.

Mentor(s): Carla Finkielstein, Virginia Tech, Biological Sciences;

REBECCA, C BUTTON,
THE COMMONWEALTH GOVERNOR'S SCHOOL / HIGH SCHOOL STUDENT

Reliable Cell Segmentation using Machine Learning in Fiji

Many biological applications leverage cell identification and tracking based on microscopy data. While there have been many algorithms built for this purpose, they tend to be sensitive to the shape and physiology (health) of cells. Such algorithms are often built in a bottom-up manner, where a sequence of image processing steps were carefully chosen and refined to make the problem of cell segmentation easier, but it is rarely intuitive how to refine these algorithms when they consistently fail to properly identify cells. Through the use of the freely-available image analysis program, Fiji, we show that a machine learning plugin can be rapidly trained and then applied to identify cells within microscopy data using a binary Random Forest classifier.

Mentor(s): William Mather, Virginia Tech, Physics;

SHAMILLE, N DODOO; HOLLY, TIMME
VIRGINIA TECH / COMPUTER SCIENCE, VIRGINIA TECH/ COMPUTER SCIENCE

A Scientist's Adventure

With the next generation of children on the verge of becoming fully integrated into today's level of technology, the pertinence to galvanize their interest into STEM fields has taken the forefront of many minds and institutions. Kids' Tech University (KTU) has had this imperative idea in mind since its culmination some years ago. Through an engaging, approachable, and intuitive manner, Virtual KTU has accumulated a plethora of educational modules geared towards the critical ages of elementary and middle school students. Currently, the creation of one such module, A Scientist's Adventure, allows the student to vicariously fulfill their inherent curiosity as an avatar as they traverse a fantasy world, completing games that give them insight into some fundamental mathematical ideas of Queuing Theory. A Scientist's Adventure ensures the any student using a computer has access to an interactive, hands-on learning tool that teaches relevant science curriculum. By offering an alternative way and an informal setting to reap the benefits of education, young scientists can investigate how cells optimize their resources for protein formation. By using easy to grasp concepts adapted from the most current research on protein recycling and queuing theory, the scientists of tomorrow will gain an early interest into STEM fields. In this sense, future KTU programs, supplemented by the reinforcement of Virtual KTU modules, will conceivably assure the STEM engineers and scientists of tomorrow.

Mentor(s): Kristy Collins, Virginia Tech, Biocomplexity Institute; Will Mather, Virginia Tech, Biocomplexity Institute

KANDACE DONALDSON

VIRGINIA TECH / CIVIL AND ENVIRONMENTAL ENGINEERING

Acanthamoeba Prevalence in a Simulated Reclaimed Water Distribution System

With increasing drought as well as increased sustainability initiatives, water distribution authorities are searching for alternative water sources. Reclaimed water is widely used for irrigation, both agricultural and recreational. Substantial regrowth of opportunistic pathogens in reclaimed water distribution systems can occur even following rigorous disinfection due to a variety of reasons such as temperature, organic carbon levels, disinfectant type, and the time spent in the system [1]. One opportunistic pathogen (OP) that is critical to understanding microbial activity in both reclaimed and drinking water distribution systems is Acanthamoeba. Acanthamoeba not only causes severe eye disease but also acts as a host for Legionella pneumophila, the pathogen responsible for Legionnaire's disease, and can cause it to behave more invasively [2].

In order to better understand how this amoeba, along with various other OPs, behaves in the reclaimed water microbiome, a system was designed to simulate the path of reclaimed water in distribution systems. The system consisted of six parallel continuous flow reclaimed water pipe rigs under various disinfection conditions and organic carbon levels. Samples of bulk water and biofilm have been collected at various water ages within the pipe system and over three temperature conditions (14°C, 22°C, and 30°C). Following DNA extraction, quantitative polymerase chain reaction (qPCR) of the [which gene?] was performed to quantify amoeba DNA in both the bulk water and biofilm samples. The abundances of gene copies will be compared between the rigs to determine which conditions contribute to the proliferation of the amoeba.

Mentor(s): Dr. Marc Edwards

LANDON, P FRAZIER,
VIRGINIA TECH / BIOLOGY

Mammalian Circadian Clock Regulation by a non-coding RNA, Per2AS

The circadian rhythm controls behavioral and cellular day-and-night rhythms and regulates body function and many biochemical processes such as metabolism and hormone secretion. The circadian rhythm is controlled by approximately 10 _–"core_–ù clock genes, and Period2 (Per2) is one of the most important genes in regulating circadian rhythmicity. Interestingly, we recently discovered a non-coding gene at Per2 locus and named it Per2AS. Per2AS is transcribed from the antisense strand of Per2, is rhythmically expressed, and its expression pattern is anti-phasic in relation to Per2. Based on these observations, we hypothesized that Per2 and Per2AS reciprocally repress each other_–Ès expression and form a double negative feedback loop. Per2AS and Per2. To understand the functions of Per2AS, I first performed a loss-of-function experiment by generating cell lines that do not express Per2AS using CRISPR, followed by fluorescence-activated cell sorting (FACS) technology. To investigate the mode of action, I observed the effect of Per2AS overexpression on Per2 expression in mouse cell lines using quantitative PCR (qPCR). Lastly, I constructed luciferase reporter genes to identify the DNA elements required for Per2AS rhythmic expression, which will provide a better understanding of the interactions associated with Per2AS. Upon completion of these projects, we expect to understand the importance of Per2AS in the mammalian circadian clock system.

Mentor(s): Shihoko Kojima, Virginia Tech, Department of Biological Sciences;

MARY, C FRAZIER,
VIRGINIA TECH / MICROBIOLOGY

Developement of Methanocaldococcus jannaschii Genetics

Before oxygen came to the environment, early Earth dwellers were strict anaerobes such as the anaerobic methanogenic archaeon, Methanocaldococcus jannaschii. M. jannaschii naturally grows at 85ÎçC in deep sea volcanoes called hydrothermal vents. This habitat provides pristine environments for the ancient organisms to continue to flourish with their ancient pathways and metabolisms. Consequently, the metabolism of these ancient organisms is both interesting and unique. Studies on the ancient organisms have revealed several unique enzymes, cofactors, and metabolic pathways. Our laboratory is interested in studying the physiology and metabolism of M. jannaschii, which grows by consuming hydrogen and carbon dioxide as an electron donor and acceptor, respectively, and producing methane as the metabolic byproduct. Methane is used as fuel and in industrial feedstock, which make methanogens economically attractive. Methane is also a potent greenhouse gas, and therefore, a better understanding of methanogen physiology is necessary for mitigating the emission of this gas into the atmosphere. To further investigate the physiology of M. jannaschii and to complement in vitro biochemical studies, genetic analysis is very crucial. However, M. jannaschii is currently not genetically tractable due to its antibiotic resistance and thermophilic properties, which challenges the development of genetic system. Accordingly, we are developing a genetic system in M. jannaschii employing sulfite as a selective marker. We are creating a M. jannaschii strain that is sensitive to this oxyanion by deleting a gene responsible for sulfite resistance. Other non-antibiotic selection markers are also under investigation.

Mentor(s): Biswarup Mukhopadhyay, Virginia Tech, Biochemistry; Dwi Sustani, Virginia Tech, Biochemistry

COURTNEY D HOWELL,
VIRGINIA TECH / HISTORY

The Impact of Tuberculosis on American Society, 1870-1910: An Undergraduate Research Project

This research project explores the impact of tuberculosis on American lives and communities in the late nineteenth century. Our team is comprised of undergraduate researchers from Virginia Tech, the University of Virginia, and George Mason University. We are applying research techniques from the humanities, social sciences, and data analytics to understand the significance of tuberculosis, which was the single greatest cause of death in this historical period. Using online historical newspaper archives, medical journals, and data mapping software, we have conducted original undergraduate research in the field of medical history and have plans to create a searchable database to share our findings with a public audience. As a result of our project, we aim to provide insight on contemporary questions about the role of history in shaping attitudes towards disease, the value of historical scholarship for integrating narratives and data into an interpretive approach, and the importance of historical perspectives for developing effective public health policies.

Mentor(s): Dr. Tom Ewing, Virginia Tech, History;

COURTNEY D HOWELL,
VIRGINIA TECH / HISTORY

No Place Like Home: Home Care, Hospitals, and Dying of Consumption from 1870 to 1910

The goal of this project was to determine where Americans suffering from tuberculosis in the late nineteenth and early twentieth centuries were dying, as well as to track the narrative shift within newspaper obituaries about where Americans died. My research moved beyond analyzing geographic location of death such as city, state, or region and instead focused on specific location of death. I codified a database of nearly 4,000 victims of tuberculosis collected through obituaries within historical newspapers nationwide. While processing this data, I tracked how many victims died at home or the homes of loved ones, in medical care facilities, and in several other specific locations. Additionally, I kept a record of how specific newspapers were when giving death location of victims in order to follow overall changes in obituary narratives. I did further research to explain general data trends and American death care preferences within the context of this disease, which was the single greatest cause of death in this period of history. The outcome of this project is to humanize the victims of tuberculosis across the United States and to educate the public on their experiences with death and with this disease. This project also contributes to wider scholarship on the history of disease and medicine, and fits within a larger conversation on palliative care choices and options.

Mentor(s): Dr. Tom Ewing, Virginia Tech, History;

MATTHEW MCGUIRE,
VIRGINIA TECH / CHEMISTRY

Synthesis of benzothiophene intermediates for a malaria drug hit-to-lead optimization.

Research consisted of the synthesis of benzothiophene intermediates for a malaria drug hit-to-lead optimization. The development and optimization of reactions in the multi-step synthesis for larger scale production in excess of 10g was also pursued. Continuing development of effective and affordable drugs is necessary to sustain the fight against malaria in the face of parasite drug resistance. One of Dr. Carlier's collaborators (Prof. Klemba, BICH) has identified a promising benzothiophene-containing compound AD11 that shows significant antimalarial properties in phenotypic and growth inhibition assay. Compound AD11 possesses a phenolic Manich base moiety that presents the risk of chronic toxicity. Research consisted of synthesizing analogs of AD11 that eliminate this structure and optimize the compounds antimalarial properties, which will be assessed by the Klemba lab with assays. The first 3 reactions of the sequence were scaled to 10+ g without loss of yield. In fact, yields were improved relative to the corresponding small scale reactions in all cases. The mono bromination of compound 3 continues to prove difficult. Acceptable 50% yields of the dibrominated compound 3 have been achieved. Alternative synthetic routes utilizing the dibrominated product are being explored for future work.

Mentor(s): Dr. Paul Carlier, Virginia Tech, Chemistry;

BRITTNEY, L WORRELL,
VIRGINIA TECH / BIOCHEMISTRY

Structural Distinctions Between Isoforms of Human and Mouse Sphingosine Kinases

Alterations in or disruption of cell proliferation and cell signaling pathways are significant given their connection to multiple disease states including cancers and fibrosis. Current research efforts focus on sphingosine kinases (SphKs), which exist in two isoforms, SphK1 and SphK2, and are the sole enzymes that catalyze the phosphorylation of sphingosine to sphingosine-1-phosphate (S1P). S1P is important to cellular processes such as cell differentiation, but has been found in elevated levels in certain cancer cells, making these kinases of interest as drug targets. Mouse SphKs bind sphingosine and produce different levels of S1P in certain conditions compared to human SphKs, so it is necessary to determine the structural qualities that may result in varied S1P expression levels. Homology models of mouse SphK1 and SphK2 were created and validated. Molecular docking to isoform specific inhibitors, analysis of key residue positioning in the binding pocket, and binding site volume analysis were performed to compare the four enzymes and elucidate difference based on sequence variance in the binding cavity. Mouse SphK1 docked compounds in a manner most similar to human SphK2, based on distance measurements and ligand positioning. Additionally, surface images and binding cavity analysis showed that SphK1in both species has a larger binding site that branches, whereas SphK2 only has a single cylindrical channel. This study has the potential to aid in SphK inhibitor design and in vivo studies involving mice by highlighting structural distinctions and identifying the role of key residues that cause observable, functional differences in isoforms and species.

Mentor(s): David Bevan, Virginia Tech, Biochemistry; Anne Brown, Virginia Tech, University Libraries