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July 31, 2013
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Undergraduate Peer Mentors:

Ben Fox (Biological Systems Engineering) Fralin SURF (2012)
Carrie Hughes (Chemistry & Biochemistry) Scieneering summer research (2012)
Alex Jones (Psychology) Scieneering summer research (2012)
Ashley Lohr (Wildlife), Fralin SURF (2012, 2013) ACC Research Scholar (2013)
Jen Samuels (Human, Nutrition, Foods and Exercise), Fralin SURF (2012, 2013)

Undergraduate Team Leaders:

Korie Bush (Cornell University, Biology)
Martin DeBerardinis (Human, Nutrition, Food and Exercise)
Kristen Fread (Biochemistry)
Beck Giesy (Mathematics)
Ben Heithoff (Biological Sciences)
Alex Karikari (Mechanical Engineering)
Meredith Leonard (Biological Sciences)
Nathan Roberson (Engineering Science and Mechanics)
Shree Sanyal (Mathematics)
Christine Tin (Biological Sciences)
Sydney Vaughan (Biochemistry)
Stephanie Wiltman (Materials Science and Engineering, Psychology)

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SURF, HNFE Scholars, SEEC, Tire & Automotive, EFRI – BSBA, Bioprocess Engineering for Sustainability

10:45 am – 12:00 pm
Concurrent Sessions 2 – 5: Oral Presentations (Drillfield, Duck Pond, Smithfield, Solitude)
Cognitive Communications, Interdisciplinary Water Sciences, SURF, SEEC and Violence Prevention REU

12:00 pm
Networking lunch, Session 1 Poster take-down, Session 6 Poster set-up (Ballrooms)

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Session 6: Poster presentations (Ballrooms)
Cognitive Communications, Individual presenters, Scieneering, StREAM Lab, Summer Veterinary Research Program, Violence Prevention REU

2:15 – 3:45 pm
Concurrent Sessions 7-12: Oral Presentations (Drillfield, Duck Pond, Smithfield, Solitude)
Interdisciplinary Water Sciences; SURF +Vet Med + Individual; EFRI-BSBA + Tire and Automotive, + StREAM; Scieneering

3:45 – 4:00 pm Break

4:00 pm
Program video screenings, votes, and prizes (Ballrooms)

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Session 1 - Poster Presentations
9:30 – 10:45 am
Ballrooms

Bioprocess Engineering for Sustainability NSF-REU

EFRI BSBA (NSF)

HNFE Scholars Program

Summer Engineering Education Collaboratory (SEEC)

Session 1 - Poster Presentations
9:30 – 10:45 am
Ballrooms

Tire and Automotive Engineering NSF-REU

Fralin Sumer Undergraduate Research Fellowship (SURF)

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1:00 – 2:15 pm, Ballrooms

HHMI Scieneering

Summer Veterinary Student Research Program (SVSRP)

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Keynote Address

Emphasizing the Connections Among Science, Technology, and Society: The Virginia Tech Transportation Institute

With increased access to information and reduced government funding for research, our ability to communicate the role of science and technology in society is critical. Research grant proposals require explicit statements on outreach, education, and broader impacts. Many research journals require submission of a summary that can be shared with, and understood, by the populous. We are challenged with increasing the diversity and depth of perspective of research scholars while creating an informed public that values innovation and education when the immediate impacts may not be clear.

The Virginia Tech Transportation Institute (VTTI) provides an excellent example of the power of the connections among science, technology, and society. VTTI conducts research to save lives, time, and money as well as to protect the environment. Researchers and students from multiple fields are continuously developing the techniques and technologies to solve transportation challenges from vehicular, driver, infrastructure and environmental perspectives. As one of 7 premier research institutes created by Virginia Tech to answer national challenges, VTTI has effected significant change in public policies for driver, passenger and pedestrian safety and is advancing the design of vehicles and infrastructure to increase safety and reduce environmental impacts.

Keynote speaker: Dr. Tom Dingus, VTTI Director

Dr. Dingus has conducted transportation safety and human factors research since 1984, including the safety and usability of advanced in-vehicle devices, crash avoidance countermeasures, truck driver fatigue, and driver distraction and attention. He has pioneered studies of naturalistic driving, which involve instrumenting cars, trucks and motorcycles with video cameras and sophisticated instrumentation (e.g., radar) designed to assess crash and near-crash causation and to test a variety of crash countermeasures. VTTI leads such studies worldwide with more than 4,000 equipped vehicles.

Dr. Dingus was recently named a White House Champion of Change and was selected for his exemplary leadership in developing or implementing transportation technology solutions. He has had the honor of testifying before a U.S. Congressional subcommittee, the National Transportation Safety Board, and the National Council of State Legislatures about issues of driver distraction and attention. Dr. Dingus has more than 220 technical publications and has managed more than $250 million in research funding thus far in his career.

Virginia-Maryland Regional College of Veterinary Medicine

Summer Veterinary Student Research Program (SVSRP)

The objective of the SVSRP is to expose veterinary students to research and opportunities for a biomedical research career. Veterinarians with a biomedical research background are in demand and this career provides many opportunities in universities, federal, biotech and pharmaceutical institutions.

2013 Scholars:

Name	School	Mentor
Jordan Adair	VMRCVM – VT	Michelle Theus/Will Eyestone
Camille Brandenburg	VMRCVM – VT	Zach Adelman
Penelope Burchfiel	Kansas State University	Jennifer Barrett
Elle Donnini	VMRCVM – VT	Linda Dahlgren
John Gil	VMRCVM – VT	Xin Luo
Madison Jubirt	Mississippi State University	Clay Caswell/ Nammalwar Sriranganathan
Sarah Peloquin	VMRCVM – VT	Lijuan Yuan
Jonathan Samuelson	VMRCVM – VT	Jia-Qiang He/Liwu Li
Patricia Shanteau	VMRCVM – VT	Theresa Hrubec
Vanessa Wallace	VMRCVM – VT	Marion Ehrich

Funding provided by: Merial Limited, the NIH (T35OD011887-07), and the Office of Research and Graduate Studies – VMRCVM

Program Director: S. Ansar Ahmed, BVSc, PhD
Program Co-Director: Roger J. Avery, PhD
Program Coordinator: Jessica Adkins, PhD

Jordan E. Adair

The role of EphA4 in pial arteriole collateral development

Cerebrovascular occlusion (stroke) is a major health concern for both humans and companion animals; however, treatment largely focuses on supportive care rather than neuroprotective or reparative strategies. Pial collateral arterioles, which connect major arterial trees, help to minimize tissue damage following stroke by providing an alternative route for blood flow. Collaterals form in utero and then undergo significant postnatal pruning. Our studies seek to identify novel proteins that regulate this developmental process in order to understand how arteriole collaterals may remodel/repair after occlusive injury. Previous studies show that adult mice having a global knockout of the EphA4 receptor have more pial arteriole collaterals. Furthermore, EphA4 stimulation on endothelial cells (EC) in culture prevents vascular organization. Thus, we hypothesize that EphA4 negatively regulates EC activities during pial arteriole collateral development in a cell autonomous fashion. To test this, we generated tissue-specific EphA4 knockout mice using the Cre recombinase enzyme under the endothelial-specific Tie2 promoter to delete the EphA4 gene (EphA4f/f x Tie2-Cre+/-). We demonstrate by RT PCR the knockout and control litter mates this produced as well as evidence demonstrating loss of EphA4 expression in ECs isolated from the brains of these mice. Next, using vessel painting to selectively label the arteriole network, we seek to analyze the effects of deleting EC-specific EphA4 on pial collateral formation at embryonic and post-natal time points. Initial findings show robust collateralization in the absence of EC-specific EphA4. Further studies are needed to confirm this and to identify critical intracellular signaling pathways aiding EphA4 in limiting collateral growth.

Mentor(s): Dr. Michelle Theus (Biomedical Sciences and Pathobiology)

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Abstracts: Summer Veterinary Student Research Program

Camille M. Brandenburg

Visualizing the Colocalization of Proteins involved in RNAi using IFA in Aedes aegypti

Aedes aegypti is the mosquito responsible for transmitting vector-borne diseases worldwide, including dengue viruses and yellow fever virus. RNA-interference (RNAi) is a significant biological process triggered by double stranded RNA (dsRNA). RNAi is responsible for the control of gene expression and provides a significant antiviral response in arthropods. The proteins Dicer-1 (DCR-1), Dicer-2 (DCR-2), Argonaute-1 (AGO-1) and Argonaute-2 (AGO-2) are the primary effectors of this pathway. Dicer proteins process dsRNA into short duplexes RNAs approximately 21-23 nucleotides long [1]. These duplexes are unwound and incorporated into an Argonaute-led RNA induced silencing complex (RISC). Dicer-1 is responsible for processing pre-microRNAs (miRNAs) in order to load each segment onto miRISC containing AGO-1 [2]. Dicer-2 does not play a role in miRNA synthesis, but cleaves dsRNA into short interfering RNAs (siRNAs) to load onto AGO-2 to create the siRISC complex [2]. Both Dicer-1 and Dicer-2 proteins interact with dsRNA binding domain proteins (dsRBP), R3D1 and R2D2, respectively, to facilitate loading of RISC. To view the spatial localization of DCR and AGO proteins with their dsRBP partners, we performed immunofluorescence assays (IFA) on transfected mosquito cells. For cells transfected with plasmid DNA encoding the dsRBP, a primary α-HA or α-FLAG mouse monoclonal antibody was used, and a primary α-DCR-1, DCR-2, AGO-1, or AGO-2 rabbit polyclonal antibody to detect endogenous proteins. The secondary antibodies, Alexa 488 and 594, detect the primary mouse or rabbit sera. The existing IFA protocol was optimized and we successfully detected the dsRBPs HA-R3D1, HA-ExLoqs, HA-R2D2, and the positive control HA-GFP.

Mentor(s): Dr. Zachary Adelman (Entomology)

Penelope G. Burchfiel

Evaluation of the anti-inflammatory properties of equine mesenchymal bone marrow stem cells in three-dimensional spheroid culture versus monolayer culture

Endotoxemia is a serious medical condition resulting in significant morbidity and frequent mortality in both horses and humans. The detrimental effects are exacerbated by a pro-inflammatory immune response by the body. Mesenchymal stem cells (MSCs) from bone marrow initiate anti-inflammatory processes and secrete soluble factors that may mediate this inflammatory cascade. Traditionally, MSCs are grown in a two-dimensional monolayer culture, which shifts their gene expression over time. Previous studies in rodent models suggest that three-dimensional culture maintains the anti-inflammatory properties of MSCs. We propose that three-dimensional culture would mount a heightened therapeutic response when challenged with endotoxin relative to the monolayer cells due to increased cell-to-cell communication and more physiological extracellular environment. To test the comparative therapeutic response between the two experimental populations, we seeded equine bone marrow stem cells in three-dimensional spheroid culture and compared their anti-inflammatory properties to monolayer cultures when exposed to lipopolysaccharide. Spheroids and monolayer cells were treated with 0ng, 100ng, or 200ng of LPS and then harvested at 0, 6, 12, and 24 hours. ELISA analysis showed an increase in IL-10 and PGE2, both anti-inflammatory signaling molecules, in the three-dimensional cultures when compared to the monolayers. Spheroids had less expression of the pro-inflammatory cytokine IL-6. Both spheroids and monolayers had negligible expression of TNFα, a pro-inflammatory signaling molecule. Further studies investigating other gene expression changes are ongoing.

Mentor(s): Dr. Jennifer G. Barrett (Large Animal Clinical Sciences, VA-MD Regional College of Veterinary Medicine); Sophie Bogers, Masters Student (Equine Medical Center)

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Abstracts: Summer Veterinary Student Research Program

Elle K. Donnini

Ability of stromal vascular fraction cells to induce a regenerative response in tendon fibroblasts via secretion of soluble factors

Tendon injuries are common in horses and have a high incidence of recurrence due to scar tissue deposition during natural healing. The stromal vascular fraction (SVF) (nucleated cells harvested from adipose tissue) has been used successfully for the treatment of equine tendon injuries clinically. The production of growth factors and cytokines from SVF cells following injection into healing tendon may be responsible for stimulation of tissue regeneration. The purpose of this study was to investigate the ability of SVF cells to induce a regenerative response in equine tendon fibroblasts (TFBL) indirectly via the production of soluble factors. We hypothesized that co-culture of TFBL with SVF cells would result in a dose-dependent increase in TFBL proliferation and extracellular matrix (ECM) gene expression. Fresh SVF from 6 horses was plated in increasing density (0-5 x 10^5 cells/transwell insert) and grown in co-culture with allogeneic TFBL from 3 horses. TFBL were harvested at 72 hours for gene expression of ECM proteins via real time fluorescent PCR and for DNA quantification as an estimate of cell numbers. Cell monolayers and culture medium were harvested for quantification of glycosaminoglycan (GAG) content. Data were analyzed using mixed model ANOVA with significance set at $P<0.05$. There were no significant differences between treatment groups for GAG content of culture medium or cell monolayers. Increased cell proliferation and/or increased expression of ECM proteins would provide evidence of an indirect means by which SVF could induce a regenerative response following intratendinous injection.

Mentor(s): Dr. Linda Dahlgren (Large Animal Clinical Sciences, Virginia-Maryland Regional College of Veterinary Medicine)

John J. Gil

All-Trans-Retinoic Acid (atRA) Regulates CpG-mediated Production of Inflammatory Cytokines in Human Plasmacytoid Dendritic Cell (pDC) Line CAL-1

Systemic lupus erythematous (SLE) is an autoimmune disease characterized by severe and persistent inflammation. At the cellular level, SLE is associated to pDCs whose main role is to produce inflammatory cytokines such as interferon (IFN)-α, IFNβ, and to a lesser extent, tumor necrosis factor (TNF)-α and interleukin (IL)-6. In this study, we have used the human pDC cell line CAL-1 to examine the effect of atRA, alone or in combination with CpG-B, on the production of inflammatory cytokines as an *in vitro* demonstration of whether atRA can be used as a potential treatment for SLE. Because CAL-1 cells do not produce a detectable level of IFNα, we focused on the other 3 cytokines. Our results showed that compared to CpG alone, the production of IFNβ in cells treated with atRA+CpG was significantly lower. In addition, we showed that CpG-mediated production of TNFα was significantly greater in the presence of atRA. Moreover, both mRNA and protein production of IL-6 in atRA+CpG treated cells was significantly higher than that with CpG alone. Furthermore, we showed that atRA on its own was able to significantly increase IL-6 mRNA and TNFα/IL-6 protein levels, suggesting a direct effect of atRA on these genes. Overall, our results suggest that atRA regulates CpG-mediated production of inflammatory cytokines by lowering IFNβ and increasing TNFα and IL-6. We hypothesize that atRA may induce pDCs to differentiate into a conventional dendritic cell-like phenotype and thereby has the potential to modulate the pathogenesis of SLE.

Mentor(s): Dr. Xin Luo (Biomedical Sciences and Pathobiology); Dr. Ansar Ahmed, Faculty (Virginia-Maryland Regional College of Veterinary Medicine); Xioafeng Liao, Ph.D. Student (Virginia-Maryland Regional College of Veterinary Medicine)

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Abstracts: Summer Veterinary Student Research Program

Sarah K. Peloquin

The influence of simvastatin on cytokine response in gnotobiotic pigs after GII.4 2006b human norovirus infection or P particle vaccination

Noroviruses (NoV) are the leading cause of non-bacterial gastroenteritis in peoples of all ages and can be deadly for infants and elderly, causing over 200,000 deaths annually worldwide. Studies have shown that simvastatin, a drug commonly used to control hypercholesterolemia in humans, can modulate antigen presenting cell and T cell immune responses, and increase the infectivity of NoV in gnotobiotic (Gn) pigs. This current study is aimed to determine the effect of simvastatin on serum cytokine responses to NoV infection or P particle vaccination. NoV inoculated pigs received 2.74x104 viral RNA copies of 092895 (a GII.4 2006 variant) at 33 days of age. Vaccinated pigs received three intranasal doses of P particles with MPL/chitosan adjuvants using mucosal atomization devices starting at 5 days. Control pigs received diluent (for NoV infection) or adjuvant only (for the vaccine). Pigs were treated with or without simvastatin (8 mg/day) for 11 days until post-inoculation day (PID) 28. Serum samples from all pigs were collected weekly on PID 7, 14, 21 and 28. A multiplex porcine cytokine magnetic bead-based assay (Millipore) was used to measure concentrations of selected proinflammatory, Th1, Th2 and Treg cytokines. TGF-β was determined by an enzyme-linked immunosorbent assay (ELISA). Understanding the modulatory effect of simvastatin on the adaptive immune responses induced by NoV infection or vaccination is important for the success of NoV vaccine development, especially for the elderly. This work was supported by a grant (R01AI089634-01) from NIAID, NIH to XJ and LY, and a NIH training grant (T35OD011887-07).

Mentor(s): Dr. Lijuan Yuan (Biomedical Sciences and Pathobiology)

Jonathan P. Samuelson

Preconditioning of Human Cardiac Stem Cells with Lipopolysaccharides Enhances Cell Survival Probably through TLR-4-mediated an Anti-apoptotic Mechanism.

Heart failure is a common and lethal disease in Western countries, including the USA, with about 6 million patients to date. The most common cause of heart failure is heart ischemia. Stem cells demonstrate great promise in repairing an infarcted heart. However, one of the major challenges in stem-cell based therapy for repairing ischemic myocardial infarction is lowered efficiency, mainly due to significant cell death following transplantation. Enhancement of stem cell survival rates and/or its anti-apoptotic abilities are therefore critical steps to successfully advance stem cell-based therapy. Previous publications have demonstrated the potential beneficial effects of lipopolysaccharides (LPS) in protecting mouse embryonic stem cells from apoptosis. In the present study, we examined the impacts of LPS on cell survival and proliferation of human cardiac stem cells (hCSCs) subject to apoptosis induced by Doxorubicin (Dox). In addition, we explored the underlying mechanism of LPS/Toll-like receptor (TLR) mediated anti-apoptotic protection. As expected, Dox treatment alone significantly increased cell death, especially at the concentration of >0.1uM (0, 0.001, 0.01, 0.1, 1, 10uM) and incubation time of 24-48 hours ($p<0.05$, n=12(24hr) and 9 (48hr)). However, Dox-induced cell death could be dramatically reduced by pretreatment of hCSCs with 10ng LPS for 6 hours ($p<0.05$, n=12). This protective effect may be mediated through TLR-4 as we for the first time demonstrated the highest expression of TLR-4 in hCSCs, among others (TLR-1 and -6), using RT-PCR. Currently, an immunocytochemistry assay using anti-TLR-4 antibody, a ligand inhibition assay with TLR-4 antagonists, and an apoptosis assay with Caspase 3 are being performed to further explore the underlying mechanism.

Mentor(s): Dr. Jia-Qiang He (Virginia-Maryland Regional College of Veterinary Medicine)

Harness the Power of Discovery
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Abstracts: Summer Veterinary Student Research Program

Patricia J. Shanteau

The Reproductive and Developmental Effects of Ubiquitous Quaternary Ammonia Compounds

Mice in our lab have experienced poor reproductive performance and an increase in neural tube defects (NTDs) in their offspring from exposure to Labsan 256Q, which is used in the animal facility. Labsan 256Q is a commercially available disinfectant. It contains two active ingredients; alkyl dimethylbenzyl ammonium chloride (ADBAC) and dodecyl dimethyl ammonium chloride (DDAC). We hypothesize that the active ingredients are causing both NTDs and decreased reproductive performance. To test this mice were dosed with commercial Labsan 256Q and with ADBAC+DDAC. CD-1 mice were raised in disposable housing in a Labsan 256Q free facility. The mice were separated into three groups of fifteen females and 5 males. One received Labsan 256Q in distilled water at 120 mg/kg of body weight daily, the second received ADBAC+DDAC in distilled water at 120 mg/kg of body weight daily, and the third received distilled water only. Mice were dosed for eight weeks. Vaginal cytology was evaluated daily from all female mice for ten days to track changes in the estrus cycle during exposure. To assess developmental effects, males and females were co-housed together after the exposure. Females identified as bred were humanely euthanized on gestational day 10. The embryos were removed and evaluated for NTDs. There was no significant differences in the cytology data between groups, indicating no change to the estrus cycles in treated mice. Possible reasons for these results are being investigated. This study was made possible by funding from VCOM and NIH grant T35OD011887-07.

Mentor(s): Dr. Terry C. Hrubec (Virginia-Maryland Regional College of Veterinary Medicine, E. Via College of Osteopathic Medicine Virginia Campus); Vanessa E. Melin, Ph.D. Candidate (Biomedical and Veterinary Science, Virginia-Maryland Regional College of Veterinary Medicine)

Vanessa J. Wallace

Acute effects of multiple dose fullerene exposures in mice after intravenous or intraperitoneal exposure

Acute effects of multiple dose fullerene exposures in mice after intravenous or intraperitoneal exposure V. Wallace, J Hinckley, B. Jortner, M. Ehrich Virginia-Maryland Regional College of Veterinary Medicine Gadolinium trimetasphere (GdTms; Gd3N2C80) is a fullerene compound, a nanoparticle that contains carbon atoms oriented in a hollow sphere formation with gadolinium at its center. In addition to its suggested use for prevention of organophosphate poisoning, GdTms has been proposed as a contrast agent in medical imaging techniques. Although current published *in vitro* and *in vivo* studies utilizing single-dose GdTms have not revealed toxic responses, studies examining multiple dose effects of these compounds have not been performed. This study investigates the acute effect of multiple doses of GdTms on mice (male, CD-1 strain). There were 2 treatment groups, one receiving three 8 mg/kg doses intraperitoneally (IP; n=12) and the other receiving the same doses intravenously (IV; n=16). Control mice received a saline solution either IP (n=6) or IV (n=8). Dosing was done at 0, 4, and 7 hours, with behavioral observations made throughout the day. Mice were sacrificed at either 10 or 24 hours post-exposure, at which point blood and urine samples were collected for clinical pathology analysis, and the major organs for histopathology. Results do not demonstrate abnormalities as revealed by hematology, clinical biochemistry or histopathology. The results to date suggest that multiple doses of GdTms is relatively safe in mice. Funded by NIH as part of the Summer Veterinary Student Research Program.

Mentor(s): Dr. Marion Ehrich (Biomedical Sciences and Pathobiology, Virginia-Maryland Regional College of Veterinary Medicine)

Fralin Life Science Institute Summer Undergraduate Research Fellowship (SURF)

Program description: 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.

Program director: Dr. Tomalei J. Vess
VT Office of Undergraduate Research

Undergraduate Peer Mentors:

*Ben Fox (*Biological Systems Engineering)
Fralin SURF (2012)
*Ashley Lohr (*Wildlife)
Fralin SURF (2012, 2013)
ACC Research Scholar (2013)
*Jen Samuels (*Human, Nutrition, Foods and Exercise)
Fralin SURF (2012, 2013)

Student Name	Major	Faculty Mentor
Tahsin Anwar	Biological Sciences	Isis Kanevsky
Brandi Beverage	Environmental Horticulture	Cynthia Denbow
Jacqueline Chandler	Biological Sciences	Zach Adelman
Carolyn Chapon	Biological Sciences	John McDowell
Helen Clark	Biochemistry	Shiv Kale
Miranda Creasey	Human, Nutrition, Food and Exercise	Brooks King-Casas
Martin DeBerardinis*	Human, Nutrition, Food and Exercise	Brenda Davy
Samuel Doak	Biological Sciences	Bryan Brown
Chandler Eaglestone	Wildlife Science	Marcella Kelly
Miranda Flood	Biological Sciences	Bryan Brown
Kristen Fread*	Biochemistry	Daniel Capelluto
Aaron Gringer	Biological Sciences	Pablo Sobrado

Fralin Life Science Institute Summer Undergraduate Research Fellowship (SURF)

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James Hody	Wildlife Science	Marcella Kelly
Dorian Jackson	Biochemistry	Dana Hawley
Catherine Jucha	Environmental Policy and Planning	Daniel Hindman
Osamah Khan	Biological Sciences	Gregory Welbaum
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Gregory Kralik	Wildlife Science	Kathleen Alexander
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Spencer Lovegrove	Biological Sciences	Steven Poelzing
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Devona Quasie-Woode	Biochemistry (University of Maryland-Baltimore County)	David Bevan
Emily Ronis	Wildlife Science	Sarah Karpanty
Matthew Rosati	Biological Sciences	Michael Klemba
Cameron Rose	Biological Sciences	Troy Anderson
Stephanie Seto	Biological Sciences	Carla Finkielstein
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Gloria Trivitt	Biological Sciences	Shiv Kale
Brianne Varnerin	Wildlife Science	Sarah Karpanty
Sydney Vaughan*	Biochemistry	Gregorio Valdez

**** Fralin SURF Team Leader***

Tahsin Anwar

Restorative Effects of OmniGen-AF® On Neutrophil Function During Immunosuppression

During periods of stress, such as calving, cows have an increased risk of contracting mastitis, inflammation of the mammary gland due to bacterial infections. Stress causes elevated levels of glucocorticoids which are hormones that decrease immune function, particularly that of polymorphonuclear leukocytes (PMN) or neutrophils, the first responders to infection. Neutrophils recognize pathogens via Toll-like receptors (TLRs) on the cell's surface. TLR2 binds to Lipoteichoic acid (LTA) and TLR4 binds to Lipopolysaccharide (LPS), initiating a signaling cascade involving the intracellular protein Myd88. This signaling pathway results in neutrophil production of inflammatory soluble communication molecules called cytokines. OmniGen-AF® is a probiotic supplement that restores neutrophil function during periods of stress. We hypothesize that OmniGen-AF® restores normal cytokine and gene expression during immunosuppressive conditions through a MyD88 dependent pathway. In order to investigate our hypothesis, Wildtype and MyD88 KO mice were supplemented with either OmniGen-AF® or normal chow, injected with Dexamethasone, a synthetic glucocorticoid used to mimic stress responses and challenged with LPS or LTA. In order to evaluate immune status, the cytokines MCP-1, IL-10 and IFNγ were measured using a multiplex bead array. Neutrophil activation markers L-Selectin, RANTES, and GR-1 were measured with Real-Time PCR. The results of this research will provide a fundamental understanding of how OmniGen-AF® supplementation restores immune function which may expand its market across species.

Mentor(s): Dr. Isis Kanevsky (Dairy Science); Anne Johnson, Master's Student (Dairy Science)

Brandi B. Beverage

Killer Plant Extracts: Isolation of crude extracts using the maceration method with various solvents and subsequent testing for activity

Plant extracts containing secondary compounds have been used for centuries as natural remedies in medicine and in agriculture. Increased resistance to traditional antibiotics, herbicides and pesticides as well as increases in the popularity of safer natural products have driven efforts to identify useful compounds from plants. Several plant extracts were screened for antimicrobial and nematicidal properties. Crude extracts using four solvents from ten different plants were tested for antibacterial properties against six bacteria by the disc diffusion method. Vancomycin (30 ug) and gentamicin (10 ug) served as positive controls for bacterial strains and ethanol and methanol (v/v) as negative controls. Three milligrams of bloodroot (*Sanguinaria canadensis*) extracted in methanol showed greater antibacterial activity against all bacteria tested. Both ethanol and chloroform/methanol/water extracts of bloodroot also inhibited most bacteria tested but to a lesser extent. Gram-positive bacteria were sensitive to several plant extracts as compared to gram-negative bacteria. Bloodroot, plume poppy (*Macleaya cordata*), and veld grape (*Cissus quadrangularis*) were also tested against a eukaryotic organism, the nematode *Meloidogyne javanica*. Eggs collected from roots of infected EP-7 tomato plants were treated with methanol extracts in triplicate with water and methanol (0.5% or 1% v/v) as negative controls and Dursban (50% v/v) as a positive control. Dead and active nematodes were counted after 24 h, 72 hr, and 168 hr. Calculations were completed on average individuals hatched and mortality. Higher concentrations of bloodroot increased mortality compared to controls. Bloodroot was found to be an effective antibacterial and nematicidal agent.

Mentor(s): Dr. Cynthia Denbow (Department of Plant Pathology, Physiology and Weed Science)

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Jacqueline L. Chandler

The role of DNA endonuclease genes in single-strand annealing-based repair in Aedes aegypti

Ae. aegypti mosquitoes are responsible for the transmission of many viral pathogens to human hosts, resulting in morbidity and mortality worldwide. The successful repair of double-stranded DNA (dsDNA) breaks is critical to all organisms and plays a significant role in shaping the evolution and structure of the mosquito genome. Single strand annealing (SSA) is a form of homologous recombination that repairs dsDNA breaks through collapsing of a set of direct repeat sequences flanking the damaged region. The purpose of this study is to identify and functionally characterize DNA endonuclease genes that participate or compete with SSA- based repair. To identify candidate genes in *Ae. aegypti* we performed a homology-based search (blastp) that identified five potential orthologs of DNA endonucleases. These endonucleases are known to be involved in DNA repair in *Drosophila melanogaster* and *Saccharomyces cerevisiae*. To determine the role of these genes in SSA-based repair, cells were treated with double stranded RNA targeting each gene, resulting in RNAi and depletion of the resulting protein. Using a luciferase-based reporter assay in Aag2 (*Aedes aegypti*) cells only loss of Flap-endonuclease 1 (AAEL005870) was found to significantly increase the rate of SSA-based repair. Additionally, we sought to characterize the role of DNA dependent RNA polymerase III (Pol III), recently discovered to function as a pattern recognition molecule for cytoplasmic dsDNA in plasmid based expression and repair. Elucidating these pathways will give us a greater understanding of how mosquitoes repair damaged chromosomes, and how these repair pathways in turn shape the mosquito genome.

Mentor(s): Dr. Zach Adelman (Entomology)

Carolyn R. Chapon

Optimizing effector-directed breeding to improve soybean resistance against the root rot pathogen Phytophthora sojae

Phytophthora sojae, an oomycete pathogen, is the causal agent of soybean root and stem rot. This disease causes an estimated ~$400 million in crop losses each year in the United States alone. Soybean (Glycine max) has evolved resistance (R) genes to impede pathogen growth. These R proteins recognize specific pathogen effector proteins that enter plant cells to promote disease. This recognition triggers a hypersensitive response (HR) consisting of genetically programmed plant cell death at the site of infection. This is an effective immune response; however, pathogen co-evolution is defeating known soybean R genes because non-essential effectors can be discarded without a loss of fitness to the pathogen. To improve soybean resistance against *P. sojae*, we are screening for new R genes which recognize essential effectors that consequently carry a fitness penalty when discarded by the pathogen. Currently, we are using the nonpathogenic bacterium *Pseudomonas fluorescens*, EtHAN as a system to deliver effectors one at a time to soybeans. This method enables us to visually monitor for a HR in response to essential effectors. The current version of this system is based on expression of effector genes from an autonomously replicating plasmid that can be genetically unstable. Thus, stable integration of effector genes directly into the EtHAn genome may provide a more reliable method of delivery. We hypothesize that stable integration will improve signal intensity and lower background noise. Optimization of this system will enable us to discover the role of essential effectors in the infection of soybean. Ultimately, resistant soybean cultivars provided to breeders will reach higher and more consistent crop yields allowing for economic growth in the agricultural sector.

Mentor(s): Dr. John McDowell (Plant Pathology, Physiology, and Weed Science)

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Helen R. Clark

Human and Mouse Endocytic Pathways Associated with Internalization of Aspergillus fumigatus Spores

The fungus *Aspergillus fumigatus* is known to cause a broad spectrum of diseases in humans. These diseases range from allergic bronchopulmonary aspergillosis to invasive aspergillosis. Invasive aspergillosis (IA) occurs primarily in the lungs of immunocompromised individuals and is associated with the inhalation of spores. Several clinical studies indicate there is a high mortality rate associated with established IA. Spores are predominantly inhaled via the nasal cavity. It is unknown what percentage of the spore population actually transverse the pharynx and larynx to the lower respiratory tract as most spores are believed to be caught in the mucosal layer of the airway epithelium or internalized by airway epithelial cells. The subset of spores that do enter alveoli are engulfed and processed by resident macrophages. The mechanism of internalization and dynamic interactions between spores, airway epithelial cells, and macrophages are not understood. In order to study this mechanism, we fused 11 different endocytic components involved in various mammalian endocytic pathways to a red fluorescent marker. These fusion proteins were overexpressed in both BEAS-2B airway epithelial and RAW 264.7 macrophage cell lines and then challenged with living spores and control beads. Confocal time course microscopy indicated a subset of these fluorescent fusion proteins specifically localize around the internalized spore but not the control beads. Our findings provide an initial survey on the complex endocytic interactions that occur between host cells and an internalized spore.

Mentor(s): Dr. Shiv Kale (Virginia Bioinformatics Institute)

Martin E. DeBerardinis

Does Resistance Training in Older, Sedentary, Non-Obese Men Reduce the Risk of Metabolic Syndrome?

Metabolic Syndrome (MetS) is a constellation of cardiovascular risk factors, which, in aggregate, increase cardiovascular disease morbidity. Physical activity is recommended to treat the MetS, although resistance training (RT) is not specifically recommended. Our purpose is to determine if RT reduces MetS risk in older, sedentary, non-obese men. Participants are randomly assigned to either the intervention (RT) or a wait-list control group (CON). Participants undergo a 12-week, supervised, RT program targeting major muscle groups, performed three times per week. Measurements at baseline and at week 12 are: body weight/composition (DEXA), fasting blood chemistries, resting blood pressure (BP), and muscular strength (3-RM). To date, 16 individuals have been enrolled (age: 66 ± 1 years, BMI: 26 ± 3 kg/m2) with 7 having completed the study protocol (RT, 4; CON, 3). RT participants completed 89 ± 5% of sessions. Preliminary data does not suggest improvements in Triglycerides (pre: 81 ± 17 mg/dl, post: 89 ± 19), HDL (pre: 62 ± 6 mg/dl, post: 61±8), systolic BP (n=2; pre: 129.75 ± 8.75 mmHg, post: 135.00 ± 2.00), or diastolic BP (n=2; pre: 74.50 ± 4.00 mmHg, post: 82.50 ± 3.00) with RT. Lean mass increased (pre: 54.6 ± 3.5 kg, post: 55.3 ± 3.7), although this did not reach statistical significance. Significant improvements were noted in chest (pre: 100.0 ± 14.72 lbs, post: 145.0 ± 20.21) and leg press (pre: 220.0 ± 33.67 lbs, post: 307.50 ± 30.10). Following the completion of data collection, future analyses will address changes in these outcomes, including waist circumference and glucose concentrations, in RT vs CON participants.

Mentor(s): Dr. Brenda Davy (Human Nutrition, Foods, and Exercise); Kyle Flack, Ph.D. Student (Human Nutrition, Foods, and Exercise)

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Samuel A. M. Doak

Living on a Crayfish Island: Effects of Host Interaction on Symbiont Communities

Community ecology traditionally focused on local processes to explain patterns in biodiversity. However, modern perspectives also consider interaction among local communities. Integrating dispersal effects with local processes to understand community dynamics is an emerging framework known as metacommunity theory. This framework may offer powerful insights to host-symbiont relationships where each host acts as a distinct patch, occupied by a community of symbionts and interactions among hosts facilitate dispersal of symbionts. Crayfish often host communities of ectosymbionts including multiple species of worms (*Annelida: Branchiobdellida*). Unable to free-swim, dispersal of branchiobdellidans depends on contact between hosts. To determine the effect host community interaction has on the populations of their obligate ectosymbionts we performed a study of branchiobdellid populations over several generations. We predicted that increased crayfish contact would result in increased dispersal and a resultant homogenizing of the worm metacommunity. To increase contact we manipulated crayfish density and shelter availability; many crayfish and few shelters would lead to high contact rates while few crayfish and many shelters would lead to low contact rates. Crayfish with standardized populations of worms were placed in artificial stream channels and the branchiobdellidan's numbers and location were tracked over the course of several months. Results indicated that host density effects symbiont diversity on individual crayfish and among crayfish, but shelter availability had no effect. Our results demonstrate that host interactions have an effect on symbiont community dynamics, and that use of metacommunity theory provides an applicable framework for analyzing symbiotic systems.

Mentor(s): Dr. Bryan Brown (Biological Sciences); James Skelton, Graduate Student (Biological Sciences)

Chandler A. Eaglestone

The impact of human disturbance on a large carnivore, the jaguar (Panthera onca) in Belize, Central America

The Jaguar (*Panthera onca*), a threatened species native to the Americas, is the largest spotted cat found in the Americas. Its density is among the highest in Belize, Central America. However, density estimates have primarily been conducted in protected areas, even though much of Belize contains areas that are subject to timber extraction or alternate human use. Although the impact of such human activities in Belize is unknown, jaguars are considered an umbrella species such that high densities may indicate a healthy environment for jaguars and other species that live under their umbrella. By estimating jaguar trapping rates and densities in areas with high human use we will be better able to predict their survivorship into the future. I plan to determine whether jaguar density differs between an unlogged site with little human activity (La Milpa - Rio Bravo Conservation and Management Area) to an area with logging, cattle ranching, and mining (Gallon Jug - Yalbac Ranch and Cattle Company). I used 100 remotely-triggered trail cameras spread out at 3 km intervals (2 cameras per station at 50 stations) across these 2 study sites to determine jaguar trapping rates (number of photographic captures divided by number of operational nights), abundance and density (using mark-recapture statistics) to compare them between areas with low versus high human disturbance. Camera trapping is effective for jaguars because the cats can be identified by their unique spot patterns. This study represents the first step in understanding how jaguars are influenced by human use outside protected areas.

Mentor(s): Dr. Marcella Kelly (Fish and Wildlife Conservation)

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Miranda Flood

Detecting Effects of Management on Biodiversity of Urban Pond Systems With Paleolimnology

A major goal of ecology is to evaluate the factors that influence biodiversity of ecosystems at multiple scales. When considered as an ecosystem, urban pond systems often undergo monitoring and management for both aesthetics and function. Biodiversity of these urban ponds can be compromised when human interaction directly or indirectly changes environmental condition. This study used paleolimnological data to historically pinpoint when and how chemical management jeopardized biodiversity. In adverse conditions, some crustaceans create protective egg cases called ephippia. By looking for transition zones in sediment cores where the density of ephippia changes rapidly when moving between depths, we expect to see correlations to when chemical management was employed. To explore this idea, ephippia counts were taken from sediment cores collected from five urban ponds in Columbia, Maryland. The cores were divided into 2.5 centimeter sections and each division was examined for the presence of any ephippia, which if found, were reared, taxonomically identified, and the density of ephippia in a layer was analyzed to identify transition zones. Ephippia and transition zones were found in 4 out of the 5 ponds, and their location and distribution varied highly when compared across each pond, with some having high ephippia counts towards the surface, and others having highest counts at the bottom of the core. With future experimentation and further study, it is expected that these patterns in ephippial distribution will correlate strongly with elevated urban management of the ponds forcing the creation of more protective egg cases to combat environmental stressors.

Mentor(s): Bryan Brown (Biological Sciences)

Kristen I. Fread

Adaptor proteins in the endosomal pathway: Tom1's effect on Tollip's function

There are many adaptor proteins involved in the intricate pathway of cargo trafficking within the cell. Tollip and Tom1 are just two of these proteins. Both are involved in trafficking cargo to endosomes to be either degraded by lysosomes or sorted by the Golgi apparatus. Tollip can bind to phosphatidylinositol 3-phosphate (PI3P), allowing it to associate to endosomal membranes. In addition, Tollip can also bind to Tom1 and it has been suggested that this association is critical for the involvement of these proteins in endosomal protein trafficking. The purpose of this project is to study the cooperativity between these two proteins. Observing results from a protein-lipid overlay assay, it appears that the presence of Tom1 inhibits Tollip's binding to PI3P. Surface Plasmon Resonance (SPR) experiments are also in progress to confirm this data. These results may show that Tom1 prevents Tollip from binding to PI3P so that Tollip can be committed to endosomal polyubiquitinated cargo degradation. Alternatively, Tollip is released from endosomal membranes so that the Tollip-Tom1 complex can be associated with another unknown adaptor protein in the endosomal pathway. Further research will investigate the reason for these results.

Mentor(s): Dr. Daniel Capelluto (Biological Sciences), Mary Katherine Brannon, Shuyan Xiao

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Aaron J. Gringer

Steady State Kinetic Characterization of CtOMO - a Flavin Dependent N5-ornithine Monooxygenase

Cupriavidus taiwanensis is a nitrogen fixing bacterium found on the nodules of the invasive tropical weed species *Mimosa pudica*. *C. taiwanensis* utilizes molecular iron chelators known as siderophores to outcompete the hosts for ferric iron required for its own metabolic processes. Specifically *C. taiwanensis* uses the hydroxamate-containing siderophore, taiwachelin. The flavin-dependent monooxygenase, CtOMO, catalyzes the NADPH-and-oxygen dependent hydroxylation of ornithine at the N5-position. This reaction is essential for the formation of the hydroxamate iron-binding site. CtOMO was cloned, expressed, purified, and biochemically characterized. A kcat value of 0.72 ± 0.04 s-1 was determined following the rate of oxygen consumption. The Km values of for L-ornithine and NADPH were 156 ± 26 _M and 30 ± 2 _M, respectively. Determination of the rate of hydroxylation of ornithine indicates that the enzyme is 86 % coupled. Availability of active stable recombinant CtOMO will allow to better understand the mechanism of action of members of the family of flavin-dependent monooxygenases.

Mentor(s): Dr. Pablo Sobrado (Biochemistry)

Albert W. Hinman

Role of Aurora A kinase in the establishment of kinetochore attachments

Mitotic chromosomes consist of two sister chromatids that must be segregated to form twin daughter cells; kinetochores bind microtubules from opposite poles of the mitotic spindle to ensure the precise separation needed for this division. However, kinetochores can occasionally establish incorrect attachments. These incorrect attachments have the potential to generate an abnormal amount of chromosome content in the progeny of each cell (aneuploidy). Aneuploidy has been identified as the leading cause of birth defects and is ubiquitous in cancer. Microtubule dynamics (e.g., microtubule poleward flux) play an important role in ensuring correct attachments and correcting erroneous ones. Aurora A kinase (AurA) has been shown to regulate microtubule dynamics *in vitro* through the inhibition of the microtubule depolymerase Kif2a. To test the role of AurA in ensuring accurate mitosis and in controlling microtubule dynamics *in vivo*, we partially inhibited its activity in PtK1 cells by means of the allosteric inhibitor Mln8054. Using quantitative light microscopy approaches, we found that partial inhibition of AurA decreases microtubule poleward flux and increases the number of kinetochore mis-attachments. Our finding that inhibition of AurA causes a reduction in poleward flux is in disagreement with the *in vitro* observation of an inhibitory activity of AurA on Kif2a, as inhibition of AurA should de-repress Kif2a's activity and thus increase microtubule poleward flux. Thus, our results suggest that *in vivo*, AurA may control other microtubule depolymerases besides Kif2a or control microtubule dynamics in ways other than through the regulation of Kif2a.

Mentor(s): Dr. Daniela Cimini (Biological Sciences)

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James W. Hody

Using spatial patterns in scat distribution to investigate habitat selection of bobcats (Lynx rufus) in the Appalachian mountains of Virginia.

Bobcats (*Lynx rufus*) are a geographically widespread predator found throughout much of North America, but the habitat preferences and ecological interactions of this species remain relatively unstudied in the central Appalachian region. As part of an ongoing study, we sampled carnivore scats (feces) along transects in George Washington National Forest and surrounding areas in Bath County, VA. Using amplified mtDNA from collected samples, we identified species and generated spatial records of detection and non-detection for bobcats, coyotes (Canis latrans), and black bears (Ursus americanus) on the study site. We used program PRESENCE to investigate the effects of vegetation, burn history, and anthropogenic disturbance bobcat habitat selection while accounting for imperfect species detection and spatial autocorrelation of samples. The findings of this study provide initial insights into the ecology of bobcats in western Virginia.

Mentor(s): Dr. Marcella Kelly (Fish and Wildlife Conservation); Dana Morin, Ph.D. Student (Fish and Wildlife Conservation)

Dorian M. Jackson

Effects of larval nutritional stress on La Crosse virus vector competence of Culex restuans

Recent ecological studies have emphasized the significance of environmental stressors on arbovirus dynamics. Larval nutritional stress has been shown to increase the vector competence of some mosquito species. This correlation was observed in the American tree hole mosquito (Aedes triseriatus), which is the primary vector of La Crosse virus (LACV). This zoonotic arbovirus is emerging in the Appalachian region. LACV is known to cause pediatric cases of La Crosse encephalitis, leading to a plethora of neurological complications. Lab and field studies conducted in Montgomery County, Virginia have found that Culex mosquitoes can serve as accessory LACV vectors. The objective of our research is to study the relationship between LACV vector competence and body size of *Cx. restuans* based on larval nutritional stress. In this experiment, *Cx. restuans* egg rafts were collected from Montgomery County and reared in lab conditions that presented half of the larvae with an abundance of nutrients and the other half with a scarce supply, which resulted in nutritionally-stressed smaller adults. We hypothesize that nutritionally-stressed larvae will be more competent LACV vectors due to an underdeveloped immune response to the virus. Results of this study will be presented.

Mentor(s): Dana Hawley (Biological Sciences); M. Camille Harris, Ph.D. Student (Biological Sciences)

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Catherine A. Jucha

Mechanical Properties of a New, Sustainable Building Material in the United States

Cross-laminated timber (CLT) is a prefabricated, composite wood product consisting of at least three orthogonal layers of lumber planks laminated together with structural adhesives. Notably, CLT is a sustainable building material that creates efficient structural systems while feasibly employing local workers and resources. This material is currently in use in Canada, Australia and is popular throughout Europe where spruce is frequently used. The United States has yet to popularize this engineered product in construction. Material testing is currently underway in the United States using various wood species for CLT production. In this research mechanical properties of southern pine CLT panels were measured and compared to other commercially produced CLTs. Mechanical properties include bending strength, modulus of elasticity, shear strength, shear modulus and rolling shear strength. A novel method for rolling shear strength was used and compared to publish values. Rolling shear is defined as shear stress leading to shear strain in a plane perpendicular to the grain direction that results from applied bending loads. All tests were conducted on five ply southern yellow pine CLT beams. Bending strength and modulus of elasticity values were greater than grade V3 established by PRG 320. Shear testing resulted in glue or bond line failures, horizontal shear in the parallel laminations, tension failure in the bottom plies, and rolling shear in the cross laminations. The cross ply layers exhibited characteristic rolling shear due to the application of bending loads, overall maximum shear values varied for each beam specimen tested.

Mentor(s): Dr. Daniel Hindman (Sustainable Biomaterials)

Osamah S. Khan

The Use of Gusseted Thermogradient Tables in Controlling Vertical Soil Temperatures

Traditional thermogradient tables have been used since the 1960's to create a temperature gradient along the surface of a metal plate for seed germination testing. The gradient is established via a heat source and cooling mechanism at the ends of the table. The temperature gradient is lost quickly as one moves away from the surface of the table. This limitation restricts experiments to using Petri dishes and other containers that lie flat on the table. By aluminum welding gussets perpendicular to the surface of the table, convective heat flow through the metal surfaces should provide uniform temperatures in air and growing media placed in the channels between gussets. The functionality of a gusseted gradient table is increased by installing LED lights, effectively turning the table into a growth chamber. This study tested the effectiveness of the gusseted design by evaluating the temperature of 3B variety soil in two gusseted and one non-gusseted thermogradient table. Experimentation involved the use of Watchdog loggers (Model 100 buttons, Spectrum Technologies Inc.) to collect soil temperature readings. Additional experiments with plexiglass and polystyrene covers were also conducted. Initial results indicated that in most cases the gusseted design proved vertical temperature control, with minimal variation. For the gusseted design, the top soil was usually within 3 degrees of the desired temperature on the ends of the table and within 1 degree in the middle. The non-gusseted design showed variations of about 5 or more degrees. These data suggest that gusseted thermogradient tables may be useful for a broader range of applications where temperatures are maintained in solid samples.

Mentor(s): Dr. Gregory Welbaum (Horticulture)

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Danna H. Kim

Diversity in three squalene synthase isoenzymes from Solanum chacoense

Squalene is a 30-carbon lipid that eukaryotes use to produce critical metabolites and hormones such as cholesterol, vitamin D and steroids in animals, and phytosterols, brassinosteroids, and secondary metabolites in plants. The membrane-bound enzyme squalene synthase (SQS) catalyzes the fusion of two molecules of water-soluble 15-carbon farnesyl diphosphate to produce squalene. Whereas animals and fungi possess a single gene encoding SQS, most plants have two genes. The genome of the diploid potato species *S. phurea* has four genes with 75-100% identity at the amino acid level to squalene synthase from cultivated potato (*S. tuberosum*). This large gene family has distinct patterns of expression, and the encoded enzymes could have different substrates, catalytic properties, or products. To explore the diversity at the level of enzyme activity, we used cDNA of three homologous genes from diploid wild potato (*S. chacoense*) and cloned the coding region minus the membrane-binding domain into pET32a plasmid expression vectors. To maximize SQS product accumulation, the genes were co-expressed with ispA, a bacterial gene that codes for farnesyl diphosphate synthase. Preliminary investigations had revealed that induced expression of these gene constructs led to reduced bacterial growth. Nevertheless, our results indicate that the bacteria expressing the three genes accumulate different amounts of squalene, suggesting that the three enzymes catalyze the formation of squalene but probably with distinct kinetics.

Mentor(s): Dr. James Tokuhisa (Horticulture)

Catherine A. Klancher

Expression and Characterization of Mutant Isoforms of Siderophore A from Aspergillus fumigatus

Aspergillus fumigatus causes serious infections among people with compromised immune systems that can often lead to mortality. Infections of this type are difficult to cure and as a result, new targets to treat *A. fumigatus* infections are necessary. A contributing factor to the virulence of *A. fumigatus* is the production of the iron-chelating compound ferrichrome. *A. fumigatus* siderophore A (AfSidA) is a flavo-enzyme that catalyzes the NADPH-and-oxygen-dependent hydroxylation of L-ornithine, which is necessary to the biosynthesis of ferrichrome. The structure of AfSidA in complex with L-ornithine suggests that S469 plays a role in substrate binding. To probe the function of this residue, site-directed mutagenesis was used to replace serine at position 469 to alanine. The resulting S469A mutant enzyme was expressed, purified, and characterized. The K_{cat} value was the same for both wild type and S469A. The K_m value for ornithine increased 13-fold while the K_m value for NADPH was unchanged. These results indicate that the S469 is important for L-ornithine binding. The role of H91 was also probed by site directed mutagenesis. This residue is in the loop region of AfSidA. The resulting H91A mutant showed significant oxidase activity (production of hydrogen peroxide instead of L-ornithine hydroxylation) and substrate inhibition was observed at higher L-ornithine concentrations. The results are consistent with H91 playing a role in domain motion during catalysis.

Mentor(s): DrPablo Sobrado (Biochemistry); Marcy Hernick, Faculty, (Biochemistry)

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Michael R. Lazear

Biochemical evaluation of kynurenine aminotransferase II in the African malaria mosquito, Anopheles gambiae

The kynurenine aminotransferase (KAT) family is primarily responsible for the irreversible transamination of L-kynurenine into kynurenic acid (KYNA) using a broad range of amino group acceptors. Kynurenic acid is the only known natural antagonist of the N-methyl-D-aspartic acid receptor, which critically affects the ability of neurons to respond to excitatory stimuli. As such, the four classes of mammalian KAT enzymes play key roles in central nervous system (CNS) function and cognition. Among insects, the physiological roles of KYNA and KAT are not fully elucidated, but it stands to reason that they are important in CNS mediation and function. Research currently indicates that insects have enzymes similar in sequence and function to mammalian KAT's. Although these enzymes have proposed functions in KYNA synthesis, their exact roles remain undefined. Additionally, sequence variation between insect KAT enzymes implicates a spectrum of functions. In this study, we aimed to investigate the substrate specificity, crystallographic structure, and function of a previously uncharacterized aminotransferase-like enzyme from *Anopheles gambiae*, the African malaria mosquito. Thus far, we have determined that this mammalian KAT II homolog catalyzes the production of KYNA using pyruvate, α-ketoglutarate and glyoxylate. We have also screened a crystal that diffracted up to 3.8 Å. By further investigating *Anopheles gambiae* KAT II, we hope to yield new insights into how the kynurenine pathway contributes to the neurochemistry of insects.

Mentor(s): Dr. Jianyong Li (Biochemistry)

Uria Lee and Cameron Rose

Examination of Health Indicators for Honey Bees Exposed to Insecticides

The honey bee is a widely managed crop pollinator that provides the apicultural and agricultural industry with the sustainability and economic viability needed to satisfy the food and fiber need of our society. The excessive use of insecticides is implicated in the reduced number of managed honey bee colonies available for crop pollination services. However, there are several gaps in our knowledge with respect to insecticide exposures and the health status of honey bees. Here, we will summarize our laboratory findings related to the acute toxicities of neonicotinoid insecticides to honey bees and the sub-lethal effects on these insecticides on individual- and group-level indicators of honey bee health. The information gathered in this study is being used for an interdisplinary research effort to not only improve the ability to predict favorable or unfavorable conditions for honey bee health, but to provide useful management practices for beekeepers, growers, and pesticide applicators to reduce the loss of honey bee colonies in the Commonwealth of Virginia.

Mentor(s): Dr. Troy Anderson (Entomology)

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Meredith E. Leonard

Crayfish versus Worm: Crayfish Showed Age Specific Behavioral Response to Four Species of Ectosymbionts

Symbiotic relationships often fluctuate between mutualism and parasitism. Although natural selection should seemingly favor evolution towards parasitism, many mutualists develop behaviors to prevent parasitism and stabilize mutually beneficial interactions. Crayfish often host ectosymbiotic worms (*Annelida: Branchiobdellida*) that provide a beneficial cleaning service, but also occasionally act as parasites that feed on crayfish tissue. Small crayfish molt frequently and are therefore thought to receive little benefit from cleaners, but are still susceptible to parasitism. Consequently, small crayfish are intolerant of cleaners and use grooming behaviors to pull them from their body. However, recent field survey data found that some worm species actually achieve highest density on smaller crayfish (early arrivers), while others are more prosperous on larger crayfish (late arrivers). Our experiment explored the reaction of crayfish to two species of early arrivers and two species of late arrivers to see if they induced similar behaviors. We used a behavioral assay to quantify the responses of various sizes of crayfish. At 27 mm carapace length, we observed a shift from strong reactions to apathy. Crayfish <27 mm reacted to worms with high grooming behaviors, whereas crayfish >27 mm had virtually no response. We observed a similar host-size threshold and response magnitude for all worm species. Our work demonstrates that early arrivers are no better at avoiding detection on small crayfish and suggests that high densities of early arrivers on smaller crayfish results from the worms' evasive maneuvers. We suggest that age-specific host control may drive diversification in symbiont assemblages.

Mentor(s): Dr. Bryan Brown (Freshwater Ecology); James Skelton Ph.D. Student (Biological Sciences)

Shannon K. Lloyd

The Role of Hepatic Glucose Metabolism in LPS-mediated Glucose Clearance

Toll-like receptor 4 (TLR4) is integral to an innate immune response and is the receptor for the endotoxin, lipopolysaccharide (LPS) produced from the death of gram-negative bacteria in the gut. Data from the Hulver lab shows low dose treatment with LPS in skeletal muscle cell culture increases glucose oxidation. Additionally, low dose LPS, delivered via intraperitoneal injections, acutely enhances whole-body glucose tolerance in C57Bl/6 mice. The liver plays an essential role in glucose homeostasis by regulating glucose uptake and release when blood glucose is high or low, respectively. There is evidence to suggest the liver is one of the first tissues affected by LPS treatment. The purpose of this study was to evaluate the role of hepatic glucose metabolism in LPS-mediated glucose clearance. The predicted outcomes were that acute LPS exposure, relative to saline controls would more potently 1) suppress transcription and activity of proteins important for hepatic glucose production, and 2) increase transcription and activity of proteins important for glucose uptake and glycogen synthesis. Wild-type (WT) and over-expressing TLR4 C57B1/6 mice were injected with saline or LPS (0.1 _L/mL) and glucose (1g/kg BW) four hours post LPS/saline treatment. Mice were euthanized 30 minutes following the injection of glucose and tissues were collected in order to study rate-limiting steps in hepatic glycolysis, glycogen synthesis and gluconeogenesis using rt-PCR and Western Blotting techniques. These studies will provide insight into the role of gut-derived endotoxin on glucose metabolism in the liver.

Mentor(s): Dr. Matthew Hulver (Human Nutrition, Foods, and Exercise); Joseph Stevens, Ph.D. Student (Human Nutrition, Foods, and Exercise); Ryan McMillan, Ph.D. Student (Human Nutrition, Foods, and Exercise)

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Abstracts: Fralin SURF

Ashley K. Lohr

Maximum Lethal Temperature and its Potential Use in Predicting the Distribution of the Brown Marmorated Stink Bug (Halyomorpha halys) in the United States

The brown marmorated stink bug (BMSB), *Halyomorpha halys* (Stål), is an invasive insect from east Asia that has rapidly become a major agricultural and household pest throughout the mid-Atlantic U.S. Its first documented sighting was in Allentown, Pennsylvania in the 1990s, and since then it has spread rapidly in North America. The purpose of this project is to determine the maximum lethal temperature of the BMSB in relation to exposure to the natural environmental conditions that it may encounter, particularly as it spreads further south in the U.S. The mechanisms that result in thermal death of an organism are not fully understood, but are believed to involve a disruption of metabolic processes including respiration from denaturation or coagulation of proteins/enzymes. Prolonged exposure to temperatures exceeding 43 °C (109 °F) typically results in death to most insect species. The lethal high temperature extremes for BMSB are not known. Based on previously collected data by me in 2012, all BMSB nymphs exposed to temperatures <40 °C (104 °F) survived and all nymphs exposed to temperatures >43 °C died. Temperatures ranging from 41-42 °C (106-108 °F) resulted in a mixture of alive, dead, and moribund nymphs and adults at the end of the four hours. More data are required to accurately assess the effects on all life stages of BMSB. Once determined, the lethal high temperature extremes will aid in predicting the potential geographic distribution and the climatic limits of the BMSB.

Mentor(s): Dr. Thomas Kuhar (Department of Entomology)

Spencer S. Lovegrove

Quantifying the Amount of Edema in the Heart using Hydrophilic Fluorescent Dyes

Sudden cardiac arrest is one of the most tragic and unexplained killers in the world today. In order to design better therapies to treat this phenomenon, it is important to identify the environmental conditions that make sudden cardiac arrest more likely to happen. We and others have observed an increased risk of sudden cardiac arrest during edema. Importantly, edema is a side effect of inflammation. The objective of this project is to find a more robust and faster method of quantifying cardiac edema. To do this, tissues from normal and inflamed hearts are sent off for histological sectioning and analysis. Initial results demonstrate that cardiac inflammation causes edema, but this process takes three weeks to complete. Histological sectioning is the control gold-standard measurement. In a parallel experiment a heart is being perfused with a fluorescent dye under normal conditions and during inflammation. Once this is done, the difference in the amount of time it took the dye to perfuse through the heart under the different conditions is then analyzed. While no results have been found yet for this part of the project, we hypothesize that it will take less time to perfuse the dye through an inflamed heart. This experiment takes less than 20 minutes. This technique would be useful for testing what effect heart inflammation might have on the likelihood of sudden cardiac arrest because the amount of inflammation in the heart could be quantified without cutting cross sections of the heart and imaging the slices.

Mentor(s): Dr. Steven Poelzing (Virginia Tech Carilion Research Institute)

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Abstracts: Fralin SURF

Tess E. Pangle

Pseudopregnancy Assessment in the American Black Bear (Ursus americanus)

The American Black Bear (*Ursus americanus*) is a species that exhibits several particular reproductive strategies that show high synchronicity with the environment. For instance, mating season occurs from June through August, months with the highest food productivity. Soon after, the fertilized embryos (blastocysts) arrest their development until mid to late November when implantation occurs. This delay in embryo development allows black bears to carry their pregnancy and give birth while denning over winter. Moreover, it is believed that black bears can experience pseudopregnancy. Previous studies conducted on various bear species, including black bears, have shown similar patterns in progesterone profiles in females that gave birth and those females that did not give birth. However, studies in American black bears did not account for pregnancy diagnosis and sample sizes were limited. These limitations could create false negatives; pregnant females that had *in utero* fetal death, could still display similar progesterone profiles to those that produce live offspring. This study's aims was to test whether black bears exhibit pseudopregnancy by comparing progesterone profiles of bears that did not give birth but were either diagnosed as pregnant or not pregnant by ultrasound. We used the ^{125}I Coat-A-Count progesterone immunoassay to measure progesterone in serum samples taken from captive female bears from October through February for various years from 1989 to 2005. A difference in progesterone concentrations and profiles were found for both groups of bears. This information about black bears reproductive physiology has implications in better understanding reproductive strategies and could have great impact on assisted reproduction for captive and endangered species of bears.

Mentor(s): Dr. Sherrie Clark-Deener, Virginia-Maryland Regional College of Veterinary Medicine, (Large Animal Clinical Sciences); J. Bernardo Mesa (Fish and Wildlife Conservation); Marcella J. Kelly (Fish and Wildlife Conservation)

Devona Z. Quasie-Woode

Molecular Dynamics Simulation of Interactions between Amyloid ß-peptide and Kisspeptin

Alzheimer's disease (AD) is a progressive, neurodegenerative disease that leads to dementia and is the sixth leading cause of death in America. The aggregation of amyloid ß-peptide ($Aß_{42}$) is known to be one of the main characteristics of AD. Current research focuses on disruption of $Aß_{42}$ aggregation by small molecules or peptides as a way to treat AD. One such peptide is Kisspeptin (KP). Certain regions of KP, particularly residues 45-50, have been shown to inhibit the toxic accumulation of $Aß_{42}$. Our research focuses on understanding the mechanism by which KP inhibits $Aß_{42}$ aggregation by observing interactions between residues 45-50 of KP and $Aß_{42}$ using molecular dynamics simulation. A simulation of $Aß_{42}$ and the experimentally proposed reactive segment of KP may indicate interactions between the two peptides that suggest disruption of the aggregation process. Associations between certain residues may alter the secondary structure of $Aß_{42}$ thereby preventing or reducing aggregation. While KP did not bind to the same region of $Aß_{42}$ throughout the systems, it bound to regions with similar chemical properties. TYR-44 of KP interacted with hydrophobic residues in all replicates, ASN-45 and ASN-47 interacted with polar residues, and TRP-46 interacted with hydrophobic resiudes and residues most likely to form hydrogen bonds. By understanding the types of amino acids KP interactions with, we can determine the effects of these interactions on aggregation properties of $Aß_{42}$. We also plan on looking at the free energy of binding of KP to $Aß_{42}$ and the possibility of KP distorting the regularity of Aß42 ß-strand formation. Using these observations, additional research can be done to further elucidate the mechanism of KP neuroprotection against the toxic aggregation of $Aß_{42}$ as well as to design other peptides that may be even more effective.

Mentor(s): Dr. David Bevan (Biochemistry), Anne Brown, Ph.D. Student (Biochemistry)

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Abstracts: Fralin SURF

Emily M. Ronis

Trends in numbers of spring migrant shorebirds and their habitat use on the Eastern Shore of Virginia from 2007-2013

The Eastern Shore of Virginia serves as a critical stopover site for migratory shorebirds. Despite widespread concern that the populations of many of these migrants are declining, we have relatively little data on trends in numbers or habitat use in Virginia. We analyzed 7 years of (2007-2013) data on spring shorebird numbers, habitat use, and available prey to 1) explore the timing of peak migration of 7 shorebird species 2) quantify how the red knot (*Calidris canutus rufa*), given its status as a candidate species for federal-listing under the Endangered Species Act, numbers during peak migration changed over time, and 3) assess variation in red knot habitat use during the peak week of migration across time. We sampled shorebirds, habitat, and prey within 200 m of a varying number of sample points that were randomly placed along the ocean intertidal zone from Fisherman's Island to Assawoman Island, Virginia during 4 weeks spread across the migration season. We found that the peak timing of migration for each species is generally consistent across years, but that the dates that migration peaks varies by species. We found red knot numbers in Virginia increased between 2007-2012, but declined by nearly 50% in 2013. In both 2012 and 2013, red knot numbers per plot were higher on peat bank habitat, which holds blue mussel prey, than on sandy intertidal zone habitat, which is home to coquina clam prey. These data will inform monitoring and management of these species not only in Virginia, but also range-wide.

Mentor(s): Dr. Sarah Karpanty (Fish and Wildlife Conservation)

Matthew M. Rosati

Characterizing the roles of two S1 subsite cap residues in determining the substrate specificity of a malarial M1-family aminopeptidase

PfA-M1 is an M1-family aminopeptidase in the malaria parasite *Plasmodium falciparum* that participates in the catabolism of host proteins and has been identified as an essential enzyme for parasite growth. PfA-M1 residues Glu572 and Met1034 serve to cap a cylindrical S1 "subsite", which is a well-defined pocket that interacts with the sidechain of the first residue of peptide substrates and is the dominant determinant of enzyme specificity. As PfA-M1 is of interest as a potential drug target, further characterization of the roles played by these two residues in defining substrate and inhibitor specificities is desirable. Recombinant PfA-M1 variants with single mutations to alanine at each residue (E572A and M1034A) as well as a double Ala mutant (E572A and M1034A) were made to elucidate the roles of the S1 cap residues. Direct interaction of E572 with basic sidechains and M1034 with hydrophobic sidechains has been reported in crystal structures of the PfA-M1, however the magnitude of the contributions of these interactions to enzyme specificity has not been characterized. We have used the peptidic aminopeptidase inhibitor bestatin to characterize the effects of the two cap residues on the potency of a model inhibitor. Determination of bestatin K_i values for wild-type PfA-M1 and the cap mutants revealed that mutation of either cap residue to alanine reduced bestatin potency around 4-fold. Simultaneous alanine mutations to the cap residues exhibited an additive effect on the K_i, resulting in a 14-fold reduction. These results indicate that both cap residues contribute to the binding of bestatin to PfA-M1. While an effect of the M1034A mutation was expected, the effect of E572A was surprising, as E572 does not interact directly with bestatin. Experiments with X-Ala dipeptide substrates are currently in progress to assess the effects of PfA-M1 cap residues on substrate specifity.

Mentor(s): Dr. Michael Klemba (Biochemistry)

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Abstracts: Fralin SURF

Stephanie Seto

A model to study the role of critical residues in cyclin-dependent kinase inhibitors for cell cycle progression

Abnormal regulation of cell cycle progression is often a cause of tumor cell development that can ultimately lead to cancer. Progression through the cell cycle is tightly mediated by cyclins and cyclin dependent kinases. Cell cycle transitions are regulated by the interaction between these cyclin/Cdk complexes and cyclin dependent kinase inhibitors (CKI's). If surrounding factors are not timely in place, cyclin kinase inhibitors can stall cell cycle progression until proper conditions are attained. A simple model system of this phenomenon, the Xenopus laevis p27Xic1 inhibitor, is often used to study the accumulation of CKI's. As an intrinsically unstructured protein that lacks a tertiary structure, the mechanism by which Xic1 can stall the cell cycle by inhibiting DNA synthesis is under dispute. Additionally, proliferating cell nuclear antigen (PCNA) is a DNA clamp and DNA polymerase processivity factor that plays a key role in the initiation of replication in Xic1, a process coupled to DNA polymerase switching. Degradation of Xic1 is dependent on binding to PCNA, both in Xenopus eggs as well as gastrulation stage extracts. To study whether post-translational modification in Thr172 in Xic1 plays a role in sustaining G1 arrest by favoring binding of the inhibitor to PCNA, we tested the inhibitor's stability and activity towards different cyclin/Cdks complexes, binding capacity, and replication potential. As a result, we defined a new critical domain in Xic1 that contains Thr172 and is absolutely required to modulate cell cycle progression.

Mentor(s): Dr. Carla Finkielstein (Biological Sciences)

Nigel A. Temple

The Ripple Effect: interactions between a keystone species and their symbionts alter aquatic communities

Symbioses between taxonomically unrelated organisms are known to shift from mutualism to parasitism with changes in symbiont densities or changing environmental conditions. These shifts in symbioses can generate rippling effects throughout ecological communities especially when hosts are keystone or dominant species. Crayfish are a keystone species in streams and are involved in a cleaning symbiosis with branchiobdellid worms (Annelida) that can shift from mutualism to parasitism. As the symbiosis shifts, effects of the worms on crayfish ripple through the entire stream community. The major effect of on the stream community is that macroinvertebrate abundance decreases with increase in worms on crayfish, however the mechanism behind this relationship is unknown. Here, we explore two possible mechanisms: shifts from mutualism to parasitism either a) create a shift in crayfish diet or b)alter crayfish activity. In field cage enclosures we implemented a randomized block design using 3 levels of crayfish cleaner densities and a no-crayfish control. To assess possible effects of worms on crayfish diet we measured changes in organic matter breakdown and macroinvertebrate diversity and abundance. Possible effects of worms on crayfish activity were evaluated by measuring treatment effects on sediment levels. We predict that parasitism at high worm densities will increase crayfish demand for nitrogen leading to directed increase in consumption of macroinvertebrates coupled with a decrease in consumption of leaf material and as a result, substrate sediment will be affected. This experiment has the potential to mechanistically link shifting outcomes in a symbiosis with rippling effects on aquatic ecosystems.

Mentor(s): Dr. Bryan Brown (Biological Sciences)

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Abstracts: Fralin SURF

Christine M. Tin

Lactobacillus rhamnosus GG enhances rotavirus-specific serum IgA responses induced by oral human rotavirus vaccine in a novel human gut microbiota associated gnotobiotic pig model

Probiotics are being increasingly studied as adjuvants for enhancing vaccine-induced immunity, but dose effects with relevance to the human gut microbiota (HGM) are important understudied issues. We have generated a HGM transplanted neonatal gnotobiotic (Gn) pig model of human rotavirus (HRV) infection and diarrhea using donor stools from a healthy infant. Starting at 12 hours after birth, germ-free pigs were fed 1 ml/dose of the fecal suspension daily for 3 days to establish human microbiota. To validate the model for its usefulness in rotavirus vaccine and adjuvant evaluation, we examined rotavirus-specific serum IgG and IgA antibody responses using the indirect isotype-specific ELISA in HGM Gn pigs inoculated with a 2-dose oral attenuated HRV (AttHRV) vaccine in conjunction with or without probiotic *Lactobacillus rhamnosus* GG (LGG) at two different dosing regimens (LGG9x and LGG14x). A subset of pigs from each group was challenged with virulent HRV at post-inoculation day 28. Although no difference was determined for IgG titers among treatment groups, LGG14x enhanced rotavirus-specific serum IgA responses to AttHRV pre-challenge, and both LGG9x and LGG14x significantly enhanced IgA responses post-challenge. Only the AttHRV+LGG14x group had sustained IgA production; IgA titers peaked and then declined in AttHRV and AttHRV+LGG9x groups before challenge. This data provides further evidence that LGG, at sufficient dosage, functions as an adjuvant augmenting vaccine immunogenicity. Validation of the HGM Gn pig model for rotavirus vaccine/adjuvant evaluation will facilitate its use in studies of the complex relationships among human gut ecology, vaccines, and protective immunity against infectious diseases.

Mentor(s): Dr. Lijuan Yuan (Department of Biomedical Sciences and Pathobiology)

Gloria E. Trivitt

Characterization of Phospholipid Binding Properties of the Effector AvrLm4/7 from a Hemibiotrophic Pathogen of Canola: Leptosphaeria maculans

Leptosphaeria maculans is a hemibiotrophic pathogen of canola, an important crop for human and livestock consumption and production of biodiesel. Each year large quantities of canola are lost worldwide due to *L. maculans*. Crop infection is mediated in part by small-secreted proteins that are capable of translocating inside the host canola cells as well as several other cell types. Such pathogen-secreted proteins are commonly known as intracellular effectors. Certain varieties of canola have resistance to *L. maculans* through the recognition of such effectors. Here we present data on AvrLm4/7, an intracellular effector of *L. maculans* that is recognized by the Lm4 and Lm7 resistance proteins of canola. Utilizing *Pichia pastoris* as a heterologous protein expression system, we were able to express large quantities of soluble protein. In addition, we present the phospholipid binding properties of AvrLm4/7 and several mutants using surface plasmon resonance, lipid filter assay, and liposome binding assay.

Mentor(s): Dr. Shiv Kale (Virginia Bioinformatics Institute)

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Abstracts: Fralin SURF

Brianne Varnerin

An assessment of the timing of Atlantic Coast piping plover (Charadrius melodus) nesting phenology in relation to climate.

The population size of the federally-threatened population of Atlantic Coast piping plovers has increased since its listing in 1986 due to intensive research and management of nesting and foraging habitat, human disturbance, and predation. Piping plovers' feeding and habitat requirements are very specific, and any change in timing of food availability on the breeding grounds related to climate change has the potential to affect their recovery. Our objective is to quantify nesting phenology, using multiple metrics, for piping plovers at multiple locations on the Atlantic Coast to assess if nesting phenology has shifted over the past 15 years, and to ultimately explore any correlations between shifts in nesting phenology and climate variables such as temperature. I used data collected by Assateague Island National Seashore, Maryland and data collected by MassAudubon and my own field work at South Beach in Chatham, MA from 1998 to 2011. Nest searches are conducted daily in each area beginning in April. When a nest is found, the date is noted. If a nest is found with more than one egg, the clutch initiation date is estimated using 1.5 days per egg in the nest and prior knowledge of that specific area. Once the nest is found, it is checked regularly and the incubation and hatch dates are recorded. If a nest fails prior to being completed, it does not have either of the last 2 dates. All estimated dates are within 3 days of the actual event. We are first testing at each site whether initiation date of first clutch varies across years. If there are significant trends across years, we will explore whether there are any correlations between mean initiation date and climate variables such as mean monthly temperature using data from NOAA's National Climatic Data Center.

Mentor(s): Dr. Sarah Karpanty (Fish and Wildlife Conservation); James Fraser, Faculty (Fish and Wildlife Conservation)

Sydney K. Vaughan

Role of Sensory Neurons in the Initiation and Progression of Amyotrophic Lateral Sclerosis

Amyotrophic Lateral Sclerosis (ALS) is recognized as a progressive neurodegenerative disease that primarily targets motor neurons, which form neuromuscular junctions (NMJs) with skeletal muscles. The disease causes deleterious changes at the axon terminals of these neurons, leading to denervation of skeletal muscles, axonal degeneration, and ultimately death. Recent findings, however, indicate that ALS affects other neuronal populations in the spinal cord and brain. We sought to determine the involvement of sensory neurons in the initiation and progression of ALS using the SOD-G93A mouse model for the disease. To start, we examined changes in proprioceptive sensory neuronal nerve endings at muscle spindles. This strategy allowed us to compare pathological changes in sensory and motor neurons innervating the same muscles. We visualized proprioceptive sensory nerve endings and motor axon terminals in the extensor digitorum longus and gracilis muscles using antibodies against synaptotagmin-2 and neurofilament. In animals showing mild and severe ALS symptoms, the incidence of degenerating axons is similar between proprioceptive sensory neurons and motor neurons, irrespective of the muscle examined. We then visualized sensory synapses in the ventral horn of the spinal cord, primarily those formed with motor neurons. As in muscle spindles, there is a significant decrease in the number of sensory synapses in the ventral horn of ALS-afflicted spinal cords. These synaptic changes, along with changes in the soma of sensory neurons, strongly suggest a key role for sensory neurons in ALS. These findings indicate that an effective therapeutic for ALS must also be designed to protect sensory neurons.

Mentor(s): Dr. Gregorio Valdez (Biology)

Bioprocess Engineering for Sustainability NSF-REU

Program description:
Bioprocess engineering is an engineering discipline that utilizes biological materials and methods to make fuels, chemicals, plastics, and pharmaceuticals. Bioprocess engineering is a rapidly growing field that applies green engineering principles to replace current fossil fuel based processes. Research areas include synthetic biology and metabolic/genetic engineering for biofuel and biochemical production, protein engineering for biopharmaceuticals, and sustainable biomaterials.

Program director: Dr. Justin Barone, Biological Systems Engineering

Allison Bakovic, Milwaukee School of Engineering, BioMolecular Engineering Mentor: Dr. Y.-H. Percival Zhanger

Roberto Castro, Texas A&M University-Kingsville, Chemical Engineering Mentor: Dr. Percival Zhang

Emily C. Harker, Case Western Reserve University, Polymer Science and Engineering Mentor: Dr. Justin Barone

Heather L. Harshbarger, University of Maryland-Baltimore County, Chemical Engineering Mentor: Chenming (Mike) Zhang

Julianne Jorgensen, Olin College, Bioengineering Mentor: Dr. Charles Frazier

Carissa E. Kloncz, University of Minnesota-Duluth, Chemical Engineering Mentor: Dr. Charles Frazier

Tiernan G. Mendes, Syracuse University, Chemical Engineering Mentor: Dr. Ryan Senger

Caitlyn Landin, The University of Toledo , Chemical Engineering Mentor: Dr. Ryan Senger

Sydney E. Shaouy, University of Florida, Chemical Engineering Mentor: Dr. Justin Barone

Nolan Shen, Virginia Tech, Biological Systems Engineering Mentor: Dr. Mike Zhang

Matthew A. Shirley, University of Maryland-Baltimore County, Chemical Engineering Mentor: Dr. Scott Renneckar

Matraca L. Steen, North Dakota State University, Biosystems Engineering Mentor: Dr. Renneckar Scott

Allison E. Bakovic

Enabling Increased Hydrogen Production from Glucose-6-Phosphate using an Improved Model with Optimized Kinetic Parameters

The need for hydrogen is growing because it is an efficient energy carrier providing potential for motive power. Utilizing hydrogen as an energy source is a more environmentally suitable alternative in comparison to burning fossil fuels because it produces zero net carbon emissions. Thus, the generation of hydrogen from a low-carbon source at a low cost is needed. It has been shown through a synthetic enzymatic pathway that hydrogen can be generated from glucose-6-phosphate (G6P). In order to proceed in increasing overall hydrogen production, creating a viable kinetic model to represent this production from G6P was needed. High performance liquid chromatography (HPLC) was used in order to develop a metabolite profile and derive kinetic parameters for the model. With these parameters, a genetic algorithm in MATLAB was designed to model the hydrogen generation from G6P. Global sensitivity analysis (GSA) was then performed on the G6P model to identify the parameters that most significantly affected the model's performance. By identifying these parameters, optimal enzyme concentrations can be predicted and confirmed experimentally in order to generate high-yield hydrogen production from G6P.

Mentor(s): Dr. Y.H. Percival Zhang (Biological Systems Engineering); Joseph A. Rollin, Ph.D. Student (Biological Systems Engineering)

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Abstracts: Bioprocess Engineering for Sustainability NSF-REU

Roberto Castro

High Yield Generation of Hydrogen From Three Types of Biomass: Dilute Acid, COSLIF, and Untreated

Finding new suitable ways to produce fuels that are environmentally friendly is a global concern. Producing Hydrogen from carbohydrates such as xylose and glucose is a different approach to obtain energy, since cell walls in plants are made out of xylose; it can be used for the production of hydrogen. The high-yield generation of hydrogen was carried out in an enzymatic reactor utilizing a cocktail of enzymes as a biocatalyst that released the hydrogen by breaking the carbon-hydrogen bonds contained in different samples of biomass. Total solids determinations were conducted in order to find the percent moisture in these samples. A quantitative analysis method was then used to determine the structural carbohydrates in biomass samples. This procedure used a two step acid hydrolysis to fractionated the biomass into forms that are more easily quantified by HPLC. At the end, the different set of reactions with diverse biomass samples showed how hydrogen generation fluctuated among the three types of biomass, differing in maximum hydrogen production rate and final hydrogen yield.

Mentor(s): Dr. Percival Zhang (Biological Systems Engineering); Joseph A. Rollin, Ph.D. Student (Biological Systems Engineering)

Emily C. Harker

Engineered "template" and "adder" proteins self-assemble into large amyloid fibers

Amyloids are self-assembled protein fibers found in prion disease pathology, such as Alzheimer's and Huntington's disease, as well as in "functional" materials, such as barnacle cement, bacterial hyphae, and some insect silks. There is growing interest in the functional amyloids due to their desirable, high mechanical properties. The ability to mimic these properties will lead to the design and creation of new high performance biomaterials. Fibers that are similar in size, morphology and properties to natural fibers such as spider silk and beta keratin have been shown to self-assemble from the molecular to macroscopic scale in protein mixtures. This study delineates important properties of the "template" and "adder" proteins that form the protein mixture. A solution using engineered Gd20KK template protein and P7 adder protein is used to observe the effect of the amino acid sequence on the production and structure of amyloid fibers. The self-assembly of the 2 proteins is observed in aqueous solution using Fourier Transform Infrared Spectroscopy (FT-IR) and upon drying using Atomic Force Microscopy (AFM). FT-IR shows beta sheet formation, a hallmark of the amyloid structure, from the 2 proteins with time. AFM shows that nanometer-sized fibrils begin to form at 72 hours of incubation.

Mentor(s):Dr. Justin Barone (Bioprocess Engineering)

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Virginia Tech Office of Undergraduate Research

Abstracts: Bioprocess Engineering for Sustainability NSF-REU

Heather L. Harshbarger

Poly(lactic-co-glycolic acid) properties: How nanoparticle size affects stability and drug release

Poly(lactic-co-glycolic acid) (PLGA) is a biodegradable polymer that has been approved by the FDA for use in humans. Using PLGA in drug delivery provides improved drug delivery and release methods, including time-based release of multiple drugs from the same PLGA unit and a more predictable release rate. PLGA nanoparticles are advantageous because they have a high loading capacity and allow controlled release of the substance loaded in the PLGA. The size of PLGA affects the amount of time required to release the drug, with smaller particles releasing drugs more quickly and larger particles releasing drugs over a longer period of time. This project focuses on the stability and drug release profile in relation to the size of PLGA nanoparticles. The PLGA nanoparticles were prepared using a double emulsion and evaporation method with poly(vinyl alcohol) (PVA) as a surfactant. Studies on stability of the nanoparticles will allow further research related to selection of PLGA particle size in drug delivery systems over a certain range of sizes with known drug release rates.

Mentor(s): Dr. Chenming (Mike) Zhang (Biological Systems Engineering); Yun Hu, Ph.D. Student (Biological Systems Engineering)

Julianne Jorgensen

Rheological Analysis of Genetically Modified Switchgrass

Switchgrass (*Panicum virgatum*) is currently studied for potential production of renewable liquid fuels. This research measures structure/property relationships in genetically modified switchgrass, with lignin contents elevated or reduced compared to wild-type plants. Emphasis is placed on how these genetic modifications impact the lignocellulose glass transition, and if aspects of the glass transition correlate to efficacy in liquid fuels production. The lignocellulose glass transition in switchgrass stem is being analyzed using solvent-submersion dynamic mechanical analysis (DMA) in tensile-torsion stress mode. Since lignocellulose properties are moisture dependent, specimens are analyzed while immersed in a plasticizing solvent. Ethylene glycol was selected as the plasticizer because it mimics the effects of water while providing for a broader temperature range. Time-temperature superposition (TTS) is employed to determine the temperature dependence of the glass transition over a broad frequency range. The validity of TTS is dependent upon operation within the linear viscoelastic region, and so careful attention is placed upon optimization of stress and frequency settings. These tests are completed with careful observation of the glass transition in order to measure and optimize structure/property relationships for liquid fuels production.

Mentor(s): Dr. Charles Frazier (Sustainable Biomaterials); Guigui Wan, Ph.D. Student (Sustainable Biomaterials)

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Abstracts: Bioprocess Engineering for Sustainability NSF-REU

Carissa E. Kloncz

Bamboo rheology and the pH dependence of the lignocellulose glass transition

Bamboo products such as structural and nonstructural composites are becoming increasingly popular around the world. This versatile and fast growing plant is comprised of about 1,200 species that vary widely in properties and value. Our group is studying detailed structure/property relationships in bamboo as one means to help advance the technology of bamboo utilization. Specifically, the pH dependence of the lignocellulose glass transition is being studied in the outer culm wall of 4 year old *Phyllostachys pubescens* Mazel plants. The broad objective in this research is to very carefully analyze the glass transition as a function of pH, where the ionization of different functional groups is expected to impact polymer softening. The specimens are studied using solvent submersion dynamic mechanical analysis. Since lignocellulose is hydrophilic, its rheological response is moisture dependent. To control this, specimens are analyzed while immersed in a a plasticizer, which is water at different pH levels (2, 7, 10). pH effects on the glass transition are being carefully monitored using time/temperature superposition (TTS; isothermal frequency sweeps from 25°C - 95°C). TTS experiments are highly dependent upon operation within the linear viscoelastic response (LVR; where the response is independent of stress level). Consequently, this work is based upon meticulous efforts to optimize the stress and frequency seetings that impact the LVR. As a result, this research presents a thorough investigation of the bamboo glass transition and its pH dependence.

Mentor(s): Dr. Charles Frazier (Sustainable Biomaterials); Fangli Sun, Visiting Scholar

Caityln E. Landin

Using Error Prone Polymerase Chain Reaction (PCR) to Identify Restrictive Nucleotides in Clostridium Acetobutylicum's DNA

Clostridium acetobutylicum is a gram-positive bacterium that is capable of producing valuable solvents such as ethanol, butanol and acetone. It is also known that *Clostridium acetobutylicum* has the genes in its genome that are necessary to produce enzymes that can degrade cellulose. Cellulose is the most commonly found organic polymer on earth and is found in all plants. For industrial purposes, it would be efficient to use a bacterium such as *Clostridium acetobutylicum* to break down cellulose and convert it into a viable biofuel: butanol. The ten genes that aid in the degradation of cellulose are located on a shared operon, but are not currently being expressed due to a promoter that has been evolutionarily deactivated. In this study mutations have been made to the promoter region of the operon by using error prone polymerase chain reaction (PCR) techniques. The variations of the promoter region were placed in front of a fluorescent gene on a plasmid and transformed into cells. The fluorescent gene served as a marker and made it possible to monitor the expression increase of the new promoter regions. If an increase of fluorescent expression is detected over the cell life cycle then it is probable that the promoter region was mutated in a way that an inhibitory nucleotide was changed. The plasmid in that cell culture can then be extracted and sent to sequencing. The mutated promoter sequence can be compared to the original promoter sequence, allowing the inhibitory nucleotide to be identified.

Mentor(s): Dr. Ryan Senger (Biological Systems Engineering), Hadi Nazem-Bokaee, Ph.D. Student (Biological Systems Engineering

Harness the Power of Discovery
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Abstracts: Bioprocess Engineering for Sustainability NSF-REU

Tiernan G. Mendes

Anti-Sense Ribonucleic Acid (asRNA) as a Method of Altering Quantitative Gene Expression in Escherichia coli (E. coli) ER2566

Ribonucleic acid (RNA), unlike deoxyribonucleic acid (DNA), is single stranded and therefore provides opportunities for anti-sense RNA (asRNA) to attach. Some asRNA sequences occur naturally, such as CopA; the sequences in this project were loosely mimicked off of natural asRNA to build off of known functioning asRNA success. The process of asRNA attachment can either enhance or reduce the expression of the target mRNA sequence by discouraging or total inhibition of ribosomal attachment for replication. In the present work, asRNA was designed in order to alter expression of florescent protein with one of three colors: HcRed1, AmCyan, or ZsYellow. In order to have the *Escherichia coli* ER2566 (*E. coli*) cells, a strain selected for it's strong protein expression properties, be optimally manipulated in their protein expression, a dual plasmid inoculation system was used. In this design, one plasmid containing the fluorescent gene sequence, and the other containing the constructed asRNA sequence were impregnated into competent *E. coli* cells and allowed to grow. In order to ensure that both plasmid gene sequences were produced by the cells, each plasmid also encompassed the resistance sequence to an antibiotic that was dissolved into the growth media; thus ensuring all surviving cells possessed both asRNA and florescent protein in their genomic makeup. After measuring the fluorescent protein expression via Microplate reader software, the eventual product of this undertaking will be a mathematical model that can be used to increase or decrease gene expression as positive or negative percentages of unaltered exhibition.

Mentor(s): Ryan Senger (Biological Systems Engineering); Hadi Nazem-Bokaee, Ph.D. Student (Biological Systems Engineering)

Sydney E. Shaouy

Self-Assembly of Peptide Mixtures into Highly Organized Protein Fibers

In nature, proteins interact under certain conditions to produce extremely durable, fibrous materials such as bacterial hyphae and barnacle cement. These amyloid fibers are a specific class of protein fiber characterized by a self-assembled structure of high β-sheet content and have similar specific stiffness to steel. Trypsin-mediated hydrolysis of gliadin (THGd) creates a matrix of disorganized peptides that are able to re-assemble into organized amyloid fibers via interaction between protein chains. Fourier transform infrared (FT-IR) spectroscopy and atomic force microscopy (AFM) are used to monitor the self-assembly of THGd when P7, an engineered protein with high glutamine content, is added to the mixture. FT-IR shows that the proteins undergo α-helix to β-sheet transitions, indicative of amyloid formation. Similarly, FT-IR suggests α to β shifting when P4AN, an engineered peptide with hydrophilic non-glutamine amino acids, is mixed with the THGd solution. AFM scans confirm a more pronounced transformation from nodular to fibrous morphology in the THGd-P4AN solution than in the THGd-P7 solution.

Mentor(s): Dr. Justin Barone (Bioprocess Engineering)

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Virginia Tech Office of Undergraduate Research

Abstracts: Bioprocess Engineering for Sustainability NSF-REU

Nolan Shen

Nano in nano; nanoparticle multi-drug co-delivering system

Various cancer cells have been observed to develop resistances to single-agent chemotherapy, but a multiple-agent chemotherapy approach to cancer treatment have been shown to be much more effective against metastasis and less prone to develop resistance. Nanoparticles can be engineered to possess abilities such as targeted delivery, biocompatibility and high drug loading capacity. The goal of this study is to develop a nanoparticle mediated drug delivery system that has the ability to carry multiple therapeutic agents with specific temporal release profiles. Two commonly used, and FDA approved, nanoparticle delivery carriers are chose. Double emulsion is used to make the poly (lactic-co-glycolic acid), or PLGA nanoparticle and membrane extrusion is used for the liposome nanoparticles. The "nano-in-nano" structure is consisted of smaller nanoparticles made from PLGA engulfed in a larger nanoparticle made from liposome. The double emulsion method was optimized for making PLGA nanoparticles in the 20 nm range. The structure of the composite nanoparticle was verified using transmission electron microscopy and the release profile was conducted over five days in different buffers as well as in human blood serum.

Mentor(s): Dr. Mike Zhang (Biological System Engineering); Yun Hu, Ph.D. Student (Biological System Engineering)

Matthew A. Shirley and Matraca L Steen

Cross-Linkable Nanocellulose Fibers

TEMPO oxidized nanocellulose (TONc) can be surface modified with polymerizable groups to form cross-linked nanocellulose composites as well as a property-enhancing additive in thermosetting plastics. Using allyl amine to introduce vinyl groups on the surface of nanocellulose fibers, the modified cellulose was polymerized using a peroxide activator to form a cross-linked composite and as an additive to poly-methyl-methacrylate (PMMA). Conversion of TONc was characterized by UV-VIS spectroscopy, nitrogen analysis, and X-ray diffraction (XRD). Polymerization of modified nanocellulose and PMMA-nanocellulose were analyzed using dynamic mechanical analysis, scanning electron microscopy (SEM) imaging, solvent solubility, and differential scanning calorimetry (DSC). Due to the cross-linking of vinyl groups, the modified nanocellulose had improved mechanical properties. The PMMA-nanocellulose composite had increased strength and durability while maintaining the transparency of the PMMA. Cross-linkable nanoparticles are an important and up-and-coming technology that can improve the strength of thermosetting plastics without affecting transparency and increasing the use of sustainable biomaterials.

Mentor(s): Dr. Scott Renneckar (Department of Sustainable Biomaterials); Zhiyuan Lin, Postdoctoral Fellow, (Sustainable Biomaterials); Wei Zhang, Ph.D. Student (Sustainable Biomaterials)

Cognitive Communications NSF REU

Program description:
Students participate in research activities in the field of Cognitive Communications through the NSF Research Experiences for Undergraduates (REU) program. REU participants will work on research projects related to software-defined radio (SDR), cognitive radio, and other aspects of wireless communications.

Dr. Carl Dietrich is the Principal Investigator (PI) and this year's REU site director.

Wosen E Agedie Electrical Engineering	University of Maryland-College Park Mentor: Dr. Louis Beex
Amos V. Ajo Electrical Engineering	Virginia Commonwealth University Mentors: Dr. Louis Beex & Carl Dietrich
Hannah C. Bowers Engineering	Sweet Briar College Mentor: Dr. Yaling Yang
Cecilia Y. Chen Computer Science	University of Puerto Rico at Mayaguez Mentor: Dr. Carl Dietrich
Chris C. Davis Electronics Engineering	Norfolk State University Mentor: Dr. Kowang jin Koh
Matthew T. Davis Computer Engineering and Electrical Engineering	University of Kentucky Mentor: Dr. Kowang jin Koh
Natasha Hatton Mechanical Engineering	Virginia Commonwealth University Mentor: Dr. Carl Dietrich
Samuel Henderson Electrical Engineering	University of Kentucky Mentors: Dr. Louis Beex & Carl Dietrich
Laci J. Sears Computer science/Engineering	Norfolk State University Mentor: Dr. Yaling Yang
Samuel J. Walker Mechanical Engineering	University of Maryland Mentor: Dr. Louis Beex

Amos V. Ajo and Samuel Henderson

An Experimental Demonstration of Dynamic Spectrum Access System

As wireless technology devices continue to be used and developed at a staggering rate, the challenge of addressing access to the limited frequency spectrum in wireless communication continues to evolve. Software Defined Radios (SDR) and Cognitive Radios (CR) are some of the promising new technologies aimed at addressing spectrum access issues faced by wireless service providers and consumers. This paper will demonstrate a Dynamic Spectrum Access System (DSA) where a cognitive Secondary User (SU) link will access a frequency channel which it shares with a primary user (PU) link, ensuring only that it operates without interfering the PU link transmissions. Moreover, the paper shows the results of an experiment using Matlab, GNU radio software and computer sound cards to implement a working model of a Binary Phase Shift Keying (BPSK) transmitter/receiver PU link, and Quadrature Phase Shift Keying (QPSK) transmitter/receiver SU link. In the experiment the SU is allowed to Access the PU spectrum by sensing the burst and inter-burst times of transmission for the PU, dynamically accessing the allotted channel of the spectrum such that it incurs minimal interference on the transmission of the PU.

Mentor(s): Dr. Carl Dietrich (Electrical and Computer Engineering); Dr. Louis Beex, Director, Digital Signal Processing Research Laboratory (Electrical and Computer Engineering)

Harness the Power of Discovery
Virginia Tech Office of Undergraduate Research
Abstracts: Cognitive Communications NSF-REU

Hannah C. Bowers and Laci J. Sears

Cognitive Radio Characterization to enable Malware Detection

Cognitive Radio (CR) is an intelligent radio technology that can learn from and adapt to its environment. Its flexibility enables it to opportunistically access spectrum white space over a large spectrum range and hence enables the development of Dynamic Spectrum Access (DSA) networks. Its huge potential in significantly boosting spectrum utilization makes it likely to be widespread in the near future. Since Cognitive Radio is a new and growing technology, measures need to be taken to protect and secure each system. As CR becomes more popular, the demand for malware detection will increase. The purpose of this project is to lay the force ground for designing an effective CR malware detection system based on dependency and correlation among CR component events. This solution is based on the observation that a normal-operating CR exhibits strong causal dependencies and correlations among its operational events. A CR that is infected by malware, however, is unlikely to exhibit similar relation. Our solution will monitor the CR operation events at multiple levels, including radio hardware and software, operating system, user application, and network levels. It will compare the event traces with the event correlation and dependency profile of normal CR operation and detect malware through the discovered discrepancy. We will achieve this goal using the Perl Scripting Language, Wireshark, GNU Radio, and the Linux System using Ubuntu.

Mentor(s): Dr. Yaling Yang (Electrical/Computer Engineering)

Cecilia Y. Chen and Natasha Hatton

Waveform Development using REDHAWK IDE

REDHAWK is new, open source software based on the Software Communications Architecture (SCA) 2.2.2 designed to create applications to simplify the rapid development of real-time Software Defined Radio (SDR) and systems. The REDHAWK Integrated Development Environment (IDE), based on Eclipse, provides a complete environment for all aspects of SDR development including: source code generation, graphical drag-and-drop waveform construction, runtime introspection of systems, integration with debuggers, and advanced signal visualization (Erik Englund, 2013). Waveform applications that use the RTL 2832-based SDR were developed and tested using custom and available REDHAWK signal processing components. Although initial REDHAWK documentation has been released, it is still under development; therefore, processes were documented and shared to broaden the community of users through YouTube tutorials and written documentation.

Mentor(s): Dr. Carl Dietrich (Electrical and Computer Engineering); Stephen Edwards, Faculty (Computer Science)

Harness the Power of Discovery
Virginia Tech Office of Undergraduate Research

Abstracts: Cognitive Communications NSF-REU

Matthew T. Davis and Chris C. Davis

Sampling Mixer for Software Defined Radio Applications in 0.18um CMOS Technology

A major aspect of cognitive radio (CR) includes the ability to dynamically adjust transmission frequency due to various changes in a devices operating environment. The basis of CR is built upon software-defined radio (SDR) technology. Sampling mixers provide the potential to move analog-to-digital converters (ADC) closer to the antenna input; a major goal to achieve low power consumption and low cost in software defined radio devices. Also, it is easy to reconfigure sampling mixers characteristics by adjusting capacitance ratios and clock frequencies. In this project, a sampling mixer has been designed, simulated, and analyzed using 0.18 um CMOS technology to meet frequency-adaptive carrier demodulation demands. Proposed sampling mixer simulation results regarding noise figure (NF), conversion gain, 1-dB compression point (P-1dB), third order input intercept point (IIP3) and power consumption are discussed.

Mentor(s): Dr. Kowang jin Koh (Electrical and Computer Engineering); Hedieh Elyasi, Ph.D. Student (Electrical and Computer Engineering)

Samuel J. Walker and Wosen E. Agedie

Wireless Network Location Verification

There are many localization techniques used in a wide variety of applications. GPS is the primary application of outdoor localization. However, GPS has short comings when trying to locate a transmitter inside of a building. This paper aims to present a model that can verify where a transmitter is located indoors by using a building-wide wireless network. Indoor location verification can be useful to emergency personnel when locating an individual who is in a life threatening situation. We experimented on the Cognitive Radio Network Testbed (CORNET), and came up with a model that can enable us to determine on which floor a transmitter is found and where on that floor the transmitter is found. By using the signal strength on arrival method in order to obtain data, we found the minimum optimal number of nodes necessary to receive reliable results.

Mentor(s): Dr. Louis Beex (Electrical & Computer Engineering)

Dynamics of Water and Societal Systems NSF REU

Program description: This REU is truly interdisciplinary. Faculty from 10 different departments and 5 colleges at Virginia Tech mentor students in this research experience. The project builds on the strength of five years of interdisciplinary collaboration at the StREAM Lab. An extensive array of real-time spatio-temporal monitors at this site permit students to investigate complex, systems-level interactions within a relatively small, manageable watershed. This REU also provides students with opportunities to communicate and interact with various stakeholders and the general public.

Program directors: Dr. Cully Hession and Dr. Leigh-Anne Krometis (Biological Systems Engineering)

Student Name	Major	School	Mentor
Celenda Alford	Biological Systems Engineering	North Carolina A&T	Durelle Scott
Elizabeth A. Andruszkiewicz	Civil Engineering	Notre Dame	Cully Hession
Romina A. Benitez	Environmental Science	Virginia Tech	Brian Badgley
Ian Bick	Environmental Engineering	SUNY Buffalo	Cully Hession
Dylan M. Cooper	Biological Systems Engineering	Virginia Tech	Durelle Scott
Breanna L. Green	Animal Science	Texas A&M University - Commerce	Leigh-Anne Krometis
Carter H. Gresham	Landscape Architecture	Virginia Tech	Durelle Scott
Kevin G. Libuit	Biology	James Madison University	Leigh-Anne Krometis
Erin B. Schaberg	Environmental Health	University of North Carolina-Chapel Hill	Brian Badgley
Emily A. Von Wagoner	Environmental Science	University of Vermont	Brian Badgley
Lucas J. Waller	Environmental Science	Virginia Tech	Kang Xia
Claire M. Wiklund	Biological Sciences	Virginia Tech	Cully Hession

Elizabeth A. Andruszkiewicz, Claire M. Wiklund, and Ian A. Bick

Designing the Next Generation of Denitrifying Bioreactors: Coupled Biological and Physiochemical Processes to Remediate Nitrogen and Phosphorus

In an effort to restore Stroubles Creek, a watershed affected by both urban and agricultural runoff and the resultant high nutrient levels, this project sought to design and monitor a denitrifying bioreactor (DNBR). Fundamentally, a DNBR is a repository of carbon based media strategically installed to intercept high nutrient concentration groundwater. Preliminary analysis of ground and surface water in the Stroubles Creek Watershed demonstrated the need for phosphorous (P) and nitrogen (N) removal to reduce eutrophication. Multiple DNBR media (with hypothesized activity on both N and P) were analyzed using a lab-scale treatment system designed in attempt to optimize denitrification efficiency. Additionally, effects of media bacterial pre-inoculation on treatment efficiency over time were examined in the small-scale DNBR system. The effectiveness of the carbon media were analyzed through nutrient mass balances and carbon loss. In order to determine best placement for a field scale DNBR, water samples were collected at 10 ponds (2 agricultural and 8 urban) as well as 6 springs in the New River Watershed. Studies demonstrated that for Stroubles Creek, a mixed urban and agricultural watershed, a mixed media woodchip and biochar DNBR performed most efficiently with inoculation. These data allowed for the recommendation of a full-scale field DNBR to be placed in a spring feeding Stroubles Creek. The appropriate DNBR was proven an effective best management practice in the watershed and likely in others of similar composition. In an effort to extend the impact of the project, Virginia Tech Students and faculty will utilize the DNBR to study denitrification and water quality in upcoming years.

Mentor(s): Dr. William Hession (Biological Systems Engineering); Durelle Scott, Faculty, (Biological Systems Engineering); Zach Easton, Faculty, (Eastern Shore Agricultural Research and Extension Center); Stephanie Houston, Ph.D. Student (Biological Systems Engineering)

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Abstracts: Dynamics of Water and Societal Systems: StREAM Lab NSF-REU

Breanna L. Green and Kevin G. Libuit

The Rising Resistance: Exploration of Patterns of Antibiotic Resistance in Stroubles' Creek to Drive Further Research

Antibiotic resistant genes (ARGs) from urban and agricultural sources that enter the natural environment are a significant public health concern. The dissemination of ARGs from these sources to water sources is not well understood. This study aims to characterize the dispersal of ARGs correlated to antibiotic resistance within the Stroubles' Creek Watershed. Stroubles' Creek is the site of the Virginia Tech StREAM Lab and is surrounded by crop fields that have been heavily supplemented with manure for decades. It is hypothesized that the concentration of ARGs from these manure-impacted sub-watersheds is greater than that from forested watersheds downstream. Using qPCR, the ARGs *erm*F and *tet*G were quantified in soil, stream bed and suspended sediment, water and manure samples, taken from both manure-impacted sub-watersheds and forested watersheds at seven points along Stroubles Creek. No significant differences in the concentration of *erm*F and *tet*G from manure-impacted sub-watersheds and forested watersheds have been observed. Given that the forested sub-watersheds are downstream, it is not surprising that they are less than pristine; these data also suggest that ARGs can travel significant distances in surface waters from their original points of origin. Further research is recommended using an alternative sampling site as control. To continue this study, an analysis will be performed using selective media infused with antibiotics to gain insight on expressed antibiotic resistance in bacteria throughout the watershed.

Mentor(s): Dr. Leigh-Anne Krometis (Biological Systems Engineering); Nicole Fahrenfeld, Postdoctoral Fellow (Civil and Environmental Engineering)

Carter H. Gresham, Dylan M. Cooper, and Celena Alford

Surface Water-Groundwater Interaction: A Study of Hydraulic Flow Paths and Nutrient Dynamics in a Floodplain Reach of a Restored Stream

A common practice of stream restoration is to reconnect a stream with its natural floodplain. Floodplain reconnection is done to achieve such benefits as reduced flood stage, nutrient removal, sediment deposition, and protection of the natural stream channel topography. In order to measure nutrient removal and hydraulic storage in a reconnected floodplain, natural flood conditions can be simulated. An artificial flood was conducted over two consecutive days on a 50 meter reach of the Stroubles Creek floodplain, a 2nd-order stream near Blacksburg, VA. The first day consisted of a nutrient injection with sampling at regular intervals for multiple nutrient parameters at three cross-sections within the reach. The experiment also focused on modeling the exchange of groundwater and surface water by measuring water level, temperature, conductivity, and volumetric moisture content in soil on the surface and subsurface of the floodplain before, during, and after the flood experiment. The first day represented "dry" antecedent conditions and the second day represented "wet" antecedent conditions. This was the summer trial of the research project as we investigate seasonal variability in both nutrient transport and hydraulics. The results were analyzed as part of an ongoing investigation within the StREAM Lab at Virginia Tech.

Mentor(s): Dr. Durelle Scott (Biological Systems Engineering); Erich Hester, Faculty (Civil and Environmental Engineering); Nathan Jones, Ph.D. Student (Biological Systems Engineering); Christopher Guth, Master's Student (Civil and Environmental Engineering)

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Virginia Tech Office of Undergraduate Research

Abstracts: Dynamics of Water and Societal Systems: StREAM Lab NSF-REU

Emily A. Von Wagoner, Romina A. Benitez, and Erin B. Schaberg

Fate and transport of sediment-associated bacteria during storm events in an urban stream

Storm runoff from urban and agricultural areas is linked to significantly increased microbial concentrations within receiving surfaces waters. Watershed-scale water quality models are often used to characterize stream systems in order to design total maximum daily load (TMDL) restoration plans and best management practices (BMP). While current models treat microbes as free-phase particles, previous evidence suggests that indicator bacteria associate with fine sediment, which can resuspend during severe weather. Furthermore, sediment-attached microbes tend to persist longer, potentially posing an increased threat to human health. The purpose of this study is to improve understanding of the transport of *E. coli* and enterococci in conjunction with streambed sediment resuspension during storm events. Concentrations of *Escherichia coli* (*E. coli*) and enterococci are generally used as indicators of human health risk and potential pathogen presence in keeping with state and federal water quality regulations. Water samples were collected at the Virginia Tech StREAM Lab under dry and storm conditions. During storms, an ISCO automatic sampler collected water samples at intervals of 15 or 30 minutes. Samples were tested for bacterial and suspended sediment concentrations. Anticipated results for this study include quantification of increased levels of E. coli and enterococci around peak flow. Data will also be presented correlating microbial concentrations with turbidity and flow rates over the course of the storm.

Mentor(s): Dr. Brian Badgley (Crop and Soils Environmental Sciences); Hehuan Liao, Ph.D. Student (Biological Systems Engineering); Leigh-Anne Krometis, Faculty (Biological Systems Engineering); Cully Hession, Faculty (Biological Systems Engineering); Stephanie Houston, Ph.D. Student (Biological Systems Engineering); Kang Xia, Faculty (Crop and Soils Environmental Sciences)

Lucas J. Waller

Effect of Storm Events on Occurrence of 4-Nonylphenol in Stroubles Creek Watershed

4-Nonlyphenol (4-NP) is an endocrine disrupting chemical that results from the anaerobic breakdown of the nonionic surfactant, nonylphenol polyethoxylate. Nonylphenol polyethoxylates are frequently used in industrial processes as a surfactant, emulsifier, and stabilizer but are also used in household cleaning products, detergents, paints, and adhesives. In areas of significant anthropogenic influence, 4-NP is ubiquitous in the environment and causes negative biological effects at concentrations as low as 1 ug/L; resulting in hermaphroditism, infertility, and reproductive abnormalities. Previous investigations within the Stroubles Creek Watershed have observed elevated 4-NP concentrations in water samples collected within 24-hours of a rainfall event relative to dry weather (baseflow) samples. The objective of the current research is to gain a more detailed understanding of the transport of 4-NP to and within surface waters following storm events. Because 4-NP is hydrophobic, it is hypothesized to attach to suspended particles and accumulate in high concentrations in underlying stream sediments. The high volume of runoff during heavy storm events may re-suspend the sediment and release 4-NP back into water. To test this hypothesis, during storm events, water samples are collected every 30 minutes using an ISCO autosampler. The sediment that was collected does so by the use of a fine sediment trap that was immediately gathered after the storm. Concentrations of 4-NP in water and sediment samples were analyzed using Gas Chromatography/tandem Mass Spectrometry (GC/MS/MS). 4-NP has been detected at five times its normal base-flow concentrations during storm events, with observed concentrations increasing throughout the duration of the storm.

Mentor(s): Dr. Kang Xia (Crop and Soil Environmental Science); Theresa Sosienski, Ph.D. Student (Crop and Soil Environmental Science); Brian Badgley, Faculty (Crop and Soil Environmental Science); Cully Hession, Faculty (Biological Systems Engineering); Leigh-Anne Krometis, Faculty (Biological Systems Engineering)

Hands-On, Minds-On: Understanding & Preventing Societal Violence NSF REU

Program description: The "Hands-On, Minds-On" research experience for undergraduates (REU) brings together faculty and staff from a variety of different disciplines, departments, and offices at Virginia Tech. Ten students will be selected from national four-year colleges and universities and within the Virginia Community College System to participate in a 10-week National Science Foundation (NSF) Research Experience for Undergraduates Program.

Program director: Dr. Diana Ridgwell, Undergraduate Research Institute, College of Liberal Arts and Human Sciences

Program coordinator: Robert Jacks, College of Liberal Arts and Human Sciences

Student Name	School	Faculty Mentor
Nathaniel Andrew	Milligan College	Jimmy Ivory
Mary Britton	Danville Community College	Scott Geller
Eric Cunningham	Loyola University	Scott Geller
Kristan Dziurzynski	Berry College	Julie Dunsmore
Allison Gornik	New College of Florida	Cindy Smith
Stephanie Montilla	University of Puerto Rico	Deborah Tatar
Sydney Moon	Lord Fairfax Community College	Cindy Smith
Zachery Rumble	Thomas Nelson Community College	Deborah Tatar
Brandon Sesler	Virginia Western Community College	Jimmy Ivory
Farah Shahsavarian	Northern VA Community College	Julie Dunsmore

Nathaniel D. Andrew, Brandon Sesler, and Winston Wu

Examining Stereotypical Responses to Race and Sex in an Online Multiplayer Game: A Field Experiment

As people are prone to make preemptive, unwarranted judgments towards others, the tendency to stereotype people is a common phenomenon across virtually every type of interpersonal interaction. Stereotyping occurs in many situations and includes biases against many different groups of people, and it is common in both face-to-face interaction and mediated settings such as computer-mediated communication. For example, recent research suggests that stereotyping in judgments and behaviors is apparent in the realm of multiplayer online gaming. In this field experiment, researchers manipulated identity cues in an online multiplayer game account, such as user name characteristics suggesting sex and race, to investigate stereotypic responses to the manipulated player account during online play. Other game user characteristics, such as user dialogue and game performance, were also manipulated to investigate potential interactions between the effects of cues about the game user's demographics and cues about the game user's behavior on other players' responses. Results of this experiment have both conceptual and practical implications regarding the presence of stereotyping attitudes and behaviors in online video game interactions.

Mentor(s): Dr. James Ivory (Communication)

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Abstracts: Hands-on Minds-on: Multidisciplinary Approaches to Understanding and Preventing Societal Violence NSF-REU

Mary E. Britton

Enhancing character strengths among bullies, victims, bully-victims, and uninvolved Students in our middle schools to promote prosocial behavior and prevent bullying: Change the behavior.Change the problem

Abstract In this study we ask the question, "Will enhancing character strengths in our schools promote pro-social behaviors and actually prevent undesirable behaviors, such as bullying?" Bullying is aggressive behavior that is intended to cause distress or harm to another person. It involves an imbalance of power or between the strength between the aggressor and the victim. Four categories of Students results from bullying: Students who bully, but do not receive bullying (bullies only), Students who receive bullying, but do not bully others (victims only), Students who perform and receive bullying (bully-victims), and those who do not receive or perform bullying (uninvolved Students). Prior research shows these four categories of Students experience differing outcomes (e.g. suicide, mental health). Actively Caring for People (AC4P) of Va. Tech has implemented the most effective research based intervention by empowering Students, teachers, parents and communities to prevent violence by cultivating a culture of compassion. The five-week elementary-focused intervention encouraged Students to observe, perform, recognize, and share AC stories daily, thus increasing desirable behavior and reducing the frequency of interpersonal bullying, observed bullying, and victimization by more than 40% in each category. Additionally, the percentage of Students self-identified as bullies decreased by 89% from Baseline to Withdrawal phases (McCarty & Geller, 2013). This study explores character strengths of hope, self-efficacy, and gratitude as they relate to middle school Students who are bullies, victims, bully-victims, and uninvolved in bullying. *(limitations)This is a part of a larger study. Previous studies were introduced only to middle schools .

Mentor(s): Dr. E. Scott Geller (Center of Applied Behavior Systems); Shane M. McCarty, Graduate Research Assistant (Center for Peace Studies and Violence Prevention, Virginia Tech Center for Applied Behavior System)

Eric M. Cunningham

Co-evolving Ties: Social Network Analysis of Friendship Formation After Prosocial Recognition

Prior research suggests adolescents act aggressively and bully to climb the social hierarchy. Prior Actively Caring for People (AC4P) interventions provided students with the tools to recognize their peers' prosocial behaviors, thereby reducing bullying behaviors. This AC4P application involved 94 incoming first-year students from a large Mideast University who were attending a five week summer camp on the University Campus. Students self-reported, via online surveys, their relational ties and prosocial-recognition behaviors. A 2-mode data set of four social networks (goodness, utility, pleasure, acquaintances) with prosocial-recognition was analyzed in three waves via social network analysis to assess the formation of four different relationship types. The co-evolution of friendship networks and the prosocial-recognition behavior network may indicate that performing and recognizing prosocial behaviors of peers can help individuals gain social capital, thereby creating a normative peer culture that rewards prosocial behaviors instead of aggression and social dominance.
Keywords: Social Network Analysis, Actively Caring for People, Social Capital, Friendship, Prosocial recognition

Mentor(s): Dr. E. Scott Geller (Psychology); Shane McCarty, P.h.D Student (Psychology)

Harness the Power of Discovery
Virginia Tech Office of Undergraduate Research

Abstracts: Hands-on Minds-on: Multidisciplinary Approaches to Understanding and Preventing Societal Violence NSF-REU

Kristan E. Dziurzynski

Family Characteristics and Socio-Emotional Adjustment in Children with Oppositional Defiant Disorder

Family environmental influence is a longstanding topic in the developmental field. Compared to research on parenting, little work has examined sibling influences. In particular, the developmental impact of siblings is understudied. Furthermore, most previous research on sibling influences focuses on typically-developing children; rather than children with disorders. The purpose of this study was to see if number of siblings is associated with adjustment for children with Opposition Defiant Disorder (ODD). Having more siblings may be a protective factor for children with ODD when family cohesion is high. One-hundred and forty-six families with a child diagnosed ODD participated. Mothers reported their child's number of siblings, adjustment, and symptoms. Mothers also reported family's cohesion. Children self-reported adjustment. Family cohesion was lower when familes had more siblings. Regressions showed when families had higher cohesion children showed less externalizing symptoms and more adaptive skills. When families were low in cohesion, number of siblings did not affect children's externalizing symptoms. When families were high in cohesion, children with fewer siblings showed less externalizing symptoms.

Mentor(s): Dr. Julie Dunsmore (Psychology); Amy Neal, Ph.D. Student (Psychology); Jordan Brooker, Ph.D. Student (Psychology); Rachel Miller, Master's Student (Psychology)

Allison E. Gornik

The Relation of Maternal Parenting Stress, and Maternal Regulation in Preschool to Children's Later Internalizing and Externalizing Behaviors

Previous literature has examined the predictive association between high levels of parenting stress and children's internalizing and externalizing problem behaviors, where more stress was associated with higher levels of both types of behavior. Additionally, optimal maternal regulation (lower negative expressivity, high cognitive reappraisal) has also been associated with fewer problem behaviors. Even though maternal regulation may have a potential protective or additive role in the connection between parenting stress and child behavior, the combintion of the interaction between stress and maternal regulation has not been studied. It was hypothesized that children whose mothers were experiencing higher levels of parenting stress and also had less optimal regulation may be at additional risk of developing problem behaviors. Alternatively, children of mothers who had higher stress levels but also had higher levels of regulation may be protected against the risk of developing these behaviors. When children were preschool-aged (T1), mothers were administered measures assessing maternal negative expressiveness, cognitive reapprasial, and parenting stress. Then, when the children were school-aged (T2), assessments of children's internalizing and externalizing behaviors were completed by mothers as well as the children's teachers. Results demonstrated that while parenting stress was the driving force in predicting problem behaviors, maternal regulation uniquely contributed to externalizing behaviors, while stress partially moderated the relationship between maternal regulation and internalizing behaviors. Implications for developmental research as well as clinical intervention programs are discussed.

Mentor(s): Dr. Cynthia Smith (Human Development); Kimberly Day, Ph.D. Student (Human Development)

Harness the Power of Discovery
Virginia Tech Office of Undergraduate Research

Abstracts: Hands-on Minds-on: Multidisciplinary Approaches to Understanding and Preventing Societal Violence NSF-REU

Stephanie Montilla

Identity in couples: How individual and collective presentations are negotiated through couples' arguments

Couples experience conflict differently from strangers because of their unique concern for preserving their relationship. In this sense, identity as a concept regarding presentations of "self" and "other" is of significant interest when the conversations between couples are concerned, given that the presentation of an individual's stance can have considerable implications for their identity as a unit or couple. It is important to inquire about what happens in conversations, most especially during conflict situations, which could eventually lead to violent behaviors. Argumentation, as a way of navigating conflict, has the capacity of placing the respective stances of each partaker at risk regarding their identity as a couple. Furthermore, mediating technology, working as frame for these conversations, can have an influence in the way that people communicate with one another. In this proposed qualitative study, couples' conversations about prior disagreements are analyzed for identity use, both individual (of the "self" and "other") and collective (of the couple as a unit), via discourse analysis. Preliminary findings are discussed for the argument that couples negotiate identity through turns in conversation. A comparison of this sense of identity co-construction between conditions of face to face arguments against that of video chat mediated arguments is initiated.

Mentor(s): Dr. Deborah Tatar (Computer Science); Samantha Yglesias, Faculty (Computer Science)

Sydney E. Moon

Predicting Child Social-Competence from Maternal Personality and Maternal Involvement

Children with higher levels of social competence show increased positive social adjustment and social behavior, but children lacking social competence may have increased levels of violence. Given the importance of children's social competence, studying parenting factors associated with optimal social competence is important. Maternal involvement with children is associated with increased child academic skills as well as social skills and child social-competence, so I expected that individual differences in maternal involvement during the preschool period of development would predict child social competence during the school-age period. Not all parents provide an optimal level of involvement, and one key factor for understanding individual differences in parenting is parent personality. Following from Belsky's model, I propose a mediated pathway where maternal personality is expected to predict maternal involvement, which is expected to predict child social competence. Children and mothers were studied at two time points: preschool (T1) and school-age (T2). At T1, mothers completed the Big Five Inventory to measure personality, and maternal involvement was observed during a mother-child free play session. At T2, teachers reported on children's social competence by completing the Teacher Rating Scale of Peer Behavior Questionnaire. Results will examine relations among maternal personality, maternal interaction, and child social competence. The potential mediating role of maternal involvement on the association of maternal personality to child social competence will be examined. By understanding how maternal personality and involvement relate to child social-competence, a better understanding of the development of child social-competence can be achieved.

Mentor(s): Dr. Cynthia Smith (Human Development), Kimberly Day, Ph.D. Student (Human Development)

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Abstracts: Hands-on Minds-on: Multidisciplinary Approaches to Understanding and Preventing Societal Violence NSF-REU

Zachery M. Rumble

I hope UR not mad at me: A Study on the Response to Ambigious Silence in Text-Based Communication

The proposed experiment examines how couples interpret and respond to unexpected, or ambiguous silence, while talking about a topic they have previously disagreed about. The experiment design asks one participant to perform a task that interrupts the conversation and requires continuous attention, unbeknownst to the participant's partner. The second, or attentive partner, may then produce utterances in an attempt explain the absence of their partner's contribution to the conversation. It is these "explanatory" utterances that navigate the ambiguous silence that are of interest to the study. A cover story will be told to both groups to set the stage for the participants, so that they respond more closely to a real world situation, instead of interpreting any silences as a lab malfunction. The data capture will constitute not only what is visible to both partners, but also vocalizations recorded by video cameras and deleted text that is recorded by a constant screen-capture. Data will be analyzed with a coding scheme for negative affect words and phrases. The expected results would include several types of explanatory responses. First the explanations given by the attentive partner will include both technical explanations, such as, "Did we lose connection?", as well as situational explanations, for example, "did the experiment end?". The second type of explanation that the attentive partner is expected to display is more closely related to the relationship, for example, "I hope you are not mad at me".

Mentor(s): Dr. Deborah Tatar (Computer Science); Sammy Yglesias, (Psychology and Computer Science)

Brandon Sesler, Nathaniel Andrew, Winston Wu

Exploring the Content Players Create in Virtual Worlds: A Content Analysis of User Behavior in a Multiplayer Online Game Environment

While video game content has been extensively analyzed in previous studies, there is a lack of similar analyses investigating the content of game players' behavior and self-representation in increasingly common online multiplayer game formats. Specifically, there is not much literature documenting the content of players' online voice chat utterances, game account user names, and personalized emblems and logos. Such content is important to examine, as it may contain objectionable and socially problematic content not assessed by industry ratings systems or existing content analyses. To add to the body of literature on the topic, a systematic content analysis of player usernames, emblems, and online behavior, featuring thirty hours of gameplay, was conducted. Players' account representations and online interactions were coded for various degrees of violence, sexual references, profanity, drug and alcohol references, verbal aggression, and other objectionable speech and representations. Player emblems will be coded for similar variables with the addition of sexual content. The analysis provides a more complete picture of what types of potentially problematic content players are exposed to in an online gaming environment, contributing greater knowledge about player attitudes and behaviors to the large and growing body of literature on video game content..

Mentor(s): Dr. James Ivory (Communication)

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Abstracts: Hands-on Minds-on: Multidisciplinary Approaches to Understanding and Preventing Societal Violence NSF-REU

Farah C. Shahsavarian

Family Income in Relation to Family Cohesion and Internalizing Symptoms in Children with Oppositional Defiant Disorder

When ODD is comorbid with internalizing disorders (anxiety, depression), children are at even greater risk for poor outcomes. Research on family income as a risk factor has focused primarily on low-income families. Recent research with affluent families show increased internalizing symptoms in adolescents living in suburban areas. Low family cohesion may account for the risk of internalizing symptoms associated with both low and high family income. Seventy-two families with a child diagnosed with ODD participated. Parents and children reported children's internalizing symptoms. Parents also reported family income and family cohesion. The purpose of this study is to test whether, in our rural sample, children from wealthier as well as poorer families experience less family cohesion and more internalized symptoms than children from middle-class families. ANOVAs were used to test the hypotheses. Families with lower income showed lower family cohesion and higher internalization symptoms. Children from families with higher incomes were at no greater risk than children from middle-income families.

Mentor(s): Dr. Julie Dunsmore (Psychology); Amy Neal, Ph.D. Student (Psychology); Rachel Miller, Master's Student (Psychology); Jordan Booker, Ph.D. Student (Psychology)

HHMI Scieneering

Program description: Building on VT's strengths in science and engineering, the Division of Undergraduate Education, through funding from a prestigious HHMI Science Education Grant, offers a novel and innovative program focused on interdisciplinary undergraduate studies and research, aptly named Scieneering. Science and engineering sophomores and juniors selected to become Scieneers will participate in coursework leading to minors in Interdisciplinary Engineering and Science or Science, Engineering and Law and conduct at least 3 credit-hours of interdisciplinary research mentored by faculty outside their major discipline. This is a great opportunity for students to gain experience tackling real-world, multi-dimensional problems under the direction of a qualified mentor. Scieneers receive a stipend and funds to purchase supplies pertinent to their selected research project.

PI and Co-PIs: Dr. Daniel Wubah, Dr. Jill Sible, and Dr. Bevlee Watford
Program coordinator: Keri Swaby, Division of Undergraduate Education
Undergraduate Peer Mentors: *Carrie Hughes (*Chemistry), Scieneering summer research (2012); *Alex Jones* (Psychology), Scieneering summer research (2012)

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Niki	Camateros-Mann	Biological Sciences	Tim	Long
Gabriela	Carrillo	Psychology	Michael	Fox
Eileen	Cheng	Chemical Engineering	David	Schmale
Letitia	Clay	Biological Sciences	Rafael	Davalos
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Sean	Hardy	Biological Sciences	Warren	Ruder
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Yejin Kim		Biochemistry	Peter Vikesland	
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Scieneering Team Leader

Michael C. Brennan

Robotic Sensing with Infrared Light by Bat Bio-sonar

Robotic teams are pervasive in science and engineering applications, particularly in situations where humans are restricted from going. The majority of existing experimental robotic teams use centralized sensing systems, such as vision systems, which are not practically implemented in the field. In this project, we design and prototype robots that have the ability to avoid obstacles and to find and follow peers inspired by communication in a bat swarm, which is inherently decentralized. Bats navigate during flight and locate prey by calculating cross correlations of ultrasonic vocalizations and their echoes. Here, we design a similar process in a two-vehicle team of custom mobile robots using infrared light sensor data. We sensorize and program the robots to enable three fundamental capabilities: i) avoidance of obstacles; ii) following of peer robots; and iii) random scanning in the absence of stimuli. The robots record incoming signals and compare them to two signals they emit, one from two "headlights" to avoid potential obstacles and one from the rear to allow peers to follow it. This implementation requires tailoring to the selected sensors through systematic experiments. Our deliverables are two robots that are able to determine the presence of obstacles in their paths and to follow peers through on board, sensor-based communication.

Mentor(s): Dr. Nicole Abaid (Department of Engineering Science and Mechanics)

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Abstracts: HHMI Scieneering

Niki Camateros-Mann

3D Printed Hydrogels for Tissue Scaffolding

Three-dimensional bioprinting allows for spatial control of cell growth through intricate organization for the replacement of damaged tissue. Poly(caprolactone) (PCL) and poly(propylene glycol) (PPG) are potential polymeric materials as tissue scaffolding templates due to biocompatibility and biodegradability. UV cross-linked PCL diacrylates and PPG diacrylates for crosslinked structures upon irradiation, but the structures are readily swollen with cells and water. The diacrylate precursors were also extruded through a 3D printer to create a hydrogel, and the hydrogels were compared through the characterization of thermogravimetric analysis, differential scanning calorimetry, dynamic mechanical analysis, nuclear magnetic resonance, swelling, and soxhlet extraction. The properties of these hydrogels offer potential for biomedical applications in drug delivery and tissue scaffolding. The research involves the synthesis of photo-curable polymers and their characterization, leading to the three-dimensional printing of various scaffolds.

Mentor(s): Dr. Asem Abdulahad (Chemistry); Nancy Zhang, Ph.D. Student (Chemistry)

Gabriela L. Carrillo

Differences in the structure and formation of retinal terminals in distinct thalamic nuclei

The nervous system is composed of billions of neurons connected into neural circuits via synapses. Malformation of synapses lead to neurological disorders including autism and epilepsy. Due to its accessibility, the visual system has served as a model for elucidating mechanisms underlying synapse formation. One synapse that has been well studied is formed between retinal axons and neurons in the thalamus. A majority of these studies have focused on projections to the dorsal lateral geniculate nucleus (dLGN), however retinal axons also innervate adjacent thalamic nuclei - the ventral lateral geniculate nucleus (vLGN) and intergeniculate leaflet (IGL). While dLGN processes image-forming information, the vLGN and IGL process light-derived information that is not used to generate an image. Previous ultrastructural analyses in our lab suggest distinct differences exist in retinal terminals in these thalamic nuclei. Here, we hypothesized that terminal formation and refinement may differ in these regions. To test this we labeled retinal terminals anterogradely with fluorescently conjugated cholera toxin (CTB) and analyzed terminal size and refinement with fluorescence and confocal microscopy. Terminals were examined at ages corresponding to initial targeting of retinal axons (postnatal day 2-3 [P2-3]), their refinement (P5-P12) and maturation (>P12) in mice. In conjunction, these studies lead us to conclude that the mechanisms underlying terminal formation differ in these thalamic nuclei, a feature that we can capitalize on to identify molecular mechanisms that drive the formation of different types of synapses.

Mentor(s): Dr. Michael Fox (VTCRI)

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Abstracts: HHMI Scieneering

Eileen Cheng

Detoxification of the Trichothecene Mycotoxin Deoxynivalenol (DON) in Yeast

Commonly found worldwide, the fungi of the genus Fusarium contain plant pathogens that produce mycotoxins in infected cereal crops and maize, which are harmful to the health of humans and animals if consumed. They contaminate crops by reducing crop yield and grade as well as affect livestock by causing them to refuse feed, therefore contributing to huge economic losses. The goal of this work is to discover enzymes that have the ability to detoxify a trichothecene mycotoxin called deoxynivalenol (DON). We used a two-step experimental approach to achieve the goal of this study. First, a DON-sensitive yeast strain was genetically engineered by disrupting several genes that involved in toxin resistance in yeast. Second, the newly engineered toxin-sensitive strain was used to test novel DON detoxifying properties of the selected candidate enzymes. Putative DON detoxifying enzymes were expressed in the engineered yeast and resistance was assessed as ability to grow in DON containing medium. Finding and confirming the activity of DON resistant enzyme(s) will benefit society in the future by reducing mycotoxin contamination in human food and animal feed thereby increasing food safety and helping in economic growth in agriculture and food industry.

Mentor(s): Dr. Dash Gantulga (Department of Plant Pathology, Physiology, and Weed Science)

Letitia C. Clay

Irreversible Electroporation (IRE) Effect on Tumor-Associated Macrophages (TAMs) Viability and Phenotype Conversion

Irreversible Electroporation (IRE) is a promising non-thermal technique for the focal treatment of pathologic tissues, which involves placing minimally invasive electrodes within the targeted region. IRE is used as a therapeutic treatment for cancer by using pulsed electric fields to kill cancer cells through the formation of nanoscale defects in their plasma membrane. Recent studies have demonstrated the ability of IRE to completely eradicate an entire population of both mammalian normal cells and mammalian cancer cells *in vitro* without inducing any thermal change. This study focuses on the potential of tumor-associated macrophages (TAMs) as therapeutic targets for IRE. Macrophages have ability to either aid or fight tumors depending on their tumor environment. In the early phase of tumor development, the TAMs mainly consist of a tumor attacking phenotype and later in the tumorigenic process, when the tumor changes its local environment, there is skewing towards the tumor promoting phenotype. Macrophages taken from two wild type mice were exposed to lipopolysaccharide (LPS) to be converted once tumor promoting cells to tumor attacking. Three different treatments of IRE with variable electric fields (100, 125 and 150 V/cm) were used to test if ultimately macrophages could convert back to their tumor cell killing state. After incubation, cells were found attached and viability was recorded for comparisons. TAMs are an important component of immune cell infiltration in the tumor microenvironment. Identification and targeting of factors and cell types that play a role in tumor microenvironment is essential to further improve novel immunotherapies.

Mentor(s): Dr. Rafael Davalos (Biomedical Engineering); Alireza Salmanzadehdozdabi, P.h.D. Student (Biomedical Engineering); Lissett Bickford, Faculty (Mechanical Engineering)

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Abstracts: HHMI Scieneering

Jackson P. Cooper

Single Cell Probe Based Perturbations on Suspended and Aligned Nanofiber Nanonets

In this work, suspended polymeric nanofibers are actively pulled with a glass probe to perform tensile testing at single-cell resolution. Unlike other methods of depositing nanofibers, Spinneret-based Tunable Engineered Parameters (STEP) creates controlled, highly aligned nanofibers arranged spatially to induce a repeatable cell shape between two parallel fibers. The fibers are laid in a crisscrossed pattern with a larger diameter and wider spacing running vertically; the fiber intersections are fused together to create sections of working length. After seeding C2C12 myoblasts and 3T3 fibroblasts on scaffolds, a glass micropipette probe is used to stretch individual nanofiber sections at different strain rates and calibrated deformations, thus applying forces to and inducing strain on single cells. The cell forces are measured by the deflection of the trailing fiber and the change of cell shape during the pull. The intrinsic viscoelastic properties of cell structure are then modeled by a Matlab program with parameters that specifically account for load bearing structures of the cell: actomyosin contractions, actin filaments, and passive microtubules. The findings of this study allow us to connect the mechanical properties of single cells to the cytoskeletal elements responsible for inducing them. The probe pull system represents a new fiber based platform to diagnose deficiencies in single-cell mechanics for characterizing diseased states.

Mentor(s): Dr. Amrinder Nain (Mechanical Engineering); Kevin Sheets, Ph.D. Student (Biomedical Engineering and Sciences)

Megan P. Gisonda

Visualizing Biosonar Pulses and Echoes from the Common Vampire Bat (D. rotundus)

The natural environments of vampire bats contain many different types of complex surfaces. The geometry of these surfaces has a major impact on the properties of the reflected echoes. In this study, four different surfaces were studied to characterize the acoustic effects of surface structure: A flat surface, a tree branch, a pile of rough stones, and a Styrofoam ball. Waveforms, audio files, and spectrograms were collected to analyze how the sound changes when reflected off the different surfaces. The echoes were obtained with an ultrasonic loudspeaker to send out the pulses and a high sensitive pressure field microphone to record the reflections. The waveforms and spectrograms of the echoes are distinct from those of the pulse in joint time-frequency domain, which indicates that the common vampire bat can gather sensory information on its surroundings by analyzing those differences. Discovering how sound reflects off different surfaces will help biologists understand how bats and dolphins perceive the world, as well as help engineers in advancing sonar technology.

Mentor(s): Dr. Rolf Mueller (Engineering); Yanqing Fu Postdoctoral Fellow (Engineering Mechanics)

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Sean A. Hardy and Ben P. Heithoff

Creating a Robot With a Bacteria Brain: Integration of Organic and Synthetic Systems

Bacterial electrochemical signaling controls all aspects of the cell's "behavior", most notably chemotaxis, the directed movement toward a food source. We hope to demonstrate this phenomenon on a macroscopic robotic platform guided by a bacterial brain microfluidic interface. Using the Arduino UNO microcontroller board and the Rovera 4W kit, we have constructed and programmed a four-wheel-drive rover with infrared sensors for line following and edge detection. Our device follows a thin white line based on the input from these sensors and adjusts itself accordingly as the delineated path changes. With this foundation we aim to eventually integrate mutant strains of Escherichia Coli (E. Coli) into our robotic system to release either green or red fluorescent protein, which in turn will direct our platform towards one of two fuel depots. Further construction and testing is pending, and the activity of the fully integrated bacterial-robotic network will be reported.

Mentor(s): Dr. Warren Ruder (Biological Systems Engineering)

Alyssa J. Huntington

Response of muscle stem cells to nerve-derived factors

Skeletal muscle regeneration following trauma cannot occur in the absence of functional motor axons. Intriguingly, quiescent muscle stem cells become activated and differentiate into myoblasts that quickly fuse to form immature muscle fibers as the innervating axons traverse the muscle on the way to forming neuromuscular junctions (NMJ). To date, however, the identity of molecules released by growing motor axons that activate quiescent muscle stem cells remains unknown. In this study, we asked if muscle stem cells contain the molecular machinery needed to respond to acetylcholine and neuronal agrin, two molecules actively secreted by motor axons that are required to form the NMJ and promote muscle growth. To this end, we examined the response of proliferating and differentiating C2C12 cells, a myogenic cell line that serves as a model for muscle stem cells, to agonists and antagonists of acetylcholine receptors as well as to neuronal agrin. We have found that C2C12 responds to carbamoylcholine, an acetylcholine mimetic, through nicotinic receptors. Treatment with carbamoylcholine while blocking muscarinic receptors reduces the formation of myotubes. However, carbamoylcholine has no effect on C2C12 differentiation when nicotinic receptors are inhibited, suggesting that muscle stem cell respond to motor axons via nicotinic acetylcholine receptors. We then tested the response of C2C12 to neuronal agrin. In contrast to carbamoylcholine, agrin induces the formation and maturation of myotubes. Together, these results indicate that muscle stem cells contain the molecular machinery needed to respond to incoming motor axons and provide the basis for identifying therapeutics to promote muscle repair.

Mentor(s): Dr. Greg Valdez (Virginia Tech Carilion Research Institute - Biological Sciences); Milagros Tenga, Postdoctral Fellow Virginia Tech Carilion Research Institute

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Abstracts: HHMI Scieneering

Alex A. Karikari

The Anopheles gambiae mosquito: Using Fluorescence in situ hybridization (FISH) to develop 3D models of polytene chromosomes

The Anopheles gambiae species complex is comprised of seven morphologically indistinguishable, yet unique malaria mosquito species. One impactful difference seen in the complex is that there are both vectors and non-vectors of malaria, making the complex an excellent model for evolutionary study. This study focuses on the chromosomal positioning within the nucleus. It has been shown that nuclei have a non-random organization in various organisms, lending to the idea that similar types of interactions can be seen within mosquito populations. Particular chromosomal interactions could lead to inversions on chromosome arms and translocation between arms. These interactions are hindered or aided by chromosomal attachments that anchor the chromosomes to the nuclear periphery. By modeling the positioning of the chromosome arms, we can visualize how the organization of the nuclei has changed. Fluorescence in situ hybridization (FISH) will help to rapidly identify chromosomal arms that can be traced and modeled in computer programs like Matlab. To make the probes better suited for 3D-FISH, we have microdissected chromosomal arms that are then put through multiple rounds of amplification to increase overall DNA quantity. Afterwards, a confocal microscope is used to visualize and create 2D Z-stacks of the polytene chromosomes that can then be used for computerized tracing. We hypothesize that we can find analogous positioning of chromosome arms, and the regions at which they attached to the nuclear envelope within different species of the Anopheles gambiae complex. To further study the evolution of nuclear architecture within malaria mosquitoes, we also plan to model Anopheles stephensi, an Asian malaria mosquito used as an outgroup, to compare organizational patterns.

Mentor(s): Dr. Igor Sharakhov (Entomology); Phillip George, Graduate Student

Jennifer Y. Kim

Nanotechnology using waste: Gold nanoparticle synthesis using coffee and banana extracts

The novel electrochemical and physical properties of nanoparticles make them suitable for applications in biomedicine, catalysis, nanobiosensors and many others. Especially, gold-based nanotechnologies have received significant attention and their applications are expected to grow in the future. Metallic nanoparticle syntheses sometimes involve harmful and toxic chemicals, such as hydrazine and boranes. Considering the toxicity, many researchers have reported greener, eco-friendly synthesis method for nanoparticles using phytochemicals. However, it is difficult to control the size and shape of nanoparticles using plant and organic extracts because of complex mixture of various phytochemicals in the reaction. The purpose of this study is to improve and optimize the synthesis of gold nanoparticles (AuNPs) using organic wastes. In this study, gold chloride salts and phytochemicals are used to synthesize AuNPs. Polyphenols and carbohydrates in phytochemicals are main reducing agents for the gold salt. We are developing an original synthesis protocol of AuNPs using extracts of spent coffee grounds as the reductant and extracts of banana peel scrapes for stabilizing the AuNPs. We are also comparing these AuNPs with those prepared using honey, tea and cinnamon, based on previously published research. The AuNPs will be analyzed by using UV-Vis spectroscopy, dynamic light scattering (DLS) and transmission electron microscopy (TEM). Anticipated results from the designed synthesis are colloidally stable, less polydispersed AuNPs, as well as an improved understanding of the factors influencing the synthesis process.

Mentor(s): Dr. Peter Vikesland (Civil and Environmental Engineering); Paramjeet Pati, Ph.D. Student (Civil and Environmental Engineering)

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Veronica M. Kimmerly and Beck Q. Giesy

A Modern Approach to Fabricating Damascus Steel: In-Situ Formation of Carbon Nanotubes in a Steel Metal Matrix

Damascus steel is famous for its historic flexibility, strength, and ability to hold a sharp edge, but the secret to its production was lost centuries ago. Metallurgists are still searching for ways to incorporate some of the features of this famed steel in modern materials. In 2006, Reibold et al. discovered carbon nanotubes (CNTs) in a sample of Damascus steel, and it is believed that these CNTs provided some of the unique properties of the steel. Based on ancient metallurgy techniques, the CNTs probably formed from the organic material used in the smelting process. Goodell et al. (2008) demonstrated that CNTs can be created from wood fiber through selective ablation of cellulose-carbon to form a lignin-carbon template. The objective of this research is to explore methods for forming CNTs, in-situ, from wood fiber within low-carbon steel. Carbonized wood fiber "sandwiched" between steel plates was heated to ~850°C, sintering both the fiber and the steel. The carbonized fiber remained intact at this temperature and current work is focused on generating CNTs within the steel-fiber sandwich through heat-cycling. Analysis of the sandwiches by x-ray diffraction, Raman spectroscopy, and scanning-electron microscopy has shown that amorphous carbon and pre-nanotube structures have formed and partially integrated into the steel. If methods can be developed to incorporate CNTs into steel, they would revolutionize modern steel production by providing a low-cost and simple method to increase the strength and flexibility of steel products.

Mentor(s): Dr. Barry Goodell (Sustainable Biomaterials)

Erin M. Koperna

Evaluation of Frankincense Oil as a Therapeutic for Glioblastoma

Malignant gliomas are a highly aggressive type of brain tumor that has a median survival rate of 15 months and a five-year survival rate of 4%. Tumor response to current treatments, including surgery, chemotherapy, and radiation, is low and patients frequently experience adverse side effects. There is a vital medical need to create cancer therapeutics that can be administered in a controlled manner without experiencing these side effects. Frankincense oil, derived from the hardened gum resin of the Boswellia trees, has previously shown anti-neoplastic properties. Studies conducted by the Virginia Maryland College of Veterinary Medicine suggest that frankincense oil induces tumor-specific apoptosis in melanoma. Based on this work, we evaluated the effectiveness of using frankincense oil to kill F98 rat glioblastoma cells as compared to normal rat astrocytes. F98 cells were chosen due to their similar characteristics with human glioblastoma cells as well the ability to ultimately generate *in vivo* models for drug testing.

Mentor(s): Dr. Lissett Bickford (Mechanical Engineering); John Roberston, Faculty, School of Biomedical Engineering and Sciences, Virginia Tech-Wake Forest University

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Philip M. Kyle

The Use of Electrokinetic Phenomena to Characterize Malignant Cells

Dielectrophoresis (DEP) is a technique that utilizes non-uniform electric fields to manipulate polarizable particles to characterize and isolate rare cells. Contactless dielectrophoresis (cDEP) was developed by Dr. Davalos' lab to prevent bubble formation, preserve sample integrity, and reduce cost. The use of cDEP allows for the separation of cells based on their individual bioelectrical properties. Using these bioelectrical properties we have been able to separate tumor initiating cells (TIC's) from overall cell populations such as DU145 and PC3 cells. In order to sort cells they must first be characterized by finding the trapping onset, the complete trapping, and in addition the crossover frequency. The use of trapping allows us to sort tumor initiating cells from an established cancerous cell line. We also plan to characterize the bioelectrical properties of drug resistant malignant cell lines.

Mentor(s): Dr. Rafael Davalos (Biomedical Engineering); Lisa Anders, Master's Student (Electrical Engineering)

Akshata A. Ladwa

Optimization of Collagen Hydrogels to Mimic Mechanical Properties of Cancer In Vivo

Cancer is differentiated from normal tissue by its stiffness, and this characteristic is felt by palpating skin or seen via scanning devices and can therefore be used to diagnose cancer. Methods to recreate the stiffness of cancer include two dimensional and three dimensional matrices made of hydrogels formed from collagen. A three dimensional matrix is more representative of *in vivo* cancer growth than a two dimensional matrix. To mimic cancer and cancer vasculature the mechanical properties of collagen hydrogels need to be optimized: stiffness, pore size and diffusivity. Collagen hydrogels are characterized using uniaxial compression testing to measure stiffness, confocal reflectance imaging to determine pore size, and fluorescence recovery after photo-bleaching (FRAP) to examine diffusivity. Fabrication parameters that were varied include pH, over a range of 7.4-8.4, concentration, from 4-10 mg/mL, and temperature from 23-37 °C. Furthermore, various research groups have created hydrogels using different parameters making comparison an issue. This work provides a tabulated data set of collagen hydrogel fabrication parameters and the resulting material properties, which will permit comparison of previously published experiments while aiding future work in the field of enabling optimization of engineering tissue to match physiological conditions.

Mentor(s): Dr. Nichole Rylander (Mechanical Engineering); Elizabeth Voigt, Ph.D. Student (Mechanical Engineering)

Harness the Power of Discovery
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Krystal T. Le

Synthesis Optimization and Localization of Gold-Gold Sulfide Nanoparticles in Pancreatic Cancer Cells

Gold-gold sulfide nanoparticles (GGS-NPs) are utilized in photothermal therapy (PTT) to ablate tumor cells. These small and highly absorbent GGS-NPs are capable of accumulating within tumor cells and upon exposure to a near-infrared (NIR) laser these particles can convert light into heat and initiate cell death. Currently, the shape and size of GGS-NPs vary to include triangles and rods. This study explores new methods of synthesizing homogenous, hexagonal shaped GGS-NP by controlling the reaction to optimize shape and improving filtration procedures to optimize size consistency. Ultraviolet-visible (UV-VIS) spectroscopy, a zetasizer, and transmission electron microscopy (TEM) were used to determine the size and shape of the GGS-NPs. In addition to optimizing the shape and size of GGS-NP, an *in vitro* study of the GGS-NPs in mouse pancreatic cancer cells, PAN-02, was conducted to evaluate the interactions between GGS-NPs and cancer cells. The GGS-NPs were pegylated to increase stability in conditions that mimic the human body and reporter molecules were attached to track the location of the GGS-NPs. Confocal Raman Microscopy (CRM) was utilized to track the location of the GGS-NPs within cancer cells. Overall, this study investigated potential protocols for synthesizing homogenous, hexagonal shaped GGS-NPs and how these GGS-NPs specifically interact with cancer cells.

Mentor(s): Dr. Lissett Bickford (Mechanical Engineering); Laura Reese, Doctoral Student (Biomedical Engineering and Science)

Andrew Y. Lee

A New Perspective: Recognizing Gene Synthesis as a Manufacturing Process

Since the first synthesis of a complete gene in the 1970s, gene synthesis techniques and technologies are playing an essential role in the field of molecular biology. There are many methods by which a novel DNA sequence can be produced, and there is no standardization of the DNA fabrication process. While one lab may prefer to use restriction enzymes to "cut and paste" existing sequences, others may choose de novo synthesis of the DNA sequence. Since there is no standard to gene synthesis there are hundreds of ways to synthesize a target gene. My approach highlights some of the more common practices in the generation of synthetic DNA. I used chemically synthesized oligonucleotides to assemble various DNA sequences of approximately 1 kilobase in length. The target sequence was then amplified using a thermocycler and cloned using a TopoTA vector. This allowed the transformation of E. coli to rapidly replicate the DNA fragment with high fidelity. Given the novel intersection of the fields of molecular biology and systems engineering, the overall goal of the project was to become intimately familiar with the gene synthesis process. This will establish a technical link from which industrial and systems engineering insights can be applied, to the standardization of gene synthesis in order to maximize optimization of results.

Mentor(s): Dr. Chris Overend (Virginia Bioinformatics Institute); Jean Peccoud, Faculty (Virginia Bioinformatics Institute)

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Abstracts: HHMI Scieneering

Yoon Kyu Lee

Effectiveness of the weight loss maintenance program and preferences of the participants on program structure

Obesity contributes to a number of chronic conditions such as diabetes, high blood pressure, and cardiovascular disease. Further, approximately one third of U.S. adults are obeseóa rate that continues to rise. To address the increasing rate of obesity, many weight loss programs have been developed. However, weight loss maintenance is challenging. Another problem is that it is difficult to deliver weight loss and maintenance programs in typical clinical settings and there is not enough information about what participants prefer in terms of structure and delivery of these programs. The primary purpose is to test two different programs on the degree to which they can prevent the regain of the weight. A secondary purpose is to determine patient preferences for program structure. Twenty-eight participants were recruited following a weight loss program and randomly assigned to either a Standard Maintenance Program (SMP) or an Individually Designed Maintenance Program (IDMP). SMP includes 3 group sessions, weekly weight reporting and motivational emails/texts, telephone support and provider progress reports. The IDMP participants were able to choose which SMP components they received. Results are currently available only for the selection of program components by the IDMP participants. Specifically, 7 participants (50%) selected the full SMP, 2 participants (14%) selected to not receive calls, 1 participant (7%) did not select group session, 1 participant (7%) chose two group sessions out of three, 1 participant (7%) did not select both call and group session, and 2 participants (14%) chose different call schedule. It was concluded that, on average, the SMP was fairly attractive for most IDMP participants, but that there is variability in patient preferences.

Mentor(s): Dr.Paul Estabrooks (Human Nutrition, Foods and Exercise)

Stephen Lowery

Self-assembly of trypsin-hydrolyzed gliadin into amyloid fibrils and fibers

Amyloids are protein structures that self-assemble in solution to the nanometer scale, but can be modified to assemble further to the micrometer scale. This is important because micrometer-sized protein fibers are used by nature to form structural materials such as silk in spider webs. In this experiment, gliadin was mixed with trypsin in pure water to hydrolyze the proteins to short peptides that self-assemble. The assembly of fibers was monitored chemically by Fourier transform infrared spectroscopy (FT-IR) daily and physically by Atomic Force Microscopy (AFM) every two days. During self-assembly, the peptides showed a loss of alpha helix and a gain in beta sheet as measured with FT-IR. FT-IR also showed a rearrangement of hydrophobic side groups on alanine, isoleucine, leucine, and valine amino acids and hydrogen bonding of plentiful glutamine amino acids with each other. Self-assembled fibrils were observed early in AFM that grew to about 0.4 μm at the end of the process in solution.

Mentor(s): Dr. Justin Barone (Biological Systems Engineering)

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Andy J. Ly

The Measurement of Mechanical Properties of Breast Cancer Cells with Applications in Cancer Diagnosis and Treatment

Breast Cancer is a type of cancer that involves the development of malignant cells in the breast tissue and is currently the second leading cause of death. In this research, we used Atomic Force Microscopy (AFM) and Microfluidic techniques to determine the mechanical properties of MCF-10A (human breast normal cells) and MDA-MB-231 (human breast cancer cells). To measure Young's modulus of cells, the contact Hertz model is fitted to the force curves obtained from cells by AFM. The results show that the average Young's modulus of MDA-MB-231 cells (0.51±0.35 kPa) is about two times smaller than that of MCF10A cells (1.13±0.84 kPa). Besides that, we utilized microfluidic technique as a high-throughput and labor-free alternative to AFM. We expect that there is a direct correlation between the traveling time of cells through a microfluidic constriction channel and their deformability. The results reveal that the average traveling time for MDA-MB-231 cells (0.115±0.0747 Sec.) is about two times shorter than that of MCF10A cells (0.203±0.226 Sec.). The findings using both techniques indicate that breast cancer cells are softer and more deformable than their healthier counterparts which are associated with the changes in their cytoskeleton structure. As a conclusion, the mechanical properties can be used as a reliable "biomarker" to help distinguish the breast cancer cells from the healthy ones. By finding the distinction between them, doctors and specialists are able to treat breast cancer at an early stage before it reaches the critical metastasis stage.

Mentor(s): Dr. Masoud Agah (Electrical and Computer Engineering Department); Hesam Babahosseini, Ph.D. Student (Mechanical Engineering)

Kyle R. Miller and Samantha L. Fenn

Measuring Critical Micelle Concentrations of Lipid-PEGs, Polymers used in Therapeutic Applications

Lipid-poly(ethylene glycol) (lipid-PEG) finds many uses in topical formulations (e.g. cosmetics and skin creams) and in drug delivery (e.g. micelles, protective coatings for "stealth" liposomes and excipients to prevent protein aggregation). Typically, a lipid-PEG, R-O-$(CH_2CH_2O)_n$-H, contains a distribution of many chain lengths (e.g., n=5–35 with an average n of 20). As modern safety standards require information on all components of a mixture, what is the best method for isolating and identifying these components (homopolymers)? What in-vitro tests provide indications of safety? Chromatography, a powerful separation method, can be used to isolate the components. The key is finding the optimal solvent systems by using thin layer chromatography and next applying column chromatography to separate and isolate the components. The ability of a detergent to disrupt membranes, an unsafe property for a lipid-PEG, is related to the critical micelle concentration (CMC). We present here our studies on the separation of octadecyl-PEG and measurements of CMCs of 1,3-dihexadecyloxypropan-2-yl-PEG (Lipid(16, 16)-PEG), 1,3-dioctadecyloxypropan-2-yl-PEG (Lipid(18,18)-PEG), and (Z,Z)-1,3-dioctadec-9-enyloxypropan-2-yl-PEG (Lipid($18^{\Delta 9}$,$18^{\Delta 9}$)-PEG). While other team members work on separating polymers, our main focus has been measuring the properties related to safety (CMC, hemolysis) of the polymers. The CMCs of five Lipid(16, 16)-PEG samples, which range from 2.4 to 1.4×10^{-5} M, show a slight decrease with increasing values of n. Further measurements of CMCs of Lipid(18,18)-PEGs and Lipid($18^{\Delta 9}$,$18^{\Delta 9}$)-PEGs is in progress.

Mentor(s): Dr. Richard Gandour (Chemistry)

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Victoria A. Nelson

Identification and quantification of microbial biomarkers (amino sugars) during soil development

Amino sugars are a major component of fungal and bacterial cell walls and exoskeleton of insects. Due to their predominance, the major source of amino sugars in soil is thought to originate from microbes. However, most of the amino sugars extracted from soil do not come from living microbes. Rather amino sugars can have a long soil residence time and thus are a major contributor to soil formation. Up to 6% of the soil organic matter has been estimated to be derived from four different amino sugar molecules, and represent an important pool of soil organic matter and plant nutrients. The objective of this project was to extract, quantify, and identify the dynamics of amino sugars during soil formation (soils of various ages), with the aim of understanding the rate of amino sugar accumulation and the relative contributions of bacteria and fungi during soil formation. I have successfully extracted amino sugar-type molecules from soil. However, because of the chemical complexity of soils, the first stage of quantification using UV-VIS spectrophotometry (Nanodrop, Inc) likely was non-specific for amino sugars, resulting in a large range of values that depended on the colorimetric procedure. Research published in the scientific literature show similar variability, and so our preliminary conclusion is that colorimetric methods are not sufficiently accurate to quantify amino sugars extracted from soil. Samples have also been prepped using a second method for analysis using gas-chromatography. It is expected that this method will provide accurate analysis of muramic acid, glucosamine, mannosamne and galactosamine and allow for estimation of the accrual of these molecules during soil development.

Mentor(s): Dr. Mark Williams (Horticulture)

Mai T. Ngo

Effectiveness of cobalt complexes in relation to biological activity against mycobacteria and MRSA

MRSA and various mycobacteria, such as *Mycobacterium tuberculosis*, are becoming increasingly difficult to treat due to their tendency to develop resistance to common antibiotics. It is therefore important to develop new compounds that show biological activity against these bacteria. The Merola group has already shown that certain iridium and rhodium complexes show antibiotic potential against MRSA and some mycobacteria. It is of interest to discover the capabilities of cobalt complexes in relation to biological activity. The use of cobalt instead of iridium or rhodium is preferential in terms of cost and availability, and there is also concern that the heavy metals may be too toxic for the human system. In this study, cobalt is coordinated to the same ligands used in synthesizing the iridium and rhodium complexes, and the resulting complexes are tested for biological activity. Results can be used to determine the usefulness of cobalt complexes as pharmaceuticals.

Mentor(s): Dr. Joseph Merola (Chemistry); George Karpin, Ph.D. Student (Chemistry)

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Alex R. Ochs

Modeling of Sea Bird Diving Dynamics

The physical mechanism behind sea bird's safe diving into the ocean remains mostly unknown. Some species of birds depend on this shallow water diving as a vital food source, and will dive into the water countless times to catch fish, but despite reaching high speeds the birds rarely if ever injure themselves. In this bio-inspired experiment, we performed an experiment to understand how an elastic (soft) body responds to impact on water surfaces. Dumbbell-shaped objects of varying stiffnesses are dropped into water while videotaping with high speed cameras. It appears that above a certain threshold the elastic object buckles on impact, which can be interpreted as a catastrophic neck-buckling of a sea bird while diving in nature. Although shape and speed differ between the models and birds, the threshold found could possibly have implications in head trauma and safety engineering, in addition to better understanding sea bird diving mechanisms.

Mentor(s): Dr. Sunghwan (Sunny) Jung (Engineering Science and Mechanics); Sean Gart, Ph.D. Student (Engineering Science and Mechanics)

Jay J. Pandya

Are resting state fMRI networks reflected in resting state MEG?

Resting state studies are popular in neuroimaging literature as they reflect the underlying structural and functional connections in the brain. They may be useful in clinical studies since these data are acquired without any task. Moreover, resting state fMRI may even be used as a potential biomarker for Alzheimer's and other neurocognitive diseases. EEG is an inexpensive measure of brain activity, but I am examining MEG which is similar measure to EEG in that it tests whether or not similar resting state networks can be found by neuroimaging methods. To do this I used DCM to test different coordinate networks located at posterior cingulate (PCC) and anterior cingulate cortex (ACC) and compared them to the null hypothesis; 16 subjects, aged 20 to 83, tested with MEG during both eyes-open and eyes-closed resting conditions, were considered for this study. The logic behind doing this experiment was to produce and predict a cheap biomarker for Alzheimer's disease, and the results are yet to be determined because we are still conducting work to conclude whether there is or there isn't a resting state condition potential.

Mentor(s): Dr. Rosalyn Moran (Virginia Tech Carilion Research Institute)

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Abstracts: HHMI Scieneering

Zack Printz

Integrin alpha3 is dispensable for class-specific retinogeniculate targeting

Understanding how neural circuits form is the key to developing therapeutic strategies aimed at treating neurological disorders. Visual system circuits have served as models of understanding mechanisms underlying circuit formation. In particular axons from the retina project to several regions of the brain, including different subnuclei of the lateral geniculate nucleus (LGN). We recently discovered that the extracellular matrix glycoprotein Reelin is necessary for distinct classes of retinal axons to target appropriate regions of the LGN. Surprisingly, genetic deletion of the two canonical receptors, Very Low Density Lipoprotein Receptor (VLDLR) and Lipoprotein-Related Receptor 8 (LRP8), revealed that Reelin's role in class-specific retinogeniculate targeting may be independent of VLDLR and LRP8. We therefore hypothesized that a less well characterized Reelin receptor, Integrin alpha3 beta1, may be necessary for Reelin induced class-specific axonal targeting. To test this hypothesis we examined retinal projections in conditional transgenic mice that lack Integrin alpha 3 in the presence of Cre recombinase (*int3a*$^{fl/fl}$). We crossed these mice to a second set of transgenic mice in which the expression of Cre recombinase was driven by Math5 (*math5-cre*), a transcription factor selectively expressed in retinal neurons. These *int3a*$^{fl/fl}$;*math5*-cre mice lacked Integrin alpha3 in retinal neurons. Retinal projections were assessed in these mutants by anterograde labeling with fluorescently-conjugated Cholera Toxin (CTB). Retinal projections appear normal in these mutants, suggesting that Integrin alpha3 is dispensible for retinogeniculate targeting. This suggests that a novel reelin receptor may exist in retinal axons or that compensatory mechanisms exist in the absence of this integrin.

Mentor(s): Dr. Michael Fox (Virginia Tech Carilion Research Institute)

Jordan A. Pruett

Leveraging Learning Games Data to Support Decision-Making in the Mathematics Classroom

Middle school mathematics education is continually subject to reform based on advances in instructional technology, leadings to recent calls for investment in learning games. The pertinent issues revolve around data collection from these technology-enhanced learning environments to improve classroom instruction. We identify priority areas where data collected from learning games could assist teachers to make informed decisions. Results from an extensive literature review and participatory design workshop with mathematics teachers (n=6) have led to a focus on three key requirements: providing students with personalized feedback, assessing student learning, and promoting deeper learning. These requirements are used to highlight potential empirical and practical implications for leveraging collected gameplay data to improve instruction, demonstrating how The CandyFactory, created by the GAMES Project Team at Virginia Tech, could be harnessed to support decision-making in a classroom. The GAMES Project partners with a school district in southwest Virginia, testing how students (n=306) from two middle schools in multiple mathematics classrooms interact with the game and how it influenced engagement and achievement. After presenting this information to partnering teachers, we received positive feedback supporting the usability and relation of the data categories to their instructional needs. Having access to information from the data categories would allow The CandyFactory to be embedded into instruction, which teachers suggested is more effective for student learning. We conclude by considering future research directions in developing targeted learning games to support evidence-based decision-making, which in turn could benefit how Students learn and achieve in mathematics.

Mentor(s): Dr. Michael A. Evans (Department of Learning Sciences & Technologies)

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Abstracts: HHMI Scieneering

Michael Restaino

Quality Control Of Milk Sample Using Miniaturized Gas Chromatography

Milk testing and quality control is an essential component for the milk processing industry. The high nutritive value of milk makes it an ideal medium for the rapid multiplication of bacteria, particularly under unhygienic production or storage without refrigeration. Analysis of organic compounds, specifically volatile organic compounds (VOCs) inside milk, has shown to be an effective marker for natural deterioration and quality defects including the presence of some dangerous compounds. VOCs are commonly detected through gas chromatography (GC) technique; however, there are certain limitations associated with standard GC systems, such as transportation of the sample to off-site laboratories, which affect the reliability of the analysis during transportation and storage phase. A novel Micro Electro Mechanical System (MEMS) is under development to allow rapid on-site detection of VOCs in complex samples such as milk. Currently, the [micro GC] is able to show that under similar conditions spoiled milk emanates three times more VOCs than normal milk. Ultimately, this system will allow the detection of low level VOCs in a multitude of medias.

Mentor(s): Dr. Masoud Agah (Electrical and Computer Engineering); Muhammad Akbar, Ph.D. Student (Electrical and Computer Engineering)

Michael A. Rigg

Water Quality Analysis in Mining- and Sewage-influenced Streams along the Virginia-Kentucky Border

The goal of this research is to compare water quality in five streams along the border of southwestern Virginia and eastern Kentucky, which are affected by discharges associated with surface coal mining and/or untreated residential sewage. Though the effects of coal mining on the local water resources have been studied extensively, the effects of improper sanitation have been scarcely examined. Moreover, the combined effects of mining and improper sewerage, which are both common influences in this region, have not been investigated. For the past year, water quality has been monitored on a monthly basis from over 40 sites along Callahan Creek (Virginia), Roaring Fork (Virginia), Looney Creek (Virginia), Yocum Creek (Kentucky), and Looney Creek (Kentucky). General parameters (i.e., pH, specific conductivity, temperature and dissolved oxygen) are measured in-situ, while water samples are collected from each site for further laboratory analyses. Inductively Coupled Plasma Mass Spectrometry (ICP-MS) is used to measure the concentrations of selected elements (both metal and nonmetal) to assess water chemistry; and the Colilert defined substrate method is used to simultaneously quantify total coliform and *Escherichia coli* to assess bacterial contamination. This poster highlights major trends observed between the discharges of interest and water quality to date. These trends should inform dialogue amongst interested stakeholders on water quality management in the region and priorities for sustainable solutions.

Mentor(s): Dr. Emily Sarver (Mining and Minerals Engineering); Leigh Anne Krometis, Faculty (Biological Systems Engineering); Nicholas Cook, Ph. D. Student (Biological Systems Engineering)

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Abstracts: HHMI Scieneering

Nathan I. Roberson

Setation: An implicit and graph semantic search engine for large biomedical term sets

Frequently, large scale biomedical experiments produce sets of data to explain a system. However, rarely does the experimental data fully explain the entirety of the system. The underlying mechanism responsible for generating the set may be illuminated by implicit biomedical objects found in the literature (Medline). Thus, biomedical objects that bind the data together may provide insights about the set. For example, a set of genes whose expression level shifts in response to experimental conditions could be analyzed to identify additional genes and other biomedical terms that may complete a system's set and inspire interpretation of the experiment. Setation uses string storage, pattern recognition, and database comparison algorithms to find implicit keywords and potentially associated genes and diseases. Result lists are refined against a random reference to provide the most significant linkages of a set and eliminate noisy associations. Iterative searches allow for connections between smaller systems to potentially visualize the larger network. Built in network visualizations provide a better understanding of the system and its associations. Setation provides insights into a set of biomedical data to uproot a larger network of associations.

Mentor(s): Dr. Harold Garner (Virginia Bioinformatics Institute)

Shree Sanyal

Mechanics of Rotating, Flexible, Developable Cones

The skirts of the Whirling Dervish create captivating wave-like patterns as the dancer spins rapidly in a circle. In its rest state, the skirt drapes with multiple curls and folds. As it is spun in a circular fashion, the number of folds decreases, their curvature localizes into sharp folds, and they create a standing wave in a rotating frame. We seek to understand the nature of these patterns by treating the tennure as an inextensible, flexible cone rotated about a central axis. We are interested in quantifying the parameters that control these waves by controlling the maximum cone angle, and the length and thickness of the cone. We will observe transitions between the initial, intermediate, and final number of lobes/flutes in the cone, and we will compare our experimental results with a theoretical model based on the local differential geometry of the dynamic cone. The mechanics of spinning disks is relevant to instabilities that emerge in spinning hard disks, and the flowing patterns that have been observed are analogous to a Coriolis effect observed in the atmosphere.

Mentor(s): Dr. Doug Holmes (Engineering Science and Mechanics)

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W. David Strickland

An alternative to alternative energy: the encapsulation of piezoelectric nanoparticles in conductive metal-organic frameworks (MOFs).

Electromechanical energy harvesting through the encapsulation of piezoelectric barium titanate (BaTiO3) nanoparticles (NPs) in various metal organic frameworks (MOFs) was investigated. Piezoelectric materials are those that when physically deformed - e.g. compressed - will produce a voltage, or a polarization of electrical charge. This property is responsible for the application of piezoelectrics to numerous fields, i.e. acoustics, electronics, energy harvesting, etc. MOFs present a sound structural basis for the incorporation of piezoelectric particles given their characteristic low density, high structural rigidity, and conductivity. The MOFs and BaTiO3 used in this study have been characterized via powder X-ray diffraction (XRD) and transmission electron microscopy (TEM), while the piezoelectric characterization of the MOFs pre- and post-encapsulation has been investigated using impedance spectroscopy.

Mentor(s): Dr. Amanda Morris (Chemistry)

Michael J. Vignali

Light to Fuel: Producing Hydrogen through Photochemical Reactions

The demand for energy is ever increasing and we have still not found a clean renewable source to take place of fossil fuels. For many years we have been using the power of the sun to produce energy through photovoltaic cells. Even with the increasing amounts of solar panels used today it is still an unlikely goal to solely rely on this source of solar energy, but there are other alternatives to harnessing the power of the sun. Hydrogen production using photochemical reactions is one of these alternatives. The reaction is possible using complexes made up of light absorbing metals and the ligands that connect them. When these complexes are placed in water with an electron donator they are able to harness the light from the sun and pull the water apart to create hydrogen. The complexes that act as the catalysts are synthesized in the lab using building block methods. After they are created they are tested on a small scale for their efficiency to produce hydrogen. Aside from varying the catalyst, the concentration of water and the electron donor can be varied to produce different results.

Mentor(s): Dr. Karen Brewer (Chemistry); Alex Wagner, Postdoctoral Fellow

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Claire M. Wiklund, Elizabeth A. Andruszkiewicz, and Ian A. Bick

Designing the Next Generation of Denitrifying Bioreactors: Coupled Biological and Physiochemical Processes to Remediate Nitrogen and Phosphorus

In an effort to restore Stroubles Creek, a watershed affected by both urban and agricultural runoff and the resultant high nutrient levels, this project sought to design and monitor a denitrifying bioreactor (DNBR). Fundamentally, a DNBR is a repository of carbon based media strategically installed to intercept high nutrient concentration groundwater. Preliminary analysis of ground and surface water in the Stroubles Creek Watershed demonstrated the need for phosphorous (P) and nitrogen (N) removal to reduce eutrophication. Multiple DNBR media (with hypothesized activity on both N and P) were analyzed using a lab-scale treatment system designed in attempt to optimize denitrification efficiency. Additionally, effects of media bacterial pre-inoculation on treatment efficiency over time were examined in the small-scale DNBR system. The effectiveness of the carbon media were analyzed through nutrient mass balances and carbon loss. In order to determine best placement for a field scale DNBR, water samples were collected at 10 ponds (2 agricultural and 8 urban) as well as 6 springs in the New River Watershed. Studies demonstrated that for Stroubles Creek, a mixed urban and agricultural watershed, a mixed media woodchip and biochar DNBR performed most efficiently with inoculation. These data allowed for the recommendation of a full-scale field DNBR to be placed in a spring feeding Stroubles Creek. The appropriate DNBR was proven an effective best management practice in the watershed and likely in others of similar composition. In an effort to extend the impact of the project, Virginia Tech Students and faculty will utilize the DNBR to study denitrification and water quality in upcoming years.

Mentor(s): Dr. Cully Hession (Biological Systems Engineering); Durelle Scott, Faculty (Biological Systems Engineering); Zach Easton, Faculty (Eastern Shore Agricultural Research and Extension Center); Stephanie Houston, Ph.D. Student (Biological Systems Engineering)

Stephanie Wiltman and Miranda P. Creasey

Hemodynamic correlates of working memory in prefrontal cortex

Social preferences in interpersonal decision making vary across individuals, and one way of characterizing this variability is described as a person's Social Value Orientation (SVO; Murphy et al., 2011). This construct reflects how much a person associates the welfare of another person with their own welfare when allocating resources. Social preferences can range from cooperative to individualistic to competitive and everywhere in between. Value computations in the brain have been shown to vary depending on the social value orientation of an individual. More, specifically, the medial prefrontal cortex (mPFC) has been shown in previous work to update value expectations for others, and both the magnitude and direction of this activity has been shown to scale with SVO. The fNIR device is designed to record hemodynamic activity of the prefrontal cortex within one to two inches of the scalp. For this reason, an fNIR device was used to analyze the hemodynamic activity of the mPFC while each subject performed a social learning task, in which participants made decisions the resulted in gains or losses for a social partner. The hemodynamic activity is hypothesized to increase when a signal is different from the individual's expected and preferred outcome. That is, each individual's motivation for either cooperative or competitive outcomes in social settings is expected to predict the direction of activity for unexpected outcomes. Murphy, R. O., Ackermann, K. A., & Handgraaf, M. J. J. (2011). Measuring social value orientation. Judgment and Decision Making, 6(8), 771-781.

Mentor(s): Dr. Brooks King-Casas (Virginia Tech Carilion Research Institute)

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Caleb Wood

Using Affective Responses from Sound Waves for Restorative Health: Music to Anyone's Ears

The affective response resulting from emotionally moving pieces of music causes physical reactions that can be quantified and used for restorative purposes in music therapy programs. Because of the generally positive neural reaction, music has been used in therapies for psychological diseases, neurodegenerative disorders, and other medicinal purposes. This project uses echoencephalogram while subjects are being stimulated by music selected by the participant to induce an emotional response. The music itself affects the levels of alpha, beta, and theta waves across the brain as well as certain frequencies in individualized sections of the brain. Binaural beats, ear-specific frequencies, are another form of sound used in the experiment, and show widespread increases in brain waves across the spectrum and the brain. Both music and binaural beats show definitive progress towards refining music therapies for aiding people with neurological issues.

Mentor(s): Dr. Kirby Deater-Dekard

Winston Wu, Nathaniel D. Andrew, and Brandon Sesler

Indecent exposure? Effects of pleasant and unpleasant portrayals of media violence on subsequent media choice preferences.

There is some evidence (albeit disputed) that exposure to violent media can lead to increased levels of aggression and desensitization to real-world violence among viewers. However, prior research has also shown that the manner of portrayals in which violence is shown can determine the emotional response of the viewer. While many media violence portrayals are presented as entertaining and enjoyable, viewing unpleasant violence that lacks moral disengagement cues may conflict with viewers' anti-violence attitudes to create cognitive dissonance. The present study compares the effects of unpleasant and pleasant media violence portrayals on viewers' subsequent selective exposure to further media content. The in-progress study will assign 60-90 participants to one of three different media violence conditions in film clips: unpleasant violence, pleasant violence, and a control condition with no violence. The participants will then be asked to choose to watch a subsequent film cilp representing one of four conditions: nonviolent, nonviolent with active violence prevention, pleasant violence, and unpleasant violence. Based on previous researh and existing theoretical frameworks, it is anticipated that exposure to the initial unpleasant violence condition will increase the likelihood that participants will prefer subsequent nonviolent stimuli, and possibly stimuli featuring active prevention of violence.

Mentor(s): Dr. James Ivory (Communications)

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Danny Yang

Potential Biodegradability and Toxicity of Nanocellulose in Wastewater Treatment Plants and Wetlands

Nanocellulose is being introduced in a wide variety of commercial products despite insufficient research done on its potential toxicity and biodegradability. Nanocellulose is assumed to be non-toxic and environmentally safe because of the ubiquity of cellulose. However, it is important to test the validity of this assumption as materials behave very differently in nanoscale when compared to bulk form. This study focuses on potential effects of nanocellulose on two specific environments: Pandapas Pond and a wastewater treatment plant. The increasing presence of nanocellulose in food and pharmaceutical products might eventually result in nanocellulose being received by waste water treatment plants. The cellulose degrading microbial communities were enriched from inocula from a lab-scale anaerobic digester and from Pandapas Pond, in step feed anaerobic reactors. Cell growth in the reactors was monitored using reverse quantitative transcriptase polymerase chain reaction (RT qPCR) of 16S ribosomal RNA (16S rRNA) and cel48 genes, which are indicative of population of bacteria and cellulose degraders. The enriched microbial communities were then exposed to various types of nanocelullose and the potential toxicity of nanocellulose was evaluated using RT-qPCR. To eliminate temperature shock as a factor in response of microbial community, gene expression was monitored at two different temperatures. Atomic Force Microscopy (AFM) and surface enhanced Raman spectroscopy (SERS) were used to visualize and confirm the dimensions of various types nanocellulose. Scanning electron microscopy (SEM) and transmission electron microscopy (TEM) will be used for further investigating microbial interactions with various types of nanocellulose.

Mentor(s): Dr. Sean McGinnis (Material Sciences and Engineering)
Nina Quadros, Postdoctoral Fellow; Gargi Singh, Ph.D. Student

Faranak Zamani

Gold-Gold Sulfide Nanoparticle Synthesis Optimization and Effect on Immune Cell Cytokine Expression

Gold-gold sulfide nanoparticles (GGS-NPs) have demonstrated efficacy in cancer cell imaging and treatment due to their versatile fabrication procedures. However, in spite of this fabrication simplicity, current formulations result in heterogeneous and diverse nanoparticle samples. To address these issues, our initial focus was to generate monodisperse and homogenous formulations through variations in fabrication conditions and purification procedures. We explored the use of temperature modifications and varied concentrations of individual constituents to examine corresponding effects on nanoparticle solutions. We also utilized ultraviolet visible (UV-Vis) spectroscopy and transmission electron microscopy (TEM) for characterization and examined the effects of filtration on increasing monodispersity. Additionally, much information is unknown regarding the interactions of nanoparticles with immune cells. In addition to synthesis optimization, the interactions of these nanoparticles with immune cells were also evaluated in order to begin our understanding of the immune response to these nanoparticles. Here, we examined the effects of nanoparticles on cytokine expression of immune cells through the use of real-time polymerase chain reaction (RT-PCR).

Mentor(s): Dr. Lissett Bickford (Mechanical Engineering); Laura Reese (Biomedical Engineering and Sciences)

Human, Nutrition, Foods and Exercise (HNFE) Scholars Program

The mission of students participating in this research program is to discover, translate, and disseminate health-related advances in the nutrition, food, and exercise sciences.

Faculty director: Dr. Deborah Good (Human, Nutrition, Foods and Exercise)

Program participants:

Virginia Tech, Human Nutrition, Foods, and Exercise

Emily K. Craft	Mentor: Dr. Jennie Hill
Justin T. Resendes	Mentor: Dr. Matthew Hulver
Maggie Reinhold	Mentor: Jamie Zoellner
Maja Tyhurst	Mentor: Dr. Jamie Zoellner
Lindsey Kummer	Mentor: Dr. Elena Serrano

Cornell University

Korie Bush (Biology)*	Mentor: Dr. Deborah Good

****HNFE Team Leader***

Korie Bush

The Genetics of Obesity: Analysis of a Nonsynonymous Nhlh2 Mutation

NHLH2 is a member of the basic helix-loop-helix (bHLH) transcription factor family, and using mouse models, has been shown to control body weight through exercise, although the exact mechanisms are not known. An estimated 111,000 humans carry a nonsynnonymous genetic mutation at position 83 within the coding region of human NHLH2, with one report suggesting that the mutation is preferentially found in obese individuals. This mutation changes a highly conserved alanine to a proline, and occurs at a position within the bHLH domain that is potentially a key site for protein:protein interaction and DNA binding. To understand how this particular mutation affects overall protein structure and protein:protein interaction, a plasmid containing mouse Nhlh2 linked to a glutathione S-transferase (GST) tag is being mutageneized to create the humanized protein. This will enable the protein:protein interactions to be analyzed *in vitro* and allow for comparisons between the mutant and normal forms of Nhlh2. Ultimately, these data will yield a more comprehensive view of the mutation as well as its potential effects on human body weight control.

Mentor(s): Dr. Deborah Good (Human Nutrition, Foods & Exercise); Hao Jiang, Ph.D. Student(Biochemistry)

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Abstracts: Human Nutrition, Foods and Exercise Scholars

Emily K. Craft

Using RE-AIM to assess the reach and implementation of community garden and physical activity programs targeting low-income youth

Health disparities are more prevalent among individuals of low socioeconomic status (SES) and low educational attainment. These vulnerable populations tend to be underrepresented in and difficult to recruit for health outcomes studies. The RE-AIM model evaluates the reach, effectiveness, adoption, implementation, and maintenance of such intervention studies. The primary purpose of this project is to report on the reach and implementation portions of RE-AIM to assess the degree to which a community-based intervention reached its target population and the degree to which the program was delivered as designed. Youth aged 8-14 attending summer programs at 6 sites were targeted. Reach was measured as the number of children enrolled during baseline data collection compared to total children at each site. Weekly attendance was tracked. Implementation was defined as the degree to which program objectives were met and was measured by recording and quantifying process data forms. Average percentage of enrolled children attending program up through week 5 was 38.61% across community garden sites and 51.10% across physical activity sites. Demographics and implementation data will be calculated and evaluated at the end of the eight week program. Future directions of the study will be determined after analysis of implementation data and will likely include relationships between age of children and receptiveness to participation in health programs.

Mentor(s): Dr. Jennie Hill (Human Nutrition, Foods, and Exercise)

Lindsey Kummer

Kids really don't eat their vegetables: A look at the cost of school lunch waste

In 2010, the Healthy Hunger-Free Kids updated the meal patterns and nutrition standards for the National School Lunch Program (NSLP) to align with the Dietary Guidelines for Americans to "meet the nutrition needs of school children" and to "enhance the diet and health of school children, and help mitigate the childhood obesity trend (GPO, 2012)." The new guidelines include increased servings of fruits and vegetables and more whole grains. While nutritionists have applauded the changes, many schools have reported increases in food waste and decreases in school lunch participation. The aim of this study was to determine the economic cost of food waste in the NSLP. Food waste was collected for all menu items for one pre-kindergarten and four kindergarten classes at one school for one full week. Recipes, production logs, and inventories of foods sold each day were used to calculate the cost of food waste by food group (main entreé, fruit, vegetable, and milk). In total, 304 school lunches were included in the food waste study. Total food waste was calculated at $219.99, approximately $0.72 per person, over 30% of a full price lunch ($2.25). Vegetables accounted for the largest food group wasted, with 70.29% wasted. Side salads represented the highest loss at $38.24, followed by potato medley, $23.01. A total of $26.12 of milk was disposed during the study period. These data do not include costs for food items not served. Further research is warranted to identify ways to promote school lunch and reduce waste.

Mentor(s): Dr. Elena Serrano (Human Nutrition, Foods and Exercise); Allisha Farris, RD (Human Nutrition, Foods and Exercise); Carmen Byker, Faculty, Montana State University (Health and Human Development); Geroge Davis, Faculty (Agricultural and Applied Economics)

Harness the Power of Discovery
Virginia Tech Office of Undergraduate Research

Abstracts: Human Nutrition, Foods and Exercise Scholars

Maggie Reinhold

Talking Health: Exploring the representativeness of enrolled participants in southwest Virginia

Residents in southwest Virginia (SWVA) experience a disproportionate number of health and socioeconomic disparities. Talking Health is a 6-month, community-based, 2-arm randomized control trial targeting sugar-sweetened beverage behaviors in SWVA. To determine the representativeness of enrolled participants for the first five Talking Health cohorts including: Lee, Giles, Pulaski, Washington, and Grayson counties. Descriptive statistics, chi-square tests, and one-way ANOVAs were used to determine if eligible and enrolled participants were representative of: 1) eligible, but declined participants and 2) the broader counties based on 2010 US county level census data. 574 participants were screened, 355 were eligible (61.8%), and 197 (55.5%) enrolled. On average, demographic data for enrolled participants included: 92.4% Caucasian; 81.2% female; income of $23,655±$17,019; 32% <high school (HS) education; and health literacy score 4.6±2.2(3=High, 15=Low). Among eligible participants, when comparing enrolled vs. declined participants there was a difference in educational attainment (enrolled=32%, declined=45.6% <HS ($p<0.01$); however, no significant differences for health literacy scores, gender, race, and income. Enrolled participants had a higher annual income, educational attainment, and proportion of females as compared to census data averaged across the five counties ($p<0.001$); however, there was no significant difference in terms of race. Among eligible participants, enrolled participants only differed from declined participants in terms of education. Higher socioeconomic individuals and females are overrepresented in the enrolled sample. The representativeness of this trial helps inform the generalizability of study findings and potential public health impacts.

Mentor(s): Dr. Jamie Zoellner (Human Nutrition, Foods and Exercise) Valisa Hedrick, Faculty (Human Nutrition, Foods and Exercise); Wen You, Faculty (Agricultural and Applied Economics); Paul Estabrooks, Faculty (Human Nutrition, Foods and Exercise)

Justin T. Resendes

Effect of acute and chronic lipopolysaccharide treatments on the insulin signaling machinery in human primary skeletal muscle cells.

Obesity has become a growing concern among the American public and has recently been classified as a disease by the American Medical Association. Research has shown a correlation between obesity and a hyperactive inflammatory response that is both a condition of and a contributing factor to the disease. Recent studies in lean individuals have shown that in the post prandial state, there is an elevation in blood endotoxin levels which soon returns to base-line. Comparatively, obese individual's exhibit chronically elevated blood endotoxin levels. When lipopolysaccharide (LPS), a common form of endotoxin, binds to the immune receptor Toll-like receptor 4 (TLR4), it initiates a pro-inflammatory response. Preliminary data from the Hulver lab demonstrates significant improvements in glucose clearance with acute LPS treatment in C57Bl/6 mice. Insulin signaling and therefore, glucose clearance are improved with acute treatments of LPS while these same outcomes are negatively affected in response to chronically elevated LPS levels (as in obese individuals). Primary human skeletal muscle cells were treated with low-dose LPS (20EU/ml) for both acute (2hrs) and chronic (24hrs) time periods. Following the LPS treatment, cells were treated with insulin (100ng/ml) for 10 min and then harvested for protein and mRNA extraction. Western blotting and rtPCR were employed to determine mRNA and protein levels of targets associated with insulin signaling, inflammation, and lipogenesis. These studies will provide insight into the role of endotoxin in insulin-stimulated glucose metabolism in skeletal muscle.

Mentor(s): Dr. Matthew Hulver (Human Nutrition, Foods, and Exercise); Stevens, Joseph, Ph.D. Student (Human Nutrition, Foods, and Exercise); Mordecai Harvey, Ph.D. Student (Human Nutrition, Foods, and Exercise); Ryan McMillan, Faculty (Human Nutrition, Foods, and Exercise)

Harness the Power of Discovery
Virginia Tech Office of Undergraduate Research
Abstracts: Human Nutrition, Foods and Exercise Scholars

Maja Tyhurst

Talking Health: Exploring baseline to six-month changes in The Theory of Planned Behavior constructs related to sugar sweetened beverage consumption and physical activity in Lee and Giles County, VA

Talking Health is a 6-month 2-arm RCT targeting sugar sweetened beverage consumption (SSB, SipSmartER condition) and physical activity (PA, MoveMore condition) in rural southwest Virginia. Both conditions are guided by the Theory of Planned Behavior (TPB) (i.e. attitudes, subjective norms, perceived behavioral control, and intentions). The purpose was to explore the internal consistency of TPB constructs, as well as to examine 0-6 month changes in constructs in the first two study cohorts. At enrollment and 6 months, participants complete 20 SSB-TPB and 20 PA-TPB questions. Analysis included ANOVAs, chi-square, Cronbach's α, and descriptive statistics. Participants enrolled in Lee and Giles County (n=72) were predominantly white (100%), females (86%), mean age 41.6±12.5 years, with 68% completing at least high school education. There were no significant differences between SipSmartER (n=35) and MoveMore (n=37) conditions in these demographic characteristics. Internal consistency of multi-item scales used to assess the TPB constructs at baseline was acceptable (Cronbach's alpha >0.70). For SSB-TPB constructs, 0-6 month changes in SipSmartER compared to MoveMore were significant for behavioral intentions, and implementation intentions ($p<0.05$), but not for affective and instrumental attitudes, subjective norms or perceived behavioral control. For PA-TPB constructs, 0-6 month changes were not significantly different between groups. Consumption of SSB in US adults doubled over the past 30 years. Behavior change interventions grounded in the TPB hold promise for reducing SSB intake. Future analysis will explore fluctuations in TPB constructs over the 6-month and help understand how they predict changes in SSB and PA behavior.

Mentor(s): Dr. Valisa E. Hedrick, RD (Human Nutrition, Foods, and Exercise) Jamie Zoellner, Faculty, RD (Human Nutrition, Foods, and Exercise);

Interdisciplinary Water Sciences & Engineering: NSF REU

REU fellows undergo research projects in water sciences and engineering while conducting research under the supervision of Virginia Tech faculty and graduate students. Research projects address issues related to sustainable management of water resources and water infrastructure, and facilitate opportunities or field research, laboratory work and testing of theoretical concepts.

Program Director: Dr. Vinod Lohani (Engineering Education)

Holly A. Clark, University of Idaho (Environmental Science)
Mentor: Dr. Vinod Lohani

Brittany L. Flittner, University of Rochester (Environmental Science)
Mentor: Dr. Marc A. Edwards

Robert B. (Quinn) Hull, Oberlin College (Geology)
Mentor: Dr. Madeline Schreiber

David R. Koser, University of Iowa (Civil & Environmental Engineering)
Mentor: Dr. Mark Widdowson

Arianna Nasser, North Carolina State University (Biomedical Engineering)
Mentor: Dr. Andrea Dietrich

Olumayokun O. Odukale, Morgan State University (Civil Engineering)
Mentor: Dr. Kang Xia

Arun Rai, Virginia Tech (Computer Engineering)
Mentor: Dr. Vinod Lohani

Kenneth Sears, Rowan University (Civil and Environmental Engineering)
Mentor: Dr. Erich Hester

Nancy M. Streu, University of Wisconsin-Platteville (Environmental Engineering) Mentor: Dr. Jennifer Irish

Sydney Sumner, James Madison (Integrated Science & Technology)
Mentor: Dr. Fred Benfield

Christina E. Urbanczyk, Humboldt State University (Environmental Re sources Engineering) Mentor: Dr. Cayelan Carey

Website:
http://www.lewas.centers.vt.edu/index.php/lewas-nsf-reu/nsf-reu/summer-2013

Abstracts: Interdisciplinary Water Sciences and Engineering NSF-REU

Holly A. Clark

Investigating the Response of a Small, Urban Watershed to Acute Toxicity Events via Real-Time Data Analysis

This study investigates the response that a small, urban watershed has to acute toxicity events. Meteorological and water quality measurements are taken at a high-temporal resolution (.5 - 3 minutes) via a trio of in-situ instruments, including a weather station, water quality Sonde, and an Acoustic Doppler Current Profiler. These sensors, located in Stroubles Creek and maintained by the LabView Enabled Watershed Assessment System Lab on the Virginia Tech campus, make real-time monitoring possible. Continuous measurements of specified water and weather parameters are taken and relayed through a network to LabView software and on to an end-user interface. The location and attributes of local storm-water catchments are surveyed and recorded using GIS software to determine the overall area of the Stroubles Creek watershed. This fieldwork results in the construction of an accurate storm-water network map, which in turn allows sources of sedimentation and pollution to be pinpointed. The efficiency of the LEWAS Lab's protocols will also be examined and compared to the suggested operations of the USGS. This will improve the quality of research that the lab performs. The zenith of the aforementioned methods is the production of a case study examining the effects of road deicing salts on an urban watershed using data collected this past spring. This analysis will characterize the creek's metabolic response to this event by illustrating the consequential "spike" in the water's specific conductivity measurements and the implications of saline runoff for native organisms.

Mentor(s): Dr. Vinod Lohani (Engineering Education: LabView Enabled Watershed Assessment System Lab); Randy Dymond, Faculty (Civil and Environmental Engineering); Walter McDonald, Ph.D. Student; Daniel Brogan, Ph.D. Student; Hari Raamanathan, Master's Student

Brittany L. Flittner

Inactivation Of Legionella Pneumophila Within Premise Plumbing Via Copper Ions

Legionella pneumophila (LP), an opportunistic pathogen, is found within premise plumbing. LP can cause Legionnaire's Disease (severe pneumonia) in immunocompromised individuals, hospitalizing 8,000 to 18,000 people each year. Premise plumbing is the area of the water distribution system beyond the property line and includes buildings of businesses, schools, and private property. Premise plumbing presents a unique situation with relatively low disinfectant residuals, high surface to volume ratios and long stagnation times. To explore the possibility of combating LP by selection of plumbing materials, the effectiveness of inactivation of LP by copper is being studied with eighteen simulated water heater reactors. All conditions have 80% of their water discarded three times a week, imitating an average family's water usage. Two plastic pipe materials, PEX and CPVC, are being utilized because past experiments have shown high levels of LP growth on PEX and there is concern of similar findings for PVC. Copper is being dosed as previous studies indicate a possible correlation between free Cu ions and LP inactivation. pH is controlled from 7 to 9, in different reactors. A more basic pH reduces the fraction of copper present as free copper ions, which might allow LP to persist. LP levels are being analyzed via qPCR and agar plating. TOC-MS, ICP, ATP, and AMP Index are also being monitored. The overall goal of this study is to show the relationship between free copper ion levels and LP inactivation, with an expectation that higher levels of free copper will reduce LP.

Mentor(s): Dr. Marc A Edwards (Civil and Environmental Engineering); Amy Pruden, Faculty (Civil and Environmental Engineering); Caitlin R. Proctor, Master's Student (Civil and Environmental Engineering); William Rhoads, Ph.D. Student (Civil and Environmental Engineering)

Robert B. (Quinn) Hull

What Do Mass Balance Methods Tell Us About Mn Behavior in the Roanoke River?

This project characterizes behavioral dynamics of manganese in the Roanoke River downstream of the Smith Mountain Dam hydroelectric facility in South/Central Virginia. Samples from fourteen sites along a 113 mile stretch of the Roanoke River were collected quarterly over the last year and analyzed for Mn and other parameters related to water quality. Over a condensed 10 mile reach immediately downstream of Leesville Lake, a mass balance approach was used to identify the primary source(s) of Mn and provide insight into the mechanisms controlling its behavior with relation to hydrologic conditions (i.e. stage). Results show that during base flow, Mn was attenuated from relatively high to low concentrations over the study reach. The behavior, which is consistent with other observations of dam tailraces, suggests that the upstream reservoirs serve as a primary source for Mn. However, during high flow events, Mn levels increased over the reach, with highest concentrations coming from a major tributary, Goose Creek. These results suggest that Mn source and downstream behavior are contingent on hydrologic condition. The mass balance analysis also supported the assumption that Roanoke River and Goose Creek were the only major Mn inputs into the study reach. During both high and base flows, nearly all Mn leaving the study area could be accounted for by riverine inputs within measurement uncertainty, with Goose Creek diluting Roanoke River Mn during base flow and Roanoke River diluting Goose Creek Mn during high flow.

Mentor(s): Dr. Madeline Schreiber (Geosciences) Zack Munger, Ph.D. Student (Geosciences)

David R. Koser

Longevity of Carbon in Aquifer Sediments Injected with Soybean Oil

Throughout the United States, groundwater supplies have become contaminated with industrial chemicals through leakages, spills, and a disregard for environmental concerns. As chronic ingestion of these chemicals can have severe public health effects, scientists developed methods such as biostimulation to clean dangerous sites. Biostimulation is the injection of micro-nutrients into the ground to grow bacteria, which help decontaminate groundwater. This research focuses on the sustainability of carbon amendment used for biostimulation from aquifer sediment samples. Soybean oil enhanced with emulsifiers and food additives spurs bacteria growth by providing materials for microbial consumption. What is unknown is how long the carbon source lasts in the subsurface. Removal resulting from natural flushing was determined using laboratory columns. The release rate of background potential bio-available organic carbon (PBOC) concentrations were determined in a control column. A solution of emulsified vegetable oil (4:1 dilution) was added to columns containing uncontaminated sediment. The total organic carbon (TOC) of fluid passing through sediment was measured to determine the rate of carbon released over time. Preliminary results show that organic carbon levels decrease after an expected spike with the addition of oil. However, TOC levels will drop as compared to PBOC analysis.

Mentor(s): Dr. Mark Widdowson (Civil and Environmental Engineering) Nicole Fahrenfeld, Faculty (Civil and Environmental Engineering)

Harness the Power of Discovery
Virginia Tech Office of Undergraduate Research

Abstracts:
Interdisciplinary Water Sciences and Engineering NSF-REU

Arianna S. Nasser

Evaluation of Mineral Content on the Performance of Point-of-Use Filters for Improving Drinking Water Quality

Although point-of-use filters are commonly used by consumers to improve their drinking water quality, few data exist concerning impacts of minerals, as measured by hardness and total dissolved solids (TDS), on filter performance for removing metal contaminants. Manganese, which is naturally occurring in drinking water, is becoming a health-concern as recent studies have demonstrated that consistent low-level exposure of children to manganese in water is linked to cognitive deficits. Studies also noted a link between co-exposure of lead and manganese to lower IQ scores in school-aged children. This current study examines point-of-use filter performance in removing manganese from drinking water containing varying mineral levels. High TDS and high hardness may inhibit the performance of the granulated activated carbon (GAC) and ion-exchange resin present in filters. Three water types, one with low hardness and low TDS, one with high TDS, and one with high hardness, were augmented with 1 mg/L Mn(II) and 0.15 mg/L Pb(II). Two commercially available household filters, each with a specified capacity of 150 liters, were used to treat each water type. Mn, Pb, Ca, Mg, pH, temperature and TDS were measured before and after filtration in ten-liter increments as well as at 0, 25, 50, 75, 100, 120, 150, 180 and 200% of capacity until 300 liters of water were passed through triplicates of each filter-type. Preliminary results indicate that filter efficiency decreases as each filter reached its rated capacity, and that there is high variability in performance between and within filter types.

Mentor(s): Dr. Andrea Dietrich (Department of Civil and Environmental Engineering); Amanda Sain, Ph.D. Student (Civil and Environmental Engineering)

Olumayokun O. Odukale

Examining The Biological Effects Of 4-Nonylphenol On Freshwater Mussels (Medionidus Conradicus)

Nonyphenol ethoxylats (NPEs) are generally discharged in large quantities into aquatic environments either directly from untreated effluents or indirectly from sewage treatment plants (Riccardo et. al, 2008). The major transformation product of NPEs is 4-nonylphenol (4-NP), an endocrine disruptor in many organisms. Water and sediment samples taken upstream and downstream of the Tazewell Wastewater Treatment Plant and the Richlands Regional Wastewater Treatment Facility (Tazewell County, Virginia) along the Clinch River were analyzed for 4-NP using a GC/MS/MS. 4-NP was detected in the water and sediment samples at a maximum of 0.2µg/L and 160µg/kg (dry weight basis) respectively. The effects of 4-NP on one freshwater mussel species inhabiting the Clinch River, Medionidus Conradicus (Cumberland moccasinshell) were also investigated. After acclimating the mussels for a week in natural pond water, they were exposed to 4-NP for two weeks at a concentration of 0.25µg/L. To achieve continuous 4-NP exposure at this concentration, 4-NP was spiked into an algal solution used to feed the mussels, and this solution was slowly released into 18.2 L of natural pond water within one hour. The mussels were fed and the water was replaced daily. Water samples were collected during the feeding period and were analyzed for 4-NP. After two weeks of exposure, the mussel tissues were analyzed to estimate 4-NP uptake and accumulation. The activities of glutathione-S-transferase (GST; a detoxification enzyme) and Na+/K+-ATPases in the tissues were also analyzed. The effect of 4-NP exposure on the activities in the mussels will be discussed.

Mentor(s): Dr. Kang Xia (Crop and Soil Environmental Sciences) Serena Ciparis, Faculty, (Fish and Wildlife Conservation)

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Virginia Tech Office of Undergraduate Research

Abstracts:
Interdisciplinary Water Sciences and Engineering NSF-REU

Arun Rai

A LabVIEW Driven Real-time Weather Monitoring System with an Interactive Database

Beginning in 2009, a real-time weather and water monitoring system called the LabVIEW Enabled Watershed Assessment System (LEWAS) has been developed on Virginia Tech campus. This system monitors the rainfall-runoff events in a small urban stream flowing through the campus. Using a real-time version of LabVIEW on a cRIO, an embedded computer system, LEWAS Lab records weather, water quality and quantity and transmits that data to a live-monitoring website. Further analysis of recorded data is done by developing post-processing tools. The current research automates the analysis of the weather LEWAS by adding a database between the data collection and web interface stages. This study consists of three major components. The first component entails the creation of a database specific to the parameters measured by the LEWAS Lab. Creating a connection between the real-time LabVIEW system and the database is the second component. Lastly, the design and creation of a new web-interface that directly queries the database is the final component. Via this web-interface, users can view either real-time or historical weather data collected at the LEWAS site. Using queries, written in SQL, the users are able to analyze the data in real-time. This research involves use of SQL and PHP programming languages in environmental monitoring.

Mentor(s): Dr. Vinod Lohani (Engineering Education); Daniel S Brogan, Ph.D. Student (Engineering Education)

Kenneth W. Sears

Effect of Stream Restoration Practices on Water Quality

Surface water-groundwater (SW-GW) exchange occurs in floodplains and channels of stream systems. This exchange has become increasingly of interest to stream restoration research as it allows for a steep gradient in redox (reduction-oxidation) conditions that enable biogeochemical reactions, buffer stream temperatures and impact water quality. For stream restoration projects attempting to improve stream water quality through removal or retention of nutrients, increasing SW-GW exchange can improve water quality under certain circumstances. The objectives of this study were to (1) examine SW-GW exchange during controlled floodplain inundation accounting for seasonal variability and (2) assess the impact of in-stream structures on solute transport. Objective (1) will be achieved through monitoring a piezometer network throughout the floodplain during natural and artificial flood events. Objective (2) will use sandbags as simple in-stream structures and measure SW-GW exchange by using a resazurin-resorufin "smart tracer" system to estimate the potential effects of structures on beneficial reactions. Preliminary results from objective (1) show that SW-GW exchange within the floodplain is complex and primarily downward but whether this relationship is significant for solute transport is yet unclear. Experiments to address objective (2) have been delayed due to weather, so discussion will focus on method development.

Mentor(s): Dr. Erich Hester (Civil and Environmental Engineering); Christopher Guth, Master's Student (Civil and Environmental Engineering)

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Virginia Tech Office of Undergraduate Research

Abstracts:
Interdisciplinary Water Sciences and Engineering NSF-REU

Nancy M. Streu

Estimating Coastal Flood Inundation Distances Using Digital Cameras

After a coastal storm, the inundation distance, or the distance from the coastline to the inland most point flooded by storm surge, is commonly measured using a debris line along the shore that is created by storm surge and waves. The goal of this project is to estimate the location of the debris line, and in turn the inundation distance, by taking a photograph of the area using a common digital camera and surveying several points within the picture. Photographs were taken of targets with known locations and were rectified to obtain real world coordinates for the entire image. The images were analyzed to determine the effect of different camera properties on the location of objects within the rectified image. Errors associated with each of the properties were then obtained and analyzed to determine the usefulness and accuracy of this method. The focal length of the camera had the largest effect on the rectified images, inducing an error of up to 8%, corresponding to 0.02m, in the real world locations. Lens distortion caused about a 3% error, corresponding to 0.01m, at zooms significantly lower than 35mm. However, autofocus had a negligible effect on object locations within the image. The method was then tested during a site visit to Duck, NC, where coastal features were measured using the images. This method is shown to be useful for estimating horizontal measurements, such as inundation distances, and it eliminates the need to walk along the coastline with bulky survey equipment.

Mentor(s): Dr. Jennifer Irish (Civil and Environmental Engineering); Stephanie Smallegan, Ph.D. Student (Environmental and Water Resources, Civil and Environmental Engineering)

Sydney L. Sumner

Analysis of Benthic Macroinvertebrate Density and Distribution in Stroubles Creek

Stroubles Creek, a third order stream in Blacksburg, Virginia is classified as impaired by the Virginia Department of Environmental Quality based on a benthic macroinvertebrate assessment. Because these organisms have diverse responses to environmental stressors and their communities reflect environmental conditions over time, benthic macroinvertebrate assessments provide information about stream quality. The Biological Systems Engineering Department at Virginia Tech recently instituted a stream restoration project on a 1.3 mile section of Stroubles Creek. One goal of the BSE project is to improve the aquatic habitat of the stream to support benthic macroinvertebrate diversity. My research evaluated the density and distribution of benthic macroinvertebrates in Stroubles Creek, used this data to assess the effectiveness of the stream restoration area, and compared benthic macroinvertebrate diversity in Stroubles Creek to that of Toms Creek. Qualitative or quantitative benthic macroinvertebrate samples were collected from six sites upstream of the restoration area, three sites in the restoration area, two sites downstream of the restoration area, and two sites in Toms Creek. The macroinvertebrates were identified to family and the data were analyzed using standard metrics from the Virginia Stream Condition Index. Conductivity, temperature, and qualitative descriptions of the aquatic and riparian environment were also recorded. Streambed substrate size at the sample sites was analyzed using a USGS standard procedure. The results of the benthic macroinvertebrate assessment and the geomorphic analysis of the sample sites will be presented at the July 31, 2013 Summer Undergraduate Research Symposium.

Mentor(s): Dr. Fred Benfield (Biological Sciences)

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Virginia Tech Office of Undergraduate Research

Abstracts:
Interdisciplinary Water Sciences and Engineering NSF-REU

Christina E. Urbanczyk

Effect of Nutrient Enrichment on Phytoplankton Growth in the Falling Creek Reservoir

The Western Virginia Water Authority (WVWA) supplies potable water to the City of Roanoke and Roanoke County from four local reservoirs. Of the four reservoirs, Falling Creek Reservoir (FCR) is the most eutrophic and exhibits problematic algal blooms as a result of nutrient enrichment, which can increase human health risks and treatment costs. The WVWA installed an oxygenation system in FCR in fall 2012 to decrease hypolimnetic phosphorus release from the sediments, thereby minimizing algal growth if phosphorus is limiting for primary production. The primary goal of this study was to determine if phosphorus is the dominant limiting nutrient for algal growth in the FCR. I performed a nutrient enrichment assay both when the oxygenation system was on and after it was turned off to test if phytoplankton were limited by phosphorus, nitrogen, or co-limited by both nutrients. My data indicate that phosphorus was the limiting nutrient for growth when the system is on, but only for Anacystis, Chlorella, and Cyclotella algal species. All other phytoplankton taxa, including Mallomonas, Ankistrodesmus, Cocconeis, Ulothrix, Oocystis, Euglena, Chrysococcus, and Anabaena, did not significantly respond to either nutrient. The limiting nutrient for algal growth when the reservoir is anoxic and results quantifying the effect of varying copper sulfate doses on algal growth will be presented on August 2, 2013. Overall, my results suggest that hypolimnetic oxygenation of FCR should exacerbate phosphorus limitation of the phytoplankton community by preventing the release of phosphorus from the reservoir sediments, but there may be specie-dependent effects.

Mentor(s): Dr. Cayelan Carey (Biological Sciences); Rick Browne, Master's Student (Civil and Environmental Engineering)

Philen NSF EFRI BSBA

Multifunctional materials exhibiting distributed actuation, sensing, and control: Uncovering the hierarchical control of fish for developing smarter materials

Program director: Dr. Michael Philen
Aerospace and Ocean Engineering

Program Description:
The National Science Foundation (NSF) Directorate for Engineering (ENG) Office of Emerging Frontiers in Research and Innovation (EFRI) continually seeks to further the progress in EFRI topic areas while broadening participation of underrepresented groups in science, technology, engineering, and mathematics (STEM) fields. NSF seeks to encourage EFRI-supported researchers to create carefully mentored research opportunities for people who may not otherwise become engaged in a research project, and to utilize contributions and talents of these participants to make further progress toward research goals.

Program participants:

Hampton University (Biology Majors):
Rebecca Anilu Castro
Eden Cunningham
Brandon Goodman
Alhaji Janeh

University of Virginia (Biomedical Engineering Major):
Esha Kapania

Virginia Tech:
Erin Elizabeth Berg (Chemical Engineering)
Abenazer Darge (Chemical Engineering)
Katherine Lizette Guillen (Chemical Engineering)
Danielle Lynn Moore (Aerospace Engineering)

Erin E. Berg and Abenazer W. Darge

Flow Sensors Fabricated from Carbon Nanomaterials

Inspired by the trend in developing devices that are modeled after systems found in living organisms, this project uses the technology developed in a fish's lateral line, which is composed of flow-sensing neuromasts. These hair cells can detect changes in water movement surrounding the fish, causing mechanical stimulation in the neuromasts, which is then converted into an electrical impulse. This study has attempted to replicate these neuromasts using carbon nanomaterials, specifically single-walled carbon nanotubes, nanohorns, multi-walled nanotubes, and most recently, peapods. These are a class of smart materials that generate a voltage response when exposed to liquid flow. The sensors are formed by coating the nanomaterial in polydimethylsiloxane (PDMS), which fixes the nanomaterial in its polymer matrix, preventing the nanomaterial from being washed away in the flow. Additionally, efforts have been made to enhance the interaction between the nanotubes and the liquid through plasma etching, which has been thought to introduce the polar functional group silanol (SiOH) to the PDMS. In continuation of this study, we have been testing of all of the previously-mentioned nanomaterials to obtain consistency in results. Additionally, we have been testing a similar etching treatment on the sensors to determine its effectiveness at enhancing the sensors' voltage generation. Finally, we have working on ways to measure the impedance of the different nanomaterials used in the sensors to determine which of the materials will theoretically be most effective in generating voltage. Based on our research, we have predicted that the long single-walled carbon nanotubes will yield the best voltage results, with the lowest impedances.

Mentor(s): Dr. Michael Philen (Aerospace and Ocean Engineering)

Rebecca Anilu Castro and Brandon Goodman

A robotic reproduction of the dynamic sonar sensing in Horseshoe bats.

Horseshoe bats (family *Rhinolophidae*) are a group of bats with a particularly sophisticated biosonar system that allows them to navigate and pursue prey in dense forest habitats. One conspicuous feature of horseshoe bat biosonar is that the pulses are emitted nasally and diffracted by a special baffle structure - the noseleaf - as the exit into the free field. Furthermore, the noseleaves can change their shapes while diffracting the outgoing ultrasonic waves. The aim of this research project is to obtain experimental data on how the deformation of the noseleaf during pulse emission affects the ultrasonic field. An automated experimental setup approach was used to achieve this aim. The experiment setup was designed and integrated the acoustic instruments for emitting the pulses and recording the signal, such as ultrasonic loudspeaker and high sensitive microphone; actuators for displacing the noseleaf and orienting the noseleaf, such as linear actuator and pan and tilt unit. A cone and tube waveguide was designed to match the loudspeaker to the nostrils. By using this experimental system, it will be possible reproduce the dynamic effect of the noseleaf and characterize it as a basis for inspired dynamic acoustic devices.

Mentor(s): Dr. Michael Philen (Aerospace & Ocean Engineering); Rolf Mueller, Faculty (Mechanical Engineering); Yanqing Fu, Ph.D. Student (Engineering Science and Mechanics)

Harness the Power of Discovery
Virginia Tech Office of Undergraduate Research

Abstracts: Philen NSF EFRI BSBA

Katherine L. Guillen, Eden L. Cunningham, and Esha M. Kapania

The Influence of Osmotic Pressure on the Lifespan of Cellularly-Inspired Energy Relevant Materials

Bimolecular unit cells, formed through the droplet interface bilayer (DIB) technique, have recently become a focus for biologically-inspired smart materials. This is largely due their ability to exhibit many of the same properties of the natural cell membrane. In this study, two lipid monolayers formed at a water/oil interface are brought together, creating a lipid bilayer at their interface with each droplet containing a different concentration of ions. This ionic concentration gradient leads to the development of a membrane potential across the bilayer as ions begin to passively diffuse across the membrane at varying rates, providing the proof of concept for energy storage through cellular mechanics.. The focus of the study is to determine the influence of osmotic pressure on the lifespan of the lipid bilayer. We hypothesize that the greater osmotic pressure that develops from a greater ionic concentration gradient will prove to have a negative impact on the lifespan of the bilayer membrane, causing it to rupture sooner. This is due to the substantial amount of osmotic swelling that will occur to compensate for the ionic concentration gradient. This study will demonstrate how osmotic pressure will continue to be a limiting factor in the effectiveness and stability of cellularly-inspired energy relevant materials.

Mentor(s): Dr. Michael Philen (Aerospace and Ocean Engineering); Dr. Eric Freeman, Postdoctoral Fellow (Aerospace and Ocean Engineering)

Danielle L. Moore and Alhaji H. Janneh

Development of a Biologically Inspired Hydrobot Tail

It has been hypothesized that Europa, one of the moons of Jupiter, has a large ocean underneath a thick layer of ice. In order to determine whether life exists, it has been proposed that an underwater glider (hydrobot) capable of propulsion could be sent to explore the vast ocean. In this research, we considered smart materials to create a propulsion device inspired by dolphin tails. Dolphins are highly efficient and excellent gliders, which makes them the ideal candidate for ocean exploration. In order to select the best dolphin species, we began by reviewing literature and then utilized the Analytical Hierarchy Process (AHP) to compare the different species. *Lagenorhynchus obliquidens* (Pacific White-Sided Dolphin) was found to be the best choice for creating a bio-inspired hydrobot. We then conducted literature review of various smart materials and using this knowledge constructed a hydrobot tail prototype. This prototype demonstrates that smart materials can be fashioned into suitable actuators to control a tail fashioned after a dolphin.

Mentor(s): Dr. Michael Philen (Aerospace and Ocean Engineering)

Complex Microsystem Networks Inspired by Internal Insect Physiology

This research aims to understand how insects use flexible systems to produce internal flows for respiration, circulation, and feeding. Our REM program incorporates four high school teachers, two high school students, and two undergraduates into our research. Additionally, teachers create a new educational module for their classrooms, based on scientific content from their research.

Program director: Dr. Jake Socha
Engineering Science and Mechanics

Program Description:
The National Science Foundation (NSF) Directorate for Engineering (ENG) Office of Emerging Frontiers in Research and Innovation (EFRI) continually seeks to further the progress in EFRI topic areas while broadening participation of underrepresented groups in science, technology, engineering, and mathematics (STEM) fields. NSF seeks to encourage EFRI-supported researchers to create carefully mentored research opportunities for people who may not otherwise become engaged in a research project, and to utilize contributions and talents of these participants to make further progress toward research goals.

Program participants:

Teachers:
Stephen Kamanda, North Stafford High School, VA
Tiffany Hunter, Courtland High School, VA
Nathan Ndiforamang
Brittney Shaw, Bowie High School, MD

Virginia Tech undergraduates:
Katherine Sheridan, Chemical Engineering
Kruthika Kikkeri, Electrical and Computer Engineering

High school students:
Ellen Granata, Blacksburg High School and Southwest Virginia Governor's School for Science, Mathematics and Technology, VA
Alexis Johnston, North Stafford High School, VA

Ellen Granata

Viscosity of Hemolymph in America Grasshoppers

Insects have been around for millennia, and scientists study them for their highly evolved characteristics, but our understanding is incomplete. The circulatory system of the insect is one subject studied by scientists and knowing the viscosity of their blood (hemolymph) would create a better understanding. Standard methods of viscosity measurement require larger amounts of fluid than can be extracted from an insect, requiring an alternative measurement technique to compensate for lack of fluid volume. There is a connection between the viscosity and surface tension of a fluid, and the first step to determine these properties is finding the contact angle. A 2μL drop of hemolymph from a grasshopper, *Schistocerca americana*, was placed on a glass slide and photographed; data were analyzed using a computer program to determine the contact angle. The average contact angle was 35.2° ±11.9° (mean± std. dev.) with a range of 16.2° to 63.5° (n=34). Data will be combined with future measurements of capillary action on the fluid to determine the viscosity of the hemolymph. This measurement will allow scientists to study the fluid mechanics of the insect circulatory system to build bio-inspired devices. The contact angle is the first step to viscosity measurements of fluids on a micro-scale.

Mentor(s): Dr. Jake Socha (Engineering Science and Mechanics)

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Virginia Tech Office of Undergraduate Research
Abstracts: Socha NSF EFRI BSBA

Alexis J. Johnston

Spiracle Opening Patterns Correlated to Patterns of Abdominal Pumping in Hissing Cockroaches

Insects have proved themselves to be very efficient at transporting substances around their bodies at a very small scale. Because of this, it is important to understand their respiratory and circulatory systems in order to be able to successfully replicate them on a similar scale. The goal of this study is to analyze one point of interest, in this case a single spiracle, in order to understand how abdomen volume and spiracle valving relate to each other and create airflow inside the animal. The hissing cockroach, *Gromphadorhina portentosa*, will be used for this study because they are both readily available and have spiracles that are large enough to be monitored easily and effectively. After immobilizing the cockroach, a camera can be placed to record a single spiracle for analysis. After the spiracle data is collected, it will then be compared to the visual and data of the abdominal pumping. Combining these images and data sets using Final Cut Pro and DLT, we will be able to see the correlation between the timing of abdominal pumping and spiracle opening and closing in the animal. Experiments are being conducted to gather more information of the correlation between abdominal pumping and spiracle opening and closing.

Mentor(s): Khaled Adjerid (Engineering Science and Mechanics); Joel Garrett (ASPES School of Biomedical Sciences)

Kruthika Kikkeri

Two-Pump Dielectric Elastomeric Micro-Actuation System

Microfluidic systems have a multitude of benefits due to the low Reynolds number at the micro-scale. Additional advantages include compatibility, versatility in design and use, and lower costs for production. However, because fluids at the micro-scale are counter-intuitive and dissimilar to traditional large fluid volumes, controlling microfluidics can be problematic. Thus, our research explored whether we could gain insight as to how to fabricate a better pumping system by mimicking fluid controls within insects. This project created a method of controlling microfluidic flow by implementing an actuated two pump system to control microfluidic flow inspired by the internal pumping system of mosquitoes. This was done by using dielectric elastomeric plates as actuators. Electrodes were fixed at both endpoints such that when an electric current was applied, a potential difference caused the material in-between to attempt to elongate. However, because the plates were confined, the elastomeric material could not elongate and instead buckled. This action created pressure on the fluid channel which, when timed correctly, enabled the user to control the rate of fluid flow. Thus, the objective of this project was to create a microfluidic device which controls flow direction and velocity by employing electric fields and timed actuators by imitating internal insect physiology.

Mentor(s): Dr. Rafael Davalos (Biomedical Engineering); Lisa Anders, Master's Student (Electrical Engineering)

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Abstracts: Socha NSF EFRI BSBA

Nathan Ndiforamang

Optimizing the surface properties of laminated microfluidic device for cell culturing

The trajectory of pharmaceutical drug being delivered to malfunctioning tissues in the human body and also the robust agricultural irrigation pumping mechanism are all physical structures that pose real-world operational challenges. This research project is an amalgamation of the science of fluid-flow dynamics in tracheal system of insects and the engineering of micro fluidic system mimic. Insects have a circulatory system for its fluids- food, air and lymph-blood that flow in the tracheae device that consist of tubes and pumps. The research outcomes from these three dimensional scaled-down structural units in the research industries could be applicable to other complex systems in real life. Microfluidic systems mimics are used for culturing cells in specified extracellular matrix materials (ECM). In this research, different concentrations of the collagen and coating times are tried to find the optimum conditions for cell adhesion to the micro-device. The experimental accomplishment included Poly(dimethylsixane) (PDMS) preparation and casting; PDMS-Glass bonding in the Plasma Cleaner; cell culturing and passaging; device preparation; testing cell viability; cell seeding; fluid flow and gradient development and laminated cell culture device. The endothelial cells cultured in the laminated microfluidic device and incubated for two days did not proliferate and end result was unsuccessful. On the other hand, cells cultured in the two dimensional microfluidic device and incubated proliferated and end result was successful. The reason behind the unsuccessful result for the laminated device is not clear at this point and further subjective experiments are underway to determine the specific cause.

Mentor(s): Dr. Rafael Davalos (Biomedical Engineering); Mohammad Bonakdar, Ph.D. Student (Mechanical Engineering)

Katherine A. Sheridan

Structure Function Relationship in Grasshopper Tracheae

The insect respiratory system, which is composed of a network of air-filled and flexible tracheal tubes, could inspire microfluidic device designs. In a recent study, it was found that different parts of the insect respiratory system have different behaviors during rhythmic tracheal compressions (1). This study will focus on the question of whether differences in structure in American locusts (Schistocerca americana) result in differences in function of the tracheal tubes. This will be accomplished by examining the structural differences (splitting, thickness, width or other) between the tracheal tubes that collapse and tracheal tubes that don't collapse. A Zeiss Stemi 2000-C microscope with a Nikon D 5000 camera will be used for dissections. For closer examination of tracheal tube structure, an Olympus IX51 Inverted Florescence microscope with an Allied Vision Stingray camera will be used. In addition, the program ImageJ will be used to analyze the photographs. With inspiration from the structure of insect tracheae, we hope to alter the function of fluidic networks by changing the local microstructure. These findings could result in new valves and pumps for microfluidic devices.

1. Harrison, J., Waters, J., Cease, A., VandenBrooks, J., Callier, V., Klok, J., Shaffer, K., and Socha, J. "How Locusts Breathe". Physiology, 28, pp 18-27, 2013.

Mentor(s): Dr. Raffaella De Vita (Engineering Science and Mechanics); Dr. Jake Socha, Faculty (Engineering Science and Mechanics); Matthew Webster, Ph.D. Student (Engineering Science and Mechanics)

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Virginia Tech Office of Undergraduate Research

Abstracts: Socha NSF EFRI BSBA

Brittney N. Shaw

Biomechanics of collapsing tubes as a model for fluid flow in insects

Cylindrical tubes play important anatomical and physiological roles in the circulatory, respiratory, and digestive system of insects. It has been observed that the pressure-driven collapse of these tubes may control the flow of air within the (Periplaneta americana) cockroach. The minuscule size of the tracheae makes *in vitro* experiments challenging, so in this study we are interested in investigating a bio-inspired approach to determining the fundamental mechanisms of soft tube collapse. Specifically, when does the collapse of the tube occur, what types of flow rates does this generate, and can these experiments give us knowledge of the internal mechanisms of insects? We will examine the buckling thresholds of various tubes by altering their elastic moduli, diameter, length, and thickness. We will focus on silicon rubbers due to their favorable biocompatibility, thus allowing future research to incorporate buckling-induced flow into a range of bioengineering technologies. We have designed and built a custom experimental apparatus that will measure flow rate, applied pressure, and the critical point of collapse. We expect the tube collapse and subsequent fluid flow to be a function of the materials and geometry of the system. If successful, we expect these results to be used to verify current hypotheses regarding the circulatory system of the cockroach, and play an important role in medical advancements with applications that may be used to synthesize artificial organs.

Mentor(s): Dr. Doug Holmes (Engineering, Science, and Mechanics); Behrouz Tavakol, Ph.D. Student (Engineering Science and Mechanics)

Tiffany S. Hunter

Determination of hemolymph volume in darkling beetles (Zophobas morio) using the isotope dilution technique

Blood pressure may have an affect on how respiratory tracheal tubes collapse in darkling beetles and other insects. In order to better understand this hypothesized mechanism, the relative volume of hemolymph (insect blood) in the body must be determined. Darkling beetles have an open circulatory system, which means their tracheal tubes are bathed in hemolymph. This research approach focuses on the isotope dilution technique to determine the volume of hemolymph. This technique involves adding a known volume of 14C-inulin (a naturally occurring polysaccharide found in plants) to a microapplicator and injecting it into the beetle. It is hypothesized that after two hours inulin has dispersed throughout the entire body. Inulin is used because tissues do not readily absorb it. Afterwards, a Hamilton syringe will be used to extract the hemolymph at predetermined increments. Scintillation fluid will be added to each extracted sample. Afterwards, each sample will be placed in the scintillation counter to determine the amount of radiation per sample. The volume is then calculated based on the original radiation emittance prior to dilution.

Mentor(s): Dr. Jake Socha (Engineering Science and Mechanics); Hodjat Pendar, Ph.D. Student (Engineering Science and Mechanics)

Harness the Power of Discovery
Virginia Tech Office of Undergraduate Research

Abstracts: Socha NSF EFRI BSBA

Stephen T. Kamanda

A Magnetic Micropump Inspired by Drinking Mechanism of Mosquitoes

This study presents a valveless microfluidic pump inspired by the drinking mechanism of mosquitoes. It is made by casting polydimethylsiloxane (PDMS) comprising one or two positive displacement chambers connected to flow rectification mechanisms. The top wall of the chambers has an embedded NdFeB magnet which is actuated by an externally applied AC magnetic field. This wall forms an oscillating membrane which drives the flow. A nozzle-diffuser pair on either side of each chamber breaks symmetry to ensure net flow is unidirectional. Dynamics of such a system is quite complicated owing to the coupling of (1) electromagnetic circuit, (2) vibration of the membrane and (3) fluid flow. The first step in the study thus characterizes the kinematics of such a membrane in a single chamber pump without any liquid. This enables studying a very interesting observation brought about by coupling of the electromagnetic and mechanical resonance of such a system. Subsequently, flow characterization is undertaken, wherein notable features are dependence of flowrate on both frequency and amplitude of membrane oscillations. Finally, a dual chamber pump is considered, wherein an additional parameter comes into play, i.e., the phase lag between the oscillations of the two membranes. The results from the latter part help in understanding advantages of flow mechanisms employed by mosquitoes and similar insects.

Mentor(s): Dr. Mark Stremler (Engineering Science and Mecahanics); Suvojit Ghosh, Ph.D. Student (Engineering Science and Mechanics)

Summer Engineering Education Collaboratory SEEC at Virginia Tech

Program description: Students involved in the Summer Engineering Education Collaboratory (SEEC) program participate in projects that invent new models for how students learn and how teachers teach. In this interdisciplinary collaborative program, students work with leading faculty and graduate student researchers to co-create educational models for the new millennium. Students in the program are mentored by faculty in the Department of Engineering Education.

Auburn University - Glenda D. Young (Industrial Systems Engineering)
Mentors: Dr. Stephanie Adams & Dr. Denise Simmons

California Polytechnic State University
Lawrence A. Domingo (Biomedical Engineering)
Mentor: Dr. Richard Goff
Matthew D Vance (Materials Engineering)
Mentor: Dr. Lisa McNair

James Madison University - Sarah A. Rowe (General Engineering);
Mentor: Dr. Richard Goff

Norfolk State University - Donnita M. McArthur (Optical Engineering)
Mentor: Dr. Maura Borrego

Ohio Northern University - Meghan E. Letizia (Engineering Education)
Mentor: Dr. Lisa McNair

Virginia Tech
Alyssa R. Cunningham (Chemical Engineering)
Mentor: Dr. Lisa McNair
Alex M. Epstein (Industrial Systems Engineering)
Mentor: Dr. Marie Paretti
Abigail F. Garrett (Mechanical Engineering)
Mentor: Dr. Lisa McNair
Christopher Nellis (Material Science Engineering)
Mentor: Dr. Maura Borrego
Julia Novak, Virginia Tech (Industrial Design)
Mentor: Dr. Lisa McNair
David Marshall (Biological Systems Engineering)
Mentor: Richard Goff
Danielle A. Smalls (Industrial Systems Engineering)
Mentor: Dr. Holly Matusovich

Alyssa R. Cunningham

Bio-inspired Autonomous Robotic Fish Teaches Applications of Science, Technology, Engineering, and Math (STEM)

Though most kids think that science and math are classes for the "nerds" of the school, it is quite the opposite. Science and math provoke intrigue and curiosity, which is useful when pursuing engineering and technology careers. There are many things every kid can do for the STEM field; they just do not realize it yet. In this project, we will inspire kids by showing them how a group of scientists and engineers are working together to study aquatic life and build biomimetic robotics in order to improve energy-efficient underwater vehicles. Kids will be informed about how important STEM can be by an interactive kiosk for the travelling museum exhibit of the robotic fish. The interactive kiosk consists of a game portion and an education portion. The game portion has one main game, but there are different results based on the choices made. The education portion consists of videos, pictures, definitions, and an interactive map. The kiosk, designed with third through fifth graders as the primary audience, will connect the kids to the very real and intriguing world of science and engineering and all of its possibilities.

Mentor(s): Dr. Lisa McNair (Engineering Education); Marcia Davitt, Ph.D. Student (Science, Technology, and Society)

Lawrence A. Domingo, David R. Marshall, and Sarah A. Rowe

Work-in-Progress: Early Stage Design Development of an Additive Manufacturing (3-D Printing) System using Nanocomposites for a Wireless Emotional-Health Physiological Monitoring Device

An ounce of prevention is worth a pound of cure. The Hippocratic Oath emphasizes a prevention-based practice of medicine rather than a symptom-solution practice of medicine. Furthermore, there has been a movement in medicine that emphasizes the personalization and individualization of medicine where such a practice reduces the number of "unintended consequence" incidences and adverse side-effects due to demographical (i.e. gender, age, ethnicity) differences in physiology. Both these observations imply a niche for a design that is able to sense and record an individual's physiological history. The research question is: Can a portable, unobtrusive wireless physiological sensing device be designed and produced using 3-D Printing of nanocomposites? The sensor design is an integral part of a larger Commonwealth Research Commercialization grant. This Work-in-Progress provides an update on the early-stages of the design process for an emotional-health physiological monitoring device. Background of this research and preliminary designs are presented.

Mentor(s): Dr. Richard Goff (Engineering Education)

Harness the Power of Discovery
Virginia Tech Office of Undergraduate Research
Abstracts: Summer Engineering Education Collaboratory (SEEC)

Lawrence A. Domingo

Design Education Research using Critical Engineering Challenges—Student Engagement on Interdisciplinary Teams and Pedagogical Implications

ABET requires and Engineering Industry requests that graduating engineers have "an ability to function on multi-disciplinary teams." Furthermore, due to economic constraints, most educational institutes have adopted team project-based elements into engineering course curricula to satisfy the ABET requirement, request from engineering industry, and to alleviate some burdens due to funding. However, the issue of engagement arises since appropriate project topics may be scarce and are frequently chosen based on majority popularity where the chosen topics may or may not coincide with an individual student's interests. The research questions asked are: 1. Can students who have varying backgrounds become engaged in a team design project that is outside of their major area of study? 2. How can these findings be integrated into current design education pedagogy? This paper reports the self-observed experiences of members of an interdisciplinary, multi-university design team working on design projects that are "atypical" to the member's majorbased identities. Pre- and Mid- Self-Reflections were analyzed for thematic commonalities in the contexts of student engagement, self-identity, and program expectation. This paper then goes further to explain mental-models synthesized to better understand the spiritual development of students in a design-based classroom and the pedagogical implications of these models. Through thematic investigation, a mental-model that explored the roles of interest and passion in context of engagement in design education was created. Furthermore, ways to apply this model in design pedagogy was developed. A second mental-model describes and juxtaposes a squeezing-pedagogy and a planted-growth-pedagogy and explores teacher-role expectations.

Mentor(s): Dr. Richard Goff (Engineering Education)

Alex M. Epstein

Facilitation Practices in Project Based Learning

This study is intended to look at practices of mentoring in entrepreneurship education and engineering capstone design projects. There is not currently a good description of the triangulation between what practices are being observed, what practices Students perceive, and what practices faculty believe they are enacting. Along with supplying this description, we would like to look at how the observed practices affect Student learning. Methods included qualitative analysis of field observations, Student surveys and faculty interviews looking at cognitive apprenticeship, capstone design mentoring, and problem-based learning frameworks. The results will help us to understand what expert mentors do in the classroom and how Students perceive and respond to different mentoring practices. Additionally, theses results should show whether faculty, Students and an observer all saw the same practices and outcomes in these project based learning situations.

Mentor(s): Dr. Marie Paretti (Engineering Education); Benjamin Lutz, Graduate Student (Engineering Education)

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Virginia Tech Office of Undergraduate Research

Abstracts: Summer Engineering Education Collaboratory (SEEC)

Abigail F. Garrett

Going Big: How to Build a Sense of Trust and Community When Converting a Course Curriculum into a MOOC

The Portfolio to Professoriate (P2P) curriculum is designed to teach graduate students how to build their online integrated identity in the format of a digital portfolio (e-portfolio). The curriculum guides students through creating a home page as well as sections for research, teaching, service, and lifelong learning. Currently, P2P is included as part of a graduate course at four different universities, which allows students to receive feedback on their writing from their peers and instructor. One way to make this curriculum more widely available is to convert it into a Massive Open Online Course (MOOC). MOOCs are a relatively new concept that make online learning readily available on a massive scale. They are typically 6-8 weeks long and consist of video lectures followed by short quizzes and assignments to check student understanding. MOOCs also include forums to allow participants to meet other students taking the course to discuss course content. In order for P2P to succeed as a MOOC, there will need to be a heavy emphasis on using discussion forums as well as other methods of providing the feedback essential to creating a strong e-portfolio. Recommendations for converting P2P to a MOOC format are based on a literature review of MOOCs, online communities, and motivation for participation. Ultimately, the online P2P curriculum will serve as the core for forming the sense of community and trust in online discussion forums that is essential for MOOC success.

Mentor(s): Dr. Lisa McNair (Engineering Education); Rachel L. Kajfez, Ph.D. Student (Engineering Education)

R. Marshall, Sarah A. Rowe, and Lawrence A. Domingo

Vetter Fuel Economy Challenge; Streamlined Motorcycle Design Research: "Racing for the Right Reasons"

Energy usage has become one of the most serious problems that we face today. Global warming due to harmful emissions from burning fossil fuels and rising gas prices as well as national security issues have driven people to look for new ways to reduce their fuel consumption. It has been known for some time that streamlining motorcycles can dramatically improve their fuel economy. In this project, an interdisciplinary, multi-university team investigated the research question of whether or not it makes sense, from both an economic and practical standpoint, to streamline a motorcycle for everyday use. To answer this question, the team gathered data on previous Vetter Fuel Economy Challenge events that were created to test motorcycle fuel economy in real riding conditions. The team also designed several components and constructed two streamlined motorcycles to compete in the Vetter Fuel Economy Challenge on July 18, 2013. Our objectives were to design the motorcycle/streamliner systems to perform comfortably when driven at 70 mph into a 30 mph headwind, carry a useful load of at least four bags of groceries, travel for at least 100 miles before having to refuel, and use the least amount of energy possible. We evaluated the performance and fuel economy of our motorcycles both before and after streamlining them and evaluated the results. Examining data from previous Vetter Challenges, dramatic improvement in the fuel economy of motorcycles after being streamlined is shown. The data from our tests confirm this improvement in fuel economy. Also due to the minimal amount of labor and materials required, the team concluded that streamlining motorcycles is both economically and practically worthwhile.

Mentor(s): Dr. Richard Goff (Engineering Education)

Harness the Power of Discovery
Virginia Tech Office of Undergraduate Research
Abstracts: Summer Engineering Education Collaboratory (SEEC)

Donnita M. McArthur

A comparison of Graduate School Expectations between Students with and without Undergraduate Research Experience

It is commonly held that undergraduate research is excellent preparation for graduate study, yet little is known about the mechanisms that aid Student integration into academic research in ways that may increase their interest in graduate study. This paper compares survey responses collected in fall 2010 from 1017 engineering undergraduate Students at four doctoral institutions across the United States (three public, one private). The survey instrument is based on an adaptation of Social Cognitive Career Theory to understand how Students perceive graduate school aligning with their interests and future goals. 21 of the 26 items were statistically significant between Students with and without undergraduate research experience using an unpaired t-test, so effect sizes were calculated to identify the relationships with the most practical significance. As expected, Students with engineering undergraduate research experiences were more likely to discuss graduate study with faculty and graduate Students and be encouraged to apply by a faculty member. Students with undergraduate research experience were more confident in their own abilities to do well in graduate school, and have a better understanding of how it may be an optimal choice for their careers. However, there are still concerns regarding external factors such as funding, competitive admissions, and being "on my own" in graduate school. These results provide empirical evidence that undergraduate research exposes Students to mentors and helps them understand differences between graduate and undergraduate study. Although this study was limited to engineering Students at doctoral institutions, these results are a promising foundation for future work.

Mentor(s): Dr. Maura Borrego (Engineering Education); Stephanie Cutler, Postdoctoral Fellow (Engineering Education)

Christopher E. Nellis

Exploring Students Expectations of the Engineering Classroom

An important component in the adoption of Research Based Instructional Strategies (RBIS) is how the Students will react to a new teaching method. Research shows that Students can perceive a new teaching method, like group discussions, as unhelpful while actual results prove otherwise. Expectation violation theory predicts that if a class is not what a Student expects it to be, the Student will resist the changes the RBIS needs to be effective. A proper understanding of what an incoming engineering Student anticipates from a college classroom will help a professor transition to using a RBIS go more smoothly. In this study, four focus groups with 2-4 participants each were conducted with current undergraduate engineering Students to discuss their experiences and expectations for transitioning to college engineering classes. These focus groups were asked to describe the ideal conditions for them to learn best in the classroom. Questions ranged from how the professor interacts with the Student to the study habits that they picked up. It was encouraged to describe how these experiences differed from what they expected. From these results, professors using an RBIS can better anticipate their Student's reaction to teaching method and prevent any loss in learning from Student resistance to it.

Mentor(s): Dr. Maura Borrego (Engineering Education); Stephanie Cutler, Postdoctoral Fellow (Engineering Education)

Harness the Power of Discovery
Virginia Tech Office of Undergraduate Research

Abstracts: Summer Engineering Education Collaboratory (SEEC)

Danielle A. Smalls

"Do you want to take a survey? Exploring tools to increase survey response rates with undergraduate students"

Students, particularly in higher education, are constantly bombarded with surveys imploring their opinions on specific issues. Previous studies have shown that they feel little need to answer these surveys because of the thought that another student will answer in their place. This in turn, results in low response rates. This study aims to address this problem by finding the best method of data collection that satisfies the needs of the researcher while grabbing the attention of the student. In particular, this study focuses on discovering the most effective method for collecting data about student's experiences learning engineering in real-time. Real-time data collection for this study is described as gathering opinion within the context of the current situation. Capturing data in the moment helps to eliminate memory loss from true opinion and also clarifies the context of the question. With emphasis on gathering data in real-time, this study compares the data collection tools from popular social media, institutional, and traditional online survey software. Data from this study will consist of focus groups with undergraduate students to gain prospective on the various survey tools. The outcomes of this study will include a comparison of the tools based on privacy controls, cost of tool, and the likelihood of use by students. Based on this comparison, researchers can develop effective strategies for real-time data collection.
Keywords: *Real-time data collection, Surveys, Motivation*

Mentor(s): Dr. Holly Matusovich (Engineering Education); Rachel McCord, Ph.D. Student (Engineering Education)

Matthew D. Vance, Meghan E. Letizia, and Julia C. Novak

Teaching Interdisciplinarity: Techniques to Promote Collaboration in Multi-Discipline Design Courses

Interdisciplinary studies allow Students to develop an appreciation of the power of cognitive diversity and provide them with collaborative skills that will translate to industrial project teams. This work centers on a course held at Virginia Tech, "Interdisciplinary Product Design Studio," in which Marketing, Engineering and Industrial Design Students work in teams to create a market-ready prototype. Faculty members expose Students to the different disciplines, promoting a collective sense of understanding to enrich the design process. This understanding was achieved through three major-specific modules which enable each Student to act as resident expert in his/her individual discipline, while giving hands-on experience in the subject to the other team members. Through the use of these modules, the expert gains confidence as the other members attain competence, allowing for an effective communication dynamic. For each course offering, different facilitation techniques were implemented and the effectiveness of each in promoting productive design teams was evaluated and verified using qualitative and quantitative methods (survey). Due to the course's success, the founders would like to share their findings with other educators so that the class can be mirrored elsewhere. The research goal was developing an understanding of the fundamental principles of this course and creating a public website to broadcast the core curriculum in an appealing and efficient manner. This website gives information about the course including implementation strategies, the philosophy, and course resources. In the future, this site will be fully functional, acting as an effective tool that educators can use to establish similarly designed classes across the nation.

Mentor(s): Dr. Lisa McNair (Engineering Education); Jason Forsyth, Ph.D. Student, (Electrical and Computer Engineering)

Harness the Power of Discovery
Virginia Tech Office of Undergraduate Research

Abstracts: Summer Engineering Education Collaboratory (SEEC)

Glenda D. Young

Impact of Non-Curricular Activities on African American Engineers' Development of Engineer of 2020 Traits

Non-curricular activities have been shown to contribute to academic success, increase persistence rates, and impact skill development in undergraduate education; while several non-curricular organizations have been shown to support the recruitment and retention of underrepresented African American engineers, little research exists to understand how these organizations uniquely impact the African American student experience. This project seeks to examine the relationship between three non-curricular activities and the development of Engineer of 2020 traits (e.g. analytical, leadership, and lifelong learning skills) among African American engineering students and alumni. Data collected via an on-line survey will be used to quantify the impact that participation in the National Society of Black Engineers (NSBE), Black Greek-letter Organizations (BGOs), and Minority in Engineering Programs (MEPs) have on the abovementioned traits. This presentation and poster will report quantitative findings of an on-line survey completed by more than 250 student and alumni members of the three non-curricular organizations. These results are preliminary and next steps include conducting participant interviews (pooled from the existing survey participants) to develop a theory based on data to explain African American engineering student and alumni perceptions of the contributions of non-curricular organizations and how these organizations support the development of Engineer of 2020 traits. Ultimately, this research seeks to increase the retention and recruitment of underrepresented groups in the field of engineering; the results of this research will contribute to further research and practices to understand aspects of the African American student experience outside of traditional curriculum and instruction.

Mentor(s): Dr. Stephanie Adams Adams (Engineering Education); Denise Simmons, Postdoctoral Fellow (Engineering Education)

Tire and Automotive Engineering NSF REU

Program description: Virginia Tech's Center for Tire Research offers summer undergraduate researchers the opportunity to participate in a broad range of research topics including: *Intelligent Tire Systems, A New Test System for Tire-Road Contact Studies, Design and Development of Large Tire Testing System, Miniaturized Electromagnetic Energy Harvester Systems, Finite Element Tire Rig Test Model For Dynamic Tire Model Validation, and Slip and Contact Patch Analysis on Deformable Soil.*

Program director: Dr. Saied Taheri, Center for Tire Research

Student	School	Major	Mentor
Douglas M. Arendt	Virginia Tech	Engineering Science and Mechanics	Saied Taheri and Corina Sandu
Allison N. Brown	Virginia Western Community College	Electrical Engineering	Michael Craft
Jordan I. Ikeda	Virginia Tech	Mechanical Engineering	Saied Taheri
Alisha M. Konst	Virginia Tech	Mechanical Engineering	Saied Taheri
Michael R. Lane	Virginia Tech	Mechanical Engineering	Robert West
Daniel C. Mead	Virginia Tech	Mechanical Engineering	Corina Sandu
James Nee	Olin College	Mechanical Engineering	Saied Taheri
Sheran R. Perera	Virginia Tech	Mechanical Engineering	Saied Taheri
Robin S. Roston	Virginia Tech	Mechanical Engineering	Robert West
Ethan A. Scott	Virginia Western Community College	Mechanical Engineering	Michael Craft and Mehdi Ahmadian
Barkot TekleMichael	Virginia Tech	Mechanical Engineering	Saied Taheri

Douglas M. Arendt

Modal Analysis for Tire Parametrization

Tires are one of the most complex components on a vehicle. They are the only link between the terrain and the vehicle, and so they are studied heavily in the automotive community. Many models for tires currently exist which analyze different tire performance aspects, for instance cornering forces and moments acting on the tire, to tire interaction on different terrains like soil, snow, or ice. All of these models need several tire parameters as input. This project aims to analyze the different mode shapes of a standard testing tire through the principles of modal analysis. A tire is subjected to an oscillating load via a shaker and data is collected by 16 single degree of freedom accelerometers mounted radially around the circumference of a standard testing tire. Once the data is filtered, it is possible to realize the mode shapes, and parametrization of the tire's various natural frequencies can be undertaken. These natural frequencies are used in conjunction with an existing finite element tire model to extract input parameters for and to help the validation of a semi-analytical tire model developed at the Advanced Vehicle Dynamics Laboratory (AVDL) at Virginia Tech.

Mentor(s): Dr. Corina Sandu (Mechanical Engineering); Shahyar Taheri, Ph.D. Student (Mechanical Engineering)

Jordan I. Ikeda and James M. Nee

Development of a testing platform for semi-active suspension control evaluation and refinement

Currently, car handling is permanently set by the springs and dampers installed on a vehicle. Semi-active suspensions allow for the rapid change in suspension stiffness, allowing drivers to achieve both optimal comfort and vehicle handling, responding quickly to changes in driving conditions. To aid researchers in this field, our goal has been to develop a system to assist in the testing and development of semi-active suspensions. These suspensions have variable dampers that can be controlled with as little as 10 Watts, making them suitable for widespread usage. To develop and refine control algorithms it is necessary to run tests using actual vehicle suspensions. This poses a design challenge that requires the construction of a platform that can accommodate a wide range of suspension geometries and also be durable enough to sustain extensive testing. Our solution utilizes t-slotted aluminum extrusions to allow for rapid assembly and modification while also providing the necessary structural rigidity. We went through seven iterations of CAD models to thoroughly address all of the design requirements. Testing is done under the quarter car paradigm, meaning that we simulate an actual vehicle using a quarter of the suspension and the quarter of the vehicle's weight, simplifying the testing process. Through this testing we hope to collaborate with industry partners to implement semi-active control systems in passenger vehicles.

Mentor(s): Dr. Saied Taheri (Mechanical Engineering); Yaswanth Siramdasu , Master's Student (Mechanical Engineering)

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Abstracts: Tire and Automotive Engineering NSF-REU

Alisha M. Konst and Barkot TekleMichael

Slip and Contact Analysis of robotic tires on deformable Soil

Small robots are dependent on their tires to safely and efficiently transport them to their destination. Our objective is to improve the mobility of small robotics for agricultural and military use through tire analysis. By knowing the characteristics of the tires we can predict and adapt to the types of surfaces the robot will come into contact with. Piezo-electric sensors and accelerometers were mounted to the base of the tires to record the pressures and forces small robotic tires undergo during operation. Through testing we concluded that there are distinct patterns in the signals we recorded, that can be associated with different surfaces such as concrete or soil. These patterns allow us to create algorithms that can be used to improve tire models. The slip created between tires and deformable soil can be characterized by the algorithms our research supports and improve the overall function and mobility of small robotic tires.

Mentor(s): Dr. Saied Taheri (Mechanical Engineering); Meysam Khaleghian, Ph.D. Student (Engineering Science and Mechanics)

Daniel C. Mead

Design Enhancement of AVDL Terramechanics Rig

The Advanced Vehicle Dynamics Laboratory at Virginia Tech hosts a unique testing facility: a terramechanics rig. This rig allows the exploration of the interaction between a tire and ground surface. Various tests can be conducted to collect information related to the traction capabilities of tires or other wheels at different slip ratios on the surface of interest, such as on soil or ice. All forces and moments at the tire-ground interface are recorded, as well as other relevant data, such as tire deflection. Using engineering design principles, I have worked to enhance the rig by adding new operational parameters, as well as developing ways to improve the data collection. Part of my work consists of exploring design and control options for an autonomous camber and toe sub-system. The main challenges are the space constraints imposed by the existing physical system, the cost, and the time to completion. Another component of my research consisted of investigating means to maintain the tire-ice system at a constant temperature, and of developing design alternatives for such purpose. Due to cost limitations and the current location of the rig, the best solution has been identified to be a climate chamber limited to the space around the tire that allows the testing to be conducted at a controlled range of temperatures. The work done in this project will facilitate the simulation of steering maneuvers on different surfaces for precise values of camber and toe, and to conduct the tire-ice tests at specified, controlled, temperature values. Overall, the project will enhance the capabilities of the rig and lead to better experimental terramechanics studies.

Mentor(s): Dr. Corina Sandu (Mechanical Engineering); Anudeep Bhoopalam, Ph.D. Student (Mechanical Engineering)

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Abstracts: Tire and Automotive Engineering NSF-REU

Sheran R. Perera

Finite Element Modeling and Analysis of a Rolling Tire

This project will create a full model of the 235/75R15 tire in a Finite Element (FE) software and run simulations to study tire performance and how it is affected by certain properties of the tire. There is a need in the industry to study how automobile performance, such as emergency braking and handling, is affected by tire performance under various conditions. This can be achieved by creating a FE tire model and virtually replicating the environment under study. This allows researchers to use the performance data and incorporate them into their models of the suspension, chassis, Anti-Lock Brake system etc. The performance of a tire can be affected by variations in its properties such as orientation of reinforcement layers, inflation pressure, contact surface, load, etc. The FE model can easily be altered to fit the requirements of the experiment and simulated to study the performance parameters. The FE model has a multitude of uses in the industry and this project will create a quick, accurate and inexpensive tool that will help engineers further develop their research in automotive engineering.

Mentor(s): Dr. Saied Taheri (Mechanical Engineering); Fatemeh Yazdandoost, Ph.D. Student (Mechanical Engineering)

Robin S. Roston and Michael R. Lane

Finite Element (FE) Modeling of Tire Load Transfer to Automotive Suspension Structures

Reducing weight while maintaining proper strength and stiffness is critical to performance vehicle design. The focus of this study is to understand the transfer of forces of forces generated at the tire contact patch and the resulting loads through the steering and suspension structures. In order to determine the forces that act at the tire contact patch in relation to steering and suspension structures, a right front quarter-car suspension model of the 2012 VT FSAE was developed for finite element analysis (FEA). The 2012 VT FSAE car was instrumented and installed in a suspension test rig for testing. Through the course of this project, tire material data was acquired to create a more accurate tire model to be incorporated into the tire/wheel/suspension assembly finite element (FE) model. Loads were transferred through the suspension joints using a Quasi-static FE analysis and testing on the car was done to validate the FE model. The information gained from this investigation have led to a better understanding of how loads are transferred through the suspension structures and will result in improved vehicle design.

Mentor(s): Dr. Robert West (Mechanical Engineering); Rea Cauthen, Master's Student

Harness the Power of Discovery
Virginia Tech Office of Undergraduate Research

Abstracts: Tire and Automotive Engineering NSF-REU

Ethan A. Scott and Allison N. Brown

Suspension Mounted Electromagnetic Energy Harvester Systems

As technology advances and the need to implement more electronics in railcars increases, an issue arises in that power available to freight cars is limited. An innovative approach to providing electricity to freight cars has been developed by researcher, Clément Nagode, by harvesting energy from the linear movement of freight car suspensions. Although the harvester is capable of generating moderate amounts of electricity, when subjected to too much torque, a torque limiting device is activated, leading to a decrease in the power output. The purpose of this research is to develop a transistor-controlled switch which can vary the load resistance within the harvester based upon track conditions. By using a small load resistance in smooth track conditions, more power can be harvested, and by switching to a higher resistance in rougher conditions, the triggering of the torque limiter can be avoided, again yielding a higher power output. To design and test the switch, preliminary harvester research was conducted to see what tests were previously run for determining voltage and power outputs. Characterization tests were done by testing the harvester on a Material Testing System machine under a sinusoidal displacement input. To more closely simulate real life conditions, track displacement data was supplied from Transportation Technology Center, Inc. (TTCi). This research focuses on simulating real life conditions by testing the harvester with the TTCi data and using sensor and harvester performance information to determine when to switch between a high or low load resistance. Testing is currently under way. According to previous research, it can be expected that fair amounts of energy can be regained by preventing power loss caused by the engagement of the torque limiter.

Mentor(s): Dr. Mehdi Ahmadian, Faculty (Mechanical Engineering); Michael Craft, Faculty (Mechanical Engineering)

A significant number of faculty members choose to mentor undergraduates in research, using precious funds, time, and resources to do so. Faculty members are not required to train undergraduates in research, but commit to training these students because they want to invest in the next generation of critical thinkers, scholars, and informed citizens. At Virginia Tech, more than 1000 undergraduates are engaged in independent research projects with faculty each year. Students may conduct research for credit, for pay, or may volunteer. Below are some of these undergraduates who conducted research in summer 2013.

Student	Major	Faculty Mentor(s)
Michele R. Anderson *2013 ACC Scholar	Biological Systems Engineering	Warren Ruder
Nina Blanson	Biomedical Engineering (Yale)	T.M. Murali
Julia A. Cushman	Environmental Science	Kang Xia and Chao Shang
Travis DePriest	Physics	Xiao Zhang and Alan Esker
Evan E. Foley	Mathematics	Sherry Hildreth
Victoria James *Diversity Grant Awardee	English & International Studies	Vinodh Venkatesh
Chelsea Kellinger	Biological Systems Engineering	Brian Tissue
Shannon L. Neal	Biological Sciences	Nicole McMaster, David Schmale, and Kim Harich
David M. Ruohoniemi	Biomedical Engineering	Tim Long and David Bevan
Douglas A. Sampson	Physics	Victoria Soghomonian

Michele R. Anderson

Utilizing microfiber-enabled lithography to engineer spatiotemporally diverse tissue microenvironments

Despite significant research investment in tissue engineering technology over the past decades, relatively few clinically-deployed innovations have been developed that go beyond engineered skin and bone tissues. In those tissue types, the clinical site of repair is frequently proximate to a resident adult stem cell population that can rapidly infiltrate an implanted engineered tissue matrix (e.g., epithelial stem cells infiltrating a collagen matrix to create skin, or mesenchymal stem cells remodeling irradiated cadaver bone to form new bone). However, other tissues are often more spatially and phenotypically complex, and thus pose a greater engineering challenge. One approach toward engineering the cellular environment has been the microscale patterning of extracellular matrix and other biomolecules on substrates using stamps created through photolithographic processes. These approaches require expertise with photolithography and a capital investment in microfabrication equipment and facilities. As an alternate approach to created miniature features, we have used polypropylene microfibers as stamps to imprint soft polydimethylsiloxane (PDMS) substrates. By using colored, water-soluble pigments as a surrogate for suspended biomolecules, we have developed an approach to pattern long, overlapping regions with molecular mixing at intersection points.

Mentor(s): Dr. Warren Ruder (Biological Systems Engineering)

Nina M. Blanson

Predicting Novel Extensions to Mechanistic Models in Systems Biology

My research focuses on utilizing top-down network analysis to identify extensions to existing mechanistic models. This work directly extends the Linker methodology (Poirel et al., Top-Down Network Analysis to Drive Bottom-Up Modeling of Physiological Processes, Bioinformatics, 20, 409-418, 2013), an efficient and automated data-driven method that analyzes molecular interactomes to propose potential extensions to simulated models. Linker combines teleporting random walks and k-shortest paths computations to discover connections from a query protein to a set of proteins collectively involved in an existing bottom-up model. I have extended Linker to facilitate the discovery of multiple non-redundant shortest paths between user-provided query proteins and proteins involved in a model of Saccharomyces cerevisiae and a model of breast cancer in humans. My initial analysis of the data from the Linker publication showcases an interesting fact: the number of unique predicted edges decreases dramatically as the number of paths computed by Linker increases. Although paths with redundant edges can provide interesting biological information, my extensions aim to provide previously unconsidered links between query proteins and modeled proteins for use in the expansion of mechanistic models. Non-redundant, partially edge disjoint shortest paths may provide novel predictions for potential connections to models. As well as providing new edges and k-shortest paths to be shared with modelers, I have worked on visualizations to increase inter-disciplinary communication and collaboration through the utilization of the GraphSpace webserver created by our group. Visual graphs allow the integration of information provided via computational work into an easily read pictoral format.

Mentor(s): Dr. T.M. Murali (Computer Science); Chris Poirel, Ph.D. Student, (Computer Science)

Julia A. Cushman

Analysis of Pirlimycin in Soils

Pirlimycin is a lincosamide antibiotic commonly used to treat clinical and subclinical mastisis in dairy cattle. Pirlimycin is excreted via feces and urine primarily as parent drug but little is known about its post-excretion environmental fate. Development of an advanced, sensitive quantification method would allow better monitoring of pirlimycin in the environment. The objective of this research is to develop a sensitive analytical method using HPLC/tandem mass spectrometry (LC/MS/MS) for quantification of pirlimycin in soils amended with dairy manure. The method involves extraction using pressurized solvent exraction system, solid phase extraction (SPE) clean-up, drying and reconstition followed by LC/MS/MS quantification. Different solvent combination and pH conditions were tested to optimize pirlimycin extraction efficiency and clean up. Methanol/0.1 M aqueous ammonium (1:1, v/v) appeared as the best extractant while optimum elution during SPE was achieved with acetonitrile/acetone mixture (1:9, v/v). After the SPE cleanup, the eluent was completely dried using a vacuum evaporator at 45% speed, 50°C, and 60 mbar. The dried residue was dissolved in 1 mL 0.1% formic acid in methanol/water (3:7, v/v) and analyzed using LC/MS/MS. The recovery and method detection limit for pirlimycin were tested with the goal of achieving the EPA required range of 60-130% for recovery and detection limit of 2 μg/kg.

Mentor(s): Dr. Kang Xia (Crop and Environmental Soil Sciences); Chao Qin, Ph.D. Student (Crop and Soil Environmental Sciences); Chao Shang, Faculty (Crop and Soil Environmental Sciences); Partha Ray, Postdoctoral Research Associate (Dairy Science); Katharine Knowlton, Faculty (Dairy Science)

Travis DePriest

Adsorption and Enzymatic Degredation of Lichenan on Regenerated Cellulose Surfaces

Mixed linkage glucan (MLG) is a hemicellulose component of the cell walls of some cereals, grasses, and lichens. Quartz crystal microbalance with dissipation monitoring (QCM-D) was utilized to study the preparation and enzymatic degradation of lichen MLG (ilchenan) surface layer on regenerated cellulose (RC) substrate. The RC substrate with a thickness of 10 nm and a root-mean-square roughness of 1 nm was prepared by regenerating spincoded trimethylsilyl cellose on gold substrate. The adsorption of lichenan onto RC substrate was studied as a function of temperature and concentration, leading to the formation of soft lichenan layers on RC substrate. A Voigt-based visioelastic model was used to fit the time dependent absorption profiles for theses soft lichenan layers. The lichenan layers prepared from a solution with a 0.05% by mass at 50°C and a thickness of 19± 1 nm, surface concentrations of 21 ± 1 $mg{\cdot}m^{-2}$, elastic shear moduli of (0.32 ± 0.04) $x10^{5}$ $N{\cdot}m^{-2}$ and shear viscosities of (0.98 ± 0.03) $x10^{-3}$ $N{\cdot}s{\cdot}m^{-2}$. The subsequent degradation of these lichenan surface layers by lichenase, an endo-1,3(4)-β-glucanase from *Bacillus subtilis*, was also studied using QCM-D as atomic force microscopy (AFM). Lichenase cleaves β-1→4 bonds adjacent to β-1→3 bonds in the lichenan and has been used in the conversion of lichenan to bioethanol. The degredation of the lichenan layers was studied as a function of enzyme concentration and pH while maintaining constant temperature, substrate surface properties, and ionic strength. Results for these studies will be the focus of the presentation.

Mentor(s): Dr. Xiao Zhang (Chemistry); Alan Esker, Faculty, Chemistry

Evan E. Foley

Arabidopsis Project

The focus of the Arabidopsis Project is to take a metabolomics approach to understanding the temporal response of Arabidopsis thaliana roots to the application of plant hormones auxin and ethylene. My role in the research is to process the raw data files collected from LC-MS analysis in the source program XCMS that runs in "R" software. I am developing a code that transforms these data files into a data matrix including the time points and hormone treatments of interest. From this code, our goal is to determine the metabolomics features that contribute to biological response by creating a list of features meeting our statistical parameters, a Venn diagram summarizing metabolomic changes that occur and a heat map to visually summarize these changes over time. These features will eventually lead us to identify and list specific chemical features by their masses. This will be done by using an extracted MS2 fingerprint to search known metabolite databases to determine the identity of the biological compounds in each sample comparison. Updated feature lists and heat maps are the expected resources of this project that will be used for the biological interpretation of the research question at hand.

Mentor(s): Dr. Sherry Hildreth (Biological Sciences)

Victoria James

¡Buenos días Blacksburg! An Exploration of Latin American Diversity and Culture in Southwest Virginia

The goal of conducting this research was to collect and publish primary source data from the Latin American Student body at Virginia Tech in the form of a bilingual podcast. Interviews focused on the student's country of origin. Interview topics included religion, politics, culture, gender roles, government policy, human rights and the economy. Throughout the interview process, the main objective was to create a wide and diverse compilation of knowledge regarding Latin American students' languages, countries, cultures and societies. The podcast allowed students to exchange valuable and relevant information concerning the diversity of Latin American countries, in an easily accessible and stimulating way. Students who participated in the interviews were given a platform to express their personal views, opinions and ideas regarding life in their countries of origin and in the United States. The bilingual interviews offer highly relevant insights into life in developing countries like Chile, Argentina, Brazil, and Mexico among others that play a major role in the international political economy. The results of the research proved that many students from Latin America feel very welcome in the U.S. Concepts such as personal safety, economic opportunity and political stability were some of the participants' strongest impressions of life in the United States. However, they were also cautiously optimistic about increasing regional integration and cooperation in Latin America. Most participants had positive impressions of diversity in the United States and marveled at how dynamic the American melting pot really is. Further research could compare and contrast the U.S. - Latin American relationship with that of China and Latin America.

Mentor(s): Dr. Vinodh Venkatesh (Foreign Languages and Literatures)

Chelsea Kellinger

Synthesis of Doped Strontium Aluminate for Persistent Luminescence

Persistent luminescence is the process by which a luminescent material continues to emit light after photoexcitation has stopped. During excitation, electrons are promoted to higher energy levels and can be trapped at defect sites. As the electrons thermally are slowly able to settle back down to lower energy levels, they release photons as an observable "after-glow." Strontium aluminate doped with europium, dysprosium, and boron, SrAl2O4:Eu, Dy, B, is one of the brighter after-glow materials with the longest recorded luminescence. We prepared SrAl2O4:Eu, Dy, B by combustion synthesis, determining the ideal ratio of strontium aluminate, dopants, and fuel, the combustion conditions and annealing process. The samples were characterized using infrared spectroscopy, powder x-ray diffraction, and fluorescence spectroscopy. Combusting the compounds as a viscous gel created a large, extremely light, porous mass. After combustion, an air anneal was necessary to remove any carbonates still remaining followed by a H2 anneal to reduce the Eu3+ to Eu2+. Although increasing the annealing time increases the crystallinity, the literature reports it also increases the particle size. Upon complete analysis of this synthesis, these materials can be used for many different applications including photocatalysis or drug delivery.

Mentor(s): Dr. Brian Tissue (Chemistry); Jennifer Rowe, Ph.D. Student (Chemistry)

Shannon L. Neal

Detection of the Mycotoxin Fumonisin B1 through Liquid Chromatography/Tandem Mass Spectrometry

Fumonisin B1 (FB1) is a mycotoxin produced by the common grain mold, Fusarium. FB1 is associated with equine leukoencephalomalacia (ELEM), a neurotoxic disease that affects horses. Presently, there is no cure for ELEM. The only method of prevention is the avoidance of contaminated grain. The goal of this research was to develop a method for detecting FB1 through the use of liquid chromatography/tandem mass spectrometry (LC/MS/MS). We developed a method to detect FB1 by extracting FB1 from 0.5g of a corn matrix sample with 8mL of acetonitrile:water (86:24). The samples were shaken and run through a C18 column attached to a vacuum manifold. The columns were washed twice with 5mL of solvent. The total volume was collected and evaporated under airflow at 70°C. The samples were then suspended in 1mL of acetonitrile:water (50:50) and filtered through a PTFE filter. These samples were then analyzed through LC/MS/MS. The presence of FB1 was confirmed by the precursor ion of 722 m/z and further established with the presence of product ions: 344.4 and 352.5 m/z. A standard curve based on pure FB1 was used to calculate the concentration of each sample from observed peak area. The method used resulted in a recovery rate of 28%. The presence of FB1 was confirmed in multiple unknown corn samples through LC/MS/MS analysis by the identification of precursor and product ions. ELEM could be prevented in the future through the use of appropriate methods to detect and quantify FB1.

Mentor(s): Dr. Nicole McMaster (Plant Pathology, Physiology, and Weed Science); David G. Schmale III, Faculty (Plant Pathology, Physiology, and Weed Science); Kim Harich, Faculty (Biochemistry)

David M. Ruohoniemi

Relative Stability of DNA Complexes with a Phosphonium/Ammonium-Based Cationic Vectors

Macromolecular cationic vectors aid in the process of nonviral gene delivery, a promising new approach to treating human genetic diseases and deficiencies. These cationic vectors complex with DNA plasmids to create gene delivery vehicles that may enter a cell and drive gene expression. Previous studies have focused on ammonium-based vectors, while more recent studies have shown the advantages of phosphonium-based vectors including higher gene expression, lower cytotoxicity, and higher cell viability. To better understand the interactions between these cationic vectors and DNA, molecular dynamics simulations were conducted to compare the two systems. The simulations provide an atomistic view of the interactions that may dictate the differences in efficacy of the vectors. We calculated electrostatic and hydrophobic interactions between each vector and DNA to propose how phosphonium serves as a more effective vector for gene delivery. Simulations have shown that the ammonium-based vectors interact more readily and for longer periods of time with the DNA, possibly indicating that the release from DNA is the rate-determining step in gene delivery. Potential explanations to this phenomenon are that the interactions are driven by differences in hydrophobicity and dissociation may be controlled by charge distribution, two factors validated by findings in our simulations. These results warrant further inquiry into the role of phosphonium-based vectors in efficient gene delivery design. Proper vectors design allows for safe, high-quality gene expression that can influence the treatment of human genetic diseases and deficiencies.

Mentor(s): Dr. David Bevan, (Biochemistry); Timothy Long, Faculty (Chemistry); Anne Brown, Ph.D. Student (Biochemistry)

Douglas A. Sampson

Solid-state electrochemical studies of vanadium centers

We investigate the solid-state electrochemical properties of vanadium in single crystals of a model compound containing hexafluoro vanadium centers, and aim to correlate the redox properties in the solid state to the known values of vanadium species in solution. The purpose of the study is to understand electrochemical processes in the solid-state specifically for transition metal centers such as vanadium, of importance in electrochemical energy storage schemes such as batteries, capacitors, etc. The electrical properties of the single crystals are studied by variable temperature transport measurements, while elemental analysis, single crystal x-ray diffraction, FT-IR and UV-VIS spectroscopies provide us with the chemical composition, 3-dimensional arrangement of the vanadium centers in the structure, characteristic vibrational energies and optical band gap value respectively. In the solid state, the electrochemical properties are investigated through a 3-electrode configuration: working, counter and pseudo-reference. We then calibrate the pseudo-reference electrode versus a standard Ag/AgCl electrode, and we obtain reduction potential values of vanadium centers in the solid state versus a known standard potential. These studies provide a cohesive presentation of electrochemical processes and their interpretations.

REU under NSF Grant 1206338 (DMR-CER)

Mentor(s): Dr. Victoria Soghomonian (Physics); Qifan Yaun, Ph.D. Student

Notes:

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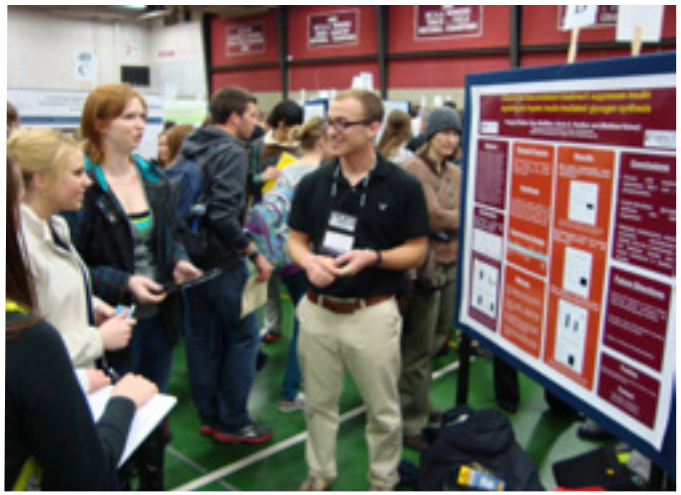

Greg Rodden (SURF 2012) presents at the National Conference on Undergraduate Research.

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Thank you to University Libraries.

You all played a significant role in the success of the summer researchers!

Special Thanks to you!

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Rebecca Miller
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