



Summer Undergraduate Research Symposium

August 3, 2012

Presented by:

VT Office of Undergraduate Research

***Fralin Life Science Institute's Summer Undergraduate
Fellowship (SURF) Program***

HHMI Sciencering Program

HNFE Summer Scholars Program

NSF-REU Sites:

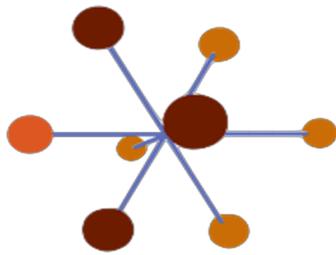
Cognitive Communication

Dynamics of Water and Societal Systems:

StREAM Lab

Microbiology in the Post-genome Era

Interdisciplinary Water Sciences & Engineering



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Fralin Life Science Institute's Summer Undergraduate Fellowship (SURF) Program

HHMI Scieneering Program



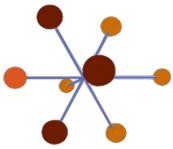
***Human Nutrition, Foods, and Exercise
Summer Scholars Program***

***Microbiology in the Post-Genome Era, NSF- REU Site in the
Virginia Bioinformatics Institute***

***Cognitive Communications, NSF-REU Site in Industrial
Systems Engineering & Electrical and Computer
Engineering departments***

***Dynamics of Water and Societal Systems: StREAM Lab,
NSF-REU in Biological Systems Engineering***

***Interdisciplinary Water Sciences & Engineering,
NSF-REU Site, Engineering Education Department***



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SCHEDULE

8:00–8:30 a.m. – Presenter Registration & Poster Set-up (Lobby Area)

8:00–9:00 a.m. – Breakfast and Guest Registration (Alumni Assembly Hall Atrium)

9:00–9:05 a.m. – Welcome & IGERT Fellowship Information (Alumni Assembly Hall)

9:05–10:05 a.m. – *In Search of the Black Swan* (Alumni Assembly Hall)

**Keynote Address by Dr. Roop Mahajan, Director, Institute for Critical
Technology and Applied Science and Lewis A. Hester Chair in Engineering**

10:05–10:15 a.m. – Break (Alumni Assembly Hall Atrium)

10:15–11:45 a.m. – Poster Session 1 (Latham BCDEF)

Fralin Summer Undergraduate Research Fellowship (SURF) Program

Human Nutrition, Foods, and Exercise Summer Scholars Program

Microbiology in the Post-genome Era, NSF-REU Site in VBI

Life Sciences undergraduate research students

11:45 a.m. – 1:30 p.m. – Lunch (Latham BCDEF, by invitation only)

**Remarks by Dennis Dean, Fralin Life Science Institute & Virginia
Bioinformatics Institute Director
Career Panel**

1:30 – 2:50 p.m. – Poster session 2 (Latham BCDEF)

HHMI Sciencering Program

Cognitive Communications Program, NSF-REU Site in ISE and ECE

Dynamics of Water and Societal Systems: StREAM Lab, NSF-REU Site in BSE

1:45 – 3:00 p.m. – Oral Presentations: Session 1 (Ellett Valley)

Interdisciplinary Water Sciences & Engineering, NSF-REU Site,
Engineering Education

3:00 – 4:15 p.m. – Oral Presentations: Session 2 (Ellett Valley)

Interdisciplinary Water Sciences & Engineering, NSF-REU Site,
Engineering Education

Oral Presentations: Session 3 (Latham BCDEF)

HHMI Sciencering Program

Oral Presentations: Session 4 (Alumni Assembly Hall)

Fralin Summer Undergraduate Research Fellows (Life Sciences)

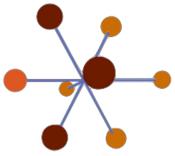
Oral Presentations: Session 5 (Draper's Meadow)

Cognitive Communications Program, NSF-REU Site in ISE and ECE

4:15 p.m. – Break (Alumni Assembly Hall Atrium)

4:30 p.m. – Student Video Unveiling and Vote for winner (Alumni Assembly Hall)

5:30 p.m. – Closing Remarks (Alumni Assembly Hall) and Poster take-down



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At lunch,
remarks
from Dennis
Dean

Director of
the Fralin
Life Science
Institute at
Virginia
Tech

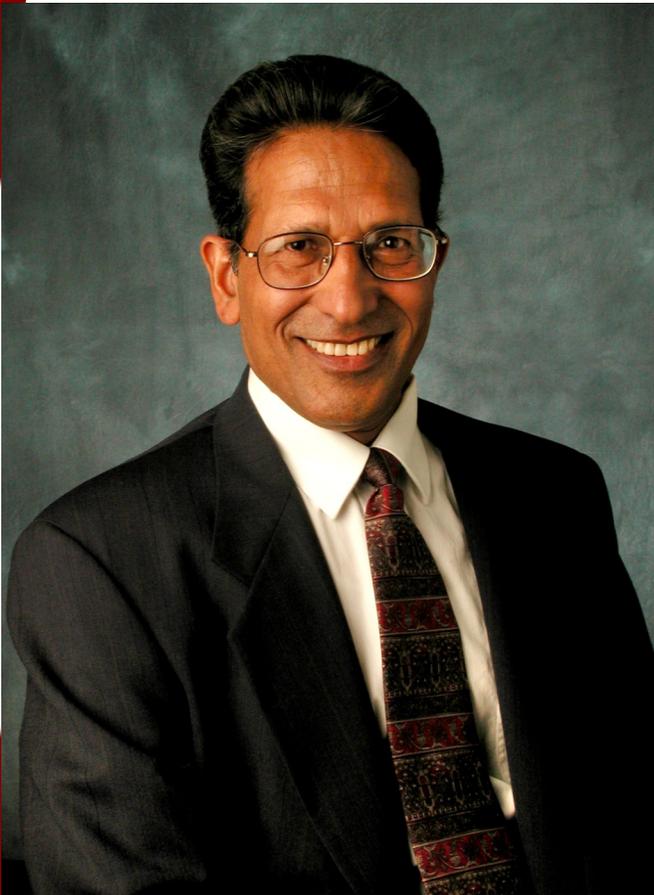




ICTAS

INSTITUTE *for* CRITICAL TECHNOLOGY
and APPLIED SCIENCE *Virginia Tech*

**Roop Mahajan,
ICTAS Director and Lewis A. Hester Chair
in Engineering**



“In Search of the Black Swan”

Innovation remains a potent force for survival. The well-known PBS series “Human Spark.” explores the role of innovation in human development. It notes that although Neanderthals and modern humans evolved from the same ancestors in central Africa, the Neanderthals who left their homeland and settled in the vast expanses of Europe became extinct after living there for 200,000 years. On the other hand, those left behind

evolved into modern humans who have since thrived and populated the planet. A major reason for this difference in fortunes was that Homo sapiens developed the ability to innovate and make the technological great leaps forward that have led to their survival and perhaps the mastery of



ICTAS

INSTITUTE *for* CRITICAL TECHNOLOGY *and* APPLIED SCIENCE *Virginia Tech*

Roop Mahajan,

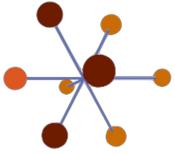
ICTAS Director and Lewis A. Hester Chair in Engineering

In Search of the Black Swan continued....

The ability to innovate is as critical to success and survival in the modern world as it was in the ancient times. To quote Ted Levitt, marketing guru, Harvard Business School, “Just as energy is the basis of life itself and ideas the source of innovation, so is innovation the vital spark of all human change, improvement and progress”. It holds true for individuals as well as corporations and societies and is essential to solving the major problems facing humanity-- energy, water, environment, poverty, terrorism and war, among others. I like to think of innovation as belonging to two separate tracks—the linear and incremental innovation, and thenon-linear and transformative innovation. The first is associated with an extension of a current innovation and may involve cost reduction or the incorporation of a new feature etc. The latter, on the other hand, is disruptive and a game changer--it is a Black Swan.

In his New York Times best seller, "The Black Swan", author Nassim Nicholas Taleb defines a Black Swan as an event that has three characteristics; it is an outlier; it carries anextreme impact; it has retrospective predictability. He further makes a claim that our world is dominated by Black Swans. He cites the example of the three recently implemented technologies that most impact our world today - the Internet, the computer, and the laser - and notes that all three were unplanned, unpredicted, and unappreciated upon their discovery, and remained unappreciated well after initial use.

While it may not be possible to predict the next Black Swan, at least as defined by Taleb, it is my contention that we can create an environment and a breeding ground for future Black Swans - an environment in which engineers, scientists and humanists from different disciplines can come together to move beyond the predictable and incremental advances in current technologies to the transformative science and technology of the future.



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Career panel

Latham BCDEF 11:45-1:30

Introducing your panel...

Richard DiSalvo, Draper Aden Associates



Richard M. DiSalvo, PE, is the Chief Operating Officer for Draper Aden Associates, a civil, environmental and surveying consulting firm headquartered in Blacksburg with offices in Charlottesville, Richmond and Newport News. Draper Aden Associates has consistently been listed in Virginia Business Review as one of the top ten architectural

and engineering firms and in ENR's top 500 national design firms.

Rick began his career in 1977, after graduating with his BS in engineering and began working for the Virginia Department of Health (VDH), Division of Water Programs in Richmond, VA. Given the opportunity for VDH and EPA financing to pursue a Master's Degree, he did so in '78 / '79, studying wastewater treatment at Virginia Tech.

In the mid 1980's, Rick helped to establish a newly opened Richmond branch of Dewberry and Davis where he worked until taking the Blacksburg office manager position with Draper Aden Associates in 1991.

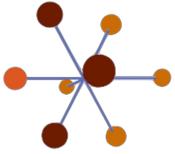
Outside of work, Rick is the Department of Civil and Environmental Engineering Alumni Board Chair, Chair of the Montgomery County Board of Zoning Appeals and is the past chair (2009/2010) of the Virginia Section of the American Water Works Association. He is active in Church and is called upon for various Town and VT ad hoc committees (most recently the Stadium Woods committee). Married to Susan Guthrie DiSalvo ('77 VT grad) a Montgomery County School teacher, they have 3 children. Michael the oldest is a police officer in Richmond, Betsy, also a Montgomery County teacher, and Peter, who currently pursuing a doctorate in Physical Therapy.

Suzanne Noakes, US Patent Office



Dr. Suzanne Noakes is a native of Bismarck, North Dakota. She completed two years of undergraduate study at Creighton

University (Omaha, NE) before transferring to University of East Anglia (Norwich, England) where she completed her undergraduate degree in Biochemistry in 1996. In 2000, she received her Ph.D. in the area of protein crystallography, studying the enzyme nitrogenase, from the John Innes Centre and University of East Anglia (Norwich, England). She worked as post-doctorate research associate from 2000-2003 in the laboratory of Dr. Dennis Dean at Virginia Tech in the area of biochemistry/enzymology. Since 2004 she has been employed as a Biotech Patent Examiner at the U.S. Patent and Trademark Office and reviews patent applications in the areas of Recombinant Proteins and Enzymes; and Protein Crystallography and In silico Drug Design. She became a Primary Examiner in 2008 (e.g. Full autonomous decision making regarding patentability of patent applications). The USPTO offers an extensive telework program for its Patent Examiners and thus she has been able to work full-time from home for the Patent Office while living here in Blacksburg, VA since 2009.



VT OFFICE OF UNDERGRADUATE RESEARCH

Harness the Power of DISCOVERY

Career panel

Latham BCDEF 11:45-1:30

Introducing your panel...

Shawn Semones, Novozymes Biologicals, Inc.



I started with Novozymes Biologicals, Inc. in 1999 at the completion of my Ph.D. I am now the Director of R&D for Novozymes BioAg Group. I am responsible for managing a research and development teams in Salem, VA.,

Saskatoon, Canada, Pilar, Argentina as well as a global field agronomy team. I have global responsibility for delivering on the technology pipeline for the business. Our focus is on three main platforms: 1) Biofertility; 2) Biocontrol; and 3) Bioyield enhancement. My major areas of research expertise are Plant Physiology (how plants respond physiologically to stress), Mycology and Microbiology.

The R&D team has expertise in: Plant physiology, Microbiology Mycology, Weed Science, Community and Ecosystem Ecology, PGPR, Biocontrol (fungicides, bactericides, insecticides, herbicides and algicides), Entomopathogens, Entomology, Molecular Microbiology, Plant Systematics, Mycorrhizal Biology and Ecology, Crop Science, Field Agronomy, Plant Molecular Biology, Plant Pathology, Turfgrass Science, Analytical Chemistry, Seed Inoculants and Plant Breeding.

We conduct lab and field based research dedicated to the development of microbial based technologies for improving plant health, stress tolerance, growth enhancement, and pest control for the production of more and better food, feed fuel and fiber.

Jim Nardone, Defense Intelligence Agency

Mr. Jim Nardone was named the chief of the Technology Warning Division in the Defense Intelligence Agency's (DIA) Directorate for Analysis, Defense Technology and Long Range Analysis Office in 2010. Prior to that position, he was chief of the Strategic Futures Division from 2009-2010. From 2008-2009, he was Managing Editor of the Defense Intelligence Digest, the flagship daily publication of the Directorate of Analysis, DIA. From 2005-2008, he served as a Defense Intelligence Agency representative to the United

Kingdom in London. From 2002-2005 he served as Senior Intelligence Analyst for the Counterterrorism Division in DIA's Joint Intelligence Task Force-Combating Terrorism. From 1997-2002, he served as an all-source analyst, Energy Systems Division, Directorate for Analysis. He currently resides in Charlottesville, Virginia, with his wife and two sons. Company website: www.dia.mil

Steve Baily, Defense Intelligence agency

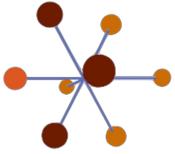


Mr. Bailey is originally from Princeton, WV about 50 miles west of Blacksburg on US Rt. 460. He graduated from Virginia Tech in 1977 with an MS in Sanitary Engineering, UVA in 1994 with an ME in Civil Engineering, and has certificates from Penn State in Acoustics, George Washington University in Modeling and Simulation and Georgia Tech in Radar and Electro-Optic Systems.

After graduating from Virginia Tech, Mr. Bailey worked 6 years with two consulting firms that specialized in water, wastewater and industrial waste treatment facilities. In 1983, he went to work for the Navy Technical Intelligence Center in Washington, DC and spent the next 5 years serving as foreign naval weapons analyst. In 1988, Mr. Bailey moved to Charlottesville, VA and began working for the Army Foreign Science and Technology Center as a ground and air defense weapon and sensor analyst. In May 2010, he went to work for the Defense Intelligence Agency (DIA) as a Senior Intelligence Engineer.

Mr. Bailey was commissioned as an Intelligence Officer in the Navy reserve in May 1984. He has served for the past 28 years in variety of reserve assignments at the Office of the Secretary of Defense at the Pentagon, Office of Naval Intelligence, CIA, DIA, and the European Command in the United Kingdom. Currently, Captain Bailey is a reserve attaché supporting the Defense Attaché Offices in London and Paris.

Mr. Bailey was married for 30 years to Rebecca Bailey who died in November 2010. They have two children, Amanda and Zach. Zach graduated from Virginia Tech in 2006 with a BS and in 2007 with a MS, both in Accounting.



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Career panel

Latham BCDEF 11:45-1:30

Introducing your panel...

Mike Rosenzweig, Education and Outreach Programs- Biological Sciences and SEEDS



Mike is an Advanced Instructor and Director of the VT Biological Sciences Outreach Program. In his position, Mike teaches Principles of Biology to 330+ students each semester; bridges academics and public outreach to K-12 in the life sciences; and develops hands-on

and inquiry teaching tools primarily for the regional and state-wide K-12 community.

Mike is the Director of Seek Education, Explore, Discover - SEEDS, a 501(c)(3) community education organization formed in 1995. In a partnership between VT Biological Sciences Outreach, SEEDS, and the Town of Blacksburg Mike supervises and teaches youth education programs and camps through the SEEDS Blacksburg Nature Center located in the downtown Blacksburg area in the town's historic Price House.

Mike is a member of the Blacksburg Breakfast Lion's club. He enjoys being in his seventh year as a yoga student; and enjoys living within a short bike ride or walk to work and the many outdoor opportunities that we have here.

Mike currently serves on the following committees and Boards:

- Blacksburg Board of Zoning Appeals
- YMCA at Virginia Tech Board of Directors
- Downtown Blacksburg, Inc Board of Directors
- Blacksburg Environmental Management Committee
- Blacksburg's Bennett Hill/Progress Neighborhood Group

Kim Thurlow, NRV Planning District Commission

Kim Thurlow is the New River Valley Livability Initiative Program Coordinator for the New River Valley Planning District Commission (NRVPDC). The Livability Initiative is a three-year multidisciplinary regional planning project funded by the Department of Housing and Urban Development (HUD), the Department of Transportation (DOT), and the Environmental Protection Agency (EPA). Prior to her work with the NRVPDC, Thurlow served as Assistant Director of the Catawba Sustainability Center at Virginia Tech. Thurlow coordinated student and faculty research projects and provided a wide range of project support to the Center and VT EarthWorks, a land based incubator program. Before moving to Virginia, Thurlow also worked for six years as a conservation planner and program manager for The Nature Conservancy's Caribbean and Bahamas Country Programs. She has experience coordinating multidisciplinary research and community outreach projects and has guided the development of management, strategic and land use plans for a variety of non-profit organizations and government agencies. Ms. Thurlow attained her B.A. in Environmental Law and Policy from American University and an M.S. in Environmental Science from The Yale School of Forestry and Environmental Studies.



Biological Systems Engineering

1:45 – 3:00 p.m. – Oral Presentations: Session 1 (Ellett Valley)

Interdisciplinary Water Sciences & Engineering, NSF-REU Site, Engineering Education

Josh L. Caldwell, *Hot Water Heater System Design: Effect on Water Quality Parameters Associated with Biological Activity*

Meghan F. Risky, *Oxygenation at Falling Creek Reservoir*

Kate E. Aulenbach, *Macropores As Preferential Flow Paths And Their Effects On Surface Water-Groundwater Exchange Within Hyporheic Zones*

Zach S. Bailey, *Applications of Molecular Tools For Exploration of Microbial Community Structure and Function at the Bemidji, Minnesota Oil Spill Site*

3:00 – 4:15 p.m. – Oral Presentations: Session 2 (Ellett Valley)

Interdisciplinary Water Sciences & Engineering, NSF-REU Site, Engineering Education

Ashley E. Griffin, *Taste Threshold of Manganese in Drinking Water*

Jennifer L. Moutinho, *Investigating the Occurrence and Fate of Organic Contaminants in a Watershed Impacted by Urban Development*

Maureen R. O'Brien, *Antibiotic Resistance Genes in Recycled Water*

Manuel A. Martinez, *Integration of Software and Hardware Components for a Real-Time Environmental Monitoring System*

William J. Raseman, *Effect of Bioavailable Fe³⁺ on the Sustainability of Monitored Natural Attenuation of Petroleum Hydrocarbons*



3:00 – 4:15 p.m. – Oral Presentations: Session 5 (Draper’s Meadow)

Cognitive Communication, NSF-REU Site in ISE and ECE

Biniyam A. Zewede, Joseph Smith, Tapas Misra, and Matthew Montgomery

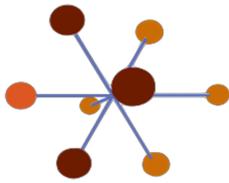
Cooperative Spectrum Sensing

Thomas P. Zachariah, Rafael Isaac, Lilian Kim, and Norberto Rios

Development of space weather monitoring system and statistical study of GPS scintillations

Diane Kayitesi, Josh Noble, Adam Rozenberg, and George Micros

Cognitive Performance Evaluation



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3:00 – 4:15 p.m. – Oral Presentations: Session 3 (Latham BCDEF)
Life Sciences & Engineering

Apoorva Mishra (Fralin SURF), *Accelerating mitotic progression can cause chromosome segregation errors in the form of chromosome bridges.*

Jennifer G. Park (Fralin SURF), *The effect of high fat diets on mTOR signaling pathways in red muscle from BCATm KO mice.*

William R. Klima, Robert Burnham, Kevin Sprenger, and John Fenninger (HHMI Sciencering) *An Introduction to Tech Transfer: Assessment, Protection, and Licensing*

AhRam Kim (HHMI), *Controlling Biofilm Formation of Candida Albicans on Medical Implant Materials Using Nanofiber Texture*

Benjamin Fox, *Detection of Histophilus somni using Ionic Self-assembled Multilayer Technology*

3:00 – 4:15 p.m. – Oral Presentations: Session 4 (Alumni Assembly Hall)
Fralin SURF

Kelly C. Drews, *Identification and characterization of novel intracellular effectors from Aspergillus fumigates*

Alicia R. Peters, *Host identity and number of ectosymbiont species alter host-cleaner interaction in a cleaning symbiosis*

Alex J. Garretson, *Loggerhead Shrike Habitat Evaluation: A comparison of abundance and carbon isotope ratios of Orthopterans in native vs non-native grasslands*

Jennifer A. Samuels, *Systems dynamic modeling of latent tuberculosis and drug resistance for South Africa*

Kathryn E. Battle, *Antibiotic Resistant Escherichia coli in African Wildlife in Botswana*

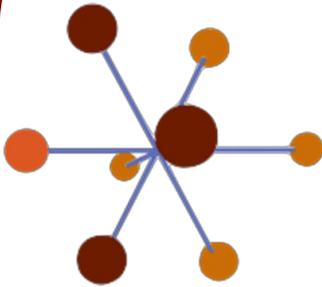


Summer Undergraduate Research Fellowship (SURF) Program

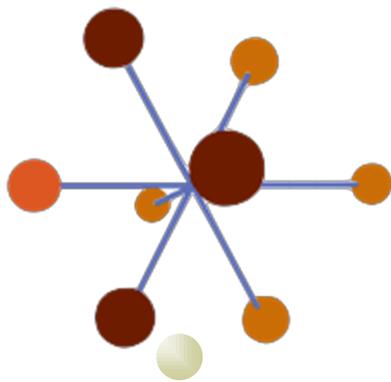
Program Manager: Tomalei Vess, VT Office of Undergraduate Research

Program administration: Ceci Elpi, Fralin Life

Science Institute; Ann Rogers, Fralin Life Science Institute; and Anita Dodson, VT Office of Undergraduate Research



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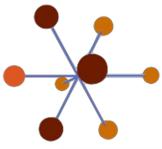
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The Fralin Life Science Institute SURF (Summer Undergraduate Research Fellowship) Program

Mentors: Kaja Abbas, Population Health Sciences; Kathleen Alexander, Fish and Wildlife Conservation; Bryan Brown, Biological Sciences; Amy Brunner, Forest Resources & Environmental Conservation; Daniela Cimini, Biological Sciences; Linda Dahlgren, Large Animal Clinical Sciences; Joseph Eifert, Food Science and Technology; W. Mark Ford, Fish and Wildlife Conservation; Madlyn Frisard, Human Nutrition, Foods, and Exercise; David E. Gerrard, Animal and Poultry Sciences; Deborah Good, Human Nutrition, Foods, and Exercise; Thomas Gorman, Fish and Wildlife Conservation; Carola Haas, Fish and Wildlife; Dana Hawley, Biological Sciences; Matthew Hulver, Human Nutrition, Foods, and Exercise; Susan Hutson, Human Nutrition, Foods, and Exercise; Thomas Inzana, Biomedical Sciences and Pathobiology; Tom Inzana, Biomedical Sciences & Pathobiology; Shiv Kale, Virginia Bioinformatics Institute; Thomas Kuhar, Entomology; Timothy Larson, Biochemistry; John McDowell, Plant Pathology and Weed Science; Bill McShea, Smithsonian Institution; Stephen Melville, Biological Sciences; David Mittelman, Virginia Bioinformatics Institute; Andrew Neilson, Food Science and Technology; Sakiko Okumoto, Plant Physiology; James Parkhurst, Fish and Wildlife Conservation; David Popham, Biological Sciences; Sharon Ramey, Psychology; Michelle Rhoads, Animal and Poultry Science; Marissa Rylander, Mechanical Engineering; Andrew Rypel, Fisheries and Wildlife; Webster Santos, Chemistry; Richard Veilleux, Horticulture; Boris Vinatzer, Plant Pathology, Physiology, Weed Science; Pavlos Vlachos, Mechanical Engineering; Mark Williams, Horticulture; Kang Xia, Crop & Soil Environmental Sciences

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Abstracts: Fralin SURF (Summer Undergraduate Research Fellowship)

2. Alex J. Garretson

Loggerhead shrike habitat evaluation: A comparison of abundance and carbon isotope ratios of orthopterans in native vs. non-native grasslands

Loggerhead shrikes (*Lanius ludovicianus*) have declined dramatically in the eastern U.S., largely due to the conversion of native warm season grasslands (NWSG) to non-native cool season grasslands (CSG). Evidence suggests that arthropod prey is most abundant in NWSG. However, in areas with a mix of NWSG and CSG, it is unclear whether arthropod abundances are significantly different between fields. Also, field ornithologists lack the techniques to determine which patches of habitat shrikes are successfully foraging in. In this study I 1) sweep netted 7 NWSG and 7 CSG adjacent to them to compare arthropod abundances, 2) determined whether carbon isotope ratios were different in Orthopterans caught in different field types, and 3) fed Orthopterans found in each grass type to captive shrikes to determine whether the carbon isotope ratios of the grasshoppers were detectable in the shrikes' feces. The most abundant large insect prey (at least 1.5 cm) in both field types were Orthopterans, yet I found more per trial in NWSG. I found that there was a difference in carbon isotope ratios between Orthopterans caught in NWSG vs. CSG. I am still determining whether this difference in carbon isotope ratios is detectable in shrike feces.

Mentor: Carola Haas

4. Benjamin R. Fox

Detection of histophilus somni using Ionic Self-assembled multilayer technology

Histophilus somni is a gram-negative bacterium causing bovine respiratory disease and a variety of systemic infections. Better diagnostic tests are required to detect *H.somni*. Our goal was to develop Ionic Self-assembled Multilayer (ISAM) technology to detect *H. somni*. A 400-bp product specific for the 16S-rRNA region of *H. somni*

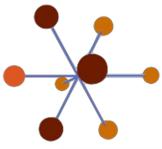
was PCR amplified. A biotinylated DNA probe specific for the 16S-rRNA was coupled to the streptavidin-coated magnetic beads, followed by the test sample containing the PCR-amplified DNA. Binding of the sample with the biotinylated probe was detected using a second probe labeled with digoxigenin. Reaction of the PCR sample produced a purple color, suggesting that the biotinylated-probe is suitable for use in ISAM assays for detecting *H. somni*. We then assembled the ISAM layer on the optical fiber, coupled the biotinylated-probe on to ISAM, reacted the negative control or the PCR sample with the ISAM/probe duplex, and quantified the light transmission through fiber. Reaction of the negative control or the PCR-sample produced respectively -0.43% and 50.17% attenuation of light transmission, suggesting that the assay is useful in detecting 2336-specific DNA. Further work is underway to use this assay to detect *H. somni* in tissues from animals infected with the bacterium.

Mentor: Tom Inzana

6. Byron W. Hayes

Chemotaxis contributes to the virulence of the plant pathogen pseudomonas syringae

Bacteria are able to detect environmental chemical cues through methyl-accepting chemotaxis proteins (MCPs). MCPs initiate a phosphorelay transduction system that controls motility and forms the mechanism known as chemotaxis. We analyzed the role of two chemotaxis pathways of *Pseudomonas syringae* during plant interactions by disrupting a core component of both of the chemotaxis histidine-aspartate phosphorelay systems, cheA1 and cheA2. Both pathways contribute to chemotaxis through different mechanisms - the che1 pathway is associated with type IV pili motility and che2 is associated with flagellar motility. Furthermore, disrupt-



Abstracts: Fralin SURF (Summer Undergraduate Research Fellowship)

ions in both the cheA1. Both pathways contribute to chemotaxis through different mechanisms - the che1 pathway is associated with type IV pili motility and che2 is associated with flagellar motility. Furthermore, disruptions in both the cheA1 and cheA2 pathway led to a significant reduction in growth in host plants. Disruption of cheA1 significantly reduced delivery of virulence factors into plants suggesting a basis for the variable growth of the chemotaxis mutants in plant hosts. On the opposite, in nonhost plants disruptions frequently led to an increase in growth exposing an important role for these pathways in determining the host range of *P. syringae*.

Mentor: Boris Vinatzer

8. Calvin Stephens

Validation of repeatSeq genotyping tool

Repetitive sequences are biologically and clinically important because they can influence traits and disease, but repeats are challenging to analyze using short-read sequencing technology. We present a tool for genotyping microsatellite repeats, called RepeatSeq, which employs Bayesian model selection guided by an empirically derived error model that incorporates sequence and read properties. To validate the accuracy of this tool, PCR amplification using primers designed specifically for the repetitive regions was performed followed by Sanger sequencing. Further analysis of the true alleles of the repeat loci was performed using basic molecular cloning techniques. The ambiguity associated with these repetitive sequences, especially when heterozygosity is present, was minimized through selection of single clones of individual alleles. We also compare RepeatSeq to the only other currently available tool, lobSTR, and find that RepeatSeq makes far more genotype calls than lobSTR and the accuracy of RepeatSeq is slightly better than lobSTR.

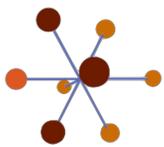
Mentor: David Mittelman

10. Connor Grimes

Construction of an efficient shuttle vector for Histophilus Somni

Histophilus somni is a Gram-negative coccobacillus and obligate inhabitant of bovine and ovine mucosal surfaces. Commensal strains are commonly found in the genital tract, while pathogenic strains are agents of pneumonia, myocarditis, thrombotic meningoen- cephalitis, and other diseases. To identify genes involved in virulence, a more efficient system for genetic manipulation is needed due to the tight restriction-modification system in *H. somni*. A small, native plasmid (pHS649) from *H. somni* strain 649 was isolated and modified to contain a streptomycin resistance marker from pLS88 (pHS649S). pHS649S was successfully electroporated into preputial isolate 129Pt, isolated from 129Pt, and will be moved into pneumonia isolate 2336. The gene lob2A will be cloned into pHS649S to complement a lob2A mutant of strain 2336, to confirm if pHS649S can be used as a shuttle vector. The streptomycin resistance gene will be replaced with a kanamycin resistance cassette from the Tn5 <Kan2> gene from pUC4-kixx. A multiple cloning site from pGEM-3Z will then be added in frame with an *H. somni* promoter. This new shuttle vector should have much higher transformation efficiency due to its small size and origin from *H. somni*, and can then be modified to be a temperature-sensitive suicide vector.

Mentor: Tom Inzana



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12. Jennifer A. Samuels

Systems dynamic modeling of latent tuberculosis and drug resistance for South Africa

Objective: To analyze the effectiveness of the treatment of latent tuberculosis infection (LTBI) in South Africa using system dynamics modeling, incorporating the risks of developing drug resistance. Background: LTBI is non-infectious and asymptomatic. However, LTBI can develop into tuberculosis disease. South Africa has a large TB epidemic that is intensified by multi-drug resistance and TB/HIV co-infection. Methods: A system dynamics model simulates the transmission dynamics of tuberculosis and will assess the effect of treating LTBI. Three different scenarios were tested: null drug resistance, inclusion of treating drug resistant TB, and the inclusion of treating drug resistant and drug sensitive LTBI. Results: The tuberculosis transmission rate was estimated to be 5.813 cases per million contacts between susceptibles and infectious people. Among those with LTBI, an incidence of 1.69 cases for 1000 person-years and a recovery rate of 400 people from drug sensitive TB for every 1000 person-years were estimated. Conclusion: Based on preliminary results, we are unable to draw conclusions on the epidemiological impact of LTBI treatment. We are conducting further work to determine the effectiveness of LTBI treatment, considering the risk of drug resistance.

Mentor: Kaja Abbas

14. Jocelyn Funes

The viability response of MDA-MB-231 and MRC-5 cells in different type I collagen hydrogel micro-environmental condition

To fully understand the effect of three-dimensional cell culture in Type 1 collagen hydrogels, different microenvironmental conditions must be tested. First, the viability and proliferation of MDA-MB-231 human breast cancer cells were tested when seeded in varying collagen concentrations (1.0, 1.5, 2.0, 4.0, 8.0, 10.0 mg/ml) in 48 well dish

molds. Results were assessed using a calcein AM/propidium iodide LIVE/DEAD assay on Days 1, 3, 7. Another test assessed the viability of the MDA-MB-231 mixed in collagen (8.0 or 10 mg/ml) and injected into FEP tubing fit concentrically with a 2.0" 22G needle, essentially inhibiting oxygen supply. The FEP mold is necessary to fabricate microfluidic collagen scaffolds for more complex culture conditions. Results were obtained at 15 min, 30 min and 1 hr post seed using the LIVE/DEAD assay. Second, MRC-5 human fibroblast cells have a tendency to significantly contract the collagen scaffolding. Henceforth, a study was conducted in which MRC-5 cells were treated with 0.05 mg/ml of Mitomycin-C (and compared to untreated MRC-5 cells as control) in an effort to inhibit contraction. The results were assessed using an F-actin stain, an alamarBlue metabolic assay, and a LIVE/DEAD assay on Days 1 and 4. Results for all experiments are pending.

Mentor: Marissa Nichole Rylander

16. Laura Griffin

Dietary grape seed extract administered at 10 mg/kg prevents increases in body fat percentage induced by high-fat feeding in male C57BL6J mice

Grape seed inhibits metabolic syndrome, potentially by preventing gut barrier dysfunction. A compromised gut barrier may increase gut permeability to antigens and systemic endotoxemia. This study was conducted to investigate whether grape seed extract (GSE) inhibits the development of metabolic syndrome by protecting against gut barrier dysfunction and lowering circulating endotoxin levels. Mice (N=48) were randomly assigned to control (C) or high fat (HF) diets (10% or 45% kcal from fat) and GSE was administered to the mice at 0-100 mg/kg/d within diets (n=8/dose/diet). At week 9, average



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within diets (n=8/dose/diet). At week 9, average percent weight gains for C/0, C/100, HF/0, HF/10, HF/50, HF/100 were 8.3, 16.7, 33.0, 26.5, 40.1, and 36.7%, respectively. Changes in body fat percent were 5.1, 5.2, 11.2, 9.5, 15.7, and 15.8% for C/0, C/100, HF/0, HF/10, HF/50, HF/100, respectively. Based on 1-way ANOVA with Bonferroni's multiple comparison test, HF diet increased weight gain significantly ($P < 0.05$) compared to control for all treatments of GSE. HF significantly increased fat gain compared to C/0, however, fat gains in HF/10 mice were not significantly greater than C/0, while all other HF and GSE treatments were significantly greater than C/0. Therefore, 10mg/kg GSE appears to inhibit body fat percent increases induced by HF diet.

Mentor: Andrew Neilson

18. Matthew D. Thompson
Characterizing fluid flow over a "flying snake" (*C. Paradisi*) using particle image velocimetry

Out of the many methods of gliding, the "flying snake" (*Chrysopelea paradisi*) is the only animal known to actively generate lift while gliding. Most gliding animals extend their skin to act as wings to control their descent, even though *C. paradisi* does not have this feature it is still able to produce lift to glide. *C. paradisi* utilizes an undulating motion while increasing its cross-sectional area to produce lift. My aim was to examine the fluid flow around the cross-sectional area of the snake to provide insight into what mechanisms allow *C. paradisi* to generate lift. I used particle image velocimetry to examine the fluid flow around an anatomical model of *C. paradisi* in a water tunnel. Particle image velocimetry is a statistical non-invasive method of characterizing fluid flow by seeding the fluid with micron sized particles and taking multiple images of the particles. From these images the velocity of the flow can be estimated. I expect to find that *C. paradisi* is

able to optimize its vortex shedding and interactions with anterior sections of the snake to generate the lift necessary for *C. paradisi* to glide. Understanding how *C. paradisi* is able to fly may provide insight into non-traditional methods of flight.

Mentor: Pavlos Vlachos

20. Michael S. Krug
Nuclear-to-cytoplasmic partitioning of the Nescient helix-loop-helix 2 protein

Signals of energy availability converge on central nervous system neurons, where changes in gene expression translate into energy homeostasis. Nescient helix-loop-helix 2 (NHLH2), a neuronal basic helix-loop-helix transcription factor, plays a key role in controlling gene expression in response to these signals. Negative energy balance causes a significant decrease in Nhlh2 expression, whereas positive energy signals such as increased leptin secretion by fat, leads to an increase in Nhlh2 mRNA levels. This proposed study tests the conditions of serum-deprivation and leptin stimulation, and their effect on Nhlh2 nuclear-to-cytoplasmic localization. New work from our laboratory suggests that acetylation, and/or phosphorylation of Nhlh2 shuttles the protein between the nuclear and cytoplasmic compartments. Western results show that Nhlh2 protein has slower migrating bands, present more prominently in the serum-deprived, than in the leptin- or serum-treated conditions. These bands most likely represent secondary modifications of the Nhlh2 protein. A human-derived mutation in the Nhlh2 protein results in a significant structural change in Nhlh2, but does not appear to affect these secondary modifications, or nuclear-to-cytoplasmic partitioning. As the slower migrating band is more prominent in serum-deprived conditions, future work to characterize phosphorylation and/or acetylation sites in Nhlh2 are necessary to understand their role in cellular partitioning.

Mentor: Deborah Good



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22. Ashley K. Lohr

Evaluating the maximum lethal temperature of the brown marmorated stink bug (*Halyomorpha halys*)

The brown marmorated stink bug (BMSB) is an invasive insect from east Asia that has rapidly become a major agricultural and household pest throughout the mid-Atlantic U.S. The extent to which this bug is capable of spreading in North America and elsewhere is currently difficult to determine because the temperature extremes at which these bugs can survive are unknown. This project investigates the maximum lethal temperature of the BMSB. Field-collected BMSB nymphs (ten bugs per rep) were placed in a Fisher Scientific Isotemp Incubator and exposed to elevated temperatures ranging from 35 to 45 °C for up to four hours or until all bugs died. A total of 120 BMSB nymphs were placed in the oven at five different temperature ranges (35-36, 37-38, 39-40, 41-42, and 43-45 °C). Temperatures from 40-42 °C resulted in 40% mortality and temperatures greater than or equal to 43 °C (109 °F) produced 100% mortality in fewer than four hours. Certain areas of southeastern Virginia typically experience temperatures that may be detrimental to BMSB. The results of this experiment will aid in predicting the potential geographic distribution and the climatic limits of the BMSB.

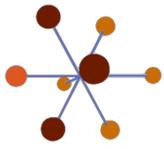
Mentor: Thomas Kuhar

24. Daniel J. Inman

Temporal expression of scleraxis following nucleofection in mouse mesenchymal stem cells

Tendon and ligament injuries are common in people and horses. Strategies for directing stem cell differentiation into mature ligament fibroblasts are lacking. The transcription factor scleraxis is believed to play an early role in initiating stem cell differentiation along a ligament lineage. The purpose of this study was to characterize the temporal expression of scleraxis following nucleofection in mouse mesenchymal stem cells (MSCs). MSCs were nucleofected with the scleraxis plasmid and maintained in selection or normal growth medium and harvested for gene expression and protein production at multiple time points from 2 hours to 7 days. Nucleofection followed by maintenance in normal growth medium is expected to result in a rapid increase in overexpression, which will remain elevated for two days before returning to baseline by 72 hours. Nucleofection followed by maintenance in selection medium is expected to result in scleraxis overexpression for all seven days of the trial. Results are expected to show that MSCs can be induced to overexpress scleraxis for varying lengths of time depending on the type of medium in which they are maintained. Verification of prolonged expression is essential for later studies investigating the ability of scleraxis overexpression to drive ligament differentiation in mouse MSCs.

Mentor: Linda A. Dahlgren



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26. Grace K. Lee

Expression and characterization of ROP GTPase and pyruvate kinase, two interacting proteins associated with wood formation in poplar

Developing a better understanding of the protein-protein interactions that are central to the regulation of lignocellulosic biomass (wood) formation is crucial to meeting national goals of using wood for the sustainable production of biofuels and bioproducts. Here, we describe our efforts to characterize the function of two interacting proteins associated with wood formation in poplar. ROP (Rho of Plants) GTPases are signaling proteins that regulate cell elongation and differentiation, two fundamental aspects of wood formation. In poplar, PB15 is a ROP GTPase that is highly upregulated in wood-forming tissue. PB484, a pyruvate kinase, interacts with PB15 in yeast two-hybrid assays. We hypothesize that PB484 modulates PB15 activity through pyruvate kinase-catalyzed production of GTP. To further study the PB15/PB484 interaction and its effects on GTPase and pyruvate kinase activities, we cloned two recombinant proteins, GST-PB15 and 6H-PB484, with glutathione S-transferase and poly-histidine tags, respectively, for expression in *E. coli*. High levels of GST-PB15 were expressed and after testing various conditions for elution from glutathione-sepharose, a highly purified preparation of GST-PB15 was obtained. In contrast, 6H-PB484 was apparently not expressed at high levels in *E. coli*. Results from GTPase activity assays and continuing efforts to express and isolate 6H-PB484 will be reported.

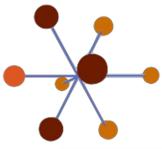
Mentor: Amy Brunner

28. Gregory R. Rodden

Effects of toll-like receptor 4 (TLR4) activation on carnitine acetyltransferase (CrAT) in skeletal muscle: possible links to insulin resistance in obesity

Blood concentrations of lipopolysaccharide (LPS) are known to be chronically elevated in the obese state, a condition known as metabolic endotoxemia. LPS is the known ligand for toll-like receptor 4 (TLR4), a protein integral to an innate immune response. The Hulver laboratory, and others, have shown that the expression of TLR4 is elevated in skeletal muscle of obese and/or type 2 diabetic humans relative to healthy controls. Additionally, the Hulver laboratory has observed that chronic (24 hours), but not acute (2 hours), LPS treatment impairs insulin signaling in skeletal muscle cells. Carnitine acetyltransferase (CrAT) is an enzyme responsible for mitochondrial export of acetyl groups in times of acetyl-CoA overload, and is negatively associated with insulin resistance. The hypothesis of this work was that chronic treatment with LPS would suppress CrAT expression in C2C12 myotubes. To this end, C2C12 myotubes were treated with LPS (20 EU) for 2 and 24 hours and CrAT mRNA was measured. Relative to controls, CrAT mRNA expression was significantly ($p < 0.05$) decreased at 24 hours of LPS treatment but not 2 hours. These results warrant further study into the role of TLR4-modulated CrAT activity as a potential mechanism for skeletal muscle insulin resistance.

Mentor: Matthew Hulver



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30. Jennifer Park

The effect of high fat diets on mTOR signaling pathways in red muscle from BCATm KO mice.

The branched chain amino acid leucine is known to stimulate protein synthesis through the mammalian target of rapamycin (mTOR) signaling pathway. Male mice lacking functional branched chain aminotransferase (BCATm KO) have elevated serum leucine levels and are much leaner than their wild-type (WT) littermates, which may be due to an energy-demanding futile cycle of protein turnover. This phenotype is exacerbated when the mice are fed a diet with 45% of the calories derived from fat. To determine if differential mTOR signaling is involved, the phosphorylation state of proteins in the mTOR signaling cascade were assessed. Red muscle tissue (soleus) from BCATm KO and littermate WT mice fed a high fat diet for 12 weeks were studied. Using the Western blotting technique, the levels of ribosomal protein S6, 4EBP1, AKT, and AMPK, both in their total and phosphorylated forms, were measured. Although differences in the amount of total protein were found between BCATm KO mice and WT mice for the target proteins, the ratios of phosphorylated over total protein between BCATm KO mice and WT mice were not significantly different. This suggests that mTOR is not differently activated in red muscle from BCATm KO and WT mice on high fat diet.

Mentor: Susan Hutson

32. Jeronimo Da Silva Neto

Demographics of one of the rarest anurans in North America

Often we are unable to conserve a target species because we lack basic natural history information. The Florida bog frog (*Lithobates okaloosae*), discovered in the 1980s, is considered a species of special concern in Florida because of its limited distribution. This species is endemic to

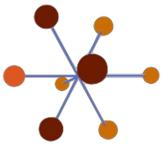
three counties in Northwest Florida, and its geographic range occurs almost exclusively on Eglin Air Force Base. Since little is known about this species' population demographics, we used a mark-recapture approach to examine 1) population sizes at multiple sites and across multiple years, 2) the recapture rates of males among sites, within years, and between years, 3) the relationship between male body condition and residency time, and 4) variation among male body condition across sites. We captured a total of 161 adult male Florida bog frogs at 1 site from 2002-2003 and 4 sites from 2006-2008. We documented that male bog frog population sizes and recapture rates were not different among sites (n=3) and across years (2006-2008). Lastly, residency was not explained by body condition and body condition was not different across sites. Understanding this species' population status will aid future conservation efforts and management of the species.

Mentor: Thomas A. Gorman

34. Jiaming L. Yao

The effect of manipulation of amino acid export from the maternal plant tissues on the protein and lipid ration in seeds

In this summer research program we set out to examine the hypothesis that manipulation of amino acid export from maternal plant tissues will change the protein and lipid ratio in seeds. In daily life, seeds provide oils that are used as a food source or fuel. In addition, some seeds are rich in protein, serving as the primary protein source in food and feed. Therefore, the ability to control a seed's protein and lipid ratio has a promising future both in the energy industry and in human/animal nutrition. We target three genes, Bidirectional Amino acid Facilitator (BAF) 9, BAF 22 and BAF 23, which are preferentially expressed in the seeds of *Arabidopsis*



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thaliana. The project consisted of three objectives; 1) Quantification of protein and lipid in a gene knockout of BAF9, 2) Construction of artificial microRNAs targeting BAF22 and BAF23 genes and 3) Overexpression of an additional amino acid transporter in the developing seed coat. The collected data will be used to evaluate the effects of amino acid export from maternal tissue on seed composition.

Mentor: Sakiko Okumoto

36. Kara B. Kosarski
Effect of Social Dominance on Sickness Behavior Expression in House Finches (Carpodacus mexicanus)

Individual behavior has great potential to influence the spread of directly-transmitted pathogens. In social species, dominance status is a significant source of behavioral differences that may influence pathogen transmission. Here we explore the links between dominance status and sickness behaviors, which are expressed during infection, in a social bird species, the house finch (*Carpodacus mexicanus*). House finches are susceptible to infection by the bacterial pathogen *Mycoplasma gallisepticum* which causes severe conjunctivitis and sickness behaviors like lethargy and anorexia. Because dominant individuals maintain better control of food resources, we predict they will display sickness behaviors to a greater extent than subordinates. Birds were housed in small groups and dominance hierarchies assessed via focal observation. The most dominant or subordinate individual per group was injected with lipopolysaccharide, which initiates sickness behaviors, or saline as a control. Behavior was quantified using focal observations after injection and anorexia was quantified by measuring weight before and after injection. The extent of sickness behaviors can greatly influence transmission because individuals

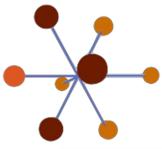
that express lethargy and anorexia will be less likely to contact other individuals and spread disease. Therefore, this research will shed light on how social status influences the probability of spreading diseases such as *M. gallisepticum*.

Mentor: Dana Hawley

38. Roxzanna D. Dalton
Prey selection of coyotes in western Virginia

Prey selection strategies of coyotes (*Canis latrans*) in western Virginia were studied by comparing prey abundances with frequency of occurrence in coyote scat. Mark-recapture methods and program MARK were used to determine that mice (*Peromyscus spp.*), eastern chipmunks (*Tamias striatus*), and voles (*Clethrionomys gapperi* and *Microtus spp.*) occur with a frequency of 60.82/ha, 7.41/ha, and 4.77/ha, respectively, throughout the study site. Density was determined by placing Sherman live traps baited with sunflower seeds and bedding materials in 8x8 grids with 10 meters between each trap at eight different locations in Bath County. These traps were checked twice daily for five days and each captured animal was marked with a unique ear tag. Coyote scat was also collected along sixteen, 5 km transects on roads and trails in public and private lands. To determine frequency of occurrence of these mammals, dichotomous keys and reference collections were used to identify bones and teeth found in the coyote scat. This data and program SCATMAN were used to test whether coyotes in this region are behaving as generalists, consuming prey items in proportion to their availability, or specialists, targeting specific prey items.

Mentor: James Parkhurst



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40. Alexandre P. Marand

Transposon tagging in *Arabidopsis thaliana* with transposase under the control of the sidecar pollen promoter

Transposons are DNA gene sequences that can change their relative position in the genome, and are typically referred to as transposable elements. The transposase gene is usually located on a non-mobile Activator (Ac) element and is transcribed/translated by the cellular machinery into the transposase protein, which recognizes conserved inverted repeats. The inverted repeats flank the mobile Dissociator (Ds) element. Transposase cleaves the DNA within the inverted repeats, and randomly inserts the Ds element in another site within the genome.

Expression of transposase depends upon the promoter sequence. With a constitutive promoter, expression occurs in somatic tissue, leading to genetic mosaic plants with Ds transposed to new sites in different tissues. This can hinder the development of transposon tagged populations by generating seedlings with the same transposition site. The sidecar pollen promoter derived from Genbank accession AT3G47870 directs transcription within male gametophytic tissue, restricting expression to pollen producing cells. By using this promoter to drive transposase in a vector for *Agrobacterium tumefaciens* GV3101-mediated transformation, we hope to direct transposon tagging to developing pollen grains, thereby generating unique transposon tagged lines. We transformed *Arabidopsis thaliana* Columbia strain with the new construct and screened the seedlings by fluorescence microscopy for EGFP expression indicative of an intact Ac/Ds element. The GFP positive seedlings were planted and allowed to self-pollinate. Seeds were collected and again screened for GFP expression. Seedlings lacking GFP expression but still harboring the Ds element represent possibly unique transposon tagged lines. Tracking of their putative insertion sites can be accomplished with

high-efficiency Thermal Asymmetric Interlaced Polymerase Chain Reaction (hi-TAIL PCR).

Mentor: Richard Veilleux

42. Alicia R. Peters

Host identity and number of Ectosymbiont species alter host-cleaner interaction in a cleaning symbiosis

Branchiobdellid annelids are obligate ectosymbionts of crayfish. Two species of worms, *Xironogiton instabilis* and *Ankyrodriilus koronaeus* are found on the claws of two crayfish species (*C. bartonii* and *C. sciotensis*) in the New River Drainage. We simultaneously assessed host/symbiont interactions and interactions between two different species of branchiobdellids on a common host. We performed a 2-way full-factorial experiment in which the two species of host crayfish were crossed with four combinations of worms – 12 *Xironogiton*, 12 *Ankyrodriilus*, 12 Mixed (6X and 6A) and 24 Mixed (12X and 12A) – with three replicates of each treatment. We then used non-invasive procedures to observe worm abundance, position and species of worm on each host. We predicted negative effects of the worm species on each other but also that worms on their original host would be less negatively affected. Our results demonstrate that both host identity and worm treatment affected the change in worm numbers through time. Branchiobdellids paired with their original hosts were more successful in survival than those paired with the alternative host. Furthermore, rather than finding evidence of interspecific competition between worm species, the results indicate facilitation. Worms on their original hosts did better in a mixed treatment rather than alone.

Mentor: Bryan L. Brown



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44. Christopher P. Parker

Microbial degradation of Triclosan adsorbed to aluminum oxide and montmorillonite

Triclosan is an antimicrobial agent that is an emerging contaminant. It is widely used in many personal care products and enters the environment through several pathways. In this study, the micro-organisms that are capable of degrading Triclosan were enriched from a typical Southwestern Virginia soil. These microorganisms were incubated with Triclosan as the only carbon source through several enrichment cycles in order to harvest the microorganisms that degrade Triclosan most efficiently. Microbial degradation of Triclosan adsorbed to both aluminum oxide and montmorillonite was then monitored in an aqueous solution inoculated with Triclosan degrading microorganisms. The microbial degradation of mineral-sorbed Triclosan was compared to that of free Triclosan. The concentration of Triclosan in the solutions was determined periodically within a 10-day period using liquid-liquid extraction coupled with HPLC-UV.

Mentor: Kang Xia

46. David J. Woodward

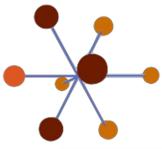
Countergradient growth variations of cold-water fishes along a major elevational cline

Countergradient growth variations (i.e., faster sub-annual somatic growth rates for individuals that undergo shorter growing seasons) are increasingly recognized as a key life-history characteristic for species with large geographic ranges. The phenomenon is considered to be an evolutionary product of strong selection against individuals with a lower genetic capacity for growth due to strong over-winter mortality of smaller individuals. However, previous studies on this topic have only been conducted on very large spatial scales

(e.g., over the latitudinal gradient of a continent). In this study we evaluate countergradient growth variations for coldwater fishes at three stream reaches along Wilson Creek of Mt Rogers, VA which expresses an elevation gradient ranging from 792-1280 meters. Summer water temperatures can vary by $\sim 5^{\circ}$ C between these sites. Specimens of blacknose dace *Rhinichthys atratulus*, and brook trout *Salvelinus fontinalis* were collected from each reach and their otolith sagittae extracted and analyzed to develop in situ estimates of somatic growth.

A series of common garden growth trials using adolescent blacknose dace from each reach have also been initiated to experimentally evaluate countergradient growth variations. Results are critical for improved understanding of climate change impacts on stream fishes throughout the southern Appalachian range and may have broader ecological significance for montane organisms in general.

Mentor: Andrew L. Rypel



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48. Hannah S. Cheng

Glycolytic enzymes are not inactivated by postmortem pH decline in skeletal muscle

Anaerobic glycolysis occurs within skeletal muscle post-mortem, resulting in acidification of the tissue. This carbohydrate-degrading pathway eventually arrests within twenty-four hours despite the availability of residual metabolites and reaches a final pH near 5.5. We hypothesized that pH inactivation of glycolytic enzymes is not responsible for the cessation of anaerobic glycolysis post-mortem. To test this hypothesis, tissue from the *Longissimus dorsi* of three pigs was used in an in vitro system utilizing pH specific buffers to determine enzyme activity. Enzyme function was evaluated at pH 5.0, 5.5, and 6.0. Phosphoglucose isomerase, which converts glucose 6-phosphate to fructose 6-phosphate, was not inactivated at any pH tested. The eight enzymes responsible for converting fructose 1,6-bisphosphate to lactate were also tested and produced similar results. In both experiments, decreased pH resulted in reduced enzymatic activity. These data suggest that phosphoglucose isomerase and the group of enzymes that convert fructose-bisphosphate aldolase to lactate dehydrogenase are not inactivated by low ultimate muscle pH and do not cause the termination of postmortem metabolism in skeletal muscle.

Mentor: David Gerrard

50. Jacob L. Estienne

Evaluation of hair snares as a non-invasive method to collect molecular samples from coyotes (*Canis latrans*)

Non-invasive hair collection methods can provide valuable information about cryptic species, such as coyotes (*Canis latrans*), that are often difficult to capture. DNA from hair follicles can be analyzed to obtain genotypes, and the shaft of hairs can be analyzed for stable isotopes to provide information about diet. We assessed the suitability of ground anchored rub pads for coyote hair sam-

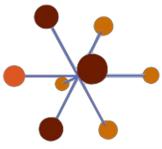
ple collection for these purposes. Our objective was to design a hair snare and observe animal behavior and responses to the snares using remote triggered cameras. In July 2012, we constructed twelve ground anchored hair snares and deployed them in Bath County, Virginia, five with remote-triggered cameras. We secured the rub pads in locations with relatively high coyote activity and used a scent lure in a hole in the center of the rub pad. At this time rub pads appear to interest coyotes, as well as other species including black bears (*Ursus americanus*), but so far coyotes appear to be reluctant to rub on the pads. We believe this could be due to the short amount of time the snares have been deployed, and the season.

Mentor: Mark Ford

52. Kathryn E. Battle

Microbial Antibiotic Resistant *Escherichia coli* in African Wildlife in Botswana

In arid environments, such as Botswana, surface water is limited and represents an essential resource concentrating humans, domestic animals, and wildlife populations. Environmental accumulation of antibiotic resistance from human fecal contamination of the environment is an increasingly important health concern. In this study, *Escherichia coli* is used to evaluate levels of antibiotic resistance among wildlife species found along the Chobe River in northern Botswana. Using a panel of 10 antimicrobials (Ampicillin, Tetracycline, Doxycycline, Ciprofloxacin, Gentamycin, Neomycin, Streptomycin, Ceftiofur, Chloramphenicol, and Sulfamethoxazole-trimethoprim), we evaluated resistance among *E. coli* isolates collected from fecal samples of fifteen species of wildlife occurring in both protected and unprotected land areas in this region. Fecal samples from Chacma baboon (*Papio*



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ursinus), elephant (*Loxodonta africana*), spotted hyena (*Crocuta crocuta*), and common waterbuck (*Kobus ellipsiprymnus*) yielded multi-drug resistant isolates. While isolates from warthog (*Phacochoerus africanus*), banded mongoose (*Mungos mungo*), leopard (*Phacochoerus africanus*), and crocodile (*Crocodylus niloticus*) demonstrated only single-drug resistance. Ampicillin and tetracycline resistance were wide spread while all isolates were susceptible to gentamycin and ciprofloxacin. Identification of environmental accumulation of antibiotic resistance among a wide variety of African wildlife in this region highlights the need for increased focus on improved sanitation across these landscapes.

Mentor: Kathleen Alexander

54. Megan R. McDermott
Meta-analysis of the impact of pediatric constraint-induced movement therapy on children's daily use of their Impaired (hemiparetic) arm and hand

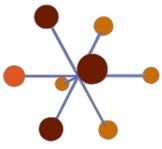
Constraint-Induced Movement Therapy (CIMT) is an emerging neurorehabilitation technique, originally developed to treat stroke patients with hemiparesis (Wolf et al, 2006) and then adapted to treat children with cerebral palsy (DeLuca, Echols, & Ramey, 2007). This research project focused on obtaining and then re-analyzing data from published case studies and clinical trials that used a common outcome measure – namely, the Pediatric Motor Activity Log (PMAL). The PMAL is a standardized rating tool completed by the child's parent that assesses 22 arm-hand motor function skills. For each skill, the parent rates the Quality of the Movement and the Amount of Use of the affected extremity. The meta-analysis provides a first-ever comparison of results across the studies, and applies a new metric – the Minimal Detectable Change (Lin et al 2011) – in as-

certaining the impact of CIMT on the children's everyday use of their impaired arm and hand. This is important because the magnitude effects (i.e., benefits) detected ranges widely. In addition, many studies tested modified versions of CIMT that differed considerably in terms of their duration, the intensity of the therapy, and the form of constraint used. Further, the ages and ability levels of children included in the published studies have varied. As this therapy practice becomes more common, it is vital to know which features of the therapy might be correlated with greater versus lesser benefits for different types of children.

Mentor: Sharon L. Ramey

56. Spencer M. Cesar
Site directed mutagenesis of the germination specific lytic enzyme SleB in bacillus anthracis

The *Bacillus anthracis* spore is the etiological agent of the disease anthrax. These spores are highly resilient to many different treatments that are lethal to vegetative *B. anthracis* cells. Knowledge about enzymes involved in the initial stages of germination could be used to induce germination and simplify decontamination of spore-affected sites. Germination specific lytic enzymes (GSLEs) are the proteins that are involved in spore cortex hydrolysis, a crucial early germination event. Three different sites in sleB, a gene encoding a GSLE, have been targeted for mutation: the active site, the signal sequence, and the metal ion-binding region. The mutations are being introduced through site-directed mutagenesis and the effects of the mutations on germination are being measured by germination assays and western blots. Mutations altering the SleB signal sequence should prevent signal peptide cleavage and anchor SleB in the spore inner membrane.



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Tests so far have shown that while the germination rate is slower, spores are still able to germinate even though SleB with attached signal sequence should still be attached to the membrane. Western blot analysis revealed that a small amount of SleB still underwent signal peptide cleavage even though the mutation is present.

Mentor: David Popham

58. S. Tyler Williams
Pioneering the utility of oil mixture for fluorescent powder tracking for salamanders

Tracking salamanders allows researchers to study aspects of their behavior, including habitat selection and movement. Fluorescent-powder tracking is a method of following salamanders that does not adversely affect their overall health, but researchers can only follow salamanders until the powder wears off. I tested the efficacy of a mixture of fluorescent powder with mineral oil to extend the distance salamanders can be tracked. Because mineral oil has not been used on salamanders before, this study evaluated 1) mineral oil's health effects on the Red-Back Salamanders (*Plethodon cinereus*) and 2) its ability to improve tracking. In my study, the survival and health of *P. cinereus* was not significantly impacted by the application of mineral oil alone or of the oil-powder mixture. To test whether the mixture may extend the distance which salamanders can be tracked; I dragged inanimate objects, with powder or with the mixture applied, through grass. Objects with mixture were tracked 64% farther (n=10, Mean= 43.3m SE= 4.8m) than objects with fluorescent powder alone (n=10, Mean= 26.3m SE=4.1m). Future research may further explore specific health effects of an oil powder mixture as well as evaluate mixture trails using wild salamanders in the field.

Mentor: Carola Haas

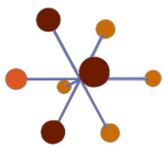
60. Apoorva Mishra
Accelerating mitotic progression can cause chromosome segregation errors in the form of chromosome bridges.

Chromosome bridges are a rare mitotic defect that can lead to chromosome breakage, aneuploidy (incorrect number of chromosomes), failure of cytokinesis (cytoplasmic division), or cell cycle arrest. Interestingly, chromosome bridges are frequently observed in certain cancer cells. Chromosome bridges are believed to occur when the sister chromatids cannot separate at anaphase onset (stage of mitosis when chromosomes segregate to the poles). Because the replicated sister chromatids must be physically disentangled prior to anaphase onset, we hypothesized that premature entry of a cell into anaphase would result in high frequencies of chromosome bridges. To test this hypothesis, cells were treated with inhibitors of the SAC (Spindle Assembly Checkpoint), a biochemical pathway that regulates mitotic progression timing. Live cell imaging and high-resolution fluorescence microscopy were used to analyze mitotic timing and image chromosome bridges, respectively. The results support our hypothesis that accelerated mitosis directly correlates with an increase in chromosome bridges. We propose that this is due to the inability of the enzyme topoisomerase II to physically separate the sister chromatids prior to anaphase onset.

Mentor: Daniela Cimini

62. Ashley Rhodes
The effect of nutrient availability on exopolysaccharide production in soils during drying

Microorganisms are known to produce a matrix of extracellular polymeric substances ("EPS") attached to their cell wall. However, the relevance of EPS as an



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adaptation in soils is not known. One hypothesis is that they may protect microorganisms from rapidly changing environmental conditions, such as soil drying and rewetting. One possible limitation for the use of EPS in soil is the availability of carbon and nitrogen. Experimental evidence to show the role of EPS in microbial tolerance to desiccation is limited. A study was conducted to investigate EPS production in oligotrophic soil conditions and its correlation with soil drying. The objectives were 1) to determine the changes in EPS concentrations in soils at different water potentials and 2) to determine the effect of nutrient availability (bioavailable carbon and nitrogen) on EPS production. The experiment was conducted on two soils, Marietta and Sumter, amended with three nutrient treatments (carbon only, carbon and nitrogen, and no nutrient added) and three drying treatments (relatively dry, relatively moist, and an "intermediate" moisture). The soils underwent extractions for EPS, free sugars, and amino acids (potential osmolytes). They were then analyzed using Phenol sulfuric acid and Ninhydrin analysis. Microbial biomass was determined using PLFA analysis. We hypothesize that EPS production increased with water stress compared to moist soils, and that samples receiving nutrient amendment will produce more EPS than samples receiving no nutrient amendment.

Mentor: Dr. Mark Williams

64. Charlotte M. L. Marsh

Effects of AMPK activator AICAR on tumor necrosis factor- α induced C2C12 mouse skeletal muscle cells

The Bacillus anthracis spore is the etiological agent of the AMP activated protein kinase (AMPK) is an important enzyme which controls cellular homeostasis by regulating fat oxidation, glucose metabolism and mitochondrial function. Studies in rat L-6 muscle cells demonstrate that activation of inflammatory pathways via

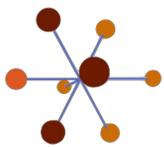
exposure to Lipopolysaccharide (LPS), leads to reduced fatty acid oxidation and mitochondrial dysfunction; however, the mechanisms underlying these effects are unknown. AICAR activates AMPK, which in turn increases metabolic flux. For this study, C2C12 mouse skeletal muscle cells were cultured and fully differentiated into myotubes, which were then exposed to 20EU of LPS or 10ng/mL of TNF- α for 30 minutes, 2 hours, 8 hours, 16 hours with and without AICAR. Immediately post treatment, RNA was collected and gene expression was measured. Interestingly, activation of inflammatory pathways by LPS and TNF- α led to differential expression of genes involved in inflammation and oxidative stress (IL-6 and SOD), mitochondrial biogenesis (PGC1 α), dynamics (MFN), and mitophagy (LC3 and Beclin). For example, while acute LPS exposure led to significant increases in IL-6, SOD2, PGC1, MFN2, LC3, and Beclin, TNF- α only significantly increased IL-6. The addition of AICAR was able to attenuate some, but not all of these effects. In summary, the activation of inflammation by various pathways results in differential expression of genes regulating mitochondrial turnover and this is not always modulated by AMPK.

Mentor: Madlyn Frisard

66. Christy Weaver

Low concentrations of cetylpyridinium chloride can inhibit salmonella growth within 24 hours

Salmonella found on raw fruits has caused outbreaks of food-borne illness. The food industry is continually examining new techniques to reduce the growth of pathogens on fresh produce. This research project evaluated the efficacy of two chemicals cetylpyridinium chloride (CPC) and delmopinol hydrochloride (Decapinol) for reducing Salmonella after direct treatment. CPC is an antimicrobial found in mouthwash that was recently approved for use in the poultry industry. Decapinol is used in oral hygiene products to reduce the attachment of bacteria to teeth. Tubes of tryptic



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soy broth were inoculated with Salmonella and then treated with 0.5% CPC, 1% CPC, or 1% Decapinol solutions. After 1 hour and 24 hours the samples were spiral plated, incubated, and enumerated. Additionally, a Bioscreen growth curve analysis system was used to measure growth every 15 minutes for 24 hours. Preliminary results show that concentrations of 0.5% CPC and 1% CPC reduced the growth of Salmonella in 1 hour samples by 2-3 logs; however, after 24 hours the populations generally recovered. Decapinol had no effect at reducing Salmonella in either time interval. If CPC is approved for use on produce, this study could help determine when to apply CPC for optimal food safety.

Mentor: Joseph Eifert and Raul Saucedo

68. Diep Nguyen

Potential role of azotobacter vinelandii sulfur dioxygenases in sulfide detoxification

Human patients with defects in ETHE1 gene, encoding a mitochondrial sulfur dioxygenase (SD), suffer from ethylmalonic encephalopathy, the result of fatally toxic sulfide accumulation. In *Azotobacter vinelandii*, a gram negative bacterium, there are two ETHE1-like genes, SD1 and SD2 potentially involve in sulfur trafficking. We hypothesize that these genes encode sulfur dioxygenases that participate in sulfide detoxification. SD1 and SD2 were expressed in *E. coli* and were found to possess SD activity (oxygen-dependent conversion of glutathione persulfide). The SD1 gene is found in the same operon with a sulfurtransferase gene (*rhdB*). SD1 and RhdB were purified to near homogeneity. The substrate of SD is glutathione persulfide that can be generated chemically by reaction of glutathione with elemen-

tal sulfur or biochemically from RhdB in the present of thiosulfate and glutathione. *A. vinelandii* mutant strains deficient in either or both SD1/SD2 were constructed and their phenotypes were assessed. The mutants deficient in SD2 or both SD1 and SD2 showed higher sulfide accumulation compared to the wild type suggesting that the sulfur dioxygenases participate in the sulfide oxidation pathway. Future experiments will focus on kinetic properties, identification of key residues for activity and metal binding, as well as the relationship between SD1 and RhdB in *A. vinelandii*.

Mentor: Timothy J. Larson

70. Erica Feldman

Effect of Atosiban on in vitro bovine embryonic development

The fertility of dairy cattle has been steadily decreasing for decades. However, the mechanisms responsible for these decreasing reproductive rates are poorly understood. The hormone prostaglandin $F_{2\alpha}$ is known to negatively affect the development of bovine embryos. Prostaglandin $F_{2\alpha}$ concentrations are upregulated via a positive feedback loop involving oxytocin. Atosiban, an oxytocin receptor antagonist, blocks part of this pathway, hindering the production of $PGF_{2\alpha}$. Atosiban has the potential to be used *in vivo* to inhibit the production of $PGF_{2\alpha}$ -thereby improving reproductive rates in dairy cattle. The objective of this study was to determine whether Atosiban has any direct effects on embryonic development by assessing embryo viability at varying concentrations of Atosiban. Ovaries were transported from a slaughter house, and oocytes were collected via follicular aspiration. Oocytes were then fertilized with sperm from multiple bulls and allowed to mature to day 5. Embryos were then cultured in media containing 0, 300, or 30,000 nM Atosiban from day 5 to day 12. Embryonic development was monitored daily through day 12 of development. Based on previous research conducted with rabbit embryos, the low concentration of



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Atosiban should not affect embryonic development, whereas the high concentration of Atosiban will likely be embryo-toxic.

Mentor: Michelle Rhoads

72. James D. Gumkowski
Synthesis and biological characterization of sphingosine kinase II selective inhibitors

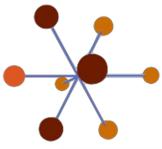
As the widespread and devastating consequences of cancers continue to affect millions of people worldwide, the demand for novel methods of combating these diseases is increasing. One of the more recent focuses of research regarding multiple forms of cancer is the role of sphingosine kinase II (SPHK2) in promoting tumor-cell survivability and how the enzyme can be targeted. Recently, the Santos lab synthesized SLR080811, (S)-amino(2-(3-(4-octylphenyl)-1,2,4-oxadiazol-5-yl)pyrrolidin-1-yl)methaniminium chloride, that was shown to selectively inhibit SPHK2 to a moderate degree. Although SLR080811 was shown to inhibit SPHK2 in mice using sphingosine-1-phosphate levels as the pharmacodynamic marker, the compound needs to be further developed into a potential drug. The focus of this research is to synthesize analogues of SLR080811 which would have improved binding affinity and selectivity towards SPHK2. Utilizing multiple synthetic routes, two molecules are synthesized, (S)-amino(2-(3-(4-decylphenyl)-1,2,4-oxadiazol-5-yl)pyrrolidin-1-yl)methaniminium chloride and (S)-amino(2-(3-(4-dodecylphenyl)-1,2,4-oxadiazol-5-yl)pyrrolidin-1-yl)methaniminium chloride, in which the octyl chain of SLR080811 is replaced with a decyl (Unnamed) and dodecyl (SLG120701) chain. SLG120701 is analyzed for its effects on SPHK1 and SPHK2 inhibition and is found to selectively inhibit SPKH2 with an inhibitory constant of 1 μ M. These compounds are currently being tested for in vivo effects in mice.

Mentor: Webster Santos

74. Kathryn M. Slaughter
Scleraxis overexpression drives ligamentous differentiation of mesenchymal stem cells in vitro

Ligament injuries are common across species. There is a need for alternative sources of anterior cruciate ligament replacements due to limitations with existing allografts and autografts. Tissue engineering is a means by which grafts may be produced; however, differentiation of mesenchymal stem cells (MSCs) into ligament fibroblasts is challenging. The objective of this study was to investigate more effective ways to utilize MSCs for ligament tissue engineering. We hypothesized that overexpression of the transcription factor, scleraxis, in combination with mechanical strain would drive MSC differentiation down a ligament lineage. Scleraxis will be overexpressed in mouse MSCs via nucleofection, cells seeded in collagen gels, and gels maintained under static tension for three days. Cellularized collagen gels will be harvested for geneexpression by PCR and for protein production by western blot. We expect that gene expression for extracellular matrix proteins related to a ligament phenotype will increase in gels with scleraxis-overexpressing cells and the cellular phenotype will be more elongated and organized along lines of tension compared to the controls. These expected results will provide evidence for the role of scleraxis in MSC differentiation along a ligament lineage and enable the ability to more effectively engineer replacement ligaments..

Mentor: Linda A. Dahlgren



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76. Kelly C. Drews

Identification and characterization of novel intracellular effectors from *Aspergillus fumigatus*

The ascomycete fungus *Aspergillus fumigatus* manifests a variety of diseases in the respiratory tract of birds, humans, and other mammals. Immunocompromised individuals are vulnerable to invasive aspergillosis (IA) while another subset of the population, comprised mostly of individuals suffering from cystic fibrosis or asthma, develops a strong allergic response termed allergic pulmonary bronchial aspergillosis (ABPA). The paradigm for IA is primarily host-centric, where a deficiency in the host facilitates pathogenesis.

Through the use of comparative genomics we have identified a N-terminal motif conserved between a cluster of secreted proteins from several primary and opportunistic fungal pathogens. We show this motif is capable of mediating translocation of several secreted proteins into primarily and immortal human airway epithelial cell lines. We hypothesize *A. fumigatus* secretes this conserved cluster of protein in order to facilitate virulence by modulating host intracellular machinery. By identifying and characterizing candidate intracellular virulence factors we will be able to better understand the contributions from *A. fumigatus* during IA.

Mentor: Shiv Kale

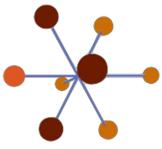
78. Megan Rochford

Development of an in-frame deletion mutagenesis strategy for a food poison-associated strain of *Clostridium perfringens*

Clostridium perfringens is a gram positive, anaerobic, spore forming, rod shaped bacterium responsible for a wide range of diseases, from mild food poisoning to deadly gas gangrene. In-frame deletion mutagenesis is an effective method for gene function analysis, allowing a better understanding of pathogenesis at the molecular level. Currently there is no efficient markerless mutagenesis for *C. perfringens* strain SM101, which causes food poisoning due to its ability to produce both an enterotoxin and heat-resistant spores. We deleted the single *galkT* operon for galactose metabolism in *C. perfringens* SM101 and named the strain HLL101.

To construct an in-frame deletion mutant, we can amplify the flanking region of the gene we are interested in and put this into a suicide plasmid carrying a *galk* gene, and then introduce the plasmid into strain HLL101 and select with galactose. Only those strains that go through recombination and lose the plasmid backbone will grow due to the toxicity of phosphorylated galactose. Those galactose insensitive isolates have a 50% chance to be mutants and PCR will be used for further screening. With this markerless mutagenesis strategy, we are able to analyze specific gene functions, especially those involved in sporulation and spore germination in *C. perfringens*.

Mentor: Steve Melville



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80. Reed H. Bryant

Characterization of the oomycete pathogen effectors Ha96 and Ps163, and their potential targets within plant cells

Effector proteins are secreted by pathogens into plants to manipulate host cellular processes. *Hyaloperonospora arabidopsidis* (*Hpa*) is a downy mildew pathogen of *Arabidopsis thaliana* that encodes for the effector protein Ha96. Exo70B2 is a regulator of polarized secretion in Arabidopsis, which is targeted for degradation by Arabidopsis E3 ubiquitin ligase PUB22, to modulate plant immune signaling. Based on previous yeast two-hybrid screens, we hypothesized that the *Hpa* effector Ha96, and its homologue in *Phytophthora sojae*, Ps163, interact with EXO70B2 and PUB22. This interaction suppresses plant immune responses. Experimentation involved co-expression of Ha96 and Ps163 with Exo70B2 and PUB22 in *Nicotiana benthamiana*, followed by western blotting and confocal microscopy. When co-expressed, neither EXO70B2 nor PUB22 showed significant changes in protein levels or size relative to control groups. Plant cells imaged using confocal microscopy showed a decrease in fluorescence of Exo70B2 during an immune response that was mitigated when co-expressed with Ha96. Bimolecular fluorescence complementation and protein complex immunoprecipitation carried out between Ha96, Exo70B2 and PUB22 are still in progress. Experimental results support the idea that Ha96 and Ps163 suppress plant immunity by interfering with the degradation of EXO70B2 by PUB22 during immune signaling.

Mentor: John McDowell



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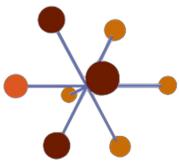


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Mentors: Bahareh Behkam, Mechanical Engineering; Anthony Cate, Psychology; Rafael Davalos, Biomedical Engineering; Raffaella De Vita, Engineering Science and Mechanics; Andrea Dietrich, Civil and Environmental Engineering; Tiffany Drape, Educational Research and Outreach; Michael Evans, Learning Sciences & Technologies, School of Education; John Geikler, Virginia Tech Intellectual Properties; Glenda Gillaspay, Biochemistry; Robert Grange, Human Nutrition, Foods and Exercise; Greg Hess, Virginia Tech Intellectual Properties; Douglas Holmes, Engineering Science & Mechanics; James Ivory, Communication; Marcella Kelly, Fisheries and Wildlife Sciences; Alexander Leonessa, Mechanical Engineering; Steve Lockett, Virginia Tech Intellectual Properties; Chang Lu, Chemical Engineering; Stephen Melville, Biological Sciences; Amanda Morris, Chemistry; Andre Muelenaer, School of Biomedical Engineering and Science; Rolf Mueller, Mechanical Engineering; Konark Mukherjee, Virginia Tech Carilion Research Institute; Biswarup Mukhopadhyay, Virginia Bioinformatics Institute; Amrinder Nain, Mechanical Engineering; Christopher North, Computer Science; Padma Rajagopalan, Chemical Engineering; Birgit Scharf, Biological Sciences; David Schmale, Plant Pathology, Physiology & Weed Science; Eva Marie Schmelz, Human Nutrition Foods and Exercise; Durelle Scott, Biological Systems Engineering; Pablo Sobrado, Biochemistry; Rebecca Splan, Animal and Poultry Sciences; Al Wicks, Mechanical Engineering

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1. Ashley R. Taylor

Using accelerometers to quantitatively assess infant general movements for early detection and intervention of cerebral palsy

According to the National Institute of Health, nearly 800,000 persons suffer from Cerebral Palsy in the United States alone. While there is currently no cure for Cerebral Palsy, many physical therapies may be implemented to lessen the traumatic impact of this disease on a person's life. Current diagnostic techniques are subjective and often inaccurate until a child reaches 4-5 years of age. By using micro-electromechanical accelerometers, the general movements of infants can be quantified. Small transducers will be placed on the limbs of infants to assess the specific frequencies and phase displacement of an infant's general movements. Signal processing with high-speed data acquisition allows observation of specific "fidgety" and high-frequency motions, which can be undetected by the human eye. This research is focused on the development of a clinical tool to diagnose Cerebral Palsy in infants. While this sensor development is not a cure for Cerebral Palsy, it is potentially a step towards early diagnosis, which could ultimately lead to better lives for persons with Cerebral Palsy.

Mentor: Andre Muelenaer & Al Wicks

3. Bryce Allen

Role of CASK in neurodevelopment

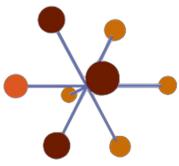
CASK (Calcium/Calmodulin-Dependant Serine Protein Kinase) is a MAGUK (Membrane Associated Guanylate Kinase) protein present at various cell-cell junctions including neuronal synapse. Mutations in CASK gene are known to cause X-linked mental retardation (XLMR) and other neurodevelopmental disorders. Since a complete knockout of CASK is

lethal, a hypomorph line of mice expressing 30% CASK was analyzed. In this study, we evaluated gross morphology, histopathology, and motor activity of hypomorph mice to better understand the roles of CASK in neurodevelopment. We obtained twelve mice that have the first coding exon of the CASK gene flanked by loxP sites (CHF). Force plate activimeter was used to monitor motor activity in CHF mice and their wild-type (WT) siblings. Whole brains were evaluated by comparing the size of cerebellum, brain length, and number of folia in cerebellum by using ImageJ software. Microscopic evaluation of brain tissue sections was determined using hemotoxylin & eosin staining methods. This mouse line showed a significant decrease in the size of the cerebellum and the number of cerebellar folia, consistent with findings of cerebellar hypoplasia in human disease states. However, no significant decrease in motor activity was observed. These results have led to a better understanding of the functions of CASK and its importance as a synaptic protein for normal neurodevelopment.

5. Carolyn Y. Hughes

Fused nanofiber scaffolds as force measurement probes for breast cancer cell lines

Understanding the role of mechanical forces in cancer cell behavior is important for enhancing fundamental knowledge of physical stimuli on cancer invasiveness and metastasis. Current state-of-the-art platforms to study these forces involve culturing cells on 2D surfaces, which do not accurately mimic the native cell environment. In this study, using our previously-reported spinneret based tunable engineered parameters (STEP) technique, we are able to fabricate a 3D environment mimicking native tissue mechanics and topography, which is used to measure the forces exerted by individual migratory cells. Fibers are deposited in double layers in a cross-hatch pattern and fused at the intersections, thus forming nanonets of different diameter fibers (200 and 500 nm) which deflect when pulled by



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cells. Wild type breast cancer E0771 cells along with genetically altered E0771 cells deflect these fibers during migration, and beam theory is used to calculate the force required to cause that deflection. Preliminary results show that wild type E0771 cell lines exert an average force of 7.5 picoNewton (pN) while the altered E0771 cells exhibit 1.5 pN, indicating that genetic modifications weakened cell migration force by fivefold. Our current and future studies are aimed at investigating the role of cytoskeleton components (actin stress fibers, nucleus, and focal adhesion complexes) causing the differences in cellular force generation.

Mentor: Dr. Nain

7. Hannah Barber & Stephanie P. Hitchcock

Neonatal abstinence syndrome: current paradigms and novel technology for treatment

Illicit and licit drug abuse during pregnancy is a rising problem globally. One such class of drugs is opioids, such as heroin, morphine, and methadone. An unfortunate side effect of opioid use during pregnancy is the potential for development of Neonatal Abstinence Syndrome (NAS), which is the clinical term for opioid withdrawal in the newborn. This is characterized by presentation of specific withdrawal symptoms in the child between 48 and 72 hours after birth; symptoms are scored using the Finnegan system, a checklist of symptoms that are ranked and subjectively judged by clinicians. Infants are then treated accordingly. To eliminate the subjectivity, we would like to use accelerometers to quantitatively measure movement-based symptoms, such as tremors, in NAS babies. This is in hopes of allowing clinicians to treat symptoms earlier and more accurately, and to get the babies home sooner. The number of babies born addicted

to illicit substances is only growing each year, and while it would be more ideal to eliminate drug use altogether, it is vital for the future of these children that we give them the best fighting chance possible to have a good life.

Mentor: Andre Muelenaer

9. Karli N. Brittain

Contactless Dielectrophoretic Sorting and Analysis of Ovarian Cancer Cells

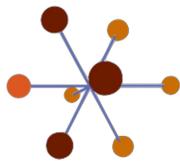
Contactless dielectrophoresis (cDEP) is an emerging microfluidic technique currently utilized for rapid, label-free isolation and analysis of cancer cells based on their intrinsic electrical properties. The goal of this work was to use cDEP to sort ovarian cancer cells from peritoneal cells and to briefly explore the effect of drug treatments on the physical characteristics of ovarian cancer cells. We used high frequency (100-600kHz, 0-300Vrms), non-uniform electrical fields to trap mouse ovarian surface epithelial (MOSE) cells and macrophages on a cDEP microfluidic device. Certain regions of the device will trap cells at a given frequency and applied voltage, and in the ideal case, trap MOSE cells and allow macrophages to pass. Additionally, we used immunofluorescence imaging to examine the effect of a series of drugs on the cytoskeleton of MOSE cells, which could lead to changes in their dielectrophoretic (DEP) response. This interdisciplinary work could ultimately lead to improved early detection and treatment for ovarian cancer patients.

Mentor: Rafael Davalos

11. Kwaku P. Akom

Reinforcing anti-violence attitudes through exposure to violent entertainment media

Previous studies involving violent entertainment media have shown that violence in the media may have negative effect on an individual's emotions and behavior. It has been proven that exposure to violence through movies and video games leads to increased aggression. However, no research study



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has explored the positive effects of violence in the media itself. Our study aims to address the question of whether anti-violence attitudes towards real world violence can be reinforced through video media that is violent in nature. We hope that the findings from violence attitudes towards real world violence can be reinforced through video media that is violent in nature. We hope that the findings from this study will promote interventions that encourage anti-violence attitudes to real-life media by changing the emotional responses to entertainment. Participants are being recruited from an undergraduate summer class and via flyers on different places on campus and at local businesses around campus. The study is ongoing and we are planning on recruiting approximately 45-60 adult participants who will be compensated with \$10 cash per experiment session. The study is ongoing, but we have found possible effects of the violent video stimuli to include desensitization, increased aggression, Trauma/disturbance to participants and also, long-term effects are unlikely. All our participants are at least 18 years old.

Mentor: James Ivory

13. Lynn Harvey & Clarissa Stiles ***Bats and Tomography: optimizing non-destructive CT imaging of museum specimens***

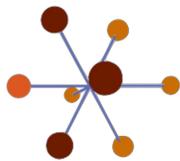
Bats use sound waves at ultrasonic frequencies to navigate and hunt. The nose-leaves and ears of bats help shape these outgoing and incoming sounds. We are interested in exploring how these structures affect emitting and receiving of sound. To study these structures x-ray micro computed tomography (CT) was used to make high resolution 3-D models. However, there are remaining scanning issues that must be addressed. First is that soft tissues have poor contrast. This obstacle can be overcome by the use of a contrast agent. However many contrast agents tend to stain, and finding a non-destructive contrast agent is critical to examining museum specimens. Another problem is the shifting that oc-

curs during scanning due to drying out of specimens that adversely affects model accuracy. To address these problems we searched for suitable contrast agents, such as potassium iodide, and mechanical supports, such as Styrofoam, shaving cream, mineral oil, and tested their effects on non-museum specimens and on the scans. The promising solution is a combination of contrast agent (potassium iodide) and shaving foam. In the future we hope to explore this solution in depth and apply it to museum specimens.

Mentor: Rolf Mueller

15. Robert Burnham ***Tech Transfer: A review of the university intellectual property protection***

In many US universities, the transition of research from laboratory data into usable goods, products, and services in the marketplace is supported by a tech transfer group or intellectual property office. Virginia Tech's tech transfer process is managed by Virginia Tech Intellectual Properties, Inc. (VTIP). To gain a better understanding of the operation of university tech transfer groups or intellectual property offices, the invention analysis, intellectual property protection, and licensing process at VTIP was reviewed on a case by case basis with a focus on the initial stages of the patenting process (invention disclosure and evaluation). The majority of the reviewed inventions were focused in the life sciences (cancer diagnostics/therapeutics, pharmaceuticals, genetics, and biomass processing). Also included were inventions in electrical engineering, mechanical engineering, and industrial chemistry. Research was conducted using patent databases, including the USPTO's PAIR and freepatentsonline.com, in addition to SEC records, FTC rulings, investor resources, inventor interviews, and outside consultation. Drawing from these individual cases, a broad outline of the IP and tech transfer process was then created and specific



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examples are provided at each stage of the progression.

Mentor: John Geikler

17. John Fenninger

Transferring intellectual property to industry: commercializing research and inventions through Virginia Tech Intellectual Properties

The purpose of my work at Virginia Tech Intellectual Properties (VTIP) was to help identify technologies and inventions conceived at Virginia Tech that have commercialization and licensing potential. VTIP receives invention disclosures on a weekly basis, and I assisted in conducting prior art searches, analyzing related markets and industries, and creating licensing strategies for various inventions. The majority of the inventions I researched came from the Electrical and Computer Engineering Department and the School of Biomedical Engineering and Sciences at Virginia Tech, as well as the School of Architecture, with invention topics ranging from advanced computed tomography scanners to nanofiber scaffolds in cellular biology. One particular project that I spent significant time on related to the development of a new educational toy and how to best market the toy through manufacturers, designers and distributors. As a result of my work at VTIP, I was exposed to the legal and business side of university research and the technology transfer process.

Mentor: Michael Miller

19. Kevin H. Sprenger

Patent Prosecution from a technology transfer perspective

The field of technology transfer is one that requires the understanding of a variety of different subjects as well as a strong professional and business acumen. It represents the synergy of academic research, intellec-

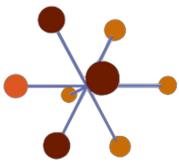
tual property law, and commercialization, and ideally enables a product to be transformed from a laboratory experiment to a household name. Successful navigation through this process is often challenging due to the apparent conflict of motivations among the parties involved in the process. This research provides an assessment of a real-world example which illustrates how this conflict affects the patent prosecution stage of the overall technology transfer process, where the term patent prosecution refers to the process of obtaining a patent from the United States Patent and Trademark Office. A critical analysis of the scenario is presented, as well as some solutions to the problems and an analysis of how the different solution options affect each party involved in the process. Finally, both a best case and a realistic recommendation is presented, from the perspective of the technology transfer office.

Mentor: John Geikler

21. William R. Klima

An introduction to tech transfer: assessment, protection, and licensing

My research this summer was focused on an introduction to tech transfer. Tech transfer consists of three main categories, an assessment of a technology, the protection of said technology, and the licensing of said technology. One of the first projects that I worked on at VTIP was a technology on fingerprint scanning. This was a perfect introduction because the technology was fairly easy to comprehend and the market is well documented. I assessed the technology by performing prior art searches, creating a contact list, conducting an inventor interview, and using market research databases to find additional companies and determine market potential. The latest technology I worked on was for a novel sensory stimulation device. This



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project was focused on the licensing section of tech transfer. In addition, this technology was a more difficult project due to ambiguity in market potential and its field of use. The market for the technology was relatively small and poorly documented. I performed licensing evaluation by making a list of companies that are involved with similar or competing technologies, providing relevant information of the companies, calculating their profit margins, calculating a royalty rate based off of those profit margins, and calculating the total sales figures. **Mentor: John Geikler**

23. Kyle Harring, Madison Preib & William Garrett Burks

Electromagnetic stimulation of intrinsic vocal fold muscles involved in sound vocalization, respiration, and airway protection in patients with unilateral vocal fold paralysis

Every year, millions of Americans suffer from vocal cord paralysis, one of the main causes of dysphagia, sound vocalization reduction and respiration complications. Using electromagnetic stimulation, the nerves controlling the muscles surrounding the vocal folds can be stimulated. The muscles provide adequate tension or relaxation to the folds, allowing the patient to regain vocal fold function. The electromagnetic stimulation uses two solenoids: a primary coil outside of the neck and a secondary micro-coil implanted near the nerve controlling the vocal folds. A current runs through the primary coil generating a magnetic field, and producing a voltage in the micro-coil. Our progress has been centered around designing and testing various solenoids while focusing on achieving the necessary output to stimulate the nerves. In order to maximize the output, we adjusted the coil dimensions, and varied the number of turns, wire gauge, as well as core permeability. Each coil was tested using controlled wave types and frequencies, with an added resistance and capacitance to the secondary coil in order to gener-

ate the desired output. The projected goal is to stimulate the desired nerves in the neck controlling the muscles surrounding the vocal folds allowing the patient to improve phonation and decrease dysphagia.

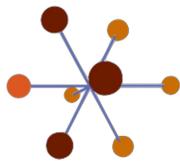
Mentor: Alexander Leonessa

25. Lauren A. Withers

Electroporation of Chinese hamster ovary cells using microfluidic devices

The purpose of the research is to examine the affect of shear stress on electroporation. During electroporation, the cells are exposed to a direct current voltage while they pass through microfluidic devices of varying narrow lengths. This increases the permeability of the cell membrane allowing small molecules to pass through opened pores. Chinese hamster ovary (CHO) cells flowing with different flow rates experience different shear stresses. Propidium iodide (PI) and plasmid were used in order to enter the cell membrane through electroporation in separate experiments. The cell viability was later determined using Sytox dye and PI respectively. The research has shown that generally if we increase the electric field strength then a higher electroporation efficiency can be obtained and is accompanied by lower percentage of cell deaths. This knowledge can be applied to delivering other genes and drugs of similar sizes into cells.

Mentor: Chang Lu



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27. Min Sung Kang

Delivery of molecules in Chinese hamster ovary cells using alternating current and direct current electroporation

Purpose of this experiment is to compare the results of electroporation using alternating current (AC) and direct current (DC). Electroporation is a tool for delivery of small molecules and genes in the cells by creating pores in the cell membrane with an electric current. In this study, different electric field intensities (200V~700V) were utilized while performing electroporation with alternating current and direct current. Transfection efficiency, cell viability, and transfection yield were calculated at the end of the experiment for comparison. Our results reveal that transfection efficiency decreases in Direct current when electric field intensities are increased. But transfection efficiency increases in Alternating current as electric intensity increases. These results can be later used for more efficient gene transfection in gene-therapy applications

Mentor: Chang Lu

29. Sarah Steinke

Data Analysis for determining damage in medial collateral ligaments

Sprains of ligaments are very common injuries in sports. In sprains, damage of the ligamentous tissue is determined by different mechanical stimuli. This research project aims at characterizing the damage mechanisms in medial collateral ligaments (MCLs) caused by consecutive stretches. Toward this end, tensile tests were performed on rat medial collateral ligaments (MCLs) using a protocol previously established in our lab. Prior to testing, black ink speckles were created on the MCLs using an airbrush. The motion of these speckles was recorded, while loading the MCLs, using a high-speed video camera. The recorded images were then analyzed by employing point-tracking

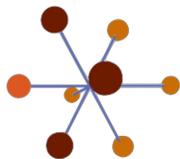
software (ProAnalyst®). The load data obtained by the tensile machine and displacement of the speckles on the MCLs were converted into mechanical data. These data were then analyzed to find threshold stretches that indicated the onset of mechanical damage. The long-term outcome of this study is to enhance current preventive and treatment strategies of knee ligament sprains.

Mentor: Raffaella De Vita

31. Karishma V. Tolani

High throughput screening for inhibitors of *Aspergillus fumigatus* siderophore A and *Aspergillus fumigatus* UDP-Galactopyranose Mutase

Aspergillus fumigatus (*A. fumigatus*) is a human pathogenic saprotrophic fungus that is typically found in soil and decaying organic matter. Infection by *A. fumigatus* is a significant health problem to immunocompromised individuals, such as patients in intensive care units, organ transplant recipients, and AIDS victims. *A. fumigatus* Siderophore A (*Af SidA*) is a flavin-dependent monooxygenase that catalyzes NADPH and oxygen dependent hydroxylation of ornithine to N5-hydroxyornithine in *A. fumigatus* biosynthesis. *A. fumigatus* UDP-Galactopyranose Mutase (*Af UGM*) is a flavoenzyme which catalyzes the isomerization to UDP-galactofuranose, a precursor of Galactofuranose which is essential in *A. fumigatus* virulence. It is essential for pathogenesis for *A. fumigatus*, and, therefore, is a validated drug target against *A. fumigatus* infections. Previously, in our group we developed a chromophore that mimics the NADPH substrate of *Af SidA*. It consisted of the ADP portion linked to TAMRA chromophore for *Af SidA*. A similar procedure was done for *Af UGM* and consisted of a UDP portion linked to TAMRA chromophore. These chromophores were shown to bind in the



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active site of the enzymes with a K_d value of $2.1 \pm 0.2 \mu\text{M}$ and $2.6 \pm 0.2 \mu\text{M}$ respectively. These chromophores were used to develop a fluorescence polarization-binding assay, which was optimized for high throughput screening of potential inhibitors of AfSidA and AfUGM. Here, we present the results of screening a library consisting of 2320 small molecule compounds.

Mentor: Pablo Sobrado and Karina Kizjakina

33. Trevor White

Testing Game Cameras for Effectiveness at Photographing Animals of Various Size

While there are many remotely-triggered game cameras available, there is little information available concerning what animals are best detected by which models. In this study, we analyzed past data from an ongoing study at the Mountain Lake Biological station (MLBS) and pitted 6 different camera models against each other. We analyzed past data from 20 camera stations from 2008 and 2009 that each had two opposing camera models. We categorized animals by size; counted total animals captured in each category; then calculated the trap rate per 100 nights. This information was then used to choose three stations to place our six camera models. The cameras were arranged so that each camera had a chance to trigger when an animal walked by. We used paired t-tests on past data to determine which cameras had significantly more photos of animals within each size category. We used ANOVA for our head-to-head trials to determine whether there were differences in number of photos or trapping rates of the camera models. Preliminarily, it appears that the Moultrie cameras with their traditional flash produce the best images. However, they do not tend to detect everything that passes by in time to take a photo. The Reconyx cameras do well at detection,

but often produce blurry images due to the less intense LED flash.

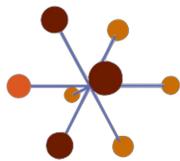
Mentor: Marcella Kelly

35. Emily L. Gibson

The Investigation of Iron Present in Dairy Cow Drinking Water throughout Virginia

This project will research the solubility and bioavailability of iron in groundwater supplied to dairy cows throughout Virginia. Dairy cows consume 20-30 gallons of water a day and their drinking water can be a major source of iron in their diet. Many farmers pump groundwater from wells for their livestock, which generally contains bio-available ferrous iron. However, when the water sits stagnant in water troughs, the iron can oxidize to ferric iron, which is less soluble and less bioavailable. The longer the ferrous groundwater stands in the dairy cow's drinking trough, the less nutrients the cow will consume as the ferric iron precipitates and thereby causes a nutrient depletion in the cow's diet. In turn, the amount of bio-available soluble iron that results in the milk of the livestock can ultimately affect the nutritional needs of calves and people who consume the milk. Water samples will be collected and tested from dairy cow farms in almost every county in Virginia. This survey will allow for a better understanding of the varying concentrations of iron present in dairy cow drinking water throughout the state and show the variability throughout different regions.

Mentor: Andrea Dietrich



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37. Daniel E. Neighbors

The identification and analyses of a high cellulose Arabidopsis thaliana mutant

The objective of this research was to identify mutant Arabidopsis plants with an increased cellulose concentration. Cellulose can be broken down into monomers of glucose and then fermented to ethanol for biofuel use; therefore, a plant with elevated cellulose may help increase biofuel production efficiency. A genomic-scale modeling of Arabidopsis, called AraGEM, was used, in silico, to identify Gene Candidate 1 (gc1) as a loss-of-function candidate for increasing cellulose concentration. Homozygous gc1 mutants were subjected to Updegraff cellulose quantification method and were found to have significantly elevated cellulose per dry mass. These findings could offer an improvement in biofuel production as well as a new strategy for bio-engineering.

Mentor: Glenda Gillaspy

39. Danielle A. Smalls

Informal learning: what are they talking about? Understanding the transfer of STEM concepts to social media.

Research has demonstrated that interests in science, technology, engineering, and mathematics (STEM) are initially fostered during middle school years. Inquiry-driven curricula based on loosely-structured problems and semi-structured design challenges have shown to engage youth in STEM. Moreover, social media (blogs, social networks, and video sharing sites) provide students a platform to extend informal learning experiences. Consequently, the purpose of this qualitative study is to answer two questions: 1.) How are middle school students in Southwest Virginia us-

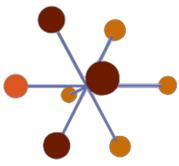
ing Edmodo, a social networking site for youth, to craft ideas about science and engineering? 2.) Are these students using Edmodo to expand their understanding the concepts learned in an afterschool STEM Club? Our goal is to better understand how students interact via a computer-mediated communication interface (Edmodo) to see if they are leveraging for its intended purpose, to further knowledge of scientific and engineering principles related to heat transfer. Methods used to analyze the data include the separation and grouping of topics discussed on the chat feature of Edmodo. Given minimal prompting, the students in the STEM Club used the social media website for personal and academic interests. Students progressed from just "hanging out" to "geeking out," which precipitates learning..

Mentor: Michael Evans

41. David R. Marshall

Metal organic frameworks as catalysts for the reduction of CO₂ into a viable energy source

In this day of age, the search for alternative sources of energy has become of paramount importance to all mankind. Our heavy dependence on fossil fuels is no longer acceptable due to their limited supplies and the environmental impact of the CO₂ that they produce. My research focuses on providing a solution to both of these problems by utilizing metal organic frameworks to catalyze the reduction of CO₂ into products that may serve as a viable source of energy. I have synthesized metal organic frameworks as thin films on conductive fluorine doped tin oxide glass slides. I have studied the electrochemistry of the thin films by utilizing cyclic voltammetry techniques in which the thin films are exposed to an electrolyte solution purged with CO₂. I have found one particular metal organic framework, CPO-27-Co, to be catalytic and reduce CO₂.



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The next step in my research is to identify what the CO₂ is being reduced into. Ideally the product would be something such as methane, which could be harvested and utilized as an energy

Mentor: Amanda Morris

43. Elizabeth C. Pickering

MATLAB/MicrobeTracker analysis of fluorescent type IV pili protein localization in Clostridium perfringens and Bacillus subtilis

Clostridium perfringens is a pathogenic, Gram-positive bacteria that causes a range of diseases in people and animals, including gas gangrene and food poisoning. *C. perfringens* has genes that code for proteins homologous to Type IV pili (TFP) proteins. Experiments were conducted to learn how PilT, the retraction ATPase motor, associates with PilB and PilB2, the extension ATPase motors, and where those proteins move within the cell. Images of fluorescently-tagged PilB, PilB2, and PilT in wildtype *C. perfringens*, PilB and PilT mutants, and *Bacillus subtilis*, a bacteria lacking any TFP proteins except the inserted, tagged PilT were obtained. MicrobeTracker was used to analyze length of the cells, and SpotFinder was used to detect and count fluorescent spots and their positions with respect to the cell poles. The PilB proteins localized to the poles and center of the cells, as did PilT. PilB failed to localize to the poles in the PilT mutant, though PilT localized normally in *B. subtilis* and the PilB mutants. Cell length was consistent in all strains with the exception of cells in which the cell division protein FtsZ was inhibited. In conclusion, PilT appears to play a role in the localization of PilB.

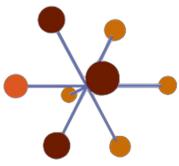
Mentor: Stephen Melville

45. Jacob D. Mason

Viscosity measurement techniques for agar surfaces using analysis of the motion dynamics of charged microspheres in a uniform electric field

This project aims at elucidating the mechanism of gliding motility in the disease causing bacteria, *Clostridium perfringens*. We have previously measured the motility speed of *C. perfringens* on the agar gel surface using optical microscopy, but we are unable to exactly quantify all the forces involved in its locomotion due to lack of experimental data for viscous forces between the *C. perfringens* and the underlying agar surface. Knowledge of the dynamic viscosity coefficient is essential for calculating this drag force. However, the aqueous layer atop agar surfaces is only a few microns thick; making standard viscosity measurement techniques unfeasible. In this work, we have developed an apparatus for measurement of the viscosity of the aqueous film on the agar surface. A uniform 210 Vm⁻¹ electric field applied to negatively charged 2.19 μm diameter polystyrene microspheres with COOH surface groups creates a quantifiable and reproducible force. At this force value, microspheres move at a constant terminal velocity indicating a balance between the electrostatic force and the drag force applied on the microsphere. The velocity and the electrostatic force data can then be used to calculate the drag force and the viscosity of the aqueous film. This value will be critical in future bacterial motility analysis.

Mentor: Dr. Bahareh Behkam and Dr. Stephen Melville



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47. Megan E. Lewis

Combined effects of BMP-2 and fiber stiffness on C2C12 differentiation

The ability to control cell differentiation has vast potential in the field of reconstructive medicine. Cell differentiation is dependent upon both biochemical and biophysical cues. Current strategies of cell culture on 2D platforms necessarily fail to capture the entire set of biophysical cues a cell encounters in a native 3D environment. This study uses nanofibers to more accurately replicate the 3D fibrous environment of the extracellular matrix (ECM). Using this platform, the combined effects of chemical (BMP-2) and physical (fiber beam stiffness, N/m) stimuli on differentiation are investigated. C2C12 myoblasts were cultured on mechanistically tunable suspended fiber scaffolds (diameter: 300-800nm, length: 4 mm) in DMEM or DMEM supplemented with BMP-2 for a week and stained with fluorescent antibodies indicative of muscle or bone growth. Preliminary results on 500 nm fiber scaffolds and flat glass indicate muscle formation was halted when treated with BMP-2, whereas untreated cells developed multinucleated myotubes. These results demonstrate the cell's ability to sense both the composition and structure of its surroundings. Current and future studies are aimed at determining the critical minimum chemical concentrations and lowest biophysical stiffness scaffolds required to induce muscle, bone and osteoblast differentiation.

Mentor: Amrinder Nain

49. Nicole Szanyi

A. Release of *Fusarium graminearum* ascospores from perithecia

B. Aerial Surveillance

A. Aerobiology is the study of movement and transportation of organisms through the atmosphere.

The phases are preconditioning, takeoff and ascent, transport, descent and landing, and impact

(Isard et al., 2005). *Fusarium graminearum* is a high risk plant pathogen carried through air's turbulent boundary layer and infects crops with a disease known as *Fusarium head blight*. Billions of dollars have been lost due to reduced crop quality and yield throughout the United States (Windels, 1999). This study focused on the preconditioning and take-off phases of *F. graminearum*. By altering nutrient availability it will be determined if nutrient concentrations affect perithecia production and if the number of spores within perithecia are nutrient dependent. This was observed by varying the concentration of carrots in media. Preliminary data indicates that perithecia production increased with nutrient availability. Also shown was that the highest number of spores produced was on the highest concentration of media but varied at lower concentrations.

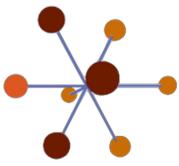
B. The Bumblebee is a quadcopter optimized for aerial videography and photography. By mounting a camera underneath Bumblebee, it will be able to track autonomous aerial vehicles, used for aerial sampling, and to take high resolution photographs of crop fields to identify high risk pathogens.

Mentor: David G. Schmale III

51. Stefanie L. Pagano

The effect of resveratrol on skeletal muscle miRNA profiles in obese mares

Resveratrol is a natural polyphenol found in various fruits and particularly in the skin of red grapes. Its beneficial effects on obesity and metabolic dysfunction have been well documented, but little is known about the regulatory processes of resveratrol on skeletal muscle metabolism. One potential mechanism may involve regulation of miRNA, or small non-coding nucleotides involved in gene silencing. In this study, the effect of resveratrol on miRNA expression pattern signatures will be studied in the skeletal muscle of obese



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mares. Mares were allocated to resveratrol (n=5; 5.5 grams) or placebo (n=5) supplementation over three consecutive estrous cycles and were matched by age (8.8 ± 2.5 vs. 10.0 ± 1.6 , respectively) and body condition score (7.5 ± 0.2 vs. 7.6 ± 0.2 , respectively) prior to treatment. Muscle biopsies were taken from the gluteus medius prior to and at the end of the treatment period. Using a miRNA profiler kit and quantitative PCR, the investigators will explore differences in genome-wide miRNA expression patterns between treatment groups pre- and post-supplementation. Differences in miRNA profiles could shed new light on resveratrol's regulatory role in skeletal muscle metabolism and identify potential biomarkers and therapeutic targets related to metabolic dysfunction

Mentor: Rebecca Splan

53. Austin J. Allen

Investigation of the strength of adhesion of rat myoblasts to a 3D nanofibrous scaffold in a microfluidic device

Cell adhesion to the extracellular matrix (ECM) is a complex process which plays a significant role in cell motility, migration, and differentiation. Current methods of studying cell adhesion include use of microfluidic devices, spinning disks, and parallel plates. These methods involve culturing cells on 2D flat substrates followed by shear flow measurements. Current estimate of adhesion strength vary between 300 and 700 dyne/cm², which is correlated directly with adhesion area. 2D adhesion strength provides only a partial glimpse in overall cell behavior; in vivo cell adhesion takes place along the ECM, which is a 3D environment. We hypothesize this to dramatically alter the adhesion strength. To study this, we are developing a hybrid method which uses a microfluidic device, within which cells are seeded on a 3D fibrous scaffold fabricated using our previously reported STEP (Spinneret based Tunable Engineered Parameters) technique. Fluid is

passed through the channel at controlled volumetric flow rates. We are then able to calculate the shear stress at the wall of the channel. Our preliminary results have indicated the feasibility of the compound device (live cell-scaffold and microfluidic channel), with cells surviving for extended periods of time. This study is envisioned to aid in development of accurate hybrid cell culturing systems.

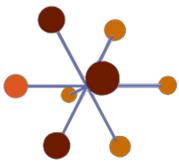
Mentor: Dr. Nain

55. Douglas Smith

Spatial and semantic memory for kinesthetic learning in large-scale interactive displays

As large-scale interactive displays become more commonplace, user performance hinges on how efficiently users can acquire information from these settings, both spatially and semantically. Research shows that physically larger virtual displays improve cognitive performance on spatial tasks through kinesthetic learning. However, it is unclear whether kinesthetic learning uniquely enhances spatial memory compared to semantic learning. The objective of this study is to examine the relationship between spatial memory and semantic knowledge when exposed to a large display and a smaller desktop interface. Participants will explore each display actively by reading through 200 bits of information, from which they will be asked questions on a subsequent memory test. Responses to the memory test include semantic knowledge of the correct term from a given statement, spatial memory of where the term is on the display, and confidence levels. In accord with past research, the theory is that larger displays will allow the participants to organize spatial information more efficiently as opposed to a small display, where kinesthetic movement is restrained to minimal activity. This study will have implications for both spatial memory and wayfinding in large-scale immersive displays.

Mentor: Anthony Cate



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57. Josephine A. Restaino ***MRI-based planning of irreversible electroporation treatment in a canine patient with brain cancer***

Therapeutic Irreversible electroporation (IRE) is a non-thermal ablation technique that uses pulsed electric fields to kill cancer cells through the creation of nano-scale defects within their plasma membrane. IRE does not affect major nerve and blood vessel architecture, which makes it a desirable treatment for inoperable tumors located in close proximity to these sensitive structures. However, because IRE focally ablates all tissue subjected to a critical electric field threshold, patient-specific treatment planning must be conducted a priori in order to maximize tumor destruction while minimizing damage to the surrounding healthy cells. Treatment planning is a critical multi-step process that is needed to ensure complete tumor coverage. First, a segmentation of the main tissue components from the patient's MRI is performed in each slice. Then a three-dimensional reconstruction of the tumor and surrounding tissues are generated from the segmentation. This allows for a volumetric mesh to be created that is compatible with numerical modeling software. With these simulations we can visualize electric field distribution and use them for optimization of electrode placement and determining IRE pulse parameters prior to surgery. Improved pretreatment planning leads to a more successful procedure and thus an overall better treatment for the patient.

Mentor: Rafael Davalos

59. Loran E. Steinbereger ***Chemotaxis based sorting of micro-particles in a microfluidic assay***

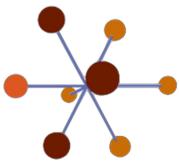
Bacteria utilized as machines (biomotors) for the manipulation of micro/nanoscale structures could be developed as a cost-effective alternative to Scanning

Tunneling Microscopy (STM) and Atomic Force Microscopy (AFM) guided protocols. In this work, we have developed a micro-particle sorting method that relies on bacterial chemotaxis. *Serratia marcescens* were used to separate polystyrene micro-beads of diameter 6-7 μm having two distinct surface properties within a microfluidic platform. The bacteria were able to selectively attach to particles due to differences in surface chemistry created by poly-L-lysine (PLL) treatment. The microfluidic platform was fabricated in Polydimethylsiloxane (PDMS) gel, and consisted of two circular 4 mm diameter compartments connected by a 100 μm wide channel, with a third circular compartment of 2 mm diameter halfway along the channel. One large compartment contained hydrogel releasing chemoattractant (casamino acid) via diffusion, while the other contained *S. marcescens* and attached microparticles. Using this method, preliminary results have indicated that 68% more PLL treated particles collected in the center 2 mm compartment near the chemoattractant source when compared with non-treated particles over a one hour time period.

Mentor: Bahareh Behkam & Sylvia Powell

61. Meghan Canter ***Quorum sensing based actuation regulation for bacteria-powered micro-robots (bacteriabots)***

Cells, the building blocks of life, are capable to efficiently perform specific functions such as sensing, motility, self-healing, and communication. The challenge we face is to harness these nature-perfected abilities and use them for our own benefit. We aim to exploit the sophisticated and robust machinery of bacteria for actuation, sensing, communication, and control of a new class of micron-scale robotic systems called BacteriaBots. A BacteriaBot is a bio-hybrid swimming micro-robot fabricated by interfacing an ensemble of live



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engineered *Escherichia coli* (*E. coli*) bacteria with a micro-robot body. Mobile networks of BacteriaBots can be utilized as intelligent, reconfigurable, and adaptable networks to address challenges in sensing, and transport and delivery of cargo at reduced length scales. In this work, we explore a novel quorum sensing-based method to regulate motility in BacteriaBots. AI-2 was synthesized and introduced in the experimental environment at known concentrations to quantify enhanced motility of *E. coli* strain MG1655 as a function of AI-2 concentration. Chemotaxis swim plate assay showed a halo diameter increase however, microscopy tracking and flagella staining did not show an increase in the swimming speed or the flagella count in presence of AI-2. In conclusion, our results indicate that presence of AI-2 leads to an enhanced chemotactic response but it does not enhance the motility speed.

Mentor: Bahareh Behkam

63. Solange Paredes

Blood-brain barrier disruption with pulsed electric fields

The blood-brain barrier (BBB) is lined with endothelial cells that are closely joined by tight junction proteins. The tight junction proteins create a highly selective barrier in terms of allowing certain molecules to transport through the blood into the brain. Drug treatment of intracranial tumors is difficult due to the impermeable characteristic of the BBB. We hypothesize that pulsed electric fields (PEF) will create transient openings in the BBB. Physically disrupting the integrity of the cell monolayer using PEF does not emit heat or kill the cells therefore the cells are able to fully recover. To investigate the effectiveness of PEF to transiently disrupt the BBB, we performed permeability assays and analyzed the distribution of ZO-1 throughout the BBB with immunofluorescence staining. The permeability assay assesses the ability of molecules to pass through the

disrupted BBB. Immunofluorescence staining provides evidence to visually show how PEF affects tight junction protein expression and also quantitatively compare the expression between control and PEF-treated groups through imaging software. Together, these data will allow us to determine how PEF affects the BBB.

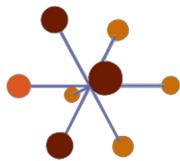
Mentor: Rafael Davalos

65. Paul B. Caron

Continuous sorting of particles using multilayer contactless dielectrophoresis

Contactless dielectrophoresis (cDEP) is a new technique for the sorting of cells or particles which excludes the actual contact between the electrodes and sample. Instead, the electrodes are placed in fluidic channels to induce an electric field needed to control the particle flow. This avoids any contamination or heating of the sample. Based on the differences in size and electric properties of the particles the multilayer poly dimethylsiloxane (PDMS) devices use cDEP to separate the particles. The fluid electrode channels are placed directly on top of the main fluid channel separated only by a thin membrane (20 μ m-100 μ m) of PDMS. As a relatively inexpensive model, these devices can be used frequently with consistent results. Furthermore, the separation of particles with different electric signatures can lead to the isolation and detection of cancerous cells; a substantial benefit to detecting cancer in early stages. The goal is to separate different particles consistently and group similar particles using cDEP in a multilayer device.

Mentor: Rafael Davalos



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67. Karadeep Singh

The effects of bovine hemoglobin supplementation on primary hepatocyte function.

The liver performs several metabolic functions. Liver cells, specifically hepatocytes, require higher levels of oxygen in order to maintain optimal functions. The performance of primary hepatocytes in in-vitro cell cultures is limited by oxygen availability. Hemoglobin supplementation to cell culture media has been shown to increase oxygen solubility. In this study, different concentrations of bovine hemoglobin were supplemented to hepatocyte culture media and the effects on primary hepatocyte function were investigated. Two essential functions of the liver, albumin production and urea production, were measured over 10 day culture periods. Cultures supplemented with 20mg/mL hemoglobin exhibited stable urea and albumin production over time.

Mentor: Padma Rajagopalan

69. AhRam Kim

Controlling biofilm formation of Candida Albicans on medical implant materials using nanofiber texture

Biofilms tend to be significantly less responsive to antibiotics and antimicrobial stressors, compared with planktonic bacteria. There is a compelling need for new anti-biofilm biomaterials to effectively delay biofilm formation of microorganisms on biomedical surfaces. This work aims at developing a bio-inspired antifouling design framework based on topographical cues. Model surfaces with well-defined surface topographies were manufactured by deposition of highly aligned polystyrene (PS) nano-fibers (diameter: 300 nm - 900 nm and average edge-to-edge spacing: 2000 nm - 3000 nm) on flat PS, polymethyl methacrylate (PMMA), and polytetrafluoroethylene (PTFE) surfaces. Flat and nanofiber-textured surfaces are exposed to the suspension of *Candida albicans* SC5314 in the Center for Disease

Control (CDC) biofilm reactor (80 RPM, 37°C). After one day, cells were detached from all surfaces and counted using serial dilutions and plating. Our experiments demonstrate that fibers with average diameter of 400 nm reduce the number of adhered cells by 26% for PS substrate. The data reveals presence of an anti-fouling design space in which fibrous topographical features reduces number of cells present on the PS, PMMA and PTFE surfaces. To the best of our knowledge, this work is the first report of delaying biofilm formation of pathogenic yeast with only topographical modification of the surface.

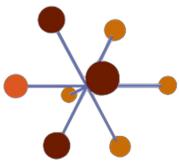
Mentor: Bahareh Behkam

71. Alex Jones

Soft/Hard transitions in adaptable materials

Rapidly altering a material's properties will have numerous applications in advanced, adaptable materials ranging from medical equipment, to automobiles, to self strengthening structures. Utilizing the classical problem of jamming, where particles can no longer move or compress and effectively become a solid material, we can make a soft structure hard by changing its modulus in response to an applied stress. Polyvinylsiloxane (PVS) rubbers, with cavities separated by a thin film, are filled with a high concentration of spherical particles. Applying a uniform pressure to the film will compresses the particles to a jammed state, and we will measure the change in modulus through this jamming transition. Initial qualitative results indicate the feasibility of these soft-hard structures, though a more detailed study will allow us to controllably and rapidly change the stiffness of a soft structure.

Mentor: Douglas Holmes



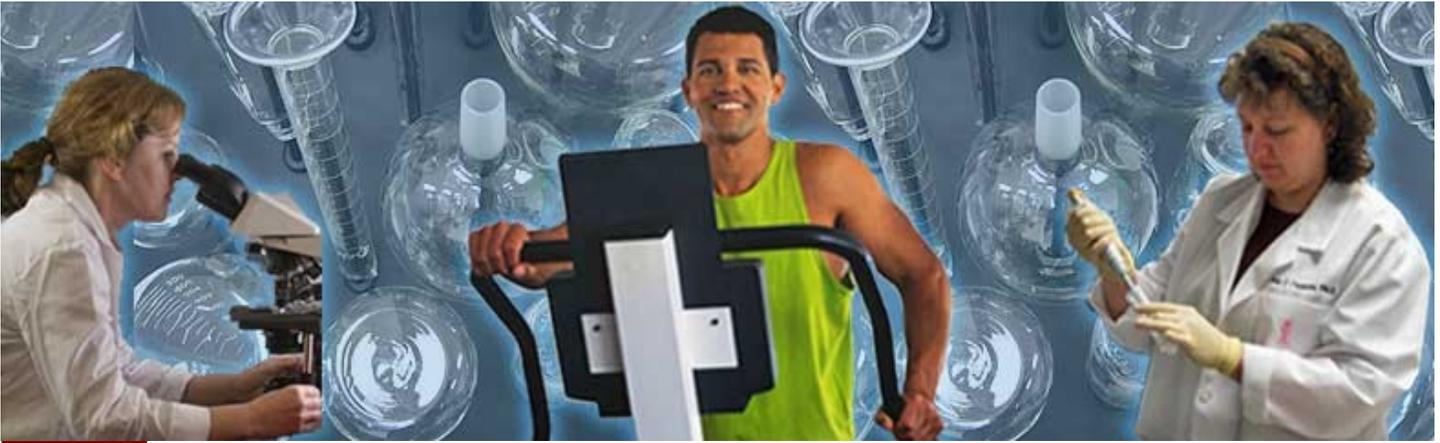
Abstracts: Scieneering

73. Dan M. Torre

Influence of surrounding environment on net ecosystem metabolism

The surrounding environment of a stream ecosystem plays an important role on the biological processes and reactions which effect water quality in streams. In order to study the variability of net ecosystem metabolism in different environments, several parameters were measured daily in five minute intervals. The parameters measured as part of the study include temperature, dissolved oxygen concentration, pH, Carbon Dioxide concentration, and conductivity. To test the influence of surrounding environments on stream metabolism, a set of sondes was deployed in agricultural, urban, and forested sites of Strouble's Creek. The data was collected using a Campbell's scientific datalogger, taking measurements every ten seconds and averaging the values over five minute intervals. From the data collected, the diurnal patterns of dissolved oxygen concentration, temperature, and carbon dioxide concentration will be analyzed. These measurements will be used to calculate gross primary production, respiration and ultimately net ecosystem metabolism to conclude whether the system is autotrophic or heterotrophic, and what role surrounding environment plays on the site.

Mentor: Dr. Scott



HNFE (Human, Nutrition, Foods and Exercise) Scholars

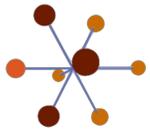
Program Director:

Dr. Deborah Good

Mentors:

**Jamie Zoellner; Jennifer Hill,
Paul Estabrooks, Robert
Grange, Elena Serrano, Mat-
thew Hulver**

<http://www.hnfe.vt.edu/>



Abstracts: HNFE Scholars

82. Grace A. Wilburn

Talking Health: Exploring cross-sectional and longitudinal relationships between dietary and biological variables from a randomized-control trial targeting sugar-sweetened beverages in Lee County, VA

BACKGROUND: Over the past several decades, the intake of sugar-sweetened beverages (SSB) has doubled across all age groups and currently contributes to ~10% of total energy intake in US adults. To address SSB behaviors, a community-based trial, Talking Health, has been launched. This is a 2-group, 6-month RCT. OBJECTIVE: The purpose of this secondary data analysis project is to study the relationship between dietary variables and anthropometric/biological data, as well as assess changes over the course of the intervention. METHODS: At enrollment, height, weight and fasting biological markers were assessed and 3 24-hour dietary recalls were collected. Follow-up data is scheduled for Oct 2012. RESULTS: The 1st cohort involved 41 adults from Lee County, VA (92.7% female; 100% white, non-Hispanic; 34.2% with annual income of \$5,000-14,999; mean age 42.4±2 yrs). Mean BMI was 36±1.6, with 70.7% with a BMI >30. Mean blood pressure was prehypertensive (123±15 mmHg systolic and 82±12 diastolic) and blood glucose, total cholesterol, triglycerides and LDL cholesterol were within normal ranges (95±37 mg/dL, 156±29 mg/dL, 130±92 mg/dL and 93±27 mg/dL, respectively). Analysis of dietary data is on-going. DISCUSSION: Future analysis will explore relationships between dietary variables and biological markers at baseline, and at a 6-month follow-up. Further analysis will help understand intervention effects of mitigating health problems associated with SSB, such as obesity and comorbidities.

Mentor: Jamie Zoellner & Valisa Hedrick

84. Eileen F. O'Connor

A systematic assessment of the physical activity environment in the Dan River Region

Physical inactivity is contributing factor to the prevalence of obesity in America. The extent to which the built environment plays a role in physical activity has significant implications to community development. The purpose of this study is to systematically assess the quality and accessibility of public physical activity outlets and to describe the physical activity environment in the Dan River Region. Outlets were enumerated based on local government information of recreation sites. A pair of trained auditors used the Physical Activity Resource Assessment (PARA) to objectively rate outlets based on amenities, features and incivilities. Inter-rater reliability was calculated to ensure data quality ($k=0.849$). A total of 140 outlets were enumerated across Henry, Pittsylvania and Caswell counties including the cities of Danville and Martinsville. PARA data was collected from 105 outlets. Forty-three percent of outlets were parks, thirty-seven were schools, nine were community centers, six were fitness clubs and five were sport facilities. Ongoing analysis will determine mean scores of incivilities, features and amenities as they relate to BMI. Overall, schools represented a significant amount of total outlets (37%) therefore, pursuing the extent to which shared use agreements are in place may be useful to increase physical activity. Future directions will investigate relationships between number, type and quality of outlets by geographic location, race and income.

Mentor: Jennie L. Hill



Abstracts: HNFE Scholars

86. Victoria Anderson

Developing childhood obesity counseling resources for peer leaders

Background: Low-income families have little access to supportive health-based programs. Community organizations with lay-leaders, such as Virginia Cooperative Extension (VCE), provide education to low-income families on healthy eating and physical activity but have a difficult time reaching a large number of families.

Purpose: The purpose of this study was to design interviewer assisted phone calls that can easily be used by VCE lay-leaders (i.e., program assistants) to overcome travel and time barriers. It was also a goal of the project to create content from evidence-based childhood obesity programs that focus on (1) the physical activity environment at home, (2) the home food environment, (3) parenting skills, and (4) parental role modeling.

Results: Six interactive telephone scripts were developed to align with current content delivered by VCE program during in-home visits and integrated into an easy to use hyperlinked presentation. Calls included the following structure and aligned with home environmental principles: review of the goal set the previous week, a short lesson based on one program principle, a goal setting opportunity, and multiple opportunities to ask questions.

Conclusions: The telephone scripts were reviewed by a VCE program assistant and found to be easy to use and helpful for making telephone calls.

Mentor: Paul Estabrooks

88. Sarah R. Donnelly

Serum creatine kinase in sphingomyelin treated mice

Duchenne Muscular Dystrophy (DMD) is an x-linked muscle disease. Mutations of the dystrophin gene result in absence of the encoded protein, dystrophin. In its absence, both mechanical and signaling functions at the muscle fiber membrane are lost and severe muscle weakness occurs. With disease progression, membranes are leaky and muscles lose their capacity to regenerate and ultimately die. Membrane leakiness is typically detected by the presence of the muscle enzyme, creatine kinase (CK) in the serum. Sphingomyelin, a type of sphingolipid commonly found in the plasma membrane of eukaryotic organisms, is important to the structural integrity of cell membranes. We used mdx mice, a model for DMD, to test the hypothesis that dietary sphingomyelin would strengthen the muscle cell membrane and decrease serum CK. MDX mice were fed a diet \pm sphingomyelin for 6 weeks. At sacrifice, we will exsanguinate the mice to obtain serum from the blood. CK activity will be determined spectrophotometrically (at 340 nm) using a commercially available kit. We predict mdx mice fed +sphingomyelin will demonstrate a ~20% decrease in serum CK compared to mice fed -sphingomyelin. These data would suggest that dietary sphingolipids can decrease muscle membrane leakiness in DMD.

Mentor: Robert Grang



Abstracts: HNFE Scholars

90. Maggie M. Reinhold

Talking Health: Exploring the representativeness of enrolled participants in Lee County, Virginia

Residents in southwest Virginia (SWVA) experience numerous health and socioeconomic disparities. Talking Health is a community-based health intervention targeting sugar-sweetened beverages (SSB) in SWVA. The purpose of this project was to determine the representativeness of enrolled participants in the Lee County, VA, the first cohort enrolled in Talking Health. Descriptive statistics, t-tests, and Chi-square tests were used to determine if enrolled participants were representative of: 1) screened and eligible, but non-enrolled, participants, and 2) the broader county as based on Lee County US Census Data. In total, 64 participants were screened, 52 were eligible, and 41 enrolled. Enrolled participants included: mean age of 42 ± 2 yrs, 100% non-Hispanic white, 92.7% female, 33.4% earning ~\$25,244 annually, and 66.7% reporting < college education. Enrolled participants did not differ from eligible but non-enrolled participants. When compared to census data, the enrolled sample was well-represented in terms of age and race/ethnicity; however, men were underrepresented. Furthermore, enrolled participants had a much lower average annual income ($p < 0.01$) and a slightly higher educational attainment ($p < 0.01$). For future cohorts, additional efforts are needed to recruit more males as well as those with less than a high school degree. Understanding the representativeness of this trial helps inform the generalizability of study findings and potential public health impacts.

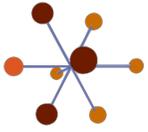
Mentor: Jamie Zoellner

92. Alicia Powell

Systematically identifying evidence- and practice-based food, nutrition, and wellness programs for dissemination by FCS Extension Agents.

Virginia Family and Consumer Sciences (FCS) Extension Agents are Educators within the Cooperative Extension service that are responsible for delivering research-based programs within their communities across the Commonwealth to empower individuals, families, and communities to adopt food, nutrition, and activity choices that contribute to a healthy and productive society. The purpose of this integrated research-extension project was to 1) conduct a needs assessment of FCS Agents for programming areas related to food, nutrition, and wellness, then 2) identify evidence-based programs that fit needs through a scientific literature review and 3) assess programs that have been developed specifically for Cooperative Extension. The results of the needs assessment, consisting of an online survey, found programming gaps for the following audiences or topics: families (parents and middle age children), seniors (aging), type 2 diabetes prevention (adults/seniors), and weight loss and maintenance (adults). Programs for families were the first priority. Corresponding evidence-based programs were identified through PubMed and Google Scholar and reviewed. Extension Agents and Specialists around the country were also solicited to submit evaluated extension programs for consideration. The next steps are to create an online forum for Extension Agents to review and rank all identified programs. The results will guide future trainings and dissemination of programs in Virginia.

Mentor: Elena Serrano



Abstracts: HNFE Scholars

94. Alfred (CJ)M. Phillips

The effects of acute and chronic LPS treatment in C2C12 myotubes on p38 MAPK activation.

The Hulver laboratory recently observed that 5 days of high fat feeding in nonobese, healthy humans disrupted the normal postprandial metabolic response in skeletal muscle. This maladaptation was associated increased fasting endotoxin levels and heightened activation of p38 mitogen-activated protein kinase (MAPK) in skeletal muscle. The purpose of this work was to use a skeletal muscle cell culture model to determine the effects of acute and chronic endotoxin treatment on p38 MAPK kinase activation. To this end, C2C12 myotubes were cultured and treated with 20EU and 1500EU of lipopolysaccharide (LPS) for 2 hours and 24 hours. Protein levels of p38 MAPK and phospho-p38 MAPK were examined through western blotting.

LPS treatment, under these conditions, did not elicit an increase in p38 MAPK phosphorylation. Based on these findings, we cannot conclude that elevated blood endotoxin levels mediated the increased p38 MAPK activation in skeletal muscle with high fat feeding.

Mentor: Matthew Hulver



Biological Systems Engineering

REU Site: Dynamics of Water and Societal Systems – An Interdisciplinary Research Program at the Virginia Tech StREAM Lab

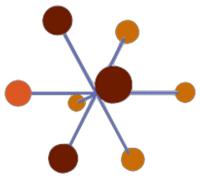
Program Coordinators: Dr. W. Cully Hession, Professor, BSE, Co-Project Director and Mentor; Dr. Leigh-Anne Krometis, Assistant Professor, BSE, Co-Project Director and Mentor; Dr. Karen Kline, Research Assistant Professor, BSES, Program Coordinator and Mentor
Mr. C. Nathan Jones, BSE, Senior Graduate Leader and Mentor

Mentors: Dr. Troy Anderson, Assistant Professor, ENT
Dr. Fred Benfield, Professor, BIOL; Dr. James Hawdon, Professor, SOC; Dr. Erich Hester, Assistant Professor, CEE

Universities Represented: Hampshire College; Louisiana State University; North Carolina Agricultural and Technical State University; Texas State University; University of Arkansas
University of North Carolina at Chapel Hill; Dr. Eric Kaufman, Assistant Profes-



<http://streamlab.bse.vt.edu/>



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Abstracts: REU Site: Dynamics of Water and Societal Systems – An Interdisciplinary Research Program at the Virginia Tech StREAM Lab

75. Katy L. Hofmeister & Tyler Weiglein

Experimental flooding of a restored floodplain within an urbanized watershed

Floodplains provide essential ecosystem services by increasing the residence time of water (e.g. the amount of time water spends in the floodplain environment) and promoting contaminant removal (e.g. nitrogen removal through denitrification). Stream-floodplain connectivity is essential for reducing the export of pollutants downstream because it allows for the exchange of water, organic matter, sediment, and nutrients between the floodplain and the stream. The importance of large river system floodplains for regulating water and nutrients has already been established, but the impact of floodplains on smaller streams is not yet fully known. Despite this lack of knowledge, many stream restoration projects on small to mid-size streams claim there is nutrient removal through the reconnection of the channel and floodplain. To better understand these processes, we artificially flooded a remnant oxbow along the Stroubles Creek Restoration Project near Blacksburg, VA. Probes measuring temperature, conductivity, pressure, pH, dissolved oxygen, and soil moisture were placed throughout the floodplain to monitor the flux of water and biogeochemical transformation in both overland and subsurface flow paths. From the data collected during the simulated flood, the relationship between nutrient removal capacity and the residence time of water on the floodplain will be examined.

Mentors: Durelle Scott & Nate Jones (BSE), Erich Hester (CEE), Chris Cianfrani (Hampshire College)

77. Kevin K. Chu & Adam Oliphant

Analysis of water and nutrient loads using the soild and water assessment tool and geographic information systems in

Stroubles Creek watershed

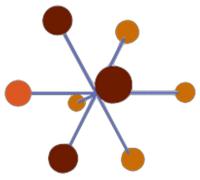
The Soil and Water Assessment Tool (SWAT) has been used in conjunction with GIS for over a decade in various environments for a range of applications from calculating total mass daily loads to assessing impacts of development and restoration on water systems. Employing ArcGIS tools and a SWAT model of the Stroubles Creek watershed, we examined the effects of land use on the stream's hydrologic and nutrient characteristics. This study compiled preexisting hydrologic and climate data and collected additional nutrient data to be used in the calibration and validation of the model. Nutrient samples were taken by automated samplers over the course of several storm events in the summer of 2012. This data was subsequently used to calibrate the model by comparing it with outputs produced by the model. Validation of the model using this data was also conducted to verify the accuracy and effectiveness of the model. Upon completion of validation, the model can be used to assess and examine the impacts of historical land use and development on the watershed's hydrology and nutrient content.

Mentors – Javier Osorio (BSE), Cully Hession (BSE), Randy Wynne (FREC), Karen Kline (BSE)

79. Sara N. Gokturk & Deandrae Smith

A multilevel health assessment of Stroubles Creek

Stroubles Creek was considered "impaired" by the Virginia Department of Environmental Quality in 1999 because it does not support a diverse community of aquatic insects and fish. The main pollutants are sediment and bacteria. Clean and healthy waterways provide jobs, boost property values, and tourism. Functional waterways also help filter storm flows, slow flooding and provide habitats for birds and other wildlife. A multilevel study was done on Stroubles Creek to assess



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the amount of contaminants of health concern that may affect the aquatic insects, fish and human beings alike. Samples of sediment and water were taken from ten sites in Stroubles Creek. These samples were analyzed for fecal indicators, antibiotic resistant genes, inorganic metals and emerging chemicals. The exact coordinates of each site were recorded through gps in hopes that a correlation between the amount of contaminants and where exactly it is located in the stream can be made. Early results have shown that indeed emerging chemicals and fecal bacteria are present not only in the water but in greater abundance in the sediment. The research done on Stroubles Creek will hopefully shed more light on the amount of contaminants of health concern that is washed into watersheds everyday and how they affect the organisms in and surrounding it.

blotting.

Mentors: Leigh-Anne Krometis (BSE), Amy Pruden (CEE), Troy Anderson (ENT), Kang Xia (CSES), Maddie Schreiber (GEO)

81. Margaret L. Whitsel & Teneil Sivells

Spatial assessment of Stroubles Creek using macroinvertebrates and total suspended sediment

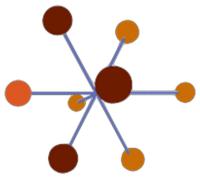
Assessing water quality by monitoring aquatic systems in the United States is an important aspect to improve quality of our waters. In the Blacksburg area, Stroubles Creek is currently undergoing a water quality improvement implementation effort. Aquatic macroinvertebrates and total suspended solids (TSS) are often used as measures of water quality in streams. Excessive sediment in streams can serve as a pollutant for macroinvertebrates and other aquatic wildlife living there. We developed

macroinvertebrate indices using 22 wire baskets filled with river rocks. The baskets were placed throughout Stroubles Creek watershed along various urban, agricultural, and forested gradients. The rock baskets were left in the creek for 21 days to allow for macroinvertebrate colonization. By identifying the different types of macroinvertebrates that colonize the rocks to family level, a general water quality assessment can be made using the metrics developed by the Virginia Department of Environmental Quality. We also deployed automated storm samplers at the same locations as two urban and two agricultural rock baskets over the course of several storms. TSS values were estimated in the laboratory using vacuum filtration from these samples. We will present the overall assessment of the Stroubles Creek watershed based on macroinvertebrate indices, along with correlations found between macroinvertebrates and TSS values from concurrent locations.

Mentors: Cully Hession (BSE), Kevin McGuire (FREC), Fred Benfield (BIOL)

83. Jerod Myers & Charlotte Brown *Community Knowledge and Attitudes towards Water Resources within Stroubles Creek Watershed*

Countergradient growth variations (i.e., faster sub-annual somatic growth rates for individuals that undergo shorter growing seasons) are increasingly recognized as a key life-history characteristic for species with large geographic ranges. The phenomenon is considered to be an evolutionary product of strong selection against individuals with a lower genetic capacity for growth due to strong over-winter mortality of smaller individuals. However, previous studies on this topic have only been conducted on very large spatial scales (e.g., over the latitudinal gradient of a continent). In this study we evaluate countergradient growth variations for coldwater fishes at three stream reaches along Wilson Creek of Mt Rogers, VA



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which expresses an elevation gradient ranging from 792-1280 meters. Summer water temperatures can vary by $\sim 5^{\circ}$ C between these sites. Specimens of blacknose dace *Rhinichthys atratulus*, and brook trout *Salvelinus fontinalis* were collected from each reach and their otolith sagittae extracted and analyzed to develop in situ estimates of somatic growth. A series of common garden growth trials using adolescent blacknose dace from each reach have also been initiated to experimentally evaluate countergradient growth variations. Results are critical for improved understanding of climate change impacts on stream fishes throughout the southern Appalachian range and may have broader ecological significance for montane organisms in general.

Mentors: Leigh-Anne Krometis, James Hawdon (SOC), Eric Kaufman (AEE), Mike Sorice (FREC)

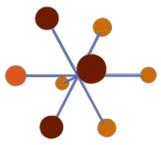


REU-Site: Microbiology in the Post Genome Era

Mentors: Marcy Hernick, Assistant Professor; Monica Ponder, Assistant Professor; Amy Pruden, Associate Professor; Peter Kennelly, Professor; Mark Williams, Assistant Professor; Stephen Melville, Associate Professor; Pablo Sobrado, Assistant Professor; Tom Inzana, Tyler J. and Frances F. Young Professor of Bacteriology; Biswarup Mukhopadhyay, Associate Professor; Birgit Scharf, Assistant Professor; Ann Stevens, Associate Professor; Isis Mullarky, Assistant Professor; Zhaomin Yang, Associate Professor; David Popham, Professor

Universities Represented: University of Puerto Rico; SUNY Fredonia; Oakwood University; Rochester Institute of Technology; Lehigh University; Fairfield University; Kalamazoo College; Utah State University; Simmons College

<http://microbiologyreu-ret.vbi.vt.edu/>



Abstracts: Microbiology in the Post-genome Era, NSF-REU Site

87. Maralis Butler

Effects of yhcN and ylaJ deletions during spore germination in Bacillus anthracis

Certain bacteria produce spores as a defense mechanism. Bacterial spores have thick walls, are very resistant, and remain inactive until they germinate. To complete germination, the spore needs to degrade the spore cortex peptidoglycan through the activity of germination-specific lytic enzymes (GSLEs). An important GSLE in *Bacillus anthracis* is SleB, which is coexpressed from an operon with YpeB and YlaJ. A gene similar to ylaJ, yhcN, is found elsewhere in the chromosome, and a deletion of either gene results in a small, uncharacterized defect during spore germination. It's likely that YlaJ is involved in the cortex degradation step of germination because it is expressed from the same operon as SleB, and YhcN may play a redundant role due to its similarity with YlaJ. The objective of this study is to determine the specific function of YlaJ and YhcN during germination and to determine the effect on spore germination when both genes are deleted. To accomplish this, $\Delta yhcN \Delta ylaJ$ and $\Delta yhcN$ strains were created in *B. anthracis* using markerless gene replacement. Understanding GSLEs and the proteins that interact with them may enable the simplification of spore decontamination methods in the future.

Mentor: David Popham

89. Nicholas J. Catanzaro

A novel expression vector for genetic studies in Myxococcus Xanthus

Myxococcus xanthus is a developmental organism used to study bacterial gliding motility mediated by type four pili (T4P). However, the study

of this phenomenon has been greatly hampered by the lack of effective genetic tools. Here we report the construction of a novel shuttle vector capable of independent and stable replication in both *M. xanthus* and *Escherichia coli*. This vector will provide an efficient system for more advanced genetic studies to further elucidate the biology of T4P machinery in *M. xanthus*.

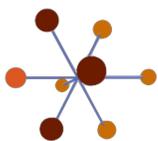
Mentor: Zhaomin Yang

91. Shevel Dacosta

Granzyme B production by T cells in response to S. aureus infection.

Staphylococcus aureus is a species of bacterium commonly found on human skin, in the nose and other body cavities. Although usually harmless at these sites, it may occasionally get into the body and cause mild or serious infections of the bloodstream, bones or joints. Additionally, *S. aureus* is a common cause of mammary gland infections, or mastitis, in dairy cows. The increase of resistance of *S. aureus* to antibiotics justifies further research in a new treatment approach. Our goal is to develop a cellular based vaccine that can be used against *S. aureus*. The Objective of this research was to observe the production of Granzyme B protein from T cells when exposed to the antigens of irradiated or live *S. aureus* (ISA, LSA). Dendritic cells will be loaded with antigens and will be used to evaluate the T cell responses. We will observe whether or not active Granzyme B is present. We have utilized the enzymatic properties of granzyme B so as to detect its activity. Ac-IEPD-pNA is a chromogenic substrate that has been used to detect Granzyme B activity. We are hoping our data along with cytokine profiles of lymphocytes can be used in the development of vaccines.

Mentor: Isis Mullarky



Abstracts: Microbiology in the Post-genome Era, NSF-REU Site

93. Mathew R. Faggion

Direct regulatory targets of the quorum-sensing transcription factor OpaR in *Vibrio parahaemolyticus*

Vibrio parahaemolyticus is a marine bacterium that colonizes shellfish and causes gastroenteritis if consumed. The regulatory process known as quorum sensing (QS) has a role in the pathogenicity of VP and is controlled by the master regulator OpaR.

OpaR is regulated via an upstream signal cascade of proteins which are controlled by self-produced signaling molecules called autoinducers (AIs). When high levels of AIs are sensed, OpaR is turned on through a phosphorylation relay leading to a nonpathogenic opaque phenotype. At low levels of AIs, OpaR is not activated and VP takes on a pathogenic translucent motile phenotype. Since OpaR is critical for pathogenicity, we want to know what proteins are under direct control of OpaR. Cognate targets of OpaR will be identified using a ChIP-Seq assay. The associated gene promoters will be sequenced and compared to the VP genome. Ultimately, the binding sites will be characterized via in vitro EMSAs and foot printing analyses to determine a consensus sequence.

Knowledge of the direct gene targets controlled by OpaR will lead to greater understanding of the regulatory circuitry of the OpaR regulon, and will serve as a model for building the network of control used by other enteric pathogenic bacteria.

Mentor: Ann M. Stevens

95. Gregory Forbes

Under the hood of *S. Meliloti*: Identification of genes affecting motility in *Sinorhizobium meliloti* using transposon mutagenesis

Sinorhizobium meliloti is a nitrogen-fixing bacterium utilizing a flagella motor that operates differently than

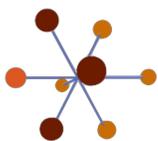
the well-known *Echerichia coli* motor. *E. coli*'s motor rotates either counter-clockwise or clockwise at a constant speed, while the *S. meliloti*'s flagellar motor only rotates in the clockwise direction but at varying speeds. *S. meliloti*'s variation to the standard *E. coli* bacteria model is the reason for intense study. The method used to study *S. meliloti*'s motor is transposon mutagenesis. Through triparental mating and the use of a neomycin resistance marker, we were able to select for *S. meliloti* mutants. The mutated strains have a transposon inserted somewhere in their genome at a seemingly random site. After this, non-motile mutants are screened for using a swim-plate assay. Arbitrary primed Polymerase Chain Reaction (ARB-PCR) is used to identify transposon sites. The PCR amplifies DNA fragments adjacent to the transposon. DNA from the PCR is cleaned up and sent out for sequencing to find where the transposon inserted itself. An online database is used to compare the sequencing results to the genome sequence of *S. meliloti* and determine protein that gene codes for. With that information, previously known (as well as new) flagellar genes are identified and we will better understand the mechanism that brings this bacterium to plant roots.

Mentor: Birgit Scharf

97. Sharon R. Gutu

Role of Coenzyme F₄₂₀ in antibiotic production by *Streptomyces coelicolor*

Coenzyme F₄₂₀ is a deazaflavin derivative that functions in redox reactions. F₄₂₀ is universally found in methanogenic archaea and is rare in bacteria. It is found in most Actinobacteria, including *Streptomyces* species. Previous studies have shown that *Streptomyces* use F₄₂₀ for antibiotic production. The purpose of this project is to determine the role of F₄₂₀ in the production of antibiotics by *Streptomyces*. *Streptomyces coelicolor* is a model organism for our work with *Streptomyces* as it is genetically tractable. It produces two antibiotics, tryptirrole



Abstracts: Microbiology in the Post-genome Era, NSF-REU Site

undecylprodigiosin and polyketide actinorhodin, which can be differentially produced on two different types of solid media. A gene called *fbjC* is essential for the production of F₄₂₀. Through deletion insertion mutagenesis via homologous recombination, we will construct a strain of *S. coelicolor* that will lack *fbjC*. This strain will be examined for its ability to produce antibiotics. If it does not produce an antibiotic we will complement the strain with a replicable plasmid containing *fbjC* and determine restoration of antibiotic production. If that occurs, we will conclude that F₄₂₀ is necessary for the production of the antibiotic in *S. coelicolor*. The future experiments will be conducted to identify and characterize the respective enzymatic reactions.

Mentor: Biswarup Mukhopadhyaya

98. Haeja A. Kessler ***Characterization and type specificity of the Capsular Polysaccharide of Haemophilus parasuis serovar 4***

Haemophilus parasuis (Hps) is a member of the family Pasteurellaceae, and the etiologic agent of Glässer's disease in piglets and pneumonia in adult pigs. Hps is found in the nasal cavities of healthy pigs, but can disseminate to cause fibrinous polyserositis, arthritis, and septicemia. Fifteen serotypes of Hps have been identified based on antigenic specificity. The antigens responsible for type specificity are not yet characterized, and may also be responsible for virulence. We propose that Hps produces a polysaccharide capsule (CPS) that defines serotype specificity and acts as a virulence factor. To support this hypothesis we isolated a CPS from Hps serotype 4 by enzyme digestion, phenol extraction, and ultracentrifugation. Antiserum produced in mice to the CPS was used in ELISA and dot immunoblotting to demonstrate the antiserum was serotype-specific. Comparison of the sequenced genomes of Hps serotype 5 with various bacterial CPS loci using IMG and BLAST identified a locus with homology to the

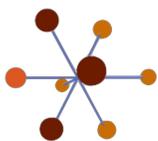
Escherichia coli capsule group 1/4 region, and was distinct from loci of capsule groups 2/3, which are commonly found in other members of the Pasteurellaceae. Therefore, Hps produces a novel CPS among the Pasteurellaceae that is responsible for type-specificity and likely contributes to bacterial virulence.

Mentor: Thomas J. Inzana

99. Lauren M. Kraft ***Characterization of 2-haloacrylate hydratase***

2-Haloacrylate hydratase from *Pseudomonas* sp. YL is a flavin-dependent enzyme that catalyses the removal of chloride from 2-chloroacrylate forming pyruvate. Interestingly, although the reaction results in no net redox change, the flavin is required to be in the reduced state for activity. Dehalohydratases and other similar enzymes are of interest because the organohalogens they biodegrade are often hazardous to the environment. The details of the mechanism for the reaction involving 2-haloacrylate hydratase remain unclear. A better understanding of a chemical mechanism underlying the cleavage of chloride will aid in designing systems capable of biodegradation of organohalogens, which will be less harmful to the environment. We expressed, purified, and characterized the enzyme. We also looked at the activity of dehalogenation through a chloride elimination assay and measured parameters of steady state kinetics.

Mentor: Pablo Sobrado



Abstracts: Microbiology in the Post-genome Era, NSF-REU Site

100. Ian J. Miller

The effect of TiO₂ nanomaterials on bacterial community in the wastewater treatment process

Rapid development and widespread use of nanotechnology has resulted in the increased presence of nanomaterials in wastewater streams. Biological wastewater treatment has the potential to be a crucial technique in controlling, modifying and capturing nanomaterials before they enter the environment. However, little is known about the effects of nanomaterials on microbial communities involved in the wastewater treatment process. This project implemented qPCR and RT-qPCR to examine the impact of TiO₂ nanomaterials on the total and nitrifying bacteria, and the induction of antibiotic resistance genes in typical nitrifying activated sludge system. Six lab-scale sequencing batch reactors (SBR) were set up and fed with synthetic wastewater suitable for nitrification. Three test conditions were examined in duplicate reactors: nano-sized TiO₂, bulk TiO₂, and no-TiO₂ control. Comet Assay was used to examine the mutagenicity of SBR effluents. This project provides new and important data on the effect of TiO₂ nanomaterials on the bacterial community in a simulated nitrifying activated sludge system.

Mentor: Amy Pruden

101. Keila N. Miles

Does Kae1 stabilize PK5 in vitro in Methanocaldococcus jannaschii?

The use of Archea as model organisms has been beneficial in understanding the kinase activity of various protein complexes. An example of such would be the Kae1/PK5 fusion protein from *Methanocaldococcus jannaschii*. PK5 is a homolog of the human p53 related protein kinase, which phosphorylates the tumor suppressor p53. PK5 was

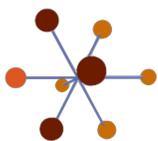
first studied in *Sulfolobus solfataricus* where PK5 and Kae1 are encoded by separate, but adjacent open reading frames. It was noted that PK5 was unstable when expressed alone in *E. coli*. In the *methanogen*, *Methanocaldococcus jannaschii* the genes encoding Kae1 and PK5 genes are located within the same open reading frame and thus they are translated as a fusion protein. We hypothesize that Kae1 may be responsible for stabilizing PK5 by complexing with the latter in *S. solfataricus*. If so, we predict that expression of the Kae1/PK5 fusion protein from *M. jannaschii* in *E. coli* should yield a stable product. Studying the relationship between these two proteins reveals their kinase activity and proposes the substrate upon which they function both in vitro and in situ. Furthermore, analyzing the interaction of these two proteins sheds light on their human homolog, p53, a tumor suppressor involved in cancer prevention in mammalian cells.

Mentor: Peter Kennelly

102 Taryn J. Rowe

Identifying risks for handling associated contamination of Salmonella in lettuce

Food-borne illness outbreaks associated with consumption of contaminated fresh produce are increasing in frequency. Contamination with human pathogens may originate at all stages of production. However, the scale of contamination can be amplified through post-harvest handling activities; therefore, research on the handling of produce is vitally important. This study will identify risk factors for contamination of Salmonella and other human pathogens associated with post-harvest handling and processing of hydroponic grown lettuce. Transmission from contaminated lettuce roots or worker gloves will be simulated for all stages of processing using a mixture of *Salmonella enterica* serotype Typhimurium and a fluorescent microsphere product (



Abstracts: Microbiology in the Post-genome Era, NSF-REU Site

GloGerm). The number of heads contaminated from a single contamination event will be established, as well as the persistence of the pathogen on the edible portion of the plant after harvest. The outcome has the potential to lead to the establishment of new safety measures in the lettuce production industry and ultimately will lower the risk of outbreaks.

Mentor: Monica A. Ponder

103. Emily A. Yasi ***Identification of MshA2 for activity in the mycothiol biosynthesis pathway***

Actinobacteria is a group of diverse, gram-positive, high G+C bacteria, such as *Mycobacterium tuberculosis*. Most produce mycothiol (MSH) which is analogous to glutathione (GSH). It is used in detoxification of xenobiotics, reduction, and inactivation of reactive oxygen and nitrogen species. The biosynthesis of MSH requires five different enzymes, MshA (glucosyltransferase), MshA2 (phosphatase), MshB (deacetylase), MshC (ligase), and MshD (acetyltransferase). The focus of this project is MshA2 which is currently unidentified. MshA2 catalyzes the dephosphorylation of 1-O-(2-acetamido-2-deoxy- α -D-glucopyranosyl)-D-myo-inositol-3-phosphate (GlcNac-Ins-P) to form N-acetyl-1-D-myo-inositol-2-amino-2-deoxy- α -D-glucopyranoside (GlcNac-Ins). Out of four inositol monophosphatase homologous in *M. tuberculosis*, only impC (Rv3137) is shown to be essential. The current hypothesis is that impC involved in the biosynthesis of MSH. This specific project will try to confirm the if the impC gene encodes for MshA2, the missing activity in MSH biosynthesis. The goals are to: 1) express and purify recombinant MshA2, and 2) measure enzymatic activity of MshA2 using potential substrates. This research could lead to the discovery of new antibiotics that target MshA2 for diseases like tuberculosis.

Mentor: Marcy Hernick

104. Haley M. Krem ***Purification of the type IV pili proteins PilB2 and PilC2 from *Clostridium perfringens****

Clostridium perfringens is a Gram positive, pathogenic bacterium responsible for gas gangrene. It has been shown that *C. perfringens* has Type IV pili (TFP) genes that are homologous to Type IV pili in Gram negative organisms. The three proteins that are thought to make up the core pilus assembly apparatus are PilA2, the pilin monomers that are polymerized into the pilus, PilB2, the cytoplasmic assembly ATPase, and PilC2, the integral membrane protein. The *C. perfringens* vector pKRAH1 with an insert containing a hexahistidine tagged PilC2 was inserted into *C. perfringens*. PilC2 was then purified from the membranes of these cells, but not in significant amounts. A pET vector with an insert containing hexahistidine and human influenza hemagglutinin antibody recognition site tagged PilB2 sequence was inserted into *E. coli*. PilB2 was then purified from the cytoplasm of these cells. We have optimized expression of and initially isolated PilB2, and measured biological activity. These steps are the first towards the ultimate goal of assembling the three proteins in vitro.

Mentor: Stephen Melville



Wireless @ Virginia Tech

NSF Research Experience for Undergraduates (REU) Cognitive Communications @ Virginia Tech

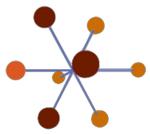
Leaders: Dr. Tonya Smith-Jackson , Professor, Industrial & Systems Engineering; Dr. William Tranter, Bradley Professor of Communications; Dr. Carl B Dietrich Jr., Research Associate Professor, Electrical and Computer Engineering; Alfred K. Titus-Glover, Jr., Industrial & Systems Engineering

Mentors: Dr. Alireza Babaei, Research Scientist, Electrical and Computer Engineering; Daniel Richard DePoy, Electrical Engineering; Ashwin E. Amanna, Sr. Research Associate, ICTAS; Hyomin Kim, Postdoc. Associate, Center for Space Science and Engineering Research, Bradley Department of Electrical & Computer Engineering, VT.

Universities Represented: Inter American University of Puerto Rico; Pennsylvania State University; University of Florida; NC Agricultural & Technical State University; Smith College; Old Dominion University; Mercer University; Rowan University ; Arizona State University; Stony Brook University; Loyola Marymount University

<http://wireless.vt.edu/reu/>

<http://www.ece.vt.edu/news/ar10/wirelessreu.php>



Abstracts: Cognitive Communications Program, NSF-REU Site

81. Diane Kayitesi, Joshua Noble, George Micros & Adam Rozenberg

Cognitive engine performance evaluation

Cognitive radios are software-defined radios that have the ability to sense and adapt their operational parameters to changing environments. A cognitive radio's adaptation is controlled by a cognitive engine that employs some combination of optimization and machine learning techniques. These flexible radio devices can enable efficient use of radio and spectrum resources in wireless communication networks. Because cognitive radios have dynamically varying parameters, it is difficult to use conventional measurement techniques and thus new performance evaluation methods must be used. In this project multiple different cognitive engines are tested in a variety of parameterized channel conditions and signal environments with varying signal-to-noise ratio, signal-to-interference ratio, and interfering signal characteristics and behavior, and performance metrics are evaluated. We use metrics such as Packet Error Rate (PER), throughput, and good throughput to allow performance evaluation of cognitive engines. The measurement system used consists of a unidirectional transmitter-receiver link with introduction of a noise/interference source. By analyzing the cognitive engines' performance metrics and the simulated environments in which they are measured, we can draw conclusions about cognitive engines' performance, and study their characteristics with the goal of improving design of future cognitive engines.

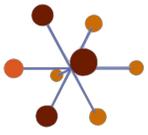
Mentor: Carl Dietrich

83. Lillian S. Kim, Thomas Zachariah, Noberto Rios & Rafael Isaac

Development of Space Weather Monitoring System and Statistical Study of GPS Scintillations

Autonomous Adaptive Low-Power Instrument Platforms (AAL-PIP), containing several space weather instruments, were recently deployed in Antarctica. Among the instrumentation on the platforms are magnetometers for measuring magnetic activity and Connected Autonomous Space Environment Sensor (CASES) Global Positioning System (GPS) software-defined receivers for measuring ionospheric scintillation. However, no reasonable monitoring system for the AAL-PIP stations exist. As a result, the majority of recorded data has not yet been analyzed. In this project, we develop a Graphical User Interface (GUI) that displays daily magnetic activity and GPS scintillation events, as well as housekeeping data to monitor system health. Also, we conduct a statistical study to reveal a correlation between the disturbances in the ionosphere and GPS signal fading. In this study, we find general patterns of the relationship in the recorded data from 24 January 2012 through 7 May 2012 utilizing different sets of data from the AAL-PIP system and reputed solar storm indices.

Mentor: Hyomin Kim



Abstracts: Cognitive Communications Program, NSF-REU Site

85. Matthew Montgomery, Tapas Mishra, Joseph Smith & Biniyam Zewede

Cooperative spectrum sensing

Due to the proliferation of wireless communication devices, the much of the available RF spectrum has already been licensed by the FCC. However, there is still much available “whitespace” – licensed spectrum that is underutilized on which cognitive radios can operate. In order to effectively utilize this whitespace, cognitive radio networks must be able to accurately sense when a given bandwidth of spectrum is occupied by a licensed user and when it is available. This paper explores the ways in which cooperative spectrum sensing can be performed within a cognitive radio network using MATLAB. First, the probability of detection and probability of false alarm for an individual node are theoretically developed. Cooperative overhead, such as fading and different values of signal to noise ratio, are taken into account when calculating these probabilities. The ability of an individual node to detect the presence or absence of a transmitted signal while subject to various channel conditions is then simulated. Next, various cooperative sensing algorithms which fuse the sensing results of individual nodes are simulated within a virtual cognitive radio network. These cooperative sensing results are then compared to each other and the sensing performance of an individual node.

Mentor: Alireza Babaei



LEWAS LAB

LABVIEW ENABLED WATERSHED ASSESSMENT SYSTEM

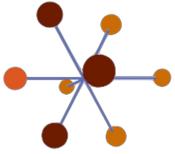
NSF/REU Site: Interdisciplinary Water Sciences and Engineering

Mentors: Dr. Vinod K Lohani, Professor, Department of Engineering Education and Program Director; Dr. Andrea Dietrich, Professor, Department of Civil and Environmental Engineering; Dr. Marc Edwards; Professor, Department of Civil and Environmental Engineering; Dr. Erich Hester, Assistant Professor, Department of Civil and Environmental Engineering; Dr. John Little, Professor, Department of Civil and Environmental Engineering, Dr. Amy Pruden, Associate Professor, Department of Civil and Environmental Engineering, Dr. Mark Widdowson, Professor, Department of Civil and Environmental Engineering, Dr. Kang Xia, Associate Professor, Department of Crop and Soil Environmental Sciences, Dr. John Muffo, Assessment Consultant; Dr. Julie Martin, Clemson University, External Assessment Expert

Represented Institutions: Texas Tech; Auburn University; Colorado School of Mines; University of Notre Dame; Worcester Polytechnic Institute; University of Delaware; University of Maryland, Baltimore County; University of Georgia; Virginia



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NSF/REU Site: Interdisciplinary Water Sciences and Engineering

108. Meghan F. Risky

Oxygenation at Falling Creek Reservoir

Cyanobacteria can control their depth within water allowing them to bloom in ideal conditions and cause taste and odor changes, as well as release possible toxins, which cause problems in the drinking water at Falling Creek Reservoir. In order to understand the conditions in which cyanobacteria bloom, the amount of phosphorus going into the lake, as well as that in the lake at different depths, temperature, dissolved oxygen, and turbidity have been recorded on a weekly basis. The phosphorus in the lake also increases the rate of eutrophication allowing cyanobacteria to thrive as the different layers created during thermal stratification are closer together allowing the cyanobacteria to reach sunlight easier and use photosynthesis to bloom. In an attempt to control this, Western Virginia Water Authority will be installing a side stream oxygenation system to introduce oxygen into the Hypolimnion layer in order to control anoxic conditions. Monitoring phosphorus levels before and after the oxygenation system is installed will be assessed in order to determine its effectiveness in suppressing phosphorus release as phosphorus is a major problem in eutrophication, leading to the growth of cyanobacteria.

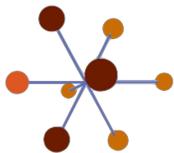
Mentor: Dr. John Little

109. Kate E. Aulenbach

Macropores as preferential flow paths and their effects on surface water-groundwater exchange within hyporheic ones

Hyporheic exchange, the mixing of surface water and groundwater, is beneficial to water quality and stream ecology as it can buffer stream temperatures, promote biogeochemical reactions, attenuate pollutants, and provide habitat. Bank storage is a subset of hyporheic exchange where stage fluctuations within a stream or river cause surface water to infiltrate into banks and interact with groundwater. Macropores are physical void spaces within the bed and banks of streams that act as preferential flow paths and increase hyporheic exchange, however, previous studies have not quantified their abundance or impact on streams. The objectives of this study are to (1) survey and quantify reach scale macropore abundance and dimensions (i.e., diameter, depth, height above channel bed), (2) determine reach scale temporal variation of macropore activity (i.e., when macropores are saturated), and (3) quantify macropore impact on bank storage rates and hyporheic zone size at the patch scale. Objective (2) will be addressed by combining stage data, stream discharge measurements, and macropore surveys in a computer model to predict the activation (i.e., saturation) of macropores over time. Objective (3) will be met by monitoring and comparing water levels in piezometers at two stream bank faces, one with and one without macropores. Preliminary results suggest that macropores are common geomorphic features that increase hyporheic exchange by acting as preferential flow paths.

Mentor: Dr. Marc Edwards



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NSF/REU Site: Interdisciplinary Water Sciences and Engineering

110. Josh L. Caldwell

Hot water heater system design: effect on water quality parameters associated with biological activity

The advent of modern water treatment technology has significantly decreased the number of human infections by fecal-derived pathogens in potable water. The most common source of waterborne disease is now caused by opportunistic premise plumbing pathogens (OPPPs). OPPPs grow in premise plumbing systems, outside the jurisdiction of water treatment authorities. Hot water heater system design can significantly affect water quality parameters associated with OPPP growth. This work quantifies the effects that pipe orientation and hot water heater temperature setting have on temperature stratification, disinfectant residual concentrations, and stagnant mixing rates within a model hot water heater system. Specifically, comparative analysis of differences between upward oriented pipes and downward oriented pipes will be performed. Preliminary results suggest temperature differences as a function of pipe orientation are significant; upward oriented pipe temperatures are 7°C to 22°C hotter during steady state mixing conditions during stagnation than downward oriented pipes across six hot water heater temperature settings: 40°C, 43°C, 48°C, 54°C, 60°C, and 66°C. Significantly higher disinfectant residuals (up to 4ppm) were observed in upward oriented pipes only when compared to downward oriented pipes after 24 hours of stagnation at 48°C hot water heater temperature setting. Tracer tests are currently underway and results are forthcoming.

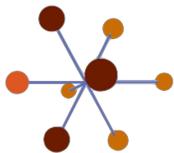
Mentor: Dr. Marc Edwards

111. Zach S. Baily

Applications of molecular tools for exploration of microbial community structure and function at the Bemidji, Minnesota oil spill site

Research at the Bemidji Minnesota terrestrial oil spill site continues to provide information about the anaerobic biodegradation of toxic hydrocarbons. The goal of this project is to gain a better understanding of the microbial community structure and function involved in the degradation. Several molecular tools were applied including Polymerase Chain Reaction (PCR), Denaturing Gradient Gel Electrophoresis (DGGE), and Real-Time Polymerase Chain Reaction (qPCR). Samples were taken from in-situ microcosms, with different electron accepting conditions, to characterize population and functional changes with time. Aquifer sediment cores were taken from different regions of the plume and sampled. These samples were analyzed to provide insight into stratification within a given electron accepting condition. Cluster analysis of DGGE fingerprints illustrate significant changes in the microbial community structure of different electron accepting regions of the oil plume but no significant changes occurring with depth or time. Community function was investigated by screening for several functional genes involved in the anaerobic degradation pathway of aromatic compounds found in crude oil. This work compliments geochemical work done by the USGS and will be relevant for remediation efforts at current and future oil spill sites.

Mentor: Dr. Amy Pruden



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NSF/REU Site: Interdisciplinary Water Sciences and Engineering

112. Ashley E. Griffin

Taste threshold of manganese in drinking water

Manganese is a micronutrient commonly found in drinking water at very low mg/L concentrations. The US-EPA issued a secondary maximum contaminant level of 0.05mg/L for manganese; above this concentration, oxidized manganese has a black-brown color and stains plumbing fixtures and causes discoloration of drinking water.. This regulation also ascribes a “bitter metallic taste” to manganese in drinking water, but no known studies confirm this description. Recent studies link manganese in drinking water to impairment of children’s IQ and other neurotoxic effects. The goal of this study is to determine the human taste threshold for aqueous Mn²⁺ to know if consumers can protect themselves by detecting an off-taste. Thirty-one volunteers (15 female) participated in 1-in-5 choice tests where one sample contained Mn²⁺ in deionized water at concentrations 8.867mg/L-506.25mg/L and four samples contained deionized water. Each volunteer repeated the 1-in-5 choice test at varying concentrations for 6-10 sessions to accurately determine their threshold. Individual thresholds were calculated using geometric means. Preliminary results indicate that 108.9mg/L is the population taste threshold, which is much higher than typical Mn concentrations in water. A concentration this high indicates that consumers are unlikely to observe any taste in their drinking water due to soluble manganese.

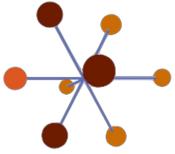
Mentor: Dr. Andrea Dietrich

113. Jennifer L. Moutinho

Investigating the occurrence and fate of organic contaminants in a watershed impacted by urban development

Increased urban development has prompted increasing concerns about organic chemical concentrations in fresh water sources due to urban and agricultural runoff. Endocrine disrupting compounds are of particular concern due to their effect on ecosystems and wide use in many consumer products and fertilizers. Investigating the level of 4-nonylphenol, a common anthropogenic endocrine disrupting compound, will improve understanding of the degree of impact urban development has on the water quality of urban watersheds. The purpose of this study is to determine the occurrence of 4-nonylphenol within the Stroubles Creek Watershed in Blacksburg, Virginia to help gain a better understanding of the environmental impacts of urban development and natural rain events. Throughout this study, water and sediment samples were collected at six locations along the creek. Extraction and cleanup of 4-nonylphenol in the water samples was performed using solid phase extraction. 4-nonylphenol in the sediment samples was extracted using ultrasonication and cleaned up using silica gel. The analysis of 4-nonylphenol in the final extract was conducted on a gas chromatography-tandem mass spectrometer. The levels of 4-nonylphenol in the water samples were detected at 100’s ng/L, while in the sediment samples they were detected at 1000’s µg/kg. This investigation helped determine the relationship between the concentration of 4-nonylphenol and different types of urban development.

Mentor: Dr. Kang Xia



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NSF/REU Site: Interdisciplinary Water Sciences and Engineering

114. Maureen R. O'Brien

Antibiotic resistance genes in recycled water

Water shortages around the United States are causing regions to rely on recycled wastewater as an inexpensive and sustainable option for irrigation. While this water is being treated to a high standard, there has been evidence suggesting that certain pathogens are surviving the treatment process and remaining in the distributed reclaimed water. Antibiotic resistant bacteria (ARBs) are an example of these persistent pathogens and may be harmful to humans. In order to quantify antibiotic resistant genes (ARGs), which are markers of ARB presence, samples from irrigation systems in Flagstaff, AZ and Santa Barbara, CA utilizing recycled "purple pipe" wastewater are being analyzed using DNA extraction and quantitative polymerase chain reaction (qPCR). This qPCR analysis allows the presence of these genes to be verified and quantified in order to give a better idea of how many ARGs are surviving the treatment processes and in potential contact with humans in those areas. Initial analysis of samples has indicated bacterial presence; however, both incidence and quantity of specific ARGs have yet to be determined. If any ARGs are identified, it may support the installment of more aggressive water treatment and/or changes in the water distribution process.

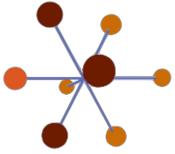
Mentor: Amy Pruden

115. Manuel A. Martinez

Integration of software and hardware components for a real-time environmental monitoring system

A LabVIEW Enabled Watershed Assessment System (LEWAS) Lab has been under development on VT campus since 2008. The outdoor site of LEWAS is located on the Webb Branch, just upstream of Duck Pond. The goal is to collect, store, and wirelessly communicate real-time water (quality and quantity) and weather data for water sustainability research and education. This interdisciplinary lab supports research work of students in various disciplines including engineering education, civil and environmental engineering, electrical and computer engineering and chemical engineering. The LEWAS uniquely integrates LabVIEW's data acquisition capability with the water and weather hardware. Specifically, it includes a Hydrolab which collects water quality data; a Flow Tracker, which measures flow and stage of the stream; and a weather station which collects weather data. In this research, calibration procedures for water and weather hardware were established. Real-time water and weather data were collected for a number of storm events and rainfall-runoff analysis is in progress. Using LabVIEW File I/O, a Virtual Instrument (i.e., program) for storing weather data was written. A case study to analyze environmental impacts of a water main break in the town of Blacksburg is developed to show the importance of a real-time environmental monitoring system.

Mentor: Vinod Lohani



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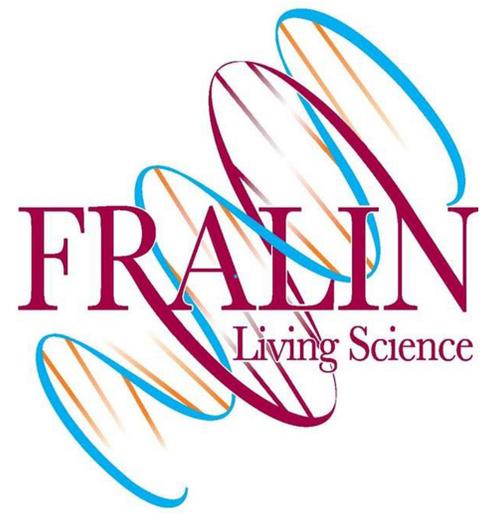
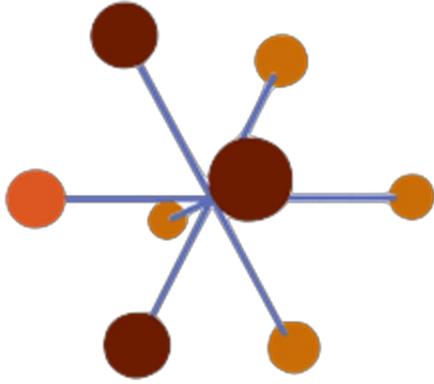
NSF/REU Site: Interdisciplinary Water Sciences and Engineering

116. William J Raseman

Effect of bioavailable Fe³⁺ on the sustainability of monitored natural attenuation of petroleum hydrocarbons

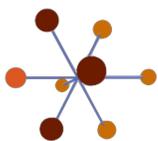
Petroleum-derived compounds, particularly benzene, remain among the most frequently cited groundwater contaminants (USGS, 2011). At these sites, Monitored Natural Attenuation (MNA) is often employed to manage residual contamination. MNA is a cost-effective technique which utilizes biodegradation and other natural attenuation mechanisms to remediate petroleum hydrocarbon plumes in the groundwater before reaching points of contact in a time-frame comparable to alternative methods (USEPA, 1999). In order for microbes to biodegrade contaminants, electron acceptors, such as oxygen and iron, must be available. Due to its abundance in soils, iron often has the most potential for anaerobic biodegradation of organic matter (Lovley, 1989). However, only a portion of the iron, known as bioavailable Fe³⁺, can be utilized by microbes. We are interested in modeling the effect of different bioavailable Fe³⁺ distributions on the sustainability of petroleum hydrocarbon plume biodegradation. To determine representative distributions, we are using a Bioavailable Fe³⁺ Assay in order to characterize borehole samples from Site 45, Marine Corps Recruit Depot, Parris Island, South Carolina. Using iron distributions from these data and other realistic scenarios, we will numerically model the fate and transport of gasoline, including E10 fuel, in hypothetical groundwater systems using SEAM3D (Sequential Electron Acceptor Modeling in 3-Dimensions).

Mentor: Dr. Mark Widdowson



Individual projects





Abstracts: Individual Projects

105. Jesus Ramirez

Understanding the role of an Allyl Alcohol Dehydrogenase-like gene in Arabidopsis

Flavonoids are a diverse class of secondary metabolites that are best known as the red, blue, and purple pigments in plant tissue. There is immense interest in flavonoids due to their important roles in plants and their potential health benefits in animals. Several environmental stimuli, including abiotic and biotic stressors, and metabolic changes, including sugar and hormone conditions, affect expression of genes in the flavonoid biosynthetic pathway. Microarray analyses in *Arabidopsis thaliana* have identified a number of genes of unknown function that are tightly co-expressed with flavonoid genes. This project focuses on one of these genes, encoding a putative allyl alcohol dehydrogenase-like protein (AAD-L). Knock-out mutants for the AAD-L gene were characterized in order to understand the function of the gene. Homozygous mutants missing the gene were closely observed in order to detect any differences in physical characteristics or development compared to wild-type plants. Mutants exhibited yellow and small rosette leaves and, as well as differences in bolting and flowering time. Experiments are underway to gain further understanding of the gene's function, including efforts to identify where in the cell its protein accumulates, additional phenotypic analyses, also in response to various environmental stressors, and complementation of the mutants to confirm that the observed phenotypes are indeed correlated with the AAD-L gene.

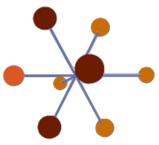
Mentor: Brenda Winkel

106. Allen E. Rosss

Conspecific aggression in relation to neighbor distribution in urban and rural populations of song sparrows (*Melospiza melodia*)

Territorial aggression can be influenced by a variety of ecological factors including population density, resource availability, and degree of urbanization. It follows that the number and proximity of neighbors, which may be a measure of density more relevant to the individual, could influence territorial aggression. This study was conducted to answer the following question: does the distribution of neighboring birds' territories influence same-species aggressive territorial behavior? We predicted that a bird with more neighbors in closer proximity will be more aggressive. Our focal species was the song sparrow (*Melospiza melodia*), a bird found in urban and rural areas of southwestern Virginia that defends a territory. We studied territorial male song sparrows during the pre-breeding period at three urban and three rural sites. Two measures of neighbor distribution were used: 1) the distance from the focal sparrow to its nearest neighbor and 2) the number of neighbors located within a radius of 75M. Territorial aggression was quantified in response to a simulated territorial intrusion in which a speaker broadcasting a pre-recorded song is placed on the territory. Analyses suggest that neighbor distribution impacts number of songs. These results mean that there is a change in behavior to compensate for increased neighbors.

Mentor: Ignacio T. Moore



Abstracts: Individual Projects

107. Coleman P. Burch
Roofers' task performance and perceived usability of fall protection and OSHA Standards

Falls in construction have and continue to be a serious issue on jobsites. On June 16, 2011, the Occupational Safety and Health Administration (OSHA) revised their previous policy regarding fall protection and implemented a new compliance guidance, which went into effect on September 16, 2011. This new guidance varies from the previous in both its definition of residential construction and its allowance of alternative fall protection measures. In this study, we examined these changes to OSHA's fall protection standard while also examining how roofers felt about these changes. An archival analysis of the research literature was conducted to understand roofers' perspectives on the revised fall protection standard. In order to accomplish this, a study was developed that allowed roofers to perform a series of roofing tasks—laying OSB and tar paper and then installing shingles on a section of a roof—while wearing a personal fall arrest system. Roofers were video-taped during task performance to record behavioral and verbal data throughout the test. A post-task interview was conducted to elicit their experience with the fall arrest system, including usability. Several high-risk behaviors were observed during the roofing tasks, and recommendations will be provided to alter work practices to increase safety.

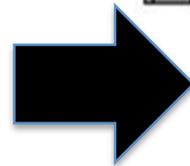
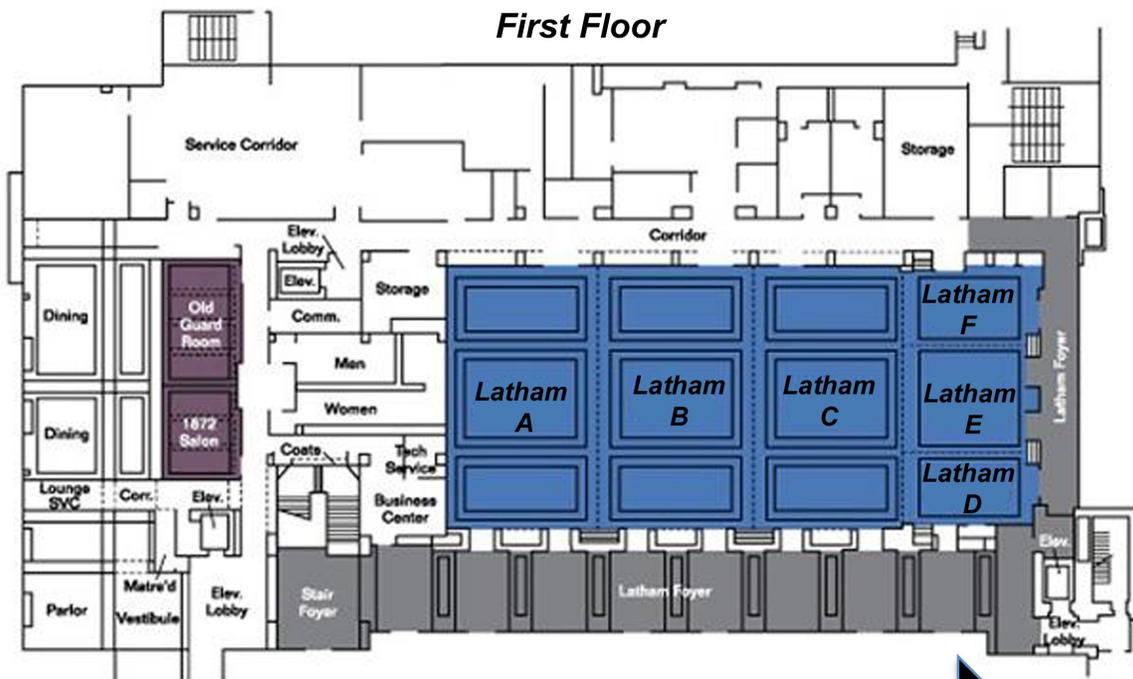
Mentor: Dr. Smith-Jackson

96. Grayson Cobb & Jaklyn Daly
Maternal nutrition and offspring predisposition to metabolic syndrome

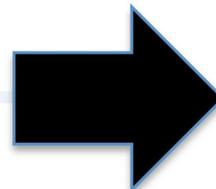
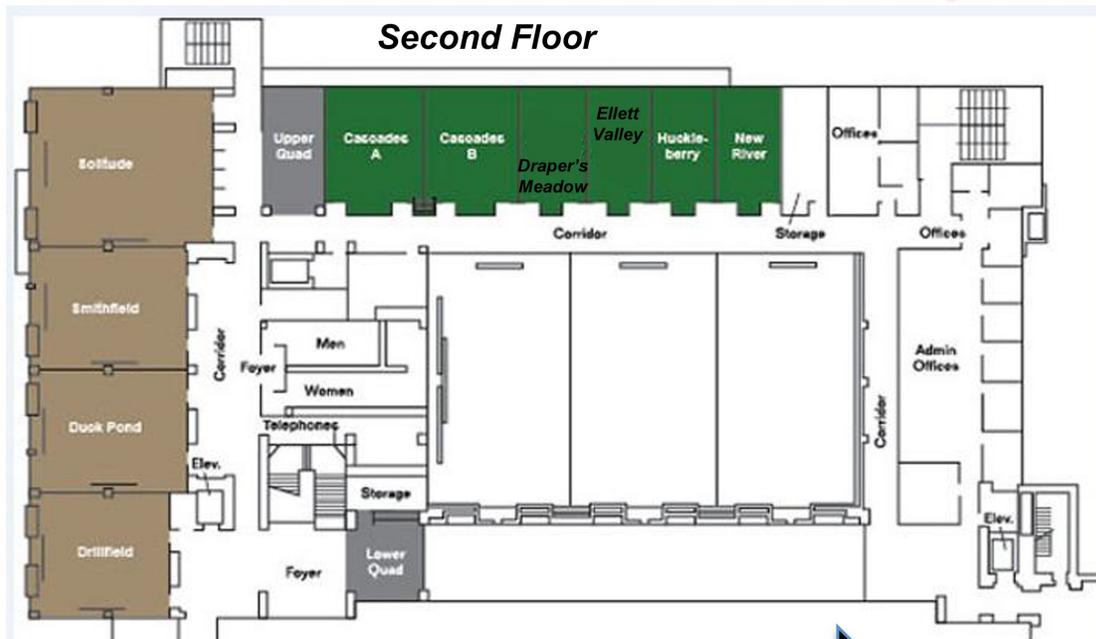
The effects of prenatal exposure to a high fat diet modeling the “fast food diet” in American society have been well- documented in rodent models, showing a high predisposition to obesity and metabolic disorders. However, while the effects of a single diet are evident, no experiment has yet mimicked the reality of choice in human society in which several diets are available. Using a mouse model, this experiment studies the relationship of food and food selection choices to lifelong health. The offspring from dams fed either high fat or low fat diet were further split into high fat and low fat diet groups along with a choice condition with the option of both diets. Body weight, body fat, food intake, food choice, glucose tolerance and serum protein levels will be measured in offspring at 7 and at 16 weeks of age. Preliminary data shows that offspring from high fat diet have significant early growth restriction, but subsequently gain body fat more quickly than those offspring from low fat diet dams. These studies have direct relevance to the effects of diet choice on obesity and metabolic disorders in our own society.

**Mentors: Deborah Good, Renee Prater, VMRCVM
George Davis, Agriculture and Applied Economics**

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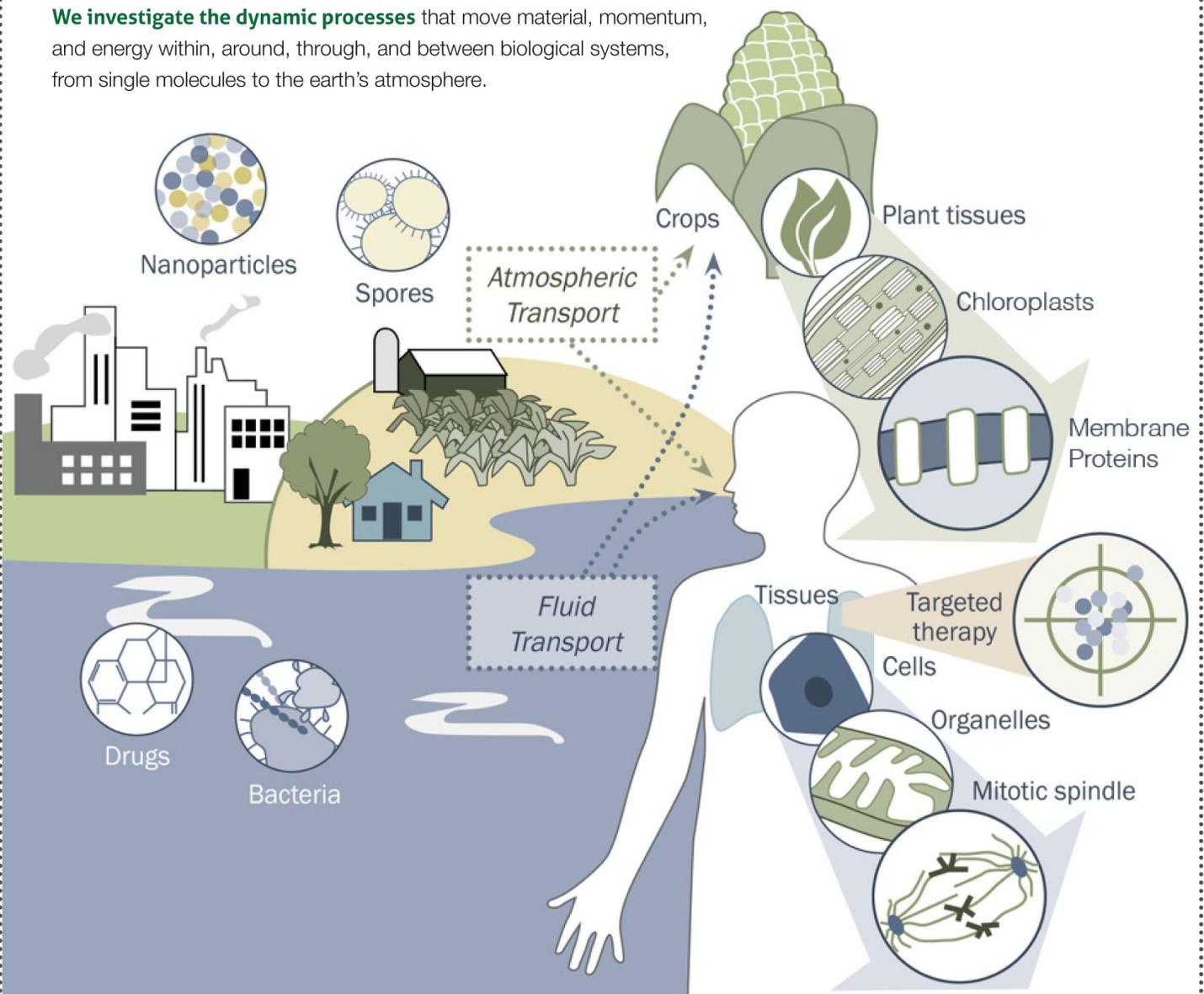
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