**Global Systems Science Destination Area**

# CONCEPT: Microbiology at the Nexus of Food, Energy, Water and Health


Team Leaders:

Ann M. Stevens, Biological Sciences, COS
David G. Schmale III, Plant Pathology, Physiology and Weed Science, CALS

Team Members:

Brian D. Badgley, Crop and Soil Environmental Sciences, CALS
Renee R. Boyer, Food Science and Technology, CALS
Monique Dufour, History, CLAHS
Zhen (Jason) He, Civil and Environmental Engineering, COE
Laura L. Hungerford, Veterinary Medicine, Public Health, CVM
Melanie A. Kiechle, History, CLAHS
David D. Kuhn, Food Science and Technology, CALS
Christopher Lawrence, Biological Sciences, COS
Linsey C. Marr, Civil and Environmental Engineering, COE
Stephen B. Melville, Biological Sciences, COS
F. William Pierson, Veterinary Medicine, Public Health, CVM
David L. Popham, Biological Sciences, COS
Ryan S. Senger, Biological Systems Engineering, CALS
Susan S. Sumner, College of Agriculture and Life Sciences
Boris A. Vinatzer, Plant Pathology, Physiology and Weed Science, CALS

## 1. Vision Statement

"The role of the infinitely small in nature is infinitely great."-Louis Pasteur. Microorganisms are absolutely critical to myriad aspects of the human existence. As a field of study, microbiology could and should serve a greater role on our campus, as it has key connections with many of the Destination and Strategic Growth Areas. We propose the development of a broad concept area in microbiology that will serve as a nexus, as it is applied to solve critical global challenges related to food, energy, water and health, by bridging across multiple disciplines at Virginia Tech (VT). There is increasing recognition of microbes as a driving force in natural and managed environments, biological processes, and ecological structure. Conversely, the importance of culture and individual behavior in affecting microbial communities has also become apparent. Applied microbiology is therefore an integral component of the GLOBAL SYSTEMS SCIENCE Destination Area (see GSS white paper here, https://goo.gl/SqAQ6B) and is a truly interdisciplinary science. Our concept contains four areas of emphasis within the GSS DA relating to microbiology: (1) **infectious disease,** (2) **food sustainability and safety,** (3) **energy, and** (4) **water**. Microbes play key roles in both the maintenance and deterioration of human, animal, and plant health (**infectious disease**), in the production, preservation and degradation of food (**food sustainability and safety**), in the creation of next generation fuels and chemicals (**energy**), and in maintenance of the earth's environment and climate (**water**). Microbes not only contribute to multiple fields related to scientific and technology endeavors, but their impacts on the world have huge societal, cultural, historical, and ethical implications.

Our long-term vision (supported through at least five new hires in this concept area) is to direct the resources allocated through this interdisciplinary effort to enhance and further strengthen teams of scientists, engineers, sociologists, and practitioners working on applied microbiology problems at VT. Our short-term vision (supported through an initial $75K investment in the development of this concept) will enable increased communication and coordination across the VT campus, creating a large and organized group that will immediately provide VT with a visible strength and a uniquely integrated approach in the field. Small seed grants will provide the opportunity to support the design of new research projects and innovative curricular paths and career opportunities for our faculty and students. These initial investments will be the base from which the long-term investments will grow.

## 2. Relevance

Driven by human health issues and demand for renewable resources to create global sustainability, the field of microbiology is at the forefront of some of society's grand challenges. Application of microbes and microbial-driven processes has the capacity to provide the needed solutions, but only when informed by societal and cultural norms that influence technological adoption. This will take teams of experts working together across the different subdisciplinary and transdisciplinary lines.

Microbes can contribute to increased health and/or cause widespread disease in humans, livestock and crops. Reports of pathogen transmission between animals, crops and humans are increasing, and the use of antimicrobials affects the well-being of the entire human-animal-environment system. Understanding the roles of microbes in animal and plant health, and our ability to inhibit **infectious disease** and promote beneficial species, will contribute immensely to the future of **food sustainability and safety**.

Microbes are responsible for the majority of the flux of the elemental cycles on earth (e.g., the carbon and nitrogen cycles). Investigations into the impact of microbes on causing and mitigating global change are, therefore, key to efforts to preserve and improve the environment required for sustained future human life. Efforts to discover, characterize, and metabolically engineer microbes to produce **energy** (e.g., the conversion of feedstocks into next generation fuels and chemicals) will reduce our dependence on nonrenewable fossil fuels. Microbial activity also has critical implications for wastewater and drinking water treatments impacting our natural **water** resources, and microbes are responsible for remediation of industrial wastes.

Funding opportunities: There are opportunities for significant growth in new funding through partnerships with industry (e.g., aquaculture, biotechnology, food processing, pharmaceutical companies). A number of Virginia-based companies supported development of the new Microbiology degree at VT and/or offer internship opportunities to our students (Table 1). Several of the PIs of this proposal already work with industrial sponsors (Table 1). All of the major federal funding agencies support research in applied microbiology and some have special programs that target research proposals in this area including the NIH (e.g., Antimicrobial Resistance

Diagnostic Challenge), NSF (e.g., Innovations at the Nexus of Food, Energy and Water Systems), NSF-USDA joint programs (e.g., Plant Biotic Interactions), USDA (e.g., aquaculture), DOE (e.g., Biological and Environmental Research), DOD (e.g., Fuels and Chemicals), and NASA (e.g., extraterrestrial life/Mars mission). In addition, the NIH (NIAID, NIGMS, NHLBI, etc.) routinely fund basic, clinical, and applied research related to a myriad of human health disorders with a microbial etiology or exacerbation perspective (e.g., allergy, asthma, CF, etc.). Private organizations such as the Gates Foundation also support work in areas of applied microbiology.

Connections to other destination and strategic growth areas: Connections between applied microbiology and several other areas of investment at VT are clear: Intelligent Infrastructure for Human-Centered Communities (air and water resources); Integrated Security (energy and biosecurity); Data Analytics and Decision Science (healthcare, infrastructure, security and social analytics); Strategic Growth Areas (Equity and Social disparity in the Human Condition and Policy); VT Centers (Center for Applied Water Research and Innovation; Drug Discovery Center; Global Change Center; Virginia Water Resources Research Center); and the new School of Plant and Environmental Sciences (CALS, VT).

**3. Curriculum Opportunities**

Future curricula at VT will be influenced and shaped by the Beyond Boundaries report, Destination Areas, and pathways for general education. The goal is for our VT-shaped students to receive disciplinary education and be allowed the flexibility to explore and experiment in other educational areas. This proposed initiative is uniquely positioned to build on existing curricula and leverage established industry partnerships to design new curricular opportunities to enrich student educational experiences.

In Spring of 2015, the first students graduated from the new Microbiology (MICB) degree. This degree is offered by the Department of Biological Sciences in the COS and is the only undergraduate degree in microbiology in Virginia. The curriculum is enriched and dependent on courses contributed by colleagues in CALS and Veterinary Medicine (CVM). In addition, CALS has a pathways minor, “Civic Agriculture and Food Systems”, and has a new approved minor, “Global Food Security and Health”, that will be reviewed as a pathways minor. A new CVM undergraduate degree in public health, under university review, has been approved by the Commission on Undergraduate Studies and Policies. Many of the courses already in existence have graduate sections that routinely enroll students from across campus, further demonstrating the cross-disciplinarity of microbiology (e.g., BIOL 5634-Microbial Physiology regularly has graduate students from CALS, COE, COS and CVM). Building on these successes we propose that the existing MICB curriculum can be leveraged and expanded to include other units on campus, including CLAHS (that offers a relevant “Medicine in Society” minor) and COE. Many existing courses already integrate both scientific and societal issues. Examples include PPWS 2004- Mysterious Mushrooms and Molds (a Curriculum for Liberal Education course that has been approved for Pathways), HIST 3714- War and Medicine, and HIST- 3724 History of Disease, Medicine, and Health, and several electives within the MICB degree (e.g. BIOL 4674- Pathogenic Bacteriology, BIOL/CSES/ENSC 4164- Environmental Microbiology, FST 3604- Food Microbiology, and PPWS 4114- Microbe Forensics/ Biosecurity). In consultation with colleagues in CLAHS and a collegiate faculty hire, new cross-disciplinary pathways courses to educate non-sciences majors will be developed.

We will develop the VT-shaped student through deep discipline-specific training including a variety of hands-on laboratory experiences on campus. In addition, many of the participating faculty are actively engaged in extension and/or outreach educational activities that will be incorporated into classroom instruction, and/or students will go into the community to deliver appropriate resources to the public. We are also in a unique position to work with industrial partners to create new formal internship programs and lecture series. We envision a curriculum where undergraduate and graduate students from life sciences, engineering, and social sciences work together to solve grand challenges in applied microbiology.

**4. Description of Resources Needs**

A. Long-term investments. Hires of four tenure-track faculty members and a collegiate faculty member are proposed that will contribute to research and teaching in FEWH Microbiology:

1. Food processing and safety (unique approaches to processing and packaging foods and feeds to improve food safety and security)
2. Energy sustainability (metabolic engineering of microbes for next generation fuels/fuel cells and chemicals; development of novel uses for ethanol production byproducts)

3. Water biotechnology/bioremediation (engineering microbes to ensure a safe supply of water; biofilms)
4. Public health of domestic animals and humans (strategies to combat airborne infectious diseases; aquaculture disease agents; biologicals/probiotics/beneficial microbes; emerging public health issues relevant to agriculture)
5. Collegiate faculty member(s) to develop new pathways courses in history and ethics of applied microbiology (ethical issues of microbes being used to remediate environments, public health, vaccinations, and use of antimicrobials in agriculture/aquaculture) and perform Scholarship of Teaching and Learning (SoTL) research.

We also propose a staff position to manage student internships, manage and advise the MICB major and minors, and perform assessment/ SoTL research in collaboration with faculty.

Resources are requested for a grand challenges lab space. Teams consisting of biologists, engineers, and social scientists will work together in an open source grand challenge lab to invent the future of applied microbiology. Student teams, motivated by over-arching key questions in microbiology at the nexus of food, energy, water and health, will drill down from large-scale research questions to shorter term, achievable research and design projects. It will be important that a physical space on campus become associated with the concept area where faculty and students may meet.

B. Short-term investments. We envision investing the $75K allocated through this proposal effort into marketing, communication, symposia, and seed funds. An external marketing company will be hired to critically evaluate industry needs for each of the designated hires, and to provide content for a strong online presence needed to attract the best and brightest students to this DA. We will leverage internal resources (e.g., Fralin's communications team) to develop a series of VT news pieces and an annual magazine (similar to what has done for BIOTRANS and TPS). Funds will be used to will help maintain communication and collaborations across the group (e.g. annual research symposia) and outwardly to both public and private partners (e.g. website provided through Fralin). Resources are also needed to provide seed grants enabling junior and senior from two or more distinct units on campus to develop and design novel areas of research so they may be competitive for additional outside funding. These seed grant funds will also be used to enable the development of new curricular innovations involving faculty from two or more distinct units on campus.

**Appendix I: Biosketches in alphabetical order by last name**

1. Badgley
2. Boyer
3. Dufour
4. He
5. Hungerford
6. Kiechle
7. Kuhn
8. Lawrence
9. Marr
10. Melville
11. Pierson (CV/biosketch not received by deadline; website information included for review)
12. Popham
13. Schmale
14. Senger
15. Stevens
16. Sumner
17. Vinatzer

**Brian D. Badgley**

Crop & Soil Environmental Science
Virginia Tech
1880 Pratt Drive, Room 1121
Blacksburg, VA 24061
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## (a) Professional Preparation

| | | |
|---|---|---|
| University of Georgia | Zoology | B.S., 1995 |
| University of Maryland | Marine-Estuarine-Environmental Sciences | M.S., 2002 |
| University of South Florida | Biology | Ph.D., 2009 |
| University of Minnesota | Environmental Microbiology | Post-doc, 2009-12 |

## (b) Appointments

| | |
|---|---|
| 2012- | Assistant Professor, Crop & Soil Environmental Science, Virginia Tech |
| 2009-12 | Post-Doctoral Associate, BioTechnology Institute, University of Minnesota |
| 2002-04 | Coastal Training Coordinator, Rookery Bay National Estuarine Research Reserve |
| 2001-02 | Sea Grant Fellow, NOAA, Estuarine Reserves Division |
| 1996-97 | Environmental Education Instructor, Jekyll Island 4-H Center, Jekyll Island, Georgia |

## (c) Products

### (i) Related products (*student co-authors)

*Sun S, Li S, Avera BN, Strahm BD, **Badgley BD** (in press) Bacterial and fungal communities show distinct succession patterns during ecosystem restoration. *Appl Environ Microbiol.*

Wepking C, Avera B, **Badgley BD**, Barrett JE, *Franklin J, Knowlton KF, Ray PP, *Smitherman C, Strickland MS (2017) Exposure to dairy manure leads to greater antibiotic resistance and increased mass-specific respiration in soil microbial communities. *Proc Roy Soc B* 284*.*

Li X, *Sun S, **Badgley BD**, He Z (2016) Long-term performance and microbial community characterization of an osmotic anammox system for removing reverse-fluxed ammonium. *Bioresource Tech* 211:628-635.

Li X, *Sun S, **Badgley BD**, Sung S, Zhang H, He Z (2016) Nitrogen removal by granular nitritation - anammox in an upflow membrane-aerated biofilm reactor. *Water Res* 94:23-31.

Scholz F[#], **Badgley BD**[#], Sadowsky MJ, Kaplan DH (2014) Immune mediated shaping of microflora community composition depends on barrier site. *PLoS One* 9:e84019. ([#]co-first authors)

**(ii) Other Significant Products**

Harwood VJ, Staley C, **Badgley BD**, Borges K, Korajkic A. (2014) Microbial source tracking markers for detection of human sewage and fecal contamination in environmental waters: relationships to pathogens and human health outcomes. *FEMS Mirobiol Rev.* 38:1-40.

Sugawara M, Epstein B, **Badgley BD**, Unno T, Xu L, Reese J, Gyaneshwar P, Denny R, Mudge J, Bharti AK, Farmer AD, May GD, Woodward JE, Medigue C, Vallenet D, Lajus A, Rouy Z, Martinez-Vax B, Tiffin P, Young ND, Sadowsky MJ (2013) Comparative genomics of the core and accessory genomes of 48 *Sinorhizobium* strains comprising five genospecies. *Genome Biol* 14:R17.

**Badgley BD**, Thomas FIM, Harwood VJ (2011) Quantifying environmental reservoirs of fecal indicator bacteria associated with sediment and submerged aquatic vegetation. *Environ Microbiol* 13:932-942.

**Badgley BD,** Thomas FIM, Harwood VJ (2010) The effects of submerged aquatic vegetation on the persistence of environmental populations of *Enterococcus* spp. *Environ Microbiol* 12:1271-1281.

**Badgley BD**, Nayak BS, Harwood VJ (2010) The importance of sediment and submerged aquatic vegetation as potential habitats for persistent strains of enterococci in a subtropical watershed. *Water Res* 44:5857-5866.

**(d) Synergistic Activities**

- Co-organized and hosted a workshop entitled “Strategies for sequence-based analyses of microbial communities (and the caveats)” which was attended by over 35 students, post-docs, and faculty from eight different departments across the Virginia Tech campus (2013)

- President of the Virginia Branch of the American Society of Microbiology (2015-2017)

- Cofounded a microbial ecology networking group of students and faculty at Virginia Tech to facilitate collaboration, discussion, and project development on campus (2012-ongoing)

- Dedicated to providing undergraduate research opportunities, including direct mentoring of 6 NSF REU students, 3 VT Minority Summer Research Interns, and 7 paid undergraduate research assistants since 2013.

- Manuscript reviewer for *Appl Env Microbiol, Bioremediation, Environ Sci Tech*, *FEMS Microbiol Ecol*, *J Environ Mon*, *J Great Lakes Res*, *Sci Tot Environ*, *Water*, *Water Res* (ongoing)

## BIOGRAPHICAL SKETCH

Provide the following information for the Senior/key personnel and other significant contributors.
Follow this format for each person. DO NOT EXCEED FIVE PAGES.

NAME: Renee Raiden Boyer

eRA COMMONS USER NAME (credential, e.g., agency login): RRBOYER

POSITION TITLE: Associate Professor and Extension Specialist

EDUCATION/TRAINING *(Begin with baccalaureate or other initial professional education, such as nursing, include postdoctoral training and residency training if applicable. Add/delete rows as necessary.)*

| INSTITUTION AND LOCATION | DEGREE *(if applicable)* | Completion Date MM/YYYY | FIELD OF STUDY |
|---|---|---|---|
| Radford University, Radford, VA | B.S. | 05/1999 | Biology |
| Virginia Tech, Blacksburg, VA | M.S. | 08/2002 | Food Science & Technology |
| Virginia Tech, Blacksburg, VA | Ph.D. | 05/2006 | Food Science & Technology |

### A. Personal Statement

I have extensive training and experience in food microbiology, food safety and consumer/grower outreach related to reducing food safety risks in the growing environment. Throughout my education I was trained as a produce microbiologist, with an emphasis on understanding how foodborne pathogens attach to produce surfaces, and exploring methods to remove pathogens if they are present on fresh fruits and vegetables. This work led to investigating novel antimicrobial compounds that plant products may possess. My extension program, and translating research to the public has always been a cornerstone of my scholarship efforts. This has developed into a primary strength of my program. Main emphasis has been include management of the delivery of educational interventions through extension agents; as well as evaluation of educational content through a variety of methods including surveys, interviews and focus groups.

1. Pollard, S., R. Boyer, B. Chapman, J. di Stefano, T. Archibald, M. Ponder and S. Rideout. 2016. Identification of risky food safety practices at Southwest Virginia farmers markets. *Food Protection Trends*. 36,168-175.
2. Pollard, S., J. Barak, R. Boyer, M. Reiter, G. Gu and S. Rideout. 2014. Potential interactions between *Salmonella enterica* and *Ralstonia solanacearum* in tomato plants. *Journal of Food Protection*. 77, 320-324.
3. Harrison, J., J. Gaskins, M. Harrison, J. Cannon, R. Boyer, G. Zehnder. 2013. Survey of food safety practices on small to medium sized farms and farmers markets. *Journal of Food Protection*. 76, 1989-1993.

4. Robertson, L. R. R. Boyer, B. J. Chapman, J. D. Eifert, A. Villalba, and N. Franz. 2013. Educational needs assessment and practices of grocery store food handlers through survey and observational data collection. *Food Control*. 34,707-713.

## B. Positions and Honors

**Positions and Employment**

| | |
|---|---|
| 2006 – 2012 | Assistant Professor and Extension Specialist. Department of Food Science and Technology, Virginia Tech, Blacksburg, VA |
| 2012 – | Associate Professor and Extension Specialist. Department of Food Science and Technology, Virginia Tech, Blacksburg, VA |

**Other Experience and Professional Memberships**

| | |
|---|---|
| 2016 – | Vice chairperson, program committee, International Association for Food Protection |
| 2014 – | Program committee, International Association for Food Protection |
| 2001 - | Member, International Association for Food Protection |
| 2000 – 2012 | Member, Institute of Food Technologists |

**Honors**

| | |
|---|---|
| 2015 - | Andy Swiger Land Grant Award Recipient, Awarded to faculty at Virginia Tech that best exemplifies the land grant mission, showing excellence in research, teaching and Extension. |
| 2013 - | Gamma Sigma Delta Extension Award of Merit. Awarded to faculty that are GSD members that show excellence in the Extension mission. |

## C. Contribution to Science

1. Produce research – Preventing contamination of fresh fruits and vegetables with foodborne pathogens is the primary method to prevent foodborne illness. Understanding how produce can become contaminated in the field and then identify methods of removing pathogens if present is paramount to ensuring safety of fresh foods consumed with no thermal processing. Through the references cited below, I have worked to identify methods to enhance removal of pathogens (through the use of detergents) and understand how contamination occurs. One of the newest discoveries in produce food safety, is the potential for contamination to translocate through the plant during irrigation.

    a) Raiden, R. M., S. S. Sumner, J. D. Eifert, and M. D. Pierson. 2003. Efficacy of Detergents to remove *Salmonella* and *Shigella* spp. from the surface of fresh produce. *Journal of Food Protection*. 66(6):2210-2215.
    b) Miles, J. M., S. S. Sumner, R. Boyer, R. C. Williams, J. G. Latimer, and J. M. McKinney. 2009. Internalization of *Salmonella enterica* serovar Montevideo into greenhouse tomato plants through contaminated irrigation water or seed stock. *Journal of Food Protection*. 72(4):849-852.
    c) Hintz, L., R. Boyer, R. C. Williams, S. R. Rideout and M. Ponder. 2010. Recovery of *Salmonella enterica* Newport introduced through irrigation water from tomato (*Lycopersicum esculentum*) fruit, roots, stems and leaves. *HortScience*. 45(4):675-678.
    d) Huff, K. R., R. Boyer, C. Denbow, S. O'Keefe and R. C. Williams. 2012. Effect of storage temperature on survival and growth of foodborne pathogens on whole,

damaged and internally inoculated jalapenos (Capsicum annuum var. annuum). *Journal of Food Protection*. 75(2)382-388.

2. Tracking cross contamination in retail deli – *Listeria monocytogenes* is a pathogen of concern in retail delis. In 2010, a collaborative group which involved university partners, the USDA and the FDA worked on developing a risk assessment to describe the risk of *L. monocytogenes* contamination in the retail deli setting. I was recruited to work on a contract with the USDA to collect data which was lacking, for inclusion into the risk model. To do this, we uses a model system using an abiotic surrogate to track cross contamination in a mock deli that was established in my laboratory. The data collected directly enhanced the outcomes of the risk assessment. This work gained a lot of attention from industry and resulted in my presenting 4 invited talks on the results.

    a) Maitland, J., **R. Boyer**, D. Gallagher, S. Duncan, N. Bauer, J. Kause and J. Eifert. 2013. Tracking cross-contamination transfer dynamics at a mock retail deli market using GloGerm. *Journal of Food Protection*. 76(2)272-282.

3. Use of observational data collection methodology – food safety education evaluation methods have typically focused on measuring knowledge and intention changes, mostly through self-reported data collection methods such as surveys. In determining the effectiveness of a food safety intervention, such as a training program, direct measurement of behavioral change is advocated, as opposed to indirect self-reported practices or a self-reported increase in awareness. Observing behaviors is one way to directly report a change in behavior as a result of an educational program. The prime benefit of observation is that it does not depend on second-hand reported actions and can be considered objectively by someone other than the performer of the action. My research program began using observation to collect data in 2008, and this is a primary method used to report effectiveness of educational outreach.

    a) Pollard, S., R. Boyer, B. Chapman, J. di Stefano, T. Archibald, M. Ponder and S. Rideout. 2016. Identification of risky food safety practices at Southwest Virginia farmers markets. *Food Protection Trends*. 36,168-175.
    b) Schroeder, M., L. Yang, J. Eifert, R. Boyer, M. Chase and S. Nieto-Montenegro. 2016. Evaluation of how different signs affect poultry processing employees' hand washing practices. *Food Control*. 68,1-6.
    c) Robertson, L. R. R. Boyer, B. J. Chapman, J. D. Eifert, A. Villalba, and N. Franz. 2013. Educational needs assessment and practices of grocery store food handlers through survey and observational data collection. *Food Control*. 34,707-713.

4. Enhancing the safety of locally grown produce - I have worked extensively with direct market growers selling in farmers markets over the past five years. In collaboration with the University of Georgia, I was lead on the development and implementation of a curriculum entitled "Enhancing the Safety of Locally Grown Produce". This curriculum has be delivered across over 7 southeastern states including Virginia, Georgia, North Carolina, South Carolina, Tennessee, Arkansas and Alabama. I lead the delivery of this curriculum across Virginia. This is accomplished using the train the trainer model where Extension agents are trained in the curriculum and deliver it in their counties according to local need. Presently there are over 20 agents in Virginia trained in these concepts,

10 actively delivering the training. Since its beginning, over 320 produce growers, and 50 farmers market managers have been certified.

a) Pollard, S., R. Boyer, B. Chapman, J. di Stefano, T. Archibald, M. Ponder and S. Rideout. 2015. Identification of risky food safety practices at Southwest Virginia farmers markets. *Food Protection Trends*. In Press.
b) Harrison, J., J. Gaskins, M. Harrison, J. Cannon, R. Boyer, G. Zehnder. 2013. Survey of food safety practices on small to medium sized farms and farmers markets. *Journal of Food Protection*. 76, 1989-1993.
c) Harrison, J., J. Gaskins, M. Harrison, J. Cannon, R. Boyer, G. Zehnder. 2013. Enhancing the Safety of Locally Grown Produce curriculum. The University of Georgia Cooperative Extension System.

Complete list of Published Work in Google Scholar:
https://scholar.google.com/citations?hl=en&user=b9ls5h8AAAAJ&view_op=list_works

## D. Research Support

**Ongoing Research Support**

2015-70020-24397 USDA NIFA Danyluk (PI) 9/01/2015 – 08/31/2018
A Southern Training, Education, Extension, Outreach, and Technical Assistance Center to Enhance Produce Safety.
The overall goal of this proposal is to build a collaborative infrastructure in the Southern US to support Food Safety Modernization Act (FSMA) compliant food safety training, education, extension, outreach, and technical assistance as it relates, primarily, to the produce industry.

2014-001100-21 USDA-AMS-FSMIP Vallotton (PI) 9/30/2014 – 9/29/2016
Accessing Markets by Improving Virginia's Fresh Produce Food Safety Culture
The overall goal of this project is to mitigate market barriers to the procurement of local and regional produce by improving the understanding and expectation for scale appropriate on-farm food safety practices within Virginia

2013-68003-21258 USDA NIFA Boyer (PI) 9/01/2013 – 8/31/2018
Investigating and Enhancing Positive Food Safety Culture in Farmers' Markets
Major outcomes from this work include increasing the number of farmers' market managers and vendors both educated and trained in safe food handling and preparation (specific to fresh produce); implementing risk reducing practices which will enhance the safety of farmers markets and the local food system. Ultimately creating a positive food safety culture within these market and a framework for educating other markets.

2012-68003-30155 USDA-AFRI CAP Moxley (PI) 1/2012 – 12/2016
Prevention, detection and control of shiga toxin producing *Escherichia coli* (STEC) from pre-harvest through consumption of beef products.
This is a large 25 million dollar CAP grant. My work focuses on understanding consumer behaviors related to handling mechanically tenderized beef. Ultimately my group will be creating and evaluation educational interventions to encourage safe handling by consumers.

2014-06144 USDA-AFRI CAP Wu (PI) 1/2015 – 12/2019
Enhancing food safety through improved processing technologies
This is a large 5 million dollar CAP grant. My work focuses on conducting a national survey to evaluate consumer perceptions related to various food processing technologies and creating

and evaluating tools to educate consumers on food processing terminology and technologies in an effort to de-demonize

**Completed Research Support**

2015-387 Center for Produce Safety Rideout (PI) 1/01/2015 – 05/30/2016
Investigation of risk criteria and foodborne pathogens reduction practices for irrigation water. The outcomes of this research benefits stakeholders especially vegetable and fruit industries to reduce the contamination risks of foodborne pathogens during irrigation and achieve the new requirements of FSMA on produce safety.

# MONIQUE DUFOUR

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Department of History
406 Major Williams Hall, Blacksburg, VA 24061
msdufour@vt.edu


## EDUCATION

Ph.D. Science and Technology Studies, Virginia Tech, December 2014
Dissertation: Reading for Health: Bibliotherapy and the Medicalized Humanities in the US, 1930-1965
Advisor: Dr. Matthew Wisnioski

M.S. Science and Technology Studies, Virginia Tech, 2012

Ph.D. candidate, American Literature/Composition and Rhetoric, Syracuse University, 1993-1999

M.A. English, University of Rhode Island, 1992

B.A. English, Providence College, 1987

## CURRENT EMPLOYMENT

Assistant Collegiate Professor and Director of the Medicine and Society Minor
Department of History, Virginia Tech, 2016-present

Faculty Development Consultant
Language, Arts and Media Program (LAMP), Duke University, 2015-present

## EMPLOYMENT HISTORY

Instructor and Director of the Medicine and Society Minor
Department of History, Virginia Tech, 2015-2016

Visiting Assistant Professor and Director of the Medicine and Society Minor
Department of Science and Technology in Society (STS), 2014-2015

Graduate Assistant
STS, Virginia Tech, 2009-2014

Faculty Development Consultant and Director, University Writing Program
Center for Excellence in Undergraduate Teaching, Virginia Tech, 2003-2008

## FELLOWSHIPS

Andrew W. Mellon Fellow, University Writing Program, Duke University, 2000-2003

## SELECTED PUBLICATIONS

"Review: *Groovy Science: Knowledge, Innovation, and American Counterculture*, edited by David Kaiser and W. Patrick McCray." *Science* magazine (Summer 2016).

"Review Essay: *Tales of Literacy for the 21st Century: The Literary Agenda* by Maryanne Wolf and *Words Onscreen: The Fate of Reading in a Digital World* by Naomi S. Baron," *Configurations: A Journal of Society, Literature, Science and the Art*s (forthcoming Spring 2017).

"Good Writers Always Follow My Rules," chapter in the book *Bad Ideas About Writing* (forthcoming Spring 2017).

"Review: Matthew Halliwell, *Therapeutic Revolutions: Medicine, Society and American Culture, 1940-1970,* Social History of Medicine 27, no 1 (2014): 174-175. <http://goo.gl/9e91v4>

Dufour, Monique, Gregory Sandstrom and Adam Riggio. "Critical Exchange: Curtis White, *The Science Delusion*." *Social Epistemology Review and Reply Collective* 2, no. 12 (2013): 7-21. <http://wp.me/p1Bfg0-18o>

Johri, Aditya, Monique Dufour, Jenny Lo, and Daniel Shanahan. "Adwiki: Socio-Technical Systems Engineering for Managing Advising Knowledge in a Higher Education Context," *International Journal of Sociotechnology and Knowledge Development* 5, no. 21 (January 2013): 37-59.

Under Review

"Sadie Peterson Delaney, Bibliotherapy, and the Politics of Reading for Health," submitted to *Journal of Medical Humanities*.

"Can There Be a Science of Bibliotherapy?" submitted to *Literature and Medicine*.

Works-in-Progress

"'What is Reading Doing to Johnny?' Literacy Education for the Healthy Personality in the Midcentury US," in final preparation for submission to *Social History of Medicine*.

*The Embodied Reader*, book proposal in preparation for University of Chicago Press.

## SELECTED CONFERENCE PRESENTATIONS

"Forging Connections between Literacy and Health." (presenter and panel organizer)
Society for Literature, Science, and the Arts; History of Science Society, Atlanta, October 2016

"Bibliotherapy as Medicine and Public Policy for Veterans in the US."
Veterans in Society Conference, Blacksburg, VA, November 2015

"'Recovering the Lost Art of Telling Teaching Stories," workshop co-leader, Feminisms and Rhetorics (FemRhets); Arizona State University, October 2015.

"'What Is Reading Doing to Johnny?' Literacy Education for the Healthy Personality in the Midcentury US."
American Association for the History of Medicine (AAHM), New Haven, April 2015

"'The Library as Laboratory': Studying Reading Patients and Producing Scientific Knowledge in the US, 1940-1965."
History of Science Society (HSS), Chicago, November 8, 2014

"The Embodied Reader: Bibliotherapy and the Clinical Study of Literature as Medicine, 1940-1960."
AAHM, Chicago, May 9, 2014

"The Embodied Reader: Bibliotherapy and the Clinical Study of Literature as Medicine, 1940-1960."
Joint Atlantic Seminar in the History of Medicine (JAS-MED), Harvard University/MIT, October 25, 2013

"Sadie Peterson Delaney and the Politics of Reading at the US Veterans Facility at Tuskegee, 1924-1958."
Protest on the Page, Center for the History of Print and Digital Culture, University of Wisconsin, Madison, September 2012

"Is Reading Treatment?"
Society for the Social Studies of Science (4S), Copenhagen, Denmark, October 2012

"Can There Be a Science of Bibliotherapy?"
HSS, Cleveland, OH, October 2011

"Pedagogies of Scholarly Authorship," Panel Organizer, "Graduate Pedagogy and STS."
4S, Cleveland, OH, October 2011"When the Doctor Prescribes Books"
Society for the History of Authorship, Reading and Publishing (SHARP), Library of Congress, Washington, DC, July 2011

## SELECTED TEACHING

Awards

Certificate of College Teaching, College of Liberal Arts and Human Sciences, Virginia Tech, 2016.

Graduate

*Writing Skills for Professional Historians* (History 5114), instructor; fall 2016; fall 2015; fall 2014; Virginia Tech. Designed and taught required writing seminar for History graduate students.

*Understanding and Overcoming Writing Blocks*, invited workshop leader; May 2012, 2013, 2014; Thompson Writing Program, Duke University.

Faculty Advisor, STS writing group.

Undergraduate

*History through Film: Medicine in the US since 1970* (History 3694)*,* instructor, spring 2017; Virginia Tech.

*Sickness and Health on the Battlefield and the Home Front, 1861-present* (History 2984), instructor; spring 2016; Virginia Tech.

*History of Disease, Medicine, and Health* (History 3724), spring 2017; spring 2016; fall 2015; spring 2015; fall 2013; spring 2012; spring 2011; Virginia Tech. Modern cultural and social history of medicine in the US, 1800-present. Emphasis varies by semester.

*Writing the History of Reading* (History 4004), instructor; spring 2014; Virginia Tech. Senior research and writing capstone course for History majors.

*Medical Dilemmas and Human Experience* (STS 3314), instructor; fall 2015; fall 2014; Virginia Tech. Bioethics in modern history and contemporary culture.

*Medical Humanities* (STS 4304), instructor; spring 2015; Virginia Tech. Upper-division seminars in historical and contemporary issues in the medical humanities. Thematic emphases on mind/body medicine and pain.

*Engineering Cultures*, instructor (online); summer 2012; teaching assistant, fall 2010; Virginia Tech.

*History and Cultures of the Book*, instructor; fall 2002 and spring 2003; Duke University. First-year inquiry-based writing seminar.

*The Art of Memory: Exploring the Modern Cultural Archive*, instructor; fall 2001 and spring 2002; Duke University. First-year inquiry-based writing seminar.

*Buddhism in the US,* instructor; spring 2001; Duke University. First-year inquiry-based writing seminar.

Other courses include: First-Year Writing; American Literature Surveys; Creative Non-Fiction; Professional Writing. Syracuse University, 1993-1998.

Faculty Development—Pedagogy and Writing Workshops (selected)

*Faculty Writing Retreat*, week-long summer workshop leader; May 2013, 2014, 2015, 2016, and 2017. Duke University.

*Recovering the Lost Art of Telling Teaching Stories*, workshop co-leader, Feminism and Rhetoric (FemRhets); Arizona State University, October 2015

*Creating a Culture of Research*, workshop leader; May 2004, May 2005, May 2006; CEUT, Virginia Tech. Week-long faculty workshop about integrating writing and research learning.

*Composing Ourselves: Crafting a Teaching Philosophy Statement,* workshop leader; CEUT, Virginia Tech.

*Rubrics for Teaching and Learning,* workshop leader, CEUT, Virginia Tech.

*Writing to Learn*, workshop leader; CEUT, Virginia Tech.

*Responding to Student Writing Efficiently and Effectively,* workshop leader; CEUT, Virginia Tech.

*Understanding and Overcoming Writing Blocks*, workshop leader; CEUT, Virginia Tech.

*Online Learning*, workshop leader; CEUT, Virginia Tech.

**Zhen He, Ph.D.**

Professor (pending)

Department of Civil and Environmental Engineering

Virginia Tech

1145 Perry St.

Blacksburg, VA 24061

Phone: (540) 231-1346

Fax : (540) 231-7916

E-mail: zhenhe@vt.edu

Web: https://ebbl.cee.vt.edu

## Professional Preparation

| | | |
|---|---|---|
| Tongji University | Environmental Engineering | B.S., 2000 |
| Technical University of Denmark | Environmental Engineering | M.S., 2003 |
| Washington University in St. Louis | Environmental Engineering | Ph.D.,2007 |

## Appointments

| | |
|---|---|
| August, 2017 (pending) | Professor, Department of Civil and Environmental Engineering, Virginia Polytechnic Institute and State University, Blacksburg, VA |
| August, 2013 – July, 2017 | Associate Professor, Department of Civil and Environmental Engineering, Virginia Polytechnic Institute and State University, Blacksburg, VA |
| August, 2009 – July, 2013 | Assistant Professor, Department of Civil Engineering and Mechanics, University of Wisconsin – Milwaukee, Milwaukee, WI |
| July, 2007 – July 2009 | Postdoctoral Research Associate, Department of Chemical Engineering and Material Sciences, University of Southern California, Los Angeles, CA |

## Five Relevant Products (>140 journal publications in total)

Li, X., Sun, S., Badgley, B.D., Sung, S., Zhang, H. and He, Z. (2016) Nitrogen removal by granular nitritation - anammox in an upflow membrane-aerated biofilm reactor. *Water Research*. Vol 94, pp 23-31.

Luo, S., Guo, W., Nealson, K.H., Feng, X. and He, Z. (2016) 13C pathway analysis for the role of formate in electricity generation by Shewanella Oneidensis MR-1 using lactate in microbial fuel cells. *Scientific Reports*. 6: 20941

Xiao, L., Young, E. B., Grothjan, J. J., Lyon, S., Zhang, H. and He, Z. (2015) Wastewater treatment and microbial community in an integrated photo-bioelectrochemical system affected by different wastewater algal inocula. *Algal Research*. Vol 12, pp 446-454.

Zhang, F., Ge, Z., Grimaud, J., Hurst, J. and He, Z.* (2013) Long-term performance of liter-scale microbial fuel cells installed in a municipal wastewater treatment facility. *Environmental Science & Technology*. Vol 47, pp 4941-4948.

He, Z., Kan, J., Mansfeld, F., Angenent, L. T. and Nealson, K.H. (2009) Self-sustained phototrophic microbial fuel cells based on the synergistic cooperation between photosynthetic microorganisms and heterotrophic bacteria. *Environmental Science & Technology*. Vol 43, No 5, pp 1648-1654.

### Other Significant Products

Yuan, H., Abu-Reesh, I. and He, Z. (2016) Mathematical modeling assisted investigation of forward osmosis as pretreatment for microbial desalination cells to achieve continuous water desalination and wastewater treatment. *Journal of Membrane Science*. Vol 502, pp 116-123.

Lu, Y. and He, Z. (2015) Mitigation of salinity buildup and recovery of wasted salts in a hybrid osmotic membrane bioreactor - electrodialysis system. *Environmental Science & Technology*. Vol 49, pp 10529-10535.

Qin, M. and He, Z. (2014) Self-supplied ammonium bicarbonate draw solute for achieving wastewater treatment and recovery in a microbial electrolysis cell - forward osmosis coupled system. *Environmental Science & Technology Letters*. Vol 1, pp 437-441.

Li, W.W, Yu, H. Q. and He, Z. (2014) Towards sustainable wastewater treatment by using microbial fuel cells-centered technologies. *Energy & Environmental Science*. Vol 7, pp 911-924.

Zhang, B. and He, Z. (2013) Improving water desalination by hydraulically coupling an osmotic microbial fuel cell with a microbial desalination cell. *Journal of Membrane Science*. Vol 441, pp 18-24.

### Synergistic Activities:

### Major Courses Developed/Taught

Introduction to Environmental Engineering (UG), Freshwater Engineering (G), Environmental Biofuel and Resource Recovery (G), Hazardous Waste Management (UG/G), Bioelectrochemical Systems for Environmental Engineering (G)

### Professional Affiliations, Honorary Societies, and other Honors

Vice Chair of Research and Innovation Committee, Water Environment Federation

### Reviewing

Manuscript reviewer for more than 35 journals (> 300 manuscripts)

Proposal reviewer for NSF Energy for Sustainability, NSF PIRE, NSF Environmental Sustainability, USDA SBIR, Research Foundation Flanders, HongKong ITSP

### Editorial Activities

Associate Editor, *Water Environment Research*

# BIOGRAPHICAL SKETCH

Provide the following information for the Senior/key personnel and other significant contributors.
Follow this format for each person. DO NOT EXCEED FIVE PAGES.

NAME: Hungerford, Laura

eRA COMMONS USER NAME (credential, e.g., agency login): lhungerford

POSITION TITLE: Professor and Head

EDUCATION/TRAINING *(Begin with baccalaureate or other initial professional education, such as nursing, include postdoctoral training and residency training if applicable.)*

| INSTITUTION AND LOCATION | DEGREE | START DATE | END DATE | FIELD OF STUDY |
|---|---|---|---|---|
| Michigan State University, E. Lansing, MI | DVM | 07/1977 | 06/1980 | |
| University of Illinois School of Public Health, Chicago, IL | MPH | 01/1985 | 06/1987 | Biostatistics and Epidemiology |
| University of Illinois College of Veterinary Medicine, Urbana, IL | PHD | 07/1981 | 06/1989 | Veterinary Epidemiology |
| University of Illinois College of Veterinary Medicine , Urbana, IL | Other training | 07/1980 | 06/1981 | Food Animal Medicine and Surgery Intern |
| University of Illinois College of Veterinary Medicine, Urbana, IL | Resident | 07/1981 | 06/1986 | Veterinary Diagnostic Microbiology |

## A. Personal Statement

This proposal is designed to strengthen and uniquely blend microbiological, agricultural, health, engineering, and social sciences to position VT for applying microbiology to address societal grand challenges. It emphasizes both generation of innovative solutions and creation of the next generation of innovative problem solvers. It will also integrate biological, technical and social dimensions. My extensive experience in teaching and mentoring students (primary mentor or chair for 2 postdoctoral fellow, 7 MS, 14 MPH and 4 PhD students and committee membership for an additional 17 MS and 18 PhD students), recognized by my academic appointments, promotions and awards, and by the success of my previous students, will allow me to strongly contribute to this effort. Further, I have balanced career with family life including a 35 year marriage to another scientist, raising two children now in college, and extensive community involvement with Boy Scouts, schools, and American Red Cross, as well as professional societies. I have blended academic and federal leadership roles which provides additional experiences to enhance my mentoring role. My work at both the university and FDA has been and remains largely as an integrator and problem-solver in team science; which is well suited to working with the multidisciplinary approach of this proposal. My specific research experience in vector-borne disease, transdisciplinary studies, geographic health, dynamic modeling and quantitative epidemiology align well with the project aims.

## B. Positions and Honors

### Positions and Employment

1980 - 1981 Food Animal Medicine and Surgery Intern, University of Illinois College of Veterinary Medicine, Urbana, IL

1981 - 1986 Veterinary Diagnostic Microbiology Resident, University of Illinois College of Veterinary Medicine, Urbana, IL

1989 - 1996 Assistant Professor, University of Illinois College of Veterinary Medicine, Urbana, IL

1996 - 1998 Associate Professor with Tenure, University of Illinois College of Veterinary Medicine, Urbana, IL

1998 - 2002 Associate Professor with Tenure, Great Plains Veterinary Educational Center, University of Nebraska, Clay Center, NE

2002 - 2005 Associate Professor, Univeristy of Maryland School of Medicine, Baltimore, MD

2002 - 2016 Senior Advisor for Science and Policy, US FDA Center for Veterinary Medicine, Rockville, MD

| | |
|---|---|
| 2004 - 2006 | Interim head, Division of Foodborne and Emerging Pathogens, Univeristy of Maryland School of Medicine, Baltimore, MD |
| 2005 - 2016 | Professor with Tenure (2006), Univeristy of Maryland School of Medicine, Baltimore, MD |
| 2012 - 2015 | Director, Graduate Program in Epidemiology and Human Genetics, GPILS, Univeristy of Maryland School of Medicine, Baltimore, MD |
| 2015 - 2016 | Vice Chair for Academic Programs, Department of Epidemiology and Public Health, University of Maryland School of Medicine, Baltimore, MD |
| 2016 - | Professor and Head, Department of Population Health Sciences, Virginia-Maryland College of Veterinary Medicine, Virginia Tech, Blacksburg, VA |

## Other Experience and Professional Memberships

| | |
|---|---|
| 1980 - | Member, American Veterinary Medical Association |
| 1987 - | Founding member, Beta Tau Chapter, University of Maryland, Baltimore and Delta Mu Chapter, Virginia Tech; Chapter President, 2010-2012, 2017-, DELTA OMEGA Honorary Society for Public Health |
| 1990 - | Executive Board (1990-1996, 2001-2008), President Elect (2001-2002), President (2003-2004); Schwabe Symposium Co-Chair (2002, 2004), Schwabe Symposium Chair (2005), Association for Veterinary Epidemiology and Preventive Medicine |
| 1991 - | External Reviewer, USDA/ARS and USDA/CSRS |
| 1997 - | Section Head (2000-2010), Executive Board (2005-2009), Vice President (2009-2010), President (2010-2011), Co-Chair of Epidemiology Session (1991, 1992, 1994, 1997, 1998, 1999, 2003), Leader, Epidemiology Section (1998-1999), Nominations Committee (1999), ACVPM Awards Committee (1999), Section founder and Companion Animal Epidemiology Section Co-Chair (2010 - present), CRWAD - Conference of Research Workers in Animal Disease |
| 1998 - | Panel member (1998, 1999, 2008, 2014), U.S.D.A., NRI Competitive Grants |
| 2002 - | Member, Maryland Veterinary Medical Association |
| 2005 - | Panel member (2005, 2006, 2008); external reviewer in other years, N.S.F, EID Competitive Grants |

## Honors

| | |
|---|---|
| 1975 | National Merit Scholar, National Merit Scholarship Corporation |
| 1983 | Inductee, PHI KAPPA PHI Honorary Society |
| 1986 | Inductee, SIGMA XI Honorary Scientific Research Society |
| 1987 | Inductee, PHI ZETA Honorary Society for Veterinary Medicine |
| 1987 | Inductee, DELTA OMEGA Honorary Society for Public Health |
| 1990 | Teachers Rated as Excellent (and 1992, 1994, 1996), University of Illinois |
| 2008 | Outstanding Teacher Award, Department of Epidemiology and Preventive Medicine, University of Maryland School of Medicine |
| 2009 | Honorary Diploma, American Veterinary Epidemiology Association |
| 2011 | First Annual Student Teaching Award in Recognition of Outstanding Teaching and Mentoring, University of Maryland School of Medicine MPH Program |
| 2013 | Distinguished Scholar and Fellow, National Academies of Practice, Veterinary Medicine Academy |

## C. Contribution to Science

1. My initial engagement in infectious disease epidemiology was a direct response to questions that I developed as a clinician about the extent and transmission patterns of a vector-borne pathogen at the species interface between cattle and deer. To address these questions, I have applied a blend of quantitative epidemiologic methods with approaches from other disciplines. For anaplasmosis, this allowed us to map and analyze disease patterns; find key factors associated with disease at the animal and county level; provide information to veterinarians and regulators; and suggest interventions. For sheep diseases, we combined environmental monitoring, risk factors, production practices, producer

preferences, economics and simulation modeling to understand the impact of mortality and management in sheep. For E. coli O157:H7, we developed a novel pen-level sampler and used laboratory methods and longitudinal designs to demonstrate the ubiquitous nature and sources of variability in the occurrence of this pathogen. In raccoons, by integrating health questions into ongoing wildlife ecology studies, we examined infection in the context of animal behavior and population dynamics. More recently, I have used this same transdisciplinary approach to collaborate on studies of a range of human microparasites.

a. Hungerford LL, Smith RD. Variations in seroprevalence and host factors for bovine anaplasmosis in Illinois. Vet Res Commun. 1997 Jan;21(1):9-18. PubMed PMID: 9060138.
b. Hungerford LL, Mitchell MA, Nixon CM, Esker TE, Sullivan JB, Koerkenmeier R, Marretta SM. Periodontal and dental lesions in raccoons from a farming and a recreational area in Illinois. J Wildl Dis. 1999 Oct;35(4):728-34. PubMed PMID: 10574532.
c. Nash ML, Hungerford LL, Nash TG, Zinn GM. Risk factors for perinatal and postnatal mortality in lambs. Vet Rec. 1996 Jul 20;139(3):64-7. PubMed PMID: 8857578.
d. Smith D, Blackford M, Younts S, Moxley R, Gray J, Hungerford L, Milton T, Klopfenstein T. Ecological relationships between the prevalence of cattle shedding Escherichia coli O157:H7 and characteristics of the cattle or conditions of the feedlot pen. J Food Prot. 2001 Dec;64(12):1899-903. PubMed PMID: 11770614.

2. Throughout my research, I've pioneered transdisciplinary approaches to health research, building partnerships that introduced new methodologies that subsequently became inculcated in the field. I was one of the first to promote use of geographic information systems (GIS) and spatial statistics in animal disease epidemiology, working with pioneers outside the veterinary or health fields. I worked with other faculty to develop methods for outside assessment of veterinary training to guide curriculum reform; a practice now commonly used in program review. We used detailed follow-up of individual raccoons to show that drugs used to handle the animals have behavioral impacts and can affect population estimates, which had never been considered. We used recognition of the natural curiosity and 'mouthing' behavior of cattle to design a new, efficient, pen-level, bacterial sampling system that allowed us to conduct many studies and is now widely used in research and monitoring. Currently, with the enormous advancement of methods within disciplinary silos, the potential for new insights through cross-disciplinary fertilization continues to grow rapidly.
   a. Gehrt SD, Hungerford LL, Hatten S. Effects of immobilization agents on post-release behavior and population estimates of raccoons. Wildlife Society bulletin. 2001; 29:833-7.
   b. Hungerford L. Use of spatial statistics to identify and test significance in geographic disease patterns. Prev Vet Med. 1991 December; 11(3-4):237-42.
   c. Johnson AL, Greenfield CL, Klippert L, Hungerford LL, Farmer JA, Siegel A. Frequency of procedure and proficiency expected of new veterinary school graduates with regard to small animal surgical procedures in private practice. J Am Vet Med Assoc. 1993 Apr 1;202(7):1068-71. PubMed PMID: 8473216.
   d. Smith DR, Gray JT, Moxley RA, Younts-Dahl SM, Blackford MP, Hinkley S, Hungerford LL, Milton CT, Klopfenstein TJ. A diagnostic strategy to determine the Shiga toxin-producing Escherichia coli O157 status of pens of feedlot cattle. Epidemiol Infect. 2004 Apr;132(2):297-302. PubMed PMID: 15061505; PubMed Central PMCID: PMC2870106.

3. Many diseases, particularly zoonotic and vector-borne infections, have inherently heterogeneous and meaningful geographic distributions. I have helped develop, used, and taught GIS and spatial methodology throughout my career. This was key to understanding the epidemiology of anaplasmosis in Illinois. In another project, we worked with geographers to develop methods to use satellite data to understand tsetse fly distributions. With ecologists, we used mapping and regression to examine relationships predicting the vulnerability and resiliency of endangered amphibian populations and found associations that were later confirmed by laboratory studies. We used similar approaches to examine individual-, environmental-, and hamlet-level associations with malaria in a low transmission setting. This success has led to significant funding and, most recently, to a grant to foster inter-campus collaborations to build new partnerships in health geography for other faculty.

a. Hungerford LL, Smith RD. Spatial and temporal patterns of bovine anaplasmosis as reported by Illinois veterinarians. Preventive veterinary medicine. 1996; 25:301-13.

b. Kitron UD, Otieno LH, Hungerford LL, Odulaja A, Brigham WU, Okello OO, Joselyn Mark, Mohamed-Ahmed MM, Cook E. Spatial analysis of the distribution of tsetse flies in the Lambwe Valley, Kenya, using Landsat TM satellite imagery and GIS. The Journal of animal ecology. 1996; 65:371-80.

c. Lawpoolsri S, Chavez IF, Yimsamran S, Puangsa-Art S, Thanyavanich N, Maneeboonyang W, Chaimungkun W, Singhasivanon P, Maguire JH, Hungerford LL. The impact of human reservoir of malaria at a community-level on individual malaria occurrence in a low malaria transmission setting along the Thai-Myanmar border. Malar J. 2010 May 26;9:143. PubMed PMID: 20504308; PubMed Central PMCID: PMC2887882.

d. Witte CL, Sredl MJ, Kane AS, Hungerford LL. Epidemiologic analysis of factors associated with local disappearances of native ranid frogs in Arizona. Conserv Biol. 2008 Apr;22(2):375-83. PubMed PMID: 18261148.

4. Epidemiologic methods traditionally focus on identification of risk factors in a dataset. However, this describes the risk in the past. We may infer the future, but dynamic modeling provides explicit methodology for conceptualizing complex future results or consequences. In addition to using modeling to study sheep disease management costs and options, we used preliminary models to explore if distemper epidemics in raccoons and measles epidemics in humans could be generated by pathogen shifts rather than the traditional herd immunity explanation. This led us to molecular studies to explore this finding and the resulting discovery of previously unrecognized strain diversity in a raccoon outbreak. We also used modeling to explore cross-species transmission risk from primates to humans and enhanced treatment schemes for malaria in low transmission areas. A current student is using modeling to examine potential effects of a new vaccine for Salmonella. At a larger scale, we have combined spatial analysis and modeling to create transmission risk maps for avian influenza and are applying this to raccoon rabies.

   a. Engel G, Hungerford LL, Jones-Engel L, Travis D, Eberle R, Fuentes A, Grant R, Kyes R, Schillaci M. Risk assessment: A model for predicting cross-species transmission of simian foamy virus from macaques (M. fascicularis) to humans at a monkey temple in Bali, Indonesia. Am J Primatol. 2006 Sep;68(9):934-48. PubMed PMID: 16900504.

   b. Lawpoolsri S, Klein EY, Singhasivanon P, Yimsamran S, Thanyavanich N, Maneeboonyang W, Hungerford LL, Maguire JH, Smith DL. Optimally timing primaquine treatment to reduce Plasmodium falciparum transmission in low endemicity Thai-Myanmar border populations. Malar J. 2009 Jul 15;8:159. PubMed PMID: 19604346; PubMed Central PMCID: PMC2718908.

   c. Lednicky JA, Dubach J, Kinsel MJ, Meehan TP, Bocchetta M, Hungerford LL, Sarich NA, Witecki KE, Braid MD, Pedrak C, Houde CM. Genetically distant American Canine distemper virus lineages have recently caused epizootics with somewhat different characteristics in raccoons living around a large suburban zoo in the USA. Virol J. 2004 Sep 2;1:2. PubMed PMID: 15507154; PubMed Central PMCID: PMC524033.

   d. Prosser DJ, Hungerford LL, Erwin RM, Ottinger MA, Takekawa JY, Ellis EC. Mapping avian influenza transmission risk at the interface of domestic poultry and wild birds. Front Public Health. 2013;1:28. PubMed PMID: 24350197; PubMed Central PMCID: PMC3854848.

5. A final area of work has been to use my strong quantitative expertise, my background in clinical medicine, and my communication skills to advance clinical epidemiology and population health in veterinary medicine. In general, these collaborations have resulted in publications with co-authors from fields outside of population health. Among the many examples across my career are articles with clinical pathologists, equine clinicians, and animal behaviorists. All of these collaborations focused on answering clinical questions in an evidence-based manner. This approach is also a fundamental aspect of my role with FDA. As an example, we conducted and published a study that demonstrated the potential for use of systematic review and meta-analysis in drug review. This led to a paradigm shift in viewing evidence for safety and effectiveness that provided a new path recently used for approval of a new cattle drug.

a. Austin SM, Foreman JH, Hungerford LL. Case-control study of risk factors for development of pleuropneumonia in horses. J Am Vet Med Assoc. 1995 Aug 1;207(3):325-8. PubMed PMID: 7628934.
b. Baird-Heinz HE, Van Schoick AL, Pelsor FR, Ranivand L, Hungerford LL. A systematic review of the safety of potassium bromide in dogs. J Am Vet Med Assoc. 2012 Mar 15;240(6):705-15. PubMed PMID: 22380809.
c. Gaskins LA, Hungerford L. Nonmedical factors associated with feather picking in pet psittacine birds. J Avian Med Surg. 2014 Jun;28(2):109-17. PubMed PMID: 25115039.
d. Solter PF, Hoffmann WE, Hungerford LL, Peterson ME, Dorner JL. Assessment of corticosteroid-induced alkaline phosphatase isoenzyme as a screening test for hyperadrenocorticism in dogs. J Am Vet Med Assoc. 1993 Aug 15;203(4):534-8. PubMed PMID: 8407509.

Complete List of Published Work in My Bibliography:
http://www.ncbi.nlm.nih.gov/myncbi/laura.hungerford.1/bibliography/48871817/public/?sort=date&direction=ascending

## D. Additional Information: Research Support and/or Scholastic Performance

### Recently Completed Research Support

FDA IPA: Hungerford, Laura
06/01/13-10/25/16
Innovation in Science and Regulatory Decision-making for Animal Drugs
Role: PI

Zoological Society of San Diego
11/01/15-10/01/16
Systems Modeling and Network Analysis of Disease Epidemiology among Wild and Captive Species
Role: PI

State MPowering Maryland Initiative
01/01/15-06/01/16
Piloting Collaboration between the UMCP Center for Geospatial Information Science and the UMB Schools of Medicine, Nursing and Pharmacy
Role: Multiple PI

Zoological Society of San Diego
08/01/13-10/01/15
Developing Population Health-based Research among Wildlife Species
Role: PI

AHRQ, Johns Hopkins Univeristy subaward
01/01/12-08/01/13
MidAtlantic Public Health Training Center
Role: PI

**Melanie A. Kiechle**
Assistant Professor of History
Virginia Tech
417 Major Williams Hall (0117)
220 Stanger Street
Blacksburg, VA 24061
phone: (540) 231-7523
email: mkiechle@vt.edu

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Employment:

2012-present Assistant Professor, Department of History, Virginia Tech
Affiliated Faculty, Science and Technology in Society, Virginia Tech

Education:

2012 PhD, History
Rutgers University, New Brunswick, New Jersey

2003 BA, History, summa cum laude
Colgate University, Hamilton, New York

Research and Teaching Interests:

United States, 19th Century; cultural and intellectual history; environmental history; urban history and built environment; history of medicine and public health; history of science

Relevant Publications:

2017 *Smell Detectives: An Olfactory History of Nineteenth-Century Urban America* (Seattle: University of Washington Press, forthcoming July 2017)

2017 Co-Author with Kristoffer Whitney, "Introduction: Counting on Nature," *Science as Culture*, 26, no. 1 (2017): 1-10.

- Co-editor with Kristoffer Whitney, Special Issue: "Counting on Nature"

2016 "Preserving the Unpleasant: Sources, Methods, and Conjectures for Odors at Historic Sites," *Future Anterior*, 13, no. 2 (Winter 2016): 22-31.

2016 "Navigating by Nose: Stench Nuisance and the Urban Environment, 1840-1880," *Journal of Urban History*, 42, no. 4 (2016): 753-771.

Works in Progress:

"Industrialization, Urbanization, and Sanitary Reform, 1832-1892," in James A. Schafer, Jr., Richard M. Mizelle, Jr., and Helen K. Caliber, eds., *Oxford Handbook of American Medical History*, under contract with Oxford University Press

"'Health is Wealth': Valuing Health in American Cities," article manuscript in preparation

*Between Common Sense and Nonsense: Scientific Knowledge in the Nineteenth-Century United States*, book manuscript in development

Grants & Fellowships:

| | |
|---|---|
| 2016 | Niles Research Grant, Virginia Tech College for Liberal Arts and Human Sciences |
| 2014-15 | American Antiquarian Society-National Endowment for the Humanities Fellowship, American Antiquarian Society |
| 2014 | Visible Scholarship Initiative Libraries Mini-Grant, Virginia Tech College for Liberal Arts and Human Sciences |
| 2014 | Niles Research Grant, Virginia Tech College for Liberal Arts and Human Sciences |
| 2013 | Provost's Mentoring Grant, Virginia Tech |
| 2011-12 | Mellon/ACLS Early Career Dissertation Completion Fellowship |
| 2011-12 | Mellon Dissertation Completion Fellowship (declined), Rutgers University |
| 2010-11 | Haas Dissertation Fellowship, Chemical Heritage Foundation |
| 2010 | Winterthur Research Fellowship, Winterthur Library and Museum |
| 2010 | Rutgers Initiative on Climate and Social Policy Small Grant |
| 2007 | Marie Curie Foundation Travel Grant |

Invited Talks & Conference Papers:

| | |
|---|---|
| 2017 | "Between Common Sense and Nonsense: Environmental Knowledge in Patent Medicines," Annual Conference, American Society for Environmental History, Chicago, IL |
| 2016 | "'Health is Wealth': Valuing Health in Antebellum Cities," Annual Meeting, Society for History of the Early American Republic, New Haven, CT. |
| 2016 | "'An Inherent Right to Breathe Pure Air:' How to Validate Stench in the Nineteenth-Century City," Annual Meeting, Organization of American Historians, Providence, RI. |

- Panel Organizer, "Governing Bodies of Evidence: Labor, Citizenship and

Sensory Knowledge in the Gilded Age"

2015 "Visualizing Vapors, Seeing Smells: Health Boards, the Graphic Press, and Proving the Invisible in the 1870s and 1880s," American Antiquarian Society Regional Seminar & 19th Century US Workshop, Brown University History Department.

2015 "Smells Like Home: Disinfection and the Domestic Environment, 1840-1869," Lunchtime Fellows' Talk, American Antiquarian Society.

2013 "'Nature's Great Disinfectant, Prophylactic, Curative, Stimulant, and Sedative': Ozone Generators and Personal Provisions for Health," Annual Conference, Society for the History of Technology, Portland, ME.

- Panel Organizer, "Replacing Nature? Technologies for Health"

2013 Comment, "Beyond the Five: Extrasensory Perceptions," Ways of Knowing the World: History and the Senses, Bi-Annual Hagley Fellows Conference, Wilmington, DE.

2013 "Seeing Smells, Knowing Nature," Annual Conference, American Society for Environmental History, Toronto, ON

- Panel Organizer, "When Nature and Numbers (Don't) Meet"

2012 "Seeing, Smelling and Knowing the City," Seminar Talk, Science and Technology in Society, Virginia Tech.

2012 "The Smell Detectives: Chemists, Politicians and the Public Nose in the Industrial City," York University History Department.

2012 "Visualizing Vapors: The Shift from Smell to Smoke in Defining Air Quality," Brown Bag Lecture, Chemical Heritage Foundation.

2012 "Fresh Air Infrastructures in the Sanitary City," Annual Conference, American Society for Environmental History, Madison, WI.

2011 "'The Nose as Sanitary Agent': Scenting the Home," Environmental Issues Working Group, Philadelphia Area Consortium in the History of Science, Philadelphia, PA

2011 "'The Nose as a Sanitary Agent': The Importance of Odors to Health in Nineteenth- Century Homes," Annual Conference, American Society for Environmental History, Phoenix, AZ

2011 "'The Uses and Abuses of Air': Mapping the Air in Nineteenth-Century New York," Chemical Weather and Chemical Climate: Body, Place, Planet in Historical Perspective, 13th Annual Gordon Cain Conference, Chemical Heritage

Foundation

2011 "'The Uses and Abuses of Air': Mapping the Air in Nineteenth-Century New York," Creating Healthy Landscapes: Human and Environmental Well-being in Comparative and Historical Perspective, Yale University

2010 "Travels with the Court-House Ghost: The Smell of Disease in Chicago's Water, 1840-1890," Urban History Association Biennial Conference, Las Vegas, NV
- Panel Organizer, "Scents and Flows: Perceptions of Water and Health in the Nineteenth-Century City"

2009 "'Intolerable Pestilence-Breeding Stench': Breathing in the Industrial City," Society for American City and Regional Planning History 13th National Conference on Planning History, Oakland, CA

2009 "'The Air We Breathe': Debating Air Quality and Health in the Industrial City," Joint Atlantic Seminar in the History of Medicine, University of Pennsylvania

2009 "Regulating the Air and Ignoring the Water: Nineteenth-Century New Yorkers and the Fight Against the Offensive Trades," Hagley Fellows Conference, Hagley Museum and Library, Wilmington, DE

2008 "Visualizing Vapors: The Politicization of Odor in Nineteenth Century New York," History in the Making Conference, Concordia University

Relevant Teaching Experience:

**Virginia Tech**

| | |
|---|---|
| Undergraduate courses: | American Environmental History |
| | Disease, Medicine, and Society |
| | Global Environmental History |
| | Special Topics: The American Family Home |
| | United States to 1865 |
| Graduate courses: | Research Seminar: Cultures of Capitalism |
| | United States to 1877 |

Academic Service:

Occasional manuscript reviewer: *American Historical Review, Senses and Society*, *Journal of Urban History*

2013-14 Co-Organizer, "Cities Old and New: Transformations in Urban Spaces," History Department Visiting Speaker Series, Virginia Tech. Funded by a Virginia Tech College of Liberal Arts and Human Sciences Diversity Grant.

2012-14 Co-Organizer, "When Nature and Numbers (Don't) Meet: A Symposium on Quantification and Qualification in History," Holtz Center for Science and Technology in Society, University of Wisconsin-Madison.

2011-12 Conference Committee, "Science and Method in the Humanities," Interdisciplinary Graduate Conference, Rutgers University.

Professional Associations:
American Association for the History of Medicine

American Historical Association

American Society for Environmental History

History of Science Society

Organization of American Historians

Society for History of the Early American Republic

## BIOGRAPHICAL SKETCH

Provide the following information for the Senior/key personnel and other significant contributors.
Follow this format for each person. **DO NOT EXCEED FIVE PAGES.**

NAME: David D. Kuhn

eRA COMMONS USER NAME (credential, e.g., agency login): davekuhn

POSITION TITLE: Assistant Professor

EDUCATION/TRAINING *(Begin with baccalaureate or other initial professional education, such as nursing, include postdoctoral training and residency training if applicable. Add/delete rows as necessary.)*

| INSTITUTION AND LOCATION | DEGREE *(if applicable)* | Completion Date MM/YYYY | FIELD OF STUDY |
|---|---|---|---|
| Saint Lawrence Univ., Canton, NY | B.S. | 05/2000 | Mathematics |
| Clarkson University, Potsdam, NY | B.S. | 05/2001 | Civil Engineering |
| Clarkson University, Potsdam, NY | M.S. | 05/2003 | Civil Engineering (Environmental Conc.) |
| Virginia Tech, Blacksburg, VA | Ph.D. | 05/2008 | Civil Engineering (Environmental Conc.) |

### A. Personal Statement

For the past twelve years I have worked on various aquaculture projects as a graduate student and now as a faculty member at Virginia Tech. My current faculty appointment is 60% research and 40% extension. My aquatic laboratories have a track record for excellent animal husbandry. Understanding how to properly design, construct, and manage life-support systems for culturing aquatic animals is paramount for a top-tier aquatic research program. In addition to conducting research projects in the laboratory at our institution I have also served as a Principal Investigator at eight different privately owned aquaculture facilities that culture finfish, shrimp, oysters, or clams. Conducting research in these public-private partnerships brings a unique and practical aspect back to our research programs, which has tremendous value. Much of my work aims to directly benefit and improve the aquaculture industry through basic and applied research programs that address practical technical issues and limitations from *cradle* (hatchery and production) to *grave* (marketing and waste handling). Accordingly, water quality, water filtration and recirculation, waste and by-product utilization, microbiomes, disease protection, food production, and animal and food nutrition are current focus areas that are investigated in my laboratory. A unique capability that we have in our group is our aquatic biosafety laboratory-2 (BSL2) where we have experience working with risk group-1 and -2 pathogens (*Edwardsiella ictaluri*, *Aeromonas hydrophila*, *Vibrio parahaemolyticus*) for introducing pathogens and/or inducing disease in invertebrates (eastern oyster, Pacific white shrimp) and vertebrates (tilapia, trout).

### B. Positions and Honors

**Positions and Employment**

| | |
|---|---|
| 1998-2000 | Environmental Lab Technician (summers), Northeast Lab Services, Waterville, Maine |
| 2000 | Consultant (summer), A.E. Hodsdon Consulting, Waterville, Maine |
| 2001-2003 | GE/NSF K12 Fellow, Dept. of Civil Engineering, Clarkson University |
| 2003-2008 | Graduate Research Assistant, Dept. of Civil Engineering, Virginia Tech |
| 2008-2010 | Research Associate, Dept. of Food Science and Technology, Virginia Tech |
| 2010-2012 | Research Assistant Professor, Dept. of Food Science and Technology, Virginia Tech |
| 2012-present | Assistant Professor, Dept. of Food Science and Technology, Virginia Tech |

**Other Professional Experiences**

| | |
|---|---|
| 2011-2013 | Board of Directors, Aquacultural Engineering Society |
| 2012 | USAID-MERC Review Panel Committee Member |
| 2014 | Vice President, Aquacultural Engineering Society |
| 2015 | President, Aquacultural Engineering Society |
| 2015 | USDA-NIFA Water for Agriculture Review Panel Committee Member |
| 2016 | USDA-SBIR Aquaculture Review Panel Committee Member |
| 2016 | USDA-NIFA Water for Agriculture Review Panel Committee Member |

## C. Contribution to Science

1. **Oyster and Clam Aquaculture Industry.** I initiated a public-private partnership between the Virginia Institute of Marine Sciences, Virginia Marine Resource Commission, and University of New Hampshire along with six commercial oyster and/or clam producers. This partnership provides a mechanism for the sharing of vital resources to address intricate and complex water quality issues that are significantly compromising the shellfish industry. These six shellfish hatcheries provide almost all of the clams and oysters that are aquacultured in the State of Virginia, which has overall economic impact of $100 million a year and employs over 1,100 people. Since this program has been implemented, shellfish hatcheries have seen an increase in oyster and clam production. However, the issues experienced at these hatcheries is not entirely mitigated. The approach we are taking to address our issues is now being modeled by others world-wide.

   **Kuhn, D.D.**, M.E. Angier, S.L. Barbour, S.A. Smith, G.J. Flick. 2013. Culture feasibility of eastern oysters (*Crassostrea virginica*) in zero-water exchange recirculating aquaculture systems using synthetically derived seawater and live feeds. Aquacultural Engineering 54, 45-48.

   Kingsley, D.H., **D.D. Kuhn**, L.S. Lawson, G.J. Flick, J. Oh, G.K. Meade, C.C. Giesecke. 2013. Desirability of oysters treated by high pressure processing at different temperatures and elevated pressures. American Journal of Food Technology 9, 206-216.

   **Kuhn, D.D.**, G.J. Flick. 2014. Temperature affects quality, safety of Quahog clams. Global Aquaculture Advocate. March/April 2014. p. 52-54.

   Choi, M., A.M. Stevens, S.A. Smith, D.P. Taylor, **D.D. Kuhn**. 2016. Strain and dose infectivity of *Vibrio parahaemolyticus:* the causitive agent of early mortality syndrome in shrimp. Aquaculture Research. DOI: 10.1111/are.13197

2. **Aquaculture Waste Utilization**. I was at the fore-front of developing and researching how to convert effluent waters to healthy microbial proteins as a value-added ingredient in aquaculture diets. This process is now being seriously explored as a viable option by aquaculture producers, and the food processing and energy production industries.

   **Kuhn, D.D.**, A.L. Lawrence, G.D. Boardman, S. Patnaik, L. Marsh, G.J. Flick Jr. 2010. Evaluation of two types of biofloc meals derived from biological treatment of fish effluent as feed ingredients for Pacific white shrimp, *Litopenaeus vannamei*. Aquaculture 303: 28-33.

   **Kuhn, D.D.**, G.D. Boardman, A.L. Lawrence, L. Marsh, G.J. Flick. 2010. Microbial floc meal as a replacement ingredient for fishmeal and soybean protein in shrimp feed. Aquaculture 296:51-57.

   **Kuhn, D.D.**, A.L. Lawrence, J. Crockett, D.P. Taylor. 2016. Evaluation of bioflocs derived from confectionary food effluent water as a replacement feed ingredient for fishmeal or soy meal for shrimp. Aquaculture 454, 66-71.

   **Kuhn, D.D.**, A.L. Lawrence, J. Crockett. 2017. Dietary toxicity of manganese to shrimp and its accumulation in bioflocs. Aquaculture Nutrition. doi:10.1111/anu.12480

3. **Other areas**. Three other program areas where we are making impacts include (i) the use of biotechnologies to improve fish production, disease resistance, and overall health, (ii) value-adding fish using novel aquafeed formulations, and (iii) development of value-added ready-to-eat aquacultured products.

**URL for "My Bibliography" list of published work (29 total)**
http://www.ncbi.nlm.nih.gov/myncbi/browse/collection/48676968/?sort=date&direction=ascending

**D. Research Support**

**Ongoing External Research Support**

**Title:** Protecting the Chesapeake Bay aquaculture industry from a dynamic carbonate chemistry environment
**Sponsor:** National Oceanic and Atmospheric Administration (NOAA) Saltonstall-Kennedy Program
**Project Period:** June 2015 – May 2018
**Overall Goals:** Assist the oyster and clam hatchery industry to understand and adapt to extreme carbonate chemistry water quality conditions
**Role:** PI

**Title:** Virginia shellfish aquaculture support
**Sponsor:** National Oceanic and Atmospheric Administration (NOAA) – Sea Grant Aquaculture Extension and Technology Transfer
**Project Period:** September 2015 – August 2017
**Overall Goals:** Assist the oyster and clam industry with hatchery production (water quality, engineering solutions) and health management (genetic strains, biosecurity).
**Role:** Co-PI

**Title:** Enhancing seafood quality by reducing reliance on antibiotics: applying a novel antibody in tilapia
**Sponsor:** National Fisheries Institute (NFI) – Seafood Industry Research Fund (SIRF)
**Project Period:** April 2016 – May 2017
**Overall Goals:** Implement novel biotechnologies (antibodies) to improve finfish health and increased resistance to disease
**Role:** PI

**Title:** Evaluation of new family lines of tilapia for aquaculture production
**Sponsor:** Private Industry
**Project Period:** June 2016 – August 2017
**Overall Goals:** Evaluate production performance and health of different lines of tilapia
**Role:** PI

**Title:** Development and optimization of novel yeast protein for salmonid diets
**Sponsor:** Private Industry
**Project Period:** July 2016 – June 2017
**Overall Goals:** Implement novel biotechnologies to improve finfish and shrimp ability to utilize nutrients and health.
**Role:** PI

**Title:** Effects of direct fed microbes (probiotics) on gut health
**Sponsor:** Private Industry
**Project Period:** December 2015 – May 2017
**Overall Goals:** Implement novel biotechnologies to improve finfish and shrimp ability to utilize nutrients and health.
**Role:** PI

**Title:** Microbial-driven enhancements and modes of action for tilapia, salmonids, and marine shrimp: Improved nutrition and health
**Sponsor:** Private Industry
**Project Period:** August 2015 – July 2017
**Overall Goals:** Implement novel biotechnologies to improve finfish and shrimp ability to utilize nutrients and health.
**Role:** PI

**Title:** Improving fish (tilapia) nutrition using two distinct forms of selenium
**Sponsor:** Pratt Foundation Competive Grant
**Project Period:** July 2015 – January 2017
**Overall Goals:** Improve fish nutrition and fillet quality value using selenium as a micronutrient.
**Role:** PI

**Title:** Dietary strategies to enhance long chain omega 3 fatty acids content in tilapia: high oleic and omega 3
**Sponsor:** Pratt Foundation Competive Grant
**Project Period:** July 2015 – December 2017
**Overall Goals:** Improve fish nutrition and fillet quality value using novel oil formulations in aquafeeds.
**Role:** Co-PI

**Title:** Improving quality and value of fish (tilapia) fillets and by-products

**Sponsor:** United States Department of Agriculture (USDA) - The Federal/State Marketing Improvement Program (FSMIP)
**Project Period:** September 2014 – August 2017
**Overall Goals:** Improve fish nutrition and fillet quality value using novel oil formulations in aquaculture feeds and discovering new uses for by-products from the processing industry.
**Role:** PI

**Title:** The expansion of the local fish marketplace via creation of locally sourced, ready-to-eat products made available to surrounding communities by Virginia Aqua-Farmers Network
**Sponsor:** United States Department of Agriculture (USDA) – Local Food Promotion Program (LFPP)
**Project Period:** September 2015 – August 2018
**Overall Goals:** The Virginia Aqua-Farmers Network, LLC project will benefit the situation of the surrounding communities by adding value to local farmers production and by increasing consumer access to a locally produced ready-to-eat foods.
**Role:** Co-PI

**Recently Completed External Research Support**

**Title:** Microbial protein substitution for fishmeal in aquaculture diets: Phase I and 2
**Sponsor:** Private Industry
**Project Period:** July 2015 – August 2017
**Overall Goals:** Implement novel biotechnology unit processes to convert an organic byproduct of ethanol production into value-added microbial proteins that can be used in aquaculture diets.
**Role:** PI

**Title:** A plan to develop a viable oyster industry
**Sponsor:** Virginia Marine Resource Commission
**Project Period:** March 2012 – February 2014
**Overall Goals:** Extension funding to help train industry personnel and monitor *Vibrio* spp. at six shellfish hatchery sites.
**Role:** PI

**Title:** Water chemistry studies for oysters
**Sponsor:** Virginia Marine Resource Commission
**Project Period:** March 2012 – February 2013
**Overall Goals:** Extension funding to outfit hatcheries with wet lab equipment.
**Role:** PI

**Title:** Protecting Virginia's shellfish aquaculture industry from acidified waters: a proposed partnership for the rigorous monitoring of seawater chemistry in VA shellfish hatcheries
**Sponsor:** Virginia Sea Grant Competitive Supplemental Outreach Funding
**Project Period:** June 2013 – January 2015
**Overall Goals:** Seed funding for developing a partnership and collect preliminary data for helping the hatchery industry understand and adapt to a changing carbonate chemistry environment.
**Role:** PI

**Title:** Correlating near‐infrared reflectance spectrometry (NIRS) to physiological parameters in oysters
**Sponsor:** The Virginia Institute of Marine Science
**Project Period:** July 2012 – November 2012
**Overall Goals:** Develop a tool to help the oyster industry quickly determine flesh quality.
**Role:** PI

**Title:** Developing and validating protocols for waterless shipping of live shrimp
**Sponsor:** United States Department of Agriculture (USDA) - The Federal/State Marketing Improvement Program (FSMIP)
**Project Period:** October 2012 – September 2015
**Overall Goals:** Assist the industry in finding new ways to move live shrimp to high-value live seafood markets.
**Role:** PI

**Title:** Effects of direct-fed probiotics and disease-induced stress on fish metabolome

**Sponsor:** Private Industry
**Project Period:** July 2014 – June 2015
**Overall Goals:** Implement novel biotechnologies to improve finfish and shrimp ability to utilize nutrients and health.
**Role:** PI

**Title:** Microbial-driven enhancements and modes of action for tilapia, salmonids, and marine shrimp: improved nutrition and health

**Sponsor:** Private Industry
**Project Period:** July 2013 – June 2015
**Overall Goals:** Implement novel biotechnologies to improve finfish and shrimp ability to utilize nutrients and health.
**Role:** PI

| BIOGRAPHICAL SKETCH | | | |
|---|---|---|---|
| NAME<br>Lawrence, Christopher | | POSITION TITLE<br>Associate Professor of Biological Sciences, Virginia Polytechnic Institute and State University, Blacksburg, VA | |
| eRA COMMONS USER NAME<br>CLAWRENCE | | | |
| EDUCATION/TRAINING | | | |
| INSTITUTION AND LOCATION | DEGREE | YEAR(s) | FIELD OF STUDY |
| Auburn University, Alabama | B.S. | 1990 | Microbiology |
| Auburn University, Alabama | M.S. | 1993 | Molecular Plant Pathology |
| Wageningen University, the Netherlands | Practical Training | 1993 | Molecular Biology |
| Auburn University, Alabama | Ph.D. | 1998 | Plant Pathology, Molecular Biology |

**A. Personal Statement**

One focus of our research program is genomics, bioinformatics, and immunological aspects of pathogenic fungal-host (mammal and plant) interactions. We have developed methods and tools for functional genomics applications in fungi for assessing gene function in relation to biological processes, proinflammatory activities, and virulence towards mammals and plants. We use experimental and informatics-based (systems biology) approaches to develop hypotheses, identify candidate genes and then determine the role of these genes and gene products in developmental, biochemical, and signaling processes by utilizing human cells (primary cells and cell lines), animal models, and model plant systems (Arabidopsis). We have been particularly involved over the past decade in fungal genomics, bioinformatics, and development of database platforms and computational approaches for studying fungi. My laboratory was responsible for sequencing and annotation of the first Alternaria genome in 2004, and has grown to over 25 species/isolates of this ubiquitous fungal genus. We have also developed resources such as the Alternaria Genomes Database (http://alternaria.vbi.vt.edu/index.html), a user-friendly, queryable database housing all genomic sequences, and annotated data including gene/protein models, predicted functional annotation of each protein, secretion signals, homology based prediction, etc. Lastly, one newer project in our lab is centered on the role of LysM domain containing proteins in mammals and their role in disease and immune signaling processes.

**B. Employment & Positions**

1990-98 Awarded Competitive Graduate Research Fellowship, Auburn University
1988-90 Research Assistant, Institute of Fungal Lipid Research, Department of Botany and Microbiology, Auburn University, Auburn, AL.
1993 Visiting Scholar, Wageningen University, the Netherlands.
1990-97 Graduate Research Assistant (M.S. and Ph.D.), Molecular Plant Pathology Laboratory Department of Plant Pathology, Auburn University, Auburn, AL.
1998-00 Staff Scientist III, Director of Plant Biotechnology Program, University of Kentucky, Lexington.
2000-03 Assistant Professor of Molecular Biology/Genomics, Colorado State University, Fort Collins, CO.
2001-present Leader, Alternaria Genome Consortium
2003-present Associate Professor, Department of Biological Sciences, Virginia Polytechnic Institute and State University, Blacksburg, VA.
2003-2015 Associate Professor Virginia Bioinformatics Institute, Virginia Polytechnic Institute and State University, Blacksburg, VA.
2003-present Faculty member, Graduate Program in Genetics, Bioinformatics, and Computational Biology, Virginia Tech
2008-present Faculty member, Graduate Program in Inflammation and Inflammation Focus Group, Institute for Critical Technology and Applied Sciences (ICTAS), Virginia Tech
2012-present Associate Editor, Fungal Genetics and Biology (Elsevier Publishing)

## C. Grant Panels & Study Section Memberships

2009 NIAID Special Emphasis Panel, Innovative Approaches to Target Identification and Assay Development for Fungal Diagnosis (R21/33)
2009 CSREES-USDA Review Panel member, Microbial Functional Genomics
2011 NIFA-USDA Review Panel member, Plant Associations with Microbes
2013 NIAID, U.S.-China Program for Biomedical Collaborative Research (R01) Panel Member ZAI1 BDP-M (2013)
2013 NIFA-USDA Review Panel member, Plant Associations with Microbes
2014 NIAID Centers of Excellence in Translational Research (CETR)
2016 NIH ZRG1 CVRS-B (04) Respiratory Science
2016 NIH ZRG1 CVRS-N (02) Pulmonary Diseases
2016 NIAID Special Emphasis Panel: Discovery/Development of Novel Therapeutics for Eukaryotic Pathogens (R21/R33)
2017 NIH NIAID Immunology IMM-T90 Allergy, Asthma, Mucosal Inflammation SEP Study Section member

## D. Selected Publications

### ***Fungal Genomics and Bioinformatics***

1. Dang, H. X., Pryor, B., Peever, T., & Lawrence, C. B. (2015). **The Alternaria genomes database: a comprehensive resource for a fungal genus comprised of saprophytes, plant pathogens, and allergenic species**. BMC genomics, 16(1), 239.
2. Dang H and Lawrence C. 2014. **Alternaria Comparative Genomics: The Secret Life of Rots**. In Dean R, Lichens-Park A, and Kole C (Eds), Genomics of Plant-Associated Fungi and Oomycetes. pp. 45-63. Springer, 2014.
3. Ohm RA, Feau N, Henrissat B, Schoch CL, Horwitz BA, Barry KW, Condon BJ, Copeland AC, Dhillon B, Glaser F, Hesse CN, Kosti I, LaButti K, Lindquist EA, Lucas S, Salamov AA, Bradshaw RE, Ciuffetti L, Hamelin RC, Kema GH, Lawrence C, Scott JA, Spatafora JW, Turgeon BG, de Wit PJ, Zhong S, Goodwin SB, Grigoriev IV. (2012) **Diverse lifestyles and strategies of plant pathogenesis encoded in the genomes of eighteen Dothideomycetes fungi.** PLoS Pathog. 2012;8(12):e1003037. doi: 10.1371/journal.ppat.1003037. Epub 2012 Dec 6. PubMed PMID: 23236275.
4. Dang, H. X., & Lawrence, C. B. (2014). **Allerdictor: fast allergen prediction using text classification techniques**. *Bioinformatics*, *30*(8), 1120-1128.

### ***Functional Genomics and Host-Pathogen Interactions***

1. Babiceanu MC, Howard BA, Rumore AC, Kita H, Lawrence CB. (2013). **Analysis of global gene expression changes in human bronchial epithelial cells exposed to spores of the allergenic fungus, *Alternaria alternata***. *Frontiers Microbiology*. 2013;4:196. doi:10.3389/fmicb.2013.00196.
2. Cho, Y., J.W. Davis, K. Kim, J. Wang, Q. Sun, R.A. Cramer, Lawrence, C.B. (2006). **A high throughput targeted gene disruption method for *Alternaria* functional genomics using linear minimal element (LME) constructs**. *Molecular Plant-Microbe Interactions*, **19**:7-15.
3. Kim, K.-H., Y. Cho, C.M. La Rota, R.C. Cramer, Lawrence, C.B. (2007)**. Functional analysis of the *Alternaria brassicicola* Non-Ribosomal Peptide Synthetase gene *AbNRPS2* reveals a role in conidial cell wall construction**. *Molecular Plant Pathology*, **8**:23-29.
4. Willger, S.D., S. Wannaying, K.H. Kim, J.B. Burritt, L.J. Metzler, R. Barbuch, M. Bard, Lawrence, C.B., Cramer, R.A. (2008). **A sterol-regulatory element binding protein is required for cell polarity, hypoxia adaptation, azole drug resistance and virulence in *Aspergillus fumigatus***. *PLoS Pathogens*, **4**(11): e1000200. doi:10.1371/ journal.ppat.1000200. PMCID: PMC2572145
5. Yoon, J., J.U. Ponikau, Lawrence, C.B. Kita, H. (2008). **Innate anti-fungal immunity of human eosinophils mediated by a β2-integrin, CD11b**. *Journal of Immunology*, **181**:2907-2915.
6. Cho, Y., K.-H. Kim, D. Scott, G. Santopietro, T.K. Mitchell, Lawrence, C.B. (2009). **Identification of novel virulence factors associated with signal transduction pathways in *Alternaria brassicicola***. *Molecular Microbiology*, **72**(6):1316-33.

7. Matsuwaki, Y., K. Wada, T.A. White, Y. Inoue, J.U. Ponikau, C.B. Lawrence, H. Kita. (2009). **Recognition of fungal protease activities induces cellular activation and eosinophil-derived neurotoxin release in human eosinophils**. *Journal of Immunology*, **183**(10):6708-16. PMCID: PMC2843542.
8. Kim, K.H., S.D. Willger, S.W. Park, S. Puttikamonkul, N. Grahl, Y. Cho, B. Mukhopadhyay, R.A. Cramer, C.B. Lawrence. (2009). **TmpL, a transmembrane protein required for intracellular redox homeostasis and virulence in a plant and an animal fungal pathogen**. *PLoS Pathogens*, **5**(11):e1000653. PMCID: PMC2766074.
9. Kale, S.D., B. Gu, D.G.S. Capelluto, D. Dou, E. Feldman, A. Rumore, F.D. Arredondo, R. Hanlon, I. Fudal, T. Rouxel, C.B. Lawrence, W. Shan, and B.M. Tyler. (2010). **External Phosphatidylinositol-3-phosphate Mediates Host Cell Entry by Eukaryotic Pathogen Effectors**. *Cell*, 142:284-295.
10. Akhil Srivastava, Robin A. Ohm, Ha Dang, Sharadchandra P. Marahatta, Christopher B. Lawrence, Koon-Hui Wang, Igor Grigoriev, Fred Brooks, and Yangrae Cho. (2012). **The transcription factor Amr1 regulates melanin biosynthesis and suppresses virulence in *Alternaria brassicicola***.*PLoS Pathogens*. Oct;8(10):e1002974. doi:10.1371/journal.ppat.1002974. Epub 2012.
11. Kidane, Y., Lawrence, C.B., Murali, T.S. (2013). **The Landscape of Host Transcriptional Response Programs Commonly Perturbed by Bacterial Pathogens: Towards Host-Oriented Broad-Spectrum Drug Targets.** *PLoS One*, 2013;8(3):e58553. doi: 10.1371/journal.pone.0058553. Epub 2013 Mar 13.
12. Park SW, Li W, Viehhauser A, He B, Kim S, Nilsson AK, Andersson MX, Kittle JD, Ambavaram MM, Luan S, Esker AR, Tholl D, Cimini D, Ellerström M, Coaker G, Mitchell TK, Pereira A, Dietz KJ, Lawrence CB. (2013). **Cyclophilin 20-3 relays a 12-oxo-phytodienoic acid signal during stress responsive regulation of cellular redox homeostasis.** *Proc Natl Acad Sci U S A*. 2013 May 13. [Epub ahead of print] PubMed PMID: 23671085.

**Patents**

1. Kita, H, Ponikau, J and Lawrence CB. **Fungus induced inflammation and eosinophil degranulation**. Mayo Intellectual Property Ventures and VTIP, United States Patent 7,662,400, issued 02/16/2010, 02/16/2011.
2. Hunt, AG, Collins, GB, Li, Q-S, Dasgupta S, Lawrence CB. **Bacterial acetate kinases and their genes for protection of plants against different pathogens**. University of Kentucky Research Foundation, United States Patent 6,476,293, issued 11/05/02.
3. Everett, NP, Li Q-S, Lawrence, CB, and Davies M. **Peptides with enhanced stability to protease degradation**. University of Kentucky Research Foundation, United States Patent 7,214,766, issued 05/08/07.

## E. Current Research Support

NIH NIAID, 1R21AI115986-01, Lawrence PI 05/01/15-04/31/18
**Novel Innate Receptor for the Fungal PAMP chitin**
This project stems from the informatics-based discovery of a novel class of genes/proteins in mammals that appear to participate in innate immune responses, particularly to fungal cell wall products like chitin. Furthering our understanding of these unique genes in the context of innate immunity and allergic inflammatory processes is the overall goal of the project.

NIH NIAID, R01 AI071106-06A1, Kita, Mayo Clinic Rochester, MN (PI) 07/01/13-06/30/18
**Alternaria and ribonucleases in Th2 Immunity**
This project is focused on dissecting the role of airborne fungal ribonucleases in driving Th2 immunity.
Role: Lawrence (Co-Investigator)

## BIOGRAPHICAL SKETCH

| NAME | POSITION TITLE |
|---|---|
| Marr, Linsey C. | Professor of Civil and Environmental Engineering |
| eRA COMMONS USER NAME<br>LIMARR | |

EDUCATION/TRAINING

| INSTITUTION AND LOCATION | DEGREE *(if applicable)* | MM/YY | FIELD OF STUDY |
|---|---|---|---|
| Harvard, Cambridge, Massachusetts | B.S. | 06/96 | Engineering Sciences |
| University of California at Berkeley | Ph.D. | 05/02 | Civil and Environmental Engineering |
| Massachusetts Institute of Technology | Postdoctoral | 06/03 | Earth, Atmospheric, and Planetary Sciences |

### A. Personal Statement

Based on the fundamentals of atmospheric physics and chemistry, my research focuses on interdisciplinary questions about airborne transmission of infectious disease and environmental impacts of engineered nanomaterials and other emerging pollutants. I am heavily involved in interdisciplinary research and education across campus, including two Interdisciplinary Graduate Education Programs (Sustainable Nanotechnology and BIOTRANS) and two thrust areas of ICTAS (Nanoscale Science and Engineering and Exposome). I have a demonstrated record of success and productivity, as evidenced by my strong publication history (73 peer-reviewed papers), citation metrics, (>3400, h-index of 27 according to Google Scholar) and funding record. I have been the PI on seven grants funded by NIH, NSF, or EPA, including an NIH New Innovator award and an NSF CAREER award, and a Co-PI on many others.

### B. Positions and Honors

**Positions and Employment**

1996-2002 Research Assistant, Civil and Environmental Engineering, University of California at Berkeley
2002-2003 Postdoctoral Associate, Earth, Atmospheric, and Planetary Sciences, MIT
2003-2005 Assistant Professor, Civil and Environmental Engineering, Virginia Tech, Blacksburg, VA
2005-2013 Associate Professor, Civil and Environmental Engineering, Virginia Tech, Blacksburg, VA
2013- Professor, Civil and Environmental Engineering, Virginia Tech, Blacksburg, VA

**Other Experience and Professional Memberships**

2017 Member, National Academy of Sciences Committee on Grand Challenges in Environmental Engineering
2017 Invited speaker, Gordon Research Conference on Environmental Nanotechnology
2016 Invited speaker, National Academy of Sciences Committee on Indoor Microbiomes
2016- Editorial Advisory Board member for *Environmental Science & Technology Letters*
2016- Editorial Advisory Board member for *Environmental Science: Processes and Impacts*
2015 Invited plenary speaker, American Association for Aerosol Research 34th Annual Conference
2013-2016 Treasurer, American Association for Aerosol Research
2014- Editorial Advisory Board member for *Aerosol Science and Technology*
2014 Invited contributor, OECD Expert Meeting on Categorization of Manufactured Nanomaterials
2012 Invited speaker, Sloan Foundation Microbiology of the Built Environment Conference
2012 Invited speaker, NSF Nanoscale Science and Engineering Conference
2012 Invited speaker, American Chemical Society National Meeting, San Diego, CA
2010 Chair, American Association for Aerosol Research Combustion and Nanoparticles Working Group

2006, 2010 Invited participant, NSF Workshop on Indoor Air Chemistry
2003- Reviewer for California Air Resources Board, Environmental Protection Agency, National Institutes of Health, National Science Foundation, *Aerosol Science and Technology, Applied and Environmental Microbiology, Atmospheric Chemistry and Physics, Atmospheric Environment, Atmospheric Research, Environmental Monitoring and Assessment, Environmental Science: Nano, Environmental Science and Policy, Environmental Science and Technology, Global Change Biology, Indoor Air, Journal of Applied Meteorology and Climatology, Journal of Environmental Engineering and Science, Journal of Environmental Informatics, Journal of Geophysical Research, Journal of the Air and Waste Management Association, Journal of the Royal Society Interface, Medicine and Science in Sports and Exercise, Nature Nano, Particle and Fibre Toxicology, PLoS One, Science of the Total Environment, Scientific Reports*
2003-2009 Member, Association of Environmental Engineering and Science Professors
2005- Member, American Association for Aerosol Research

**Honors**

1996 National Science Foundation Graduate Research Fellowship
1999 US Environmental Protection Agency STAR Graduate Research Fellowship
1999 Outstanding Graduate Student Instructor, University of California at Berkeley
**2006 National Science Foundation CAREER award**
2006 Virginia Tech College of Engineering Outstanding New Assistant Professor
2007 Virginia Tech College of Engineering Faculty Fellow
2010 Civil and Environmental Engineering Alumni Board Teaching Excellence Award
**2013 NIH Director's New Innovator Award**
2014 Virginia Tech College of Engineering Dean's Award for Excellence in Research
2014 Virginia Tech Innovator Award
2017 Fulbright Scholar

**C. Contribution to Science**

**1. Role of aerosolized pathogens in transmission of infectious disease.** Despite tremendous advances in medicine and technology in recent decades, infectious diseases remain a major threat to public health, and our understanding of transmission mechanisms remains primitive. My publications have shown that airborne transmission of influenza is indeed feasible and reveal mechanisms for the seasonality of influenza. Low indoor humidity during the wintertime in temperate regions affects the size and fate of respiratory aerosols, and varying degrees of evaporation of the aerosols affect the pathogen's microenvironment and its viability. Expanding beyond influenza, we are currently studying the airborne microbiome in indoor environments.

a. Lin, K., Marr, L.C., (2017). Aerosolization of Ebola virus surrogates in wastewater systems, *Environmental Science and Technology*, 51, 2669–2675.
b. Prussin II, A.J., Marr, L.C., (2015). Sources of airborne microorganisms in the built environment, *Microbiome*, 3, Art. no. 78.
c. Prussin II, A.J., Garcia, E.B., Marr, L.C., (2015). Total concentrations of virus and bacteria in indoor and outdoor air, *Environmental Science and Technology Letters*, 2, 84-88.
d. Yang, W., Elankumaran, S., Marr, L.C., (2011). Concentrations and size distributions of airborne influenza A viruses measured indoors at a health centre, a day-care centre and on aeroplanes, *Journal of the Royal Society Interface*, 8, 1176-1184.

**2. Exposure to air pollutants.** Exposure assessment is a key step in risk characterization, and I have measured exposure to various air toxics and pollutants of emerging concern. My publications have defined exposure levels to diesel exhaust, including polycyclic aromatic hydrocarbons, in the workplace and to engineered nanomaterials in realistic scenarios involving the use of nanotechnology-based consumer products. I have collaborated with the US Environmental Protection Agency and the Consumer Products Safety Commission on some of this research.

a. Xie, M., Wu, Y., Little, J.C., Marr, L.C., (2016). Phthalates and alternative plasticizers and potential for contact exposure from children's backpacks and toys, *Journal of Exposure Analysis and Environmental Epidemiology*, 26, 119-24.
b. Vance, M.E., Marr, L.C., (2015). Exposure to airborne engineered nanoparticles in the indoor environment, *Atmospheric Environment*, 106, 503-509.
c. Sheesley, R.J., Schauer, J.J., Smith, T.J., Garshick, E., Laden, F., Marr, L.C., Molina, L.T., (2008). Assessment of diesel particulate matter exposure in the workplace: freight terminals, *Journal of Environmental Monitoring*, 10, 305-314.
d. Marr, L.C., Grogan, L.A., Wohrnschimmel, H., Molina, L.T., Molina, M.J., Smith, T.J., Garshick, E., (2004). Vehicle traffic as a source of particulate polycyclic aromatic hydrocarbon exposure in the Mexico City Metropolitan Area, *Environmental Science and Technology*, 38, 2584-2592.

**3. Sources of airborne engineered nanomaterials.** Nanomaterials are inevitably released into the indoor and outdoor atmosphere. Prediction of their health and environmental impacts requires detailed characterization of their physical and chemical properties. My publications have shown that nanomaterials are released during production, use, and disposal and have quantified them not just in terms of exposure but also in terms of emission factors, which enable others to use these results to estimate emissions from similar processes. In addition to characterizing the nanomaterials themselves, my research group has also shown that their presence during combustion can affect releases of other toxic byproducts, such as dioxins and polycyclic aromatic hydrocarbons. The US Environmental Protection Agency has used our results to guide its policymaking surrounding nanotechnology.

a. Tiwari, A.J., Ashraf-Khorassani, M., Marr, L.C., (2016). $C_{60}$ fullerenes from combustion of common fuels, *Science of the Total Environment*, 547, 254-60.
b. Vejerano, E.P., Leon, E.C., Holder, A.L., Marr, L.C., (2014). Characterization of particle emissions and fate of nanomaterials during incineration, *Environmental Science: Nano*, 1, 133-143.
c. Vejerano, E.P., Holder, A.L., Marr, L.C., (2013). Emissions of polycyclic aromatic hydrocarbons, polychlorinated dibenzo-p-dioxins, and dibenzofurans from incineration of nanomaterials, *Environmental Science and Technology*, 47, 4866-4874.
d. Quadros, M.E., Marr, L.C., (2011). Silver nanoparticles and total aerosols emitted by nanotechnology-related consumer spray products, *Environmental Science and Technology*, 45, 10713-10719.

**4. Transportation-related air pollutant emissions.** Accurate estimates of emissions are critical for effective air quality management, and the transportation sector is one of the largest sources of air pollutant emissions. Employing various techniques to study emissions under real-world conditions, I have quantified organic compounds, nitrogen oxides, carbon monoxide, particulate matter mass and number, particle-bound polycyclic aromatic hydrocarbons, and black carbon emitted by various transportation-related sources, including motor vehicles, construction equipment, and aircraft. These results have helped explain discrepancies between ambient observations and laboratory-based studies of emissions and have contributed to improved understanding of air quality by scientists and policy-makers.

a. Hong, A., Schweitzer, L., Yang, W., Marr, L.C., (2015). The impact of temporary freeway closure on regional air quality: A lesson from Carmageddon in Los Angeles, United States, *Environmental Science and Technology*, 5, 3211-3218. (*ES&T is considered the top journal in environmental engineering and has an impact factor of 5.48.*)
b. Heidari, B., Marr, L.C., (2015). Real-time emissions from construction equipment compared with model predictions, *Journal of the Air and Waste Management Association*, 65, 115-125.
c. Marr, L.C., Moore, T.O., Klapmeyer, M.E., Killar, M.B., (2013). Comparison of $NO_x$ fluxes measured by eddy covariance to emission inventories and land use, *Environmental Science and Technology*, 47, 1800-1808.
d. Klapmeyer, M.E., Marr, L.C., (2012). $CO_2$, $NO_x$, and particle emissions from aircraft and support activities at a regional airport, *Environmental Science and Technology*, 46, 10974-10981.

**D. Research Support**

**Ongoing Research Support**

NIH DP2-AI112243 Marr (PI) 9/1/2013-7/30/2018
The Role of Pathogen-Environment Interactions in the Pandemic Potential of Influenza
The goal of this project is to identify the relationship between influenza virus viability in aerosols and relative humidity and to determine the mechanisms that control the relationship.
Role: PI

NSF CBET-1438103 Marr (PI) 8/15/2014-8/14/2017
Solving the Mystery of Humidity's Effect on Viability of Airborne Microorganisms
The goal of this project is to determine the relationship between the viability of aerosolized bacteria and viruses and ambient environmental conditions.
Role: PI

US Army Research Office W911NF-16-1-0007 Marr (PI) 11/1/2015-10/31/2018
The Effect of Humidity and Particle Composition on Partitioning of Volatile Organic Compounds
The goal of this project is to measure gas-aerosol-soil partitioning of certain VOCs that are widely used as solvents, degreasers, or pesticides as a function of temperature, relative humidity, soil textural class, and particle chemical composition.
Role: PI

Virginia DEQ Marr (PI) 10/30/2013-10/29/2016
Air Quality Modeling System Services (AQMSS)
The goal of this project is to provide high-performance computing hardware and support for air quality modelers at the state environmental agency.
Role: PI

NSF CBET- 1605355 Dietrich (PI) 7/1/2016-6/30/2019
Assessing Inhalation Exposure to Aerosolized Contaminants from Drinking Water
This project fills a critical knowledge gap concerning human exposure, at the air-water-human interface, to contaminants from aerosols emitted by ultrasonic humidifiers
Role: Co-PI

EPA 83560601 Little (PI) 7/1/2014-6/30/2017
Rapid Methods to Estimate SVOC Exposure
The goal of this project is to develop rapid methods to estimate exposure to semi-volatile organic compounds (SVOC) using both a source-oriented approach and a measurement-based approach.
Role: Co-PI

NSF EF-0830093 Wiesner (PI) 10/1/2009-9/30/2019
Center for the Environmental Implications of Nanotechnology
The goal of this project is to assess the environmental fate and transport and risks posed by engineered nanomaterials.
Role: Core Faculty

NSF ECCS-1542100 Hochella (PI) 9/15/2015-8/31/2020
NNCI: The Virginia Tech National Center for Earth and Environmental Nanotechnology Infrastructure (VT $NCE^2NI$)
Virginia Tech is a site in NSF's national network of nanotechnology facilities that specializes in supporting researchers who work with nanoscience- and nanotechnology-related aspects of environmental sciences and engineering.
Role: Co-PI

**Completed Research Support**

NSF CBET- 1509493 Marr (PI) 1/8/2015-12/31/2016
RAPID: The Role of Aerosolization from Wastewater Systems in the Fate and Transport of and Exposure to Ebola Virus
The overall goal of this research is to assess the potential for inhalation exposure to Ebola virus that is aerosolized during the regular operation and maintenance of wastewater systems.
Role: PI

Water Environment Research Foundation 2C15 Marr (PI) 3/1/2015-8/31/2016
Potential for Exposure to Ebola Virus Surrogates Aerosolized from Wastewater Systems
The overall goal of this research is to assess the potential for inhalation exposure to Ebola virus that is aerosolized during the regular operation and maintenance of wastewater systems.
Role: PI

EPA 83485601-0 Marr (PI) 2/1/2011-1/31/2015
Transformation and Fate of Nanomaterials During Wastewater Treatment and Incineration
The goal of this project was to characterize the transformation, fate, and toxicity of engineered nanomaterials and co-pollutants during biological wastewater treatment and incineration.
Role: PI

NIH R21-OH010330 Agah (PI) 7/1/2012-6/30/2014
A Miniaturized GC with MEMS-Enabled Selective Preconcentration for Monitoring Exposure to Transportation-Related Air Pollutants
The goal of this project was to develop a smart, portable gas analyzer that can be used to measure hazardous air pollutants in (near) real-time in transportation-related and other workplaces.
Role: Co-PI

## BIOGRAPHICAL SKETCH

Provide the following information for the Senior/key personnel and other significant contributors.
Follow this format for each person. **DO NOT EXCEED FIVE PAGES.**

NAME: Stephen Melville

eRA COMMONS USER NAME (credential, e.g., agency login): MELVILLE

POSITION TITLE: Associate Professor

EDUCATION/TRAINING *(Begin with baccalaureate or other initial professional education, such as nursing, include postdoctoral training and residency training if applicable. Add/delete rows as necessary.)*

| INSTITUTION AND LOCATION | DEGREE *(if applicable)* | Completion Date MM/YYYY | FIELD OF STUDY |
|---|---|---|---|
| San Diego State University, San Diego CA | B.S. | 1978-1982 | Microbiology |
| University of California, Davis, Davis CA | Ph.D. | 1983-1987 | Microbiology |
| UCLA, Los Angeles CA | Post-doc | 1988-1992 | Microbiology |
| Tufts University School of Medicine, Boston MA | Post-doc | 1993-1995 | Microbiology |

### A. Personal Statement

As a post-doctoral fellow in the lab of Dr. A. L. Sonenshein at Tufts Univ. Medical School, I began investigating the molecular regulation of a toxin, CPE, that causes one of the most common types of food poisoning in the U.S. As a an assistant professor at the Univ. of Tennessee Health Science Center in Memphis, I discovered that the *cpe* gene is regulated by the same sigma factors that are involved in the sporulation cycle, establishing a new paradigm for sigma factor regulation in Clostridia. I also established that the anaerobic pathogen, *C. perfringens*, could escape the phagosome of macrophages and persist in tissues due to the activity of the cholesterol-binding toxin PFO. After moving to Virginia Tech with a promotion to Associate Professor, I continued my work with the role of toxins in gangrene infections and discovered that PFO is necessary for survival of the bacteria in host tissues, another important step in understanding this deadly disease. I also organized and coordinated the consortium that sequenced the genomes of two strains of *C. perfringens* and three large plasmids. Leading this consortium gave me valuable experience in organizing large multi-faceted projects and taught me the importance of communication in running group research efforts. In work designed to identify heat resistance properties of *C. perfringens* spores, I have engaged in a large scale proteomics analysis of germination proteins in Gram-positive spores which was funded by an R21 NIH grant. I used my genomic research experience to uncover a novel form of type IV pili-mediated gliding motility in *C. perfringens*, the first time type IV pili (TFP) were shown to function in motility in Gram-positive bacteria. We also found that the TFP system in *C. perfringens* is one of the simplest known and makes an excellent model for understanding the basic elements of TFP assembly and retraction. One of the outcomes of this study was the identification of a Type II secretion-like system in *C. perfringens*, the first time such a system has been discovered in a Gram-positive bacterium and the subject of an R21 NIH grant.

### B. Positions and Honors

**Positions and employment**

1981-1982: Undergraduate Research Assistant, San Diego State University.
1983-1984: Graduate Teaching Assistant, University of California, Davis. Department of Bacteriology.
1988 Adjunct Assistant Professor, California State University, Northridge CA
1994-1995: Lecturer, Tufts University School of Medicine.
1995 -2001: Assistant Professor, Department of Microbiology and Immunology, The University of Tennessee, Memphis, School of Medicine.
2001-present: Associate Professor, Department of Biology, Virginia Tech.

**Other experience and professional memberships'**

1984- Member, American Society for Microbiology
1993- Member, American Association for the Advancement of Science
2005- Member, Sigma Xi Scientific Research Society
2006- USDA NRIGCP Food Safety Proposal Review Panel, Member
2009- USDA Food Safety Proposal Review Panel, Member
2010 NIH Peer Review Committee: NIH Partnerships for Development of New Therapeutics Classes for Select Viral and Bacterial Pathogens
2011-13 Chair, Mid-Atlantic Microbial Pathogenesis Meeting
2015 NIH Peer Review Committee: NIAID Microbiology and Infectious Diseases Committee B, ad hoc reviewer

**Honors**

1980-82: Academic scholarship, San Diego State University
1982: Outstanding Graduating Senior, Department of Microbiology, San Diego State University.
1985-87: Department of Animal Science research assistantship, awarded for academic achievement, University of California, Davis.
2008: Outstanding Teaching Award, Department of Biological Sciences, Virginia Tech
2011: Outstanding Teaching Award, Department of Biological Sciences, Virginia Tech
2014: Outstanding Teaching Award, Department of Biological Sciences, Virginia Tech

**C. Contributions to Science**

1. My lab was the first to report the presence of complete Type IV pili (TFP) systems in any Gram-positive bacterium, in this case *C. perfringens*. The non-flagellated *C. perfringens* are able to move with a unique and previously undescribed type of gliding motility. We have examined the role of TFP in this motility using a mariner transposon mutagenesis system we developed. We also showed the universality of pilin structure/functions in bacteria by successfully expressing and getting polymerization of the major pilin from *C. perfringens* in the Gram-negative pathogen, *Neisseria gonorrhoeae*. TFP are not only associated with motility but also biofilm formation in *C. perfringens*.


1. Varga, J. J., Nguyen, V., O'Brien, D. K., Rodgers, K., Walker, R. A. and **Melville, S. B.** (2006) Type IV pili-dependent gliding motility in the Gram-positive pathogen *Clostridium perfringens* and other Clostridia. Mol. Microbiol. **62** (3): 680-694.
2. Liu, H., L. Bouillaut, A. L. Sonenshein, and **S. B. Melville**[C]. 2013. Use of a mariner-based transposon mutagenesis system to isolate *Clostridium perfringens* mutants deficient in gliding motility *J. Bacteriol.* 195: 629-636.
3. Hendrick WA, Orr MW, Murray SR, Lee VT, Melville SB. (2017) Cyclic-di-GMP binding by an assembly ATPase (Pilb2) and control of Type IV pilin polymerization in the Gram-positive pathogen *Clostridium perfringens.* Journal of Bacteriology, Feb 27. pii: JB.00034-17. doi: 10.1128/JB.00034-17. [Epub ahead of print]
4. Varga, J. J., Therit, B. H., and **Melville, S. B**. 2008. Type IV pili and the CcpA protein are needed for maximal biofilm formation by the gram-positive anaerobic pathogen *Clostridium perfringens*. Infect Immun **76**:4944-4951.
5. Rodgers K., Arvidson, C. G., and **Melville, S. B.**. 2011. Expression of a *Clostridium perfringens* type IV pilin by *Neisseria gonorrhoeae* mediates adherence to muscle cells. Infect Immun. **79**:3096-3105


2. In collaboration with the lab of Dr. David Popham, we demonstrated the heat resistance properties of *C. perfringens* spores were due to intense dehydration of the spore core. We also discovered a novel pathway for the synthesis of the important spore heat resistance molecule, dipicolinic acid, in *C. perfringens* and other pathogenic Clostridia.


1. Orsburn B., **Melville, S. B**., and. Popham D. L. 2010. EtfA catalyzes the formation of dipicolinic acid in *Clostridium perfringens.* Mol. Microbiol. **75**:178-86.
2. Orsburn, B., Sucre, K., Popham D. L.., and **Melville S. B**. 2009. The SpmA/B and DacF proteins of *Clostridium perfringens* play important roles in spore heat resistance. FEMS Micro Lett. **291**:188-94.

3. Orsburn B., **Melville, S. B**., and. Popham D. L. 2008. Factors contributing to heat resistance of *Clostridium perfringens* endospores. Appl Environ Microbiol. **74**:3328-3335.

3. Our research showed that *C. perfringens*, despite being an obligate anaerobe, was capable of escaping the phagosome of macrophages under aerobic conditions. We also showed that the cytotoxin PFO, which had a poorly defined role in gas gangrene myonecrosis, was actually responsible for allowing *C. perfringens* to persist in host tissues even under aerobic conditions. As a complement to these studies, we demonstrated that, somewhat unexpectedly, macrophages/monocytes were more responsible for controlling the onset of gas gangrene infections than were PMNs.

1. O'Brien, D. K. and **S. B. Melville**. 2000. The anaerobic pathogen *Clostridium perfringens* can escape the phagosome of macrophages under aerobic conditions. Cell. Microbiol. **2**: 505-519.
2. David K. O'Brien and **S. B. Melville.** 2004. Effects of *Clostridium perfringens* alpha-toxin (PLC) and perfringolysin O (PFO) on cytotoxicity to macrophages, on escape from the phagosomes of macrophages, and on persistence of *C. perfringens* in host tissues. Infect Immun. **72**:5204-5215.
3. O'Brien, D. K., Therit, B. H., Woodman, M. E, and. **Melville S. B**. 2007. The role of neutrophils and monocytic cells in controlling the initiation of *Clostridium perfringens* gas gangrene infections. FEMS Immunol. Med. Microbiol. **50**:86-93.

**D. Research Support**

**Ongoing Research Support**

NIH 1R21AI109391-01A1 Melville (PI) 7/1/14-6/30/17
Characterization of a Type II secretion system in a Gram-positive pathogen
The goal of this project is to characterize a potential type II secretion system in Clostridium perfringens, a Gram-positive bacterium

**Completed Research Support**

NSF EAGER 1057871 Melville (PI) 3/1/11-2/28/15
"Molecular analysis of the assembly of bacterial Type IV pili.
The goal of this study was to assemble a minimal type IV pili assembly apparatus using purified protein from Pseudomonas aeruginosa.

NIH 1R21AI088298-01 Multiple PIs: Melville, Popham, Jensen, Helm 3/1/10-8/28/13
Proteomic Analyses of *Clostridium difficile* Spore Germination Apparatus
The goal of this project was to characterize the entire spore inner membrane proteome and identify unique proteins in each species analyzed, *C. perfringens*, *B. subtilis*, and *C. difficile*.

NIH 1R13AI100552-01A1 Melville (PI) 1/15/13-12/31/13
Mid-Atlantic Microbial Pathogenesis Meeting (MAMPM), 2013
This grant was to fund the operations for the MAMPM 2013 scientific meeting in Wintergreen, VA

USDA 2012-03815 Melville (PI) 1/1/13-12/31/13
Mid-Atlantic Microbial Pathogenesis Meeting (MAMPM), 2013
This grant was to fund the operations for the MAMPM 2013 scientific meeting in Wintergreen, VA

Burroughs Wellcome Fund 1011689 Melville (PI) 8/1/12-7/31/13
Mid-Atlantic Microbial Pathogenesis Meeting (MAMPM), 2013
This grant was to fund the operations for the MAMPM 2013 scientific meeting in Wintergreen, VA

## BIOGRAPHICAL SKETCH

Provide the following information for the Senior/key personnel and other significant contributors.
Follow this format for each person. **DO NOT EXCEED FIVE PAGES**.

NAME: Pierson, Frank William

eRA COMMONS USER NAME (credential, e.g., agency login): PIERSON

POSITION TITLE: Professor, Biosecurity and Infection Control; Clinical Specialist, Poultry Health

EDUCATION/TRAINING *(Begin with baccalaureate or other initial professional education, such as nursing, include postdoctoral training and residency training if applicable. Add/delete rows as necessary.)*

| INSTITUTION AND LOCATION | DEGREE *(if applicable)* | Completion Date MM/YYYY | FIELD OF STUDY |
|---|---|---|---|
| University of Delaware, Newark, DE | B.S. | 05/1978 | Animal Science |
| Purdue University, West Lafayette, IN | M.S. | 12/1980 | Animal Physiology |
| Virginia Tech, Blacksburg, VA | D.V.M. | 05.1984 | Veterinary Medicine |
| Virginia Tech, Blacksburg, VA | Ph.D. | 05/1993 | Infectious Diseases |
| American College of Poultry Veterinarians (Board Specialization), Jacksonville, FL | Diplomate | 07/1994 | Poultry Health |

### A. Personal Statement

During my time in academia, my investigatory work has primarily focused on infectious diseases of poultry (pathogenesis, multi-agent / factorial disease interactions, vaccine development) as well as food safety (*Salmonella* and *Salmonella* bioremediation). As an adjunct to research, my service and instructional activities have included such areas as biosecurity, agrosecurity (anti-terrorism / biologicals and toxicants), and animal disaster response (partial funding for the latter two areas from DHS). A specific outgrowth from my work on biosecurity has been to oversee the infection control program (ICP) of Veterinary Teaching Hospital at Virginia Tech. This has involved the design / development of Standard Operating Procedures for cleaning and disinfection (C&D), training of personnel, compliance, and investigation of hospital -acquired infections (HAIs) and zoonoses. My specific role relative to the oversight and implementation of the hospital ICPs position's me well for participation in this project i.e., monitoring of environmental exposure to the quaternary ammonium compounds used by personnel in the C&D process. I also served as hospital director and veterinarian-in-charge from 2007-2014, with administrative responsibility for the 120+ staff that will comprise the study pool. I recently returned from a 6 mo. research sabbatical leave split between the Southwest Border Food Protection and Emergency Preparedness Center, New Mexico State University, Las Cruces, NM and the Max Planck Institute for Infection Biology, Berlin, Germany.

### B. Positions and Honors

**Positions and Employment**

1984-1987 Private Veterinary Practitioner, Londonderry Animal Hospital, Middletown, PA
1987-1990 Graduate Research Assistant, Department of Large Animal Clinical Sciences, Virginia-Maryland Regional College of Veterinary Medicine, Virginia Tech, Blacksburg, VA.
1990-1991 Research Associate, Department of Large Animal Sciences, Virginia-Maryland Regional College of Veterinary Medicine, Virginia Tech, Blacksburg, VA.

| | |
|---|---|
| 1991-1993 | Research Scientist, Department of Large Animal Clinical Sciences, Virginia-Maryland Regional College of Veterinary Medicine, Virginia Tech, Blacksburg, VA. |
| 1993-1999 | Assistant Professor, Department of Large Animal Clinical Sciences, Virginia-Maryland Regional College of Veterinary Medicine, Virginia Tech, Blacksburg, VA. |
| 1999-2011 | Associate Professor, Poultry Health, Department of Large Animal Clinical Sciences, Virginia-Maryland Regional College of Veterinary Medicine, Virginia Tech, Blacksburg, VA. |
| 2002-Present | Coordinator, Biosecurity and Infection Control, Veterinary Teaching Hospital, Virginia-Maryland Regional College of Veterinary Medicine, Virginia Tech, Blacksburg, VA. |
| 2007-2008 | Interim Director and Veterinarian-in-Charge, Veterinary Medical Teaching Hospital, Virginia-Maryland Regional College of Veterinary Medicine, Virginia Tech, Blacksburg, VA. |
| 2008-2014 | Director and Veterinarian-in-Charge, Veterinary Medical Teaching Hospital, Virginia-Maryland College of Veterinary Medicine, Virginia Tech, Blacksburg, VA. |
| 2011-Present | Professor, Biosecurity and Infection Control; Clinical Specialist, Poultry Health; Department of Population Health Sciences, Virginia-Maryland College of Veterinary Medicine, Virginia Tech, Blacksburg, VA. |
| 2016-Present | Interim Head, Department of Biomedical Sciences and Pathobiology, Virginia-Maryland College of Veterinary Medicine, Virginia Tech, Blacksburg, VA. |

**Other Experience and Professional Memberships (selected)**

| | |
|---|---|
| 1978-Present | Poultry Science Association |
| 1984-Present | American Veterinary Medical Association |
| 1988-Present | American Association of Avian Pathologists |
| 1992-Present | Association of Avian Veterinarians |
| 1999-Present | Member, Virginia Poultry Disease Task Force |
| 2000-2013 | Secretary, Northeastern Conference on Avian Diseases |
| 2007-2013 | Secretary / Chair, Northeastern Conference on Avian Diseases |
| 2007-2014 | Member, Executive Board, Virginia-Maryland Regional College of Veterinary Medicine |
| 2007-2014 | Member, University Outreach Council, Virginia Tech |
| 2011-Present | Member, Organizing Committee, Virginia Agroterrorism Conference (annual) |
| 2011-Present | Chair, Committee on Diseases of Public Health Significance, American Association of Avian Pathologists. |
| 2011-2013 | Member, National Institute for Occupational Safety and Health, National Occupational Research Agenda, Subcommittee-Veterinary Medicine and Allied Professions. |

**Honors (selected)**

| | |
|---|---|
| 1992 | College Teaching Award, Virginia-Maryland Regional College of Veterinary Medicine |
| 1992 | Virginia Tech Certificate of Teaching Excellence |
| 1998 | Recognized by the Distinguished Professors, Division of Research and Graduate Studies, Virginia Tech, for research contributions in the area of poultry health |
| 2007 | Virginia Tech Scholar of the Week, Office of the Vice President for Research, Virginia Tech, for research contributions in the area of poultry health |
| 2012 | Virginia Tech Scholar of the Week, Office of the Vice President for Research, Virginia Tech, for contributions in the areas of agroterrorism risk assessment and mitigation; food and agriculture infrastructure protection, biosecurity. |
| 2015 | Nominated, Excellence in Graduate Advising Award, Virginia Tech |
| 2015 | Virginia M. and Edward E. Thompson Award for professionalism, humanitarianism and significant, creative contributions to the advancement of veterinary medicine. |
| 2015 | Nominated, Virginia-Maryland College of Veterinary Medicine, Alumni Lifetime Achievement award. |

## C. Contribution to Science

1. My early work focused on diseases of turkeys, especially the interactions of multiple infectious agents in the production of respiratory colibacillosis. I eventually concentrated on the role of hemorrhagic enteritis virus; a member of the family-*Adenoviridae*, genus-*Siadenovirus*. This is a rather unique virus with a small genome compared to other adenoviruses and it has an unusual coding sequence for a sialidase homolog. We continue to work on this virus (one of two labs worldwide); specifically - pathophysiology, genomics, and vaccinology. In addition to the publications below, three new manuscripts are in process based on the work of a recent PhD student; now post-doc.

    a. Beach, N.M., R.B. Duncan, C.T. Larsen, X.J. Meng, N. Sriranganathan, and **F.W. Pierson**, 2009, Comparison of 12 turkey hemorrhagic enteritis virus isolates allows prediction of genetic factors affecting virulence. J Gen Virol, 90:1978-1985.
    b. Beach, N.M., R.B. Duncan, C.T. Larsen, X.J. Meng, N. Sriranganathan, and **F.W. Pierson**, 2009. Persistent infection of turkeys with an avirulent strain of turkey hemorrhagic enteritis virus. Avian Dis 53:370-375.
    c. Mahsoub, H.M., N. Evans, N, Beach, L. Yuan, K. Zimmerman, and **F.W. Pierson**, 2016. Real-time pcr-based infectivity assay for titration of turkey hemorrhagic enteritis virus, an adenovirus, in live vaccines. J. Virol Meth 239:42-49.

2. I continue to work on other diseases of importance to the poultry industry in a manner consistent with my academic service appointment. In this respect, research flexibility is an important characteristic, both in scholarly pursuit and research support acquisition. Generally this research addresses diagnostics, epidemiology, pathophysiology, and vaccinology.

    a. McQuiston, J.H., L.P. Garber, B.A. Porter-Spalding, J.W. Hahn, **F.W. Pierson**, S.H. Wainwright, D.A. Senne, T.J. Brignole, B.L. Akey, T.J. Holt, 2005. Risk factors for spread of low pathogenicity H7N2 avian influenza virus among commercial poultry farms in Virginia, 2002. J Amer Vet Med Assoc 226:767-772.
    b. Elvinger, F., B. L. Akey, D. A. Senne, **F. W. Pierson**, B. A. Porter-Spalding, E. Spackman, D. L. Suarez. 2007. Characteristics of diagnostic tests used in the 2002 low pathogenicity avian influenza H7N2 outbreak in Virginia. J Vet Diagn Inves 19:341-348.
    c. Walters, J., R. Evans, T. LeRoith, N. Sriranganathan, A. McElroy, and **F. W. Pierson**, 2014. Experimental Comparison of Hemolytic and Non-Hemolytic *Ornithobacterium rhinotracheale* Field Isolates *In Vivo.* Avian Diseases 58:78-82.
    d. Lighty, M.E., F. Elvinger, R.D. Evans, N. Sriranganathan, T. LeRoith, and **F.W. Pierson**, 2016. Incidence of Clostridial Dermatitis (Cellulitis) and Factors for the Development of Disease in Turkeys. J Appl Poult Res 25:104-112.

3. Food safety as it relates to poultry, specifically *Salmonella* detection and bioremediation has been a parallel interest of my lab. We have specifically looked at novel, bacteriophage-mediated methodologies to reduce *Salmonella* load on poultry products as well as early detection methods to facilitate timely diversion of product for reprocessing or repurposing.

    a. Whichard, J.M., N. Sriranganathan, and **F.W. Pierson**, 2002. Bacteriophage Felix O1: Suppression of Salmonella growth by wild-type and large-type plaque isolates in liquid culture and on poultry frankfurters. J. Food Protect 66:220-225.
    b. Whichard, J.M., L.A. Weigt, D.J. Borris, L.L. Li, Q. Zhang, V. Kapur, **F.W. Pierson**, E.J. Linghor, Y. She, A.M. Kropinski, and N. Sriranganathan, 2010. Complete genomic sequence of bacteriophage Felix O1. Viruses 2:710-730.

c. Evans, N.P., R.D. Evans, J. Regalado, J.F. Sullivan, V. Dutta, F. Elvinger and **F.W. Pierson**, 2015. Preharvest *Salmonella* Detection for Evaluation of Fresh Ground Poultry Product Contamination. J Food Prot 78:1266-71.

4. Finally, I have also been part of a research team working on hepatitis E virus, a member of the family-*Hepeviridae*, genus-*Orthohepevirus*. The virus has a broad host range, most notably humans, swine and poultry. Hepatitis E virus can produce anything from subclinical infection to significant mortality in humans (approaching 20% among pregnant women in industrializing / developing countries) as well as fulminant disease in poultry. The latter inspired the development and validation of an avian (chicken) model to study viral replication and pathogenesis with the ultimate goal of advancing treatment and prophylaxis.

   a. Billam, P., F.F. Huang, Z.F. Sun, **F.W. Pierson**, R.B. Duncan, F. Elvinger, D.K. Guenette, T.E. Toth, and X.J. Meng, 2005. Systematic Pathogenesis and Replication of Avian Hepatitis E Virus in Specific-Pathogen-Free Adult Chickens. J Virol 79:3429-3437.
   b. Pudupakam, R.S., Y. W. Huang, T. Opriessing, P.G. Halbur, **F.W. Pierson**, and X.J. Meng, 2009. Deletions of the hypervariable region (HVR) in open reading frame 1 of hepatitis E virus do not abolish virus infectivity: Evidence for attenuation of HVR deletion mutants in vivo. J Virol 83:384-395.
   c. Pudupakam, R.S., S.P. Kenny, L. Cordoba, Y.W. Huang, B. A. Dryman, T. LeRoith, **F.W. Pierson**, and X.J. Meng, 2011. Mutational Analysis of the hypervariable region of hepatitis E virus reveals its involvement in the efficacy of viral RNA replication. J Virol 85:10031-100040.
   d. Kenney S.P., R.S. Pudupakam R, Y.W. Huang, **F.W. Pierson**, T. LeRoith, and X.J. Meng, 2012. The PSAP motif within the ORF3 protein of an avian strain of the hepatitis E virus is not critical for viral infectivity in vivo but plays a role in virus release. J Virol 86:5637-46.

5. My scholarly work includes: 77 authored or co-authored peer-reviewed papers, reviews, book chapters, and manuals, 31 research presentations given at regional / national / international meetings (excluding keynotes and continuing education presentations), and 106 co-authored papers / posters presented at regional / national / international meetings. A list of published work in NCBI cataloged journals (up to Dec 31, 2015) can be found at: **http://www.ncbi.nlm.nih.gov/sites/myncbi/collections/bibliography/49614900/**

**D. Research Support**

**Ongoing Research Support**

NIH R01 AI050611 (competitive) Meng, X.J. (PI) 2013-2018
A Chicken Model to Study Hepatitis E Virus Pathogenesis.
Chickens are one of the few species in which distinct clinical signs and lesions can be produced following experimental hepatitis E virus inoculation. The goal of this project is to better define the pathogenic mechanisms (likely immune mediated) responsible for disease in humans.
Role: Co-I

NIH T35 (competitive) Ahmed, S.A. 2011-2018
Summer Veterinary Research Program.
The purpose of this grant is to provide DVM students with financial support and other structured opportunities that will encourage the selection of alternative career paths in research.
Role: Co-I

Cargill Turkey, LLC and Virginia Poultry Growers Cooperative (solicited) 2015-2017
Control of Hemorrhagic Enteritis in the Shenandoah Valley and Continued Research for Disease Prevention.
The purpose of this project is to support improvements in the control of hemorrhagic enteritis of turkeys (Siadenovirus) and address other diseases of importance to the turkey industry.

Role: Co-PI

Internal Research Fund, Multiple Corporate Donors 2015-2017
Testing the Efficacy of Feed Additives Against Various Gastrointestinal Infections in Turkeys
The purpose of this project is to evaluate various GRAS compounds, botanicals, essential oils for ameliorative effects on gastrointestinal bacterial and protozoal diseases of turkeys.
Role: PI

Egyptian Cultural and Educational Bureau, Channel Program, Arab Republic of Egypt. 2015-2017
Transcriptional Analysis of the Turkey Hemorrhagic Enteritis Virus Genome.
The goal of this project is to develop a transcriptional map of the Siadenovirus genome.
Role: PI

VMCVM – Internal Research Competition Burgess, B. (PI) 2015-2017
Characterization of Prevention Practices and the Occupational Exposure Risk of Veterinary Personnel to Cryptosporidium.
The goal of this study is to determine the risk factors that contribute to human infection with C. parvum and develop practical and effective prevention practices
Role: Co-I

VMCVM – Internal Research Competition Burgess, B. (PI) 2015-2017
Analysis of the Contributions of Pathogenic Resistance Genes to the Equine Veterinary Hospital Environmental Microbiome and the Potential Impact on Equine Health
The purpose of this project is to evaluate various environmental bacterial contaminants in a veterinary teaching hospital and determine commonalities in antimicrobial resistance.
Role: Co-I

**Completed Research Support (selected, last 5 years)**

Cargill Turkey, LLC and Virginia Poultry Growers Cooperative (solicited) 2011-2014
Characterization and Control of Diseases Responsible for Significant Losses to the Commercial Turkey Industry in the Shenandoah Valley.
The goal of this project was to provide veterinary support for the treatment, control and prevention of diseases of economic concern to the turkey industry.
Role: PI

USDA-NRI (competitive) 2009-2014
Integrated Education and Biodegradable Litter Amendment Development to Enhance Adoption of Ammonia Emissions Mitigation Practices in Poultry Houses.
The goal of this research was to evaluate the ability of an agricultural plant-based byproduct to reduce ammonia emissions from poultry house litter.
Role: Co-PI

Land-O-Lakes (solicited) 2015-2016
Investigation of Medium Chain Fatty Acids for Salmonella Reduction in Poultry with the In Vivo Imaging System (IVIS).
The goal of this grant is to determine the effect of dietary medium chain fatty acids on *Salmonella* load and location in gastrointestinal tract of experimentally infected poultry.
Role: Co-PI

Virginia Department of Environmental Quality (solicited) 2016-2017
Systematic Review of 9 VAC 20-120 - Regulated Medical Waste Regulations and Recommended Changes to Ensure Proper Handling of Highly Infectious Materials.
The goal of this project is to review, update and strengthen 9 VAC 20-120 (Virginia Administrative Code) so that VDEQ has the flexibility and operational authority to deal with emerging and / or unforeseen issues related to the management of regulated medical waste in the Commonwealth of Virginia.

## BIOGRAPHICAL SKETCH

Provide the following information for the Senior/key personnel and other significant contributors.
Follow this format for each person. **DO NOT EXCEED FIVE PAGES.**

NAME: Popham, David Lee

eRA COMMONS USER NAME (credential, e.g., agency login): dpopham

POSITION TITLE: Professor of Microbiology

EDUCATION/TRAINING *(Begin with baccalaureate or other initial professional education, such as nursing, include postdoctoral training and residency training if applicable. Add/delete rows as necessary.)*

| INSTITUTION AND LOCATION | DEGREE *(if applicable)* | Completion Date MM/YYYY | FIELD OF STUDY |
|---|---|---|---|
| Washington University, St. Louis, MO | B.A. | 05/1983 | Biology |
| University of California-Davis | Ph.D. | 03/1989 | Microbiology |
| Institut de Biologie Physico-Chimique, Paris, France | Postdoctoral | 09/1991 | Microbiology |
| University of Connecticut Health Center, Farmington, CT | Postdoctoral | 09/1996 | Biochemistry |

### A. Personal Statement

I have a broad background in bacterial physiology and genetics, with specific expertise in bacterial spore structure and resistance properties. As a postdoctoral fellow, first in Paris and then in Connecticut, I completed investigations of genetic factors involved in *Bacillus subtilis* spore formation and of the synthesis and structure of the specialized cortex cell wall of the spore. As a faculty member at Virginia Tech, my laboratory has continued studies of *Bacillus subtilis* cell wall synthesis and has expanded into studies of spores produced by *Bacillus anthracis*, *Clostridium perfringens*, and *Clostridium difficile*. For all of these projects, we have developed and refined methods for the analysis of peptidoglycan structure. My lab is one of few in the USA with the expertise to carry out these peptidoglycan analyses and the only USA lab that carries out analysis of spore peptidoglycan structure.

### B. Positions and Honors

**Positions and Employment**

1982-1983 Researcher, laboratory of Dr. David Apirion, Washington University, St. Louis, MO
1983-1989 Graduate student, laboratory of Dr. Sydney Kustu, University of California-Davis
1989-1991 Postdoctoral fellow, laboratory of Dr. Patrick Stragier, Institut de Biologie Physico-Chimique, Paris, France
1991-1996 Postdoctoral fellow, laboratory of Dr. Peter Setlow, University of Connecticut Health Center, Farmington, CT
1996-2002 Assistant Professor of Microbiology, Virginia Polytechnic Institute and State University
2002-2008 Associate Professor of Microbiology, Virginia Polytechnic Institute and State University
2008-present Professor of Microbiology, Virginia Polytechnic Institute and State University

**Other Professional Experience**

1998-2000 & 2007-2018 Editorial Board of the Journal of Bacteriology
2012-2018 Editorial Board of Applied and Environmental Microbiology
2010-present Editorial Advisory Board for Molecular Microbiology

| | |
|---|---|
| 6/2000 | NIH Bioengineering Research Partnership Study Section |
| 2/2004, 2/2007 | NIH Bacterial Biodefense Study Section |
| 2005-16, 10 meetings | NIH Topics in Bacterial Pathogenesis Study Section |
| 6/2005, 6/2015, 2/2016 | NIH Prokaryotic Cell and Molecular Biology Study Section |

| | |
|---|---|
| 2007 | EPA Federal Insecticide, Fungicide, and Rodenticide Act Scientific Advisory Panel |
| 2009-2011 | National Academies of Science/National Research Council - Committee on Review of the Scientific Approaches used during the FBI's Investigation of the 2001 *Bacillus anthracis* Mailings |
| 2017 | NASA-JPL Mars 2020 Spore to Viable Organisms Program Review Panel |

| | |
|---|---|
| 2004-2006 | Chair-Elect, Chair, & Advisor of ASM Division J, Ultrastructure and Function |

| | |
|---|---|
| 2003-2012 | Chair of Virginia Tech Interdepartmental Microbiology Graduate Program |

**Honors**

| | |
|---|---|
| 1985-1986 | Earle C. Anthony Graduate Fellowship, U.C. Davis |
| 1986-1988 | University Regent's Fellowship, U.C. Davis |
| 1986, 1987 | Jastro-Shields Research Scholarship, U.C. Davis |
| 1989-1990 | NIH-French CNRS Fellowship, Fogarty International Center |
| 1990-1991 | Human Frontiers Science Project Fellowship |
| 1997-1998 | Eli Lilly & Company Infectious Diseases Research Contact Award |
| 2013 | Journal of Bacteriology, Jack Kenney Award for Outstanding Service on the Editorial Board |
| 2016 | Fellow, American Academy of Microbiology |

**C. Contribution to Science**

1. My Ph.D. dissertation work examined the repression and activation of transcription of genes involved in nitrogen incorporation in response to N-availability in Enteric Bacteria. This work clarified the function of one of the first, and a novel, alternative RNA polymerase sigma factor, a novel transcription activator that utilizes enhancer sequences and hydrolyzes ATP, and the first well characterized bacterial 2-component regulatory system. The work has been widely cited in successive generations of studies of two component systems and transcription activation mechanisms.
   a. Popham, D.L., D. Szeto, J. Keener, and S. Kustu (1989) Function of a bacterial activator protein that binds to transcriptional enhancers. Science 243:629-635.
   b. Wedel, A., D.S. Weiss, D. Popham, P. Dröge, and S. Kustu (1990) A bacterial enhancer functions to tether a transcriptional activator near a promoter. Science 248:486-490.
   c. Popham, D.L., J. Keener, and S. Kustu (1991) Purification of the alternative $\sigma$ factor, $\sigma^{54}$, from *Salmonella typhimurium* and characterization of $\sigma^{54}$-holoenzyme. J. Biol. Chem. 266:19510-19518.

2. As a postdoctoral researcher, I entered the field of bacterial spore formation and specialized in the formation of the peptidoglycan cell wall of the *Bacillus subtilis* spore. This work continued for over 10 years in my lab as a faculty member. My publications identified the key proteins involved in spore peptidoglycan assembly, revealed the importance of various peptidoglycan structural modifications in the generation of spore resistance properties, clarified the relationship between spore dehydration and heat resistance within a set of isogenic strains, revealed a process that regulated the timing of spore peptidoglycan synthesis, and revealed the essential nature of one peptidoglycan modification for the eventual germination of the spore. Overall, this body of research provided a set of principles and tools for the study of relationships between aspects of spore structure and spore resistance and germination properties.
   a. Popham, D.L., B. Illades-Aguiar, and P. Setlow. (1995) The *Bacillus subtilis dacB* gene, encoding penicillin-binding protein 5*, is part of a three-gene operon required for proper spore cortex synthesis and spore core dehydration. J. Bacteriol. 177:4721-4729.
   b. Popham, D.L., J. Helin, C.E. Costello, and P. Setlow. (1996) Muramic lactam in peptidoglycan of *Bacillus subtilis* spores is required for spore outgrowth but not for spore dehydration or heat resistance. Proc. Natl. Acad. Sci. USA. 93:15405-15410.

c. McPherson, D. C., A. Driks, and D. L. Popham. (2001) Two class A high-molecular-weight penicillin-binding proteins of *Bacillus subtilis* play redundant roles in sporulation. J. Bacteriol. 183: 6046-6053.
d. Vasudevan, P., A. Weaver, E. D. Reichert, S. D. Linnstaedt, and D. L. Popham. (2007). Spore cortex formation in *Bacillus subtilis* is regulated by accumulation of peptidoglycan precursors under control of sigma K. Molec. Microbiol. 65:1582-1594.

3. My work on peptidoglycan synthesis in *Bacillus subtilis* extended into vegetative cell wall synthesis. Colleagues and I identified and characterized the functions of most of the genes encoding penicillin-binding proteins in this organism. This work reveled the roles of these proteins in cell shape determination and demonstrated the presence of a novel, alternative peptidoglycan synthetic enzyme in this species. Overall, this body of research provided a set of principles and tools for the study of cell wall synthesis in this as well as other Gram-positive species.
   a. McPherson, D. C. and D. L. Popham. (2003) Peptidoglycan synthesis in the absence of class A penicillin-binding proteins in *Bacillus subtilis*. J. Bacteriol. 185:1423-1431.
   b. Wei, Y., T. Havasy, D. C. McPherson, and D. L. Popham. (2003) Rod shape determination by the *Bacillus subtilis* class B penicillin-binding proteins encoded by *pbpA* and *pbpH*. J. Bacteriol. 185:4717-4726.
   c. Vasudevan, P., J. McElligott, C. Attkisson, M. Betteken, and D. L. Popham (2009) Homologues of the *Bacillus subtilis* SpoVB protein are involved in cell wall metabolism. J. Bacteriol. 191:6012-6019.
   d. Tan, I.S., C.A. Weiss, D.L. Popham, K.S. Ramamurthi (2015) A Quality-Control Mechanism Removes Unfit Cells from a Population of Sporulating Bacteria. Dev Cell. 34:682-693.

4. My studies of peptidoglycan synthesis and structure in spores led on to studies of the degradation of this structure during germination. Work in my lab has focused primarily on *Bacillus anthracis*, where we identified the enzymes involved in spore peptidoglycan degradation, determined the substrate specificity and enzymatic activities of these proteins, examined the phenotypic effects of the loss of these enzymes, and are studying the mechanism by which activity is inhibited during spore dormancy and activated during germination. A goal is the efficient triggering of lytic enzyme activity in order to force spore germination and render the spores more sensitive to decontamination methods. We are also working with an industry partner to determine conditions under which a lytic enzyme can be externally applied and trigger the efficient germination and activation of a spore-containing product.
   a. Dowd, M. M., B. Orsburn, and D. L. Popham. (2008). Cortex peptidoglycan lytic activity in germinating *Bacillus anthracis* spores. J. Bacteriol. 190:4541-4548.
   b. Heffron, J., E. A. Lambert, N. Sherry, and D. L. Popham. (2010). Contributions of four cortex lytic enzymes to germination of *Bacillus anthracis* spores. J. Bacteriol. 192: 763-770.
   c. Bernhards, C.B., Y. Chen, H. Toutkoushian, and D.L. Popham (2015) HtrC is involved in proteolysis of YpeB during germination of *Bacillus anthracis* and *Bacillus subtilis* spores. J Bacteriol. 197:326-336.
   d. Blankenship, B.G., J.D. Heffron, and D.L. Popham (2015) Lytic enzyme-assisted germination of *Bacillus anthracis* and *Bacillus subtilis* spores. J Appl Microbiol. 119:521-528.

5. Due to my expertise on peptidoglycan metabolism and the mastery of peptidoglycan structural analysis methods in my lab, I have collaborated with numerous researchers to examine aspects of peptidoglycan synthesis and structure in other species.
   a. Ho, T.D., K.B. Williams, Y. Chen, R.F. Helm, D.L. Popham, and C.D. Ellermeier (2014) *Clostridium difficil*e extracytoplasmic function σ factor σV regulates lysozyme resistance and is necessary for pathogenesis in the hamster model of infection. Infect Immun. 82:2345-2355.
   b. Jorgenson, M.A., Y. Chen, A. Yahashiri, D.L. Popham, and D.S. Weiss (2014) The bacterial septal ring protein RlpA is a lytic transglycosylase that contributes to rod shape and daughter cell separation in *Pseudomonas aeruginosa*. Mol Microbiol. 93:113-128.
   c. Sandoz KM, Popham DL, Beare PA, Sturdevant DE, Hansen B, Nair V, Heinzen RA. (2016) Transcriptional Profiling of *Coxiella burnetii* Reveals Extensive Cell Wall Remodeling in the Small Cell Variant Developmental Form. PLoS One. 11(2):e0149957

Complete List of Published Work in MyBibliography:
https://www.ncbi.nlm.nih.gov/myncbi/browse/collection/40550541/?sort=date&direction=descending

D. Research Support **(last 3 years)**

**Ongoing Research Support**

NSF IOS-1557964 Stabb (PI) 3/1/16-2/28/19
Collaborative Research: Experimental evolution of peptidoglycan in the bacterial symbiont *Vibrio fischeri*
The major goal of this project is to drive evolutionary change of the *V. fischeri* cell wall structure and observe the impact on the formation of a symbiotic association with a squid.
Role: Co-PI

NIH R21AI109111 Popham (PI) 12/1/13-6/30/17
Stabilization and regulation of a *Bacillus anthracis* spore lytic enzyme
The major goal of this project is to determine the role of a spore protein in regulating the activity of a key spore germination lytic enzyme.
Co-PI: Florian Schubot

**Completed Research Support**

Role: PIPilot project grant from NASA to Jet Propulsion Laboratory Venkateswaran (PI) 9/1/15-3/31/17
Germination-Induced Molecular Detection of Spores
The major goal of this project is to determine conditions that cause spore germination and improved spore detection in monitoring clean-room spacecraft assembly facilities.
Role: Subcontract to Popham, Co-PI

Research Agreement with Novozymes Biologicals, Inc Popham (PI) 6/1/14-5/30/16
Enzyme-Facilitated Spore Germination
The major goal of this project is to determine conditions under which an externally-applied spore lytic enzyme can drive improved germination of spores contained in biological industrial products.
Role: PI

## BIOGRAPHICAL SKETCH

Provide the following information for the Senior/key personnel and other significant contributors.
Follow this format for each person. **DO NOT EXCEED FIVE PAGES.**

NAME: Schmale III, David Garner Burton

eRA COMMONS USER NAME (credential, e.g., agency login):

POSITION TITLE: Professor

EDUCATION/TRAINING *(Begin with baccalaureate or other initial professional education, such as nursing, include postdoctoral training and residency training if applicable. Add/delete rows as necessary.)*

| INSTITUTION AND LOCATION | DEGREE *(if applicable)* | Completion Date MM/YYYY | FIELD OF STUDY |
|---|---|---|---|
| University of California, Davis | B.S. | 04/2001 | Biological Sciences |
| Cornell University | Ph.D. | 01/2006 | Plant Pathology |

### A. Personal Statement

One of the goals of my research program is to understand how microorganisms are transported over long distances in the atmosphere. To do this, I have developed technologies with drones (unmanned aerial vehicles or UAVs) to peer into the life of microorganisms flying tens to hundreds of meters above the surface of the earth. These drones are equipped with unique sampling devices to collect and analyze microorganisms during flight. We were the first to document the transport of microorganisms along unique atmospheric features known as Lagrangian coherent structures (LCSs)—dynamic boundaries between air masses that shape atmospheric transport over long distances. We showed that a unique strain of a fungus collected with drones likely moved into the state of Virginia via LCSs. We applied the language of LCSs to the transport of fungi in the genus *Fusarium*—one of the most important groups of pathogenic fungi in the world. This work was recognized by *Popular Science* Magazine (I was named one of the Brilliant Ten in 2013), *Scientific American* (an invited feature article in early 2017), and TedX Virginia Tech.

### B. Positions and Honors

**Positions and Employment**

2001-2005, Graduate Research Assistant, Cornell University, Dept of Plant Pathology, Ithaca, NY
2006-2011, Assistant Professor, Dept of Plant Path, Phys, & Weed Sci, Virginia Tech, Blacksburg, VA
2011-2016, Associate Professor, Dept of Plant Path, Phys, & Weed Sci, Virginia Tech, Blacksburg, VA
2016-Present, Professor, Dept of Plant Path, Phys, & Weed Sci, Virginia Tech, Blacksburg, VA

**Other Experience and Professional Memberships**

2006-2008 Elected Chair, Committee on Academic Programs & Policies, Virginia Tech
2007-2010 Elected Secretary-Treasurer/ Vice-President/ President, APS Potomac Div.
2010-2013 Associate Editor, Plant Disease
2012-2015 Chair, Pathogen Genetics and Biology RAC, USDA-USWBSI
2012-2014 Elected Divisional Councilor, American Phytopathological Society
2013-2015 Chair, Academy of Teaching Excellence, Virginia Tech
2014-Present Director, Biological Transport (BIOTRANS Graduate Program, Virginia Tech

**Honors**

2010 Favorite Faculty Award, Office of Residence Life at Virginia Tech
2010 Member, Virginia Tech Academy of Teaching Excellence
2010 Sporn Award, Virginia Tech Undergraduate Teaching Excellence
2013 Recipient of the *Popular Science* 2013 Brilliant Ten Award

2013 TEDx Virginia Tech Speaker, “Drone-ing for life in the atmosphere”

**C. Contributions to Science**

1. We developed the first autonomous (self-controlling) drone to sample plant pathogens in the atmosphere hundreds of meters above crop fields. This work has changed the technological landscape for crop biosecurity; new technologies with drones are now available to detect and track the movement of pathogens in the atmosphere, and transport models validated with field experiments can now be used to predict the risk of disease spread between neighboring fields.

a) Schmale, D. G., Dingus, B. R., and Reinholtz, C. F. 2008. Development and application of an autonomous unmanned aerial vehicle for precise aerobiological sampling above agricultural fields. Journal of Field Robotics 25:133-147.
b) Techy, L., Schmale, D. G., and Woolsey, C. A. 2010. Coordinated aerobiological sampling of a plant pathogen in the lower atmosphere using two autonomous unmanned aerial vehicles. Journal of Field Robotics 27:335-343.

2. We were the first to document the transport of microorganisms along unique atmospheric features known as Lagrangian coherent structures (LCSs)—dynamic boundaries between air masses that shape atmospheric transport over long distances. We showed that a unique strain of a fungus collected with drones likely moved into the state of Virginia via LCSs. We applied the language of LCSs to the transport of fungi in the genus *Fusarium*, and LCSs are now considered to be an important mechanism by which microorganisms can invade new territories.

a) Tallapragada, P., Ross, S.D., and Schmale, D.G. 2011. Lagrangian coherent structures are associated with fluctuations in airborne microbial populations. Chaos 21:033122-033122-16.
b) Schmale, D. G., Ross, S.D., Fetters, T.L., Tallapragada, P., Wood-Jones*, A.K., and Dingus*, B. 2012. Isolates of *Fusarium graminearum* collected 40-320 meters above ground level cause Fusarium head blight in wheat and produce trichothecene mycotoxins. Aerobiologia 28:1-11.
c) Schmale, D.G., and Ross, S.D. 2015. Highways in the sky: Scales of atmospheric transport of plant pathogens. Annual Review of Phytopathology, 53: 591-61.

3. Another goal of my research program is to develop strategies to detect, monitor, and control mycotoxins. We have also quantified mycotoxins in a nutrient-rich co-product of fuel ethanol production (dried distiller’s grains with solubles, or DDGS) that is a significant food source for domestic animals.

a) Khatibi, P.A., Berger, G., Liu, S., Brooks, W.S., Griffey, C.A., and Schmale, D.G. 2012. Resistance to Fusarium head blight and deoxynivalenol accumulation in Virginia barley. Plant Disease 96:279-284.
b) Khatibi*, P.A., McMaster*, N., Musser, R., and Schmale, D.G. 2014. Survey of Mycotoxins in Corn Distillers' Dried Grains with Solubles from Seventy-Eight Ethanol Plants in Twelve States in the U.S. in 2011. Toxins 6(4): 1155-1168.

**D. Additional Information: Research Support**

**Ongoing Research Support**

Tokekar, P., and Schmale, D.G. $900,835. NSF. NRI: Coordinated Detection and Tracking of Hazardous Agents with Aerial and Aquatic Robots to Inform Emergency Responders. 10/2016-9/2019. Co-Principal investigator, ~50% of funding. *The goal of this project is to coordinate unmanned robots in the air and water to assist in the identification of hazardous agents in water.*

Peacock, T., Shadden, S., Rypina, I., Lermusiaux, P., Ross, S, Schmale, D., Woolsey, C., Kirincich, A., and Gawarkiewicz, G. $2,677,195. NSF. HAZARDS SEES: Uncovering the hidden skeleton of environmental flows: advanced Lagrangian methods for hazard prediction, mitigation, and response. 9/2015-8/2019. Co-PI; ~5% of funding. *The goal of this project is to use unmanned robots in the air and water to develop, test, and validate models to track hazardous agents in marine environments.*

Schmale, D.G. $80,027. USDA-USWBSI. Diagnostic testing services for deoxynivalenol in the eastern U.S. 05/2015 to 04/2016. Principal investigator. *The goal of this project is to provide mycotoxin testing services.*

Christner, B., Vinatzer, B., Schmale, D.G., Weber, C., Morris, C., and Sands, D. $1,997,876. NSF. Research on Airborne Ice-Nucleating Species (RAINS). 1/1/13 to 12/31/16. Co-Principal investigator. *The goal of this project is to examine the diversity of ice-nucleating microbes in precipitation.*

## BIOGRAPHICAL SKETCH

Provide the following information for the Senior/key personnel and other significant contributors.
Follow this format for each person. **DO NOT EXCEED FIVE PAGES.**

NAME: Senger, Ryan Stephen

eRA COMMONS USER NAME (credential, e.g., agency login): SENGER01

POSITION TITLE: Associate Professor

EDUCATION/TRAINING *(Begin with baccalaureate or other initial professional education, such as nursing, include postdoctoral training and residency training if applicable. Add/delete rows as necessary.)*

| INSTITUTION AND LOCATION | DEGREE *(if applicable)* | Completion Date MM/YYYY | FIELD OF STUDY |
|---|---|---|---|
| Millikin University, Decatur, IL | BS | 05/1999 | Chemistry |
| Colorado State University, Fort Collins, CO | MS | 12/2002 | Chemical Engineering |
| Colorado State University, Fort Collins, CO | PhD | 05/2005 | Chemical Engineering |
| Texas Tech University, Lubbock, TX | Postdoctoral Researcher | 02/2006 | Chemical Engineering |
| Northwestern University, Evanston, IL | Postdoctoral Researcher | 05/2007 | Chemical and Biological Engineering |
| University of Delaware, Newark, DE | NIH NRSA Postdoctoral Fellow | 12/2008 | Chemical Engineering |

### A. PERSONAL STATEMENT

I have received training in chemistry as well as chemical and biological engineering, and I perform experimental and computational research in the areas of (i) metabolic engineering, (ii) systems biology, (iii) synthetic biology, and (iv) real-time physiological monitoring. My research group uses novel techniques in genome-scale metabolic flux modeling to derive metabolic engineering strategies for production of valuable chemicals, therapeutics, and biofuels by microbes and plants. We also develop novel techniques involving surface-enhanced Raman scattering (SERS) to (i) monitor physiological changes of cells, tissues, and organs in real-time and (ii) determine the chemical composition of sub-cellular locations and organelles.

### B. POSITIONS AND HONORS

**Positions and Employment**

2016- Associate Professor, Department of Chemical Engineering, Virginia Tech, Blacksburg, VA
2015- Associate Professor, Department of Biological Systems Engineering, Virginia Tech, Blacksburg, VA
2014- Chief Technology Officer, DialySensors LLC, Floyd, VA
2009-2015 Assistant Professor, Department of Biological Systems Engineering, Virginia Tech, Blacksburg, VA

**Honors**

2009 The Gaden Award (with Eleftherios T. Papoutsakis), Metabolic engineering paper award presented by *Biotechnology & Bioengineering*
2012 Outstanding New Faculty Award, College of Engineering at Virginia Tech

2013 Outstanding Faculty Member Award, Department of Biological Systems Engineering Alpha Epsilon Honor Society
2016 Outstanding Faculty Member Award, Department of Biological Systems Engineering Alpha Epsilon Honor Society

**C. CONTRIBUTIONS TO SCIENCE**

I have made contributions in the following areas: (i) systems biology for metabolic engineering; (ii) real-time physiological monitoring of cells, tissues, and organs using Raman spectroscopy; (iii) biological discovery in clostridia; (iv) mathematical modeling of biological processes; and (v) discovery and predictions of protein glycosylation. Relevant publications are given below for each area. (*) Denotes a student in my lab.

1. Systems biology for metabolic engineering: I have contributed new "genome-scale" metabolic flux models of non-pathogen clostridia and have developed several new tools that are used to resolve metabolic activity and predict metabolic engineering targets.

(1) Nazem-Bokaee*, H., Senger, R.S. (2015) ToMI-FBA: A genome-scale metabolic flux based algorithm to select optimum hosts and media formulations for expressing pathways of interest. *AIMS Bioengineering*. 2(4):355-73. doi:10.3934/bioeng.2015.4.335.
(2) Ebrahim, A., Almass, E., Bauer, E., Bordbar, A., Burgard, A.P., Chang, R.L., Drager, A., Famili, I., Feist, A.M., Fleming, R.M.T., Fong, S.S., Hatzimanikatis, V., Herrgard, M.J., Holder, A., Hucka, M., Hyduke, D., Jamshidi, N., Lee, S.Y., Le Novere, N., Lerman, J.A., Lewis, N.E., Ma, D., Mahadevan, R., Maranas, C. Nagarajan, H., Navid, A., Nielsen, J., Nielsen, L.K., Nogales, J., Noronha, A., Pal, C., Palsson, B.O., Papin, J.A., Patil, K.R., Price, N.D., Reed, J.L., Saunders, M., Senger, R.S., Sonnenschein, N., Sun, Y., Thiele, I. (2015) Do genome-scale models need exact solvers or clearer standards? *Molecular Systems Biology.* 11(10):831. doi:10.15252/msb.20156157.
(3) Yen*, J.Y., Tanniche*, I., Fisher*, A.K., Bevan, D.R., Gillaspy, G.E., Senger, R.S. (2014) Designing metabolic engineering strategies with genome-scale metabolic flux modeling. *Advances in Genomics and Genetics*. 5:93-105. doi:10.2147/AGG.S58494.
(4) Fisher*, A.K., Freedman*, B.G., Bevan, D.R., Senger, R.S. (2014) A review of metabolic and enzymatic engineering strategies for designing and optimizing performance of microbial cell factories. *Computational and Structural Biotechnology Journal*. 11, 91-9. doi:10.1016j/j.csbj.2014.08.010.
(5) Senger, R.S., Yen*, J.Y., Fong, S.S. (2014) A review of genome-scale metabolic flux modeling of anaerobiosis in biotechnology. *Current Opinion in Chemical Engineering*. 6, 33-42. doi:10.1016/j.coche.2014.08003.
(6) Yen*, J.Y., Nazem-Bokaee*, H., Freedman*, B.G., Athamneh*, A.I., Senger, R.S. (2013) Deriving metabolic engineering strategies from genome-scale modeling with flux ratio constraints. *Biotechnology Journal*. 8, 581-594. doi:10.1002/biot.201200234.

2. Real-time monitoring of cells, tissues, and organs using Raman spectroscopy: My lab has developed new multivariate statistical techniques to deconvolute Raman spectra and have used this to characterize the responses of bacterial cells to multiple classes of antibiotics and 1-butanol exposure. This technique also characterized the changes in livers undergoing *ex vivo* perfusion. Finally, we are using a new technique of peptide-guided surface enhanced Raman scattering (pg-SERS) to probe intracellular compartmentalized chemical compositions.

(1) Olson, M.L., Johnson, J., Carswell*, W.F., Reyes, L.H., Senger, R.S., Kao, K.C. (2016) Characterization of an evolved carotenoids hyper-producer of *Saccharomyces cerevisiae* through bioreactor parameter optimization and Raman spectroscopy. *Journal of Industrial Microbiology & Biotechnology.* 43(10):1355-1363. Doi:10.1007/s10295-016-1808-9.
(2) Freedman*, B.G., Zu*, T.N.K., Athamneh*, A.I.M., Wallace*, R.S., Senger, R.S. (2016) Raman spectroscopy detects phenotypic differences among *E. coli* enriched for 1-butanol tolerance using a metagenomic DNA library. *Biotechnology Journal.* 11(7):877-889. doi:10.1002/biot.201500144.
(3) Zu*, T.N.K., Athamneh*, A.I.M., Senger, R.S. (2016) Characterizing the phenotypic responses of *Escherichia coli* to multiple 4-carbon alcohols with Raman spectroscopy. *Fermentation.* 2(1):3. doi:10.3390/fermentation2010003.

(4) Zu*, T.N.K., Athamneh*, A.I.M., Collakova, E., Robertson, J., Hawken, T., Aardema, C., Senger, R.S. (2015) Assessment of ex vivo perfused liver health by Raman spectroscopy. *Journal of Raman Spectroscopy*. 46:551-8. doi:10.1002/jrs.4688
(5) Zu*, T.N.K., Athamneh*, A.I.M., Collakova, E., Senger, R.S. (2014) Near real-time analysis of the phenotypic responses of *Escherichia coli* to 1-butanol exposure using Raman spectroscopy. *Journal of Bacteriology*. 196, 3983-3931. doi:10.1128/JB.01590-14.
(6) Athamneh*, A.I., Alajlouni, R.A., Seleem, M.N., Senger, R.S. (2014) Identifying the phenotypic response of bacteria to antibiotic treatment using Raman spectroscopy. *Antimicrobial Agents and Chemotherapy*. 58, 1302-14. doi:10.1128/AAC.02098-13.

3. Biological discovery in clostridia: I helped design DNA microarrays for *Clostridium acetobutylicum* ATCC 824 and used these to elucidate the sigma factor driven sporulation network in a large time-course study. My lab has also collaborated to further characterize magnesium transport in this organism.

(1) Shin, J.H., Wakeman, C.A., Rodionov, D.A., Goodson, J.R., Freedman*, B.G., Senger, R.S., Winkler, W.C. (2014) Transport of magnesium by a bacterial NRAMP. *PLoS Genetics*. 10, e1004429. doi:10.1371/journal.pgen.1004429.
(2) Jones, S.W., Paredes, C.J., Tracy, B., Cheng, N., Sillers, R., Senger, R.S., Papoutsakis, E.T. (2008) The transcriptional program underlying the physiology of clostridial sporulation. *Genome Biology*. 9, R114. doi:10.1186/gb-2008-9-7-r114.
(3) Paredes, C.J., Senger, R.S., Spath, I.S., Borden, J.R., Sillers, R., Papoutsakis, E.T. (2007) A general framework for designing and validating oligomer-based DNA microarrays and its application to *Clostridium acetobutylicum*. *Applied and Environmental Microbiology*. 73, 4631-8.
(4) Paredes, C.J., Jones, S.W., Senger, R.S., Borden, J.R., Sillers, R., Papoutsakis, E.T. (2008) Molecular aspects of butanol fermentation, in *Bioenergy: Microbial contributions to alternative fuels* (Wall, J.D., Harwood, C.S., Demain, S., Eds.), American Society for Microbiology Press.

4. Mathematical modeling of biological processes: My lab has used combinations of cellular automata and global sensitivity analysis to optimize cell-free enzymatic pathways, design novel cellulose systems, and discover gene regulatory mechanisms. I have also contributed new tools in DNA microarray analysis to identify cell culture phenotype shifts and genetic algorithms to study signaling pathway synergies.

(1) Rollin, J.A., Martin del Campo, J., Myung, S., Sun, F., Bakovic, A.E., Castro, R.L., Candrayan, S., Adams, M.W.W., Senger, R.S., Zhang, Y.H.P. (2015) High-yield enzymatic hydrogen production from biomass by in vitro metabolic engineering. *Proceedings of the National Academy of Sciences USA*. 112(16):4964-9. doi:10.1073/pnas.1417719112.
(2) Apte*, A.A., Senger, R.S., Fong, S.S. (2014) Designing novel cellulase systems through agent-based modeling and global sensitivity analysis. *Bioengineered*. 5, 436-446. doi:10.4161/bioe.29160.
(3) Ogejo, J.A., Senger, R.S., Zhang, R. (2010) Global sensitivity analysis for a process based model for ammonia emissions from manure storage and treatment structures. *Atmospheric Environment*. 44, 3621-3629. doi:10.1016/j.atmosenv.2010.06.053.
(4) Wang, M., Senger, R.S., Paredes, C.J., Banik, G.G., Lin, A., Papoutsakis, E.T. (2009) Microarray-based gene expression analysis as a process characterization tool to help establish comparability of complex biological products: the scale-up of a whole-cell immunotherapy product. *Biotechnology and Bioengineering*. 104, 796-808. doi:10.1002/bit.22441.

5. Discovery and predictions of protein glycosylation: I discovered how CHO cells respond to shear stress by altering recombinant product glycosylation. I have also developed models that predict (i) the presence of variable site-occupancy of N-linked glycosylation given an amino acid sequence input and (ii) glycan branching characteristics given an amino acid sequence and secondary structure inputs.

(1) Senger, R.S., Karim, M.N. (2007) Optimization of fed-batch parameters and harvest time of CHO cell cultures for a glycosylated product with multiple mechanisms of inactivation. *Biotechnology and Bioengineering*. 98, 378-90.
(2) Senger, R.S., Karim, M.N. (2005) Variable site-occupancy classification of N-linked glycosylation using artificial neural networks. *Biotechnology Progress*. 21, 1653-62.

(3) Senger, R.S., Karim, M.N. (2003) Neural-network-based identification of tissue-type plasminogen activator protein production and glycosylation in CHO cell culture under shear environment. *Biotechnology Progress*. 19, 1828-36.
(4) Senger, R.S., Karim, M.N. (2003) Effect of shear stress on intrinsic CHO culture state and glycosylation of recombinant tissue-type plasminogen activator protein. *Biotechnology Progress*. 19, 1199-209.

**D. RESEARCH SUPPORT**

**Ongoing Research Support (March, 2017)**

**1. 2013/10/01-2017/09/30**
NSF1254242; National Science Foundation; Senger, Ryan S. (PI); Bevan David (Co-PI)
Production of the building block 2-pyrrolidone using a model-guided platform for *de novo* biosynthetic pathway integration
Total award: $275353

**2. 2013/03/01-2017/12/31**
NSF1243988; National Science Foundation; Senger, Ryan S. (PI), Collakova, Eva (Co-PI)
Enabling phenotype predictions of cyanobacteria" NSF MCB Networks and Regulation Program
Total award: $621,182

**3. 2016/06/01-2017/04/01**
USDA-USWBSI; Schmale, David (PI); Senger, Ryan S. (Co-PI)
Enzymatic detoxification of deoxynivalenol
Total award: $39,908

**4. 2016/09/01-2017/08/31**
Industrially funded project; Kuhn, David (PI); Senger, Ryan S. (Co-PI); Stevens, Ann (Co-PI)
Microbial protein substitution for fishmeal in aquaculture diets: Phase II+: Bacterial strain characterization, application, and validation
Total award: $126,662

**5. 2016/07/01-2017/06/30**
NSF1637780; National Science Foundation; Barone, Justin (PI); Senger, Ryan S. (Co-PI)
Multi-scale metabolic modeling and engineering workshop
Total award: $25,000

## BIOGRAPHICAL SKETCH

Provide the following information for the Senior/key personnel and other significant contributors.
Follow this format for each person. **DO NOT EXCEED FIVE PAGES.**

NAME: Ann M. Stevens

eRA COMMONS USER NAME (credential, e.g., agency login): ANNSTEVENS

POSITION TITLE: Professor

EDUCATION/TRAINING *(Begin with baccalaureate or other initial professional education, such as nursing, include postdoctoral training and residency training if applicable. Add/delete rows as necessary.)*

| INSTITUTION AND LOCATION | DEGREE *(if applicable)* | Completion Date MM/YYYY | FIELD OF STUDY |
|---|---|---|---|
| Iowa State University, Ames, IA | B.S. | 05/1987 | Microbiology |
| University of Illinois at Urbana-Champaign, IL | M.S. | 08/1989 | Microbiology |
| University of Illinois at Urbana-Champaign, IL | Ph.D. | 01/1993 | Microbiology |
| University of Iowa, Iowa City, IA | Postdoc | 12/1996 | Microbiology |

### A. Personal Statement

I have a broad background working in bacterial physiology and genetics with specific expertise in bacterial cell-cell communication that is relevant to the proposed work. Understanding how bacteria use information from the environment to change their networks of gene regulation affords the opportunity to identify ways to modify the bacterial responses so that beneficial activities might be enhanced and undesired ones eliminated. As a postdoctoral research associate, I began my studies of quorum sensing in Vibrios and my interest in that area of research continues to the present. Initially my laboratory at Virginia Tech worked primarily on studying aspects of quorum sensing in the bioluminescent symbiotic bacterium *Vibrio fischeri* with a particular focus on understanding the structure and function of a quorum-sensing transcription factor. This work expanded into an analysis of the quorum-sensing system of the phytopathogen *Pantoea stewartii* and how it relates to plant disease; this work is on-going. In addition, more recently and directly relevant to this project, we have initiated work on the quorum-sensing system and pathogenesis of the BSL-2 foodborne pathogen *Vibrio parahaemolyticus*. Thus, I will be able to apply my knowledge of bacterial gene regulation and experience working with bacteria that form symbiotic or pathogenic relationships with eukaryotic hosts to the proposed research plan.

### B. Positions and Honors

**Positions and Employment**

| | |
|---|---|
| 1983-1987 | Work Study Laboratory Technician, Dept. of Microbiology, Iowa State University |
| 1985 | Roswell Park Memorial Inst. Summer Research Participant, Buffalo, NY |
| 1986, 1987 | Summer Research Technician, Microbial Genetics Division Pioneer HiBred, Johnston, IA |
| 1987 | Undergraduate Research Project, Microbiology, Iowa State University |
| 1987-1992 | Graduate Research/Teaching Assistant, Microbiology, University of Illinois at Urbana |
| 1992-1996 | Postdoctoral Research Associate, Microbiology, University of Iowa |
| 1997-2004 | Assistant Professor, Biology (now Biological Sciences), Virginia Tech |
| 2004-2010 | Associate Professor, Biological Sciences, Virginia Tech |
| 2010-present | Professor, Biological Sciences, Virginia Tech |

**Other Professional Experience**

| | |
|---|---|
| 2010-2014 | NSF Grant Review Panels (3) |
| 2014-2019 | Editorial Board of Applied and Environmental Microbiology |

**Honors**

| | |
|---|---|
| 1983-1987 | Phi Beta Kappa, Phi Kappa Phi and Dean's List, Iowa State University |
| 1987-1991 | NIH Predoctoral Trainee in Cell & Molecular Biology, Monsanto Fellowship, Excellent Instructor Ranking and DeBoer Fellowship, University of Illinois |
| 1994-1996 | NIH Postdoctoral Trainee in Infectious Diseases, University of Iowa |
| 1999-2004 | NSF CAREER Award Recipient, Virginia Tech |
| 2002-2017 | Dept. of Biological Sciences Teaching (4) and Advising (2) Awards, Virginia Tech |
| 2004, 2007 | College of Science (COS) Certificate of Teaching Excellence, Virginia Tech |
| 2009 | Univ. Alumni Award for Excellence in Teaching, Member Academy Teaching Excellence |
| 2009 | Advisor of the Year, Univ. Student Leadership Award from Dept. of Student Activities |
| 2010 | Most Influential Professor, 2010 senior class Biological Sciences |
| 2013 | COS Outreach Excellence Award, with others |
| 2014 | Virginia Tech Academy of Faculty Service |
| 2017 | Scholarship of Teaching and Learning Award & COS Outstanding Graduate Mentor Award |

**C. Contribution to Science**

**1.** As a graduate student, working in the laboratory of Abigail A. Salyers, I discovered and studied the role of a two-component regulatory system that controls the transfer of conjugative transposons in *Bacteroides* in response to subclinical doses of the antibiotic tetracycline. *Bacteroides* are present at a high concentration in the human colonic microbiome. This work contributed to a broader appreciation that low doses of antibiotics can lead to the dissemination of antibiotic resistance determinants via horizontal gene transfer.

**Stevens, A. M.**, N. B. Shoemaker, and A. A. Salyers. 1990. The region of a *Bacteroides* conjugal chromosomal tetracycline resistance element which is responsible for production of plasmidlike forms from unlinked chromosomal DNA might also be involved in transfer of the element. J. Bacteriol. 172:4271-4279.

**Stevens, A. M.**, J. M. Sanders, N. B. Shoemaker, and A. A. Salyers. 1992. Genes involved in production of plasmidlike forms by a *Bacteroides* conjugal chromosomal element share amino acid homology with two-component regulatory systems. J. Bacteriol. 174:2935-2942.

**Stevens, A. M.**, N. B. Shoemaker, L.-Y. Li, and A. A. Salyers. 1993. Tetracycline regulation of genes on *Bacteroides* conjugative transposons. J. Bacteriol. 175:6134-6141.

Salyers, A. A., N. B. Shoemaker, **A. M. Stevens**, and L.-Y. Li. 1995. Conjugative transposons: An unusual and diverse set of integrated gene transfer elements. Microbiol. Rev. 59:579-590.

**2.** As a postdoctoral research associate, working in the laboratory of E. Peter Greenberg, I was the first person to demonstrate the capacity of the quorum-sensing regulatory protein LuxR to bind DNA. Additional studies helped to further define its interactions with RNA polymerase. LuxR is the master quorum-sensing regulator in *Vibrio fischeri*, a bioluminescent marine bacterium that is a symbiont of fish and squid. The studies of LuxR have served as a model for subsequent analysis of other members of the LuxR protein family important for quorum sensing. Work done in collaboration with Bonnie Bassler demonstrated for the first time that quorum sensing between different bacterial species was possible.

**Stevens, A. M.**, K. M. Dolan, and E. P. Greenberg. 1994. Synergistic binding of the *Vibrio fischeri* LuxR transcriptional activator domain and RNA polymerase to the *lux* promoter region. Proc. Natl. Acad. Sci. USA 91:12619-12623.

**Stevens, A. M.** and E. P. Greenberg. 1997. Quorum sensing in *Vibrio fischeri*: Essential elements for activation of the luminescence genes. J. Bacteriol. 179:557-562.

Bassler, B. L., E. P. Greenberg and **A. M. Stevens**. 1997. Cross-species induction of luminescence in the quorum sensing bacterium *Vibrio harveyi*. J. Bacteriol. 179:4043-4045.

**Stevens, A. M.**, N. Fujita, A. Ishihama and E. P. Greenberg. 1999. Involvement of the RNA polymerase $\alpha$ subunit C-terminal domain in LuxR-dependent activation of the *Vibrio fischeri* luminescence genes. J. Bacteriol. 181:4704-4707.

**3.** As an assistant professor at Virginia Tech, a NSF-CAREER award permitted me to continue an in-depth analysis of the interactions of LuxR from *V. fischeri* with RNA polymerase. I was a member of the team that sequenced and annotated the first genome of *V. fischeri.* In collaboration with Andre Levchenko, with support from a NIH R01, we developed a microfluidics chemostat system to study quorum-sensing in *V. fischeri* and applied mathematical modeling to reveal additional levels of regulatory control.

Finney, A. H., R. J. Blick, K. Murakami, A. Ishihama and **A. M. Stevens**. 2002. Role of the C-terminal domain of the alpha subunit of RNA polymerase in LuxR-dependent transcriptional activation of the *lux* operon during quorum sensing. J. Bacteriol. 184:4520-4528 (plus cover image).

Ruby, E. G., M. Urbanowski, J. Campbell, A. Dunn, M. Faini, R. P. Gunsalus, P. Lostroh, C. Lupp, J. McCann, D. Millikan, A. Schaefer, E. Stabb, **A. Stevens**, K. Visick, C. Whistler, and E. P. Greenberg. 2005. Complete genome sequence of *Vibrio fischeri*: A symbiotic bacterium with pathogenic congeners. Proc. Natl. Acad. Sci. USA 102:3004-3009.

Groisman, A., C. Lobo, H. Cho, K. Campbell, Y. S. Dufour, **A. M. Stevens** and A. Levchenko. 2005. A microfluidic chemostat for experiments with bacteria and yeast cells. Nature Methods 2:685-689.

Williams, J. W., X. Cui, A. Levchenko and **A. M. Stevens.** 2008**.** Quantitative analysis reveals robust and sensitive control of a quorum sensing circuit by two interlocked feedback loops. Mol. Syst. Biol. 4:234.

**4.** A second NSF grant enabled my research group at Virginia Tech to study the quorum-sensing regulator EsaR and its regulon in the phytopathogen *Pantoea stewartii*, the causative agent of Stewart's wilt disease in corn. EsaR serves as a model for a subfamily in the LuxR protein family whose members are functional in the absence of the acyl-homoserine lactone signal. Recent work has focused on defining the regulon controlled by EsaR and its relationship to virulence; our group was one of the first on the Virginia Tech campus to develop and use RNA-Seq technologies in a bacterial system.

Ramachandran, R. and **A. M. Stevens**. 2013. Proteomic analysis of the quorum-sensing regulon in *Pantoea stewartii* and identification of direct targets of EsaR. Appl Environ. Microbiol. 79:6244-6252. (Article of Significant Interest selected by the editors)

Ramachandran, R., A. Kernell Burke, G. Cormier, R. V. Jensen and **A. M. Stevens**. 2014. Transcriptome-based analysis of the *Pantoea stewartii* quorum-sensing regulon and identification of EsaR direct targets. Appl. Environ. Microbiol. 80:5790-5800.

Kernell Burke, A., D. A. Duong, R. V. Jensen and **A. M. Stevens.** 2015. Analyzing the transcriptomes of two quorum-sensing controlled transcription factors, RcsA and LrhA, important for *Pantoea stewartii* virulence. PLoS ONE: 10(12):e0145358.

Packard, H., A. Kernell Burke, R. V. Jensen and **A. M. Stevens.** 2017. Analysis of the *in planta* transcriptome expressed by the corn pathogen *Pantoea stewartii* subsp. *Stewartii* via RNA-Seq. PeerJ. Apr 27;5:e3237. doi: 10.7717/peerj.3237. eCollection 2017.

**5.** In recent years, my research group, together with collaborator Roderick Jensen, has worked to sequence and annotate the complete genome of *Vibrio parahaemolyticus* BB22 and defined the regulon controlled by the master quorum sensing regulator OpaR using Next-Gen sequencing technologies. A sabbatical experience lead to the development work with collaborators David Kuhn and Stephen Smith to develop probiotics to fight BSL-2 pathogenic vibrios, including *V. parahaemolyticus,* in aquaculture systems. These projects are all directly relevant to the work in this grant proposal.

Jensen, R. V., S. M. DePasquale, E. A. Harbolick, T. Hong, A. L. Kernell, D. H. Kruchko, T. Modise, C. E. Smith, L. L. McCarter and **A. M. Stevens**. 2013. Complete genome sequence of prepandemic *Vibrio parahaemolyticus* BB22OP. Genome Announc. 1: Epub 2013 Feb 21

Kernell Burke, A., L. T. C. Guthrie, T. Modise, G. Cormier, R. V. Jensen, L. L. McCarter and **Ann M. Stevens**. 2015. OpaR controls a network of downstream transcription factors in *Vibrio parahaemolyticus* BB22OP. PLoS ONE: 10(4):e0121863

Choi M., A. M. Stevens, S. A. Smith, D. P. Taylor, D. D. Kuhn. 2016. Strain and dose infectivity of *Vibrio parahaemolyticus*: the causative agent of Early Mortality Syndrome in shrimp. Aquaculture Research September 24:1-9. Doi:10.1111/are.13197.

Williams, S. L., R. V. Jensen, D. D. Kuhn, and **A. M. Stevens**. 2017. Analyzing the metabolic capabilities of a *Vibrio parahaemolyticus* strain that causes Early Mortality Syndrome in shrimp. Aquaculture. In press.

URL for "My Bibliography" list of published work
https://www.ncbi.nlm.nih.gov/sites/myncbi/ann.stevens.1/bibliography/48660149/public/?sort=date&direction=ascending

**D. Research Support**

**Ongoing Research Support**

**Title:** Microbial protein substitution for fishmeal in aquaculture diets: Phase I and II
**Sponsor:** Private Industry
**Duration:** 07/01/15-08/31/17
**Goal:** Implement novel biotechnology unit processes to convert an organic byproduct of ethanol production into value-added microbial proteins that can be used in aquaculture diets.
**Role:** Co-PI

**Title:** Microbial-driven enhancements and modes of action for tilapia, salmonids, and marine shrimp: Improved nutrition and health
**Sponsor:** Private Industry
**Duration:** 08/01/15-06/30/17
**Goal:** Implement novel biotechnologies to improve finfish and shrimp ability to utilize nutrients and health.
**Role:** Co-PI

**Recently Completed External Research Support**

**Title:** Novel aspects of quorum-sensing signal transduction in *Pantoea stewartii*
**Sponsor:** NSF
**Duration:** 08/01/09-07/31/14
**Goal:** Analyze the quorum-sensing regulon of EsaR in *P. stewartii* via proteomic and transcriptomic methods.
**Role:** PI

**Title:** Microbial-driven enhancements and modes of action for tilapia, salmonids, and marine shrimp: Improved nutrition and health
**Sponsor:** Private Industry
**Duration:** 07/01/13-06/30/15
**Goal:** Implement novel biotechnologies to improve finfish and shrimp ability to utilize nutrients and health.
**Role:** Co-PI

## BIOGRAPHICAL SKETCH

Provide the following information for the Senior/key personnel and other significant contributors.
Follow this format for each person. **DO NOT EXCEED FIVE PAGES.**

NAME: Sumner, Susan S.

eRA COMMONS USER NAME (credential, e.g., agency login):

POSITION TITLE: Associate Dean and Director of Academic Programs

EDUCATION/TRAINING *(Begin with baccalaureate or other initial professional education, such as nursing, include postdoctoral training and residency training if applicable. Add/delete rows as necessary.)*

| INSTITUTION AND LOCATION | DEGREE *(if applicable)* | Completion Date MM/YYYY | FIELD OF STUDY |
|---|---|---|---|
| North Carolina State University, Raleigh, N.C. | BS | 12/1982 | Food Science |
| University Wisconsin, Madison, WI | MS | 12/1984 | Food Science |
| University Wisconsin, Madison, WI | PhD | 12/1987 | Food Science |

### A. Personal Statement

One of my goals has always been to integrate my research, teaching, and extension programs. My focus area has been food safety in relationship to how programs can effectively apply research knowledge to enhance food safety of these products. I focused on food safety so I have been able to translate the science learned in the laboratory to actual food processing environments. This concept easily translated to my educational goals as well, regardless of student or adult learning. Today, I concentrate on learning principles and pedagogy in regard to the broad concept of the food system.

### B. Positions and Honors

Professional Experience

| | |
|---|---|
| 11/08 – present | Associate Dean and Director for Academic Programs, College of Agriculture and Life Sciences, Virginia Tech |
| 10/00 – 11/08 | Department Head, Professor and Extension Project Leader, Department of Food Science & Technology, Virginia Tech |
| 1996 – 2000 | Associate Professor and Extension Project Leader, Department of Food Science & Technology, Virginia Tech |
| 1990 – 1996 | Associate Professor/Assistant Professor and Extension Food Microbiologist, Department of Food Science & Technology, University of Nebraska-Lincoln |
| 1987 – 1990 | Assistant Manager, Microbiology Department, Technical Coordinator for Microbiological and Aseptic Projects, National Food Processors Association, Washington, D.C. |

Honors and Awards

- Selected as an inaugural member of the Food Systems Leadership Institute 2006-2008.
- Elected Fellow of the International Association for Food Protection. 2005
- Excellence in Teaching Award. 2004. Virginia Tech Department of Biology. Selected by the students and faculty members of the department for this award.
- Alumni Extension Award. 2001. Virginia Tech Alumni Association.
- Educator Award. 2000. International Association for Food Protection. Given to a member of the association who has demonstrated a commitment to food safety education.
- Virginia Tech Gamma Sigma Delta Extension Award of Merit. 2000.
- IFT Regional Communicator Outstanding Service Award. 1992.

**C. Contributions to Science**

- Associate Dean and Director for Academic Programs. The associate dean is appointed by and reports to the dean of the college. In this role, the associate dean is responsible for facilitating a college climate that respects diversity, undergraduate and graduate education, assessment of programs, curriculum development, curriculum delivery, academic budgeting for the college, scholarships and facilitating submission of academic grants. The associate dean is an advocate for the teaching mission within the context of the college and university's tripartite mission. The associate dean works collaboratively with college administration as well as with other university deans and associate deans.
- Developed an internationally recognized food safety program that integrated all the missions of a land grant university.
- Developed a learning outcomes based curriculum for food microbiology. The food microbiology course taught at Virginia Tech is the largest food microbiology course in the nation. Biology majors have selected this course as the best outside major course taken at Virginia Tech.
- Received over $3 million in grant funds to support food safety programs.
- Developed multi-disciplinary and multi-state research and extension projects that involved faculty from departments of animal science, consumer science, horticulture, veterinary science, and sociology.

**D. Additional Information: Research Support and/or Scholastic Performance**

- Sumner, S.S. 2012. Visit to Wageningen University in the Netherlands to establish study abroad programs.
- Sumner, S.S. 2011. Invited speaker at the Conference for Strategies for Achieving Food Security in Central Asia sponsored by NATO-ATC. Held in Antalya, Turkey. March 31-April 2.
- Sumner, S.S. 2007. Visit to Universidad Austral de Chile in Valdivia Chile to promote exchange of undergraduate and graduate students. I hosted a visitor from the university in the fall of 2008 to finalize exchange plans for 2009.
- National Academic Programs Summit Creating Change: Enabling Excellence in Teaching and Advising, June 18-19, 2012. Fort Collins, CO.

**BIOGRAPHICAL SKETCH**

| NAME<br>Vinatzer, Boris, A | POSITION TITLE<br>Professor |
|---|---|

EDUCATION/TRAINING

| INSTITUTION AND LOCATION | DEGREE *(if applicable)* | YEAR(s) | FIELD OF STUDY |
|---|---|---|---|
| University of Bologna (Italy) | MS | 1996 | Plant Science |
| University of Bologna (Italy) | PhD | 2000 | Biotechnology |
| The University of Chicago | Postdoctoral training | 2000-2004 | Molecular Plant Pathogen Interactions |

**A. Personal Statement**

My training and professional expertise in conducting highly productive research projects in the field of molecular plant sciences and microbiology, my experience in teaching Microbial Forensics and Biosecurity, mentoring undergraduate and graduate students, and my expertise in administration in my current role as department head have prepared me for participation in the " Microbiology in Food, Energy, Water and Health" area as part of the Global Systems Science Destination Area.

**B. Positions and Honors**

**Positions and Employment**

1995-1999 Graduate Fellow at the University of Bologna (Italy)
1996-1997 Visiting Scientist at Texas A&M University (5 months)
1998 Visiting Scientist at the Swiss Federal Institute of Technology (7 months)
1999 Visiting Scientist at Southern Illinois University (6 months)
2000-2004 Postdoctoral fellow at The University of Chicago
2004-2010 Assistant Professor, PPWS, Virginia Tech
2010-2016 Associate Professor, PPWS, Virginia Tech
2015-current Interim Department Head, PPWS, Virginia Tech
2016-current Professor, PPWS, Virginia Tech

**Professional Memberships**

Since 2004 Member, American Society for Microbiology
Since 2004 Member, American Phytopathological Society
Since 2008 Member, International Society for Molecular Plant-Microbe Interactions

**Awards and Honors**

March 2017 Distinguished Service Award, Potomac Division of the American Phytopathological Society
May 2010 R.G. Henderson Award for Outstanding Faculty (Department-level award)
April 2008 NSF Faculty Early Career Development (CAREER) award
July 2002 Postdoctoral Ruth L. Kirschstein NIH National Research Service Award
July 1995 Graduation with 110/110 "con lode" (maximum distinction) from the University of Bologna (Italy)

**C. Contribution to Science**

My research has contributed to elucidating the molecular underpinning of the interaction between bacterial plant pathogens and plants, the evolution of bacterial plant pathogens, and the genetic and functional diversity of airborne bacteria with ice nucleation activity.

**A selection of 10 peer-reviewed publications since 2010 out of 38** (Corresponding authors in bold)


Hind SR, Strickler SR, Boyle PC, Dunham DM, Bao Z, O'Doherty IM, Baccile JA, Hoki JS, Viox EG, Clarke CR, Vinatzer BA, Schroeder FC, **Martin GB** (2016) Tomato receptor FLAGELLIN-SENSING 3 binds flgII-28 and activates the plant immune system. Nature Plants DOI:10.1038/nplants.2016.128.

Clarke CR*, Studholme DJ, Weisberg A*, Hayes B**, Runde B**, Cai R*, Wroblewski T, Daunay MC, Castillo J, Wicker E, **Vinatzer BA** (2015) Genome-enabled phylogeographic investigation of the quarantine pathogen *Ralstonia solanacearum* race 3 biovar 2 and screening for sources of resistance against its core effectors. Phytopathology DOI: 10.1094/PHYTO-12-14-0373-R.

**Vinatzer BA,** Monteil CL*, Clarke CR* (2014) Harnessing population genomics to understand how bacterial pathogens emerge, adapt to crop hosts, and disseminate. Annu Rev Phytopathol 52:19-43. DOI: 10.1146/annurev-phyto-102313-045907.

Marakeby H, Badr E, Torkey H, Song Y, Leman S, Monteil CL*, Heath LS, **Vinatzer BA** (2014) A system to automatically classify and name any individual genome-sequenced organism independently of current biological classification and nomenclature. PLoS ONE 9(2):e89142 doi: 10.1371/journal.pone.0089142.

Clarke CR*, Chinchilla D, Hind SR, Taguchi F, Miki R, Ichinose Y, Martin GB, Leman S, Felix G, **Vinatzer BA** (2013) Allelic variation in two distinct *Pseudomonas syringae* flagellin epitopes modulates the strength of plant immune responses but not bacterial motility. New Phytologist DOI: 10.1111/nph.12408.

Monteil CL*, Cai R*, Liu H*, Mechan Llontop ME*, Leman S, Studholme DJ, Morris CE, **Vinatzer BA** (2013) Non-agricultural reservoirs contribute to emergence and evolution of *Pseudomonas syringae* crop pathogens. New Phytologist 199(3):800-11. DOI: 10.1111/nph.12316.

Mazzaglia A, Studholme DJ, Taratufolo MC, Cai R*, Almeida NF, Goodman T**, Guttman DS, **Vinatzer BA**, **Balestra GM** (2012) *Pseudomonas syringae* pv. *actinidiae* (PSA) isolates from recent bacterial canker of kiwifruit outbreaks belong to the same genetic lineage. PLoS ONE 7(5): e36518. DOI:10.1371/journal.pone.0036518.

Cai R*, Lewis J*, Yan S*, Liu H*, Clarke CR*, Campanile F*, Almeida NF, Studholme DJ, Lindeberg M, Schneider DJ, Zaccardelli M, Setubal JC, Morales-Lizcano NP, Bernal A, Coaker G, Baker C, Bender CL, Leman S, **Vinatzer BA** (2011) The plant pathogen *Pseudomonas syringae* pv. *tomato* is genetically monomorphic and under strong selection to evade tomato immunity. PLoS Pathogens 7(8):e1002130. DOI: 10.1371/journal.ppat.1002130.

Almeida NF, Yan S*, Cai R*, Clarke CR*, Morris CE, Schaad NW, Lacy GH, Jones JB, Castillo JA. Bull CT, Leman S, Guttman DS, Setubal JC, **Vinatzer BA** (2010) PAMDB, A multilocus sequence typing & analysis database and website for plant-associated and plant-pathogenic microorganisms. Phytopathology 100(3):208-15. DOI: 10.1094/PHYTO-100-3-0208.

Clarke CR*, Cai R*, Studholme DJ, Guttman DS, **Vinatzer BA** (2010) *Pseudomonas syringae* isolates naturally lacking the canonical *P. syringae hrp/hrc* locus are common leaf colonizers equipped with an alternate type III secretion system. Mol Plant-Microbe Interact 23(2):198-210. DOI: 10.1094/MPMI-23-2-0198.

**Book Chapters**

**Vinatzer BA**, Monteil CL (2014) *Pseudomonas syringae* Genomics: From Comparative Genomics of Individual Crop Pathogen Strains Toward Population Genomics. In: Genomics of Plant-Associated Bacteria. Heidelberg, Germany: Springer. Editors: Gross DC, Lichens-Park A, Kole C. Pages: 79-98.

Hao W, Vinatzer BA, and **Hong C** (2014) Pasteurization for Irrigation Water Treatment. In: Biology, Detection, and Management of Plant Pathogens in Irrigation Water. Minneapolis, MN: APS Press. Editors: Hong C, Moorman GW, Wohanka W, Büttner C. Pages: 187-196.

Vinatzer BA, **Bull CT** (2009) The impact of genomic approaches on our understanding of diversity and taxonomy of plant pathogenic bacteria. In: Plant Pathogenic Bacteria: Genomics and Molecular Biology, Editor: Jackson RW, Norwich, UK: Horizon Press, 37-61.

Vinatzer BA, **Greenberg JT** (2006) Whole-genome analysis to identify type III-secreted effectors. In: Plant-Pathogen Interactions, Editor: Ronald PC, Totowa, NJ: Humana Press. Series: Methods in Molecular Biology 354: 19-34.

**D. Additional Information: Research Support**

**Completed Research Support**

Science Applications International Corporation 2008-2009
Developing Highly Discriminatory Molecular Markers from Whole Genome Sequences for Use in Microbial Forensics
Five *Pseudomonas syringae* genomes were sequenced to identify single nucleotide polymorphisms that can be used for molecular marker design in microbial forensics applications.
Role: PI

NSF-IOS 0746501 2008-2013
CAREER: What is behind the worldwide success of *Pseudomonas syringae* pv. *tomato*: a comparative evolutionary genomics investigation
This study aims at unraveling the evolution of *P. syringae* isolates with different host ranges and at identifying the genes in *P. syringae* pv. *tomato* that make pv. *tomato* strains such successful tomato pathogens.
Role: PI

**Ongoing Research support**

NSF-IOS 1354215 Vinatzer (PI) 05/01/14-04/30/18
Leveraging Pathogen Diversity for Gaining Insights into Molecular Plant – Microbe Interactions
The goal of this study is to take advantage of natural genetic variants existing within pathogen populations to unravel virulence mechanisms in plant pathogenic bacteria to identify new targets for plant disease control.
Role: PI

NSF-DEB 1643288 Vinatzer (PI) 01/01/13-06/30/17
Dimensions: Collaborative Research: Research on Airborne Ice Nucleating Species (RAINS).
The goal of this study is to study the phylogenetic, genetic, and functional diversity of airborne bacterial species with predicted roles in the water cycle to gain a deeper understanding of how bacteria adapt to life the atmosphere and possibly influence quantity and frequency of precipitation.
Role: PI

Virginia Agricultural Council 671 Vinatzer (PI) 07/01/16-06/30/18
Identification and Testing of Novel, Locally Isolated Biopesticides for Fire Blight Control in Virginia.
The goal of this study is to identify and characterize bacterial strains for use in plant disease control with a focus on the apple disease fire blight caused by Erwinia amylovora.
Role: PI

**Appendix II: Supporting tables and figures**

**Table 1: Companies supporting MICB degree and/or already sponsoring VT research projects**

- Afton Scientific, Charlottesville, VA
- Altria, Richmond, VA
- American Biosystems, Roanoke, VA
- American Type Culture Collection^, Manassas, VA
- AO Smith*, Milwaukee, WI
- BHO Technologies*, Baton Rouge, LA
- Dupont, Wilmington, Delaware
- Diversey, Inc*, Racine, WI
- Engineered Biopharmaceuticals, Danville, VA
- Flint Hills Resources*, Wichita, KS
- Gannett Fleming*, Harrisburg, PA
- Hampton Roads Sanitation District*, Virginia Beach, VA
- Hannahville Indian Community*, Wilson, MI
- Health Diagnostic Laboratory Inc., Richmond, VA
- Indoor Biotechnologies, Charlottesville, VA
- Intrexon*, Germantown, MN
- Jefferson College of Health Sciences, Roanoke, VA
- Mediatech Corning, Manassas, VA
- Milwaukee Metropolitan Sewerage District*, Milwaukee, WI
- Mitre Corporation^, McLean, VA
- Nanosonics Inc*, Pembroke, VA
- Novozymes*^, Salem, VA
- PepsiCo.*, Purchase, NY
- Sabra*, White Plains, NY
- Seagull Water Treatment,* Changzhou, Jiangsu Province, China
- Sealed Air*, Charlotte, NC
- TechLab^, Blacksburg, VA
- Techulon, Blacksburg, VA
- Tyson Foods*, Chicago, IL
- United States Dept. of the Navy, Dahlgren, VA
- Veolia Water*, Chicago, IL
- Western Virginia Water Authority*, Roanoke, VA
- Whitedog Labs*, Wilmington, DE

* indicates sponsored research or consulting contracts to one of the participating faculty
^ indicates existing internship opportunities for VT students

**Table 2: MICB curriculum**

Core Microbiology courses
- BIOL 2604 General Microbiology
- BIOL 2614 General Microbiology Lab
- BIOL 2004 Genetics
- BIOL 2104 Cell & Molecular Biology
- BIOL 4624 Microbial Genetics
- BIOL 4634 Microbial Physiology
- BCHM 3114 Biochemistry for Biotechnology
- BIOL 4764 Microbiology Senior Seminar

Microbiology elective courses
- BIOL 3104 Cell & Molecular Biol. Lab
- BIOL 3454 Introductory Parasitology (includes lab)
- BIOL 3774 Molecular Biology
- FST/BIOL 3604 Food Microbiology (includes lab)
- BIOL/CSES/ENSC 4164 Environmental Microbiology (includes lab)
- BIOL 4644 Microbial Molecular Genetics and Physiology Lab
- BIOL 4664 Virology
- BIOL 4674 Pathogenic Bacteriology
- BIOL 4724 Pathogenic Bacteriology Lab
- BIOL 4704 Immunology
- BIOL 4714 Immunology Lab
- BIOL 4734 Inflammation Biology
- BIOL 4804 Prokaryotic Diversity
- BIOL 4824 Bioinformatics Methods (includes lab)
- BIOL 4994 Undergraduate Research (includes lab)
- FST 4634 Epidemiology of Foodborne and Waterborne Diseases
- PPWS 4114 Microbe Forensics/Biosecurity

Additional Microbiology courses on campus
- BSE 3534 Bioprocess Engineering
- BSE 4564/5546G Metabolic Engineering
- CEE 5164 Environmental Biotechnology
- HIST 3714 War and Medicine
- HIST 3724 History of Disease, Medicine, and Health
- PPWS 2004 Mysterious Mushrooms and Molds (Pathways Course)
- PPWS 4104 Plant Pathology

**Appendix III: Provisional job ad**

## Virginia Tech
## seeks candidates for faculty positions in
## Microbiology at the Nexus of Food, Energy, Water and Health

Virginia Tech will fill five new faculty positions in the area of Microbiology at the Nexus of Food, Energy, Water and Health as part of the new Global Systems Science Destination Area. The Destination Area was created to increase research training and activity through interdisciplinary initiatives. Successful candidates will receive appointments in one of the participating departments and be expected to maintain close relationships with faculty across campus associated with this Destination Area. Participating departments have specific interests in the following areas: 1) XXxxxxxx, 2) XXxxxxxx, or 3) XXxxxxxx (see below); however, applications in other areas important to fundamental research in microbiology related to Global Systems Science are encouraged. Interactions with the other emerging VT Destination areas of Data Analytics and Decision Sciences, Integrated Security, and Intelligent Infrastructure for Human-centered Communities are highly encouraged. Core laboratory facilities covering DNA sequencing, proteomics, and computation are available through the Virginia Biocomplexity Institute and the VT Mass Spectrometry Incubator. Competitive salaries and start-up packages will be provided. Applicants should submit a cover letter, curriculum vitae, a statement of research and teaching interests emphasizing career goals, how collaborative research would help you achieve your goals, and how your interests interface with the research focus using our on-line system (https://jobs.vt.edu). Three reference letters should be sent to the chairs of the search committees (see below). For complete job descriptions and additional information regarding application procedures, see the Destination Area web site. Virginia Tech has a strong commitment to the principle of diversity and, in that spirit, seeks a broad spectrum of candidates, including women, minorities, and people with disabilities. Review of applications will begin September 15, 2017 and continue until positions are filled.

**XXXXX**

The Department of XXXX seeks applicants for a tenure track faculty position. Areas of particular interest include, but are not limited to, general and molecular mechanisms of food processing and safety. Direct inquiries to Dr. XXXX, @vt.edu, 540-231-XXXX. For complete job descriptions see: (Website)

**XXXXX**

The Department of XXXX seeks applicants for a tenure track faculty positions. Areas of particular interest include, but are not limited to, general and molecular mechanisms of energy sustainability. Direct inquiries to Dr. XXXX, @vt.edu, 540-231-XXXX. For complete job descriptions see: (Website)

**XXXXX**

The Department of XXXX seeks applicants for a tenure track faculty positions. Areas of particular interest include, but are not limited to, general and molecular mechanisms of water biotechnology/bioremediation. Direct inquiries to Dr. XXXX, @vt.edu, 540-231-XXXX. For complete job descriptions see: (Website)

**XXXXX**

The Department of XXXX seeks applicants for a tenure track faculty positions. Areas of particular interest include, but are not limited to, general and molecular mechanisms of public health of domestic animals and humans. Direct inquiries to Dr. XXXXX, @vt.edu, 540-231-XXXX. For complete job descriptions see: (Website)

**XXXXX**

The Department of XXXX seeks applicants for a collegiate faculty positions. Areas of particular interest include, but are not limited to, history and ethics of applied microbiology. Direct inquiries to Dr. XXXXX, @vt.edu, 540-231-XXXX. For complete job descriptions see: (Website)