

The background of the cover is a photograph of a cave interior. Three researchers wearing white protective suits and headlamps are visible. One researcher in the center is kneeling and examining a large rock formation. Two other researchers stand on either side, one holding a flashlight. The cave walls are rugged and illuminated by the researchers' lights.

THE FRALIN
explorer

SUMMER 2019

THE FRALIN LIFE SCIENCES INSTITUTE


VIRGINIA TECH.

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Photo this page: Aftermath of Hurricane Maria
Photo credit: shutterstock

Cover photo: Researchers Kate Langwig, Joseph Hoyt, and Jennifer Redell tagged bats with fluorescent dust and observed their movements to track hidden connections that can spread disease within and between bat species.
Photo credit: Kate Langwig and Joseph Hoyt

Letter from the Director

Thank you for reading the Summer 2019 edition of the Fralin Explorer. It is an exciting time for the life sciences community at Virginia Tech. In April 2019, Virginia Tech transferred the resources of the Biocomplexity Institute into the Fralin Life Sciences Institute at Virginia Tech on the Blacksburg campus. In doing so, Virginia Tech plans to support life sciences research across the university by providing “room to grow” through shared laboratories and catalyzing collaboration and partnership.

The goal is to grow the Fralin Life Sciences Institute at Virginia Tech into a hybrid thematic and investment institute committed to supporting research, education, and outreach in Virginia Tech’s life sciences community. Residents of the institute’s five flagship buildings are automatically considered affiliated faculty members and all other life science researchers on campus are invited to become affiliated faculty members.

Under the guidance of Dr. Rich Helm, shared research facilities supporting the life sciences will be reorganized to provide core resources across departments and disciplines. Staffed by expert technicians and guided by user needs, these facilities will drive efficiencies and promote collaborations across the research enterprise. This model will allow for scale and quality of investment not currently available to individual researchers, departments, or colleges; efficiencies of scale for service and infrastructure; and strategic support for university priorities.

Co-funded faculty in strategic thematic thrusts and promising research projects will have the potential to receive additional university support for strategic hires for faculty and retention of key faculty to engage in emerging areas of research excellence.

You can read about some of the exciting research being conducted by our researchers in this issue of the Fralin Explorer. Please enjoy our feature stories about Coastal@VT, infectious disease research by Dr. Kate Langwig and

Dr. Joseph Hoyt, and cancer research being conducted by Dr. Carla Finkelstein’s lab. We also highlight our impressive Fralin Undergraduate Research Fellows and the research projects they conducted over the last year.

I am working closely with Executive Vice President and Provost Cyril Clarke to convene a group of key stakeholders that will contribute to the further development and implementation of the new model. This summer, our stakeholders will launch and oversee a national search for a new executive director of the Fralin Life Sciences Institute, and it is expected that faculty members will have the opportunity to fully participate in the recruitment of the new director.

The Fralin Life Sciences Institute was formed in 2008, itself the merger of two entities that formed in 1995 and 2003. The institute bears the Fralin name in recognition of the philanthropy by the late Horace and Ann Fralin. Horace Fralin was a member of the class of 1948 and a longtime supporter of Virginia Tech.

Last year, the Horace G. Fralin Charitable Trust and Heywood and Cynthia Fralin donated a record \$50 million to Virginia Tech to support research at the newly renamed Fralin Biomedical Research Institute within the Virginia Tech Carilion Academic Health Center in Roanoke. Heywood Fralin is the brother of Horace Fralin.



“Horace would be proud to see his vision for life science research come into focus at Virginia Tech,” Fralin said. “To see the university elevate critical research like this by investing in and supporting the Fralin Life Sciences Institute is both important and exciting.”

A handwritten signature in black ink that reads "Rich Helm". The signature is stylized and written in a cursive-like font.

01

VIRGINIA TECH RESEARCHERS RECEIVE NSF GRANT TO STUDY PARENTAL CARE IN EASTERN HELLBENDER SALAMANDERS

Although eastern hellbender salamanders are known by many unflattering nicknames — mud puppy, snot otter, grampus, and Allegheny alligator — about 70 percent of adult male hellbenders should more accurately be known as doting fathers. Unlike most wildlife species, male hellbenders provide exclusive care for their young for an extended period of seven months. William Hopkins, professor of wildlife in the College of Natural Resources and Environment, is the principal investigator on a new grant from the National Science Foundation (NSF) for \$738,817 to study parental care in the eastern hellbender salamander. This two-foot long salamander, found in cold, rocky, fast-moving rivers and streams in the Appalachian region, is one of the largest and most fascinating amphibians in the world. These giant salamanders were once common in streams across the eastern United States, but have experienced drastic population declines in the past 30 years due to habitat loss caused by erosion and pollution and are increasingly threatened by climate change. “Hellbenders are a fascinating and misunderstood species surrounded by folklore and misinformation. Their recent rapid population declines are a cause for conservation concern,” said Hopkins, director of the Global Change Center, an arm of the Fralin Life Sciences Institute. The hellbender requires well-oxygenated, clean streams and rivers; they are especially sensitive to environmental changes and pollution because they breathe

by absorbing oxygen through their skin. Small changes in water quality affect them much more quickly than they affect local fish and other wildlife, making the hellbender an important indicator for local habitat conditions. One commonality among most declining hellbender populations is indirect evidence that their reproduction may be disrupted. “Because Virginia harbors some of the hellbenders’ healthiest remaining populations as well as declining populations, our work represents one of the last opportunities to reveal the role that reproductive physiological ecology plays in the viability of hellbender populations,” said Hopkins. The research team spans three colleges and brings together diverse expertise to tackle these important questions. Co-principal investigators on the grant are Richard Helm, associate professor of biochemistry in the College of Agriculture and Life Sciences, and Joel McGlothlin, associate professor of biological sciences in the College of Science. The interdisciplinary team’s research will advance the understanding of how environmental conditions and hormonal processes interact to influence reproduction in the eastern hellbender. “Hellbenders may soon be an endangered species, so the broader impacts of this work have the potential to be huge. Learning more about their reproductive behavior may help to reverse some of the declines we see in so many populations,” said McGlothlin, an affiliated faculty member of the Global Change

A male eastern hellbender with his eggs in an underwater nest box. Photo courtesy of Cathy Jachowski.



Center. Male hellbenders exhibit extraordinary parental care under normal conditions. In the fall, hellbenders start breeding. The female hellbender lays the eggs and the male fertilizes them externally. The male then runs the female off and provides 100 percent of the parental care. The male will stay with the nest until the following spring and defend the eggs against predators. The male hellbender also waves his tail over the eggs to keep them well-oxygenated until they hatch. Many animals provide care for their young, which is critical for early development, but disruption of this relationship can lead to neglect, abandonment, and the death of offspring. Researchers have found that about 30 percent of the time, eastern hellbenders switch from being protective, doting fathers to the extreme of eating their own young, also known as filial cannibalism. More than 100 different species of animals will eat their own young, but the underlying mechanism that causes this drastic switch in behavior is unknown in most species. The investigators hope to unravel this mystery with the research funded by this grant. Changes in the environment, hormonal imbalance, and energy deficits are among the viable hypotheses as to why this may be happening. “Cannibalism of offspring has long fascinated scientists, but little is known about the environmental factors that provoke this behavior or the physiological changes that underlie the decision to care for or eat one’s young. From an evolutionary standpoint, this behavior has long



HELLBENDERS ARE A FASCINATING AND MISUNDERSTOOD SPECIES SURROUNDED BY FOLKLORE AND MISINFORMATION. THEIR RECENT RAPID POPULATION DECLINES ARE A CAUSE FOR CONSERVATION CONCERN.

WILLIAM HOPKINS

written by Kristin Rose

baffled scientists,” said Hopkins. Answering these questions will provide insights into how and why adults terminate parental care in a broad range of species. Hellbenders are a great model organism for studying this behavior because the researchers have developed techniques in the field where they can study hellbenders under natural conditions. Their study will employ underwater nest boxes in streams across a variety of hellbender habitats to determine what hormones trigger this switch in behaviors and what environmental factors influence cannibalism. Hellbenders are large, so researchers can take blood samples repeatedly over a span of time. Researchers from Hopkins’ lab will take blood samples from the hellbenders as well as egg samples and work with McGlothlin’s lab to rule out the hypothesis that male hellbenders eat their eggs when they think that another male has fertilized some of them. Students working in McGlothlin’s lab will use DNA paternity testing to test for this possibility. “Although we suspect that this type of extra-pair paternity is rare, not much is known about the hellbender breeding system, so we might be surprised,” said McGlothlin. Helm’s research team will analyze blood samples from the hellbenders using mass spectroscopy and targeted assays to test if hormonal and environmental changes are an underlying cause of filial cannibalism. Mass spectroscopy is an analytical technique that ionizes samples of a chemical species and sorts the ions based on their mass-to-charge ratio. Helm’s team will be able to identify the differences in hormones, metabolites, and proteins from hellbenders exhibiting different behaviors. “This will allow us to associate the chemical features in blood serum with hellbenders before, during, and after the mating season.

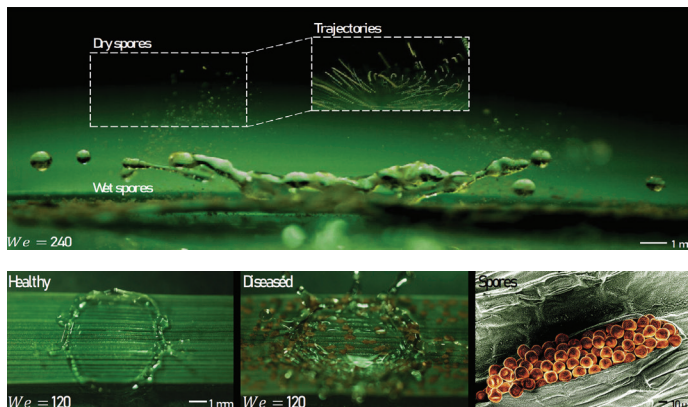
We can then link the features to behavior, potentially segregating caretakers from cannibals,” said Helm. Helm’s team will also be able to analyze chemical differences in hellbenders found in environments favorable to hellbender growth and development, and environments that are not, allowing them to help tease out the answers to some of the questions about how physiology and the environment affect hellbender parental care. Not only will this research advance knowledge of parental care, but the team’s study will also employ high school science teachers in an integrated outreach effort to conserve the hellbender species. “Southwest Virginia is home to a number of underserved groups, including rural Appalachian communities that face a number of socioeconomic and educational access challenges. These same communities live in one of the most biodiverse regions in North America, though few citizens recognize the global significance of the ecosystems that surround them,” said Hopkins. Hellbenders are well-established in the folklore of Appalachia, providing a platform to access rural communities in Southwest Virginia about science and environmental issues. Hopkins’ research team will take advantage of the charismatic nature of the eastern hellbender to reach local and global audiences. **e**

02

RESEARCHERS DISCOVER MICROSCOPIC TORNADOES OF SPORES RELEASED DURING RAINFALL

Plant diseases are a significant threat to our food security, and while rain provides fresh water to our crops, splashing drops may also contribute to the spread of plant disease. Raindrop impact is known to be a mechanism for dispersing microscopic spores of pathogens, which infect staple crops and devastate crop yields. Recent research in the Schmale Lab at Virginia Tech and the Jung Lab at Cornell University has illuminated how the splashing of rain droplets can transport spores of pathogens from infected plants. The team used high-speed video cameras to observe microscopic tornadoes of rust spores generated from the impact of raindrops on infected wheat leaves. Their findings,

Image of air-vortex dispersal of plant pathogen (top). Images of raindrops on a healthy wheat plant (left) and diseased wheat plant infected with a rust fungus (middle). High-resolution microscopy of rust spores on a wheat plant (right). Photos courtesy of Hyunggon Park.



WE ARE THE FIRST TO DEMONSTRATE TORNADO-LIKE AIR VORTICES THAT RESULT FROM RAINDROP IMPACT. THESE MICROSCOPIC TORNADOES MAY HELP TRANSPORT PLANT PATHOGENS OVER LONG DISTANCES.

DAVID SCHMALE

written by Kristin Rose

which were recently published in the Proceedings of the National Academy of Science (PNAS), have implications for preventing disease spread in wheat crops. “Previous studies only focused on wet-dispersed spores following raindrop impact. We are the first to demonstrate tornado-like air vortices that result from raindrop impact. These microscopic tornadoes may help transport plant pathogens over long distances,” said David G. Schmale III, professor in the School of Plant and Environmental Sciences in the College of Agriculture and Life Sciences and an affiliated faculty member of the Fralin Life Sciences Institute. The researchers set up experiments using a high-speed video camera to capture images of raindrops impacting wheat plants infected with the rust fungus, *Puccinia triticina*. These experiments shed new light on the physics of spore dispersal during rainfall. “Interdisciplinary research is needed to bridge plant pathology and fluid mechanics to study the mechanics of plant pathogen dispersal,” said Hope Gruszewski, a laboratory specialist senior in the Schmale Lab and a co-author on the paper. This previously unknown method of air-vortex dispersal is a swirling mechanism that can be likened to a mini-tornado of air that carries the plant pathogens off the plant and onto air currents, with the potential for transport over much longer distances. “Our lab specializes in high-speed imaging and fluid mechanics. We used a high-speed video camera to visualize rust spores being liberated from an infected wheat leaf. We observed thousands of spores being transported in air vortices following raindrop impact. That was quite surprising,” said Sunghwan Jung, professor in the Department of Biological and Environmental Engineering

at Cornell University. The air-vortex dispersal mechanism could explain abrupt increases in spores in the atmosphere immediately after major rainfalls. Understanding the spread of plant pathogens during rainfall could help farmers better manage the timing of fungicide applications to their crops. “Our research has the potential to provide new strategies for minimizing disease spread in wheat, which could help us meet future wheat yield demands,” said Hyunggon Park, a Ph.D. student in the biological transport program (BIOTRANS) at Virginia Tech, co-advised by Schmale, and a co-author on the paper. This research was funded by the United States Department of Agriculture National Institute of Food and Agriculture (USDA NIFA). ■

Photo below: Honey bees were also chosen as the model for this current grant because of their reduced gut microbiome, making it easier to test the roles of the interacting genes from the host



03

VIRGINIA TECH RESEARCHERS RECEIVE NSF GRANT TO STUDY THE HONEY BEE GUT MICROBIOME

Researchers from Virginia Tech were part of a collaborative \$958,415 National Science Foundation (NSF) grant to study the host-microbiome-parasite interactions in the honey bee gut, with \$750,000 coming to Virginia Tech. Researchers Lisa Belden, David Haak, T.M. Murali, and Richard Fell from Virginia Tech and Jenifer Walke from Eastern Washington University are collaborating to study the critical role of the honey bee gut microbiome in health and defense against parasites using a systems biology framework. “Using the honey bee gut microbiome as a model to study host defense against parasites could have implications for understanding the human microbiome and host defense, as well,” said Belden, the lead investigator on the grant and professor in the Department of Biological Sciences in the College of Science at Virginia Tech. A microbiome is a complex community of bacteria and other microbes that inhabit a specific environment; in this case, the honey bee gut. “We know that gut microbiomes change in response to various stressors in



BY STARTING WITH THE SIMPLER HONEY BEE MODEL, THE RESEARCHERS HOPE TO EXTRAPOLATE THEIR FINDINGS TO ADVANCE THE UNDERSTANDING OF WILDLIFE AND HUMAN HEALTH.

written by Rasha Aridi and Kristin Rose

the environment. What we don't yet understand are the intricate interactions that happen between the host, the microbiome, and parasites," said Haak, assistant professor of plant and microbial genomics in the School of Plant and Environmental Sciences and affiliated faculty of the Global Change Center, housed within the Fralin Life Sciences Institute. Walke, now an assistant professor at Eastern Washington University, completed her Ph.D. under Belden in 2014 and returned as a postdoctoral fellow from 2015 to 2017, when she studied the microbiomes of amphibian skin and honey bees. Her postdoctoral work led her to Fell, professor emeritus in apiculture, the practice of beekeeping, in the Department of Entomology in the College of Agriculture and Life Sciences. "There has been a tremendous loss in the honey bee population since the 1990s that continues to afflict U.S. beekeepers and agricultural producers. Virginia beekeepers lost almost 60 percent of their colonies over the winter of 2017-2018 — the highest percentage in state history, and almost twice the national average," said Fell, who has studied honey bees for over 40 years. Belden, Fell, and Walke worked together on a grant to study the effect of pesticides on honey bee gut microbiomes funded by the Virginia Department of Agriculture. "During our research funded by this previous grant, we found that the pesticides weren't producing any acute toxicity in the honey bee populations but there seemed to be chronic, longer-term effects on the honey bee gut microbiome. This was a springboard for our new grant, as we found that disruptions in the bacterial communities of the honey bee gut microbiome seem to make it easier for pathogens and parasites to invade," said Fell.

Honey bees were also chosen as the model for this current grant because of their reduced gut microbiome, making it easier to test the roles of the interacting genes from the host, the microbes, and the parasites. Researchers have identified approximately 10 key components of the honey bee gut microbiome, in comparison to the thousands found in humans. Haak will focus on sequencing the genomes of the microbes in the honey bee gut microbiome to look at the true impact of genetic variation within the microbial community and how that reflects its function. He is also working to determine which genes are actively involved in the interactions between the gut microbiome and the host using a tool called metatranscriptomics. By starting with a simpler model, the team hopes to extrapolate the findings to advance the understanding of wildlife and human health. "The host-microbiome-parasite interactions can be mathematically modeled as a network where, for instance, the biochemical products produced by genes from host cells directly affect the bacteria and vice versa," said Belden, also an affiliated faculty member of the Global Change Center. The Belden Lab at Virginia Tech studies community ecology and how species interactions influence disease dynamics. The lab focuses primarily on symbiotic microbial communities on amphibian skin and freshwater trematode parasites but has also expanded to study honey bees, songbirds, and wheat. One goal of the newly funded study is to develop a network of the genes from the parasite, microbiome, and host to determine their interactions with each other and to develop an idea of the key points where they interact. "We will develop computational tools that can

compare the parasite-microbiome-host gene networks in different conditions (for example, between infected bees and normal bees or between a bee strain that is infected and another that is resistant to infection) to identify modules of genes that might be important for resistance to the parasite. These changes in interconnections might help in identifying focal nodes that can be tested experimentally in honey bees," said Murali, professor of computer science in the College of Engineering and co-director of the ICTAS Center for Systems Biology of Engineered Tissues. The researchers expect that this approach can then be applied to other systems. Part of the grant funding allows for Haak, with the support of the team, to develop a biology and computer science-based outreach module for local elementary school students. Students and teachers will be guided through building Raspberry Pi clusters, a small computer to teach programming to beginners. Students will be doing microbiome analysis on their mini computers and develop computer science skills at a young age." ■

04

RESEARCHERS ANALYZE BIODIVERSITY PATTERNS IN ANTARCTIC DRY VALLEYS

Antarctica is a nearly uninhabited, ice-covered continent ravaged by cold, windy, and dry conditions. Virginia Tech researcher Jeb Barrett was part of an international collaborative team that analyzed biodiversity patterns in the McMurdo Dry Valleys of Antarctica. "Surprisingly, we found that biotic, or living, interactions are crucial in shaping biodiversity patterns even in the extreme ecosystems of the Antarctic Dry Valleys. Antarctic soils are model ecosystems, limited by the extreme climate and lack of vascular plants, and they host simple food webs with few species," said Barrett, professor in the Department of Biological Sciences in the College of Science. These findings were recently published in two separate papers in *Communications Biology*. A paper on biotic interactions analyzes the entire community of soil organisms; its companion paper focuses on the soil nematode community using a modeling approach. Characteristics of Antarctic communities, such as simple food webs and low species richness, allow for a greater understanding of the whole community, from bacteria to multicellular invertebrates. This research is the product of an international collaboration of scientists from half a dozen countries: the United States, New Zealand, Canada, Australia, Great Britain, and South Africa. Organized by the University of Waikato and the New Zealand Antarctic Program, it is the first of its kind to study a soil community



WE CONSIDERED THE ENTIRE COMMUNITY OF SOIL ORGANISMS AND ALL THE POSSIBLE BIOTIC AND ABIOTIC INTERACTIONS THAT POTENTIALLY SHAPE THE SPECIES COMPOSITION AND DIVERSITY.

JEB BARRETT

written by Kristin Rose



Nematode species *Plectus* (left) and *Scottnema* (right) found in the Antarctic. Photos courtesy of Jeb Barrett.

in its entirety at a regional scale. Barrett has been conducting research in Antarctica for 20 years; he deployed for this research collaboration in 2009 and 2010. Research in the Barrett lab addresses the influences of soils, climate variability, hydrology, and biodiversity on biogeochemical cycling from the scale of microorganisms to regional landscapes. “My research in the Antarctic has been focused on analyzing the physical and geochemical drivers that predict biodiversity patterns. I focused initially on the nematode communities, and my work has now expanded into the bacterial communities, as well,” said Barrett, an affiliated faculty member of the Global Change Center, housed within the Fralin Life Sciences Institute. The Communications Biology paper on biotic interactions considers the entire community of soil organisms: cyanobacteria, heterotrophic bacteria, nematodes, and other microscopic invertebrates. The scientists studied the factors that determine the distribution and abundance of these organisms, as well as temperature, topography, distance to the coast, and soil properties, such as water and pH levels, in their analysis. “What makes this paper truly unique is that we considered the entire community of soil organisms and all the possible biotic and abiotic interactions that potentially shape the species composition and diversity,” said Barrett. “We used the statistical technique of

structural equation modeling to tease out what the drivers of these communities are.” Biogeochemistry and climate have strong effects on biodiversity, but this new data demonstrated that there are two other important factors. They found that biogeography and species interactions are stronger drivers of biodiversity than originally expected. Biogeographic processes occur when an organism moves through space, interacting with its community as it moves. Species interactions, such as predator-prey relationships and competition, also influence biodiversity. In the companion paper, the researchers used a modeling approach to study the co-occurrence and distribution of three dominant nematode species found in the soil. Nematodes, also known as roundworms, are a group of simple organisms that have successfully adapted to nearly every ecosystem on Earth. The researchers demonstrated that competition is a more important driver of diversity patterns in the nematode community than previously thought. “We modeled three nematode species – *Plectus*, *Scottnema*, and *Eurdoylaimus* – that are potentially interacting. Our results show that it is not just environmental drivers that influence species distribution across the polar landscape but that competition and interactions are playing a large role in diversity patterns as well,” said Barrett. The future challenge for researchers is to understand how the effects of climate change on these

interactions will alter species coexistence in Antarctica. They expect that with increasing temperatures, the thawing of ice will create environments that select for nematode species more adapted to warmer and wetter environments. Early indications of this have already been observed in the team’s long-term monitoring studies of soil communities, as reported in the journal *Ecology* last year. Barrett’s ongoing research is funded by the National Science Foundation’s Long Term Ecological Research (LTER) Program. His research goal with the LTER is to use a combination of manipulative experiments and long-term observations to understand how climate variability influences Antarctic organisms and ecosystems. [e](#)

05

**DRUG HUNTERS
AWARDED \$2.8 MILLION
TO DEVELOP A DRUG
TO TREAT MULTIPLE
SCLEROSIS**

Webster Santos, professor of chemistry and the Cliff and Agnes Lilly Faculty Fellow in the College of Science at Virginia Tech, has received a \$2.8 million award from the National Institute of Allergy and Infectious Diseases (NIAID) to discover drugs to inhibit a small molecule transporter. Blocking this transporter modulates the immune system and has implications both in treating autoimmune diseases, such as multiple sclerosis, and in immune-oncology. Santos received this research grant in collaboration with Kevin Lynch, a professor of pharmacology at the University of Virginia. Lynch will oversee the biological testing of the drug. The NIAID award builds on an existing research grant from the National Institute of General Medical Sciences, which was awarded to Santos and Lynch in September 2016 to discover inhibitors of the enzymes that synthesize a molecule called S1P. “My laboratory is discovering inhibitors that might become a new generation of drugs against multiple sclerosis and metastatic cancers,” Santos said. “The inhibitors alter the way immune cells travel throughout the body by changing the extracellular levels of S1P. We have discovered lead inhibitors and we are optimizing these compounds so as to achieve maximum therapeutic benefit.” Santos is a member of the Virginia Tech Center for Drug Discovery and an affiliate of the Fralin Life Sciences Institute. He is an expert medicinal chemist whose research focuses on compounds with new modes of action to treat



MULTIPLE SCLEROSIS
AFFECTS 2.3 MILLION
PEOPLE WORLDWIDE
AND THERE
IS CURRENTLY NO
CURE. SANTOS
AND HIS TEAM
ARE DISCOVERING
INHIBITORS THAT
MAY
LEAD TO THE
DEVELOPMENT OF A
THERAPEUTIC DRUG
TO TREAT MS.

written by Rasha Aridi
and Kristin Rose

multiple sclerosis, kidney fibrosis, neurodegenerative diseases, aging, and fatty liver disease. Multiple sclerosis (MS) is a potentially disabling disease of the central nervous system, which comprises the brain and spinal cord. In MS, the immune system attacks the myelin sheath, the protective cover of nerve fibers, causing communication problems between the brain and the rest of the body. Eventually, the disease results in the nerves deteriorating or becoming permanently damaged, which can impair brain function, coordination, sensation, and motor ability. According to the National Multiple Sclerosis Society, MS affects 2.3 million people worldwide and there is currently no cure. Treatments, however, can help speed up recovery after attacks, modify the course of the disease, and manage symptoms. In MS, the body’s immune system attacks the myelin sheath of motor neurons in the central nervous system leading to progressive disability. Santos’ drug inhibits SPNS2, a transporter protein in the membrane of endothelial cells, which line lymph vessels. Lymph S1P (sphingosine 1-phosphate), which is secreted from endothelial cells via SPNS2, is necessary for proper positioning of immune cells. By inhibiting SPNS2, Santos’s drug will modulate the immune system and might ultimately be used to treat MS. “Insofar as we are aware, we are the only group

with SPNS2 inhibitors,” Santos said. The collaboration between Virginia Tech and the University of Virginia is crucial to the research. Santos works on refining the inhibitor and developing the compound into a drug, while Lynch does the biological and animal studies. Santos and Lynch have filed an application to the U.S. Patent and Trademark Office for the drugs and are working with other collaborators who are testing SPNS2 inhibitors in mouse models of MS and metastatic cancer. When SPNS2 inhibitors show efficacy in these models, the next phase would be to demonstrate safety for eventual testing in humans. “Drug discovery and development is a long, expensive, and uncertain path,” said Kevin Lynch. “The SPNS2 inhibitors that we have will allow validation of this transporter as a bona fide drug target. Both of our groups are working hard to take our studies from the bench to the clinic efficiently and quickly. The synergy between medicinal chemistry and pharmacology is really what makes it work.” Based on their research and to realize benefit by patients, Santos and Lynch co-founded a start-up company, Flux Therapeutics. The goal of the company is to commercialize the findings from their laboratories. **e**

The S1P transporter team: Webster Santos, Christopher Sibley, Russell Fritzscheimer, Daniel Foster, Ashley Peralta (from left to right).



COASTAL@VT

FOSTERING COASTAL RESILIENCE AND PROSPERITY THROUGH TRANSDISCIPLINARY RESEARCH, EDUCATION, AND ENGAGEMENT

written by Kristin Rose

THE COASTAL ZONE HOSTS MORE THAN HALF OF THE WORLD'S HUMAN POPULATION, LARGE PORT FACILITIES VITAL TO THE GLOBAL ECONOMY, AND MILITARY INSTALLATIONS IMPORTANT TO NATIONAL AND GLOBAL SECURITY.

10

Accelerating sea-level rise, coastal hazards, ocean acidification, population growth, and rapid economic development threaten livelihoods, tourism, health, fish and wildlife species, and ecosystem services in this area.

“The cascading impacts of these stressors represent a complex and formidable problem that can be addressed only by coordinated investment in research, teaching, outreach, and inclusive engagement efforts. The focus of the Coastal@VT concept team is characterized by disciplinary strength and excellence, and by strong interdisciplinary links among the different disciplines,” said Robert Weiss and Anamaria Bukvic, co-leaders of the Coastal@VT group.

Robert Weiss is a professor of geosciences in the College of Science and Anamaria Bukvic is an assistant professor of geography in the College of Natural Resources and Environment.

Coastal@VT's vision is to be a catalyst for finding innovative solutions to sustain development of coastal built and natural environments through diversity and inclusion in research, education, and engagement.



Image of destruction caused by Hurricane Sandy. Photo credit: Anamaria Bukvic.

The interdisciplinary linkages of Coastal@VT, developed through research and education programs, are institutionally manifested through the Destination Areas, specifically Data Analytics and Decision Sciences, Intelligent Infrastructure for Human-Centered Communities, Integrated Security, and the Global Systems Science themes of food, infectious diseases, and water.

Coastal@VT will serve as an incubator for advancing technology, policy innovation, and knowledge exchange, as well as for forging sustained and long-lasting partnerships with

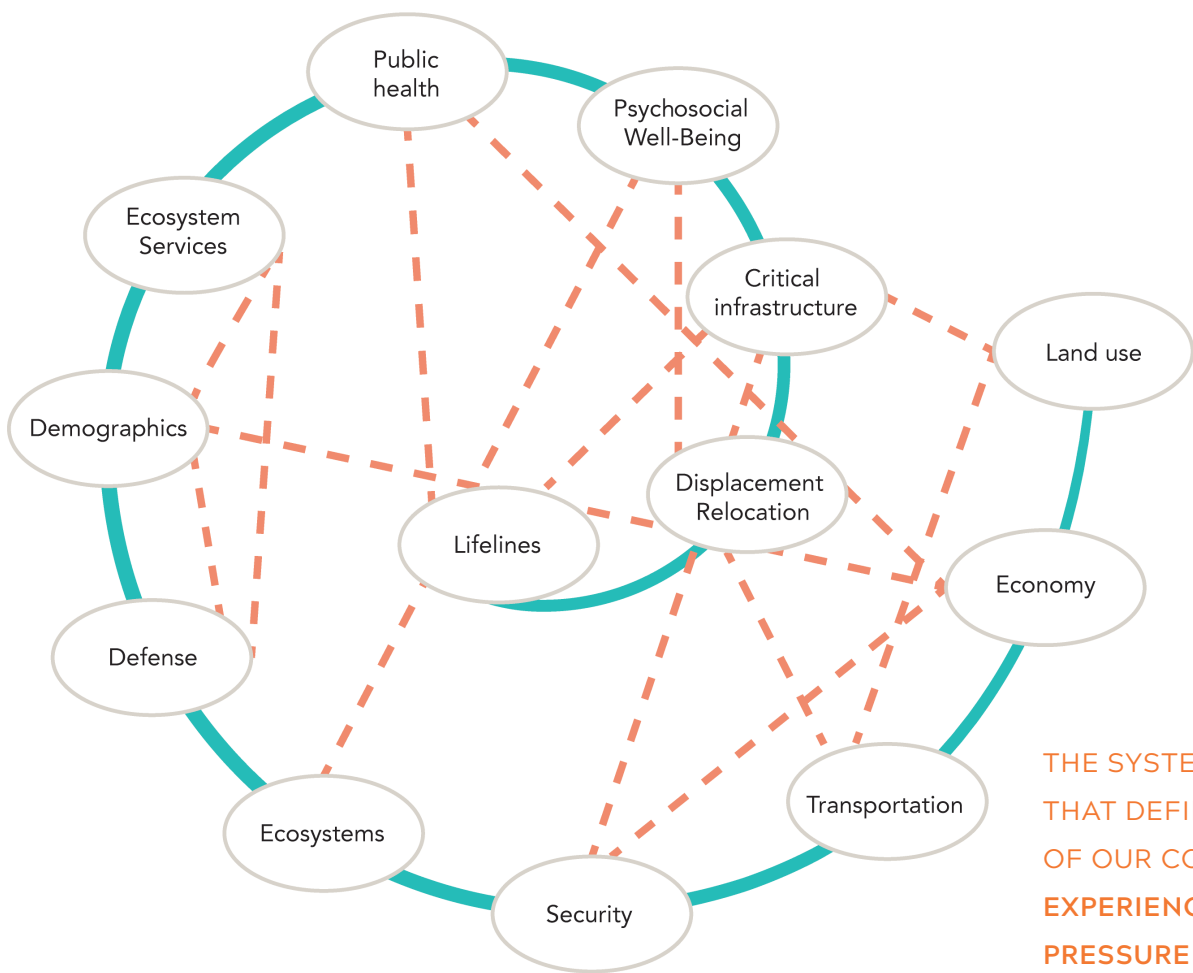
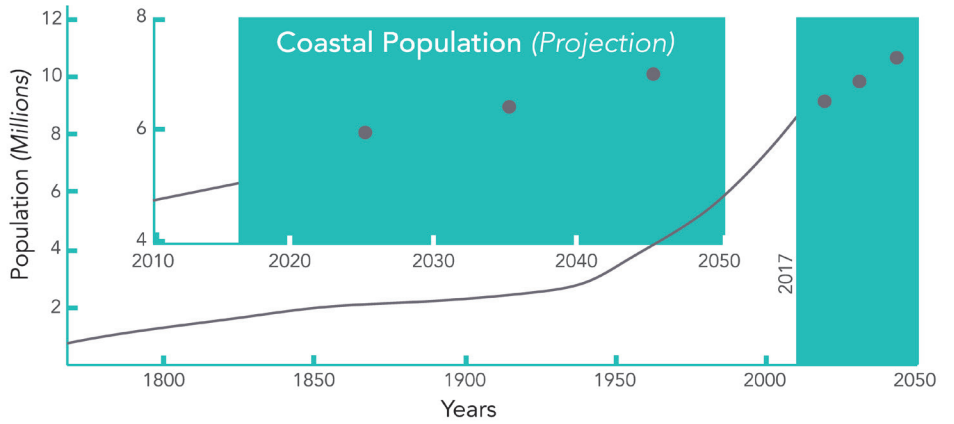
industry and other organizations that work to make coastal zones more resilient and capable of adapting to rapidly changing environments.

The Coastal@VT initiative is comprised of 36 junior and senior faculty participants from eight different colleges and various scientific disciplines at Virginia Tech. They bring a diverse range of expertise to coastal research, including, but not limited to, geophysics, engineering, geography, urban planning, public health, governance and public policy, fish and wildlife conservation, business information technology, and applied economics.

THE NUMBER OF VIRGINIA RESIDENTS LIVING IN THE COASTAL ZONE IS EXPECTED TO RISE SIGNIFICANTLY BY 2045.

Data Source: University of Virginia, Weldon Cooper Center for Public Service

Total Virginia Population



THE SYSTEMS AND NETWORKS THAT DEFINE THE WELL-BEING OF OUR COMMUNITIES WILL EXPERIENCE SIGNIFICANT PRESSURE THAT CAN DESTABILIZE THEM OVER TIME.

DID YOU KNOW?

In the U.S. alone, half of weather-related, economic damage is due to hurricanes, mostly from coastal flooding, e.g., Hurricanes Sandy (in 2012; \$67 billion, 159 deaths) and Katrina (in 2005; \$151 billion, 1833 deaths).

By 2100, population is expected to grow by 50 percent and mean sea level is expected to rise about one meter. Both increase the coastal disaster threat, with the former increasing lives and infrastructure in harm's way and the latter increasing the magnitude and spatial extent of the flood hazard.



Sarah Karpanty and Claire Helmke radio tracking collared red foxes on Fire Island National Seashore, NY, as part of a study of predator impacts on threatened piping plovers. Photo credit: Cat Black.



Robert Weiss (left, Virginia Tech) and Patrick Lynett (right, University of Southern California) inspect the damages of a beachfront house in Mantoloking, New Jersey) after Superstorm Sandy. Photo credit: Jennifer Irish.



Students learning about the beach erosion control measures such as geotubes and groins. Photo credit: Anamaria Bukvic.



Photo courtesy of Anamaria Bukvic.



Researchers and stakeholders were able to come together and assess the expertise and resources that Virginia’s universities currently have and will need in the future to answer pressing research questions and produce policy-relevant science related to the commonwealth’s resilience to coastal flooding.



Anamaria Bukvic

Coastal@VT faculty are applying innovative and holistic approaches and utilizing cutting-edge skills and technology to interpret data and solve problems. They engage in a broad range of research topics such as:

- Tsunami sedimentation and erosion
- Tropical cyclone dynamics and structure
- Storm surge dynamics and hazard assessment
- Disaster preparedness and hazard mitigation
- Climate change adaptation, resilience, and vulnerability
- Population displacement and relocation
- Wildlife conservation management
- Environmental resource economics
- Endangered species and shorebird ecology
- Public health and safety post marine oil spills
- Collaborative governance and scenario planning

To support its faculty and ensure that their research is aligned with the Coastal@VT mission, the initiative offers seed grants to fund interdisciplinary research

and organizes various events to facilitate knowledge exchange, new partnerships, and collaboration between researchers and the public and private sector. Coastal@VT places a great emphasis on generating impactful data and policy-relevant research.

Coastal disasters affect people from all walks of life. Improving the resilience of the communities in which these people live requires collaboration among experts and stakeholders from a wide range of different disciplines. To promote resiliency, Coastal@VT engages in educating future leaders, practitioners, and researchers in disaster resilience and risk management with support from a National Science Foundation Research Traineeship grant (NRT).

This inclusive program, also referred to as DRRM^{VT} (Disaster Resilience and Risk Management at Virginia Tech), invites graduate students from all colleges and departments of Virginia Tech to learn important interdisciplinary skills while

strengthening their knowledge of disaster resilience and risk management. You can read more about the DRRM^{VT} program on page 16.

In 2017, graduate students from the Climate Change and Societal Impacts course, taught by Bukvic, had an opportunity to participate in the Resilience Research and Design Tidewater Collaborative Laboratory, better known as the Tidewater Collaboratory.

This hands-on learning experience was supported by Wetlands Watch, Virginia Sea Grant, and the Hampton Roads chapter of the U.S. Green Building Council. It enabled students to partner with officials from the City of Hampton and study topics ranging from social vulnerability to flooding and community resilience in different city neighborhoods.

In October of 2018, the Coastal@VT group hosted the first 2018 Rotating Resilience Roundtable, a two-day event on the Blacksburg campus, which offered faculty the opportunity to interact with coastal scientists

Coastal@VT faculty member Sarah Karapanty scoping the beach and tending to shore birds.



and stakeholders in person and in small group settings.

The event was co-organized by Anamaria Bukvic from the Coastal@VT initiative and Michelle Covi from Old Dominion University and the Virginia Sea Grant Climate Adaptation and Resilience Program.

The Rotating Resilience Roundtables are designed to respond to the need for cohesive and policy-relevant science that will align and coordinate efforts to benefit Virginia's resilience and adaptation to changing conditions in the coastal zone.

"The roundtables' aim was to facilitate knowledge exchange and research collaborations to strengthen the statewide capacity to address coastal resilience issues in an integrated and inclusive manner. Researchers and stakeholders were able to come together and assess the expertise and resources that Virginia's universities currently have and will need in the future to answer pressing research questions and produce policy-relevant science related to the commonwealth's resilience to coastal flooding," said Bukvic.

Researchers from Virginia Tech, Old Dominion University, College of William and Mary, University of Virginia, and the Virginia Institute of Marine Science attended and discussed the state's needs in research and education for coastal resilience. Attendees

included those in disaster preparedness, engineering, technology and socio-ecological systems, as well as expert staff from the Hampton Roads Planning District Commission, Wetlands Watch, and the cities of Hampton and Norfolk.

"It was particularly gratifying to see key universities in the commonwealth coming together for the Rotating Resilience Roundtables initiative. We have an opportunity for this consortium to place Virginia at the leading edge of a research area that is critical to the future welfare of citizens, not only within our own state but also throughout the world. Our universities can and should continue to work synergistically and collaboratively on such global problems, and I see Coastal@VT as an exemplar of how this can be achieved," said Dennis Dean, director of the Fralin Life Sciences Institute.

Jennifer Irish and Robert Weiss of Coastal@VT co-chaired the organizing committee for the 2018 Annual Virginia Academy of Science, Engineering, and Medicine Summit: Securing Prosperity in the Coastal Zone. While there are ongoing initiatives to address contemporary coastal issues at the community level, the goal of the summit was to move toward a holistic conversation about promoting prosperity in Virginia's coastal zone and its role in the nation's well-being across geographic and

government scales.

"Proactive, smart, and science-informed policies must be developed to accommodate the region's growing population and ensure its economic growth. These policies require coordination across city, county, and state lines. The VASEM Summit helped to jump-start some of these conversations and collaborations among people who don't usually meet," said Weiss.


The summit format intentionally created active-engagement opportunities for attendees to begin meaningful dialogues on assets, stressors, and opportunities related to coastal prosperity. In addition to high-level oral presentations and directed discussion periods, a highlight of the event was a lively poster session that showcased critical scientific and technological advances, as well as Virginia's breadth of expertise in the area of coastal zone issues.

“Our goals for the VASEM Summit were to begin a dialogue around the interdisciplinary issues related to coastal prosperity that would engage the private sector, public sector, and academia equally. We also wanted to bring the universities within Virginia together to create a collaborative environment to address coastal issues,” said Jennifer Irish, a professor of civil and environmental engineering in the College of Engineering at Virginia Tech and a Coastal@VT faculty member.

Coastal@VT faculty not only conduct collaborative and interdisciplinary research but also place an emphasis on inclusiveness and diversity by engaging graduate and

undergraduate students in research activities, enabling them to learn cutting-edge skills. They are also active in numerous outreach and service initiatives.

In March 2019, Coastal@VT co-leader Anamaria Bukvic and Coastal@VT faculty member Sarah Karpanty led an interactive Kids' Tech University talk about the impacts of sea-level rise. The Kids' Tech University program at Virginia Tech is different from other kids' programs because it puts real researchers in front of children to give exciting interactive sessions on those famous "why" questions that have always intrigued children.

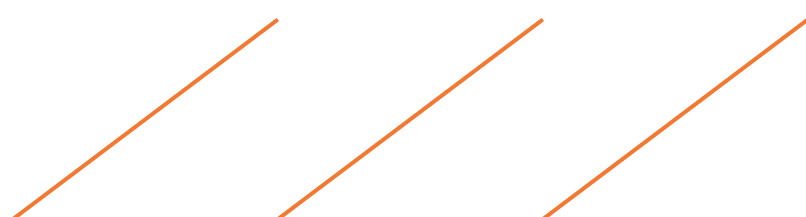
Bukvic and Karpanty encouraged the students to think about the various lines of evidence that prove that sea level is rising. Then, they asked the children to think about how that will impact individuals and communities. They concluded with brainstorming about possible solutions and a demonstration showing students how to put together an emergency backpack to be prepared for hurricanes, floods, and other natural disasters. Future plans for Coastal@VT encompass playing a part in the Future Earth Coasts program and involving Virginia Tech faculty in international, sustainable, coastal development. 



Proactive, smart, and science-informed policies must be developed to accommodate the region's growing population and ensure its economic growth. The VASEM Summit helped to jump-start some of these conversations and collaborations among people who don't usually meet.



Robert Weiss



DRRM^{VT}

NEW GRADUATE EDUCATION PROGRAM AT VIRGINIA TECH
ADDRESSES **DISASTER RESILIENCE AND RISK MANAGEMENT**

By Ebone Smith



With the country's annual average of \$20 billion in damages due to natural disasters, it is vital that researchers find ways to improve national mitigation, resilience, and recovery strategies. Disasters affect people across all walks of life, and developing resilience and restoring communities requires collaboration among experts across a wide range of different disciplines.

A group of Virginia Tech faculty including Robert Weiss, Marie Paretti, Margaret Cowell, Jennifer Irish, Yang Zhang, and Christopher Zobel set forth to address this issue by developing a new graduate program. In 2017, these faculty members were awarded a five-year grant from the National Science Foundation Research Traineeship (NRT) to support the Disaster Resilience & Risk Management (DRRM^{VT}) transdisciplinary graduate program.

The DRRM^{VT} program kicked off in the fall of 2018 after accepting 10 doctoral students with five different disciplinary focuses: geoscience, civil engineering, engineering education, business information technology, and urban affairs and planning. The cohort is led by faculty members with diverse educational backgrounds to encourage transdisciplinary collaboration.

Although the program consists of a broad spectrum of fields of study, the students and faculty strive to “cross boundaries and create new ways of thinking,” explained DRRM^{VT} coordinator, Aaron Akers. “This program aims to do that in the context of disaster and focusing on being able to help communities prepare for, recover from, and move forward from disaster and become sustainable.”

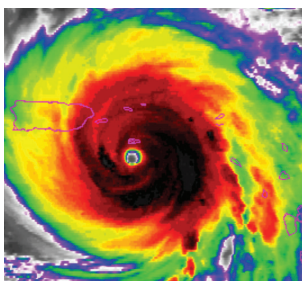
The transdisciplinary focus of the program allows for the students to work together to share ideas and build strong rapport among one another. This collaboration is encouraged by the interactive seminars and classes centered around group projects and discussions.

 The United States spends an annual average of \$20 billion in damages due to natural disasters.

Photo courtesy of Robert Weiss.

THE STUDENTS EACH HAVE THEIR OWN INDIVIDUAL PROJECTS UNDER THE THREE RESEARCH THRUSTS

NATURAL HAZARDS AND PHYSICAL IMPACT



SOCIOECONOMIC IMPACTS AND RECOVERY



STAKEHOLDER INTERACTION AND ENGAGEMENT



During the 2018 fall semester, DRRM^{VT} scholars worked in groups to analyze different research problems regarding certain disasters such as Hurricane Maria and the Fukushima nuclear disaster. Although overarching topics may have overlapped, how each group defined the problems within the topic varied just by collaborating across different disciplines.

Doctoral students Laura Szczyrba and Duygu Pamukcu conducted their study on housing recovery in Puerto Rico after Hurricane Maria, which they have continued to work on with professors. “We are taking that class project, and we are reworking it for publication,” said Laura Szczyrba.

While the program is very dynamic, the students each have their own individual projects under the three research thrusts: natural hazards and physical impacts, socioeconomic impacts and recovery, and stakeholder interaction and engagement.

The natural hazards and physical impacts thrust focuses on post-disaster destruction and mitigation strategies through a lens of business and urban affairs. The approach to this research involves using current resources to create projections of future hazard and physical impact, as well as making advancements in overall predictions of hazards.

“I want to make uncertainty quantifications so that the decision making can be more accurate and correct,” said Jun-Whan Lee, a Ph.D. student in the DRRM^{VT}, with a civil engineering background.

DRRM^{VT} was a match for Lee because of his prior work experience which left him with questions he wanted answered. His research incorporates the natural hazards and physical impacts thrusts through its focus on developing models for tsunamis and storm surge in order to predict hazards not only accurately but also rapidly.

Improving place-based models and using existing data and methods are two approaches that are also used under the socioeconomic impacts and recovery thrust. Under this research thrust, Duygu Pamukcu, an international doctoral student from Turkey with a background in business information technology, focuses on improving risk assessment policies and operations through the use of optimization and simulation.

“It is really hard to communicate with non-environmental organizations because they don’t know how to implement theoretical or academic approaches to their study; so, I would like to learn how can I connect with them better,” explained Pamukcu.

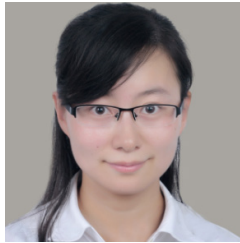
Although Pamukcu is at the beginning of her research, she is passionate about taking what she learns from her DRRM^{VT} graduate research back to Turkey, where she will try to implement her findings into the disaster management efforts and apply them to inter-organizational communication.



Aaron Akers

PLANNING, GOV., & GLOBAL

Research interests: Economic disaster, deindustrialization, and economic resilience



Qiong Wang

PLANNING, GOV., & GLOBAL

Research interests: Disaster mitigation and recovery strategies and policy including green infrastructure and property buyout policy



Jessica Deters

**ENGINEERING EDUCATION
GRADUATE ASSISTANT**

Research interests: Experiences of students who do not choose traditional engineering careers



Tiffany Cousins

PLANNING, GOV., & GLOBAL

Research interests: The use of social media and participatory GIS during disaster to help make better decisions



Catherine Jeffries

GEOSCIENCES

Research interests: Development and implementation of tsunami models to increase understanding of tsunamis and contribute to increased accuracy of tsunami warning



Anmol Haque

CIVIL ENGINEERING

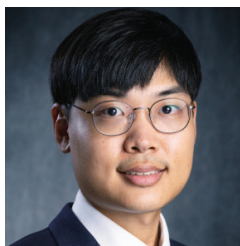
Research interests: Evaluation of risk assessment of tropical cyclones and storm surges with an integration of the physical and social characteristics associated with the hazard



Duygu Pamukcu

BUSINESS INFO. TECH

Research interests: Optimization and simulation models for quick and efficient plans for disaster management operations and real life implications of these models



Jun-Whan Lee

CIVIL ENGINEERING

Research interests: Development of rapid and accurate tsunami and storm surge models considering sea level rise



Laura Szczyrba

GEOSCIENCES

Research interests: Interpreting the information preserved in tropical storm sediment deposits in order to improve quantitative coastal hazard assessments.



Ruixiang Xie

PLANNING, GOV., & GLOBAL

Research interests: Public policy process including policy learning, policy diffusion and policy evaluation of resilience

Part of disaster management is ensuring that stakeholders are engaged and thoroughly educated on the vulnerabilities, risks, and impacts of natural hazards so they can make informed decisions. Integration – stakeholder interaction and engagement – is the third research thrust under the DRRM^{VT} program, which focuses on effectively disseminating scientific information to stakeholders to increase their understanding of the natural disaster.

“I’m interested in influencing government policy and having an impact,” said Tiffany Cousins.

Cousins, a Ph.D student in the DRRM^{VT} program, is passionate about improving policy around disaster management in order to improve stakeholders’ decisions. Cousins is confident that the DRRM^{VT} program will provide her with the tools and skills to influence stakeholder decision-making.

“We all have this common ground and interest in disaster management; we all to some extent want to revolutionize the way government and communities prepare and recover from disasters—let’s come together and do it,” said Cousins. ■

<https://www.drrm.fralin.vt.edu/index.php>



It is really hard to communicate with non-environmental organizations because they don’t know how to implement theoretical or academic approaches to their study, so I would like to learn how can I connect with them better.

Duygu Pamukcu





RESEARCHERS DISCOVER HOW “cryptic connections” IN DISEASE TRANSMISSION INFLUENCE EPIDEMICS

written by Kristin Rose
and Tim Stephens

Diseases have repeatedly spilled over from wildlife to humans causing local to global epidemics: HIV/AIDS, Ebola, SARS, and Nipah are all examples.

A new study by researchers of disease transmission in bats has broad implications for understanding hidden or “cryptic” connections that can spread diseases between species and lead to large-scale outbreaks.

By dusting bats with a fluorescent powder that glows under ultraviolet light, Virginia Tech researchers Joseph Hoyt and Kate Langwig, were able to trace the dynamics of disease transmission in bat species that have been devastated by white-nose syndrome, a deadly fungal disease that has killed 6.7 million bats in North America since 2006.

Their findings were recently published in the journal *Nature*.

“These results uncovered and quantified connections, both within and among species, that we never knew about before,” said first author Joseph Hoyt, who led the study as a UC Santa Cruz graduate student and completed the analyses at Virginia Tech as a research scientist in the Department of Biological Sciences in the College of Science.

“We had been seeing explosive epidemics where an entire bat population would become infected with white-nose syndrome within a month or two, and it was a mystery as to how that was happening. We are now able to more accurately explain and track the spread of white-nose syndrome, and our study has strong implications for predicting other epidemics,” Hoyt said.

When we think about who we might get sick from, we tend to think of our social groups: family, friends, and co-workers. But, we forget about that brief interaction with an employee at the DMV, a barista at a coffee shop, or shared airspace on public transportation. People are aware of these interactions, but not how important they are to the spread of epidemics. In the past, these types of hidden interactions have been poorly understood because they are so difficult to quantify.

Second author on the study, Kate Langwig, an assistant professor in the Department of Biological Sciences at Virginia Tech, said this study shows that infrequent and indirect connections, also called ‘cryptic connections,’ among individuals play a far larger role in the transmission of disease than was previously understood.

**ONE OF THE PUZZLING
FEATURES OF WHITE-NOSE
SYNDROME IS ITS ABILITY
TO SPREAD THROUGH A
COMMUNITY OF BATS
DURING THE WINTER,
WHEN THE ANIMALS ARE
HIBERNATING 99.5 PERCENT
OF THE TIME.**



We had been seeing *explosive epidemics* where an entire bat population would become infected with *white-nose syndrome* within a month or two, and it was a mystery as to how that was happening.

Joseph Hoyt



THE RESEARCHERS APPLIED THE FLUORESCENT DUST TO SEVERAL BATS IN EARLY WINTER, USING A DIFFERENT COLOR FOR EACH INDIVIDUAL BAT. IN LATE WINTER, THE RESEARCHERS RETURNED TO SEE WHERE EACH COLOR OF FLUORESCENT DUST ENDED UP.



“Cryptic connections are essentially pathways or connections between individuals that we wouldn’t normally be able to estimate or observe. They have largely been ignored by researchers in the past, but this study quantifies their importance. Our study creates an integrated model of social group connections and cryptic connections,” said Langwig, an affiliated faculty member of the Global Change Center, an arm of the Fralin Life Sciences Institute.

Coauthor A. Marm Kilpatrick, associate professor of ecology and evolutionary biology at UC Santa Cruz noted that spillover events, when pathogens spread from wild animals to human populations, tend to occur through these kinds of cryptic connections. “We don’t normally appreciate how important they are except retrospectively, when we investigate outbreaks of diseases like Ebola or SARS,” he said.

“Our study has compelling implications that will allow researchers to track seemingly random or indirect connections in wildlife that may spillover to human populations,” said Langwig.

The fluorescent dust used in this study proved to be highly effective at revealing cryptic connections among the bats. The researchers conducted the study at eight hibernation sites, mostly abandoned mine tunnels, in the upper Midwest. Each site had as many as four species of bats using it. At the start of the study, the pathogen causing white-nose syndrome had not yet reached these populations.

The researchers first surveyed the bats and characterized their social networks, measuring direct physical contacts among bats hibernating together in groups, as well as additional connections made by bats moving between groups. Then, they applied the fluorescent dust to several bats in early winter, using a different color for each individual bat. In late winter, the researchers returned to see where each color of fluorescent dust ended up.

“We amassed huge data sets for every single bat in each population. We characterized the bats’ social groups, and also used the fluorescent dust to track their movements and contacts,” said Langwig.

The researchers found that “the spread of the dust mirrors how the fungal pathogen spreads, so we can see if a bat deposits dust somewhere in the environment and another bat passes through and picks it up. It also reveals infrequent direct contacts that we would not normally observe,” said Hoyt.

The fungal pathogen that causes white-nose syndrome arrived in the area after the fluorescent dust studies were conducted, and the researchers also tracked its spread at each site. They found that the actual transmission dynamics of the disease were better explained by the sum of all the connections revealed in the dust studies than by just using the hibernation social groups.

“We were able to explain the actual invasion of the pathogen much better by including those cryptic connections, and they were even more important for explaining transmission between species than for transmission within species,” Hoyt said.

One of the puzzling features of white-nose syndrome is its ability to spread through a community of bats during the winter, when the animals are hibernating 99.5 percent of the time. They rouse from hibernation only very briefly every two to three weeks. Yet the dust studies showed that they move around enough to have many more connections than can be observed in their hibernation groups.



When we put fluorescent dust on the northern long-eared bat, it would show up on other species that we had never seen them interact with. *We would never have predicted that the infection could spread by that route.*

Joseph Hoyt



Most striking were the cryptic connections revealed for one species, the northern long-eared bat, which roosts by itself, not in groups. Although classical theory would predict low infection rates for this solitary species, it has been hard hit by white-nose syndrome.

“When we put fluorescent dust on the northern long-eared bat, it would show up on other species that we had never seen them interact with. We would never have predicted that the infection could spread by that route,” Hoyt said.

The researchers discovered that a different solitary species, the tri-colored bat, has a lower infection rate and showed less evidence of cryptic connections with other bats, but did transfer dust to surfaces in the sites where it roosts. “We found that the tri-colored bat is much more spatially segregated. It’s not that it doesn’t rouse and crawl around, it just does so in a range that has less overlap with other bats—it appears to be more territorial in its use of space,” Hoyt said.

Unfortunately for bats, the spores of the fungal pathogen that causes white-nose syndrome stay in the environment and remain infectious for years. Once the walls and ceiling of a cave have been contaminated with the spores, bats using the site for hibernation will be exposed to infections year after year.

White-nose syndrome is considered one of the worst wildlife diseases in modern times, having killed millions of bats across North America. White-nose syndrome does not appear to pose a risk to human health. It is caused by the fungus *Pseudogymnoascus destructans*, which grows optimally at low temperatures. The United States Geological Survey said, “Thousands of people have visited affected caves and mines since white-nose syndrome was first observed, and there have been no reported human illnesses attributable to white-nose syndrome. We are still learning about the disease, but we know of no risk to humans from contact with white nose-affected bats.”

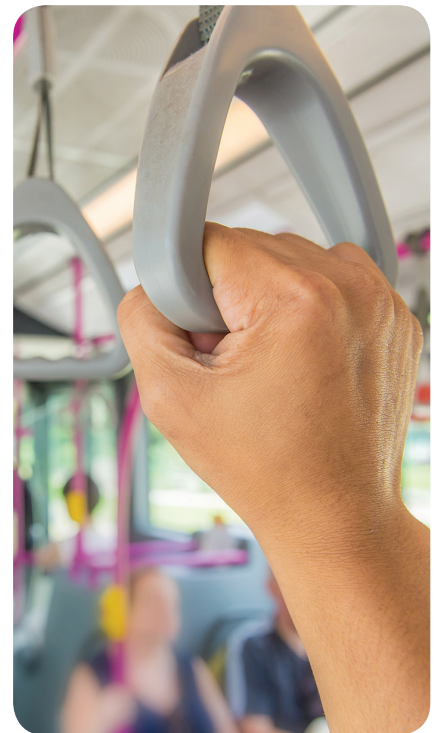
The Virginia Tech and UC Santa Cruz researchers are part of a coordinated response to white-nose syndrome involving state and federal agencies, universities, and nongovernmental organizations.

In addition to Hoyt, Langwig, and Kilpatrick, the coauthors of the paper include Paul White, Heather Kaarakka, and Jennifer Redell at the Wisconsin Department of Natural Resources; Allen Kurta at Eastern Michigan University; John DePue and William Scullon at the Michigan Department of Natural Resources; Katy Parise and Jeffrey Foster at the University of New Hampshire; and Winifred Frick at Bat Conservation International and UC Santa Cruz. This work was supported by the National Science Foundation, US Fish and Wildlife Service, and Bat Conservation International.

Hoyt and Langwig were hired as part of the Global Systems Science Destination Area in the College of Science at Virginia Tech to address issues of infectious disease. The Global Systems Science Destination Area is focused on understanding and finding solutions to critical problems associated with human activity and environmental change, that, together affects diseases states, water quality, and food production. **e**



WHEN WE THINK ABOUT WHO WE MIGHT GET SICK FROM, WE TEND TO THINK OF OUR SOCIAL GROUPS: FAMILY, FRIENDS, AND CO-WORKERS. BUT, WE FORGET ABOUT THAT BRIEF INTERACTION WITH AN EMPLOYEE AT THE DMV, A BARISTA AT A COFFEE SHOP, OR SHARED AIRSPACE ON PUBLIC TRANSPORTATION.







If you've ever experienced jetlag, you're familiar with circadian rhythms.

Various processes in the human body are governed by circadian rhythms, even down to the individual cell. These processes are tightly controlled by a variety of molecular mechanisms and feedback loops that help the body self-regulate in response to external cues like sunlight and temperature. Researchers are now discovering that molecules usually implicated in protecting us from cancer initiation and progression are directly involved in regulating the function of our daily circadian rhythms. Not only that, but this molecular interplay seems to regulate how well our body responds to therapeutic modalities seldom delivered to treat diseases such as cancer.

In a recent paper in *Science Signaling*, Associate Professor of Cell and Molecular Biology in the Department of Biological Sciences Carla Finkielstein and her collaborators identified an alternative mechanism to control circadian rhythms in normal cells that is driven by oncoproteins. This discovery places molecules involved in monitoring and calibrating the response of cells to genomic damage at the center of the machinery driving circadian rhythms.

While healthy cells share a circadian rhythm with the rest of the body, tumors often have a different rhythm than the healthy cells surrounding them. Tumors divide differently than healthy cells and at different times. Like a person singing out of tune within a chorus, that one difference can ultimately wreck the entire melody. Or in this case, the healthy functions of cells.

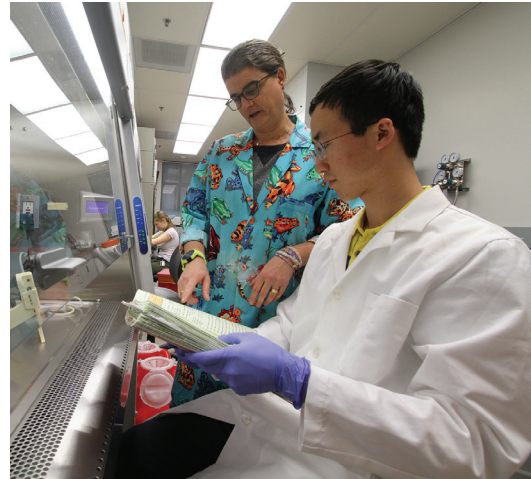
"We know that our cells experience over 10,000 mutations a day. These are usually mitigated by a repair system comprised of a host of protein interactions. However, only a handful of mutations, three to six depending on the type of cancer, are needed for malignant cells to get a foothold. And if one of these mutations occur in the repair system, then the chances for cancer increase dramatically," said Finkielstein, an affiliated faculty member of the Fralin Life Sciences Institute.





We can now test the hypothesis of how deregulation of circadian rhythms, for example by shift work, could be associated with the etiology of cancer.

Carla Finkielstein

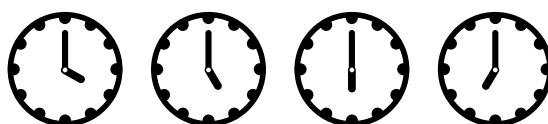


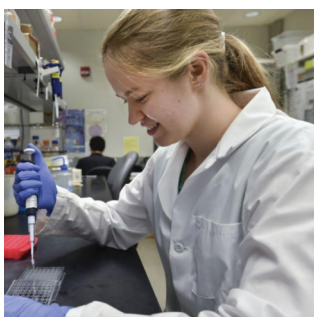
A small number of regulatory proteins like the circadian protein PERIOD 2 (PER2) act as sensors, while the tumor suppressor p53 and the oncoprotein MDM2 act as integrators. These proteins keep the division of cells regulated and timely. In the last few years, the transdisciplinary team of researchers has been patiently unwinding the crosstalk mechanisms responsible for understanding how the circadian clock and the cell division machinery coordinate processes to specifically understand how their regulation can be exploited therapeutically.

“Our findings were totally unexpected and welcome as they expanded our vision of how the circadian clock is regulated in normal cells to include components of the cell division cycle that are necessary to keep proliferation in check,” said Finkielstein. “As a result, we can now test the hypothesis of how deregulation of circadian rhythms, for example by shift work, could be associated with the etiology of cancer or how mutations in ‘guardian’ genes responsible for proliferative decisions lead to abnormal clocks in cancer cells, a finding of relevance when considering new therapeutic opportunities.”

The Science Signaling paper was authored by Ph.D. student Xianlin Zou in Finkielstein’s lab; Zou won the Sigma Xi research award for the experimental work reported in the article.

Esther Wisdom, an award-winning undergraduate student in Finkielstein’s lab, also helps study the types of cancer that most often arise from dysregulation of circadian rhythms. “Interestingly, a proportion of p53-mutated breast cancer arise in women exposed to chronic circadian disruption, such as nurses working night-shifts. Consequently, my work focuses on understanding the interplay between mutated p53 and PER2 and how their interaction can be exploited therapeutically,” said Wisdom, a double-major in the Department of Biochemistry in the College of Agriculture and Life Sciences and microbiology in the Department of Biological Sciences in the College of Science.





A proportion of p53-mutated breast cancer arise in women exposed to chronic circadian disruption, such as nurses working night-shifts.


Esther Wisdom

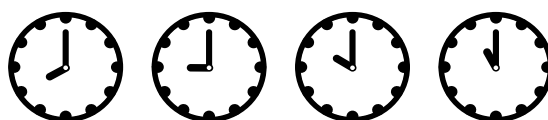
This interaction of p53 and PER2 is of particular interest to Finkielstein's lab as mutations in the p53 gene occur with the highest frequency in sporadic breast cancer cases, a form of breast cancer that is not inherited and accounts for 90 percent of all cases reported.

The good news is that this interplay among circadian molecules, oncoproteins, and tumor suppressors as previously discovered by Dr. Finkielstein's group, can be used to tailor therapeutics in a more effective way.

Fine-tuning these processes is critical for maintaining normal cell function. Chronotherapeutics, or the application of therapeutics at times when drugs are most efficacious, have seldom been used in modern medicine. But the evidence is mounting that timing is truly everything when it comes to the best treatment plans. Lower and more effective doses translate in less side effects for patients, which is particularly relevant to cancer patients who are often given massive doses of very aggressive drugs. What has delayed the application of chronotherapeutics seems to be a lack of molecular foundation for the theory.

Time in the case of the genesis of these cancers is indeed of the essence, not only in terms of dealing with the dysregulation of circadian rhythms caused by shift work or frequent international travel, but also in discovering the most efficacious moment to administer treatment.

In the uncharted waters of chronobiological research, Finkielstein and her team are forging ahead to discover not only how cancer occurs but when and why it occurs. Their findings could help us understand when tumor cells are most treatable and deliver more effective treatments at the proper time. 



Acknowledgments: Jingjing Liu – former graduate student, now at St. Jude Children's Research Hospital; Esther Wisdom – undergraduate in the College of Science; Tetsuya Gotoh – former postdoc; Anne Brown, Assistant Professor from Research and Informatics, University Libraries; Jae Kyoung Kim, Associate Professor, Department of Mathematical Sciences, Korea Advanced Institute of Science and Technology, South Korea; This work was supported by a grant from the National Science Foundation.

A New Twist on an Old Project:

ALEXA SALSURY USES COMPUTATIONAL BIOCHEMISTRY TO TACKLE NEURODEGENERATION, CANCER, AND PREMATURE AGING

by Kendall Daniels

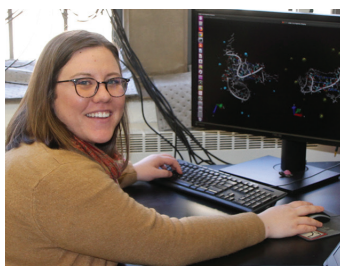
In December 2018, Alexa Salsbury, a Virginia Tech graduate student in the Department of Biochemistry, received the Bruce M. Anderson Graduate Award for the Outstanding First-Year Biochemistry Graduate Student.

“When I heard I had received the award, it was unexpected but validating. It meant a lot to me because I really respect the other people in my graduate cohort and department,” said Salsbury.

Salsbury is pursuing her interests in computational biochemistry. She is performing molecular dynamics simulations on DNA G-quadruplexes to gain a better understanding of their dynamics and folding. DNA G-quadruplexes serve as regulators of gene expression and altered stability, and their formation is linked to a number of diseases, ranging from mental retardation and neurodegeneration to several types of human cancer.

Originally from a rural area in Ohio, Salsbury is a first-generation college student. As a child, she wanted to become a medical doctor, but through her undergraduate education and research at Eastern Michigan University, she realized there were many other career possibilities in science that contribute to the medical field.

It was Virginia Tech’s strong reputation as a university, as well as its vast abundance of research opportunities, that brought her to Blacksburg as a graduate student. She instantly felt connected with the Biochemistry Department and said, “There was a combination of camaraderie and mentorship that I felt I would get in a small



“Being from a family without a lot of college or research experience, it was really cool to talk to the kids and hear, ‘Oh, I want to be a scientist when I’m older.’”

Alexa Salsbury

department, but I’d also have access to all the resources of a big university.” However, her academic aspirations didn’t stop there.

The Practice & Experience in Advanced Research Computing Conference (PEARC) is an annual meeting that provides a forum for discussing challenges, opportunities, and solutions among the broad range of participants in the research computing community. Salsbury’s involvement with PEARC was sparked by a seminar provided by the Department of Biochemistry. At that seminar, a National Science Foundation (NSF) program officer spoke about NSF’s mission and vision to promote the progress of science through research and outreach. Salsbury approached Anne M. Brown, an assistant professor in research and informatics in the University Libraries and an adjunct professor in the Department of Biochemistry in the College of Agriculture and Life Sciences, about computation-centered outreach efforts that would allow her to engage underrepresented youth, like herself, in STEM (Science, Technology, Engineering, and Mathematics).

Every year, Salsbury and Brown perform outreach with Virginia Tech’s HyperCube, an immersive visualization environment that projects anything from DNA strands to intricate networks of neurons in a large 10’ by 10’ room.

This past year, Salsbury received the award for best student paper at the PEARC conference titled, “Using Immersive Visualization Environments to Engage Students in Hands-on Learning.”

“Our ability to engage in outreach experiences like the one in the HyperCube highlights our dedication to Virginia Tech’s land-grant mission by providing routes to connect with students and highlight the connection between “cool” technology and science. Alexa’s outreach work demonstrates areas of science and research in new ways, hopefully sparking interest and increasing accessibility to all students,” said Brown.

The HyperCube attracts kids and higher achievement groups from all over the nation, as well as others who have an inherent desire to learn more about science, something Salsbury can identify with. “Being from a family without a lot of college or research experience, it was really cool to talk to the kids and hear, ‘Oh, I want to be a scientist when I’m older.’ And I can ask, ‘Okay, What kind of scientist? A researcher?’ Questions that people never asked me, and I didn’t ever really think about.”

Her first introduction to computational biochemistry was through multiple lab rotations in the Biochemistry Department. At the time, Justin Lemkul, a new assistant professor of biochemistry in the College of Agriculture and Life Sciences, was beginning projects on G-quadruplexes. In his post-doctoral position, Lemkul helped create and refine a groundbreaking polarizable force field for DNA, parametrization work that would eventually propel his research to new

and exciting heights. Salsbury says that its significance in drug design and therapeutics combined with her mentor's passion for the work drew her towards the Lemkul Lab and G-quadruplex research.

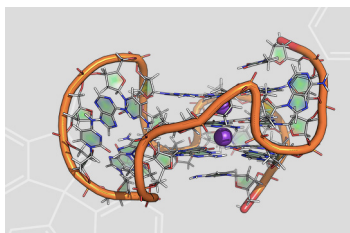
Currently, the Lemkul lab is working on two distinct projects involving computational biochemistry, one involving Salsbury's G-quadruplex research, and the other involving simulations of amyloidogenic proteins – an area of collaboration with Brown.

After years of speculation, recent research has proven that G-quadruplexes do exist in human cells, as opposed to the previous assumption that they only existed in vitro. In short, G-quadruplexes are DNA structures that are rich in guanine, one of the four bases found in DNA. In fact, these structures form in functionally relevant regions of the genome, the same areas that contain the promoter regions for oncogenes, making them an integral structure in cancerous tumor development.

To better understand how G-quadruplexes and their stability play a role in disease, Salsbury is applying a polarizable force field to these biomolecules by using nuclear magnetic resonance (NMR) and crystal structural data. The theory behind the work is extracted from the disciplines of quantum mechanics, physics, and physical chemistry.

“On a surface level, my work involves sitting down at a computer and going through data files and coding. But, the broader implication of this research is gaining insights into these biomolecules so that they can be targeted for drug design. We can also get a better idea of how they're contributing to cancer, neurodegeneration, or premature aging through these fundamental investigations,” said Salsbury.

Although many simulations of G-quadruplexes have been performed in recent years, the Lemkul lab believes they can provide new and important information on these nucleic acid structures.



G-QUADRUPLEXES FORM IN THE SAME AREAS THAT CONTAIN THE PROMOTER REGIONS FOR ONCOGENES, MAKING THEM AN INTEGRAL STRUCTURE IN CANCEROUS TUMOR DEVELOPMENT.

“Our work is modeling some aspects of G-quadruplexes really well. We are seeing what we believe to be appropriate ion coordination and binding with atomistic detail. This is really cool and possible because of the inclusion of polarization,” said Salsbury.

“If we know how ions like potassium, lithium, or sodium bind, we can use that information to dictate small molecule binding, so we can leverage this information to stabilize or destabilize the G-quadruplex and help prevent disease or treat a disease,” said Salsbury.

The methodology of the Lemkul lab's research is new because they are the first to apply polarizable force fields to provide a better model of G-quadruplexes. In his post-doc position, Dr. Lemkul worked on an empirical polarizable force field that helped them gain greater comprehension of the driving forces for protein and nucleic acid folding and stability. This new polarizable force field has allowed the team to reach new heights and stay ahead of the competition. They hope to build upon this success to continue studying ion-DNA interactions.

“Alexa's research has the potential to provide critical details about new molecular targets for drugs against a variety of human diseases. She works diligently to describe detailed interactions within DNA G-quadruplexes to provide unprecedented insights. She has recently published her first peer-reviewed, first-author article describing her work on the c-kit1 DNA G-quadruplex, an important cancer target,” said Lemkul.


Salsbury is first author of a paper in the Journal of Physical Chemistry B, entitled “Molecular Dynamics Simulations of the c-kit1 Promoter G-Quadruplex: Importance of Electronic Polarization on Stability and Cooperative Ion Binding.”

In the paper, she uses the polarizable force field to investigate how potassium ions bind to the c-kit1 promoter G-quadruplex. The c-kit gene codes for a receptor tyrosine kinase that is required for blood vessel development in tumors, and is frequently mutated in a range of cancers, making drug design difficult. There are two G-quadruplexes in its gene promoter, both of which are potential targets for pharmaceutical development to turn off the c-kit gene entirely.

The Lemkul lab used simulations to understand factors that stabilize the structure so they can eventually understand how to design molecules that bind to it. This ongoing lab work is being led by Salsbury.

Molecular dynamics simulations can provide valuable scientific data and visualizations to both bench biochemists and medicinal chemists. “Molecular dynamics makes the discovery or process of understanding a complex phenomenon more affordable,” says Salsbury. “In terms of the drug market, it can reduce the cost and energy that goes into the process of developing new

therapeutics, which, in turn, should make therapeutics cheaper for consumers.”

In terms of her favorite part about her career, Salsbury said, “Computational research can really help accelerate research and scientific discovery. Advocating for the computational research field and helping people utilize the tools that are available is what I see for myself in the future.” 

Undergraduate biochemistry student uses computational modeling to tackle Alzheimer's disease

by Ebone Smith

Alzheimer's disease, the sixth leading cause of death in the United States, is a poorly understood chronic neurodegenerative disease. David Barto, an undergraduate biochemistry student at Virginia Tech, is using computational modeling to further understand the causes of this disease.

"Major strides in advancing medicine and finding cures often involves taking smaller steps to allow the scientific community to build off of each other's research," said Barto.

His computational research will provide information for researchers working in wet labs to better design experiments and provide drug researchers with possible structure targets for drug development.

Barto is a junior who came to Virginia Tech after graduating from Thomas Jefferson High School for Science and Technology, a magnet school in Alexandria, Virginia that focuses on inspiring joy at the prospect of discovery and fostering a culture of innovation through rigorous STEM learning experiences.

Barto's commitment to science and his hunger for a more challenging learning experience drove him to apply for the Blue Waters Student Internship during the spring of his freshman year.

The Blue Waters Student Internship Program is located at the University of Illinois at Urbana-Champaign and has a primary goal of engaging undergraduate students in petascale computing research and development projects. In computing, petascale refers to a computer system capable of reaching performance in excess of one petaflops, one quadrillion floating point operations per second.

Barto's experiences at the University of Illinois

at Urbana-Champaign gave him the opportunity to fill in the gaps and apply what he learned to a research project. "I believe research is a really valuable way for a student to take charge of their own education," he said.

This was especially true for Barto as he didn't know much about computational research coming into college. The Blue Waters Student Internship Program, with his undergraduate research experience at Virginia Tech, exposed him to the petascale computing curriculum to advance his computational skill-set, expanded his network of computational professionals within the field, and provided him with hands-on experience in presenting and writing research projects.

As part of the internship, Barto attended the Petascale Institute, which is a two-week long, 12-hour day crash course on everything involving high-performance computing. While participating in the Institute, he was able to gain insight into different coding languages and computational modeling programs, thus setting the foundation for his research project.

Upon completion of the Petascale Institute, Barto returned to Virginia Tech to begin working on his research project with assistant professor Anne M. Brown in

the Bevan & Brown Lab. The Bevan & Brown Lab is a Virginia Tech research group focused on the application of computational molecular modeling of biological systems.

Barto's undergraduate research project in the Bevan & Brown Lab involves analyzing large amounts of data regarding different protein aggregates involved with Alzheimer's

PETASCALE REFERS TO A COMPUTER SYSTEM CAPABLE OF REACHING PERFORMANCE IN EXCESS OF ONE PETAFLOPS, ONE QUADRILLION FLOATING POINT OPERATIONS PER SECOND.



disease. Using predictive modeling, he studies the potential toxicity and biological behavior and structure of the aggregates through computational simulations.

"David came to our lab eager to tackle a large project. He was a great fit for the Blue Waters program and gained so much from that experience that it jumpstarted his ability to create and start collecting a lot of data on the project," said Brown, an assistant professor in research and informatics in University Libraries and an adjunct professor in the Department of Biochemistry in the College of Agriculture and Life Sciences.

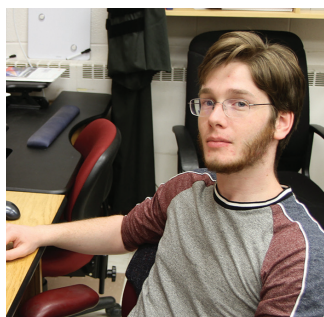
While conducting his research, Barto was appointed to represent Virginia Tech as an XSEDE Student Campus Champion at the Practice and Experience in Advanced Research Computing (PEARC) conference in 2018, where he also served as a student volunteer and delivered a poster presentation on his research.

Research projects like Barto's are essential to developing treatments in the medical field; however, "...there are many challenges to developing drugs for various diseases," he explained. One issue that he faces when producing the simulations is the sheer complexity of modeling these systems and the amount of data analysis needed and lack of tools available to find meaningful results.

He hopes the smaller steps he has taken will allow others in the scientific community to build off his research and gain further understanding of Alzheimer's disease and other neurodegenerative diseases.

Barto has continued to work through various subcomponents of his research project and hopes to complete his research soon. He will be publishing a research paper in a scientific journal and presenting his findings at more conferences.

Barto's experience with creating vast amounts of data and having to create workflows for managing them has compelled him to share his research data and findings. "What I have envisioned for



David Barto

“Major strides in advancing medicine and finding cures often involves taking smaller steps to allow the scientific community to build off of each other’s research.”

the project going forward is for the simulation output and script files to be archived on Virginia Tech University Libraries data repository, known as VTechData.”

This way, other researchers will be able to freely access his simulations without having to start from the beginning; thus, researchers will be able to start where Barto's research leaves off.

“This project is novel in the scope and magnitude that we are studying aggregate formation. With the resources from BlueWaters and VT's Advanced Research Computing, we have been able to make some big steps in our data collection and protocols. Sharing this data afterward is in-line with the concepts and initiatives of open science and data,” said Brown.

Although Barto has concentrated on this research project throughout his time at Virginia Tech, he is debating whether to continue research within this field of finding new drugs and treatments for Alzheimer's and other degenerative diseases or pivoting to focus on other interesting research.

“David has been an exceptional student to work with -- he has initiative and thinks critically about his results. I'm thrilled he decided to approach us in his Freshman year and start undergraduate research in our group,” said Brown.

Whichever research focus Barto decides to tackle next, he is confident in his plan to attend graduate school and further pursue his passion for computational and biological research. ■



FRALIN FELLOWS

THE FRALIN UNDERGRADUATE RESEARCH FELLOWSHIP IS A COMPETITIVE AWARD PROGRAM OPEN TO ALL VIRGINIA TECH UNDERGRADUATES TO PROMOTE DIVERSITY IN RESEARCH.

For the 2018-2019 academic year, 15 fellowships of \$1,000 each were awarded to individual students from 12 departments and five colleges who demonstrated academic capability and a strong interest in undergraduate research. Students applied to the program in the late spring of 2018 and began working on their research in the fall. The fellowship enabled these students to conduct research with a Virginia Tech faculty mentor who had agreed to mentor them and work on a new project.

The Fralin Fellows program was created by Dennis Dean, director of the Fralin Life Sciences Institute, in partnership with the Office of Undergraduate Research. Dean created the program because of how valuable his own undergraduate research experience at Wabash College was in launching his career. Although Dean is a biochemist, a key component of the program is that it is available to students interested in all types of research, even in fields outside of the life sciences.

Another key component of this program is Dean's desire to fund students from underrepresented groups, including but not limited to: ethnic minorities, first generation college students, students from low-income areas, students with disabilities, and LGBTQ+ students. In addition to developing a close mentoring relationship with their primary faculty member, fellows also met with Dean throughout the program. He was available for one-on-one meetings and hosted a lunch for students to meet one another and discuss their research, thus generating excitement and opening the doors to interdisciplinary collaborations. Students will present their research results at the end of the year in an undergraduate student showcase.



Photo by Kristin Rose. Color font by Twinbrush.



MIKA PAGANI

PROJECT: *Halyomorpha halys* feeding impact on industrial hemp yield and quality

Environmental Science
Mentor: Thomas Kuhar

Mika Pagani investigated the effect of *Halyomorpha halys*, the brown marmorated stink bug, on the vigor and vitality of the hemp plant. Hemp is a newly reemerging agricultural crop, and there is very little documentation about its pest presence. To study the relationship between hemp and the highly invasive bug, Pagani confined varying densities of stink bug colonies to the flowering portion of hemp on outside plots. The plants were monitored weekly to record symptoms of feeding damage. After several weeks, the seeds produced by the hemp plants were evaluated both qualitatively and quantitatively. The indoor trial consisted of rearing stink bug egg masses from nymphs to adults in a controlled environment with hemp used as habitation and sustenance. The results suggested a new finding that grain hemp is a suitable host plant for *H. halys*. Despite the stink bug feeding on the plant, the plant proved to be quite resilient. By better understanding the relationship between the insects and hemp, the threat of economic damage posed by the stink bugs is reduced. Pagani hopes that her research can empower the small community of hemp growers by providing valuable information that can aid in the future success of the crop.



MORGAN GALLAGHER

PROJECT: Identifying unknowns in the global carbon budget: quantification of water column methane production in oxic streams

Environmental Science
Mentor: Erin Hotchkiss

Morgan Gallagher's research involved freshwater streams and the greenhouse gas methane. Dissolved methane is found in streams, like in Stroubles Creek, where oxygen is plentiful. However, controls on methane production in oxygen-rich streams remain unexplored, despite recent research showing most streams emit methane to the atmosphere. Estimates suggest that ~30% of dissolved methane is internally produced in anoxic, or oxygen-free, sediments. The remaining 70% is attributed to various proportions of external groundwater inputs or from vegetation. Furthermore, recent lake studies found methane production occurring in the water column from microbes using algal carbon, potentially accounting for much of the remaining 70%. Gallagher explored if streams produce methane in the water column, how the methane is produced, and how the source of methane in streams varies temporally and seasonally. This research builds upon previous baseline data and offers a new perspective on in-situ methane production, which is crucial information to allow for better estimates of the global carbon budget.



ELIESER MEJIA

PROJECT: Scalable nanofabrication of nanotransducers

Electrical Engineering
Mentor: Wei Zhou

The emergence of new fabrication techniques, such as nanoimprint lithography, has opened new avenues for producing high resolution nanostructures with precise control. With this in mind, Elieser Mejia worked to develop a low-cost, high throughput, and scalable nanoimprint patterning process to fabricate nanohole array templates that can be used for multi-layered thin film deposition. Ultimately, the target structure is an array of opto-nanoelectrodes consisting of alternating thin layers of gold and indium titanium oxide, which yield unique optical and electrical properties ideal for a brain-machine interface. Overall, the fabrication method involves the use of polymers with select thermal, chemical, and mechanical properties to produce both the mold used for imprinting and the bi-layer polymer stack serving as the template base. Currently, the fabrication method yields uniform templates, and the next phase in the project is to vary the hole diameter using a better-quality mold coupled with atomic layer deposition to increase the hole diameter. Ultimately, the long-term goal is to use this novel fabrication method to develop opto-nanoelectrode arrays capable of simultaneously achieving cell stimulation, extracellular and intracellular recording, and surface enhanced raman spectroscopy in neural networks using acute brain slices from adult mice.



ALEXANDRA RUSSELL

PROJECT: Microscopic analysis and phase characterization of rare earth elements in select coal seams

Mining Engineering
Mentor: Aaron Noble

Alexandra Russell looked at the occurrence and presentation of rare earth elements (REEs) in fine coal waste products that contain quantities of REEs approaching that of economic deposits. She has been working for the past year to identify the mode that these REEs occur in coal byproducts by using advanced microscopy and separation technologies to specifically characterize these elements and minerals. The minerals she has identified are on the scale of microns, which adds a level of difficulty to identification and process development. Her work will be used in the future to test various forms of chemical extraction to extract these valuable elements from coal waste in order to create an economically viable resource of REEs in the United States. This is important since the U.S. does not have a domestic source of these elements and has identified them as a critical resource that is vital in national defense, clean energies, and technological advancement.



AINSLEY PATRICK

PROJECT: Sleep difficulties in youth with specific phobia: an important and unexplored relationship

Psychology
Mentor: Thomas Ollendick

Ainsley Patrick's research investigated sleep difficulties among youth with specific phobias. Specific phobia is a type of anxiety disorder that develops as an irrational fear of an object or situation that actually poses little to no harm. There are different types of specific phobias, such as situational, animal, natural environment, blood/injection/injury, and more. Patrick's study aimed to determine if there was a significant difference in the levels of reported sleep difficulties in youth who are diagnosed with one of the subtypes of specific phobia. Under the direction of Thomas Ollendick and his graduate students, she differentiated specific phobia subpopulations and compared their sleep difficulties based on parent-reported sleep difficulties on the Child Behavior Checklist. Her results showed that youth with natural environment or situational subtype specific phobias had greater levels of sleep difficulties, specifically with phobias associated with storms and the darkness. Interestingly, and contrary to hypotheses, age and gender did not significantly influence the relationship between specific phobias and sleep difficulties.



KELSEY MCMAHON

PROJECT: The effect of an increasing juvenile population in adult prisons

Sociology
Mentor: Donald Shoemaker

Kelsey McMahon studied the effect of the adult prison system on juvenile delinquents. After completing a different project in this field of study, she recognized the problems in the American justice system. An alarming number of juveniles are sent to prisons intended for adults. Within this system, children are more likely to develop mental health issues due to the difficult challenges they face that would not be present in juvenile institutions. For example, there is an increased threat of sexual assault in adult prisons. McMahon studied the type of legislature allowing judges to send children to adult prisons, what happens to them while they are incarcerated, and alternative options to prevent children from being sent to adult prisons in the first place. McMahon produced an analysis of what happens to juveniles in the adult prison system that she hopes to present at conferences and publish in literary journals at Virginia Tech. Pending approval, McMahon plans to interview formerly incarcerated individuals, as well as lawyers and judges, in the juvenile justice system to discuss the effects and experiences of the people so closely tied to this issue.



THOMAS HALE

PROJECT: China-Pakistan Economic Corridor public messaging: an economic development plan or geopolitical maneuvering?

Political Science

Mentor: Yannis Stivachtis

Thomas Hale studied how China's Belt and Road Initiative created a framework for fundamental development and strategic changes across South and Central Asia. The BRI is a multitrillion dollar initiative to strengthen China's connections with the rest of Asia, Africa, and Europe by promoting the flow of goods, investment, and people. Out of this bold initiative grew the China-Pakistan Economic Corridor, a plan to modernize Pakistan's infrastructure and economy. While marketed towards mutual cooperation and development, scholars and analysts see CPEC as a bold geopolitical move for Chinese influence in the region. Hale studied the motivation behind CPEC to determine if the initiative was a geopolitical maneuver or really an economic outreach program to help redevelop Pakistan. Hale analyzed the messaging produced by the Chinese government on CPEC projects versus the reality of the situation. His goal was to provide a strategic approach to countering Chinese narrative on CPEC. With reduced relations between the U.S. government and Pakistan, China could become the main actor for the Pakistani government to fill the void left by the current administration's aid/trade cuts. The strategic implications of CPEC projects will create major changes in the US Indo-Pacific strategy and the role Pakistan plays in South Asia.



SOPHIA TEXTORIS

PROJECT: Examining sibling experiences in families of individuals with mental illness

Human Development

Mentor: Carolyn Shivers

Sophia Textoris worked to better understand the experiences of individuals with mental illness (MI) and their siblings. This study was based on findings from a systematic review of the literature on siblings of individuals with MI. However, most current literature on siblings of individuals with MI focused on schizophrenia. Thus, there is very little known about siblings of individuals with more prevalent MI, including anxiety and depression. Data from the study built on results from a review of the literature completed by the PI expanded their knowledge of how mental illness impacts individuals and their siblings, with a focus on recruiting participants who have a wide range of MI diagnoses (e.g., depression, anxiety, eating disorders, etc.). This information will help families, clinicians, and researchers better understand the relationship between siblings when one has an MI, thus providing information to support the development of interventions and strategies to encourage healthy sibling relationships. The proposed analyses are next in a series of studies focused on siblings of individuals with MI. What started as an exploratory visit with a new professor has become, through the support of Fralin, an ongoing trajectory of research to close the gaps in understanding the experiences of MI-Sibs.





BECKY TRAN

PROJECT: Effects of butyrate on nitrogen corrected apparent metabolizable energy of broiler chicks

Animal and Poultry Science
Mentor: Michael Persia

There is an increasing pressure to replace or reduce the use of antibiotics in the poultry industry. Becky Tran studied how different butyrate feed additives could be used to improve digestion of young broiler chickens by aiding in the development of their digestive system, which can increase meat production in the absence of antibiotics. Butyrate is a short-chain fatty acid that has been shown to promote the growth of villi, finger-like projections that increase the absorptive surface area of the intestines to promote the uptake of nutrients. In her project, Tran researched if butyrate with varying attachments, which affect the location of product absorption, would have an effect on the growth performance and level of nitrogen-corrected Apparent Metabolizable Energy (AMEn) of the chicks. She hypothesized that the supplementation of a protected butyrate, designed to delay the absorption of butyrate until it reaches the intestine, should increase the intestinal health of broiler chickens, resulting in an increase in AMEn. When butyrate was added to the diet, AMEn increased by 105 kcal/kg compared to the control-fed broilers. This positive response is likely due to increased intestinal health, resulting in greater nutrient absorption.



RACHAEL WARD

PROJECT: CureVTNeuro: characterization and validation of a post-traumatic epilepsy model for the study of biological and physiological changes or predictors

Experimental Neuroscience
Mentor: Michelle Hedrick Theus

Rachael Ward and the Theus Lab studied the effects of traumatic brain injury (TBI), a highly prevalent injury that has disabled and killed millions of individuals. Ward's project focused on the relationship between the blood brain barrier (BBB) permeability and the peripheral immune system with TBI recovery. Post TBI, the breakdown and repair of the BBB is crucial in determining the extent to which the brain can recover. Disruption of the BBB allows for material from the rest of the body, including peripheral immune cells, to infiltrate the exposed tissue. EphA4, a receptor believed to play a role in BBB, is a protein found on the outer membrane of endothelial cells. Preliminary research indicated that EphA4 mediates BBB permeability and decreases the rate and ability of blood flow restoration. The change in BBB permeability is associated with an increase in EphA4 and plays a negative role in neuronal recovery. They used lab-generated wildtype and EphA4 knockout mice in a model of TBI. Each mouse was given a moderate impact and then sacrificed at 2, 24, or 48 hours post-TBI. Their brains were processed, sectioned, stained, and analyzed for immune infiltration and activation using antibodies against CD45 and CD68, respectively. Ward hypothesized that the EphA4 knockout mice showed reduced immune cell infiltration and BBB permeability, correlating with improved functional recovery.



AMBER ABBOTT

PROJECT: Ret signaling in herpes simplex virus latency and reactivation

Microbiology
Mentor: Andrea Bertke

Amber Abbott examined the role of neurotrophic factors (NTFs) in the herpes simplex virus (HSV). NTFs are small proteins that maintain neuron growth and survival, and their cellular signaling pathways are related to HSV latency and reactivation. The latency period refers to the period of time between being exposed to a disease and developing symptoms. The Bertke Lab previously found that when NTFs are bound to their receptors on the receptor tyrosine kinase Ret in adult sensory neurons, the virus is maintained in a latent state. When these factors are removed, the virus reactivates, and the disease recurs. Abbott cultured and infected adult neurons, treating them with NTFs and other chemical compounds, and performed quantitative polymerase chain reaction and Western blots to investigate the presence of viral DNA and Ret, respectively. The results showed that one chemical compound can prevent HSV reactivation during NTF deprivation, suggesting that Ret signaling is important in maintaining latency. Abbott also determined that Ret may not be activated at the specific site she previously thought after NTF treatment. Therefore, the NTFs may induce different cellular signaling pathways than expected. Future studies are needed to establish what these pathways are in order to ultimately prevent viral reactivation.



MIAN LIAO

PROJECT: Three-phase brushless DC motor control for electric bike (power electronics)

Electrical Engineering
Mentor: Jason Lai

COURTNEY LINKOUS

PROJECT: Influence of vegetation choice for nest-site selection of song sparrows in urban and rural habitats

Wildlife Conservation
Mentor: Kendra Sewall

ADRI RIDINGS

PROJECT: Queer and transgender access to collegiate mental health services: Virginia Tech

Biochemistry
Mentor: Rebecca Hester

ANNELISE STUNES

PROJECT: DNA damage as a measure of environmental stress in animals

Biological Sciences
Mentor: Ignacio Moore



about FRALIN LIFE SCIENCES INSTITUTE



The Fralin Life Sciences Institute is a hybrid thematic and investment institute committed to supporting research, education, and outreach in Virginia Tech's life sciences community. Residents of the institute's five flagship buildings, which include Steger Hall, Fralin Hall, Latham Hall, Integrated Life Sciences Building, and Life Sciences 1, are automatically considered affiliated faculty members, and all other life science researchers on campus are invited to become affiliated faculty members.

Affiliated faculty members are given resources necessary to explore new, innovative science that benefits people in the New River Valley, the Commonwealth of Virginia, and the world.

Through seminars, conferences, and research group support, the institute serves as a meeting point for progressive ideas involving multidisciplinary research. It is closely aligned with Virginia Tech's other six research institutes, which include Virginia Tech Carilion Research Institute, Virginia Tech Transportation Institute, the Institute for Critical Technology and Applied Sciences, the Institute for Society, Culture and Environment, and the Institute for Creativity, Arts and Technology.

The Fralin Life Sciences Institute strategically invests in targeted research areas within the life sciences. Such investments include recruitment and set-up support for new faculty members, retention and recognition of established faculty members, seed funds for new research projects, equipment purchases, graduate student recruitment and support, undergraduate research support, and support for outreach activities.

Research initiatives within the life sciences receiving the highest priority for support include vector-borne disease, infectious disease, plant sciences, ecology and organismal biology, obesity, and cancer biology. The Fralin Life Sciences Institute is also actively engaged in cooperative partnerships with colleges, departments, and other institutes that support the life science community.

horace FRALIN



Following his graduation in 1948 with a degree in electrical engineering, Horace Fralin forged a partnership in Fralin and Waldron Inc., a company that specializes in federal housing programs, health care facilities, and retirement centers. The company has also been involved with the revitalization of Roanoke.

Mr. Fralin was a charter member of Virginia Tech's Ut Prosim Society and was a Corporate Distinguished Benefactor, founding member of the Virginia Tech Corporate Research

Center Board of Directors, and served as president of the Virginia Tech Foundation. He served on the Virginia Tech Board of Visitors, College of Engineering Committee of 100 Advisory Board, Virginia Tech Foundation Executive and Finance Committee, and was chairman of the Hotel Roanoke Advisory Committee.

The Virginia Tech Alumni Association recognized his leadership by honoring Fralin with the Alumni Distinguished Achievement Award, and in 1992 the university conferred upon him its most distinguished award for service, the William H. Ruffner Medal.

Fralin's bequest to Virginia Tech, valued at \$8.6 million, is one of the largest gifts in university history. Four million dollars of his gift was, at his request, earmarked for the study and application of biotechnology. These funds have been used to create a permanent endowment for the institute. The proceeds from the endowment are used to match contributions and grants from other sources to continue the outreach, teaching, and research missions of the Fralin Life Sciences Institute. Through this endowment, Horace Fralin will continue to support research in the fields of human and animal health and agricultural productivity forever.



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Disaster in the wake of Hurricane Sandy, 2012. Coastal@VT p. 10

Photo credit: Anamaria Bukvic

