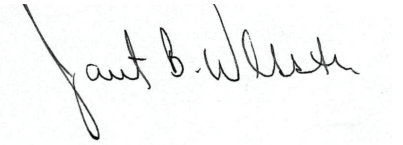
Virginia Tech
Fralin Life Science Institute

fall 2014

the FRALIN EXPLORER

WELCOME TO FRALIN

Janet B. Webster
Associate Director of Operations
Fralin Life Science Institute and
Virginia Bioinformatics Institute



Please enjoy the Fall 2014 issue of the Fralin Explorer and learn all about the exciting research, teaching, and outreach currently going on in the Institute!

One of the many interesting articles in this edition is about Dr. Amanda Stewart and her student, Meg McGuire, (Department of Food Science and Technology) and their research into apple quality and how it effects the production of hard cider, a growing industry in Virginia.

Another is about Dr. Bill Hopkin's (Department of Fisheries and Wildlife) FLeDGE program—a system that develops research and mentorship skills in graduate and undergraduate students and can be used as a model for research education in universities across the country.

We would love to hear from you. If you have any comments or questions about anything in this edition or about the Institute in general, please email me, at jbwebste@vt.edu, or our Communications Manager, Lindsay Key, at ltkey@vt.edu. Enjoy!

WHAT'S INSIDE

EDITOR: Lindsay Key
WRITERS: Cassandra Hockman, Lindsay Key

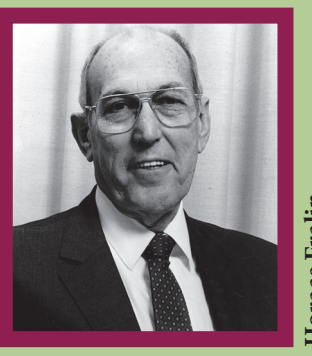
ABOUT US

The Fralin Life Science Institute is an investment institute committed to supporting **research**, **education** and **outreach** in Virginia Tech's life sciences community. Residents of the institute's four flagship buildings 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 the Virginia Tech Carilion Research Institute, Virginia Tech Transportation Institute, the Institute for Critical Technology and Applied Sciences, the Virginia Bioinformatics Institute, the Institute for Society, Culture and Environment, and the Institute for Creativity, Arts and Technology.

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 Science Institute is also actively engaged in cooperative partnerships with colleges, departments, and other institutes that support the life science community.



Horace Fralin

'tis the season for...

apples

Story and photos by Lindsay Key
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Student researcher studies the core of cider production

It's been said that the apple doesn't fall far from the tree, but one student researcher is interested in a different phenomenon: how many apples fall from the tree, and how does this affect cider quality?

Meg McGuire of Dublin, Va., a senior majoring in food science in the College of Agriculture and Life Sciences, is interested in how the crop yield of apple trees affects apple quality and, ultimately, cider quality.

Over the past ten years, entrepreneurial cider-making has enjoyed a boom in Virginia with more than ten licensed commercial cideries in operation and this boom is expected to continue to boost the Commonwealth's economy for a long time to come. Wine production is popular in the region, but McGuire believes that cider making could equal or even bypass that industry, noting that the Commonwealth's climate and soil is much more conducive to apple growing than grape growing.

McGuire is working with **Amanda Stewart**, assistant professor of food science and technology in the College of Agriculture and Life Sciences and Fralin Life Science Institute affiliate, and **Greg Peck**, an assistant professor of horticulture also in the College of Agriculture and Life Sciences, to better understand the optimal orchard management practices for hard cider production. Her goal is to see how much yield (the number of apples grown on an individual tree) can be increased before negatively impacting cider quality. Ultimately, she wants apple growers to produce fruit that have a balance of tannins and acids to create a crisp, tart, and refreshing cider.

McGuire's field research occurs at the Alson H. Smith Jr. Agricultural Research and Extension Center in Winchester, Va., which is the facility where Peck's pomology research program is based. In October, she will travel to the center to harvest this year's crop. Apple trees

naturally have a biennial bearing habit, meaning that high crop yield years are followed by low crop yield years.

"There is only so much rainfall and available nutrients in the soil," McGuire said. "In trees with higher crop loads, the nutrients and water are partitioned more sparsely than in trees with lower crop loads. Crop load certainly plays a factor in affecting apple quality and we are trying to figure out exactly how this translates to cider quality."

In addition to her lab research, McGuire receives firsthand experience in hard cider production as a part-time employee at Foggy Ridge Cidery located in Dugspur, Va., about thirty minutes from downtown Floyd, Va. The cidery utilizes an on-site orchard, and McGuire helps process the apples, which involves washing, milling, and pressing to collect juice, which is then fermented on-site to make hard cider. The cidery grows a number of apple cultivars in its orchards, including Roxbury Russet, Hewes Crab, and Kingston Black varieties.

"My goal for my research is to help inform local cideries about how to produce the best cider," McGuire said.

"We are leveraging Virginia Tech's expertise in horticulture, food science and technology, and agricultural and applied economics to develop research-based resources for the rapidly expanding cider industry in Virginia and North America," Stewart said. "We are excited that undergraduate students like Meg are finding opportunities to contribute to the land grant mission through our research and extension programs."

In November, Stewart and Peck will educate commercial apple growers and cider producers on best cider-making practices by teaching a short course entitled, "From Tree to Bottle," which will occur in the new Human and Agricultural Biosciences Building (HABB1) on Virginia Tech's campus Nov. 6-7, 2014.

Cider Production Short Course: From Tree to Bottle

Nov. 6-7, 2014 **Cost:** $150 per person
Human and Agricultural Biosciences Building (HABB1)
Virginia Tech, Blacksburg, VA

The workshop will include a mix of classroom lectures and hands-on laboratory training. Speakers will share information on the current state of Virginia Tech's cider research projects, including orchard management practices that impact cider quality, cultivar selection, the cost of growing hard cider apples, the potential increase in the Mid-Atlantic cider market, understanding apple tannins, and the laboratory skills needed for producing consistently high-quality cider. Participants will also be trained in recognizing and preventing cider faults and flaws. Guest speaker Mary Beth Williams, a practicing attorney whose clientele includes many cideries and wineries in Virginia, will discuss federal and state regulations.

More info: http://blogs.ext.vt.edu/tree-fruit-horticulture/

NEWS

Plants may use language to communicate with each other, Virginia Tech researcher finds

A Virginia Tech scientist has discovered a potentially new form of plant communication, one that allows them to share an extraordinary amount of genetic information with one another.

The finding by **Jim Westwood**, a professor of plant pathology, physiology, and weed science in the College of Agriculture and Life Sciences, throws open the door to a new arena of science that explores how plants communicate with each other on a molecular level. It also gives scientists new insight into ways to fight parasitic weeds that wreak havoc on food crops in some of the poorest parts of the world.

His findings were published on Aug. 15 in the journal *Science*.

"The discovery of this novel form of inter-organism communication shows that this is happening a lot more than any one has previously realized," said Westwood, who is an affiliated researcher with the Fralin Life Science Institute. "Now that we have found that they are sharing all this information, the next question is, 'What exactly are they telling each other?'"

Westwood examined the relationship between a parasitic plant, dodder, and two host plants, Arabidopsis and tomatoes. In order to suck the moisture and nutrients out of the host plants, dodder uses an appendage called a haustorium to penetrate the plant. Westwood previously broke new ground when he found that during this parasitic interaction, there is a transport of RNA between the two species. RNA translates information passed down from DNA, which is an organism's blueprint.

His new work expands the scope of this exchange and examines the mRNA, or messenger RNA, which sends messages within cells telling them which actions to take, such as which proteins to code. It was thought that mRNA was very fragile and short-lived, so transferring it between species was unimaginable.

But Westwood found that during this parasitic relationship, thousands upon thousands of mRNA molecules were being exchanged between both plants, creating this open dialogue between the species that allows them to freely communicate.

Through this exchange, the parasitic plants may be dictating what the host plant should do, such as lowering its defenses so that the parasitic plant can more easily attack it. Westwood's next project is aimed at finding out exactly what the mRNA are saying. His work is sponsored by the National Science Foundation.

Forestry geneticists develop tree biomass crop to grow on marginal lands

Two Virginia Tech researchers have received a $1.4 million grant to investigate the genetic regulatory networks that will allow an important bioenergy crop to be bred so it will grow in less than ideal soils and climate.

Populus, a genus of fast-growing trees commonly known as cottonwoods and aspens, is being grown for bioenergy because it produces a significant amount of biomass in two years and will re-grow robustly when cut at just above ground level. This woody biomass can be converted to liquid fuels, such as ethanol.

"The goal is to develop the species so it will not become dormant in conditions that would stress other crops, such as high temperature, drought, or marginal soil nutrients," said **Amy Brunner**, associate professor of molecular genetics in the College of Natural Resources and Environment and an affiliate of the Fralin Life Science Institute. "It is important that bioenergy crops not require prime agricultural land."

"We don't want biomass production to compete with food production," she continued. "The aim is to minimize inputs, develop varieties that grow in different environments, and maximize biomass production."

Brunner and **Jason Holliday**, assistant professor of forest genetics and biotechnology in the college and a fellow Fralin Life Science Institute affiliate, received the grant from the U.S. Department of Agriculture National Institute of Food and Agriculture and the U.S. Department of Energy Office of Biological and Environmental Research. Their project is one of 10 grants awarded as part of the national strategy of sustainable biofuels production.

"The college made the decision to enter into the specialized and highly competitive research arena of molecular genetics, and Drs. Brunner and Holliday are making important contributions to the body of molecular genetics science of tree species," said Paul Winistorfer, dean of the college. "Developing alternative approaches to biofuel crops and their adaptation and success to a changing climate is a strategic and important contribution to our future energy needs."

Brunner and Holliday are experimenting with the FT2 gene, which regulates vegetative growth. "In addition to seasonal dormancy, which happens when days get shorter, a common response to stress by woody plants is to stop growing and wait for things to get better, which is important to natural populations' ability to survive adverse conditions," said Brunner.

"Jason and I are melding our expertise to understand growth and dormancy transitions," she continued. "We will identify specific control points that can be manipulated to maximize growth in different environments."

Longer versions of these stories first appeared in Virginia Tech News, published by the College of Agriculture & Life Sciences, and the College of Natural Resources & Environment.

Teaching the life sciences: learning beyond the lecture

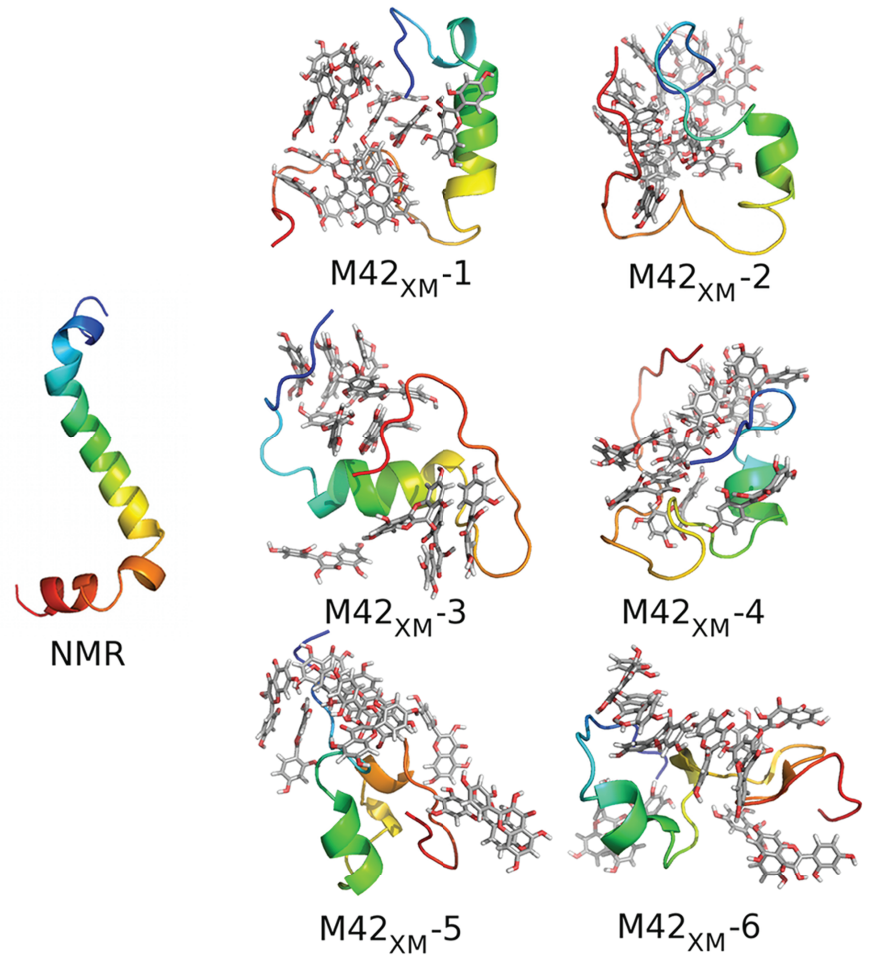

Illustration: by Justin Lemkul. Structural transitions of the amyloid beta-peptide in the presence of morin, a small molecule that is reported to prevent or alleviate the symptoms of Alzheimer's disease. The starting structure is shown on the left, and the replicates from molecular dynamics simulations are shown in the middle and right.

Story by Cassandra Hockman
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For some, teaching the life sciences is all about learning by doing. For **David Bevan,** professor of biochemistry in the College of Agriculture and Life Sciences, learning by doing involves visualizing. Not just a typical 2-D image, either. For Bevan, visualizing means conceptualizing an image as multidimensional, as a thing sitting right in front of you.

Imagine, for example, a 2-D picture of a cross-sectioned animal cell in a textbook—the nucleus sits in the center as a perfect circle, smooth and rough endoplasmic reticula sway out from the nucleus, and the flapping Golgi complex hangs out next to the kidney-shaped, neon green mitochondria, all of which remain stationary in the bright yellow cytoplasm.

Similarly, a textbook 2-D picture of proteins and DNA gives the impression that these molecular components are also stationary and rigid.

If you were a student in Bevan's class, you would quickly identify the problem with this picture: cells are not only made up of microscopic organelles like nuclei and mitochondria that in turn contain molecules such as proteins and DNA, but these cellular parts are in constant play. Proteins, for example, are continuously made and broken down in the cell.

Bevan encourages his students to construct these cellular parts, like proteins, using software that creates 3-D images. By making and referencing these images, students develop an understanding of the structure and function of proteins, and think critically about how manipulating certain parts might alter the greater whole.

For example, one protein being studied in Bevan's lab is called the amyloid beta-peptide, which is associated with the development of Alzheimer's disease. Justin Lemkul, a postdoctoral fellow at the University of Maryland and a former graduate student of Bevan's, created an image that shows the structural forms this protein can adopt, ranging from individual molecules to aggregates that are found in the brains of patients with this disease, explained Bevan.

This image, featured on the cover of *ACS Chemical Neuroscience*, was created using a popular visualization program called PyMOL. Lemkul's structural images were then overlaid on a background showing the image of a brain cell, created by Nicolas Rougier, a research scientist at the National Institute for Research in Computer Science and Control in France.

Another of Lemkul's images shows results from computer simulations that reveal why some compounds found in certain foods (represented as sticks in the figure) may prevent the aggregation of the amyloid beta-peptide that is found in Alzheimer's disease.

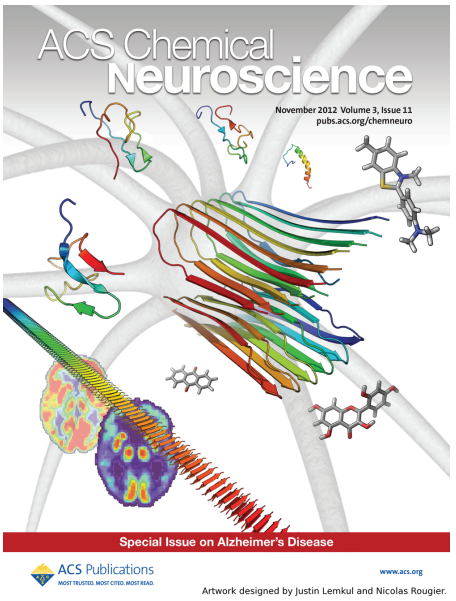

Illustration: The structural transition of the amyloid β-peptide leads to aggregation and deposition in neural tissue. Small molecules that bind to the peptide are of interest in Alzheimer's disease therapeutic design. Artwork designers: Justin Lemkul and Nicolas Rougier.

> ***"With the rapid increase in the capability of computers, students can now visualize protein structures on their own laptops and apply visualization in many of their classes."***
> ***-- Dr. David Bevan***

"When we first started using computer-based molecular visualization in the classroom in 1990, which required special computer hardware, it was clear that students enjoyed the experience and also developed a greater appreciation of protein structure," said Bevan. "An important part of the experience was being able to rotate the structure around on the screen to give different viewing angles, which revealed various important functional aspects of the structure. With the rapid increase in the capability of computers, students can now visualize protein structures on their own laptops and apply visualization in many of their classes."

For **Madlyn Frisard**, assistant professor of human nutrition, foods, and exercise in the College of Agriculture and Life Sciences, learning by doing involves effectively communicating big scientific ideas to the public. In particular, Frisard encourages her students to understand how scientific studies on diet, exercise, and physiology translate into useful information for unhealthy populations.

"What are we telling the public, and what is the truth?" Frisard asked while leading discussion in her graduate seminar, HNFE 6984 – Introduction to Translational Science. Frisard and her students were discussing common public misconceptions of diet and physical activity and how they play a role in weight gain, loss, and maintenance.

"This class gets our graduate students exposed to other areas of science, so when someone in the public promotes physical activity, calorie reduction, or fruit and vegetable consumption, they have an idea of the underlying mechanisms at work," said Frisard. "They also have an idea of how the evidence for these recommendations is generated and how this information is translated and disseminated to the public. Then they can ask, 'what is the public impact of my research?'"

Frisard ensures that readings for the course include academic, peer-reviewed publications, as well as lay materials from magazines and newspapers. In addition, many course assignments require students to research the science behind these articles. A *Time* magazine story, for example, questions the benefits of exercise in promoting weight loss. Though this questioning is important, Frisard teaches that it is good practice for translational scientists to reference the actual scientific studies and consider how the data has been construed.

"The mission of our department is to discover, translate, and disseminate health-related advances in the areas of nutrition, food, and exercise sciences," said Frisard. "In this class, we have basic scientists, behavioral scientists, and clinical scientists. Since these different perspectives have different fundamental knowledge and use different methodologies and techniques, it is good to have different students in the same room."

"We can ask, 'how do you approach solving a problem from a clinical standpoint or a behavioral standpoint?' We know, for example, the basic mechanisms of what the clinical evidence shows, but what does that mean at a population level? What does the data really mean and where does it come from? This is how we teach translational science."

Madlyn Frisard

COFFEE BREAK WITH A SCIENTIST

Madlyn Frisard, an assistant professor of human nutrition, foods, & exercise in the College of Agriculture & Life Sciences and a Fralin affiliate, discusses her research and the importance of loving what you do.

What is the focus of your current research?

My research is focused on the mechanism(s) underlying the development of obesity and chronic disease in children and adults, and using physiology to improve adherence and health outcomes in pediatric and adult weight management.

One of our projects in collaboration with **Matt Hulver**, **Kevin Davy**, and **Brenda Davy** is focused on the role of skeletal muscle mitochondria in the development of metabolic disease. Mitochondrial dysfunction has been implicated in the development of diseases, including diabetes, cardiovascular disease and many more.

Basically, we look at how our current environment of too many calories and not enough activity bombards the cells (specifically in skeletal muscle) with too much substrate (or carbons) in the absence of increased ATP/energy demand. We look at how the mitochondria maintain quality control under these conditions and how interventions such as diet, physical activity, etc., can either improve or impair the ability of the mitochondria to maintain their quality and ability to function properly.

Another project, which is in collaboration with **Paul Estabrooks**, is focused on whether physiology can help improve adherence and outcomes in weight management. For example, while overweight/obese individuals are known to have higher leptin concentrations, many have what is known as leptin resistance, which means their body doesn't respond to leptin like normal weight individuals.

Since leptin is partially responsible for controlling hunger and food intake, these individuals may have a harder time being compliant to weight loss interventions targeting behavior modification of diet and/or physical activity habits. If we can identify those individuals "at risk" for dropout or noncompliance based on their physiology, we could therefore modify the intervention or have them go through a more intense intervention where we could target some of these specific issues. This is somewhat of a personalized medicine approach to obesity treatment in that we would tailor the intervention to the specific individual and/or family.

What is the underlying physiology that you study and how does it differ from children to adults?

We look at the oxidative capacity of the mitochondria in skeletal muscle and how new mitochondria are made and how old mitochondria are removed. We are also trying to identify predictors of adherence to weight management treatment with the goal of improving patient outcomes.

We don't know since it is difficult to answer many of these questions in kids. But I don't think the mechanisms underlying either of these projects are much different in children, it's just with kids you have a "cleaner model" to work with. For example, when you are trying to answer questions around the underlying mechanisms of obesity, with kids you are less likely to have to worry about the presence of other comorbidities such as diabetes or cardiovascular disease, or even just the presence of obesity for years and years. You are able to see what's happening much earlier in the development of these defects without the presence of other confounding factors and therefore can intervene much earlier.

As I said, I don't think it is different between adults and kids, you just have less confounders when it comes to the kids. I'll continue with my previous example: if you are going to use serum leptin concentrations to predict whether a patient is going to be compliant to the treatment intervention, it is easier to test this in an otherwise healthy, but overweight/obese child when compared to an adult who has been overweight for years, is a type 2 diabetic, has hypertension, etc. All of those other factors may affect the ability of leptin (or anything else for that matter) to be predictive of adherence and intervention success.

Q&A

How does understanding these underlying mechanisms improve weight loss or contribute to weight management?

By understanding these mechanisms, we can tailor the intervention to the patient. We have long known that the one-size-fits-all approach to obesity treatment doesn't work. We need to consider the patient and the patient's circumstances when designing interventions. I want to include physiology as part of the assessment.

How did you become interested in your line of research?

I worked with a pediatric weight management program while working on my master's degree, and I loved the interaction with the kids and their families. Through my work on that project, I became very interested in physiology and metabolism in the development of obesity and related disease.

What do you consider to be the most interesting living organism? Why?

So I had this conversation once with a student from the vet school about how the horse is the most physiologically messed up animal on the planet. She said, "if nature could create a more screwed up animal, they would have to go beyond how screwed up a horse is." That idea just fascinates me. Probably not what you were looking for, but there you go.

On the other hand, I think the elephant is an amazing animal. I had a friend that worked with the elephants at the New Orleans Zoo. She was actually with them in the zoo during and immediately following Katrina. Spent about three weeks living in the zoo. Soon after, she moved away and a few years later she came back to visit so we went to see them. I swear they remembered her. It was like long lost friends seeing each other again. The connection they had with her was amazing.

What do you feel are some of the biggest challenges scientists face today?

Limited funding. It is really hard to get funded right now.

Why did you choose to continue your career at Virginia Tech?

Well, my husband is here (Matthew Hulver, associate professor and department chair in human nutrition, foods, and exercise) but we both absolutely love Blacksburg, Virginia Tech, and the surrounding area. We have made great friends here. It is our home.

What is it like to be part of The Fralin Translational Obesity Research Center launch, and how do you think it elevates your research interests or your capacity to do research?

It has been great. I have met a lot of people (faculty, students, and postdocs alike) that I don't think I would have met otherwise. The connections I have made have led to many of the projects I am working on.

What advice would you give to future scientists considering your line of work?

Make sure you love what you're doing and who you're working with. It fills such a large part of your life. Life's too short to dislike your job. Do what you love and love what you do.

Fun Facts

Where are you from? New Orleans, LA.

Favorite Hobbies: I have recently started gardening and I am really digging that. I am also trying to get out and do more service for the community. (I joined a local service organization for women.) I also just like hanging out with my husband and daughter. We are hoping to start camping with her soon because I think she would live outside if we let her.

Favorite thing about Fall: Ooooh, the cool weather. Being from New Orleans, we get excited when it gets cold because we get to make gumbo and red beans, and all of the yummy foods from home. And we love sitting outside by the fire. We do it in the summer but it seems more legit to do it in the fall.

Favorite Quote:

Science quote: "The important thing is to never stop questioning."
--Albert Einstein

Non-science quote: "People will forget what you said, people will forget what you did, but people will never forget how you made them feel."
--Maya Angelou

education

STUDENT SPOTLIGHT

Photo: While in Thailand, Reeder Robinson (right) was able to meet two international collaborators (also graduate students) who are part of the lab of Andrea Mattevi at the University of Pavia.

Strike while the iron is hot: a grad student investigates a promising TB drug target

Imagine yourself as a tiny bacterium that has been coughed into the air from the lungs of a person infected with tuberculosis (TB). Floating through the air inside microscopic water droplets, you are quickly inhaled by an unsuspecting person sitting on the other side of the train. Once inside this new host, your first inclination is to attack—but how?

Reeder Robinson, a biochemistry Ph.D. student working in the Fralin Life Science Institute, studies the biochemical pathways that TB bacteria use to attack their hosts. One attack of particular interest to Robinson is the biosynthesis of siderophores—tiny, iron-gobbling molecules that the bacteria secrete to steal iron from the human body and use it for their own needs.

Robinson investigates how enzymes involved in siderophore biosynthesis work in order to develop drugs against them in the future. If not treated effectively, TB can be fatal. One third of the world's population is infected, and in 2012 there were 1.3 million TB-related deaths, according to the Centers for Disease Control and Prevention. TB is most prevalent in people who have HIV or otherwise weak immune systems. The disease often attacks the lungs, but can attack other organs such as the brain, kidney, and spine. TB is spread through bacterial pathogens, and some strains are drug-resistant.

"Bacterial pathogens are becoming more and more drug resistant. As scientists, we must develop new drugs to act on different targets that bacteria have

Story by Lindsay Key
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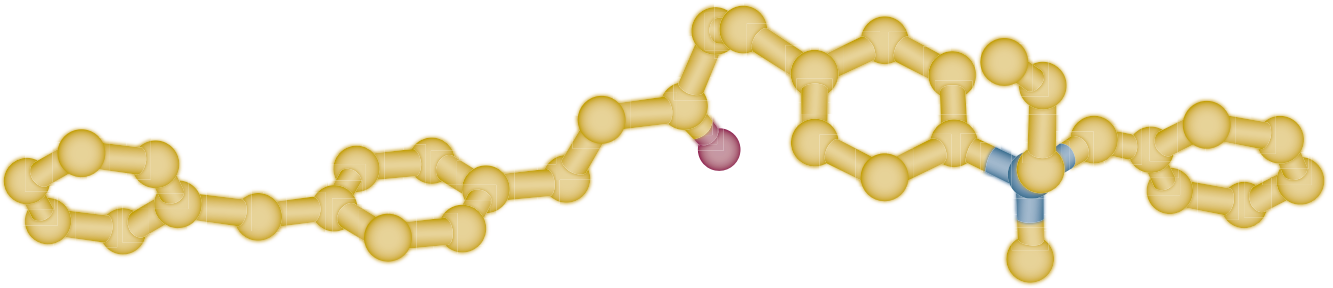

not adapted to yet," Robinson said. "Enzymes involved in siderophore biosynthesis are attractive drug targets because there are no similar enzymes present in the human body and, therefore, inhibiting those pathways should not cause major side effects to humans."

This summer, Robinson received the Vincent Massey award for his research as part of the 18th International Symposium on Flavins and Flavoproteins, held July 25-August 5 in Thailand. He is advised by **Pablo Sobrado**, associate professor of biochemistry in the College of Agriculture and Life Sciences, Fralin Life Science Institute affiliate, and key member of the **Virginia Tech Center for Drug Discovery.**

The Sobrado research team studies enzymes in a variety of bacterial pathogens to develop better treatment for the diseases they cause, including TB, Chagas disease, and fungal infections. These diseases are of greatest threat to developing countries where treatment may not be as readily available.

"Our group is targeting key biological functions in several human pathogens like parasites, bacteria, and fungi," Sobrado said. "As we understand the differences and common features among these pathogens, we hope to discover new broad-spectrum antimicrobials for the treatment of several human diseases."

Robinson began working with Sobrado in 2009 as an undergraduate and received his bachelor's degree in biochemistry from Virginia Tech in 2010. He plans to graduate with his Ph.D. in May 2015.

During his trip to Thailand, Robinson was able to meet researchers from across the world that have long partnered with the Sobrado team. He received a monetary award of $700, and more than 150 people attended his research presentation.

"Going to Thailand for this conference was an amazing opportunity that I will remember for the rest of my life," Robinson said. "I was exposed to a different culture, met a lot of amazing people who I will keep in contact with throughout my career, and was able to obtain valuable insights from other world class scientists on my research."

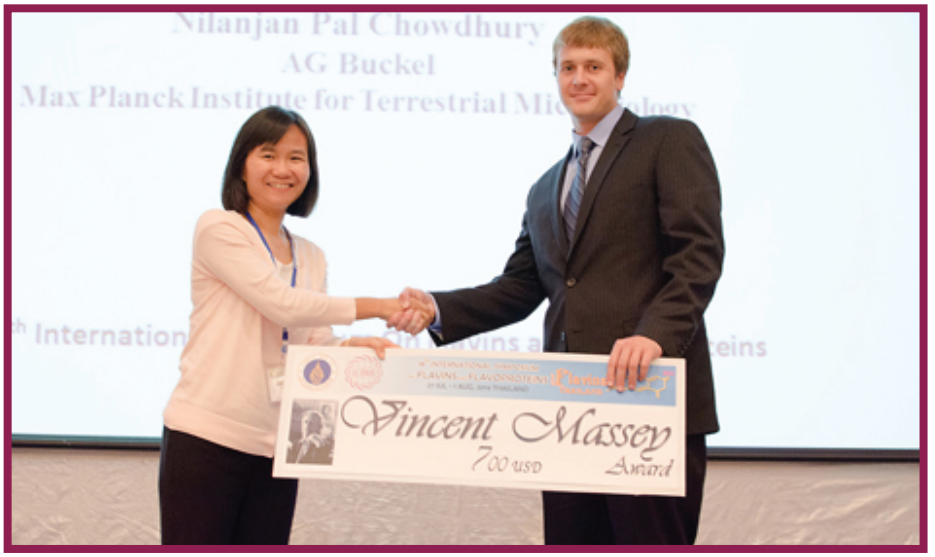

Photo: Reeder Robinson accepts the Vincent Massey Award at the 18th International Symposium on Flavins and Flavoproteins in Thailand in August 2014.

Q&A: Meet Reeder

Hometown: Virginia Beach, VA
Major: Biochemistry, 5th year Ph.D.
Fralin Advisor: Pablo Sobrado
Other degrees: B.S., Biochemistry, Virginia Tech, 2010

Why do you want to be a scientist?
I got into science because I have always had an interest in how the world works. It was this curiosity that led me into graduate school to pursue my Ph.D.

What attracted you to your particular field of science?
I really liked the aspects of Dr. Sobrado's research where he studies specific targets in pathogens with the main goal as drug discovery.

What are your ultimate career goals?
Right now I am a little uncertain about my career path, but ultimately I would like to utilize the critical thinking skills I learned in graduate school in either a management position at a biotech/pharmaceutical company or as a consultant for a firm that is biotechnology specific.

Which quality of the following do you feel is the most important for a scientist to possess—open-mindedness, precision, time management skills, optimism, cynicism, integrity, a good sense of humor? Why?
Definitely time management skills. As a scientist you always have so many things to do whether it's writing manuscripts, performing experiments, going to meetings, or even managing your social life. Having good time management skills allows you to be efficient at work and plan your time wisely so you can be productive and still have a balanced life outside of the lab.

Favorite hobby outside of school?
I have been on the Virginia Tech Men's Club Water Polo team since I was a freshman here. I really enjoy the competition with other universities and the fact that it keeps me in pretty good shape.

education

Symbiotic learning finds a home in FLeDGE

Photo: FLeDGE program participants Cathy Jachowski (left) and Valentina Alaasam study hellbenders.

Story by Cassandra Hockman
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When Valentina Alaasam was a Virginia Tech freshman, she joined the Wildlife Ecotoxicology and Physiological Ecology Lab as a volunteer research technician, cleaning animal cages and assisting researchers.

Now, three years later, Alaasam, a senior majoring in biological sciences in the College of Science, is completing her own independent research project. She has designed and implemented a research proposal, collected and analyzed field data, and successfully articulated her findings in scholarly writing and oral presentations—all as part of her mentoring experience with Cathy Jachowski, a Ph.D. student in fish and wildlife conservation in the College of Natural Resources and Environment and an Interfaces of Global Change Fellow.

Alaasam and Jachowski work together as part of the **Facilitated Learning for Developing Graduate Experiences (FLeDGE) program**, a mentoring program designed to foster symbiotic learning between graduate students and undergraduate researchers. **Bill Hopkins,** professor of fish and wildlife conservation in the College of Natural Resources and Environment, formally established the program in 2008 to prepare undergraduates for transition to graduate school and to simultaneously prepare graduate students for their transition to becoming faculty members.

"I designed and developed FLeDGE because I came to realize that some of our students had a strong desire to go beyond short-term research experiences in the lab. Graduate students really wanted to learn all aspects of mentorship, and select undergraduates were ready to take their training to the next level," said Hopkins.

As part of the program, Alaasam has received extensive hands-on training in all of the major stages of academic research. Initially, she designed a research project and wrote a formal proposal, both while working alongside her mentor, Jachowski. She then formally presented and defended this proposal to the lab's researchers, including students, postdocs, and technicians, and to faculty and students from around campus.

When Alaasam began collecting data in the field and analyzing samples in the lab, she cultivated her techniques, many of which she learned by directly shadowing Jachowski.

"Cathy and I have gotten so close. She is one of the best role models, especially in terms of science. She is always on top of things, she follows protocol, and she is very organized," said Alaasam. "Having her as an example when I go to graduate school will make all the difference."

A key component of the FLeDGE program goes beyond fieldwork, data analysis, and time spent in the lab.

"One of the great rewards of this program is to watch the simultaneous development of the mentee and mentor, as well as their interpersonal relationship. Cathy and Valentina are a wonderful example of how FLeDGE shapes the professional future of young scientists," said Hopkins. "All of our FLeDGE graduates go on to publish their findings in peer-reviewed journals, which has strong tangible benefits for their resumes, particularly for the undergraduates. But the intangible developmental experiences really shape students' perspectives and set our program aside from so many others."

As a **Fralin Life Science Institute Summer Undergraduate Research Fellow (SURF)**, Alaasam further honed her ability to articulate her research by presenting her project at the Virginia Tech Summer Research Symposium this past July. Watching proudly from the sidelines was Jachowski.

"Mentoring Valentina has been one of the most memorable and rewarding experiences of my adult life," said Jachowski. "Everyone knows that a career in academia involves teaching. While most people might imagine that teaching and learning primarily happen in a formal classroom setting, any graduate student can tell you that a huge amount of training, knowledge transfer and professional growth occurs as a result of the advisor-advisee relationship. Participating in FLeDGE has allowed me to experience that relationship from a new perspective – discovering a new suite of challenges and immense rewards."

Alaasam has also developed a deeper understanding of scientific research.

"FLeDGE has taught me a lot about the research process, the graduate-level environment, and what it takes to do science. In this program, you are actually designing a project to answer a question about something that we don't know about," said Alaasam. "I also learned a lot of field skills, like organization and collaboration, and how to articulate the research project, especially during the first proposal stage and during the SURF program presentation."

Further, she has gained invaluable experience that adds to her education in biology.

"I always had an idea that I wanted to work with animals. Although I do things like analyze blood samples, fieldwork has helped me understand what research really means beyond the building. It's a whole new experience to be the one who went out, collected the blood samples, and then came back in to analyze them," said Alaasam. "This program has also helped shape my interests in other areas like disease ecology."

Hopkins, also director of the Wildlife Ecotoxicology and Physiological Ecology lab, believes undergraduate research experiences are about experiential learning, or as he says, "learning while in the trenches."

"Bill is one of those professors that will make you read more and more, and go deeper into your research, making you ask more questions," said Alaasam.

Bill Hopkins and Brittany Coe.

Past students from the program have benefitted as well. Brittney Coe, a past FLeDGE undergraduate and current Hopkins lab technician, went on to complete a Master's degree in the lab after having completed the program.

"The FLeDGE program played an instrumental role in my development as a scientist and is the primary reason I pursued a career in scientific research," said Coe. "It taught me how to think critically and work independently, but also to seek help when needed."

Since its inception, six undergraduate students, two graduate students, and three postdoctoral fellows have participated in FLeDGE. Many of these students have moved on to graduate school, and some are now faculty. For example, Brittney Coe was mentored by Dr. Sarah DuRant, now an assistant professor at Oklahoma State University. Dr. DuRant also mentored Amanda Wilson, who is now a Ph.D. student at Illinois State University.

"FLeDGE, more than any other non-research activity I pursued in graduate school, helped prepare me for my faculty position," said DuRant. "It also gave me the opportunity to learn effective ways to manage, mentor, counsel and edit without the pressures of a tenure clock. The number of new challenges facing first-time faculty is great, so it is a relief when a few of these challenges are not new to you, allowing you to hit the ground running—FLeDGE did that for me."

"Sarah [DuRant] has been the most important and influential mentor and friend in my academic and research career," said Wilson. "She challenged me intellectually, constantly sharpening my ability to synthesize information and think critically about my work and the work of others. She taught me how to ask questions and to develop effective experimental designs to test my questions, and she always provided thorough edits on my manuscripts and practice presentations, through which I learned how to write and deliver effective seminars."

With a successful program underway, Hopkins has high hopes for its future.

"We have been doing this long enough now to understand how to make a program like this really work," said Hopkins. "The question is, how can we scale it up to impact a broader diversity of undergraduate and graduates at Virginia Tech? I would really like to see that happen."

FLeDGE Fundamentals:

The FLeDGE program provides undergraduates with an 18-month research-intensive experience that focuses on all the major components of academic research, including:

- Manuscript writing
- Critical thinking and problem-solving
- Experimental design and proposal writing
- Laboratory and field techniques
- Animal care and use
- Data management and analysis
- Practice in presentation of ideas, methods, and analysis

Mentors are given the opportunity to:

- Advise and oversee all aspects of the undergraduate research project
- Learn to navigate the multifaceted roles of faculty positions, such as advising, teaching, and conducting research
- Develop a vested interest in the success of students and their projects

research

Rhododendrons invade and conquer by disturbing nitrogen cycle

By Cassandra Hockman

How important is the soil beneath our feet to what grows above it? The short answer is very, according to Mahtaab Bagherzadeh of Annandale, VA, a senior majoring in biological sciences in the College of Science and a 2014 Fralin Life Science Institute Summer Undergraduate Research Fellow. Bagherzadeh recently participated in a study that discovered invading rhododendrons affect the nitrogen cycle and surrounding plant communities.

In recent decades, rhododendron, an evergreen shrub that grows in large, thick patches, has expanded in areas where there has been loss of other plant species. These species, which include hemlocks and chestnuts, have died off due to invasive pests. In particular, the rhododendron beats out other species because of its control over nitrogen, a chemical element essential for plant growth.

"What we have seen is that rhododendron acts like a native invader because it comes into places where hemlock has died off, and it takes over the soil because of its influence on the nitrogen cycle," said **Jeb Barrett**, associate professor of biological sciences in the College of Science, Fralin Life Science Institute affiliate, and Bagherzadeh's fellowship advisor.

Under Barrett's guidance, Bagherzadeh investigated how the rhododendron invasion has affected soil ecosystems and nutrient cycling by comparing areas of land with dense rhododendron to areas with little to none.

"We found that there is less available nitrogen in sites with rhododendrons because these plants release carbon from their degraded foliage, which then offsets the nitrogen cycle by limiting how much nitrogen is available for uptake by other plants. In addition, rhododendrons release complex proteins, which bind up nitrogen in large, organic compounds that are very difficult for microbes to degrade," explained Bagherzadeh. Soil microbes regulate the cycling and availability of nutrients. One part of this regulatory process is mineralization, a process in which microbes break down organic molecules into inorganic forms, making the nutrients accessible to plants.

In contrast, in the process of immobilization, microbes consume the inorganic nitrogen for their own use to sustain metabolism and fuel growth. Thus, in soils under dense rhododendron stands, complex organic matter accumulates and binds up nitrogen, which leaves very little of this essential element available to plants and other organisms, according to Barrett.

"Microbial communities are tightly linked with the nitrogen cycle. They determine what forms of nitrogen are present in the soil and regulate when it is available to plants, and when it is not. When there is available nitrogen in rhododendron soils, microbes use it for themselves to sustain, leaving virtually none leftover for other plants," explained Mahtaab. "In other words, the nitrogen that other plants need becomes solely available to the rhododendrons."

"Rhododendrons are prepping the soil in such a way as to enhance their competitive nature," said Barrett. So far, Bagherzadeh's project was part of a pilot study to provide a baseline for investigating the soil nutrients and the biogeochemistry of new rhododendron growth. In the future, Bagherzadeh and Barrett will look for ammonium oxidation, a process that predicts the rates of nitrate mobility in a watershed, which has implications for plant ecology and water quality. In addition, Barrett is trying to identify some of the fundamental controls of the nitrogen cycle with the idea that these insights would be applicable to soil and water quality management elsewhere.

"My lab is looking at this as an opportunity to see how the soil communities are tightly linked to the availability of nutrients and their mobility in soils," said Barrett. "The mobility of nitrogen in watersheds has a strong influence over water quality. The EPA, for example, has a limit on nitrate concentrations for drinking water, so understanding how microbial communities affect availability and mobility of nitrogen has implications for management."

Barrett and Bagherzadeh work in collaboration with the Coweeta Long Term Ecological Research (LTER) project, a long-term environmental study funded by the National Science Foundation, with sites located in eastern deciduous forests of Southern Appalachia. This region-based project focuses on the effects of biogeochemical cycling and watershed ecosystem processes, both foci that align with Barrett's lab and the Virginia Tech Stream Team and Ecosystem Research Group. Barrett's particular interest in soil chemistry and nitrogen cycling attracted Bagherzadeh, who believes strongly in the large-scale implications of the team's work.

"We really believe that it is what is below the soil that affects what is above the soil," said Bagherzadeh. "Our environment is largely regulated by things below our feet. And this is something that most people don't really think about."

This article also appears in VT News.

around fralin

Photo: On July 31, 2014, the annual Fralin-supported **Summer Undergraduate Research Fellowship (SURF)** Symposium was held in the Graduate Life Center. Hundreds of students presented their work during the poster session (pictured) as well as oral presentations.

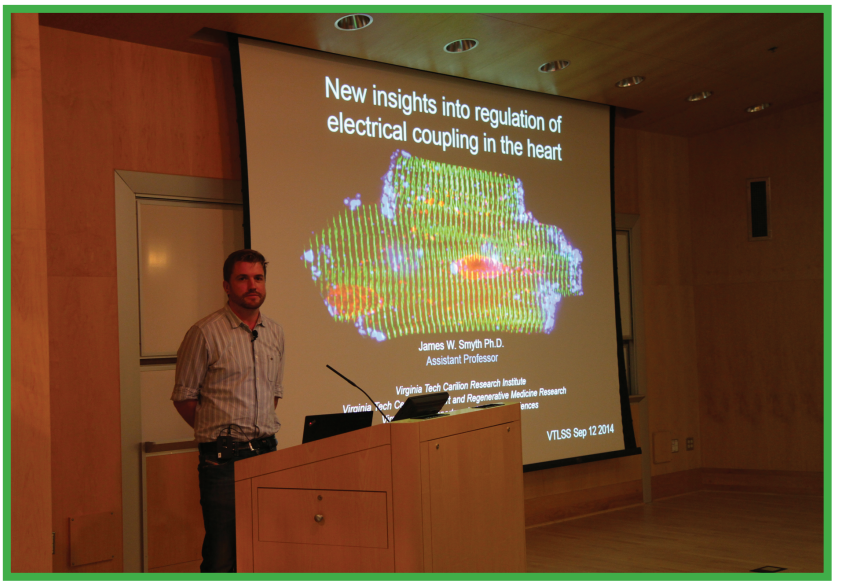

Photo: Jamie Smyth, an assistant professor at the Virginia Tech Carilion Research Institute, and an assistant professor of biological sciences in the College of Science, gave a presentation entitled "New insights into regulation of electrical coupling in the heart" on Sept. 12, 2014, as part of the Fralin-supported **Virginia Tech Life Science Seminar Series**.

Photo: A welcoming reception for the Interfaces of Global Change fellows was held at the Hahn Garden Pavilion on Aug. 26, 2014. The program is a Fralin-supported Interdisciplinary Graduate Education program directed and coordinated by **Bill Hopkins** and **Gloria Schoenholtz**.

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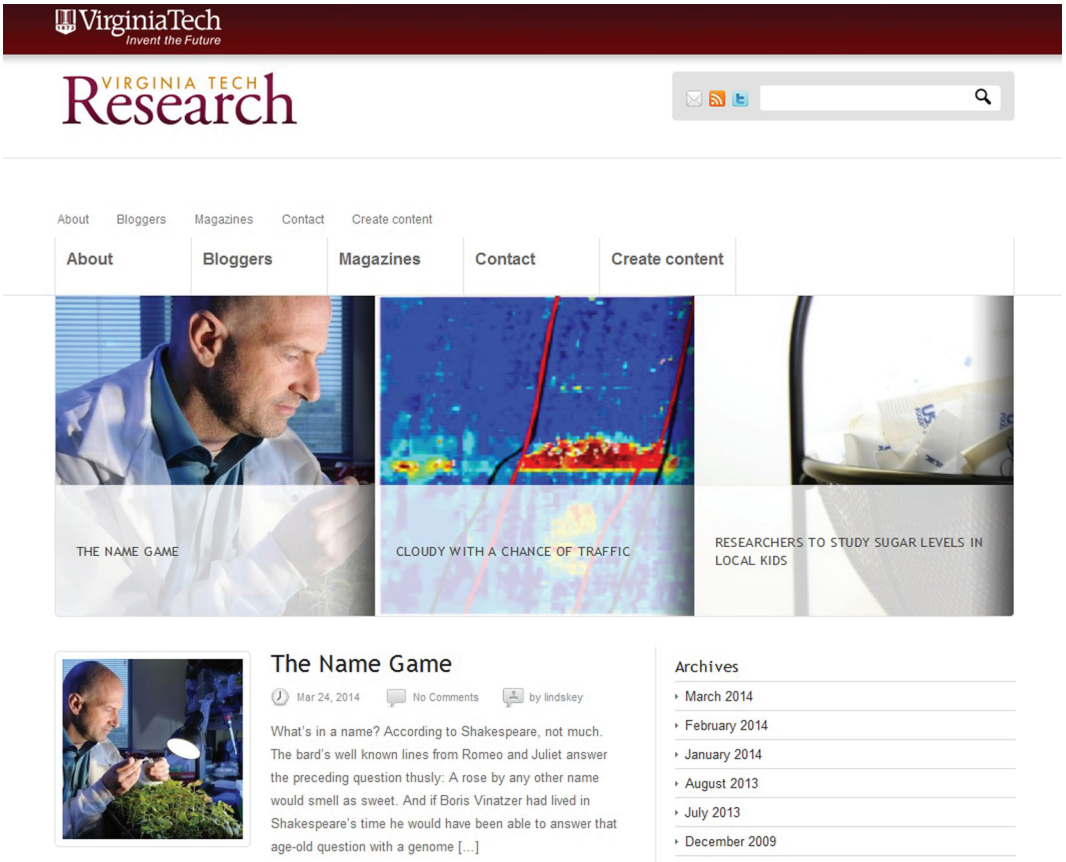

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