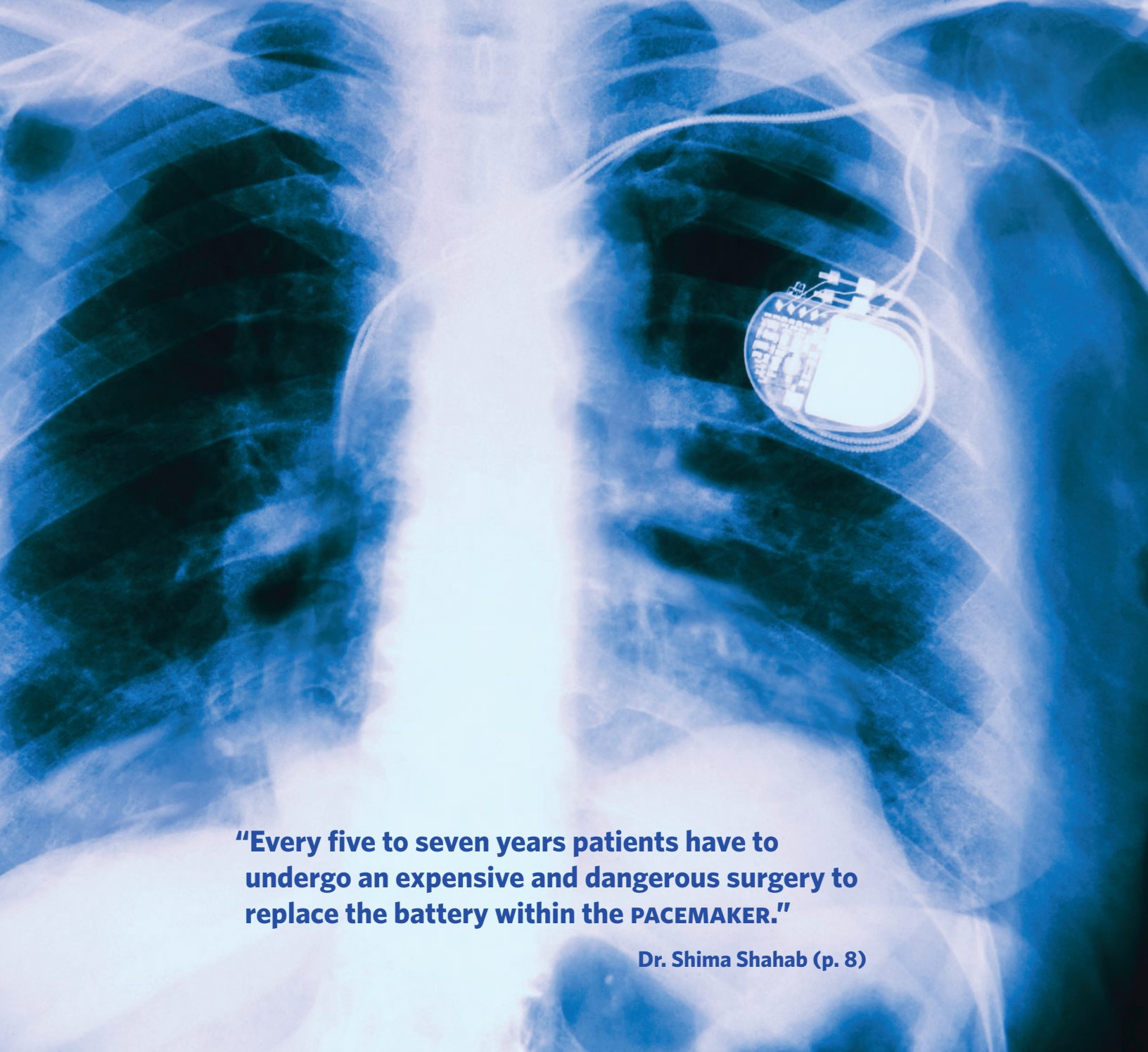


BIO TRANS

2017, Vol. 2



“Every five to seven years patients have to undergo an expensive and dangerous surgery to replace the battery within the PACEMAKER.”

Dr. Shima Shahab (p. 8)

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Cover image:

Clostridium perfringens bacteria (p. 6)

About BIO TRANS

A community of biologists and engineers that work together to study transport in environmental and physiological systems.

Editor Lindsay Key

Art Director Shelley Cline

Photography Christina + David,
Daniela Cimini, David Schmale,
Jim Stroup, Lindsay Key



Welcome to our second issue of the Biological Transport (BIOTRANS) Magazine! We are a community of biologists and engineers that work together to study transport in environmental and physiological systems. And we have been busy this past year!

We welcomed two new graduate students to the BIOTRANS family, Philip Graybill and Nastaran Alinezhadbalalami. Philip is a graduate of Grove City College with a B.S. in mechanical engineering, and a minor in physics. He conducted previous research in multi-phase flows and experimental biofluid dynamics. Nastaran is a graduate of Michigan Tech with a B.S. and M.S. in chemical engineering. She conducted previous research on the design and synthesis of nanoparticles for cancer therapy.

We also welcomed three new faculty to the BIOTRANS family, Drs. Jones, Behkam, and Shahab. You can read more about these talented individuals by visiting their websites below:

Dr. Caroline Jones, Assistant Professor, Department of Biological Sciences

<https://www.biol.vt.edu/faculty/jones/index.html>

Dr. Bahareh Behkam, Associate Professor, Department of Mechanical Engineering

<http://www.me.vt.edu/people/faculty/bahareh-behkam/>

Dr. Shima Shahab, Assistant Professor, Department of Biomedical Engineering and Mechanics

<http://www.beam.vt.edu/about/person.php?name=Shima.Shahab>

Our faculty have been landing some very large sponsored research projects!

- Dr. Cimini had a ~\$600K grant from NSF to examine the forces and dynamics of the mitotic apparatus and kinetochore attachments.
- Drs. Shane Ross and David Schmale are working with a team of researchers on a \$3M grant from the NSF to use advanced Lagrangian methods for hazard prediction, mitigation, and response.
- Dr. Rafael Davalos is working with a team of researchers on a new NIH grant of \$1.8M to study high-frequency irreversible electroporation for the treatment of brain tumors.
- Dr. Marr and colleagues had a grant from NSF for about \$130K to examine the role of aerosolization from wastewater systems in the fate and transport of and exposure to Ebola virus.
- Dr. Melville had a grant from NIH for about \$415K to characterize a Type II secretion system in a gram-positive pathogen.

In November, 2016, we held a recruiting weekend in Blacksburg to attract our next cohort of talented students. Prospective students had the chance to tour labs and learn about pathogenic aerosols (Marr Lab), gliding snakes (Socha Lab), and stream dynamics (Thompson Lab).

We hope you enjoy the second issue of our magazine. There are so many wonderful things to celebrate about BIOTRANS!

David G. Schmale III, Ph.D.

Director of BIOTRANS (2015-2017)

Take a deep breath.

by Amy Loeffler

The air you're breathing is home to tiny microbes that ride currents like molecular trapeze artists and can swing on transparent air streams for thousands of miles.

That is the subject of an article published in *Scientific American* in February by two Virginia Tech researchers who are examining what is in the air and using drones to learn how airborne microbes travel across the globe.

"Many of the microorganisms we collect in the atmosphere are understudied or even new to science. We are only just beginning to appreciate the tremendous biodiversity of microorganisms in our atmosphere," wrote David Schmale and

Shane Ross.

Schmale is a professor of plant pathology, physiology, and weed science in the College of Agriculture and Life Sciences and an affiliated researcher with the Fralin Life Science Institute. Ross is an associate professor of biomedical engineering and mechanics in the College of Engineering.

The team writes about how they have tracked the acrobatic pathways of those microbes by discovering how they contribute to plant disease and weather patterns, and travel through air and on water.

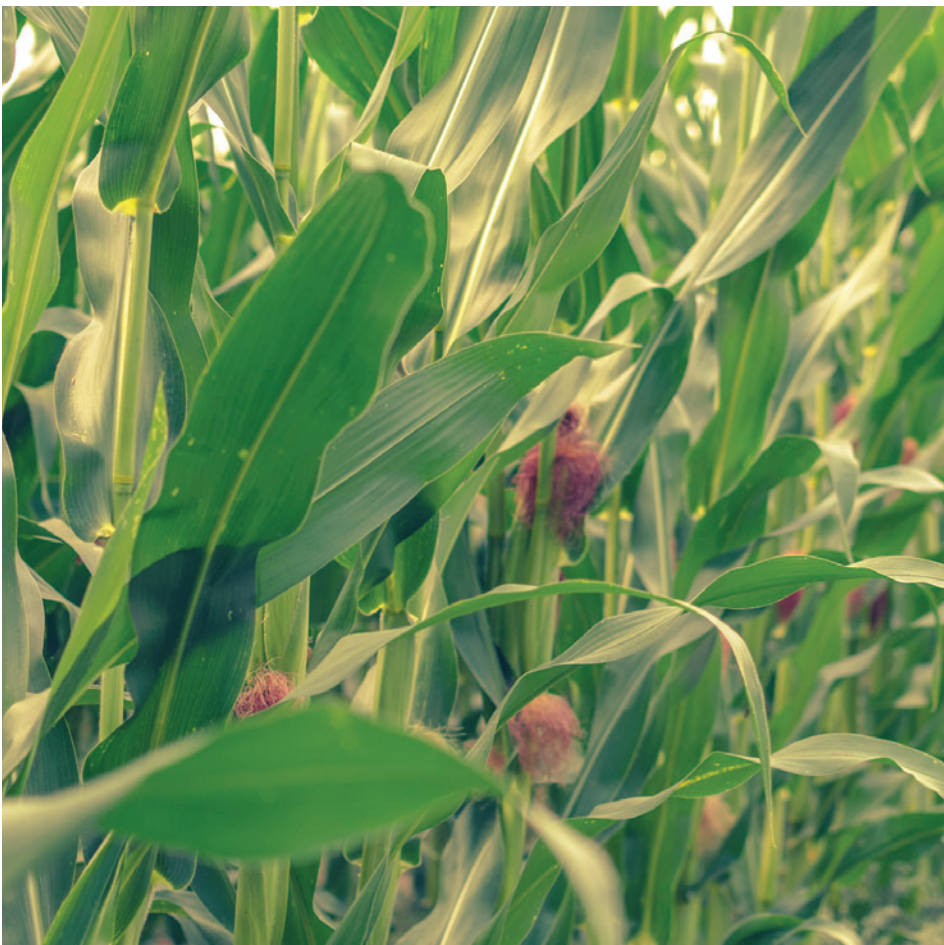
"Microbes in the atmosphere may be pathogens of plants, animals, and people. Some live in the clouds as

invisible weather-makers, nucleating rain, hail, and even snow. Others are professional surfers, riding atmospheric waves in search of new homes in new locations," the team wrote in the article. "Understanding how and when these plant pathogens are transported through the atmosphere to susceptible crops is a prerequisite for managing disease."

The article is also a window into discoveries using drones to research pathogens.

"New tools and technology enable us to answer important questions about where these microbes are coming from, where they are going, and what they are doing in the atmosphere," the team wrote.

"Microbes in the atmosphere may be pathogens of plants, animals, and people. Some live in the clouds as invisible weather-makers, nucleating rain, hail, and even snow. Others are professional surfers, riding atmospheric waves in search of new homes in new locations."



Image, left: Silks of flowering corn are vulnerable to *Fusarium graminearum*, a fungus which can take over the developing kernels and create toxins which threaten domestic animal health. **Image, opposite:** The bacterium *Pseudomonas syringae* is used in the commercial production of artificial snow.



Schmale and Ross have been tracking different species of fungi in the genus *Fusarium* in the atmosphere with drones and ground-based sampling devices.

One species, *Fusarium graminearum*, produces two types of spores that may be released from the debris of corn and small grains. When these spores land on wheat and the silks of flowering corn, the fungus takes over the developing kernels. The fungus can produce dangerous toxins, such as deoxynivalenol and zearalenone, a mycotoxin that mimics the hormone estrogen. These toxins can threaten domestic animal health.

When the team analyzed *Fusarium* colonies collected in the atmosphere with drones, they found that some of the fungi were airborne for several hours, a sufficient amount of time to be affected by large-scale weather patterns tens to hundreds of miles long.

Dust also makes for handy molecular taxicabs. Some microbes travel across continents on dust particles when they might otherwise be subsumed by ultraviolet light exposure, the team wrote. So popular are the global dust lanes for microbes that an estimated hundreds of millions of tons of African dust land in Florida every year.

The pair also discuss how microbes induce weather. Some strains of the

bacterium *Pseudomonas syringae* produce a protein that may facilitate precipitation. This bacterium is part of a commercial product that makes artificial snow.

Funding from a number of different programs through the National Science Foundation has supported the researchers' work on the atmospheric transport of microorganisms.

Microorganisms are high fliers not only on land, but also in the sea and other aquatic environments as well. Schmale and Ross discovered that aerosolization of microbes may occur when waves crash, bubbles burst, wind sweeps across still water surfaces, or from impacts from droplets splashing.

The team has been collecting microbes using drones and unmanned boats in and over water. It is the next unexplored frontier of microbial transport, according to the team.

Still breathing?

To paraphrase Morpheus from the Matrix, "You think that's air you're breathing now?" How do you define air? Schmale and Ross say the answer might be more than oxygen — it may be the microbes themselves. ☀

Student award

Daniela Cimini and her student Ellen Garcia attended the 5th annual meeting of the American Society for Cellular and Computational Toxicology, held on September 29-30, 2016 at the EPA campus (Research Triangle Park, Durham, NC). Ellen's abstract, entitled "Single-cell analysis reveals that silver nanoparticle exposure leads to multi-nucleation through defective cell division," was selected for a talk, which she presented on September 29 and for which she received the "Tox21 award" (consisting of a certificate and a \$500 check).





Photo above: Proteins involved in motility in *Clostridium perfringens* were fluorescently tagged (blue and yellow spots) to show their location in the bacteria (black rods).

BIOTRANS researchers find that bacteria has surprising moves by Lindsay Key

Whether mildly upsetting the human intestinal tract or causing a potentially fatal gangrene infection, *Clostridium perfringens* bacteria get around.

Found in soil, sediment, and water all over the world—even in Antarctica—the rod-shaped creatures are considered one of the most environmentally successful bacterial species due to their abundance.

But, strangely enough, these bacteria are missing a standard anatomical feature. They lack a curly tail called a flagellum, which propels most bacteria forward in a swimming fashion. Yet, all of their closest relatives have flagella.

When BIOTRANS microbiologist Steve Melville learned of this, he became intrigued. How, then, does *Clostridium perfringens* get around?

Melville took a closer look under the microscope and examined the DNA sequence of many strains of the bacteria and still found no flagella or genes that might code for them. What he did find, though, was an arguably more efficient strategy.

Rather than swim by using flagella, the bacteria have found other ways to be mobile.

They glide. They float. They twitch.

The movement, says Melville, depends on the environment they find themselves in.



When the bacteria are first placed on a new surface, they twitch for the first 15 minutes or so because they are using pili—tiny protruding hairs all across the surface of their bodies—to attempt to stick, or find their footing.

“The pili, known as type IV pili, act like a rope with an anchor on the end,” said Melville. “The bacteria throw out the ropes, the anchor attaches, and then pulling on the rope provides momentum to pull themselves toward a surface.”

Once attached to a surface, the bacteria switch to a type of gliding motility where the cells line up end to end to form a filament. The filament gets longer by growth and division of the rod-shaped bacteria and the bacteria at the tip of the filament get pushed across the surface.

“The gliding motion is very smooth and movies showing it are kind of relaxing and engaging,” said Melville.

The bacteria continue to move across a surface in this fashion. However, if they find themselves in a more liquefied substance, they use a combination of pili and—from what Melville can tell—gas bubbles.

The gas bubbles are generated from the bacteria’s natural fermentative metabolism, which expels carbon dioxide and hydrogen gas.

“It’s really remarkable,” said Melville.

“These bacteria use their energy resources in a very efficient way. Rather than spend energy on powering a flagella, they rely on a combination of pili and

These bacteria use their energy resources in a very efficient way. Rather than spend energy on powering a flagella, they rely on a combination of pili and natural metabolic processes to glide, float, and twitch.

natural metabolic processes to glide, float, and twitch.”

Efficient use of energy is important in the competitive microbial world where bacteria that work efficiently constantly divide and clone themselves to expand their population and, ultimately, take over and push out other species.

A deadly infection

Understanding the mechanisms behind *Clostridium perfringens*’ success is key to developing better treatments for gas gangrene, the infection that the tiny organisms cause in muscles or internal organs. Unchecked, the bacteria rapidly kill cells by releasing toxins and cutting off the blood supply to that area.

Sadly, treating these sorts of infections with intravenous antibiotics is not effective, often leaving patients with the choice of amputation or death. This tragic situation is fictionally depicted in the popular movie *Dancing with Wolves* through the character of First Lieutenant John J. Dunbar, played by Kevin Costner. Rather than face amputation



of his leg due to gas gangrene, Costner epically takes a horse and rides along Confederate lines, daring the enemy to fire. It shows how difficult a decision to amputate can be.

“Despite 3,000 years of people knowing what gas gangrene is, the treatment is still pretty much the same as it was in 1,000 BC. There is a dire need for improvements,” said Melville.

Although extremely deadly, gas gangrene research has often been overlooked and underfunded over the years because it occurs somewhat rarely and randomly. There are approximately 3,000 to 4,000 cases per year in the U.S., according to Melville.

“Despite the fact that almost every adult knows what gangrene is, it doesn’t get a lot of publicity,” he said.

However, at Virginia Tech, he has recruited four other faculty members to the project. Caroline Jones, an assistant professor of biological sciences in the College of Science, offers her expertise in microfluidic platforms, which are useful for examining proteins in single bacteria.

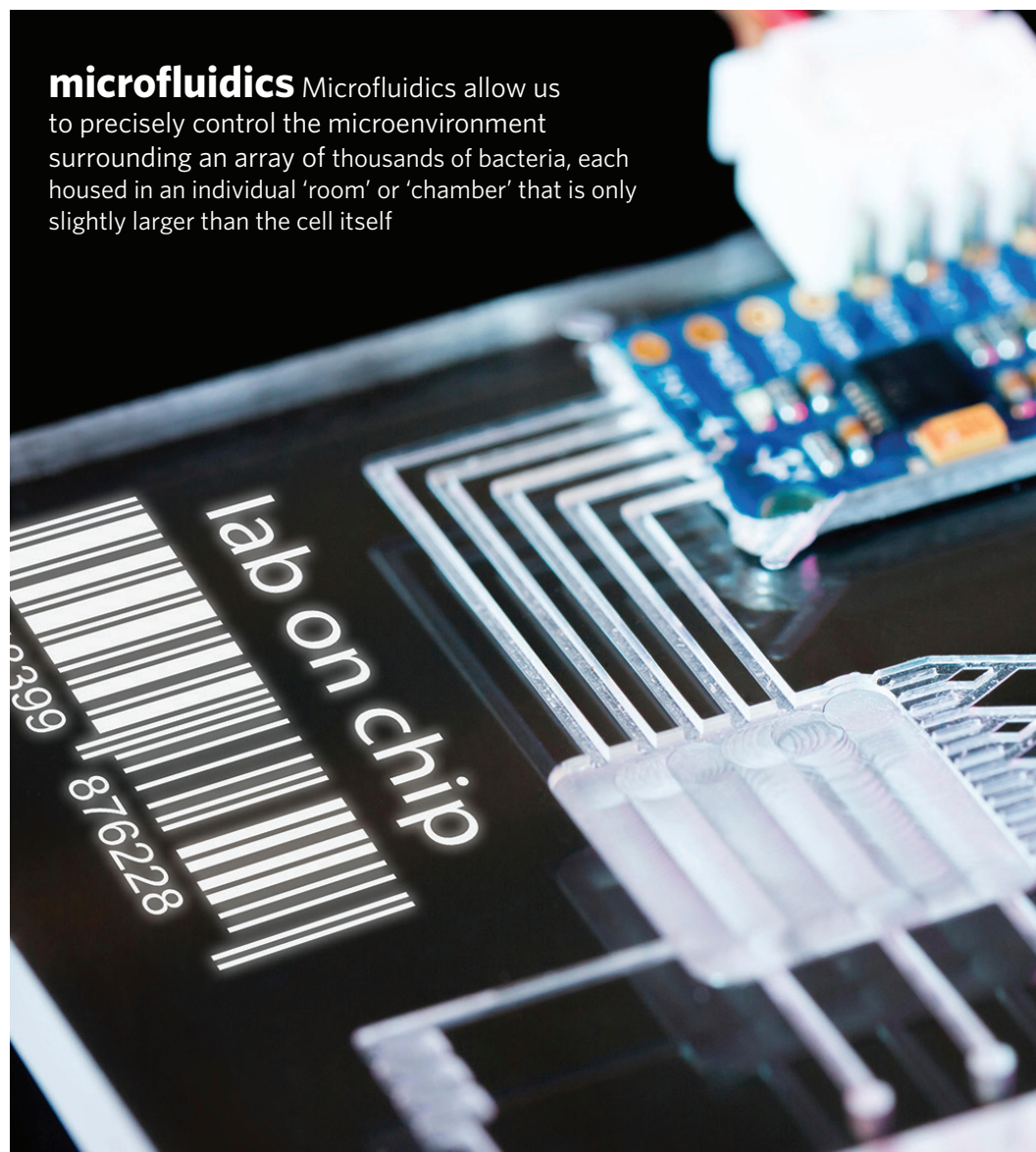
The microfluidic chambers that she designed for the project enable the team to do real-time analyses of the motility of *Clostridium perfringens* in nanoliter-sized channels and to follow fluorescent protein movement and localization.

“Microfluidics allow us to precisely control the microenvironment surrounding an array of thousands of bacteria, each housed in an individual ‘room’ or ‘chamber’ that is only slightly larger than the cell itself,” said Jones. “We can flow solutions in the microchannels that induce changes in bacteria motility and protein localization

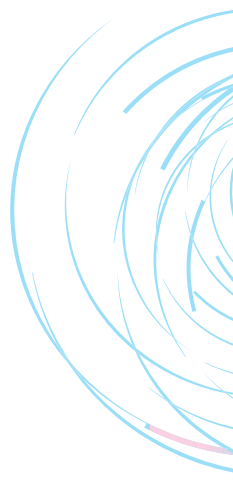


STEVE MELVILLE RESEARCHER

“Despite 3,000 years of people knowing what gas gangrene is, the treatment is still pretty much the same as it was in 1,000 B.C. There is dire need for improvements.”



microfluidics Microfluidics allow us to precisely control the microenvironment surrounding an array of thousands of bacteria, each housed in an individual ‘room’ or ‘chamber’ that is only slightly larger than the cell itself



in a synchronized, well-controlled manner.”

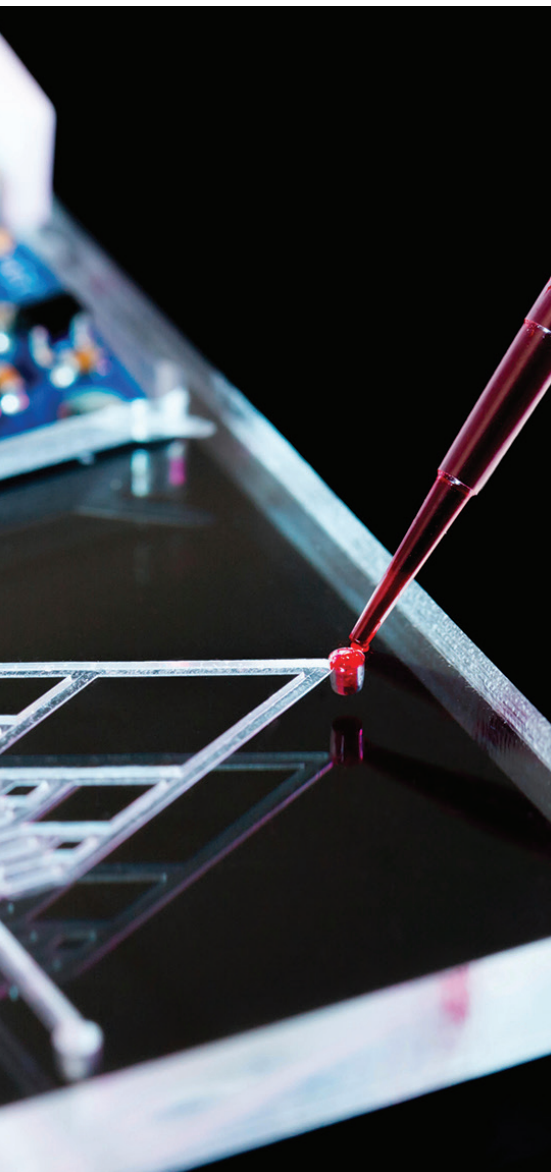
Dave Bevan, a professor of biochemistry in the College of Agriculture and Life Sciences, has helped with molecular dynamics modeling of the assembly of type IV pili proteins.

“These pili are particularly interesting because they are assemblies of one protein, pilin, that extends out of a biological membrane,” said Bevan. “We were successful in developing a model of pilin in a membrane, as a first step in characterizing details of the assembly process.”

Rick Jensen, a professor of biological sciences in the College of Science, helped with genome sequence analysis to identify the mechanism for why some mutants are hyper-motile when they glide.

Rich Walker, an associate professor of biological sciences, helped with analysis of the gliding bacteria several years ago.

Melville and Jones are in the process of applying for grants to expand the project, and to potentially bring a BIOTRANS student on board. ☀️



Dances with Wolves (1990).

Rather than face amputation of his leg due to gas gangrene, First Lieutenant John J. Dunbar, played by Kevin Costner, epically takes a horse and rides along Confederate lines, daring the enemy to fire.



credit: Ben Glass/Orion pictures



Good Vibrations

by Cassandra Hockman

The Beach Boys had it right when they picked up good vibrations. But their 1966 Grammy-nominated No. 1 hit isn't the only source of good vibes. You can also find them in the lab of Shima Shahab at Virginia Tech.

Shahab, a new BIOTRANS engineer, uses vibrations to generate waves that are safer and potentially healthier than alternative energy sources.

Generally speaking, waves are methodical movements, like the ones found at the ocean that rise and fall repeatedly. In physics, waves are measured mathematically to describe certain physical situations since they are sources of energy. This energy can come from physical movement, so as a wave moves through an object or material, it carries energy and thus acts as a force to move another object.

In biomedical areas, electromagnetic waves have been traditionally used to transmit energy from outside the body to an implanted device for wireless charging, such as a battery inside a pacemaker. These tend to travel - and

transfer energy - based on surrounding magnetic and electrical fields, which can be harmful to health by interfering with body tissue, for example.

Shahab specifically uses acoustic waves, which are mechanical waves that travel through a medium, such as human tissue, bone, blood, or water. They are generated through the physical vibrations of a particular material.

In one project, Shahab studies how acoustic waves can act as an energy source for implanted devices, such as a pacemaker and brain interference sensors, with minimal health impact.

"Every five to seven years patients have to undergo an expensive and dangerous surgery to replace the battery within the pacemaker," said Shahab, an assistant professor of biomedical engineering and mechanics (BEAM) in the College of Engineering. "The goal of our project with the acoustic energy transfer systems is to transfer energy remotely and without any wires in deep long distances."

Now she and her team are working with an acoustic transmitter that generates

acoustic waves to a receiver that would be placed inside the body in more advanced miniature designs in the future. The receiver is made of a piezoelectric base material, which converts vibrations induced by the exposed acoustic waves into electricity - or energy. The attached battery could then be charged over time. "We could do this regularly for the patient," Shahab said.

While completing her Ph.D. at the Georgia Institute of Technology, Shahab developed mathematical models of acoustic waves interacting with a piezoelectric receiver. This included analyzing how acoustic waves could be used to transfer energy from an external acoustic source, which would in turn charge the battery in the implant.

"The idea is that the pacemaker could stay charged based on how it is designed and how energy accumulates," she said.

A second application of these good vibes is in what Shahab calls an acoustic streaming effect. This effect takes place as acoustic surface waves are streamed into a channel with a particular medium in the lab.

In this project, acoustic radiation creates and manipulates bubbles and sorts body cells within microfluidic devices or channels. In the lab, the microfluidic channel mimics a blood vessel, and is made of a fluid that mimics blood. Acoustic waves excite bubbles to move erratically in a dancing motion. This radiation could then be applied to noninvasively deliver drugs to a specific target by manipulating bubbles interacting with cells, or to separate different types of cells based on their physiological differences.

New BIOTRANS engineer Shima Shahab embraces her lab's unofficial skeleton mascot while surrounded by her team of undergraduate and graduate students in the Multiphysics Intelligent and Dynamical Systems (MInDS) Laboratory in biomedical engineering and mechanics at Virginia Tech. *Image courtesy of Shima Shahab.*



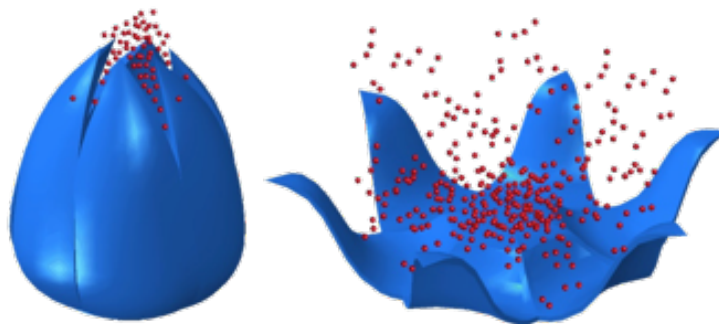
Ultimately, Shahab and her team aim to develop a new approach for sorting cells based on their acoustic properties – that is, sort them by how they respond to ultrasound waves.

Students from the College of Engineering, the Wake Forest Institute of Regenerative Medicine, and the Virginia Tech School of Performing Arts will participate in this project. The project's engineering aspect will involve biomedical engineering and mechanics students while a performing arts team will analyze the creative dance movement of bubbles.

"Cells are structurally different and their acoustic responses rely on the structural properties," she said. "The purpose of this project is to separate cell types by making a dance field and adjusting the equilibrium distance between the cells. The advantage of using acoustic waves is that it does not require altering the cells with chemical labels. This allows others to look at the behavior of the cancer cells by isolating them."

Colleagues at Virginia Tech have recently developed an approach that resulted in technology that uses electric fields

Shahab is also using this focused transducer to open tiny drug-carrying containers that could be distributed throughout the body.



When subjected to external ultrasound-induced heat, the container opens inside the body to disperse medicine.

to specifically target tumor cells while leaving healthy tissue unharmed. Shahab can work with them in the future by using microfluidic channels and acoustic waves to isolate certain cells.

Marjan Bakhtiari-Nejad, a Ph.D. student in BEAM, and Ahmed Elnahas, an undergraduate Fralin fellow majoring in mechanical engineering at Virginia Tech, began developing this simulation and found they were able to make this affect in fluid.

This excited Rafael Davalos, a professor and BIOTRANS engineer. Davalos studies brain cancer, so being able to target the cancer cells solves an additional problem for treatment.

"Imagine a microfluidic device in which you could isolate cancer cell sub-populations from other cells and particulates in a blood sample,"

said Davalos. "Further imagine if you separate these samples based on the aggressiveness."

He and Sunny Jung, an associate professor and fellow BIOTRANS engineer, will be collaborating with Shahab in the near future.

What's more is that Shahab is able to use a focused ultrasound transducer, a round and concaved mechanical device, to target a particular focal point with acoustic waves inside the body.

"Imagine placing a transducer over a particular area of a patient's body," she said. "The acoustic waves could deliver a strong beam to a specific part of a cancer. Some cells die when this high intensity ultrasound beam is focused directly on them, so you could actually kill the cells in a particular area without doing surgery."

Shahab is also using this focused transducer to open tiny drug-carrying containers that could be distributed throughout the body. She is currently experimenting with a smart polymer material, shaped like a square box with soft edges, that has the ability to hold a temporary shape and then return to its original shape when subjected to external ultrasound-induced heat.

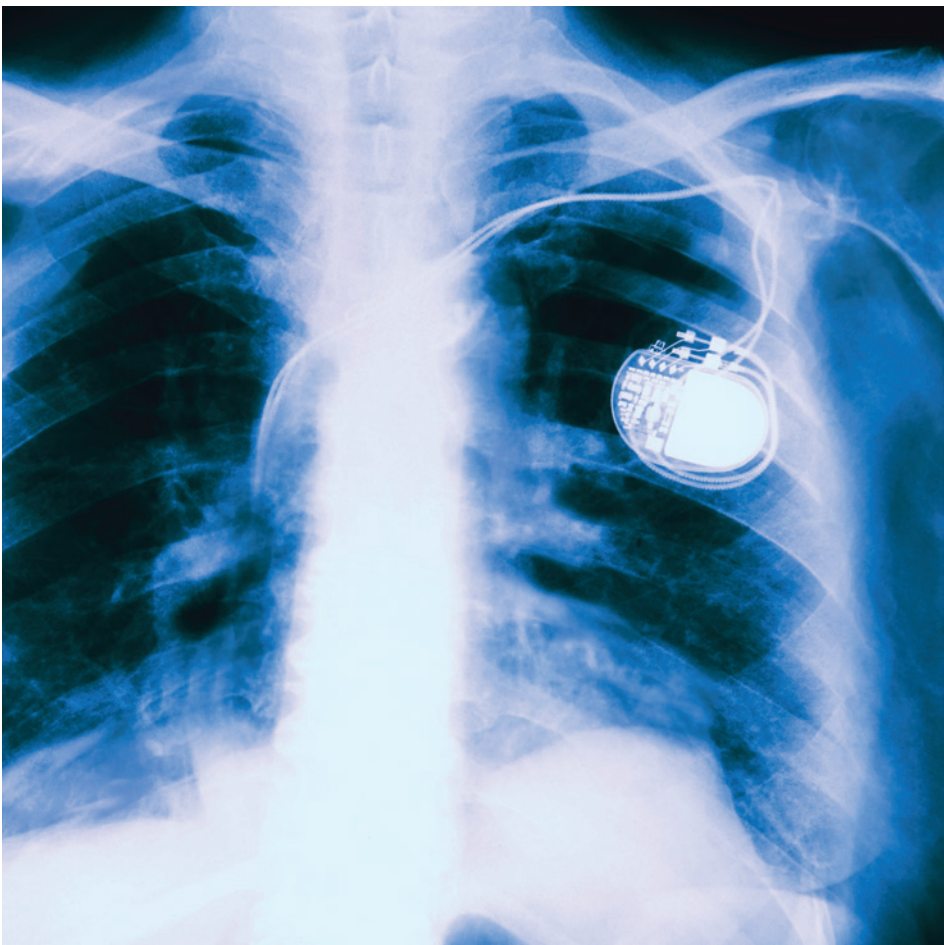
Heat opens the container inside the body to disperse medicine.

"The accuracy of the drug-releasing location is guaranteed by the implementation of this novel technique for stimulating the capsules," Shahab said. "The big picture would be to use a smart material to offer medicine to a particular location within the body with a predetermined rate. Again, the goal here is to use acoustic waves because they are safe and can transfer energy to inaccessible locations and through long distances."

She will be collaborating with Reza Mirzaeifar, an assistant professor in mechanical engineering at Virginia Tech, on this project.

Shahab runs the Multiphysics Intelligent and Dynamical Systems (MInDS) Laboratory at Virginia Tech, which focuses on the intersection of smart materials and dynamical systems for various interdisciplinary applications. Her team's work mainly focuses on the biomedical applications associated with acoustic energy transfer, with the ultimate goal of designing a new generation of smart biomedical systems that can be linked to new medical treatments and diagnostic systems. Her work is supported by the department of biomedical engineering and mechanics in the College of Engineering and a Diversity and Inclusion seed grant from the Institute for Critical Technology and Applied Science.

Anyone else picking up these good vibes? We certainly are. ☀️



Tess Thompson gives prospective BIOTRANS students a tour of her lab and talks about work being done in her flume. Members of the Thompson Lab are studying the role of vegetation in streams and wetland systems.



Linsey Marr gives prospective BIOTRANS students a tour of her lab and talks about work being done in her aerosol chamber. Members of the Marr Lab are studying the transmission of infectious diseases and the fate of nanomaterials in the environment.



Current BIOTRANS graduate students showcase their exciting research for prospective students.



Khaled Adjerid gives prospective BIOTRANS students a chance to hold some creepy insects in the Socha Lab. Members of the Socha Lab are studying the mechanics of circulation in insects.

BIOTRANS RECRUITING DAY

November 5, 2016

Photos courtesy of David Schmale

Students dropped natural and 3-D printed seeds from a boom lift at Kentland Farm Airstrip and recorded each seed's landing location.
photos by Christina + David



Flying seeds: mimicking nature's smart design

by Lindsay Key

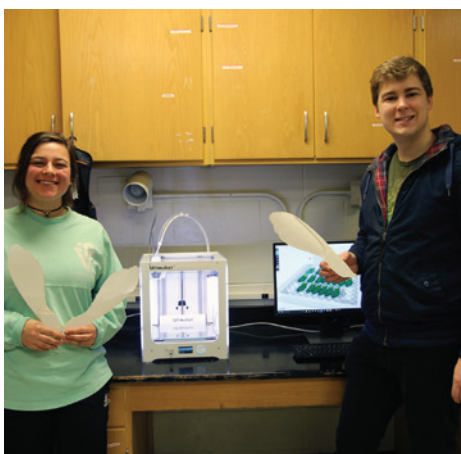
Helicopter seeds, whirlybirds or spinning jennies—whatever you call them, winged seeds scientifically known as “samaras” are a sight to behold in early autumn, when they flutter gracefully to the ground from towering maple and ash trees.

The extended fall of the seeds isn't just beautiful; it also provides a survivability advantage. Seeds with longer “airtime” have a greater likelihood of being picked up by the wind and spread, reducing resource competition and increasing species dispersal.

Two recent Virginia Tech grads—biologist Katrina Somers and mechanical engineer Brock Davis—came together during the Spring 2017 semester to study samaras and what lessons their smart biological design could provide engineers developing models to distribute sensors across landscapes.

The students collected samara seeds and used 3-D printers to make copies of them so they could study how variations in size, shape, and thickness affected the rate and speed of autorotation. They also wanted to test how the natural seeds performed against the 3-D printed seeds.

Katrina Somers and Brock Davis.
photo by Lindsay Key



This particular project was designed to inform the field of remote sensing, in which sensors are designed and remotely distributed to gather information to benefit natural resource management and hazard assessment.

They dropped 90 seeds (30 of the natural Norway Maple seeds and 30 each of two separate 3D printed designs) from a 10-foot boom lift at the Kentland Farm Airstrip. They recorded each seed's landing location and measured the distance and angle of its dropped position with respect to the downwind direction, in order to recreate the distribution using mathematical tools and to quantify the effect of the wind.

They tested on three different days to get a good sampling of wind and weather conditions.

"We roughly determined that the natural seeds perform somewhat better than the 3D printed seeds, which was not surprising," said Davis. "However, the 3D printed seeds hold their own and succeeded in self-distributing over a large range."

The students' advisors— David Schmale, a professor of plant pathology, physiology and weed sciences in the College of Agriculture and Life Sciences, and Shane Ross, a professor and engineering mechanics graduate director in the department of biomedical engineering and mechanics in the College of Engineering—will continue to analyze the results from the experiment.

Schmale and Ross launched the semester-long pilot project in order to increase interaction between undergraduate engineers and biologists at Virginia Tech.

They hope to acquire funds to expand the project to serve as a complement to the already successful interdisciplinary graduate education program BIOTRANS.

This particular project was designed to inform the field of remote sensing, in which sensors are designed and remotely distributed to gather information to benefit natural resource management and hazard assessment. Some sensors are also deployed underwater to gather information about ocean circulation and current systems, temperature and wave heights, and to track sea ice, according to the National Oceanic and Atmospheric Administration (NOAA).

Davis and Somers were additionally supported by an Institute for Critical Technologies and Applied Sciences (ICTAS) Research Experiences for Undergraduates grant. ☀️



Daniela Cimini

What is the focus of your research?

Research in my lab focuses on two major areas: (i) the role of mechanics and dynamics of mitotic apparatus components in ensuring accurate chromosome segregation during cell division; and (ii) causes and consequences of aneuploidy (abnormal chromosome numbers) in normal and cancer cells.

How is your work interdisciplinary?

Many of our studies include a mathematical modeling component, typically through collaborations. We use mathematical modeling to quantitatively interpret our experimental data as well as for generating predictions that we can then test experimentally. Moreover, we are currently engaged in a number of collaborations with engineering faculty for which we contribute our expertise in cell imaging, and our engineering collaborators contribute their expertise in building platforms for experimental testing.

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

When I visited campus during my job interview, I felt that people here were very welcoming, collegial, and friendly. So, I knew that here I would not only be able to build a successful research program, but I would also enjoy my daily interactions with colleagues.

What do you enjoy about being an affiliated faculty member with the BIOTRANS program?

I enjoy the variety of expertise among the faculty and the idea that everybody involved is open to collaborations. But most of all, I enjoy mentoring students with very diverse background. Frequently, they are the ones who bridge interests and expertise of different labs and catalyze collaborations.

What advice do you have for prospective graduate students?

My main advice is to keep a positive attitude and always remember that we really want students to succeed and want them to be ready to move on to the next step of their career by the time they graduate. Also, even though you will choose a major advisor and a co-advisor by the end of the first year in the program, you can seek mentoring elsewhere and providing good mentoring has been a priority of the program since its inception. So, if you need advice, don't be afraid to ask!

What has been your most memorable experience since joining Virginia Tech or moving to Blacksburg?

I was unfortunately already at VT when the mass shooting happened in 2007 and that is something that will be difficult to forget (and I wouldn't want to forget). However, the most memorable experience for me was witnessing the way the VT and extended Blacksburg community came together. That is something I will certainly never forget! ☀️

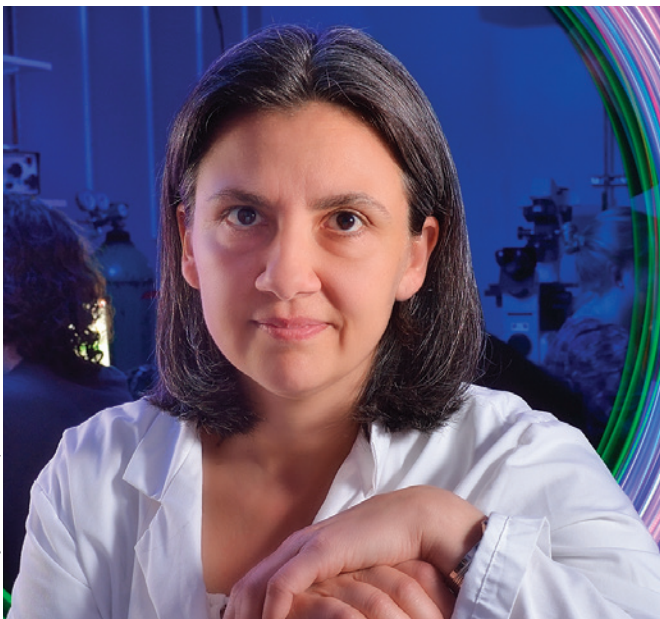
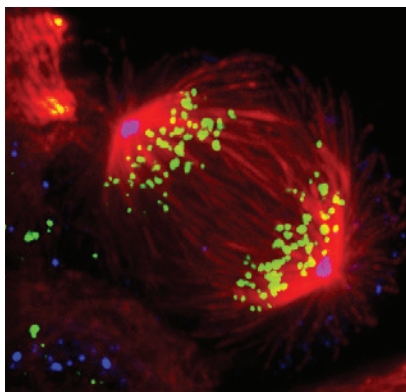
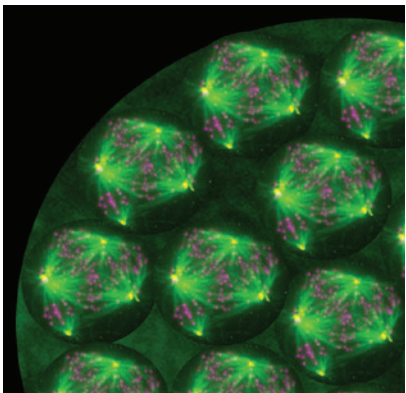


Photo by Jim Stroup

This is a mitotic cell in anaphase, the stage during cell division when chromosomes move to opposite poles. The microtubules of the mitotic spindle are in red, the spindle poles in purple, and the kinetochores in green. *Image courtesy Daniela Cimini.*



Used on the cover of a journal last year, this image shows the same mitotic cell with a multipolar spindle repeated many times. The microtubules are in green, the kinetochores are in purple, and the spindle poles are in yellow. *Image courtesy Daniela Cimini.*



ROME



Hometown

GIULIANELLO, ITALY

(Village under the municipality of Cori, in the province of Latina, region Lazio. Total population: ~2,500)

Educational Background

Postdoctoral training, Cell Biology

2001 – 2005

University of North Carolina at Chapel Hill

Advisor: Ted Salmon

Ph.D., Genetics and Molecular Biology

March 2001

University of Rome La Sapienza, Center for Evolutionary Genetics

Dissertation title: *Cellular mechanisms of aneuploidy induction in mammalian cells: role of mitotic spindle and mitotic checkpoint*

Advisor: Dr. Francesca Degrassi

Specialty degree (Highest honors), Applied Genetics

October 1997

University of Rome La Sapienza

Thesis title: *Study of chromosome malsegregation mechanisms by means of in situ hybridization on anaphases and binucleate cells*

Advisors: Prof. Caterina Tanzarella and Dr. Francesca Degrassi

Degree (Laurea, Highest honors) in Biology

November 1993

University of Rome La Sapienza

Thesis title: *Use of CREST staining and in situ hybridization for the analysis of micronuclei induced by 5-azacytidine in human fibroblast cultures*

Advisors: Prof. Caterina Tanzarella and Dr. Francesca Degrassi

Hobbies

Tennis

Favorite thing to do around Blacksburg

Attend performances by students in the Virginia Tech School of Performing Arts (e.g., Mainstage Theatre plays) and shows at the Moss Arts Center

A Favorite Quote

The best things in life aren't things. – Art Buchwald



Favorite Type of Music or Artist

Italian singer and songwriter
Lucio Dalla (1943 – 2012)

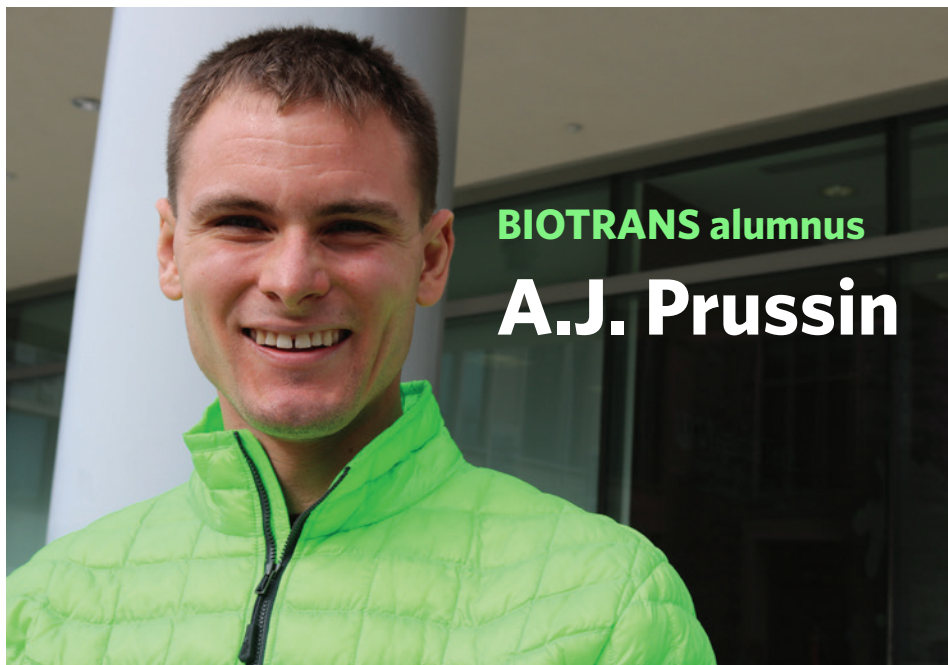


A Favorite Book

Novecento: Un Monologo

by Alessandro Baricco

Translated as *Novecento: pianist*



by Cassandra Hockman

For A.J. Prussin, Blacksburg is a place to do more than visit – it’s a place to return, time and again, and stay. When he was five years old, his family moved to Blacksburg, where his father was a medical doctor.

After learning about medicine at home, Prussin wanted to be a physician when he graduated from Blacksburg High School in 2005, so he pursued degrees in biochemistry and biology at Virginia Tech.

He started undergraduate research right after his freshman year, where he worked in an inorganic chemistry lab studying light-activated supramolecular complexes similar to cisplatin, a chemotherapy drug used to treat cancer.

“My job was to study how these metal complexes interact with DNA,” he said.

For three years, he helped synthesize these mixed metal complexes under the guidance of Brenda Winkel, professor and head of the department of biological sciences, as well as the late Karen Brewer, a former professor of inorganic chemistry, both in the College of Science.

In 2009, Prussin graduated with his bachelor’s degree, but rather than move on to medicine, he was interested in

biochemical research, so he began a Ph.D. at the University of California at Santa Barbara.

Within nine months, he realized basic research wasn’t enough. Something was missing.

“I called up Dr. Brewer and Dr. Winkel, and asked if they knew anyone in the country doing biodefense work. I don’t know what sparked that interest in me, but something about it got me excited,” Prussin said

Sure enough, Brewer and Winkel had an idea for him – they put him in touch with David Schmale, a plant pathologist studying airborne pathogens at Virginia Tech.

Prussin had never taken a plant science class, but he was willing to learn.

So he did.

In June 2010, he moved back to Blacksburg and started a Ph.D. with Schmale, a professor of plant pathology, weed science, and physiology in the College of Agriculture and Life Sciences at Virginia Tech.

Fortunately for Prussin, Schmale and a team of diverse faculty had just received a grant from the National Science

Foundation for the MULTISTEPS program, now BIOTRANS, an interdisciplinary graduate education program housed through the university’s Graduate School. The goal of the program was to bring biology, engineering, and other disciplinary perspectives together so students could investigate transport processes within biological systems at various scales by asking targeted research questions.

Prussin was excited by the program’s emphasis on applying basic science to a practical problem. He joined BIOTRANS as one of its first students, and began investigating the airborne spread of a fungal plant pathogen that wreaks havoc on wheat and barley, causing the disease Fusarium Head Blight.

But rather than simply study the pathogen’s affect on the crops, he studied the aerobiology of the pathogen, including how the fungal spores traveled in the air and how far, and then validated mathematical models to predict their transport using results from his field work.

“In a single week, I could be out on the farm in the wheat field on Monday, then Tuesday I might be growing a fungal culture using microbiology. Wednesday I could be doing molecular biology, then Thursday I might be doing mathematical modeling on a computer. How do you get more interdisciplinary than that?”

Prussin finished his Ph.D. in 2013 as the first graduate of BIOTRANS. Faculty from different disciplines served on his committee. In addition to Schmale, he benefitted from the expertise of co-advisor Shane Ross in biomedical engineering and mechanics, Jacob Barney and Anton Baudoin in plant pathology, and Linsey Marr in civil and environmental engineering.

“When I was at Santa Barbara, I was studying one single protein and I was going to be an expert in this single protein,” said Prussin. “But what I really liked about BIOTRANS was that I didn’t just focus on biology – it was engineering,

environmental engineering, microbiology, and molecular biology. I had to use many different fields to really answer the question I was interested in."

"As a graduate student, AJ embraced the interdisciplinary spirit of the BIOTRANS program," said Schmale, director of the BIOTRANS program. "His research sought to answer important questions about the transport of pathogens in the atmosphere. Now, AJ is extending his graduate and postdoctoral training to new questions involving human exposures to environmental contaminants."

With this new expertise and a desire to stay in Blacksburg, Prussin then began a postdoc position with Marr, studying how seasons affect the presence and resilience of certain bacteria and viruses in a daycare center.

After his postdoc, he moved into industry in a position with Avila Scientific, where he worked on the Cooperative Biological Engagement Program run through the U.S. Defense Threat Reduction Agency. While working on this project, he traveled back and forth from Blacksburg to work directly with scientists in the Republic of Georgia.

"Being interdisciplinary in my thinking was key here, as I worked with scientists from a wide range of fields, from

agriculture to human health, and I had to be very adaptable and know how to communicate and collaborate with people in different fields," he said.

After working for a year, Blacksburg called him back again. This time it was Marr. She was looking for a research scientist and someone to help out with the Center for Science and Engineering of the Exposome, supported by the Institute for Critical Technology and Applied Science. The goal of the center is to apply interdisciplinary approaches to the connections between engineering design and the human exposome - the sum of exposures people experience during their lifetime, from diet to environmental contaminants, and how these affect health.

"BIOTRANS helped open up collaborations, which has really allowed my research to progress," said Prussin. "Sometimes if you're a biologist and you're trying to answer this question, then there might be an engineer that might be trying to get to the exact same question but you might not know about it, so you really need each other. The biologists need engineers and the engineers need biologists."

Now as a research scientist, Prussin has a hand in a lot of different projects, including investigating how humidity affects the airborne spread of the flu virus, a project funded by the National Institutes

of Health.

He also works with several student and postdoc projects, so he's always doing something new.

"I love doing that because it's nice to get to work on a little bit of everything. It's chemistry one day, then biology another day."

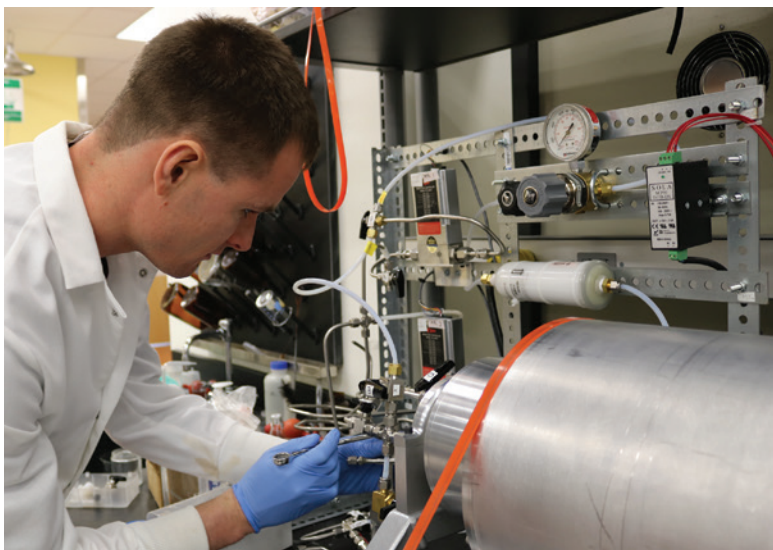
Recently, he and Marr finished collecting data as part of the flu virus project. Soon they will have a better idea of how well the flu spreads and why.

For now, Prussin is glad to be back.

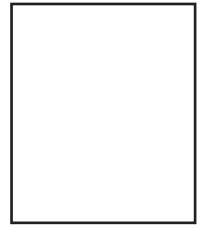
"I have tried to leave but I keep getting sucked back. I really love it here."

After all this, Prussin has some advice for potential graduate students.

"Don't be afraid to change your career directions," he said. "If you find something interesting, go for it. I think it's really fun to bounce around because you learn a lot, so don't be afraid of change." ☀️



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During the Spring 2017 semester, two recent Virginia Tech grads—biologist Katrina Somers and mechanical engineer Brock Davis—together with BIOTRANS faculty and grad students, studied samaras. Learn about what lessons their smart biological design could provide to engineers developing models to distribute sensors across landscapes on page 14.