BIOTRANS

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Welcome to our first issue of the Biological Transport (BIOTRANS) Magazine! It has been an exciting year for BIOTRANS, and we've got a lot to share with you.

Haven't heard of BIOTRANS? It's time to change that. We are a community of biologists and engineers that work together to study transport in environmental and physiological systems. Worried about a pathogen turning up in your city or crop field? BIOTRANS is finding ways to track the movement of these threat agents in the atmosphere. Need new solutions to treat cancer? BIOTRANS is studying the dynamics of cell division to develop novel approaches to fight cancer.

Are you hiring? Our graduates are some of the best and brightest in the world, and they are landing great jobs in academia and industry. In November 2015, 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 the dynamics of diving birds (Jung Lab), captain an unmanned boat in the duck pond for sampling microbes (Schmale Lab), and watch how small insects use a magnetic compass to get around (Phillips Lab).

Are you new to research in BIOTRANS? We want to hear from you! We'd love to talk to you about becoming a part of the BIOTRANS community.

Why should you care about BIOTRANS? BIOTRANS is working on some of the biggest challenges in the world today at the nexus of disease, food, energy, and water. BIOTRANS is training the next generation of interdisciplinary biologists and engineers, and these students are the future. BIOTRANS is publishing research that makes a difference, and this research impacts you.

WHAT'S INSIDE

STORIES ABOUT LAP DOGS ARE EVERYWHERE, BUT RESEARCHERS AT THE VIRGINIA TECH COLLEGE OF ENGINEERING CAN TELL THE STORY OF DOG LAPPING

Using photography and laboratory simulations, researchers studied how dogs raise fluids into their mouths to drink. They discovered that sloppy-looking actions at the dog bowl are in fact high-speed, precisely timed movements that optimize a dog's ability to acquire fluids.

Their discovery appeared Monday in the Proceedings of the National Academy of Sciences.

Researchers also compared what they learned about how dogs drink with what they knew from previous studies of cats. The scientists discovered that even though feline and canine mouths structurally are similar, their approaches to drinking are as different as — cats and dogs.

"We know cats and dogs are quite different in terms of behavior and character," said Sunghwan "Sunny" Jung, an associate professor of biomedical engineering and mechanics. "But before we did fundamental studies of how these animals drink fluids, our guess was dogs and cats drink about the same way. Instead we found out that dogs drink quite differently than cats."

Dogs and cats are biting animals and neither have full cheeks. But without cheeks, they can't create suction to drink — as people, horses, and elephants do. Instead they use their tongues to quickly raise water upward through a process involving inertia.

Both animals move their tongues too quickly to completely observe by the naked eye. But dogs accelerate their tongues at a much faster rate than cats, plunging them into the water and curling them downward toward their lower jaws, not their noses.

They quickly retract their tongues and a column of water forms and rises into their mouths, but they also curl the underside of their tongues to bring a tiny ladle of water upward.

Dogs precisely bite down to capture the water. In an instant they reopen their mouths and immerse their tongues back into the water.

Cats, on the other hand, lightly touch the surface of the water with their tongues, usually never fully immersing them, according to previous imaging by Jung and other researchers.

Image courtesy of Jake Socha, Sean Gart, and Sunny Jung

When their tongues rise into their mouths, liquid adheres to the upper side, forming an elegant water column.

When dogs accelerate their tongues upwards, the latest research reveals a water column rising, but some water remains in the ladle of the tongue and is tossed to either side of the dog's mouth or it falls downwards.

Although dogs do not use their tongues to actively scoop water into their mouths, it is possible that the scooped liquid has some positive effect on the water column dynamics below the tongue, the researchers said.

"Dog drinking is more acceleration driven using unsteady inertia to draw water upward in a column, whereas cats employ steady inertia," Jung said.

In all, 19 dogs of various sizes and breeds were volunteered for filming by their owners. Thirteen of the dogs were filmed outdoors at their owners' residences in the Blacksburg, Virginia, area. The remaining six were filmed at the Virginia Tech campus.

"This was a basic science study to answer a question very little was known about — what are the fundamental mechanics of how dogs drink?" said Sean Gart of Salem, Virginia, a graduate student in biomedical engineering and mechanics who filmed the dogs. "Cats tend be viewed as neater, dogs are messier, but dogs really have to accelerate their tongues to exploit the fluid dynamics of the water column."

The researchers measured tongue motion, recorded water volumes, and generally measured lapping in the dogs. They used the results to generate a physical model in the laboratory of the tongue's interaction with the air-fluid interface, according to Jake Socha, an associate professor of biomedical engineering and mechanics at Virginia Tech.

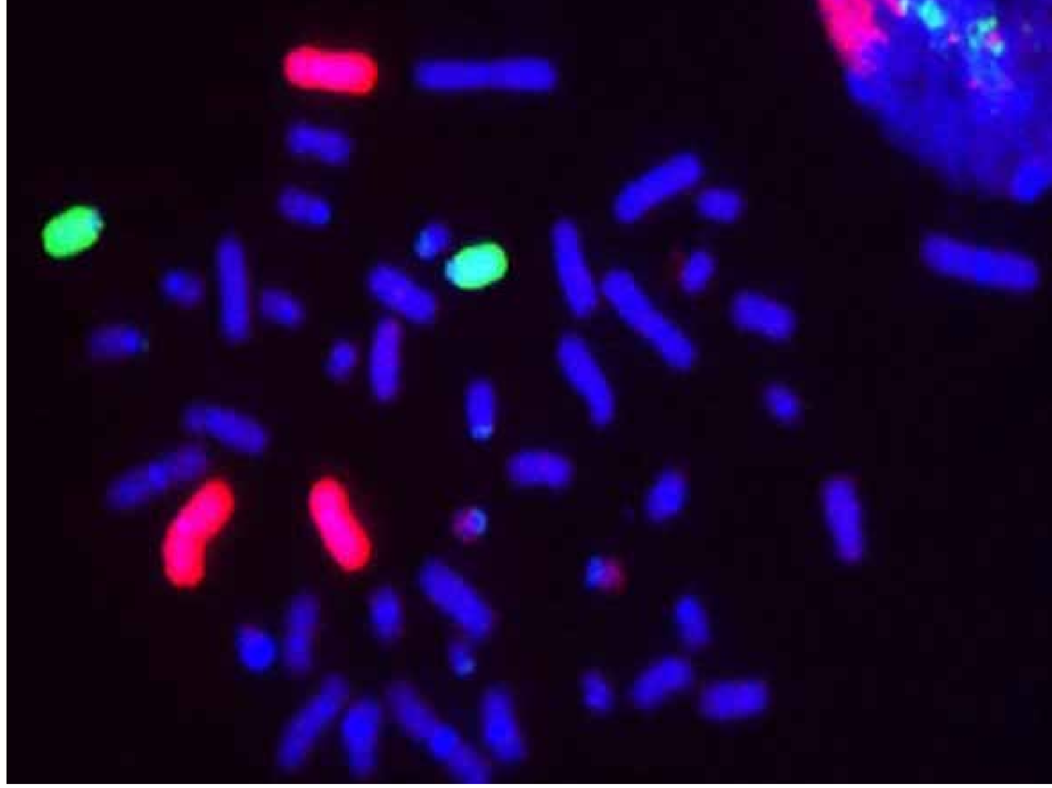
Pavlos Vlachos, a professor of mechanical engineering at Purdue University, also participated in the study.

"This is nice work and great outreach that gets people interested in science by taking an everyday activity that people see all the time and showing how it really works," said David Hu, an associate professor of mechanical engineering and biology at the George W. Woodruff School of Mechanical Engineering at Georgia Tech, who was not involved in the research. "It was surprising to me that dogs actually accelerate their tongues. When we drink, it is basically at a steady speed, but dogs are accelerating their tongues to between 2 Gs and 4 Gs. The dog moves its tongue at a higher acceleration than a rocket."

The research, supported by the National Science Foundation, is an accomplishment of the Bio-Inspired Fluid Lab of the Virginia Tech College of Engineering. The lab seeks to take cues from living systems to make practical applications that exploit the natural movement of fluids.

–John Pastor

RESEARCHERS CLOSER TO UNDERSTANDING HOW CERTAIN CANCERS RESIST TREATMENT



Pictured here are chromosomes from one of the aneuploid cell lines with a third chromosome (in pink). Image courtesy of Daniela Cimini.

A Virginia Tech cancer biologist has led an international, multi-institutional team to discover that an abnormal amount of chromosomes may be why certain cancers resist medical treatment.

Specifically, the team found that when certain cancer cells have abnormal amounts of chromosomes – a condition known as aneuploidy – they grow and adapt in conditions that are characteristic of a tumor's environment. This includes within the presence of a chemotherapeutic drug.

"We found that cells with incorrect chromosome numbers grow better than cells with normal chromosome numbers when exposed to stress," said Daniela Cimini, associate professor of biological sciences in the College of Science, a Fralin Life Science Institute affiliate, and a biology fellow at the Biocomplexity Institute at Virginia Tech.

The results were recently published in Scientific Reports.

In the study, the researchers exposed colon cancer cells with normal and abnormal numbers of chromosomes to conditions commonly found in the body when tumors form and grow. These environments include low nutrients, such as vitamins and proteins, and a lack of oxygen in a condition known as hypoxia.

Overall, the cancer cells with aneuploidy grew faster than normal cells.

The researchers also exposed the cells to a form of fluorouracil, a chemotherapeutic drug known on the market as Adrucil. Generally, the aneuploid cells continued to grow in the presence of the drug although at slower rates. Growth in cells with a normal amount of chromosomes was significantly slower in comparison.

In 2015, Cimini led another team to find that aneuploidy increases the diversity of chromosome number in daughter cells. These daughter cells then become more diverse in chromosome number, making a cell population with varying amounts of chromosomes, or a heterogeneous population.

According to the new study, this heterogeneity may provide aneuploid cells with specific advantages in adapting to certain environmental conditions, including resisting medical treatment.

"Aneuploid cells adapt to stressful conditions because they have an unstable genome that generates heterogeneous genomes and increases the probability of faster adaptation to challenging environments," said Elsa Logarinho, director of the aging and aneuploidy lab at the Institute for Molecular and Cellular Biology in Porto, Portugal, and co-author of the study.

"By showing that aneuploid mammalian cells could have some selective advantages in some stressful conditions, this work will not only contribute to our fundamental understanding of how and whether aneuploidy contributes to the formation of tumors, but could also shed light into the mechanisms underlying emergence of chemotherapy resistance," said Giulia Rancati, a group leader at the Institute of Medical Biology at the Agency for Science, Technology and Research in Singapore. Rancati was not involved in the research.

According to the study, aneuploidy may increase a cancer's tolerance to these environmental conditions even after cells have formed tumors and become malignant, or lost growth control. Aneuploidy also increases the invasiveness of cancer cells regardless of these stressful environmental conditions.

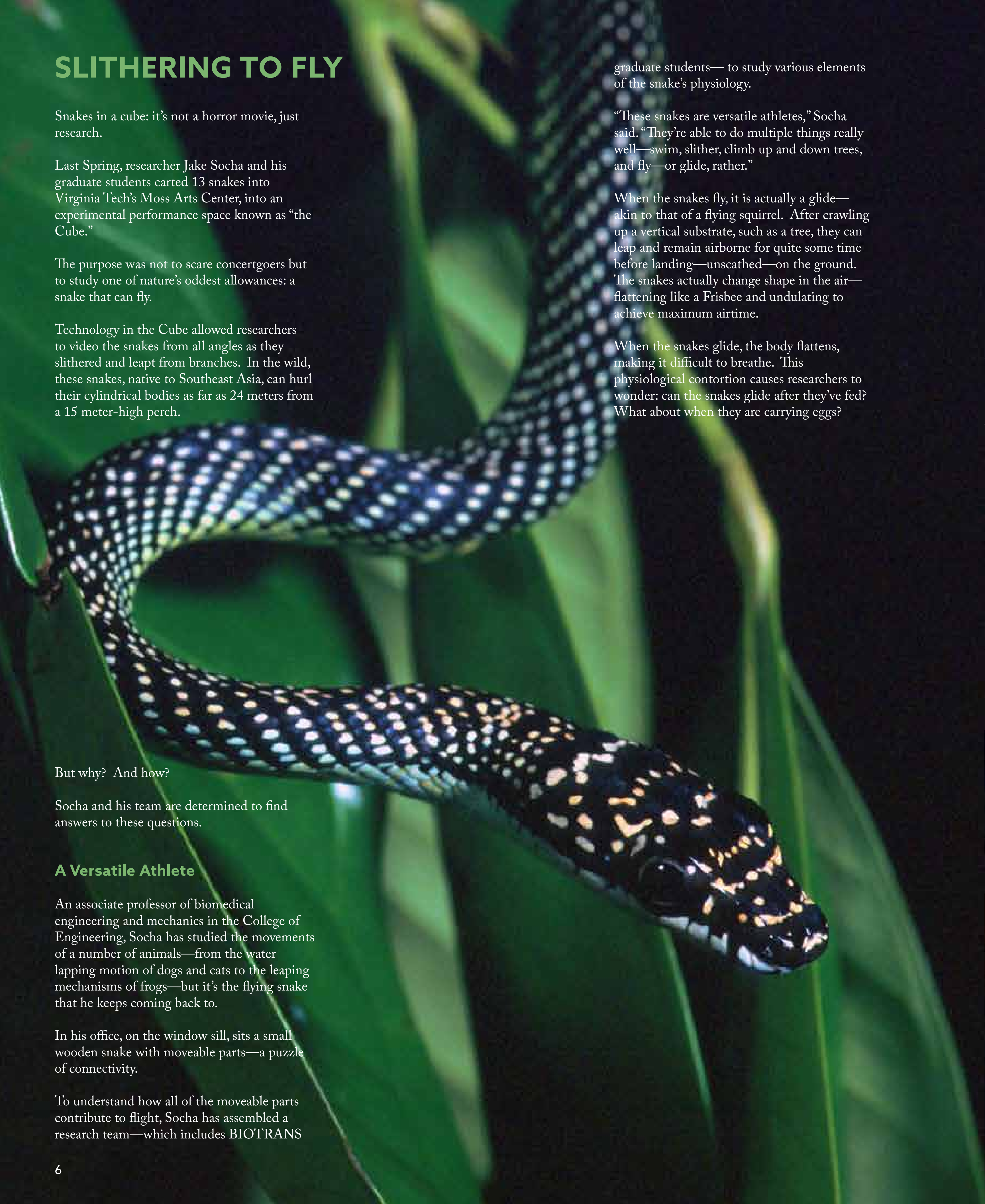
"Our findings explain previous studies showing that higher rates of aneuploidy correlate with poorer prognosis," said Cimini, the corresponding author of the study, and whose work is partly funded by the National Science Foundation. "Moreover, our findings suggest that taking into consideration the degree of aneuploidy may improve therapeutic strategies."

Since the researchers tested aneuploid cells with specific chromosome alterations, future research can target how certain types of aneuploidy contribute to the formation of tumors. According to the researchers, these different types of aneuploidy can also serve as more specific targets for therapeutic strategies.

Cimini is also an affiliated faculty member with the BIOTRANS interdisciplinary graduate education program.

–Cassandra Hockman

SLITHERING TO FLY



Snakes in a cube: it's not a horror movie, just research.

Last Spring, researcher Jake Socha and his graduate students carted 13 snakes into Virginia Tech's Moss Arts Center, into an experimental performance space known as "the Cube."

The purpose was not to scare concertgoers but to study one of nature's oddest allowances: a snake that can fly.

Technology in the Cube allowed researchers to video the snakes from all angles as they slithered and leapt from branches. In the wild, these snakes, native to Southeast Asia, can hurl their cylindrical bodies as far as 24 meters from a 15 meter-high perch.

But why? And how?

Socha and his team are determined to find answers to these questions.

A Versatile Athlete

An associate professor of biomedical engineering and mechanics in the College of Engineering, Socha has studied the movements of a number of animals—from the water lapping motion of dogs and cats to the leaping mechanisms of frogs—but it's the flying snake that he keeps coming back to.

In his office, on the window sill, sits a small wooden snake with moveable parts—a puzzle of connectivity.

To understand how all of the moveable parts contribute to flight, Socha has assembled a research team—which includes BIOTRANS graduate students— to study various elements of the snake's physiology.

"These snakes are versatile athletes," Socha said. "They're able to do multiple things really well—swim, slither, climb up and down trees, and fly—or glide, rather."

When the snakes fly, it is actually a glide—akin to that of a flying squirrel. After crawling up a vertical substrate, such as a tree, they can leap and remain airborne for quite some time before landing—unscathed—on the ground. The snakes actually change shape in the air—flattening like a Frisbee and undulating to achieve maximum airtime.

When the snakes glide, the body flattens, making it difficult to breathe. This physiological contortion causes researchers to wonder: can the snakes glide after they've fed? What about when they are carrying eggs?

A handful of other snake species, such as cobras, can change shape but have not acquired the gift of flight. So what's different about these snakes? It appears a multitude of things. That's why Socha has assigned each member of his research team a separate component of the snakes' physiology to investigate, in hopes of one day constructing the bigger picture of how it can fly.

The force of Flight

Isaac Yeaton, a BIOTRANS doctoral student working with Socha, has created three mathematical models for studying the movements of the snake.

The kinematics model calculates how the snake undulates based on the serpenoid curve, mimicking the traveling wave of muscle bending that passes down the snake's body. The dynamics model determines how the snake's body translates and rotates during the simulated guide. Lastly, the aerodynamics model allows scientists to estimate local aerodynamic forces acting on the snake's body, and is based on the lift and drag coefficients that were previously measured in the species.

"Combining these three pieces, I can change how quickly the snake undulates, how many 'waves' are on the body, and the body posture," said Yeaton, whose home department is mechanical engineering. "Then, I can look at performance metrics, such as how far did the simulated snake glide, and stability, such as did it veer off or become unstable."

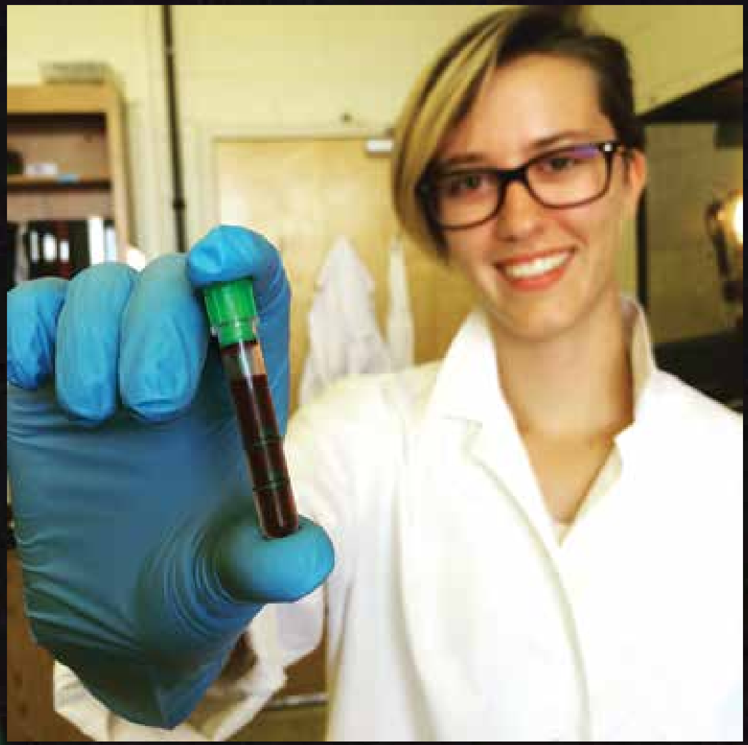
Jake Socha at 'the Cube', in the Moss Arts Center. Photo coutesy of Michael Diersing.

Yeaton is comparing the simulated glides against the recorded glides obtained from Cube experiments last summer. Flying these snakes is a huge endeavor; as such, these experiments were conducted by Yeaton, Socha and two other BIOTRANS graduate students: Gary Nave and Talia Weiss. The Cube study yielded information on 45 glide trajectories from 9 different animals, tracking 11 to 17 points on the snake's body, depending on animal size.

While the analysis is still ongoing, it seems that the snakes produce more vertical force than is required to support body weight," said Yeaton. "The animal must exchange gravitational potential energy for kinetic energy, and then convert this kinetic energy into lift and drag forces to move horizontally and stay aloft. How quickly the animal can produce sufficient force determines the overall performance of the glide. The smaller snakes appear to do this more quickly and this may be why they are better gliders."

Yeaton hopes his kinematics model could be used down the road to help determine the details for force production during a glide.

The team's hypothesis is that the back portion of the snake's body could be interacting with the wake of the front portion, so the snake is essentially riding its own wake.



Michelle Graham with 1 mL of snake's blood, drawn from a flying snake. Photo courtesy of Jake Socha.

Tiny Flyers

Michelle Graham, a doctoral student in Socha's lab, has a delicate task: her goal is to breed baby flying snakes in order to understand how their morphology and development affect their locomotion abilities.

If she is successful, it will be the first time that a flying snake has been bred in captivity in an academic setting.

But first, she must make sure that the 13 wild-caught adult snakes in the laboratory—a mix of male and female paradise tree snakes and golden tree snakes— are healthy and happy. Every day, she visits the humid 80-degree laboratory to check on them, spritzing them with water, feeding them mice and lizards, and cleaning out their cages at least once a week.

As the snake's primary care provider, she has gotten to know them on an individual level. For example, she knows that number

Sharri with a salamander. Photo courtesy of Jake Socha.

85 is a picky eater: once content with eating dead mice, he has stubbornly gone back to a preference for live lizards. When number 89 is hiding, Graham can now find him pretty easily, dangling himself like a green necklace among the fake leaves.

Getting to know the snakes is pretty important because it will help Graham decide which will make the best breeders. She is on the lookout for healthy and well-mannered snakes that will be calm enough to engage in baby making in the lab environment.

Breeding the snakes in the lab offers several advantages for researchers: a larger sample size for studies, a complete understanding of each life stage, and the elimination of parasites, which are often brought in with wild-caught snakes.

Graduate student, Isaac Yeaton, at 'the Cube', in the Moss Arts Center. Photo courtesy of Michael Diersing.

In the wild, flying snakes exhibit a 'harem model' in which multiple male snakes will approach a female snake and lock tails with her. However, Graham will attempt breeding with only one male and one female, in order to track the parentage. Incubation period for the eggs is about 90 days, and each clutch is expected to produce anywhere from 6-11 snakes.

"Having them from birth, we'll be able to study their development better," said Graham, whose home department is biomedical engineering and mechanics. "We'll be able to compare and contrast gliding ability at different ages and sizes."

Graham's hypothesis is that the snakes are born with the ability to glide, but that smaller snakes are generally more skilled at the feat due to the natural laws of physics. She wonders what body shapes make the best gliders, and if adapting to a life in the air has made the snakes less able to maneuver in other terrains than their terrestrial peers.

One day, Graham hopes to travel to Southeast Asia to study the snakes in the wild.

"I'd also like to understand more about their natural behavior—what they eat, what eats them, under what circumstances and how often they glide, etc.," she said. Graham also wonders if adapting to a life in the air has made the snakes less capable of maneuvering in other terrains than their terrestrial peers.

A Virtual Reality for Snakes

Lastly, Sharri Zamore, a postdoctoral researcher in Socha's lab, is using her background in neurobiology to study how the snakes respond to visual cues.

Her first step is to create a scene that emulates elements of their natural environment, such as tree limbs and birds.

Then, she plans to place the snakes in a small arena and project the visual scene around them, a sort of snake virtual reality.
She will rotate features the snakes like to see around the perimeter, and track the movement of the snake's head as the rotating scene gradually picks up speed, in order to determine how the snake responds to increased rates of movement. The behavior is similar to a human's attempt to stare into the windows of a passing train.

"As the stimulus gets harder to watch, the tracking behavior drops off," said Zamore. "From this we can find a cutoff point, and determine the fastest speeds they can respond to, and give us a sense of how fast their visual system processes information."

This experiment will allow Zamore to know at what point they are no longer able to receive and react to visual cues, which will help the team design gliding trails in the Cube and possibly help tailor the housing in the snake colony.

Zamore will track the head movement using small colored markers and computer vision software. This technique, as opposed to attaching electrodes to the brain, is non-invasive and does not typically require animal sacrifice.

"There's very little neural recording done on snakes, and we don't really want to try out new methods on these valuable beauties," said Zamore. "Fortunately, closed-loop stimuli enables the animals to tell us what animals like to see and avoid seeing without having to put electrodes in their brains."

Testing out various virtual realities will also help the researchers figure out what visual stimuli the snakes respond best to. Most flying, gliding, or fast-running animals have visual shapes and speeds they prefer or expect as they're moving, Zamore explained.

"It's sort of like Google Cardboard or Oculus Rift for snakes," said Zamore. "With this setup, we can provide a huge diversity of visual stimuli, and see which produce the largest behavioral responses, such as chasing or trying to fix an image in one place."

The experiments could take place as early as 2017.

-Lindsay Key

BEYOND SCIENCE 101: STUDENTS AT THE ROANOKE VALLEY GOVERNOR'S SCHOOL LEARN WHAT REALLY HELPS WATER FREEZE

Doctoral student Renée Pietsch places a water sample collected from Claytor Lake for transport back to the lab. Photo by David Schmale.

Which of the following best helps water freeze: mud, pollen, or bacteria?

This was a question faced by students in Cindy Bohland's class at the Roanoke Valley Governor's School when Renée Pietsch visited a science class there last fall.

During her visit, Pietsch, a Ph.D. candidate in biological sciences in the College of Science, challenged notions of what we commonly learn about water and ice formation in high school.

Often we learn water exists in three states: solid, liquid, and gas.

We also learn that as temperature increases, ice melts, turning water into liquid, then vapor. Of course, teachers explain, the opposite is true as well: as temperature drops, vapor turns to liquid, then freezes at 32 degrees Fahrenheit – the temperature we commonly consider freezing, especially during winter months.

What we might not know, however, is that water needs help freezing at this magic temperature.

"We usually think that water freezes at 0 degrees Celsius [32 degrees Fahrenheit], but pure water will stay liquid down to -38 degrees C [-36.4 degrees Fahrenheit]," said Pietsch. "Above this temperature, it requires another particle called an ice nucleus. These can be a lot of different organic and inorganic materials found in the atmosphere."

Different materials that help water freeze are found all around us. These include pieces of dust, pollen, dirt – and even certain kinds of bacteria.

One type of bacteria, Pseudomonas syringae, has long been studied for its role in agriculture, as it can affect the leaves of various crops. But, it also has the unique ability to help water crystalize in order to freeze through a process called ice nucleation.

"We know clouds are formed at temperatures higher than -38 degrees Celsius, but water is also very pure in clouds, so it needs something to ice nucleate in the atmosphere," said Pietsch. "This is the role of the bacteria in this case."

How these bacteria do this, Pietsch explained, is by expressing a particular protein on their surface that "grabs water molecules and organizes them into the shape that starts to form the crystal lattices of ice."

At Virginia Tech, Pietsch studies how these bacteria, which are commonly found in aquatic environments like lakes and streams, move from water into the air.

"It may be that the bacteria ice nucleate to form clouds if it is found on plants or in water and then aerosolizes," said Pietsch. "The idea is that clouds then produce rain, so bacteria can come down in raindrops. It would then land on new plants, so it may create a positive feedback loop where the bacteria use the process to reproduce and grow."

Pietsch's goal is to understand how this bacteria moves throughout the water cycle, from the ground to the atmosphere. She works under the mentorship of three advisors from different disciplines -- David Schmale, an associate professor of plant pathology, physiology, and weed science, Shane Ross, an associate professor of biomedical engineering and mechanics, and Bryan Brown, an assistant professor of biological sciences.

To test this process, Pietsch asked the science students to pick three samples to examine. Students chose from a range of matter, including mud, leaves, parts of plants, as well as bacteria, fungi, and pollen.

After building up some friendly competition, the students figured out which materials would make the best ice nucleators. These are the ones that freeze at the warmest temperatures, Pietsch said.

The students found the strongest ice nucleators to be mulch, dandelion flowers and leaves, mud, and Snomax – an industrial product made from the same bacteria Pietsch studies, which is used to make snow at ski resorts.

After experimenting, Pietsch talked with the students about the ethical dilemmas associated with the role of ice nucleation within the broader water cycle.

"We talked about how we could potentially alter the water cycle in the future," she said. "So, if we wanted to produce rain, could we spread an ice nucleating bacteria that would aerosolize and cause rain? This might be great for land owners, but could we make conditions worse for someone else nearby, and is that okay?"

- Cassandra Hockman

Renée Pietsch (right) put droplets on a Parafilm boat to determine which ice nuclei -- like bacteria, pollen, and dirt -- help water freeze. She is pictured with Virginia Tech research associate Regina Hanlon at the Roanoke Valley Governor's School during their visit last fall. Photo by Christina O'Connor/Random Found Objects.

GETTING THE FLU:
A VIRGINIA TECH ENGINEER UNDERSTANDS THE AIRBORNE SPREAD OF INFLUENZA

Linsey Marr's son was getting sick about every two weeks. After repeatedly picking him up early from day care, she wondered how he got sick so often. A researcher by trade, Marr started reading about flu transmission and realized there wasn't much knowledge on the airborne spread of viruses, especially the flu.

So Marr, a professor of civil and environmental engineering in the College of Engineering, decided to take matters into her own hands. She specializes in airborne particles at Virginia Tech, so studying flu transmission by airborne virus particles – and why her son was constantly getting sick – was a perfect fit.

"Since there wasn't much research on how viruses spread through air, I thought it made sense to investigate it," Marr said.

The flu, short for influenza, is a disease caused by an influenza virus. Though symptoms range from mild to severe, many people experience high fever, sinus congestion, body aches, and headache.

People can reduce their chances of getting the flu with vaccines, which are estimated to reduce risk by 50-60 percent, according to the Centers for Disease Control and Prevention. This estimate, however, is based on vaccines that have been designed to target certain viruses – which do not include emerging strains that evolve from previous years. This means that when flu season comes around, people are still left making doctor visits, and parents, like Marr, are left maneuvering alternatives to day care.

To address the ongoing flu epidemic, Marr combines science and engineering to understand how the flu spreads, especially during the winter months.

She knows coughing and sneezing send small globs of mucus, or respiratory fluid, into the air. These small globs range in size from a large raindrop to about one-hundredth of a strand of hair. Some land on toys, desks, and waiting room chairs, while others remain airborne, sometimes up to several hours.

While in the air, the virus is suspended in tiny droplets generated from coughing and sneezing.

Knowing the flu spreads this way, Marr asked: how does the virus survive long enough for someone to else to get sick?

Using her expertise in engineering and atmospheric science, she began looking specifically at humidity. Humidity, she explained, is the amount of water vapor in the air. The amount of moisture in the air affects what's carried in it because water and other matter can interact.

"We think humidity affects the viability of the virus when it's in the air in these tiny droplets or aerosols by affecting the chemistry of the droplet itself," said Marr. "We're interested in how environmental conditions, especially humidity, affect that because it seems like there's a strong seasonality in the flu. People tend to get it in winter time yet not at other times in the year."

Seasons affect the amount of moisture in the air, both indoor and outside. During the winter months – peak of the dreaded 'flu season' – there is less moisture. This is especially true indoors when central heating makes the air drier. This also makes a good habitat for viruses.

"When water droplets evaporate, the virus is then sitting around with dried out salts and proteins that were in the droplet," said Marr. "The virus is actually very happy in these conditions."

Viruses are able to live for hours in dry conditions because they aren't breaking down or chemically reacting with water and salts in a solution – the water droplet.

In addition to surviving in dry conditions, influenza also survives well in very moist air. It's after water droplets have begun evaporating that the virus takes a hit.

"When water evaporates enough to leave a gel-like substance that's a little bit moist, it damages the virus," said Marr.

Marr thinks that the virus has a hard time surviving in partially evaporated drops because salts and proteins are left behind in higher concentrations. These higher concentrations react with the virus to break it down and destroy it.

In the lab, Marr tests how well the flu survives at different humidity levels using an apparatus she built called a rotating drum. This drum, shaped like a large silver bullet, holds aerosolized droplets containing a surrogate virus similar to the flu but doesn't make people sick. Knobs above the drum control the level of humidity within it.

This synthetically infected spray is suspended for about an hour before it's passed through a filter, which catches what's left of the virus. Marr discovered that since dry environments help the virus survive, yet some moisture is damaging, there must be a sweet spot between too much and too little humidity.

And indeed there is: Marr found this sweet spot several years ago when she tested the flu in a range of humidity and human mucus levels. She found the flu to survive best when humidity is close to 100 or below 50 percent. Anything in between, the virus doesn't survive well.

These results, published in the journal PLoS One, may explain why a lot of people get sick during certain times of year and in regions with varying degrees of humidity.

Marr's next steps include collaborating with a flu virologist to test pathological flu strains in a laboratory designed to safely handle them.

Currently, Marr also collaborates with Peter Vikesland, a Virginia Tech environmental chemist and nanoscientist in the department of civil and environmental engineering. Together, along with colleagues from other disciplines, they work to better pinpoint how well influenza survives in these tiny aerosolized droplets, with the ultimate goal of seeing exactly how and in what amount of moisture the virus dies.

"We are very interested in biological systems, the bacteria and viruses in the air, and how they are transported in aerosols," said Marr. "We're also wondering, during that transport process, what kind of changes might be happening on the chemistry side that would affect the biology of the organisms."

Ultimately, knowing how the flu spreads may help target it during transmission, alleviating threats of new seasonal viruses.

Marr and Vikesland work together as part of a National Institutes of Health New Innovator Award grant for $2.28 million that Marr received in 2013. The two also collaborate with support from the National Science Foundation's Center for the Environmental Implications of Nanotechnology and Virginia Tech's Institute for Critical Technology and Applied Science.

Thanks to their work, all of us – especially parents – can have some peace of mind come wintertime.

Measuring airborne Ebola

In response to the 2014 Ebola outbreak, Marr began investigating how the virus goes airborne, with support from the National Science Foundation and the Water Environment Research Foundation. Because the Ebola virus is so dangerous, in her lab she uses substitute viruses that are not harmful.

Though Ebola is mainly transmitted in blood, the virus is also present in diarrhea, a side effect of contracting the disease. After people flush, water flow in the toilet sends tiny aerosols – which may contain the virus – soaring through the air. Like the flu, it then lands on surfaces, such as toilet seats, or remains in the air as a spray.

Similar to her influenza work, Marr uses a combination of physics, chemistry, and biology to understand the risk of transmission via aerosols. With the help of a local wastewater treatment plant, she and her team use 'sludge' – the stuff that gets flushed down toilets or rinsed down sinks – to see how and if material is viable enough to infect after being flushed. Fortunately, Marr's results so far suggest small risk of the virus being present in these tiny droplets.

–Cassandra Hockman

MOISTURE MAKES A BANG

Ray David studies cannons – but not the kind used for artillery.

David, a Ph.D. candidate in civil and environmental engineering, studies the spore-producing structures of *Fusarium graminearum*, a fungus that causes Fusarium head blight which threatens wheat crops worldwide. Small, bulb-shaped structures spread the fungus by shooting out tiny spores that travel through the air. Wind then carries these little peapod-shaped spores to neighboring fields and farms, sometimes up to 500 meters away.

These tiny spores are harmful to cereal crops because they produce the toxin deoxynivalenol that negatively impacts the digestive system in animals and people. Ingesting this toxin can be dangerous, then, when it makes its way into finished products like cereal and animal feed.

To make matters worse, wheat crops are devastated by Fusarium head blight, which causes bleaching. This makes the grain shrivel and turn light brown or off-white in color. Epidemics of the fungus in the 1990s cost the agricultural industry more than $2.6 billion and destroyed farms in the Midwest, according to sources cited by the U.S. Department of Agriculture.

In response, David works to understand what makes the little spore-shooting cannons fire in the first place: the key may be the amount of moisture in the air.

For his doctoral research, David measures how meteorological conditions, including humidity and temperature, affect the timing of when these bulb-shaped structures shoot.

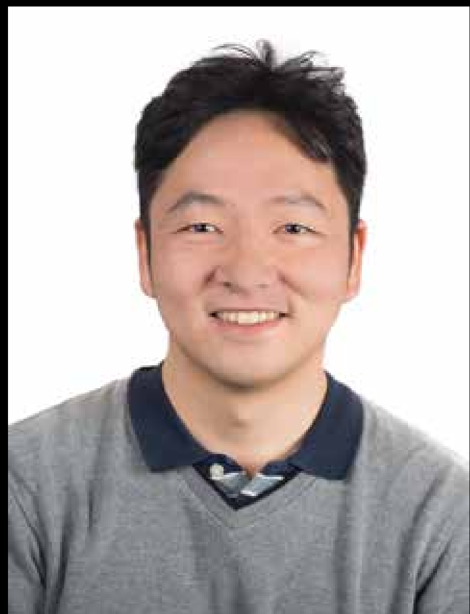
"We think what happens is that the cannon is impacted by the amount of moisture in the air, and at some moisture conditions, spores are released," said David. "We have found that humidity levels above eighty percent cause large release events."

As part of the BIOTRANS interdisciplinary graduate education program, David works with environmental engineer Linsey Marr, a professor of civil and environmental engineering in the College of Engineering, and plant pathologist David Schmale, an associate professor of plant pathology, physiology, and weed science in the College of Agriculture and Life Sciences.

Tiny spores spread a disease-causing fungus that threatens wheat crops in the Midwest.

"Based on our research, we think someone could potentially develop a field tool where they compress these spore-producing structures in the field to identify their spore-releasing potential when they are exposed to important meteorological conditions such as relative humidity," David said. "This information could help farmers and growers make effective decisions, like when and where to place fungicides."

SPOTLIGHT ON BIOTRANS FACULTY - SUNNY JUNG



Hometown:	Seoul, South Korea
Educational Background:	Bachelor's degree in Chemical Engineering at Sogang University, Master's degree in Physics at POSTECH, South Korea. Ph.D. in physics at University of Texas at Austin. Postdoc at NYU and a math instructor at MIT.
Hobbies:	No hobby is my hobby.
Favorite Thing to do Around Blacksburg:	Watch blue sky
A Favorite Quote:	"Everything is awesome, everything is cool when you are part of a team" in Lego Movie.
Favorite Type of Music or Artist:	Any pop music.

WHAT IS THE FOCUS OF YOUR CURRENT RESEARCH?

I am primarily interested in how animals or natural systems utilize mechanical principles for a better life. Furthermore, my research group looks forward to developing bio-inspired engineering systems for our better life.

HOW DID YOU BECOME INTERESTED IN YOUR LINE OF RESEARCH?

I studied fluid mechanics problems for my PhD. But, I didn't like the fact that fluid mechanists are working on engineering systems only. Then, during postdoc years, I turned my eyes to nature and tried to use fluid mechanics principles in natural systems.

WHAT DO YOU FEEL ARE SOME OF THE BIGGEST CHALLENGES SCIENTISTS FACE TODAY?

Nature has gone through trials and errors for billions or millions of years long, and has implemented structure and behaviors based on the knowledge inside. Humans have tried to understand how nature is designed and works maybe less than a few thousand years so far. A long way to go.

WHY DID YOU CHOOSE TO CONTINUE YOUR CAREER AT VIRGINIA TECH?

I like a small town, and my family does too.

WHICH ASPECT OF YOUR RESEARCH ARE YOU MOST EXCITED ABOUT RIGHT NOW?

These days my research focuses on how animals drink.

WHICH ANIMALS OR NATURAL SYSTEMS DO YOU STUDY?

I am also working on seabirds (how seabirds dive into water), tree leaves (how leaves survive from raindrop impact), and more.

IN TERMS OF YOUR RESEARCH ON HOW ANIMALS DRINK, WHAT HAS BEEN THE MOST SURPRISING FINDING?

I was very surprised by a fact that animals have evolved in a way to optimize their drinking performance. Their own drinking way utilized fluid mechanics principles.

WHAT DO YOU ENJOY ABOUT BEING AN AFFILIATED FACULTY MEMBER WITH THE BIOTRANS PROGRAM?

I am excited about being BIOTRANS faculty and involving a lot of activities in this program. My research fits well into BIOTRANS program and training program would be beneficial for future prospective graduate students in my group.

Photo courtesy of Sunny Jung.

OTHER **BIOTRANS** FACULTY

David Schmale

Daniela Cimini

Rafael Davalos

Rafaella De Vita

Iuliana Lazar

Linsey Marr

Steve Melville

John Phillips

Shane Ross

Warren Ruder

Eva Schmelz

Jake Socha

Mark Stremler

Theresa Thompson

Mary Leigh Wolfe

Zhaomin Yang

BIOTRANS faculty members are located in nine different departments and programs across three different colleges at Virginia Tech. Their research, which sits on the borders of biology and engineering, loosely falls into three categories: transport at the cellular scale, transport at the organismal scale, and transport at the environmental scale. During the application process, students must indicate three BIOTRANS faculty whose research most interests them.

BIOTRANS GRADUATE STUDENT AWARDED FULLBRIGHT TO STUDY CONNECTION BETWEEN HUMAN BODY FLOW, OVARIAN CANCER IN DENMARK

Alex Hyler with Dr. Henrik Bruus.

How does the body's natural environment impact the progression of ovarian cancer?

Researchers have long been able to study how cancer cells grow and develop in isolated lab experiments, but understanding how these cells interact in a living, breathing human body is a bit more complicated.

During the 2015-16 school year, BIOTRANS graduate student Alex Hyler was awarded a J. William Fulbright Grant to the Technical University of Denmark in Copenhagen where she continues her investigations into the impact of fluid motion on ovarian cancer progression with Dr. Henrik Bruus.

"The human abdomen naturally has small but continual fluid motion due to digestion, breathing and daily movement, and we are interested in understanding if this fluid motion cues otherwise healthy cells to start expressing cancerous characteristics," said Hyler. "If so, how is that activation occurring? Through what biological mechanisms? If we can understand and determine this biological sensor and activation switch, we could better detect and treat the disease earlier."

At Virginia Tech, Hyler works with Drs. Eva Schmelz, Rafael Davalos and Mark Stremler to optimally engineer testing platforms for use in understanding biological changes in ovarian cancer metastasis in response to biophysical stimuli.

"The determination of signaling events activated by biological fluids not only in the abdomen but also by blood or lymph flow that lead to more aggressive cancer cells will allow us to develop treatment strategies to prevent or postpone deadly metastatic disease, and prolong the life of cancer patients," said Schmelz, an associate professor of human nutrition, foods, and exercise in the College of Agriculture and Life Science.

Hyler chose to spend a year abroad in Denmark in order to foster future collaborations between the two universities and to expand her project to include another discipline, biophysics.

"Dr. Bruus is a world expert in micro-scale fluids physics," said Hyler. "In addition, I am interested in how research in the biomedical field in a country with a socialized health care system, like Denmark, functions. I am curious how the different institutional structures spur/hinder biotechnology innovation. So, Dr. Bruus' lab was a perfect fit to further my project and expand my perceptions of the biomedical field."

As an undergraduate, Hyler worked with Dr. Prahna Dhar at the University of Kansas to study how fluids affect the biology of Alzheimer's disease.

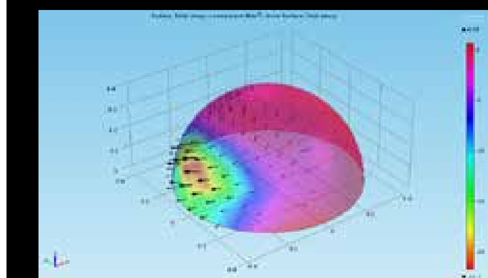
"In my current project, I found the opportunity to combine my passion for advocating for women while utilizing my fluids background and further expanding into the disciplines of biomedical engineering and biophysics," she said.

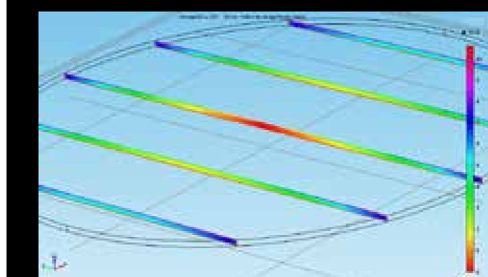
Hyler spent the first half of her grant developing computational fluid dynamics models with Dr. Bruus that mimic the fluid motion of the human body.

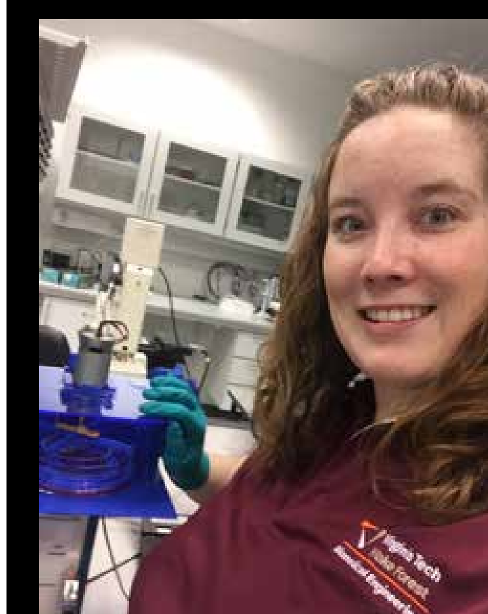
During the second part of her grant, she is using information garnered from the simulations to engineer a device for cell-based experiments that will be more physiologically relevant.

The Fulbright Program aims to increase bilateral understanding and exchange valuable ideas between the U.S. and other countries to find solutions to shared international concerns.

- Lindsay Key





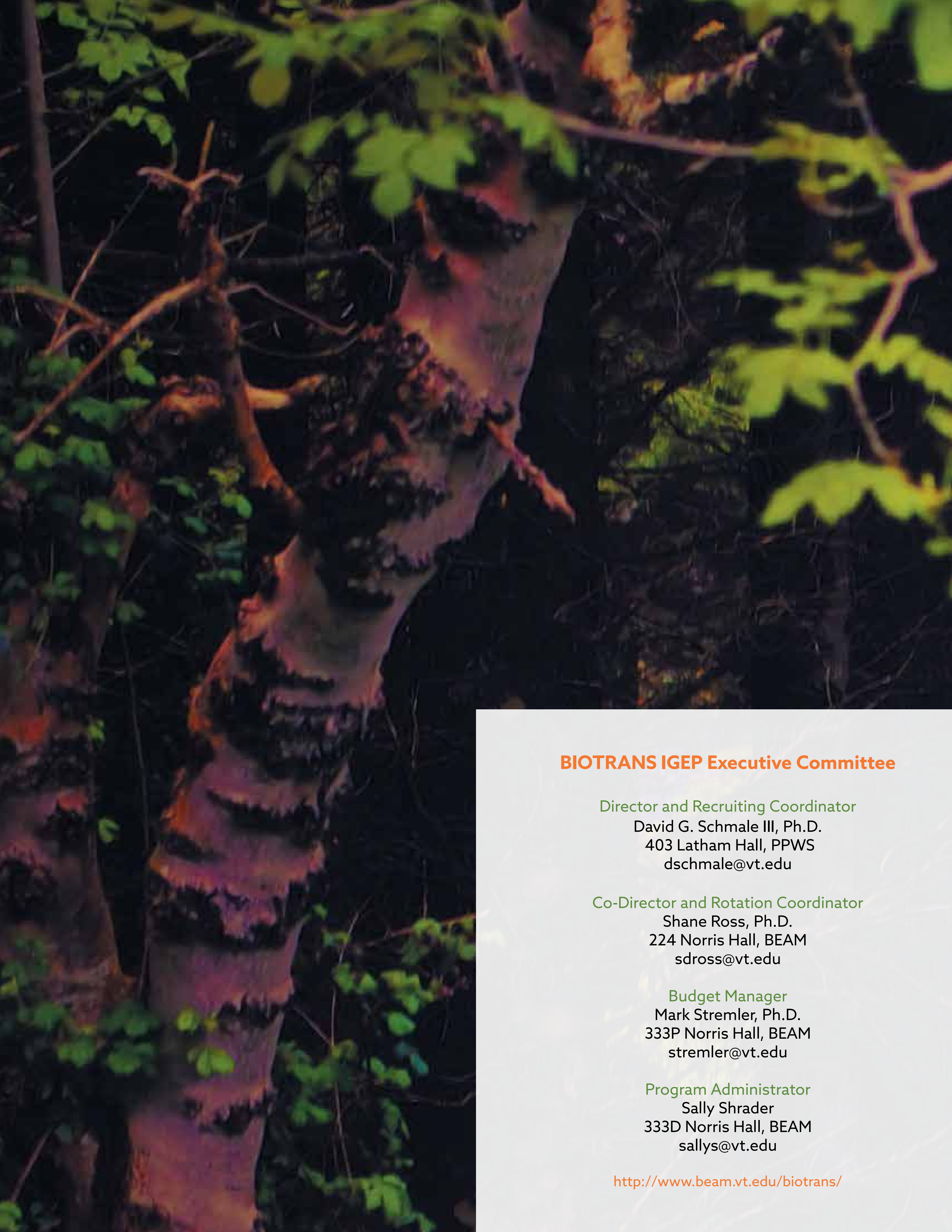


All photos courtesy of Alex Hyler

BIOTRANS RETREAT AT MOUNTAIN LAKE

The BIOTRANS graduate program provided funding for an annual graduate student retreat. This was the first hosted retreat for BIOTRANS students and occurred Friday, May 6th- Saturday, May 7th, 2016 at Mountain Lake Lodge in Pembroke, VA. There were two main purposes for this weekend retreat. First, it encouraged the community of BIOTRANS students to come together and network, socialize, and team-build during group activities. Secondly, brainstorming sessions were conducted in order to address the future needs and wants of graduate students in the BIOTRANS program. Students from each of the most recent cohorts of BIOTRANS (and MultiSteps) attended. They were: Luke Butler, Temple Douglas, Ellen Garcia, Arindam Ghosh, Gary Nave, Khaled Adjerid, Chelsea Corkins, Dan Sweeny, Jack Whitehead, Adowa Baah- Dwomoh, Ray David, Renee Pietsch, and Andrea Rolong.

- Ellen Garcia



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