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VIRGINIA TECH
GLOBAL LAND GRANT IMPACT

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Virginia Polytechnic Institute and State University

Christina DiMarino

MODERNIZING THE **ELECTRICAL GRID**

PICTURE THIS: IT'S A WARM SUMMER EVENING and you're outside enjoying the view from your backyard when suddenly, off in the distance, you see dark storm clouds rolling in. You've experienced dozens of storms over your lifetime and know exactly what to do. You head inside, light some candles, and grab a flashlight.

According to a November 2021 report published by the U.S. Energy Information Administration (EIA), 2020 was a record-breaking year for power outages. On average, a person living in the United States went more than eight hours without electricity that year. That's more than double the amount of time the average American went without power in 2013, the year that the EIA started tracking that information.

But what if it didn't have to be that way? According to Christina DiMarino, an assistant professor in the Bradley Department of Electrical and Computer Engineering at Virginia Tech, it doesn't, and power outages in the U.S. shouldn't be that common.

To address these concerns, DiMarino is leading a team that recently received $2.9 million in funding from the U.S. Department of Energy (DOE) to tackle power grid sustainability, innovative approaches to power conversion, and related technologies.

"The power grid technology in the United States is more than 100 years old. Because of this outdated grid technology, it's more susceptible to power outages – especially as we experience more and more extreme weather, said DiMarino. "When you add in the increased penetration of renewable energy sources and charging capabilities, it's putting significant demand on our grid, which it was not originally designed to fulfill.

The DOE recognizes that while the power grid in the U.S. has been supporting the electrical needs of our country for a very long time, improvements are necessary to create a more efficient and advanced system in the future. In an effort to improve these technologies, the DOE and the Advanced Research Projects Agency-Energy created the OPEN 2021 Program.

DiMarino's team submitted a proposal for a new solution called SCALED, or Substation in a Cable for Adaptable, Low-cost Electrical Distribution. While that may sound like a mouthful, simply put, the team is looking to create a more streamlined structure that combines the functionality of power electronics and the power density benefits of high-voltage cables to replace bulky power substations in the electrical grid we use today.

This new, more compact design could eliminate the need for large and expensive power substations and enable simple integration of renewable energy sources, electric vehicle fast-charging infrastructure, energy storage, and efficient direct current distribution lines.

DiMarino said SCALED's innovative design could put the U.S. back on track for leading the way in energy-efficient grid technology. Her team hopes to make SCALED adaptable for the future by making it

bidirectional so power can flow in both directions.

"By carefully controlling and routing the power flow, it's essentially going to be like an energy internet. So we're creating the type of infrastructure that will allow power to go where it needs to go, in the form that it needs to be in, when it needs to be there," said DiMarino, who also serves as assistant director of Virginia Tech's Center for Power Electronics Systems.

This enhanced grid technology will apply to all forms of energy – wind, solar, electric, and "whatever else may come," she said.

These improvements would also allow "faults" to be isolated. For example, if a tree goes down during a storm, the smart grid would limit outages to a smaller area of homes as opposed to rippling across several neighborhoods in a town.

In addition to Virginia Tech electrical and computer engineering faculty Khai Ngo, Guo-Quan "G.Q." Lu, and Yuhao Zhang serving as co-principal investigators on the project, the National Renewable Energy Laboratory and the University of Connecticut are also serving as partners to further enhance the research findings.

Lu, whose research specializes in electronic packaging of microelectronics and power electronics, said the importance of this project and its potential to revolutionize how electrical energy is converted in the power grid.

"In our daily lives, we take electricity for granted and expect it to be there whenever we need it," said Lu. "In reality, most of the electricity we use is generated at faraway locations, like at a nuclear power plant, a coal burning plant, solar farm, or wind farm. The generated electricity has to travel a long distance and goes through multiple complex conversion stages before ending up at our wall outlets for charging our computers or cellphones."

The team's work will focus specifically on the conversion stage that takes place at various power substations located in city blocks. The success of the project would considerably shrink the size of those substations, if not completely eliminate them. It would also make the grid smarter and reduce its outage frequency.

Lu's role in the project is to develop a magnetic material that will be wrapped around thick electrical cables to help with the conversion of electrical energy. This step is crucial because other members of the team will be relying on the induction of that magnetic material to create a smooth energy conversion process as they "turn the current flow on and off."

The team's novel research answers a call for proposals that prioritize funding for high-impact, high-risk technologies that support innovative approaches to clean energy challenges.

In support of these new clean energy technologies, the DOE announced that it would be giving $175 million for 68 research and development projects "aimed at developing disruptive technologies to strengthen the nation's advanced energy enterprise." DiMarino's SCALED was one of the 68 projects selected.

The team will spend the next three years working to make SCALED a reality. Although it will take substantial time to develop a working prototype, DiMarino stressed how important these advancements are to the U.S. power grid.

"I'm glad the U.S. government is talking about infrastructure," she said. "Other countries are making large strides in the incorporation of renewable energy sources and the development of new grid technologies. China, for example, has made large investments into its grid because it is continuously expanding. As a result, they've been able to try out new technologies."

DiMarino said it is time for the U.S. to catch up, and such work on grid infrastructure has the potential to lead in terms of innovation. ■

Chelsea Seeber

Read more about electrical grid research. Scan the QR code.

CASTING FOR DATA ON **MICROPLASTICS IN THE OCEAN**

WITH THE NEW SEALE COASTAL ZONE Observatory, a team of researchers led by geoscientist Robert Weiss will take on complex problems such as microplastics in the ocean by combining data analytics, innovative technologies, and interdisciplinary thinking.

Like grains of sand on a day at the beach, microplastics find their way into everything. Once formed, these tiny particles of decaying plastic bounce back and forth in dizzying fashion between people, wildlife, and the marine environment.

Scientists have traced their presence to the tissue of fish and birds. Viruses and bacteria have been discovered to form biofilms over them, which enables ocean travel for the pathogens and new entryways into organisms. Microplastics have even been detected in human blood.

If microplastics are as widespread as studies suggest, just how much of them are concentrated in the ocean and what are they made of? How do they move through its waters? And how will they affect people, wildlife, and the marine environment — now and in the future? At the Seale Coastal Zone Observatory, a new initiative in Virginia Tech's Center for Coastal Studies, an interdisciplinary group of researchers — including biologists, veterinary scientists, and engineers — will work together to find answers.

The program, led by Robert Weiss, a professor of geosciences in the Virginia Tech College of Science, aims to model the present and future effects of microplastics on the marine environment and its life. Weiss hopes to depict the results of human behavior that brings microplastics to the ocean.

"What we want to create is a set of outcomes that help people to make decisions about their behavior, and by people, I mean individuals, governments, and society as a whole," said Weiss, who directs the Center for Coastal Studies. "Decisions have consequences, and sometimes those consequences are hidden and cascading."

To do that, the team will need to collect unprecedented amounts of data from an ocean in constant flux.

The new endeavor is possible because of the generosity of Virginia Tech alumni Bill and Carol Seale, who have committed a $2 million gift to the project. Their generous support has enabled Weiss and his team to develop a comprehensive plan to begin ocean monitoring. "The Coastal Zone Observatory's work is a critical step forward to help us become better stewards of the world's oceans, which are arguably our most critical resource on Earth," said Bill Seale.

Dan Stilwell Robert Weiss

Ben Biggs

FOLLOWING THE DATA TRAIL

According to Weiss, our knowledge of the marine environment — apart from the presence of microplastics — is full of holes. That's in part because the ocean itself is a fickle source of data.

"We know the resolution of the surface of Mars better than the surface of our ocean floor," Weiss said. "But that's topography just on the seafloor. Now imagine how little we know about how conditions are when the water in the ocean is constantly moving. How can we describe a condition in a certain area if it's constantly changing? If the moment you measure it, it's gone?"

Researchers at the Coastal Zone Observatory will collect ocean data such as temperature and turbidity — the ability of sunlight to travel into depth — in a way that adapts to the ocean's transience. They'll use sensor-equipped swarms of underwater robots developed by a team of engineers led by Dan Stilwell, an electrical engineering professor in the College of Engineering and director of the Virginia Tech Center for Marine Autonomy and Robotics.

"It is energizing to watch the Seale Coastal Zone Observatory rapidly take shape," said Kevin Pitts, dean of the College of Science. "The pollution of our oceans is worsening by the day, and I'm excited to see researchers in the Colleges of Science, Engineering, and veterinary medicine collaborate to learn more about these issues and find ways to help mitigate a global problem."

The approach "rethinks the way we take ocean data," Weiss said. He believes it can help the team establish a data set that reflects the marine environment as it's shaped by climate change over time. Autonomous vehicles give researchers a much more dynamic method for measuring environmental conditions, with the ability to move through ocean depths and with currents to follow the data. Eventually, the team can then operate those vehicles to collect microplastics concentrations and learn how they're affected by the ocean conditions in flux around them.

"Let's say, in the future, we have a sensor that would allow us to determine *in situ,* very quickly, the concentration of microplastics," said Weiss, who is director of the Academy of Integrated Science, also part of the College of Science. "We can follow the value of concentrations in the ocean, and by the motion of the vehicle, we can determine how these concentrations evolve over time. So that gives us a much more comprehensive, and full, data set to understand how microplastics move in the ocean. What conditions, like temperature, are they dependent on?"

As researchers gather data on the marine environment, others at the Coastal Zone Observatory will study the impact of microplastics on marine life as that impact extends from individuals to species and moves up

the food chain. In the Chesapeake Bay area, biologists from the College of Science and veterinarians from the Virginia-Maryland College of Veterinary Medicine will study the effects of ingesting microplastics on fish used for seafood. Others will collaborate with biologists from Radford University and Connecticut's Fairfield University to study microplastics consumption by tilapia and Magellanic penguins and learn which types of microplastics affect coastal organisms the most.

The Center for Coastal Studies is part of the Fralin Life Sciences Institute. Weiss launched the center in 2020 to coordinate research, teaching, and outreach aimed at ensuring a more sustainable coexistence of humankind and nature within coastal communities.

A PASSION FOR PROTECTING OCEANS

Weiss believes that predictive models informed by both of these projects will ground a better understanding of how microplastics affect the oceans not only today, but decades out.

"We need to see how their impact grows. It's not enough to say, this is how many microplastics are in the ocean and this is the impact on fish and marine mammals," Weiss said. "We need to create models that describe what will happen in 50 years if we do this? Or if we do that? Or if we do nothing?"

With the program's research projects still in development, Weiss believes it's critical to weave them together with interdisciplinary capacity-building before jumping in. It's the complexity of coastal issues such as microplastics and the connectedness of the Coastal Zone Observatory's methods for studying them that drew the support of the Seales.

"We have long admired the college's interdisciplinary approach to science and the university's incredible breadth of expertise," said Bill Seale, who earned his bachelor's degree in chemistry in 1986 and an MBA in 1988, both from Virginia Tech. "We feel confident this strategic collaboration will leverage our strengths in the traditional sciences, engineering, veterinary medicine, and data science to help inform decision making that benefits society and defines solutions for healthy ocean ecosystems."

Added Carol Seale, who earned her bachelor's in apparel, housing, and resource management in 1988, "We live in a time of critical pressures on coastal landscapes throughout the world. It's a serious and complex problem. We're glad that the Center for Coastal Studies is stepping forward in a bold way to study and address it."

In addition to their passion for healthy and sustainable oceans, the Seales are committed to research that advances human health. Their Seale Innovation Fund at the Fralin Biomedical Research Institute at VTC helps crossdisciplinary research teams pursue bold new ideas in science, enabling transformative biomedical scientific advances in a wide range of areas, including cancer, chronic pain, and brain development. ■

Suzanne Irby

Read more about microplastics in the ocean. Scan the QR code.

PREVENTING MOSQUITO MALARIA TRANSMISSION

College of Agriculture and Life Sciences researchers are the first to study three-dimensional genome organization – particularly how the genome can be folded and still accessed by enzymes for transcription purposes – in mosquitoes.

RESEARCHERS IN THE COLLEGE OF AGRICULTURE and Life Sciences at Virginia Tech have found unique interactions in the cells of five mosquito species that could be a roadmap to removing the ability to transmit malaria and other diseases in the future. The findings were recently published in Nature Communications.

People often use insecticides to spray as much as possible to kill mosquitoes. But this form of control doesn't discriminate between good and bad insects and also builds resistance among mosquitoes and insects that survive through natural selection and mutations.

After years of relative success controlling mosquito populations in this manner, it is now being reevaluated due to a significantly decreasing effectiveness and not being ecologically friendly.

"We have to constantly invent new insecticides," said Igor Sharakhov, one of the researchers on the project, a professor of entomology and an affiliated faculty with the Fralin Life Sciences Institute. "With genomic approaches showing more promise, we can generate so-called gene drives and create a construct that could either suppress the mosquito population or render it incapable of transmitting disease."

But for the practical applications to work, scientists need to have an understanding of how the genome — the complete set of genes in a cell — is organized. To get a good picture of this, Varvara Lukyanchikova, the lead researcher of the international team and a visiting scholar in the Department of Entomology, and the other members of the project studied five species of mosquitoes with more than 100 million years of evolution between them — about the same as the evolutionary time between a mouse and a human.

The researchers wanted to check the genome organization in malarial mosquitoes using a method not previously applied to these insects to see if there are any unique features at the cellular level.

"What we also discovered is that while the mosquito genome is organized similarly to other genomes, it has active and inactive compartments. Now we can see exactly which part of the genome is functioning, expresses genes, and which does not," said Lukyanchikova, who also works at Sharakhov Lab and is affiliated with the Fralin Life Sciences Institute. "This can help with how we use gene-drives systems in particular and is one way we can use the knowledge we gained from this research."

The project was funded by a three-year grant from the National Science Foundation.

The research team established a technique for mosquito embryos using Hi-C, developed about a decade ago, that studies the three-dimensional architecture of genomes and helps researchers see which regions within a genome can contact each other.

While the idea is quite simple, the execution is a bit more complex. The researchers took the nuclei and used paraformaldehyde to keep proteins and DNA interactions within their space while being strongly linked together. Using a restriction, the researchers then cut the DNA and used ligase, an enzyme, to link the DNA molecules in their nuclear space.

Using this technique, the researchers extracted nuclei from cells of five mosquito species, *Cellia (An. coluzzii, An. merus, An. stephensi)*, Anopheles *(An. atroparvus)*, and Nyssorhynchus *(An. Albimanus)*. After sequencing the libraries and merging biological replicas, the researchers obtained 60 million to 194 million unique alignable reads for each species of mosquito.

Because of the millions of nuclei, probability needs to be created. For example, there's a contact A and a contact B. These contacts will not interact in each nucleus. They will only interact in some nuclei. Because of the technique used, estimations can be created about the number of interactions these two contacts will have in cells.

Based on this probability, a heat map can be created that shows how often these two loci contact each other. This is a strong molecular method that helps unearth genome interactions.

Then, the researchers created heat maps and compared between these between the five species of mosquitoes studied. Some similarities to mammals were found, but of particular interest were the polycomb groups, long-range loops, which are two separated regions in the genome by large distances, formed by polycomb proteins, that are not present in other species. In this case, the loops were separated by several megabases and still a strong contact after finding each other in the nucleus space.

These loops usually have specific marks that silence the particular interactions, but mosquitoes don't have that, which suggests a novel manner in which the loop operates according to the researchers.

This research was a collaboration with the University of Lausanne in Switzerland, the Department of Biochemistry at Virginia Tech, Novosibirsk State University in Russia, and others. ■

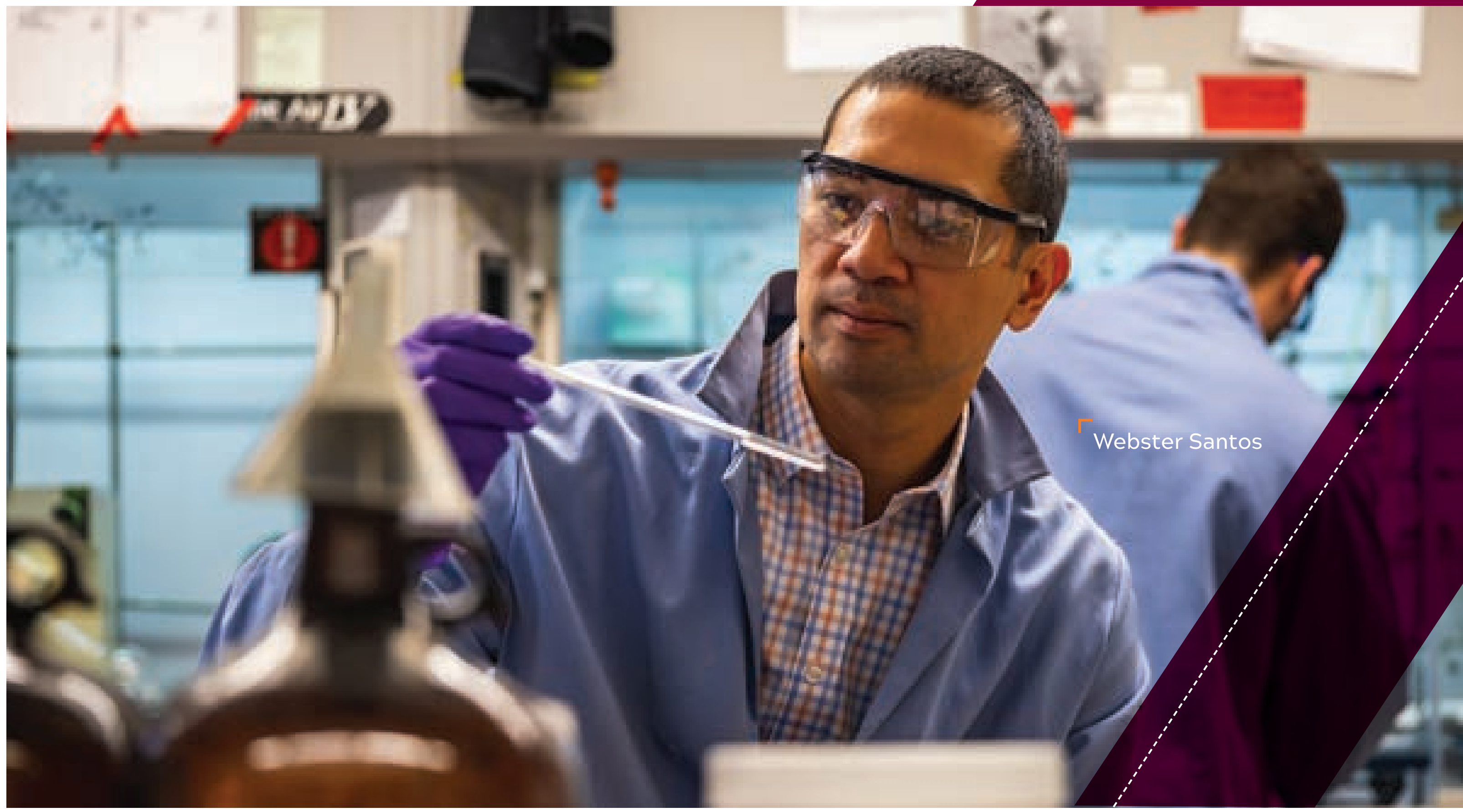
Max Esterhuizen

Article citation:
Lukyanchikova, V., Nuriddinov, M., Belokopytova, P. et al. Anopheles mosquitoes reveal new principles of 3D genome organization in insects. Nat Commun 13, 1960 (2022). https://doi.org/10.1038/s41467-022-29599-5

Read more about mosquito research. Scan the QR code.

Igor Sharakhov

Varvara Lukyanchikova



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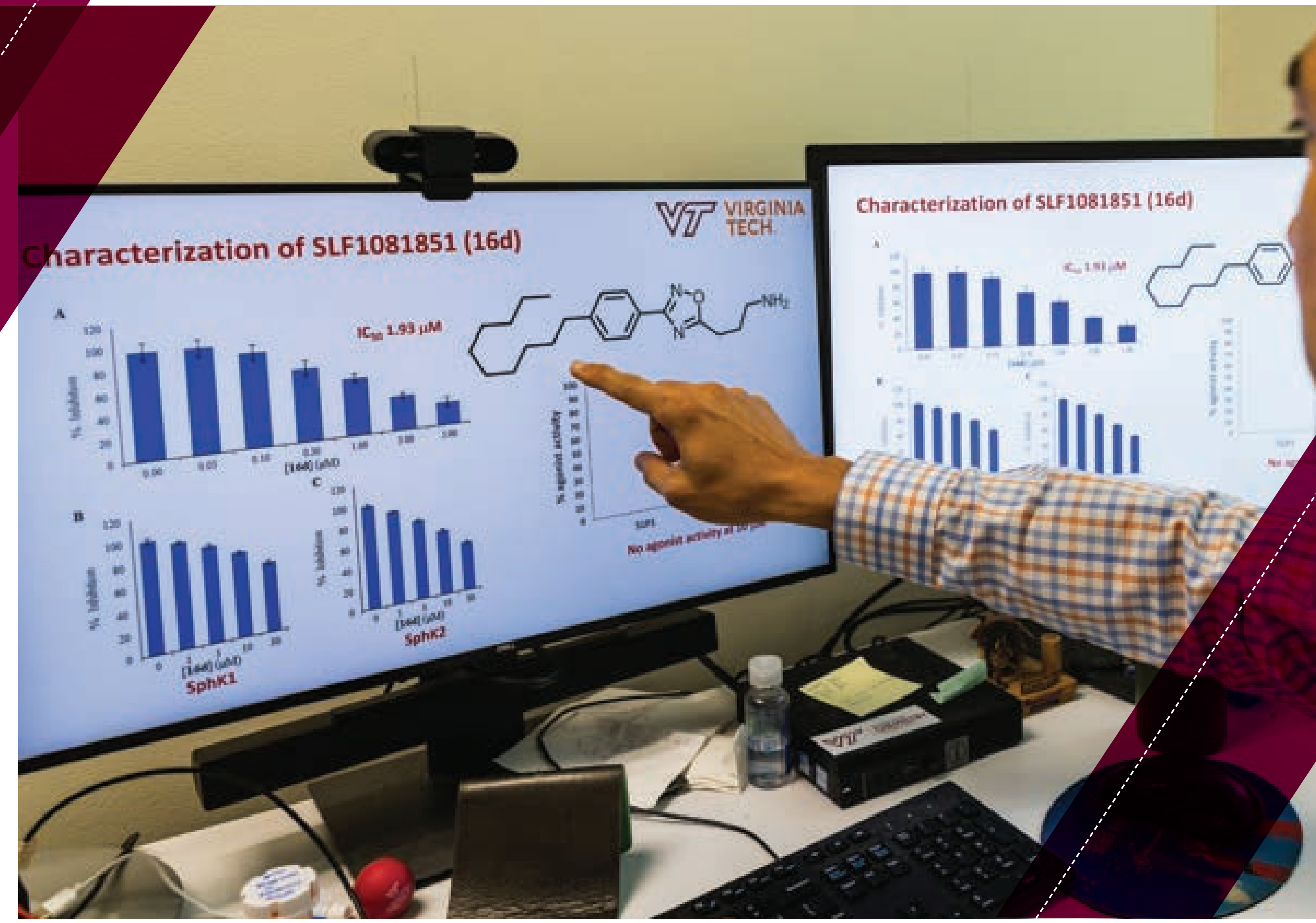


MOLECULE INHIBITOR **DISCOVERY**

Chronic kidney disease almost certainly ends in fatal renal failure. The costs are enormous, not only in lives, but also to the economy. According to 2017 estimates, chronic kidney disease cost the U.S. economy $84 billion, and end-stage renal disease treatment added another $36 billion.

WEBSTER SANTOS IS DETERMINED TO FIND A way to halt kidney fibrosis, a condition caused by persistent inflammation and assault to the kidney. The disorder leads to kidney disease, itself a pathway to kidney failure, also known as renal failure, and almost certain death.

According to medical experts, nearly 40 million Americans have what is known as chronic kidney disease, informally known as CKD. The loss of kidney function — be it gradual or sudden — is devastating on the body. Waste build-up. Heart disease. High blood pressure. Bone deterioration. The list only gets grimmer.

The costs aren't just in lives lost. Experts pin the U.S. cost of treating CKD at $84 billion. End-stage renal disease (ESRD) treatment tacks on additional $36 billion. Those are just 2017 estimates. That's five years ago, light-years in medical treatment cost estimates. Costs are, of course, expected to only increase.

Santos, a professor in the Department of Chemistry, part of the Virginia Tech College of Science, is determined to stem this ever-growing trend — certainly not a full halt, but likely a new dam. In a new paper published recently in Science Translational Medicine, Santos and an international team of scientists unveil a new breakthrough: By blocking the transporter of signaling molecule Sphingosine-1-phosphate, the progression of kidney fibrosis can be suppressed.

Think of it as radio signal jamming depicted in war and spy films throughout the years. Or, if you're a sports fan, a defensive blocker intercepting that intended pass.

"We discovered a molecule that blocks this transporter and showed that it prevents the development of kidney fibrosis in a mouse model," said Santos, the Cliff and Agnes Lilly Faculty Fellow in the College of Science. "The impact is the discovery of a new therapeutic target for the treatment of chronic kidney disease and other fibrotic diseases."

Santos likens kidney fibrosis — again the last stop before certain fatal kidney/renal disease and failure — as the worst kind of natural human disease defense. "Think of fibrosis as wound healing," Santos said. "When you cut your skin, for example, wound healing occurs, but that new skin is different than the original. It will be a little tougher — a scar forms. Fibrosis is essentially over-scarring. So there are different stages of fibrosis. The more advanced, the worse the kidney becomes disease-wise. So CKD eventually leads to end-stage kidney failure."

Santos said CKD — when the kidneys are unable to filter wastes and excess fluids from blood — may be an unstoppable condition, but maybe it can be slowed. "An ideal anti-fibrotic therapy would reverse the pathology, but even the more modest and realistic goals of slowing fibrotic progression remains unrealized. Delaying the onset of ESRD by just a few years would be enormously beneficial to human health and health care economics," Santos said.

Santos and his Virginia Tech graduate students past and present — including recent alums Daniel Foster and Russell Fritzemeier, who each earned Ph.D.s in chemistry — have been chasing this find for half a decade. (The work in this new paper builds off similar research published in May in the Journal of Medicinal Chemistry.)

"It's been a long slog because we do not have a crystal structure of the protein to help us design molecules," said Santos, also an affiliated member of the College of Science's Center for Drug Discovery and the Virginia Tech Fralin Life Sciences Institute. "Through a ton of trial and error by an iterative process of synthesis and biological testing, we identified potent inhibitors. It feels exhilarating to know that we are the first group to do this. We feel even better to realize that our work could lead to drugs that will help millions of people with CKD."

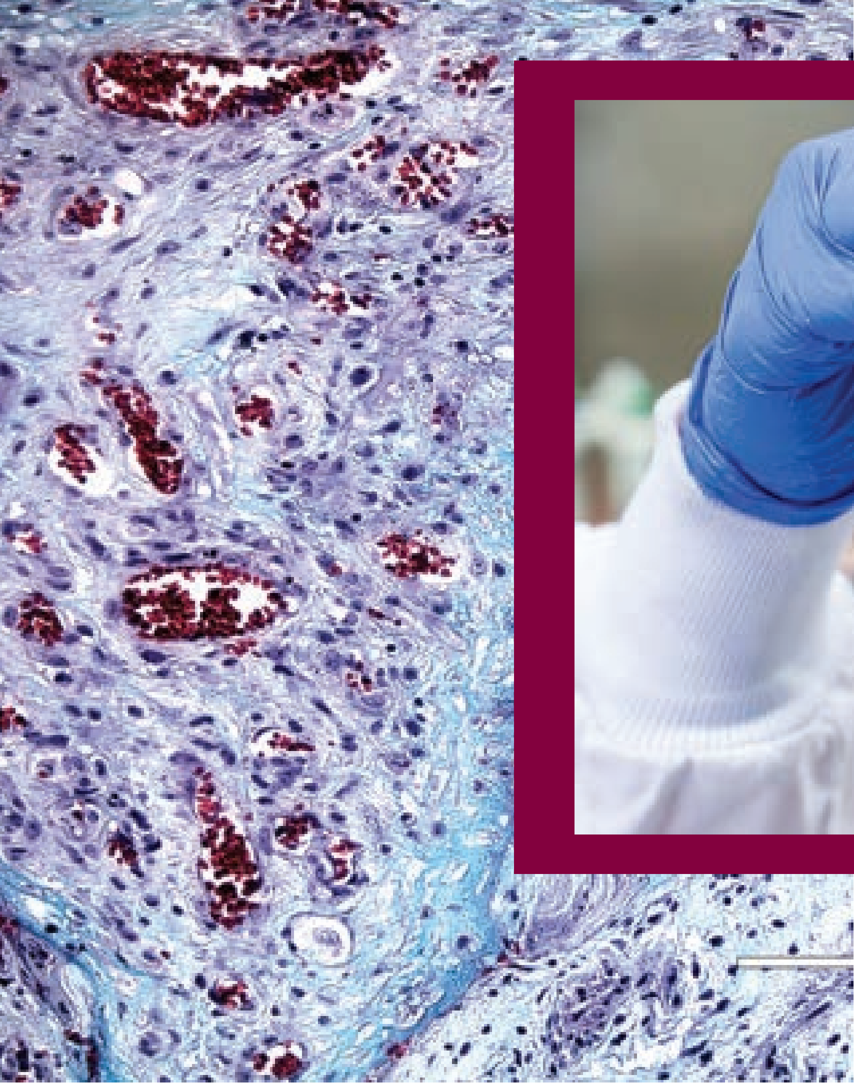
Santos also credits his collaborators, Mark D. Okusa and Kevin Lynch, both from the University of Virginia, for their efforts in bringing these findings to light. Shinji Tanaka from the University of Tokyo spearheaded the study. Funding for the project has involved the National Institutes of Health at $6.1 million since 2013 plus support from Virginia Tech's LINK+LICENSE+LAUNCH's Proof of Concept Grant Program with Santos launching a spin-off biotech company, Flux Therapeutics, to commercialize the discovery.

The work is hardly over. In terms of actual medical treatment for actual patients, the journey is just beginning.

"The next step is to make the small molecule inhibitor more drug-like, meaning we want to make them orally bioavailable for once-a-day dosing, that they are safe, and [exhibit] no bad side-effects," Santos said. "We are already working on this and have already discovered better compounds. We are a long, long way to human testing in phase one clinical trials. But we are on the right track." ■

Steven Mackay

Read more about molecule inhibitor discovery. Scan the QR code.



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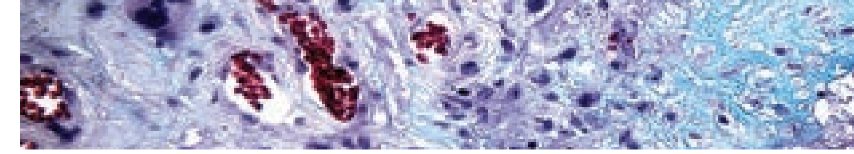


3D MODEL OF BRAIN TUMOR **COULD AID TREATMENT**

Jennifer Munson and her research team's model of the glioblastoma tumor microenvironment could help with understanding why the cancer is so resistant to treatment and so often returns after surgery.

GLIOBLASTOMA, A RARE BUT DEADLY BRAIN cancer, is wickedly sturdy. Surgeons remove tumors only to see the cancer come back ferociously. Chemotherapy and radiation therapy have limited effects. About half of patients die within 18 months.

But now Virginia Tech scientists have developed a novel 3D tissue-engineered model of the glioblastoma tumor microenvironment that can be used to learn why the tumors return and what treatments will be most effective at eradicating them – right down to a patient-specific level.

The model and its development are described in a paper published July 29 in Nature Partner Journals Precision Oncology.

"Our goal is ultimately to develop a personalized medicine approach in which we can take a patient's tumor, build a model of that tumor in a dish, test drugs on it, and tell a clinician which therapy will work best to treat it," said Jennifer Munson, associate professor at the Fralin Biomedical Research Institute at VTC and the paper's corresponding author.

The model is an important step to identify new markers and therapies for the cancer. Research using the new model has already identified a new measure for understanding a patient's tumor, including the capability of the cancer cells to renew and differentiate themselves, which is an indicator of how the cancer will respond to drug treatments.

About 15,000 people a year are diagnosed with glioblastoma, according to the National Cancer Institute.

Munson, a tissue engineer who is also an associate professor in Virginia Tech's Department of Biomedical Engineering and Mechanics and one of the co-directors of the Virginia Tech Cancer Research Alliance, began developing the models in 2014. While other engineered models exist, this one accounts for cell types other than tumor cells, along with the space for the tumor to grow and spread, and other aspects of the actual tumor microenvironment.

Munson's models, which are typically about the size of a pencil eraser, more accurately recreate that environment for study, including cells unique to the central nervous system such as astrocytes and microglia, and in ratios based on those found in patients.

The model also considers the movement of fluid between and around cells in tissues — known as interstitial fluid flow — which is known to increase in tumors and speed the cancer's spread. Fluid flow in the model also allows for easy testing of drug therapies.

Fralin Biomedical Research Institute scientists created a model of a tumor microenvironment to better understand why glioblastoma, the most common and malignant form of primary brain cancer, is so resistant to treatment. The image shows brain cells called astrocytes (red) in an environment with tumor cells (green).

The microenvironment is crucial to understanding why glioblastoma is so difficult to treat. Though a tumor can be removed, tumor cells tend to invade the surrounding tissue where they become more harmful or resistant to therapies, allowing the cancer to return.

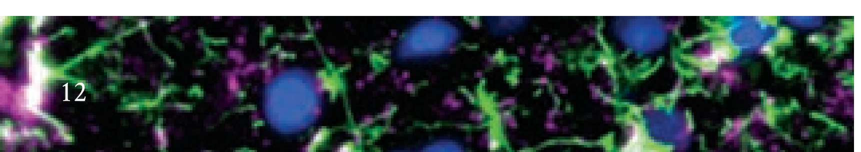
"We wanted to mimic that environment as closely as possible because that is what you would be later treating with drugs or doing any sort of follow up treatment," Munson said.

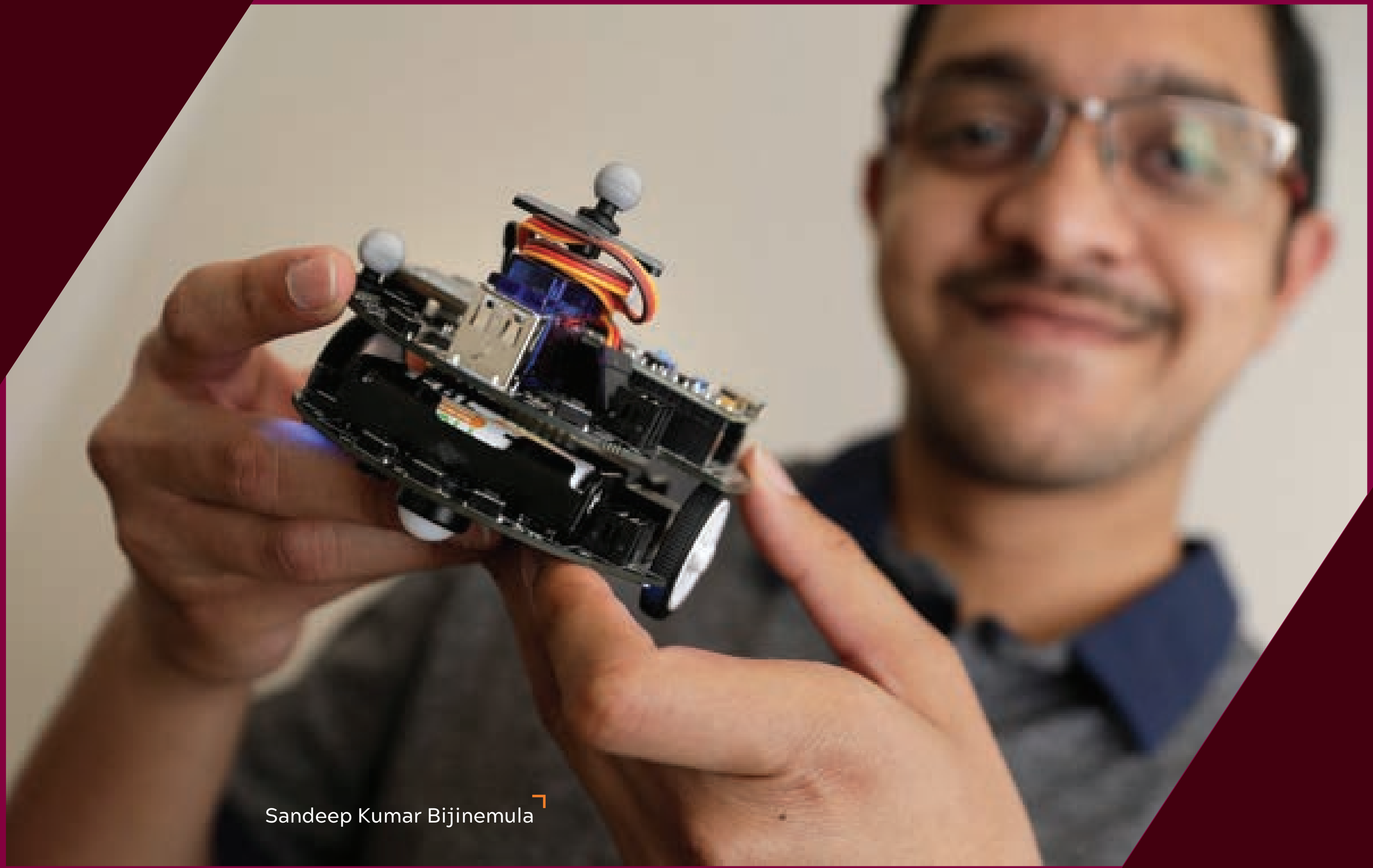
Munson and her team have used the models to test the impact of different treatments, analyzing for how cancer cells invade tissue, how they proliferate, their ability to renew themselves, and how many cells die. They found results varied widely, which highlights the importance of a personalized medicine approach to glioblastoma and the value of being able to recreate an individual patient's tumor microenvironment.

"The model can help us answer questions like, can we predict therapeutic response?" Munson said. "Can we see how these different cell types contribute to tumor cell behavior, or can we just better understand this microenvironment that allows physicians to more effectively treat patients who typically have a poor chance of survival?" ■

Matt Chittum

Read more about brain cancer research. Scan the QR code.




Sandeep Kumar Bijinemula

CULTIVATING THE **CYBERSECURITY PIPELINE**

THE NEED FOR EVOLVING technical capabilities of defense systems and complex networks is increasingly more important to protect national security, but the cybersecurity workforce to develop these emerging technologies is lacking.

Nationally, there is a critical shortage of qualified cyber professionals, with approximately 600,000 cyber jobs available and more than 53,000 positions open in the Commonwealth of Virginia, according to Cyber Seek.

In working toward closing the cybersecurity workforce gap, Virginia Tech has been awarded $1.5 million to engage undergraduate and graduate students from a variety of academic backgrounds enrolled in ROTC and other programs oriented to careers in defense and security.

The Griffiss Institute, which administers the Virtual Institutes for Cyber and Electromagnetic Spectrum Research and Employ program for the Department of Defense, selected Virginia Tech to lead the program called the Cybersecurity Research and Advanced Training of ROTC Students (CREATORS) Virtual Institute. Virginia Tech will partner with Old Dominion University and Norfolk State University, both of which are minority-serving institutions.

"As a senior military college, the establishment of a new Virginia Tech-led cybersecurity program leverages the strengths of our existing expertise in cybersecurity and related disciplines, but intentionally extends our reach to a variety of students that will allow us to diversify the tech-talent workforce and, more specifically, the development of our nation's intelligence and defense communities," said Eric Paterson, executive director of the Virginia Tech National Security Institute.

The multi-university initiative will provide students opportunities to participate in experiential learning programs, summer internship experiences, and applied research projects to address the complex cyber environment and cultivate a diverse pipeline of cyber talent.

The CREATORS Virtual Institute will bring together cross-university student teams that will learn about cybersecurity challenges and technology through a year-long project experience. The first teams will launch this fall with applications being solicited in the coming weeks.

> "THE FUTURE WORKFORCE NEEDS TO BE BETTER PREPARED TO UNDERSTAND THESE VULNERABILITIES, **WORK THROUGH THEM IN RELEVANT OPERATIONAL CONTEXTS, AND LEVERAGE DATA TO IMPROVE OUTCOMES."**
>
> **Peter Beling**
> Professor in the Grado Department of Industrial and Systems Engineering at Virginia Tech

"The defense landscape is driven by increased computing and software-defined capabilities, wireless systems, and increasing network connectivity that requires the ability to process and learn from cybersecurity data artifacts and translate cybersecurity vulnerabilities into actions with operational impact, said Peter Beling, professor in the Grado Department of Industrial and Systems Engineering and associate director of the Intelligent Systems Division in the Virginia Tech National Security Institute who is also the principal investigator. "The future workforce needs to be better prepared to understand these vulnerabilities, work through them in relevant operational contexts, and leverage data to improve outcomes.

"Although cybersecurity and intelligent defense have been the key areas for enhanced national technology and security, there has been a significant shortage for trained workforce in this domain across national labs, industry, and academia, said Jin-Hee Cho, associate professor of computer science and the director of Trustworthy Cyberspace Lab. "CREATORS will provide students with strong cybersecurity and defense knowledge and transdisciplinary experiences in developing innovative solutions for cyber problems.

Cho is a co-principal investigator of this project along with Ehren Hill, associate director for education and outreach at the Virginia Tech Ted and Karyn Hume Center for National Security and Technology. The Virginia Tech team is partnering with faculty members Yen-Hung (Frank) Hu and Mary Ann Hoppa; both from Norfolk State University; and Hongyi Wu and Chunsheng Xin; both from Old Dominion University.

The establishment of the virtual institute builds on Virginia Tech's momentum in cybersecurity education and research. This past fall, Virginia Tech announced the formation of its National Security Institute, aspiring to become the nation's preeminent academic organization at the nexus of interdisciplinary research, technology, policy, and talent development to advance national security.

Recently, Virginia Tech received a $2.8 million grant from the Department of Defense to continue developing the Department of Defense (DoD) Senior Military College Cyber Institute (SMC2I), for a second year.

Virginia Tech also leads two substantial cybersecurity initiatives with unique investments by the commonwealth that provide a strong foundation of cybersecurity education, expertise, and innovative research at the university.

The Virginia Tech led Commonwealth Cyber Initiative is a highly connected network that engages institutions of higher education, industry, government, and non-governmental and economic development organizations that launched in 2020 with a $20 million investment from the state. The initiative connects regional nodes across the commonwealth, each led by an institution of higher education, which are designed to be vibrant centers of research, learning, and innovation tailored to their local ecosystem.

Also funded by the state of Virginia, the Virginia Cyber Range was created in July 2016 with the mission to provide resources for cybersecurity education to public high schools and colleges across the state in an effort to jump-start the pipeline of qualified cybersecurity experts needed to fill tens of thousands of jobs in Virginia. Since then, the range has grown to support over 30,000 students and faculty at approximately 300 high schools, community colleges, and universities in Virginia.

Additionally, Virginia Tech is a National Security Agency Center for Academic Excellence in Cyber Defense Research and Center for Academic Excellence in Cyber Operations, and an Intelligence Community Center for Academic Excellence. The university participates in federal scholarship programs including the National Science Foundation and Office of Personnel Management's Cybercorps Scholarship for Service and the Department of Defense Cybersecurity Scholarship Program. ■

Lindsey Haugh

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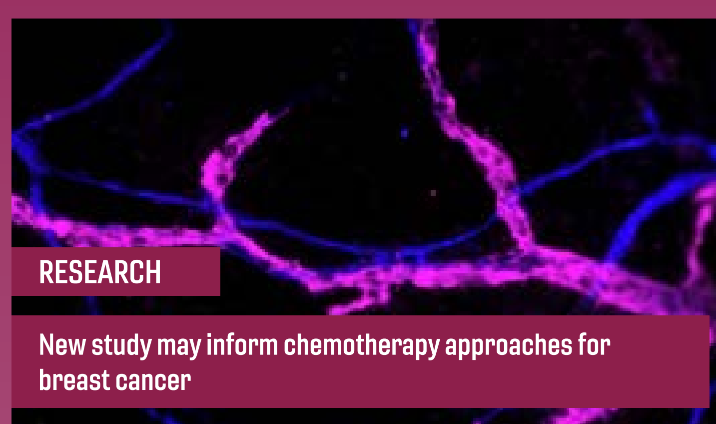
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