



18

## WHAT MAKES LYME TICK

Researchers are studying every species of bacteria carried by common ticks, in hopes of giving physicians ammunition against disease.

## \_SHELLS, SOOT AND A SHINE

*Before-and-after images show how decades of coal-powered industry in the city of Philadelphia contaminated the surfaces of shells that were displayed in open-air cases during the Academy's early years.*

STAFF AT THE Academy of Natural Sciences of Drexel University launched a large-scale cleaning program for the academy's freshwater mussels collection to bring back some of the shine to shells that have been gathering dust for decades.

It is the first major overhaul of the mussel collection since the 1950s, when the shells were moved into closed cabinets. In this new effort, staff have been placing the shells in archival trays within the Academy's new cabinets and updating their systematic order to current standards. Volunteers and students have assisted by cleaning individual shells and labels.

Many of the older mussel specimens in the collection are covered in thick layers of soot. In the days before air conditioning, windows remained open from spring to fall to counter the summer heat, and particles coated the surfaces of these significant shells for up to a century where they lay in glass cabinets or open trays. A few blocks from the Academy's location on the Benjamin Franklin Parkway was the gigantic Baldwin Locomotive Works, which ran coal-fired foundries day and night. A short distance in the other direction lay the Reading Railroad tracks, where dozens of steam trains passed through each hour. Cheap Pennsylvania coal also powered steam tractors, ferries, ships and cranes. For more than two centuries, houses and buildings throughout the city were heated with it. The air was black with fine soot, which oozed through the tiniest gaps in cabinets and doors to settle on the exhibits.

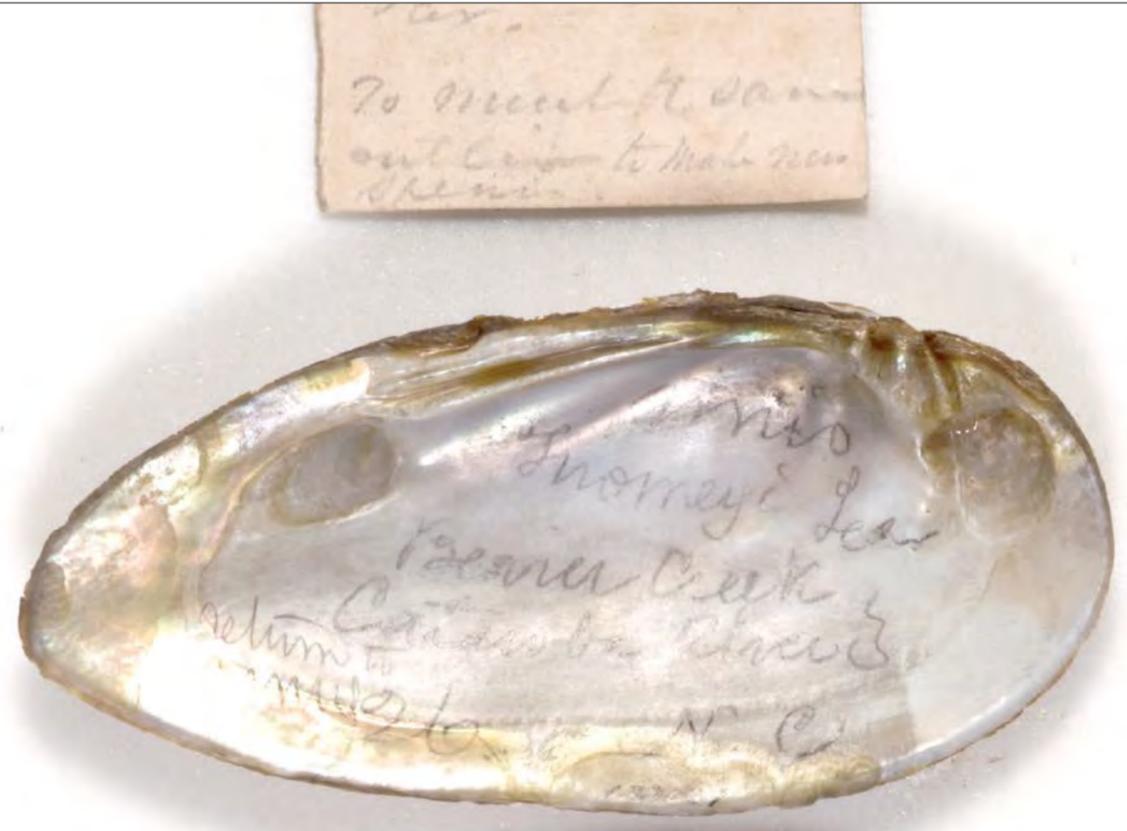
Volunteers and students have used special pads to clean the specimen labels and display boards, and paper wipes soaked in distilled water to clean the blackened mussels. The process releases the distinctive odor of anthracite coal, but for the most part, the thick coating has caused little damage to the shells underneath. — Paul Callomon, Malacology Collection manager. Previously printed in the Academy of Natural Sciences of Drexel University annual report Science Matters.



**\_#126146 ACTI-NONAIAS PECTOROSA (CONRAD, 1834)\***

The photograph on the left shows the shells prior to being cleaned; on the right, the clean shells. Over their lifetime of many decades, mussels rarely move far, but they continually add layers to their shells. The rate at which they grow can be measured in these layers down to individual days and reveals environmental factors such as water temperature and food availability. At the same time, mussels incorporate into their shells and tissues substances in the surrounding water, such as metals and chemical compounds. With their dates of collection known, the shells in this collection form a priceless and irreplaceable archive of environmental conditions stretching back into the 18th century.

\* These names are the current ones assigned to the mussels. They don't match what is on the labels because those names are now considered junior synonyms of the older valid ones.



Handwritten note: "To mount the same out line to make new specimens"

Handwritten note: "To mount the same out line to make new specimens"

#127069 ELLIPTIO ICTERINA (CONRAD, 1834) Before and after.



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MALACOLOGY

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*Unio spissus*  
 Lea  
 Saltilla River  
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127135  
*Unio spissus*  
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 Saltilla River  
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 Georgia



CHARLES M. WHEATLEY COLLECTION. No. 127135  
*U. spissus* Lea.  
 Saltilla River,  
 Wayne Co., Georgia.  
 DEPOSITED BY THE UNIVERSITY OF PENNSYLVANIA.

CHARLES M. WHEATLEY COLLECTION. No. 127135  
*U. spissus* Lea.  
 Saltilla River,  
 Wayne Co., Georgia.  
 DEPOSITED BY THE UNIVERSITY OF PENNSYLVANIA.

\_#127135 ELLIPTIO DOWNIEI (LEA, 1858)  
 Before and after.

\_HELMET SHELL

Only the right side of this helmet shell (*Cassis cornuta*) has been cleaned, showing the extent of soot contamination in parts of the old collection.





**\_ROCK SHRIMP**

This Jurassic fossil shrimp from the famous Solnhofen quarries in Germany was acquired by the Academy over a century ago. Cleaning has restored the exquisite detail that characterizes fossils from this iconic place, the home of the fossil bird Archaeopteryx.



**#127395 ELLIPTOIDEUS SLOATIANUS (LEA, 1840)**

Freshwater mussels (Unionoidea) such as these make up the largest single section of the academy's roughly 10 million mollusk specimens. They are found in rivers, streams, lakes and ponds all over the world, with particular richness in North America.



# \_IDEAS WITH IMPACT

Research for healthier, better lives

EDITORIAL\_STAFF

Editor  
Sonja Sherwood

STAFF\_CONTRIBUTORS

Beth Ann Downey  
Alissa Falcone  
Britt Faulstick  
Niki Gianakaris  
Annie Korp  
Greg Richter  
Emily Storz

DESIGN

Pentagram

ADMINISTRATION

President  
John Fry

Senior Vice President,  
University Communications  
Lori Doyle

Senior Vice Provost,  
Research  
Aleister Saunders

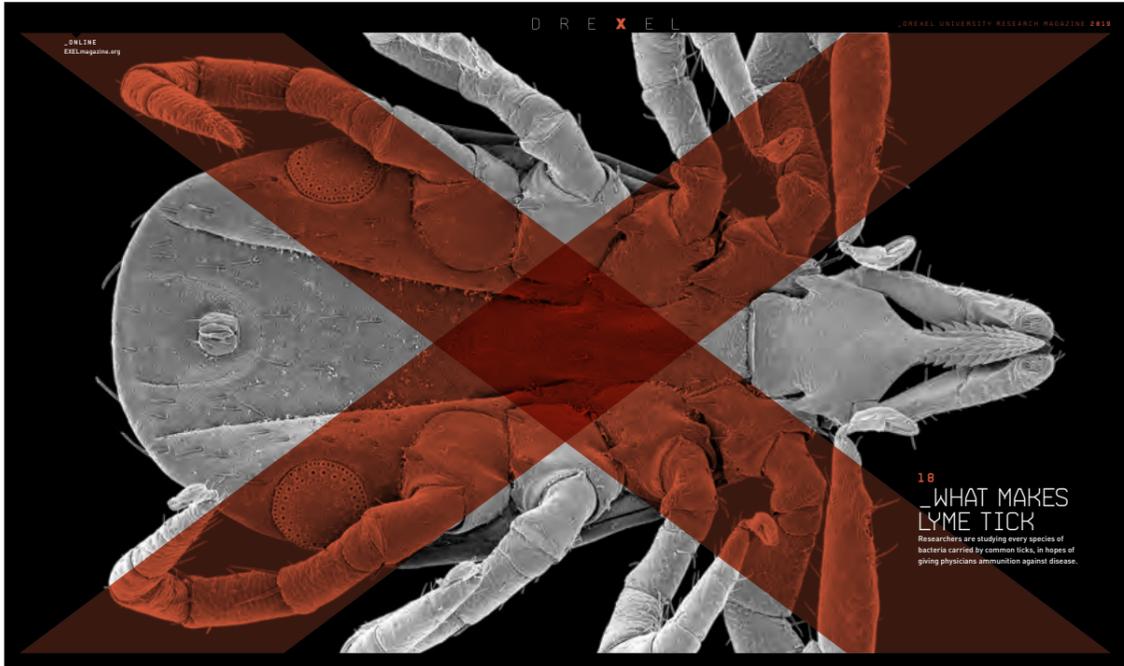
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Office of the Vice Provost for Research 3141 Chestnut St. 234 Randell Hall Philadelphia, PA 19104 Telephone: 215.895.6091



**\_ABOUT THE COVER**  
This is a scanning electron micrograph taken by Dennis Kunkel of a deer tick common to the United States. This species is known to carry the bacteria that cause Lyme disease as well as many other pathogenic bacteria. A Drexel doctoral student is studying all of the bacteria carried by common ticks to help doctors diagnose common co-infections.



RECENTLY, DREXEL REACHED a major milestone when it joined the iconic, top-tier research universities in the Carnegie Classification of Institutions of Higher Education.

The R1 Doctoral University designation by Carnegie is a coveted distinction. It is reserved for universities with the highest level of research activity, and Drexel was one of just 34 private institutions to receive this designation.

I view this not only as the latest indication of the impact of Drexel's research, but as recognition of the talent and commitment of our faculty. Drexel researchers are making their mark in so many ways, buoyed by an impressive, 15 percent increase in sponsored research awards last year, to \$124 million.

The University also just moved up several spots among the world's top 100 universities for patents granted in this country in 2018, now tied for 51st place, according to rankings by the National Academy of Inventors and Intellectual Property Owners Association.

It's at times like these that we step back and look at the big picture showing the outpouring of entrepreneurial ideas and inspiration from Drexel researchers. We rightly take note of exceptional achievements, like Sorin Siegler's work with Kinso Medical on an improved artificial ankle, or the progress made by Yury Gogotsi toward creating a unique type

of atoms-thin MXene material that may make possible portable dialysis.

All told, Drexel researchers currently have received more than 600 grants in support of their work, while securing 46 U.S. patents last year. Annually, the University's research activities regularly result in more than 100 invention disclosures. In support of our research enterprise, we just named the first director of the Human Research Protection Program within the Office of Research, charged with upholding the highest ethical standards in the conduct of research with human subjects.

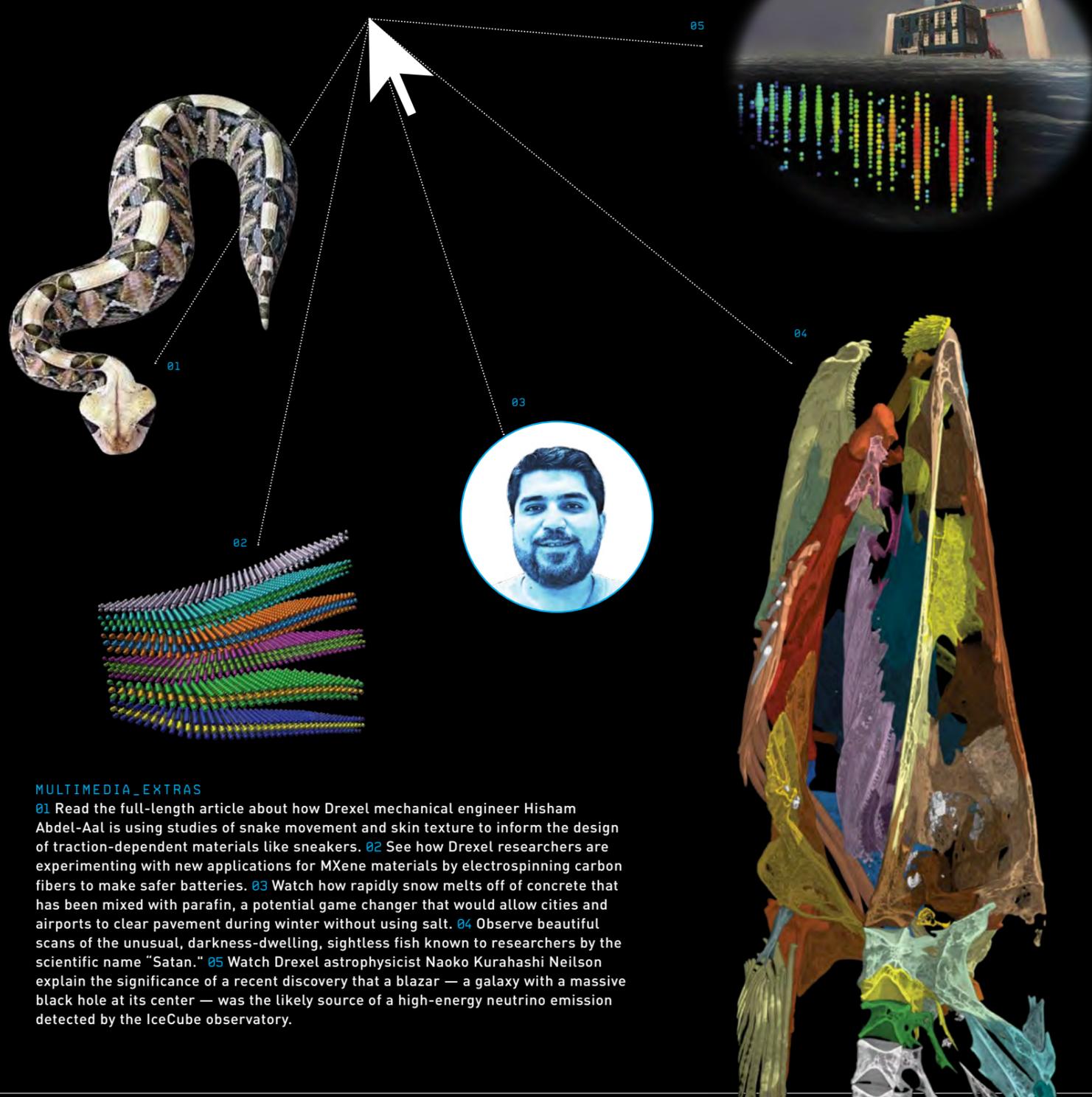
Drexel's strong record of success in driving ideas from the research stage to real-world application tells faculty and student innovators, as well as our many partners in industry and at other universities, that the University knows how to deploy our entrepreneurial ecosystem for the benefit of society. For all of us in the Drexel community and our many collaborators here and abroad, I hope national recognition for our research efforts builds upon a sense of mutual accomplishment and pride.

Sincerely,

John Fry / President

# \_EXPLORE EXEL ONLINE

Connect with EXEL Magazine on the Web for exclusive online content, interviews with Drexel researchers, and demonstration videos about our growing research enterprise. Visit [exelmagazine.org](http://exelmagazine.org).



MULTIMEDIA\_EXTRAS

01 Read the full-length article about how Drexel mechanical engineer Hisham Abdel-Aal is using studies of snake movement and skin texture to inform the design of traction-dependent materials like sneakers. 02 See how Drexel researchers are experimenting with new applications for MXene materials by electrospinning carbon fibers to make safer batteries. 03 Watch how rapidly snow melts off of concrete that has been mixed with parafin, a potential game changer that would allow cities and airports to clear pavement during winter without using salt. 04 Observe beautiful scans of the unusual, darkness-dwelling, sightless fish known to researchers by the scientific name "Satan." 05 Watch Drexel astrophysicist Naoko Kurahashi Neilson explain the significance of a recent discovery that a blazar — a galaxy with a massive black hole at its center — was the likely source of a high-energy neutrino emission detected by the IceCube observatory.

GEOLOGY

\_ICE QUAKES

Scientists have always believed that Antarctica was unusually seismically quiet. As it turns out, no one was listening closely enough.

SINCE THE FIRST earthquake was detected in East Antarctica in 1982, just eight more seismic events have ever been recorded there.

Then a team that included Amanda Lough — formerly a student but now an assistant professor in Drexel’s College of Arts and Sciences — set up the first winter-through-summer seismic array. They recorded 27 earthquakes ranging in magnitude from 2.1 to 3.9 in 2009 alone, tripling the total number of events recorded on East Antarctica’s section of the Earth’s crust.

“Ultimately, the lack of recorded seismicity wasn’t due to a lack of events but a lack of instruments close enough to record the events,” explains Lough, who is the lead author on a study discussing the array’s results in *Nature Geoscience*.

East Antarctica is what’s known as a “craton:” a large, stable piece of rock on the Earth’s crust that forms significant pieces of continents. But many scientists believed it was unusually seismically still, because of suppression via the incredible weight of Antarctica’s thick ice.

Recordings from the array, however, show that East Antarctica is similar to other cratons across the world.

The continent has been understudied because getting an array there is no easy task. To obtain their data, the team traveled to Antarctica’s frigid environment, and flew from point to point across Antarctica’s icy expanse (often having to dig out their own runways)

to place the seismic recording equipment (which required even more digging).

The experiment goes to show that you don’t know what you don’t measure.

“Antarctica is the least-instrumented continent, but other areas of the globe also lack sufficient instrumentation,” Lough says. “There are some obvious holes in coverage in the Global Seismic Network. For example, the ocean covers 71 percent of the planet, but it is expensive and very difficult to get instruments there. We need to think about improving coverage and then improving the density of it.”



\_AMANDA LOUGH  
Lough is an assistant professor in the College of Arts and Sciences.

TERM:  
**CRATON**

A large stable piece of rock on the Earth’s crust that forms significant pieces of the continents.



EARS\_TO\_THE\_GROUND  
Seismic sensors installed on East Antarctica detected 27 earthquakes, debunking the belief that the continent is seismically quiet.

ENTOMOLOGY

PHYTOLOGY

ENERGY

ENVIRONMENT

ENTOMOLOGY

\_BRAINS VS. BRAWN

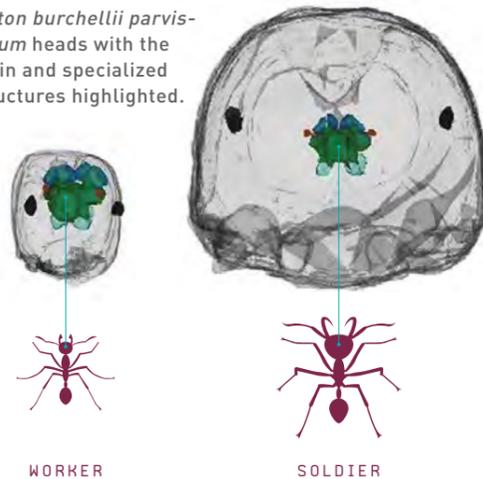
Differences in brains between ant workers with specialized behaviors suggests that the brainpower of social animals evolves to suit their role in their colony.

BRAINS AND BRAWN apparently don't mix in army ant soldiers, a new study shows.

The study in BMC Zoology showed that while army ant soldiers have larger bodies than their worker sisters, their brains are about the same size. Compared to their body size, then, the soldier ants have much smaller brains.

In many ants, individuals in a colony are divided into different "castes," meaning group members play different roles to help the colony survive. In the Eciton genus, soldier ants are larger, stronger and have powerful mandibles that work like pincers to fight off predators threatening the colony. That is their only job.

HEAD\_TO\_HEAD 3D reconstructions of Eciton burchellii parvispinum heads with the brain and specialized structures highlighted.



Why that occurs might have to do with how much energy it takes to develop and power brain tissue, according to Sean O'Donnell, a professor in the Department of Biodiversity, Earth and Environmental Science in the College of Arts and Sciences.

"The patterns we saw suggested natural selection favors efficient allocation of brain tissue, with the result of reduced investment in the behaviorally specialized soldiers," O'Donnell says.

Workers, meanwhile, have smaller bodies and mandibles more suited for grabbing and moving things. Their jobs are more varied, ranging from hunting and collecting food to tending to the young.

As such, it follows that worker ants could have larger brains to complete a variety of tasks.

So, does that mean soldier ants are dumber than workers?

"I'm not sure I'd say dumber so much as simpler," O'Donnell says.

\_NATURAL DEFENSES

A family of plants preyed on by milkweed and clearwing butterflies may have evolved away from a particular class of defensive chemicals after their predators developed a tolerance to them.



TATYANA LIVSHULTZ Livshultz is assistant curator of botany at the Academy of Natural Sciences of Drexel University and an associate professor in the College of Arts and Sciences.

IN THE THEORY OF evolution, species that routinely interact and exert strong selection on each other, adapt to each other. A striking potential example of this was uncovered by Tatyana Livshultz at the Academy of Natural Sciences. She found genetic evidence that multiple lineages of plants, whose common ancestor likely produced a class of chemicals that may deter herbivores, evolved to stop producing it.

Livshultz and her team traced the evolution of a gene that is involved in the production of a class of toxic chemicals, called pyrrolizidine alkaloids, in Apocynaceae, a flowering plant family commonly known as the dogbanes and milkweeds.

They identified a single origin of the gene (and, by inference, the chemicals) in the most recent common ancestor of more than 75 percent of current Apocynaceae species and found evidence that the gene became nonfunctional (and the chemicals "lost") at least four different times among that plant's descendants.

Looking for a correlation between the gene and interactions with animals unfazed by the defense alkaloids, Livshultz and her team found a significant connection with Danainae (milkweed and clearwing) butterflies.

Almost every species of Apocynaceae eaten by larvae of Danainae is descended from that hypothetical alkaloid-producing ancestor. Most species of this lineage of butterflies seek out pyrrolizidine alkaloids and use them for their own defense against their predators. Potentially, some species in this branch of Apocynaceae may have stopped producing the alkaloids because instead of repelling milkweed butterflies, the chemicals were attracting them.

These findings, published in the New Phytologist, support the "defense de-escalation" hypothesis, which posits that organisms will evolve to stop using precious resources on obsolete defense mechanisms.

TOXIC\_RELATIONSHIP Monarch butterflies have adapted tolerance to the defensive toxins produced by milkweeds and even prefer to feed on it.

port the "defense de-escalation" hypothesis, which posits that organisms will evolve to stop using precious resources on obsolete defense mechanisms.

One benefit of defense de-escalation is potentially diverting resources to defenses that do work.

"Apocynaceae species of this lineage produce a number of different classes of defensive chemicals, including cardenolides and other types of alkaloids," Livshultz explains. "It has been shown that cardenolides are at least partially effective defenses against adapted herbivores such as the monarch butterfly, the most familiar species of Danainae to Americans."



\_SCALING UP HVAC POWER

The Ion Pinch invented at Drexel helps keep large HVAC systems running leaner and lasting longer by preventing harmful mineral deposition.

THE HEATING, ventilation and air-conditioning systems used by large buildings tend not to get much attention unless they're malfunctioning. But in these types of systems — which account for roughly 10 percent of all energy consumption in the country and are the largest users of water — even the smallest problems are amplified by the scale of the operation.



In large cooling systems, for example, mineral deposits or "scale" can build up over time on metal surfaces and result in inefficiency or malfunctions.

"Reduced efficiency increases operating costs for facilities but could also cause system failure that would cost hundreds of thousands to repair and leave buildings without air conditioning for weeks, cause data center cooling to fail, or make production at a manufacturing plant go down," says Professor of Engineering Young Cho.

Cho invented a device that can generate an electric field to ward off scaling in systems of all sizes.

To prevent scaling, building operators have flushed out pipes, scraped them out, or used chemical additives — but each approach has undesirable costs and risks.

Cho's approach is to create a low-voltage electric field along the surface of the pipes that turns dissolved calcium into soft particles. The particles collide and coalesce into larger particles that precipitate out of the water, thus preventing them from settling on the pipes.

The technology is dubbed "ion pinch" for its ability to snag the calcium ions before they can attach to the condenser pipes.

In its first trial run, Cho's electronic descaling device was installed on a Drexel academic building with two side-by-side chillers. The chillers were given comparable workloads but only one had the device installed. Hourly data was collected on the performance of each chiller.

Not only did the unit with the electronic descaling device use 36 percent less energy than the control unit, but the test unit's pipes were also scale-free.

\_CARBON CASH

INDUSTRIES THAT OPPOSE emissions regulations tend to keep fairly quiet on the subject of climate change, but their money speaks volumes when it comes to lobbying.

In the first peer-reviewed full analysis ever conducted of mandatory lobbying reports made available on the website Open Secrets, Drexel environmental sociologist Robert J. Brulle found that between 2000 and 2016, lobbyists spent more than \$2 billion to influence Congress.

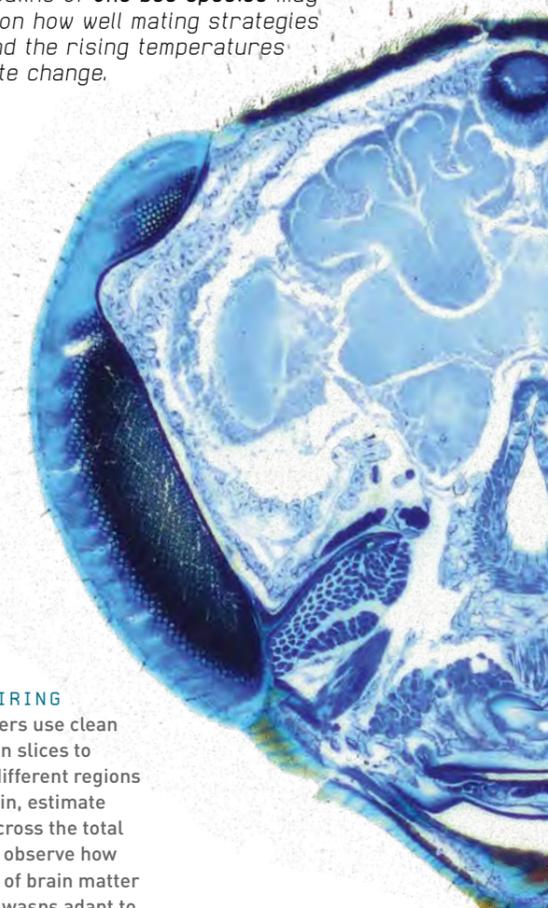
Of those expenditures, industries that are readily classifiable as opponents of emissions regulation spent nine times as much as advocates for alternative energy and environmental protection.

The study, published in the journal Climatic Change, also showed that the amount spent on climate change lobbying varied depending on the timing of proposed legislation. Only about 2 percent of total climate lobbying expenditures were spent between 2000 and 2006. But expenditures peaked in 2009 at \$362 million — 9 percent of the total spent for that year.

That was the year the American Clean Energy and Security Act barely passed the House in June 2009, by a vote of 219–212. "It's clear that when the greatest threat presents itself — like when Congress and the Executive branch are aligned and favorable to recognizing climate change as a major issue, these corporations that engage in the supply and use of fossil fuels work the hardest to upend legislative efforts," says Brulle.

\_BEES IN HEAT

The bloodline of one bee species may depend on how well mating strategies withstand the rising temperatures of climate change.



WASP\_WIRING

Researchers use clean wasp brain slices to quantify different regions of the brain, estimate volume across the total brain and observe how hierarchy of brain matter helps the wasps adapt to different conditions.

LARGE, AGGRESSIVE males patrol the ground at high speeds, landing to help dig out females from their hibernation, while fighting off other males.

Smaller males hover on the periphery, looking to mate with the females who escape themselves, or even steal them away from other, busily fighting males. Though the smaller males have lower reproductive success, Meghan Barrett, a PhD candidate in the College of Arts and Sciences, has hypothesized that warming temperatures may favor their method because

small males are able to spend most of their time in the shade.

To test her theory, Barrett is studying morphological differences between large and small males and how different sensory mate location strategies impact resource allocation in the brain. Then, she will explore whether large or small male mating behaviors may face higher selective pressure under climate change.

"Behavioral and morphological variability have not gotten the attention they deserve in previous iterations of climate change research," Barrett says.

## \_THE PIONEERS OF POOP

You've probably heard about fecal transplants, the latest way for humans to get benevolent bacteria into their intestines. But a group of ants may have been the original poop pill pioneers — 46 million years ago.

**T**URTLE ANTS (*Cephalotes*) are able to supplement their low-nitrogen diets by passing helpful bacteria from older ants to younger ones through anal secretions. Once this is done, the bacteria naturally produce the nitrogen necessary for turtle ants to survive, according to a collaborative study in *Nature Communications*.

"Turtle ants eat a lot of food that is hard to digest and contains few essential nutrients in accessible form," says Jacob Russell, an associate professor in Drexel's College of Arts and Sciences and the paper's senior author. "The fact that they can subsist on such diets and have moved away from aggressively competing for more optimal food resources with other ants is almost certainly a function of their investment in symbioses with gut bacteria."

This multi-institution, international study was spearheaded by Yi Hu, while finishing a postdoc at Drexel, and Jon Sanders, a postdoc at the University of California in San Diego.

The study was inspired by work Russell did with other researchers more than a decade ago when

they discovered that many ants with low-quality diets harbored specialized bacterial symbionts — likely to supplement their diets.

It turned out that turtle ants are a great example of this. To test whether the gut bacteria contributed to the ants' nutrient intake, the researchers kept some turtle ants in a lab, put them on a diet of urea

(the main waste in urine), and gave them antibiotics — which killed their gut bacteria. In this case, the ants weren't able to get the nitrogen they normally did when on a diet strictly made up of urea.

Finding that turtle ants keep nitrogen-producing bacteria in their guts shows how they can survive while eating foods that few other animals want.

Mammals, like us, also have a complex set of bacteria in our guts that may have also evolved with hosts for millions of years.

"The turtle ant system — which is relatively simple — may prove useful in helping us to model questions about our own partnerships with microbes and how important they are for human health," Russell concludes.

### JUNK\_DIET

A *Cephalotes*, or turtle ant, tending a sap-feeding membracid. *Cephalotes* have evolved a way to survive on food that other insects reject.



## \_SOLVED: THE ORIGIN OF NEUTRINOS

It has been long theorized that neutrinos are emitted by blazars, but no one ever saw one occur in the sky — until now.

**A** NEW WAY to look at the universe — using high-energy particles called "neutrinos" — is opening up thanks to the work of a Drexel professor and her colleagues working with a South Pole observatory.

Through the IceCube particle detector, Assistant Professor Naoko Kurahashi Neilson and her team were able to show that neutrinos originate from blazars. Blazars are giant, oval-shaped galaxies theorized to have spinning supermassive black holes at their center that blast out radiation — including light.

Not only did the IceCube team see this happen, they can prove it.

The IceCube team released two papers in *Science* that cover what their observatory recorded to have happened on Sept. 22 last year. They detected a specific high-energy neutrino arriving on a vector that lined up with a specific blazar that was flaring gamma rays.

A second paper led by Neilson took into account observations made at IceCube from the previous nine-and-a-half years. It showed that there is strong evidence of other neutrinos coming from that specific blazar.

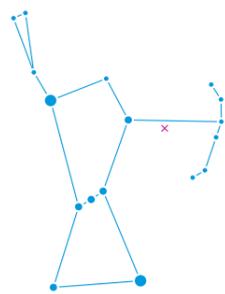
For the first time, scientists now know where at least some neutrinos come from.

That's important because neutrinos that are very high-energy can provide a glimpse into how these far-away galaxies are formed and even how they evolved.

"All of astronomy is light. You see a star because photons — which is light — hit your eyes," Neilson



**\_NAOKO KURAHASHI NEILSON**  
Neilson is an assistant professor in the Department of Physics of the College of Arts and Sciences and a member of the IceCube collaboration, a high-energy neutrino telescope operating at the geographic South Pole.



### BLAZAR\_TAG

Blazars are a type of active galaxy with one of its jets pointing toward planet Earth. In the artistic rendering above, a blazar emits both neutrinos and gamma rays that could be detected by the IceCube Neutrino Observatory. The IceCube team detected one such blazar just off the left shoulder of Orion.

says. "It's all different frequencies of light."

Neilson explained it in terms of a flashlight.

"If I shine a light on a table, you won't see the light on both sides," she says. "But with a neutrino flashlight, it will go through and you can see it on both sides."

ANT: JON SANDERS. BLAZARS: ICECUBE/NASA

## \_SATAN'S BONES

A team of researchers is learning more about an unusual catfish known as "Satan" that dwells in deep underground waters below San Antonio, Texas.

**T**HIS PALE, eyeless species of catfish is only found living deep below the surface of the Earth — a fact of its distribution that suggested its official scientific name "Satan" in 1947.

Only a handful of specimens of *Satan eurystomus* have ever been collected, and the last living ones were found in the 1980s.

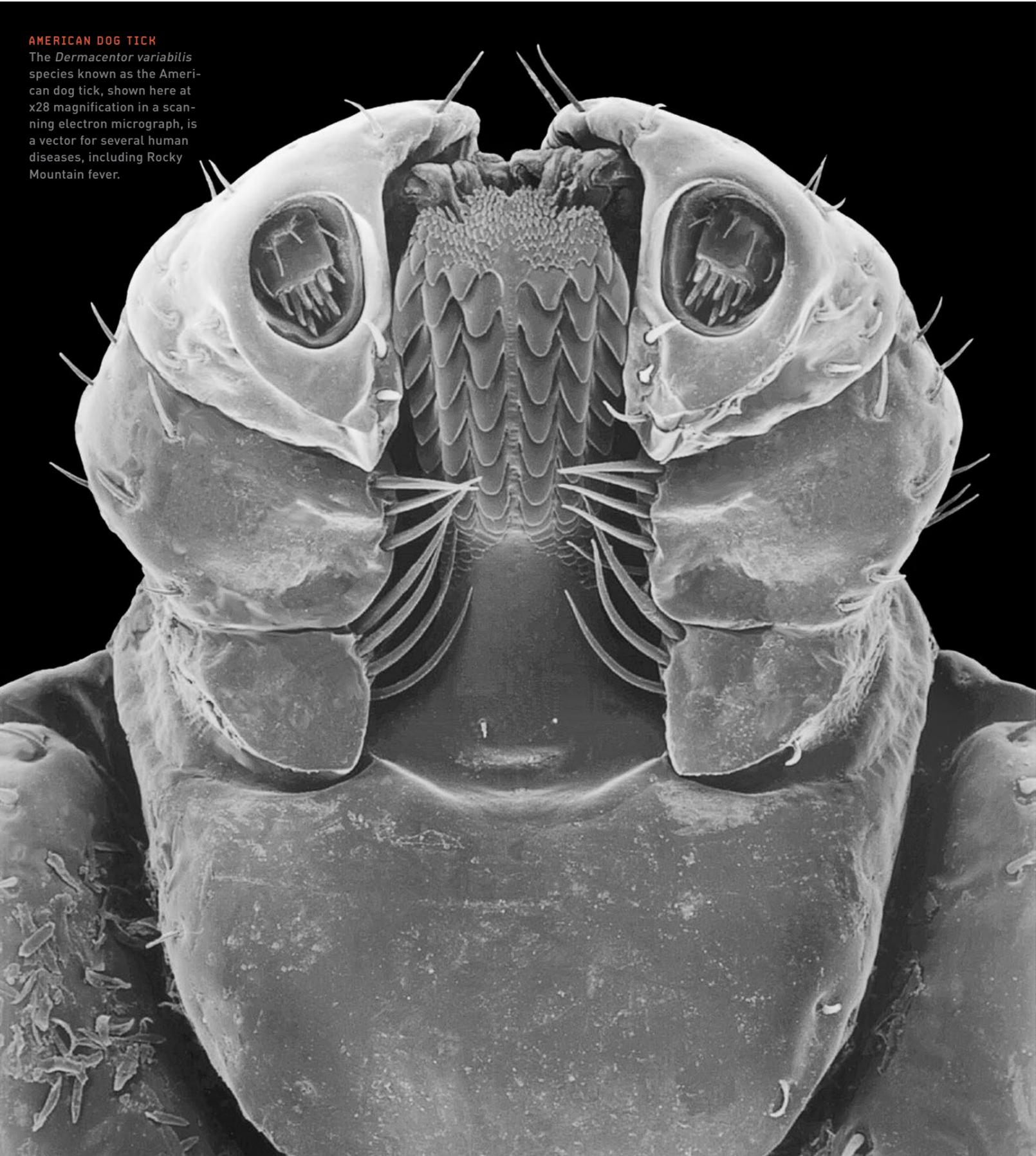
But a team from the Academy of Natural Sciences of Drexel University's Ichthyology Department, along with a researcher at the University of Texas in Austin, recently obtained full-body 3D X-ray CT scans of some of the known specimens. With these high-resolution images the scientists can compare Satan among related catfish species.

"This fish has not been collected in more than 30 years and there are only 14 specimens in collections, making it really difficult to understand to what species they're related," says Mariangeles Arce H., collection manager in Ichthyology at the Academy.

Arce H. co-authored a paper on the scanning that appeared in the *Proceedings of the Academy of Natural Sciences of Philadelphia*. Professor emeritus John Lundberg was lead author of the paper along with contributions from additional co-authors Kyle Luckenbill (research assistant and imaging specialist) of the Academy and Dean Hendrickson of the University of Texas in Austin.



**AMERICAN DOG TICK**  
 The *Dermacentor variabilis* species known as the American dog tick, shown here at x28 magnification in a scanning electron micrograph, is a vector for several human diseases, including Rocky Mountain fever.



LEFT AND NEXT PAGE: DENNIS KUNKEL MICROSCOPY/SCIENCE PHOTO LIBRARY.



**WHAT MAKES LYME TICK**  
 Ticks carry a multitude of bacteria that can harm human health, and a College of Medicine doctoral student is identifying *all* of them, in hopes of giving physicians ammunition against Lyme disease.  
 by Sonja Sherwood





aying inside a freezer in Drexel's College of Medicine are 500 dead, mourned by no one.

The deer ticks, dog ticks, lone star ticks and other tiny parasites in the diminutive morgue traveled from nearly every state in the country to reach this resting place. They arrived in baggies or cookie tins or what-have-you, scooped from meadows and forests by helpful volunteers responding to a "call for specimens" on Drexel's website that was posted by Kayla Socarrás, a doctoral student studying microbiology and immunology. Each tick contains multitudes of smaller organisms — a grab-bag of the pathogenic bacteria that make tick bites so hazardous.

Throughout 2018, Socarrás studied what makes these critters tick.

One by one, Socarrás ground them up and used a genome test to identify what percentage were infected with *Borrelia burgdorferi*, the bacteria that causes Lyme, or with other pathogens. Based on her work, she and her academic advisor, Drexel Professor of Microbiology and Immunology Garth Ehrlich, hope to come up with a better way to diagnose tick-borne infections.

When it comes to Lyme, getting the initial diagnosis right can make the difference between a passing illness and poten-

tially a debilitating long-term disease. But diagnosis is tricky. Each of the harmful bacterium within a tick will trigger a different immune response in each person bitten.

"Ticks have been referred to as sewers," says Ehrlich. "If you get a tick bite you might not just get Lyme disease, you might also get infections from *Bartonella* or *Babesia* or *Anaplasma* or *Rickettsia*, or any combination of those. And a lot of these organisms can produce symptoms that overlap with the Lyme disease itself."

So what's a scientist to do? Ehrlich and Socarrás realized that while it's hard to pinpoint the pathogens infecting a person, it's easy to diagnose infection in a tick using a powerful, proprietary pan-domain assay developed in Ehrlich's lab a few years ago. The genetic test is capable of identifying every species of bacterium present in a sample. With their tick samples, they hope to establish benchmarks for the prevalence of pathogens by species and by geography, which could be helpful to a diagnosing physician.

"If your patient is in California and the most common co-infection in that region is *Bartonella* then they would know to routinely look for *Bartonella* infection and could test for it," says Ehrlich. "It would help them treat people with the right antibiotic for the species."

Theirs is an increasingly urgent research question, as the incidence of Lyme disease has tripled over the past 20 years in the United States. With winters becoming warmer and human settlement affecting the mice and deer populations that ticks feed on, Lyme-carrying ticks are no longer concentrated in the Northeast. They're spreading west, south and into urban parks once considered safe. They're even appearing in Canada's Hudson Bay for the first time in a lifetime, says Ehrlich.

"They're now finding it in Scandinavia close to the Arctic Circle," he says. "Lyme has been around for thousands of years — the Ice Man had a massive *Borrelia burgdorferi* infection. This is not new; it's just that the prevalence has increased."

But even as more people are seeking relief from Lyme's flu-like symptoms, lethargy and joint aches, the standard approach to diagnosing and treating the infection has not advanced in three decades.

Lyme is diagnosed either through observation — the tell-tale "bull's-eye rash" at the bite site — or by testing blood with an assay. But the bull's-eye rash is only present in about half the cases. And the assay is based on a single strain of *Borrelia burgdorferi* that was isolated 30 years ago — based on science that hasn't kept up with contemporary understandings of how bacteria evolve.



Ehrlich has spent the past 20 years studying how bacteria gain a permanent foothold inside human tissues by building colonies within biofilms. Biofilms are slimy matrixes of living and dead bacteria cells bonded together by DNA, proteins and complex sugars that allow them to adhere to bodily surfaces and to each other. Biofilms make it easier for bacteria to elude antibiotics and the immune system by swapping genes or going dormant. This makes them extremely difficult for the body to eradicate and enables them to develop resistance to antibiotics, he says.

"Lyme is particularly pernicious in that its genome is unbelievably variable," he says. "A single strain of bacteria might have 1,200 genes out of a possible 5,400 genes available at the species level."

This is why, says Ehrlich, a single tick bite can result in a complex infection capable of morphing into a permanent illness, responsible for symptoms that can mimic other conditions, like multiple sclerosis and fibromyalgia. Worse, *Borrelia burgdorferi* can't be cultured, so a doctor can't just take a swab, grow it on a plate, and rule out Lyme disease. Once the spirochete gains a foothold in the brain or other organs, it's almost impossible to defeat, Ehrlich says.

Another challenge to diagnosis is that many physicians don't believe that Lyme can become chronic at all. It's a subject of intense debate in medical circles, but there's no doubt which side Ehrlich is on.

"Physicians tend to practice what they learn when they were residents," says Ehrlich.

"Ticks have been referred to as sewers. If you get a tick bite you might not just get Lyme disease, you might also get *Bartonella* or *Babesia* or *Anaplasma* or *Rickettsia*, or any combination of those. And a lot of these organisms can produce symptoms that overlap with the Lyme disease itself."

-GARTH EHRLICH



\_GARTH EHRLICH  
\_KAYLA SOCARRÁS  
Ehrlich is a professor of microbiology and immunology and professor of otolaryngology-head and neck surgery in the College of Medicine. Socarrás is a doctoral student of microbiology and immunology in the College of Medicine.



"The biofilm concept in medicine has only been broadly recognized over the past 10 years, when we had a series of papers published in the *Journal of the American Medical Association*. I think there's been a sea change just over the past two years. The evidence is just getting greater and greater and greater."

At recent Lyme conferences Ehrlich has attended, physicians shared intriguing stories of patients suffering from conditions that may have been tick-borne diseases in disguise. One physician was able to reverse Alzheimer's dementia in three patients who he determined had Lyme disease, by putting them on high-dose antibiotics. A psychiatrist noticed that some of the children referred to her had both bipolar disorder and Lyme disease; on a hunch, she tested all of her bipolar patients and determined that 90 percent were Lyme positive — she began treating them with antibiotics. Ehrlich recounts a case of a famous Duke oncologist with congestive heart failure; after he received a heart transplant, he was able to determine that the muscles of his heart had been massively infected with *Borrelia burgdorferi*.

Both Socarrás and Ehrlich have seen people close to them suffer from tick-borne illness. Socarrás, in fact, was inspired to enter the field of microbiology after experiences working in a doctor's office with infected patients and talking to a research colleague at the University of New Haven who was misdiagnosed for half a decade. "She shared her own experience with Lyme and that's what sealed the deal for me," she says. Ehrlich, who grew up on a farm, counts himself lucky that he's never been bitten, but his sister has been five times, and suffers from severe brain fog.

Ehrlich and his lab recently received funding from the Coulter-Drexel Translational Research Partnership to develop an anti-biofilm drug that would prevent bacteria from entering metabolic dormancy where they can survive antibiotics.

But the Holy Grail is a better diagnostic. Ehrlich is in discussions with others to roll out the pan domain genome assay as a clinical diagnostic for Lyme.

"If you had an adequate diagnostic then you would know definitely if somebody is or isn't infected, but we don't have that," says Ehrlich. "And that's where a lot of the problems and the controversy lies." ✕



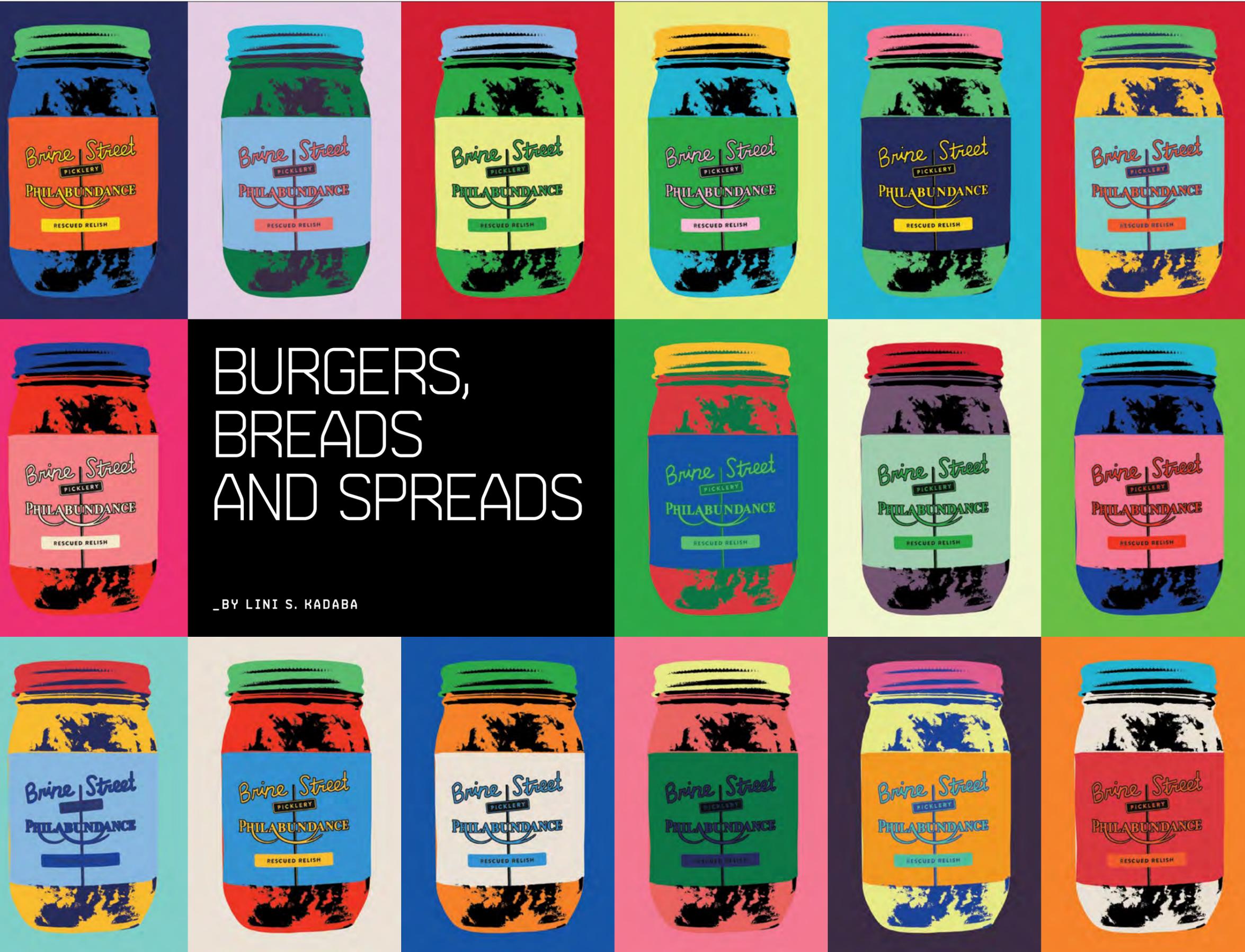
DEER TICK

The *Ixodes scapularis* species known as a deer tick often carries *Borrelia burgdorferi*, the bacteria that cause Lyme disease.



# BURGERS, BREADS AND SPREADS

\_BY LINI S. KADABA



The Drexel Food Lab is an unusual mix of food science, culinary arts and tech transfer, where future chefs work with industry partners to invent delicious new “good” foods in support of sustainability, nutrition and access.

**T**he Tale of the Blended Burger, like all good stories, begins with a grueling quest. It includes, of course, a determined heroine, a king of sorts, a wise counselor, a cast of dozens and, this being Drexel University, a dragon. And while there isn’t a villain, exactly, there have been obstacles along the way to overcome, and perhaps worse, picky taste testers to please. All well worth it.

Starting in 2019, Comcast Spectacor plans to roll out a mushroom-and-beef blended burger created at Drexel’s one-of-its-kind Food Lab to four of its venues, after a pilot last summer whetted appetites for more.

“This wasn’t just a recipe that Drexel created in Food Lab,” says Scott Swiger, vice president of culinary excellence for Spectra, a unit of Comcast Spectacor. “It was really a product Drexel was looking to bring to market and looking for a partner to do that.”

Many culinary schools help outfits with recipe development, but Food Lab has aimed for the stars — and, based on its track record, regularly makes good. The student-driven, interdisciplinary research group solves real-world culinary problems for chefs, food suppliers and food marketers, and has earned a reputation for innovation that includes patent applications and various licensing agreements.

Unusually, many of the projects tackled in the program are motivated by a progressive desire to address food system problems. Using the skills a food scientist might deploy toward making junk food more munchable, Food Lab students and faculty work on sustainability (food waste recovery), health promotion (therapeutic foods) or access (allergen-free and accessible/affordable products).

For instance, the Food Lab worked with the anti-hunger organization Philabundance to create a marketable “upcycled” chutney out of vegetables headed for disposal. Students and faculty are developing functional stool-softening candies for Children’s Hospital of Philadelphia patients who counter constipation caused by painkillers.

**BRINE TIME**  
The Food Lab worked with anti-hunger organization Philabundance to create a relish “upcycled” from vegetables that would have otherwise been discarded.

For F&S Produce, they're designing fresher green salads that use fewer carbs and mayonnaise. And they're helping bread company Amoroso's design a hoagie roll that meets Philadelphia's nutrition guidelines for sodium reduction and whole grains.

Of all the innovative foods created by the lab, the one with the potential to have the greatest public appeal is the Blended Burger.

But let's start from the beginning.

Once there was a 10-pound, plastic bag that contained button mushroom scraps very much in need of a scrub.

In 2014, our heroine Alexandra "Ally" Zeitz (BS '15, MS '18) was a junior at Drexel studying culinary arts. Earlier that year, she had gathered classmates eager for hands-on experiences — an informal club that evolved into Food Lab — and joined forces with Jonathan Deutsch '99, a Drexel professor of food and hospitality management, who had industry clients looking for help.

"He wanted me to make something with them," says Zeitz, who became Food Lab's manager in late 2015 after a post-graduation stint as a baker. Dressed in her usual chef whites and black clogs, her brown hair pinned away from her face, she recounts the tale during a break from the sixth-floor teaching kitchens of the Academic Building on North 33rd Street, where most Food Lab work is conducted.

The "he" is Harris S. Cutler, president of produce company Race-West in Clarks Summit, Pennsylvania.

Cutler wanted a mushroom-and-beef burger, known as a "blended burger" in industry speak. Mainly, he wanted a way to generate demand for mushroom scraps that were hard to sell to grocers. He also liked the idea because it married his surplus produce with his brother-in-law's meat business. (Joel I. Brodman is head of Casanova Meats in West Babylon, New York.)

For years, marketers, dieters and environmentalists have sought a burger with less beef. Worldwide, livestock contribute as much as 18 percent of human-caused greenhouse gases, according to the United Nations. Less beef content in burgers translates to a smaller environmental footprint. Blended burgers also contain less saturated fat and are often less expensive.

Since 2015, the nonprofit James Beard Foundation has sponsored the Blended Burger Project, seeking a sustainable patty through competition. More recently, Bill Gates has backed the Impossible Burger, a plant-based patty that has a meaty taste.

Cutler approached Drexel with a different focus. This blended burger must be tasty above all else, he pronounced. What's the point of a sustainable, cheaper burger if no one wants to eat it? he argued. Cutler wanted the product he and his brother-in-law dubbed the Casanova Burger "to be as good in meat as Casanova was as a lover." Zeitz, a competitive food junkie and chef-to-be, was inspired.

"We started working on the mushroom burger," she says. "It was a challenge."

And so began the journey to create a new product from scratch — one that has taken five long years and has proven Food Lab's most ambitious undertaking.



Zeitz, the twin daughter of a machine shop manager dad and paralegal mom (whose own love of cooking inspired her), arrived at Drexel eager to try culinary arts.

The Southampton, Pennsylvania, native was one of those students who devoured her classes and was always hungry for extra projects.

Deutsch, a Culinary Institute of America-trained chef, had joined Drexel in 2013 after many years teaching at the City University of New York's Kingsborough Community College and Graduate Center cam-

puses. Perhaps more important, he had to-die-for contacts as an industry consultant and the knack to develop more.

"So," Deutsch says, "we brought some of those consulting opportunities to students."

Culinary arts training is typically found at culinary institutes. But at Drexel, the culinary arts and science degree allows for an unusual, seamless blend of research, experiential education and industry involvement — all from the perspective of future chefs.

For the students' first project, they traveled to 16 Handles, a frozen yogurt company based in New York, to brainstorm products for a new menu during a day-long ideation session. The trip was successful enough that it proved preamble to Food Lab, which took off in 2014 with co-founders Zeitz as student manager and Deutsch as director/idea man/fundraiser.

Senior Isabel Guerriero says Food Lab cemented her career interest in product development. "I never knew how capable I was of creating new recipes and products until I was handed half an onion, a wrinkly eggplant and three tomatoes and told to create something totally new," the double major in culinary arts and science and hospitality management says. (She made a vegan pot pie.)

"Food Lab provides students opportunities to work with industry before they've graduated and, in many cases, before they've even done co-op," says Rosemary Trout, the University's program director of Culinary Arts & Food Science. "That's the best thing, frankly...It fits in with Drexel's vision of community engagement."

Initially, Deutsch expected to use a Robin Hood model, taking proceeds from private industry contracts to fund research into food ideas that solved access, health or sustainability problems. "We found almost immediately that there was a lot of demand from private industry, nonprofits and government to do this type of good food work," he says, "and help with the needs of consumers."

Lila Colello, the owner of the Philadelphia-area gluten-free pastry business Flakely, approached Food Lab in 2016 to create a tasty, quintessentially flakey croissant that was also gluten-free. After many experiments, Zeitz delivered the dough.

"We evaluated it just like we would any other invention," says Bob McGrath, senior associate vice president of technology commercialization at Drexel Ventures, which is the University's startup and tech commercialization arm. Well almost. Unlike most advances that cross his desk, this involved yummy samples. "We figured out they'd invented a new manufacturing process for croissants," McGrath says.

In April 2017, Drexel filed for a patent application.

"That opened the door for a whole host of interactions with us," McGrath says. "It became clear that they had a lot of expertise and were being approached by large and small companies all the time." To date, Drexel has secured four licensing agreements between the Food Lab and food purveyors, with more expected.

"We know enough food science to have conversations with clients," Deutsch says of Food Lab's unique position. "A lot of chefs have great ideas, but they can't necessarily translate their ideas to manufacturing."

In contrast, a food science program predominated by chemistry types might have trouble making it taste good, Deutsch says. "To be able to combine those things is a different way to do culinary education," he says.

Food Lab's backbone is a partnership with Cook for Your LIFE, a New York City-based nonprofit that provides healthy, easy-to-make recipes for those touched by cancer.

Deutsch, who serves on the organization's board of directors, suggested in 2014 to chairwoman Nancy Rutter Clark that Food Lab could help by testing and developing recipes pro-bono.

"Our constituents are sick, and you don't want to have recipes that fail," says Clark, who supports Food Lab's work with grants through her own foundation. She also marvels at the lab's creativity in making healthy and tasty home cooking accessible for stressed and ill patients: pumpkin ravioli made with wonton wrappers, for one.

"I'm extremely proud to be part of it," Clark says.

The rest of Food Lab's enviable client list includes the hip — Soom Foods, known for its tahini; St. Lucifer Foods, a spice company; the Cow and the Curd food truck, which sells fried cheese curds; and GetRealGetRaw, a maker of the Groothie, a green smoothie — as well as household names such as Aramark, Bimbo Bakeries and Hain Celestial.

"WE KNOW ENOUGH FOOD SCIENCE TO HAVE CONVERSATIONS WITH CLIENTS. A LOT OF CHEFS HAVE GREAT IDEAS, BUT THEY CAN'T NECESSARILY TRANSLATE THEIR IDEAS TO MANUFACTURING."

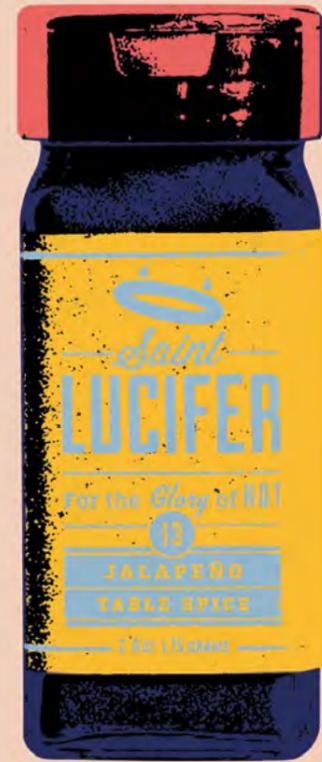
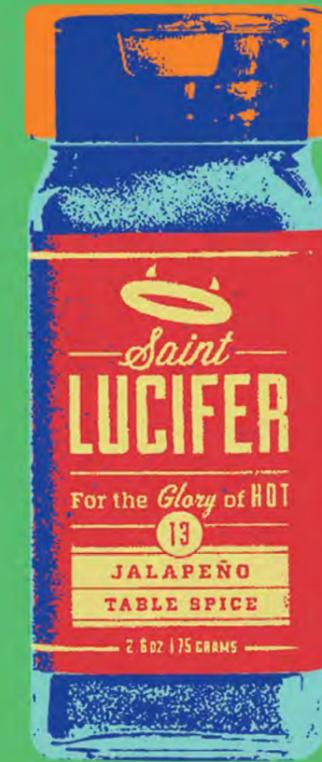
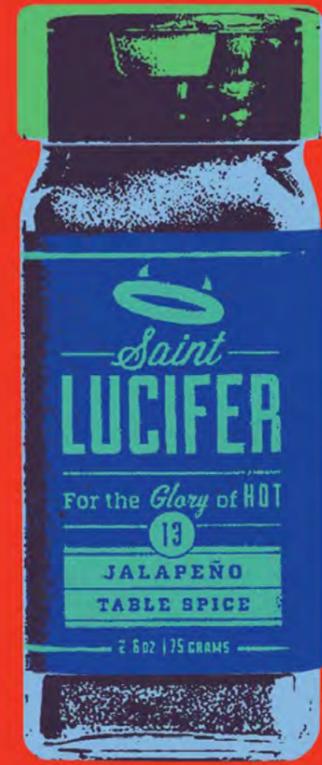
JONATHAN DEUTSCH

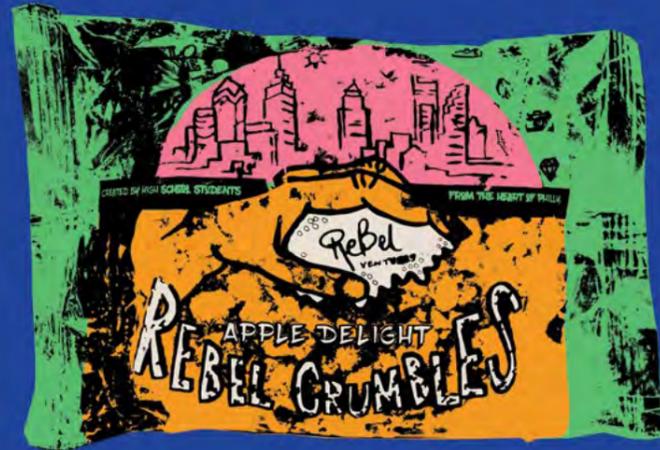
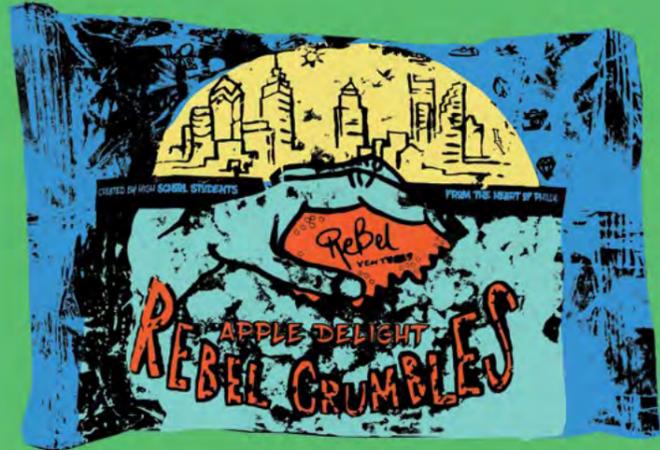
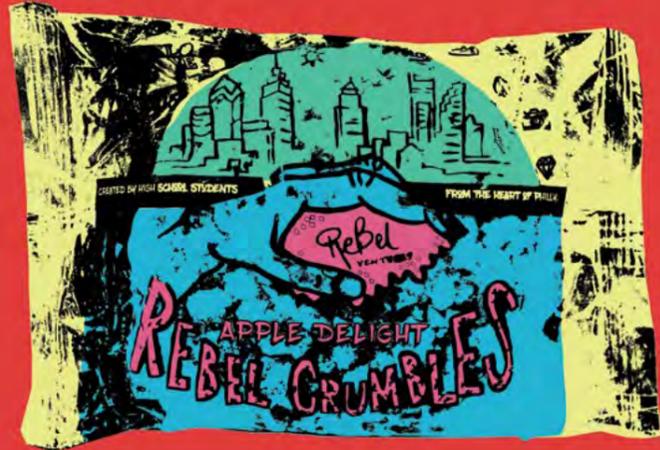
Here's a tasting of the lab's delicious inventions:

- **The Cow and the Curd:** Food Lab students spent days testing a flash-freeze process to create a frozen cheese curd product that restaurants and other venues could easily fry.
- **Bimbo Bakeries:** Students in a food product development course cooked up creations that use the company's past-due date returns of breads, muffins and pastries. During Food Lab, the ideas (fermented beverages, condiments, new sweet baked products and even a non-edible, bread Frisbee) were evaluated by Bimbo executives. The company is refining concepts of interest with students. "It was great to have extra hands," says Bimbo's Senior Manager of Product Innovation Rebecca Etter. "It enabled us to do product development quicker, but more importantly, it was good quality work with different perspectives and connected to a larger community."
- **Aramark:** When Aramark's food services business wanted to expand vegetarian and vegan dishes at college cafeterias, it turned to Drexel. Last summer, graduate students identified hot trends and developed new recipes in the Food Lab — essentially conducting R&D for the company. In January 2019, Drexel Campus Dining's U.C. Veg (a vegan and vegetarian dining concept) added three items (buffalo cauliflower wrap, roasted beet and goat cheese sandwich, and Korean mushroom sandwich), which Aramark's Culinary Development Kitchen and Zeitz helped scale. "Who better than students to develop menu items for students?" asks Michael Gilligan, Aramark's senior director of brand development. "To have a resource in Drexel's Food Lab so close to Aramark's headquarters is a tremendous benefit."

HOT\_SPICE

Jalapeño Table Spice #13 can be found in retail stores around the country and online at [saintluciferspice.com](http://saintluciferspice.com).





KID\_CRAFTED

Through Rebel Ventures, Philadelphia students create tasty, healthy snacks for the Philadelphia School District.

The blended burger, Food Lab's longest-running project, had a bumpy start. Getting the mushroom bottoms — the part of the stem that's below the ground — clean proved impossible. Then-student Andrew Rosenbach '16, who was interested in product development, even tried a wheat tumbler to no avail. The use of such scraps was scrapped. Rosenbach took up another challenge. How much mushroom — by then a mix of button mushrooms and portabella stems — could be squeezed into a patty without it falling apart? (Food lesson: Mushrooms are mostly water, making it difficult to bind to the beef.) "My big focus, as a food scientist, was to push the envelope," says the 26-year-old, now an associate staff quality assurance specialist for Reese's Peanut Butter Cups at the Hershey Co. "It was a science experiment for me."

Rosenbach tried sautéing the mushrooms and using eggs as a binder to achieve 70 percent mushrooms in a patty. But at that stage, he didn't care about taste, he allows. Enter Zeitz. "She came and took that knowledge and turned it into something that tasted good," Rosenbach says. By senior year, Zeitz had developed a way to dehydrate the mushrooms, which when ground up had a meat-like texture and held together with beef without binders. Her process also concentrated the flavor, boosting umami, or savoriness, a much-desired fifth basic taste after sweet, salty, bitter and sour.

As Food Lab manager, Zeitz strives for a take-chances vibe. "Our students want to apply what they're learning in class from the beginning," she says. "Food Lab is a safe space to show their creativity." Students also gain talking points for co-op and job interviews, she adds.

Zeitz, too, pursues her own creativity. Last year, she completed her master's in education, with a focus on creativity and innovation, at Drexel. She also kept tweaking the blended burger, participating in 2016's James Beard contest, figuring out the right build of bun and toppings. Zeitz tried hundreds of combos before landing on the St. Lucifer jalapeno spice blend that she developed mixed with sour cream plus fried onions (Cutler "sells a lot of onions," she says) and lettuce. She calls it the Green Dragon Burger. (See? We promised a dragon in this story.)

In January 2018, Zeitz served the creation at a meeting of Comcast Spectacor general managers in Florida. It was a hit.

"I was doing it all by hand, roasting the mushrooms, grinding the meat, mixing them together, pattying it, packaging it," she says of the days-long process of preparing hundreds of pounds for overnight shipment. "I did this thousands of times — these two hands."

On Friday last fall, Food Lab is in full swing in the bakery kitchen. Despite its name, there is not a dedicated lab or building. (As Drexel's Trout says, "Food Lab is not a space, but a concept.") Of five students, two slice old Bimbo bread and pastries, destined for bread pudding. Another tests an adapted muffin recipe. Two more refine Cook for Your Life recipes (cream puff with squash filling; quinoa bake with roasted veggies and arugula pumpkin seed pesto).

"It's kind of like Chopped," says sophomore Lauren Miller, referring to the TV show where chefs compete to cook with unusual items. "You come in and there's a bunch of ingredients. Hmm. What can I make?"

The culinary arts and science major spotted the arugula and decided to make pesto. A box of veggies — mushrooms, onions, cauliflower, all culinary class leftovers — led to the quinoa bake, which also includes carrot tops in an effort to reduce food waste.

"It's fun to be here with people who are interested in the same thing as you," Miller adds, between bouts of blending the pesto. "We do a lot of cool projects."

Nearby, fourth-year student Erik Ildefonso checks on the baking batch of pumpkin muffins made with soy protein isolate. The client is a homeless shelter in need of low-protein recipes for residents with renal disease.

"They feel a little moist," says the culinary arts and science major, letting the muffins go another five minutes. "Last time I made them, they fell apart. This is a second try."

This is Food Lab. "It's not like industry, where you have to already know everything," Ildefonso says. "You're free to make mistakes. You're free to correct yourself, and people help you, too."

Meanwhile, Zeitz tastes student work, troubleshoots ideas gone askew. She has readied a batch of blended burgers for a visitor to try. The moist, dark brown patty with specks of seared mushroom has a nice spring when a fork is pressed against it.

How does it taste? Trout sums up the consensus: "It's delicious. It mimics an all-beef burger very nicely."

"I WAS DOING IT ALL BY HAND, ROASTING THE MUSHROOMS, GRINDING THE MEAT, MIXING THEM TOGETHER, PATTYING IT, PACKAGING IT. I DID THIS THOUSANDS OF TIMES — THESE TWO HANDS."  
ALLY ZEITZ

Over the years, many have tasted the Casanova Burger patty. Once, Zeitz made the recipe in a Kosher kitchen for Cutler, an orthodox Jew who is licensing the technology used to prepare the mushrooms. "It was amazing," he says.

Some samplers are pickier. A few wanted a softer chew, but that would require a binder — a no-no in Zeitz's recipe book. Some say too salty; others, not salty enough.

"I have a thick skin," she allows. Comcast Spectacor plans to order "tons" of the patties, as Zeitz puts it, for a roll-out to the public at two casinos, a college stadium and fairgrounds. Happy Valley Meat Co., based in New York, will produce the patties.

"We think it's something people will like," Swiger of Spectra says. The plan is to offer a customizable menu of three patty choices (blended, Impossible and salmon) with different build options — for that gourmet experience.

As the debut nears, Zeitz is her usual low-key self. "I've worked on it so long," she says. "It's nice to see it evolve." x

EPilogue: In February, Zeitz took a job as culinary developer for coffee company Saxbys, one of Drexel's major co-op partners in Philadelphia. She credits her experience managing Food Lab for the opportunity to spread her wings — a chance, you could say, at a happily ever after. Food Lab, meanwhile, continues on under the direction of Jonathan Deutsch.

NEUROSCIENCE

\_READING MINDS ON THE FLY

A team of researchers has successfully measured the brain activity of pilots in real-time, a potential boon to designing better, safer machines and pilot-machine interactions.



\_HASAN AYAZ Ayaz is an associate professor in the School of Biomedical Engineering, Science and Health Systems.

The results showed that the pilots in the real flight condition committed more errors and had higher anterior prefrontal cortex activation than pilots in the simulator when completing cognitively demanding tasks.

“The exciting thing is we can now quantify this,” says Hasan Ayaz, an associate research professor in the School of Biomedical Engineering, Science and Health Systems.

In the future, understanding the underlying neurocognitive process of pilot-plane interactions could help to make simulators more realistic, as well as improve the safety and efficiency of aircraft-pilot interactions, he says.

CAN YOU IMAGINE an aircraft that reads its pilot’s mind and reacts in real-time? This is something that future technology could be capable of, and the first step was taken by a team of researchers at Drexel and a partner institution in France, who have successfully measured the brain activity of pilots in real-time using functional near-infrared spectroscopy, or fNIRS.

The study — published in *Frontiers in Human Neuroscience* — shows that measuring brain activity in a real-life situation is feasible, and more importantly, that it delivers better information than observing operators in a simulated activity.

Researchers split 28 pilots into two categories: The first group flew a real aircraft, while the second group operated a flight simulator.

In both cases, the researchers monitored the pilots’ brain activity as they completed a series of memorization tasks from pre-recorded air traffic control instructions, which varied in levels of difficulty.

*“Unfortunately, many human-machine interfaces expose users to workload extremes, diminishing the operator’s attention and potentially leading to catastrophic consequences.”*

— Hasan Ayaz

NEURAL\_CO-PILOT The fNIRS system measures “the brain at work” by monitoring blood oxygenation changes in the prefrontal cortex — the area underneath the forehead that is involved in cognitive functions such as problem solving, memory, judgment and impulse control.



\_ONLINE

Watch how rapidly snow melts off concrete that has been mixed with paraffin: <https://bit.ly/2FOVf8x>.

ENGINEERING

DESIGN

### \_WAX ON, MELT OFF

Researchers have discovered that adding paraffin oil to concrete can give surfaces the ability to melt ice and snow.

IMAGINE IF, after a big winter storm, there was no need for shoveling, no salting and no snowplows.

In a paper in the journal *Cement and Concrete Composites*, a team led by Yaghoob Farnam, an assistant professor in the College of

ing porous lightweight aggregate that had been infused with paraffin, and a third reference slab without paraffin. Each was sealed in an insulated container and then covered with about five inches of lab-made “snow.”



Engineering, explains how paraffin oil can be used in concrete to store and release energy as heat during times of sleet, ice and snow. Paraffin is a phase-change material, which means it releases thermal energy when it changes its physical state, such as when temperatures rise and fall above freezing.

In addition to being just as effective as the standard salting and scraping methods, paraffin oil would be less labor-intensive and more environmentally friendly, without the risk of the chemicals in road salt damaging the roads and ecosystem.

To put the material’s snow and ice-melting ability to the test, the team created a set of concrete slabs — one with paraffin-filled pipes inside, one contain-

#### SNOW\_DAY

One of the first uses of this new concrete could be at airports, where clear runways are vital.

With temperatures inside the boxes held between 35-44 degrees Fahrenheit, both of the paraffin-treated slabs were able to completely melt the snow within the first 25 hours of testing, while the snow on the reference sample remained frozen.

“Eventually this could be used to reduce the amount of deicing chemicals we use or can be used as a new deicing method to improve the safety of roads and bridges,” says Farnam. “But before it can be incorporated, we will need to better understand how it affects durability of concrete pavement, skid resistance and long-term stability.”

### \_RECONSTRUCTION FROM RUINS

The nearly two-century-old ruins of a home owned by a former slave are being used in a digital history lesson about early Philadelphia society.

WHAT CAN YOU learn from making a 3D model of a house destroyed almost 200 years ago?

A lot, it turns out, as architectural engineering major Varsha Ajith ’22 learned last summer. As part of her Pennoni Honors College STAR project, Ajith contributed to the virtual reconstruction, as a 3D-model, of the James Oronoco Dexter house in Philadelphia.

Dexter was a coachman and former slave who lived in the house between 1790 and 1799, and was active in the formation of the “Free African Society.”

The partial foundation of his home was rediscovered in 2001-03 when archaeological excavation was conducted on the site that would become the National Constitution Center.

Portions of the 3D model have been built by successive teams of students largely through the known architectural footprint of the building, historical insurance records, studying similar buildings and in consultation with archaeologists, architectural historians and museum curators at Independence National Historical Park, as well as local archaeologists who excavated the site. The long-term goal is to create an interactive learning environment to explore late 18th-century ideas on race, religion and class, and their 21st-century legacies.

“Our intention is to develop smart avatars that will be used in the learning environment to examine the social conditions of the

day in a computer game context,” says Associate Professor Glen Muschio, who was Ajith’s advisor.

As her research contribution to the project, Ajith studied the Todd House at 4th and Walnut streets in Center City Philadelphia which is similar to the Dexter House — and also the historic homes in Elfreth’s Alley, which use similar building techniques.

“While we have produced earlier Dexter House models of the first floor and exterior, Varsha with her interests in architectural engineering corrected earlier renditions of the model, added architectural details including a winding

staircase, and she produced models of two upper floors of the house,” says Muschio. “Her efforts make it possible for us to now turn our attention to creating the intelligent avatars.”

Ajith presented her work at the day-long “Explore Philly’s Buried Past,” a Pennsylvania Archaeology month and International Archaeology Day event held at the National Constitution Center in October 2018. “If we’re able to make the virtual reconstruction of the house into an educational tool, more people can understand how they lived and how they influenced the community around them,” Ajith says.



#### DIGITAL\_DWELLING

Freed slave James Oronoco Dexter was also deacon and founding member of the African Episcopal Church of St. Thomas, which is still active. Meetings planning the construction of the church were held in Dexter’s house.

ENERGY

### \_FIRE PROOF

REMEMBER BACK in 2017 when Samsung’s Galaxy Note devices were catching on fire? That’s because energy-storage devices like batteries, engineered to work ever faster, have become vulnerable to short circuiting when compounded with the presence of a flammable electrolyte liquid. Hence, the fire.

Associate Professor Vibha Kalra and a team of Drexel researchers are working to make batteries less susceptible to overload. Instead of developing a flammable electrolyte solution, Kalra

“We have completely eliminated the component that can catch fire in these devices.”

- Vibha Kalra

designed a device that uses a thick ion-rich gel electrolyte absorbed in a freestanding mat of porous carbon nanofibers to produce a liquid-free device.

This device can also improve supercapacitors, an energy-storage device similar to batteries that can be found in everything from mobile devices, laptops and electric cars. Supercapacitors differ from batteries because they disperse their stored energy in a quick spurt, but both use a flammable electrolyte solution that could result in leakage and fires.

“We have completely eliminated the component that can catch fire in these devices,” she says. “And, in doing so, we have also created an electrode that could enable energy-storage devices to become lighter and better.”

PLASMA: GREGORY FRIDMAN

\_ONLINE

See how Drexel researchers electrospin carbon fibers to make safer batteries: <https://bit.ly/2YSNrKG>.

AI

### \_LIVING MATH

Machine learning and advanced algorithms are allowing researchers to look at the inner-workings of live cells in a new light.

ORGANELLES are organized, specialized structures within a live cell that can be studied for a variety of reasons — but a new convergence between microscopy and computation is changing how we look at them.

Working with a team including Nobel laureate Eric Betzig and renowned organelle biologist Jennifer Lippincott-Schwartz from the Howard Hughes Medical Institute, engineers at Drexel developed a new way of studying these tiny organelles in living cells. The research was published in the journal *Nature*.

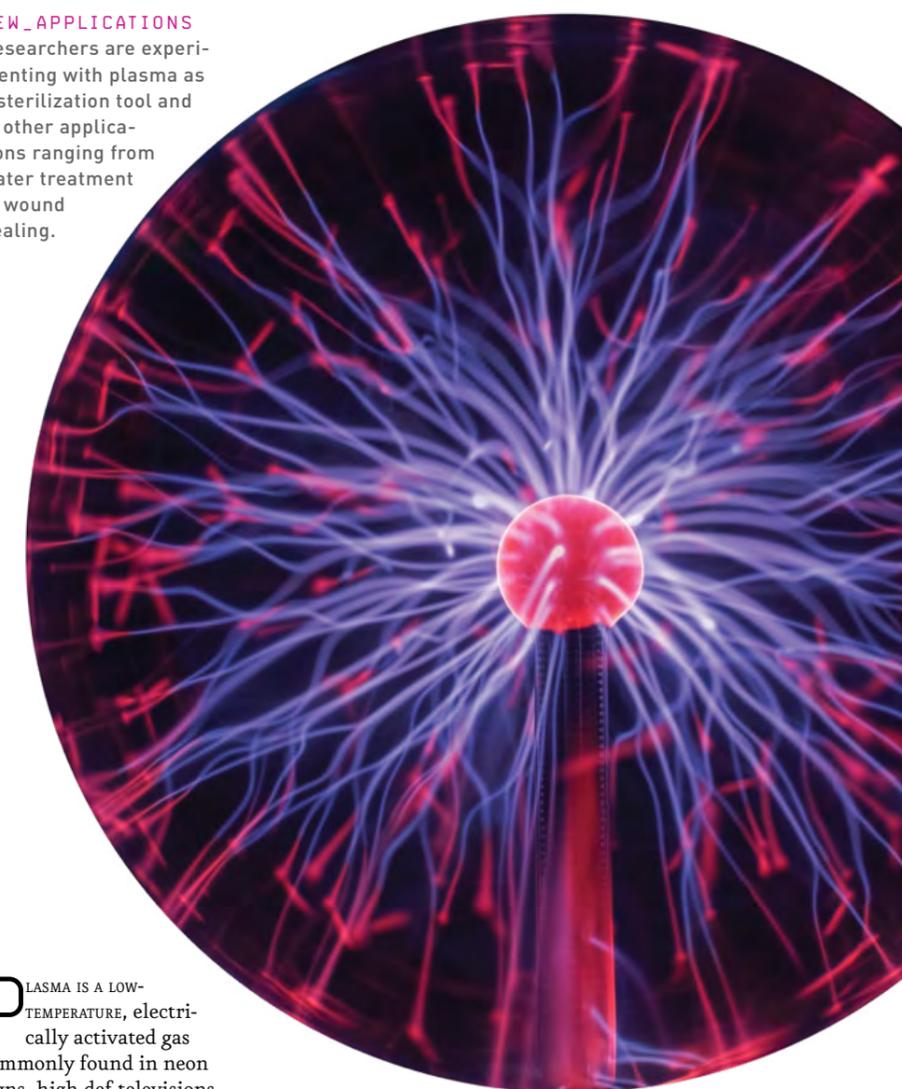
Andrew Cohen, an associate professor in the College of Engineering, led a team to build new algorithms, using machine learning to process 3D videos of cells. Now, scientists can better understand how cells react to environmental stressors, which could be used to determine how healthy and diseased cells respond to drug treatment and react to other particles and proteins that play a role in a cell’s function.

“As these tools continue to improve they will give researchers both a better look at cell behavior and many options for gathering and analyzing that data,” Cohen says. “They will be able to ask and answer increasingly complicated questions and that’s going to lead to some very exciting and important discoveries.”

PLASMA

### \_SPARKING PLASMA RESEARCH

NEW APPLICATIONS Researchers are experimenting with plasma as a sterilization tool and in other applications ranging from water treatment to wound healing.



PLASMA IS A LOW-TEMPERATURE, electrically activated gas commonly found in neon signs, high-def televisions and lightning. It is painless to the touch, but powerful enough to kill bacteria that cause infections. Now a new research center at Drexel will work with industry to uncover early-stage applications for plasma technology. The new Center for High Pressure Plasma Energy, Agriculture and Biomedical Technologies is funded by a five-year National Science Foundation grant jointly shared by Drexel, the University of Michigan, George

Washington University and multiple industrial partners. “By deepening our understanding of plasma systems and how they interact with their environment, this work will help expand the use of low-temperature plasma for applications such as food processing, agriculture, fuel conversion, medical and industrial waste water treatment, and many other new areas,” says Alexander Fridman,

director of Drexel’s Nyheim Plasma Institute and a professor in Drexel’s College of Engineering, who is director of the new center. The Nyheim Plasma Institute has been conducting plasma technology research and development since 2002, with projects ranging from water-to-energy conversion, air and water treatment, to medical applications.

BIOMEDICINE

ENGINEERING

\_A HELPING HAND



ALEX HAHN, KIMANTHI GICOVI, TYLER BOGACZYK are biomedical studies graduate students in the College of Medicine's Graduate School of Biomedical Sciences and Professional Studies.

FOURTH-GRADE STUDENT Julian wanted to play the violin for his school's spring concert, but a birth defect limiting the full use of his right hand made it hard to practice and play. His teacher, Lisa Sebastiani, sought professional help from the e-NABLE Community, an international group of volunteers who create free, 3D-printed assistive devices. She found Drexel Dragon Claws, a local e-NABLE chapter started by Drexel graduate students Tyler Bogaczyk, Kimanthi Gicovi and Alex Hahn. Using Bogaczyk's 3D printer, the group designed a customized device that allowed Julian to easily grip his violin bow.

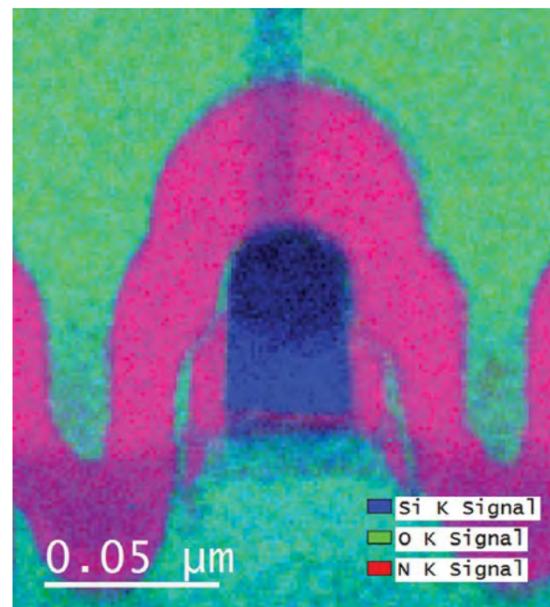
For Isaiah, a 9-year-old boy born with a congenitally reduced left hand who dreams of riding his bike around the neighborhood with his friends, the team is working on a device to help him to safely ride his bike, as well as an elbow-powered prosthetic hand that will help with everyday tasks. Joe, a former flight nurse and the team's first adult client, recently underwent a double upper limb amputation, so the team is designing a variety of devices to assist him with daily challenges, like opening doors, holding a fork and putting on socks.

Over the past year, Drexel Dragon Claws has grown to include 11 graduate students from the College of Medicine's Graduate School of Biomedical Sciences and Professional Studies. With the expanded team, they've taken on two new clients.

PRINTED\_PROSTHETIC Julian used a prosthetic device designed and 3D-printed by members of a Drexel e-NABLE chapter to play the violin in his elementary school's spring concert.



\_CAN YOU SEE ME NOW?



MICRO\_VIEWS Researchers will be able to use the direct detection technology with electron-loss spectroscopy to study biological samples like viruses and bacteria.

THE WAY THAT ELECTRON microscopes work is actually similar to movie projectors: a high-powered beam passes through a material, projecting the image on a screen on the other side. But taking photos of the data can be like trying to project a movie onto a tiny, dirty screen.

A new camera technology developed by Drexel researchers led by Mitra Taheri, Hoeganaes Professor in the College of Engineering, has fixed that. Using a direct detection camera and an image filter, the group can obtain a crisper picture of a material's chemical structure and composition — and do it much, much faster than before, capturing up to 1,600 frames per second. Plus, the device is sensitive enough so that the microscope can be used to study fragile microbiologi-

cal samples without damaging them.

Taheri's lab uses a Gatan K2 direct detection camera with an electron energy-loss spectroscopy (EELS) microscope — a type that draws its inferences about a sample by measuring how much energy electrons lose when they pass through it. EELS technology is typically used by researchers trying to determine which elements are present in a sample or the chemical structure of one given element.

Drexel is the first to combine the use of these technologies to help researchers collect higher-resolution images of data in a shorter period of time than using a conventional camera — a valuable way to look at the mechanisms behind chemical and physical reactions almost as quickly as they occur.

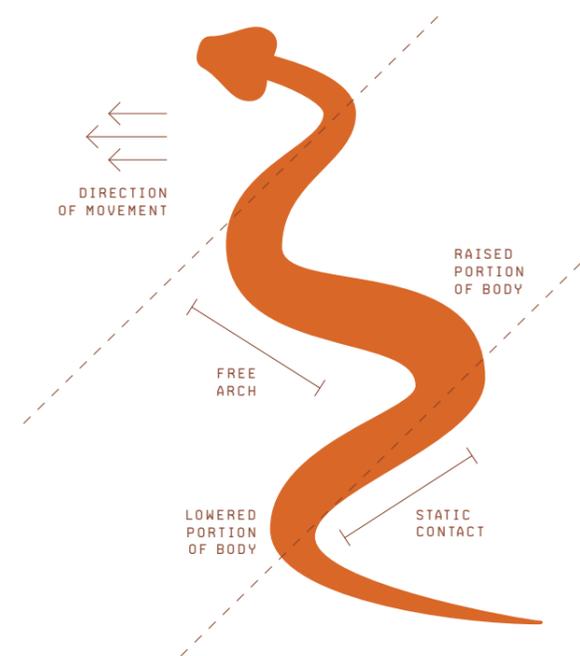
\_WHAT CAN SNAKES TEACH US ABOUT FRICTION?

To improve the design of surfaces that rely on "slip and grip," such as footwear and prosthetic joints, one researcher is turning to one of nature's most incredible materials: snake skin.

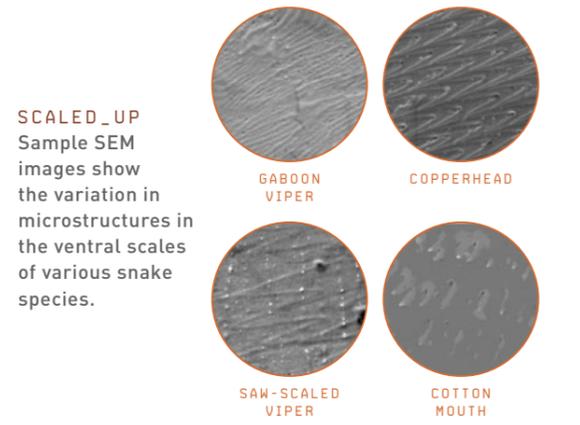
IF YOU WANT TO KNOW how to make a sneaker with better traction, just ask a snake. That's the theory driving the research of Hisham Abdel-Aal, an associate teaching professor in the College of Engineering who is studying snake skin to help engineers improve the design of textured surfaces.

Abdel-Aal has analyzed 350 complete skins shed from 40 different species over nearly a decade. In a new paper in the Journal of the Mechanical Behavior of Biomedical Materials, he explains how this "natural data" can be ported into the design of commercial products that slip and stick — a process called "bio-inspired surface engineering."

Abdel-Aal has published his datasets so any engineers could use them, and many already are. Collaborators in Colombia designed and tested a surface for a prosthetic hip joint guided by the tribological data gleaned from Abdel-Aal's analysis of Royal Python skin. Based on the work of Abdel-Aal and his collaborators, researchers in the United Kingdom are developing texturing schemes for tool inserts used in dry machining of titanium. These designs maximize friction while minimizing residual heat. And German engineers recently published work on snake-inspired cylinder liners that allow the surfaces to minimize friction whether moving forward or backward.



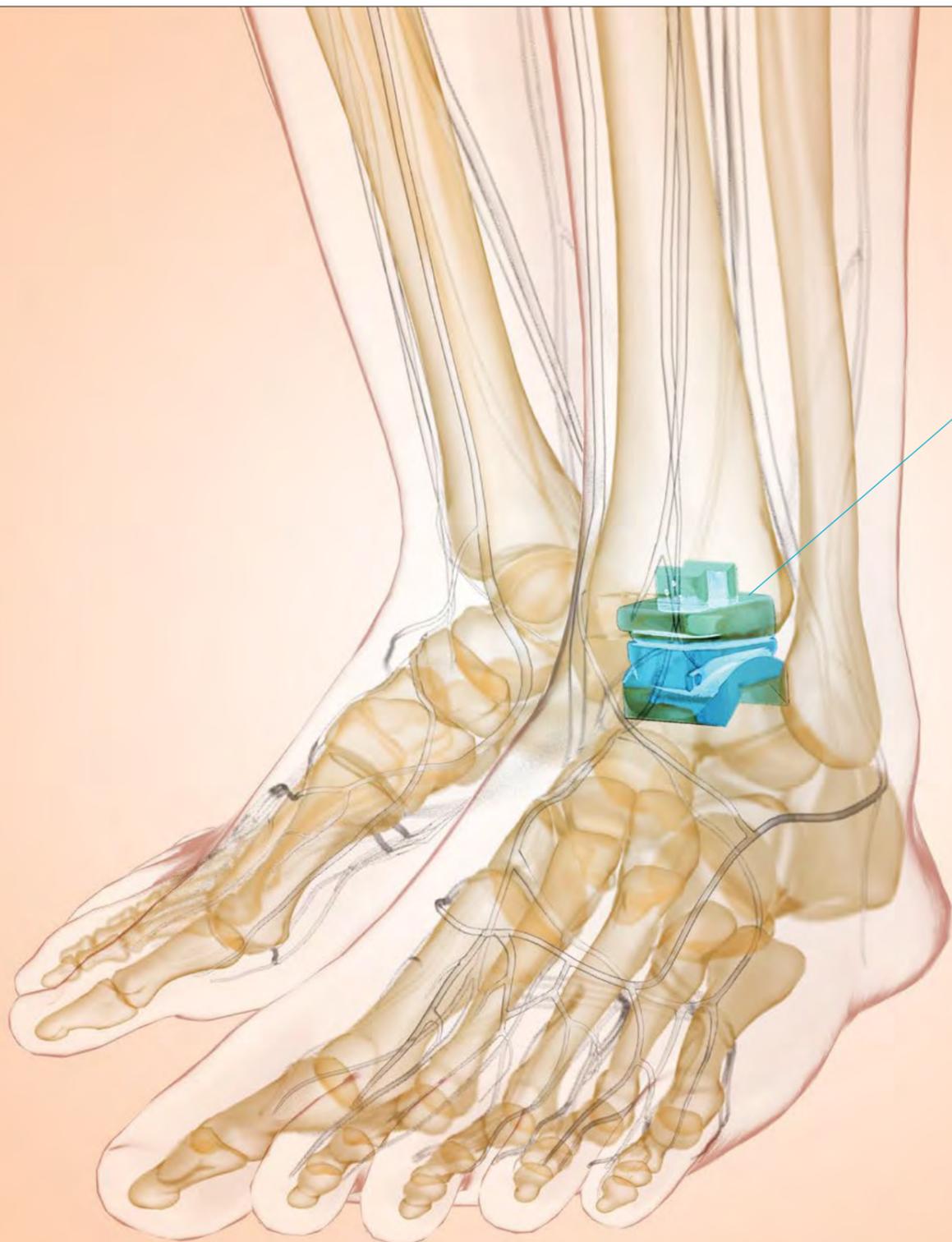
SIDEWINDER\_PHYSICS Abdel-Aal combined metrics of snake movements — in this example, he studied sidewinding tracks made by a Mojave Desert Sidewinder — with the friction profiles he created from studying skin samples. The illustration depicts the portions of the body where static contact is established (solid marked parts) and the variables used to quantify force and velocity vectors for motion analysis.



SCALED\_UP Sample SEM images show the variation in microstructures in the ventral scales of various snake species.



TERM: FIBRILS Hair-like microscopic structures, called fibrils, help create the unique texture of each snake species. Modeling and studying the distribution of fibrils allows engineers to study their effects on friction and eventually replicate their patterns on custom-designed surfaces.



# THE TOTAL ANKLE REVOLUTION

Mechanical engineer Sorin Siegler uncovered a decades-old flaw in the medical world's understanding of the human ankle that explains why so many ankle replacements fail. Now through a startup helmed by alumnus Brian Garvey called Kinosis Medical, he's building an improved artificial ankle that can be perfectly matched to a patient's anatomy. **\_by Tim Hyland \_illustrations by Bryan Christie**



**\_SORIN SIEGLER**  
**\_BRIAN GARVEY**  
 Siegler is a professor of mechanical engineering and mechanics in the College of Engineering. Garvey (BS/MS '12) is CEO of Kinosis Medical.

The explosion in the popularity of joint replacement surgery over the past two decades is one of the biggest stories in the world of health care. Yet despite this meteoric rise, it seems likely that the years to come will see these intensive, yet life-changing, surgeries grow even more popular.

According to the American Academy of Orthopedic Surgeons (AAOS), the number of total knee replacement surgeries performed each year in America is expected to increase by nearly 700 percent — to more than 3.5 million procedures annually — over the course of the next decade, while total hip replacements are projected to grow 200 percent. Advances in medical technology and improved recovery times are helping to propel this pace, but perhaps the biggest reason so many people are opting for these procedures is the simple fact that they work.

In fact, they work very, very well.

Ninety percent of knee replacement recipients report a “dramatic” reduction in pain, according to the AAOS, while those who undergo hip replacements often regain 80 percent of the total strength of their hip after just two months of rehabilitation. There are broad societal benefits as well: While knee replacement costs around \$21,000, savings in the form of increased earnings and greater productivity total nearly \$40,000. And each patient who undergoes a knee replacement will realize a lifetime net benefit of anywhere from \$10,000 to \$30,000, in addition to greater quality of life.

It is hardly a stretch, then, to say that modern medical technology has made hip and knee procedures not only cost-effective, but downright commonplace. The medical world's near perfection of these surgeries means that the

millions who will undergo them each year ultimately live happier, fuller lives — free of pain, and free to be active.

Unfortunately, the same cannot be said for the millions afflicted with arthritis of the ankle or who have suffered a traumatic ankle injury. While total knee replacements have a success rate of nearly 96 percent, the rate for ankle replacements is a comparatively woeful 78 percent.

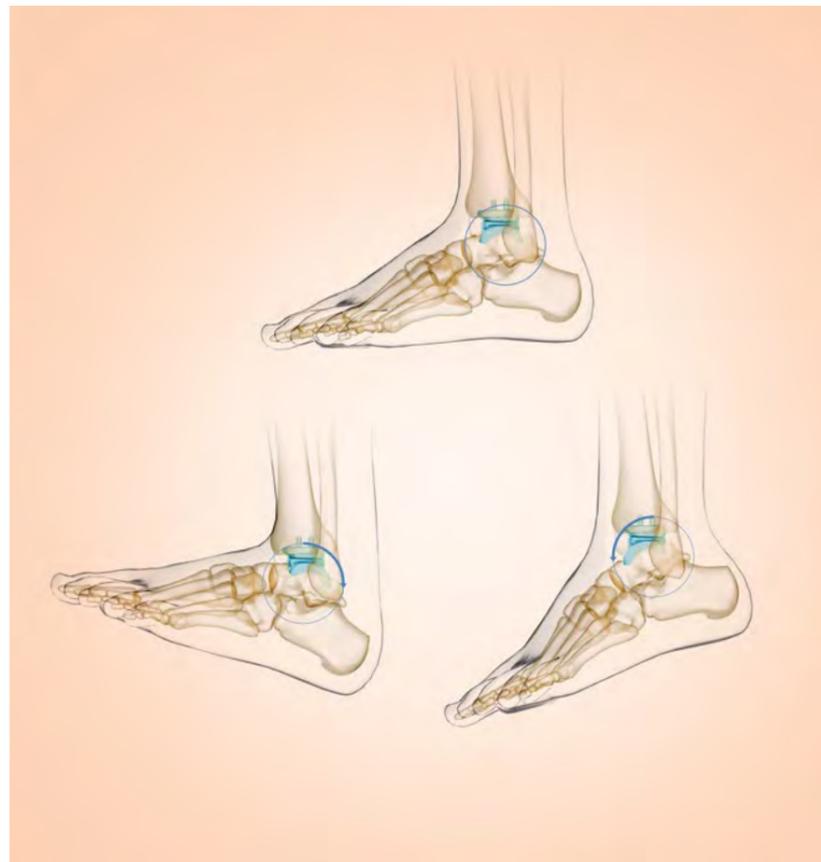
On the surface, that disparity may not seem all that striking. But in human terms, it certainly is. Given the expense, pain and rehabilitation time that comes with any joint replacement, it's hardly surprising that many patients, when informed that the failure rate for current ankle replacements is nearly 25 percent, opt for an ankle fusion instead.

That, despite the fact that fusion surgery means they will lose flexibility in their ankle joint forever.

“It's very sad, to be honest,” says Brian Garvey (BS/MS '12), who is CEO of Narberth, Pennsylvania-based Kinosis Medical. “There are a lot of ankle fusions performed each year — three times as many fusions as ankle replacements, actually. And the reality is, that's the situation only because the technology for ankle replacements isn't there yet. The anatomy is a bit more difficult, and there simply hasn't been good, quality engineering that addresses the unique challenges of the ankle anatomy.”

But now, that long-sought quality engineering has finally arrived, Garvey says, thanks to the pioneering work of a research team led by Sorin Siegler, a professor of mechanical engineering and mechanics in Drexel's College of Engineering.

Garvey's healthcare startup, Kinosis Medical, formally launched in 2017 to develop and commercialize artificial



ankle implants based on Siegler's insights about the true shape and design of ankle bones.

Siegler began a deep investigation into the unique, somewhat complicated anatomy of the human ankle joint nearly a decade ago. By using modern imaging methods such as MRIs and CT scans and creating 3D renderings of the scans on a computer, Siegler was able to reproduce highly accurate models of ankle bones. It was while creating a cast of the talus bone — one of three bones that make up the ankle, and one that forms the crucially important “pivot” on which the joint moves — that Siegler made a startling and in some ways historic discovery.

Simply put, one bone scan revealed that almost everything the medical community knew about the ankle was wrong.

#### A SEVEN-DECADES-OLD ERROR

In 1952, a University of California researcher and celebrated pioneer in the biomechanics of locomotion by the name of Verne Thompson Inman published one of his seminal works, “The Joints of the Ankle.” In it, Inman concluded that the ankle joint was “fixed,” meaning that it allowed for movement along a single plane; second, he said that the talus — so central to the ankle's functionality — was conical in shape, and that the top of that cone faced the *inside* of the foot.

Given Inman's reputation at the time, his word carried quite a bit of weight, and for a period of roughly 70 years, neither of his conclusions were challenged — until Siegler took a closer look using modern computers and imaging methods.

As Siegler's research showed, Inman was wrong on two counts. The ankle joint is actually not fixed. Rather, the joint allows for movement along a flat plane as well as a more side-to-side angle that allows humans to land on either the outside or inside of the foot. And because Inman had built his model of the talus based on his belief that the joint was fixed, that meant his calculations for the shape and orientation of the talus were wrong as well.

When Siegler recalculated and recalibrated for the actual functionality of the ankle, he discovered that the talus in actuality faces the outside of the foot; beyond that, In-

man's conception of the shape of the talus was wrong as well.

Siegler had spotted a fundamental anatomical error — one that has underpinned (and undermined) all work focused on the ankle, including ankle replacement devices, for more than a half century.

“I was looking at the geometrical features of the ankle, and the features as I saw them were almost directly contradictory to the prevailing wisdom — directly opposed to what has been known and published about the ankle in the academic literature,” Siegler explains.

“What was understood and taught for decades turned out to be not the exact case,” concurs Alberto Leardini of the Istituto Ortopedico Rizzoli in Italy, who is helping Siegler test new artificial ankle designs based on Siegler's research. “And this probably might have affected the performance of the current prostheses.”

The question, then, is obvious: how could such a fundamental error have gone unchecked for so long?

To hear Siegler tell it, it happens all the time.

“Many concepts in the world of science are allowed to exist and be very wrong for the longest time until somebody sees it,” Sorin says matter of factly. “The reality is, as new technologies come and new methods come up, you can start exploring things and looking at things in a different way.”

#### STEPS IN THE RIGHT DIRECTION

Kinos Medical's aim is to develop “next-generation technologies to bring orthopedics into the 21st century.” The ankle replacement device startup won the Clinical Biomechanics Award from the International Society of Biomechanics in 2013, rounded up \$1 million in seed funding to get up and running, and has won continuing financial support from the Coulter-Drexel Translational Research Partnership as well as from Steep & Deep Ventures in Malvern, Pennsylvania, and from Ben Franklin Technology Partners of Philadelphia.

#### BETTER TECHNOLOGY, BETTER RESULTS

The challenge for Garvey now is to take Siegler's ankle models and turn them into a profitable company.

Joining him in the effort is Siegler himself, who serves as the startup's chief technology officer; Dr. Keith Wapner, clinical professor of orthopaedic surgery at the University of Pennsylvania, who serves as the company's medical director; and Drexel alumnus and company director William Rhoda, an accomplished investor in medical technologies with more than 50 medical device patents to his name.

Rhoda, who also serves as president and CEO of Collegeville, Pennsylvania-based OT Medical LLC, got his start in the medical device industry while completing his co-op at Drexel, and later hired Garvey as a co-op student when Garvey was studying mechanical engineering at Drexel. It was Rhoda who ultimately recommended Garvey for the role of CEO at Kinos, and so it goes without saying that the mentor has confidence in his apprentice. He also has confidence in the product, even as his experience in medical device development tells him there remain several boxes to be checked and hurdles overcome.

*“I was looking at the geometrical features of the ankle, and the features as I saw them were almost directly contradictory to the prevailing wisdom — directly opposed to what has been known and published about the ankle in the academic literature.”*

— SORIN SIEGLER

“First, there's the FDA part — and that's a hurdle, but at the very least, it's a known hurdle,” Rhoda says. “The commercialization part is a whole different animal. There's going to be a little bit of resistance to anything total-ankle-related just, in general, because of the bad history associated with them. ...The gold standard is still fusion, but if you consider the amount of hips and knees that are being done every year, imagine being told, ‘Oh, we're going to fuse your ankle.’ It just doesn't seem acceptable.”

Garvey, too, understands that challenges that lie ahead. Even still, Garvey believes the opportunity is there to make a major splash — and potentially revolutionize the total ankle replacement market.

“The devices that are on the market today are basically built and based on research that was conducted in the 1950s and 1960s, and some really aren't based on technology at all,” Garvey explains. “A lot of them are just built around how engineering in this area has evolved over time. So when we looked at Sorin's research and how that research lined up as compared to the other products out there, it was almost a no-brainer.”

In fact, what Kinos intends to offer goes far beyond the hardware of the ankle itself. Siegler and Garvey's ultimate goal is to perfectly match their hardware to the anatomy of individual patients using cutting-edge imaging technology. They say that one of their products will be the first “patient specific” total ankle replacement system to ever hit the market.

This level of personalization would allow surgeons to significantly reduce the amount of healthy bone removed when placing the implant in a patient — a time-consuming, difficult task that poses potential complications.

“Because we can personalize this, it will allow us to reduce the time required for [the surgery],” says Siegler. “If you would ever see one of these procedures ... it actually takes hours. It's very hard. It's very tedious. But with our personalized solutions, we can cut that time maybe by as much as half.”

Their design also promises to dramatically improve the success rate of the implants, while allowing younger patients access to early surgical intervention.

“We have the legitimate opportunity to become a market leader in the ankle replacement world,” Garvey says. “Now, that may take 10 or 15 years to fully achieve, but at least here in the United States, we can be the undeniable market leader both in breadth of technology and in market share.”

Kathie Jordan, for one, shares Garvey's optimism. As director of Drexel's Coulter-Drexel Translational Research Partnership, an early-stage funding program established at Drexel by a gift from the Wallace H. Coulter Foundation, she works with her team to identify research and technologies with great potential in the marketplace.

Kinos, she says, is in many ways a perfect fit for the foundation, and its target market.

“This is exactly the kind of project that, historically, the Coulter program looks for,” Jordan says. “It's about an engineering technology that truly meets a medical need. Because in terms of ankle replacements, they are just not working.”

Though she acknowledges that the market for total ankle replacements is fairly small, she — like the Kinos team — believes that if Kinos can show that their proposed methods improve success rates, patients who may have previously opted for fusion would, instead, opt for total ankle replacement.

That would represent a sea change in orthopaedics.

“Obviously, if you were told there's a new ankle joint on the market that actually fails at the same low rate as the knee or hip, and then you're told your other option is to have your ankle fused — and that you'll never be able to ski again, or run again — I know which one I'd take,” she says. “At the same time, we are seeing that the reimbursement rate for ankle joints is increasing. So that means the value proposition here may eventually be much greater, and that makes a big difference.”

The potential is there. But plenty of hard work remains.

Going forward, Garvey says, his aim over the next few years is to continue to develop and perfect the company's product line — and, at the same time, continue to educate surgeons about both the limitations of current products and the potential value of that being offered by Kinos.

Once they have the opportunity to compare, Garvey says, he's confident they'll buy in. That won't just help Kinos, he says. It could help millions of patients, too.

“We're going to be putting out a product that is going to be a full step ahead of the other players in the market,” Garvey says. “Right now, those companies are offering technology that, for the most part, is already as good as it can possibly be. But ours, at its full potential, will be substantially better.” ✕

# THE MANY FACETS OF MXENES

The roster of potential applications for MXenes, the tiny two-dimensional materials invented at Drexel, continues to grow in exciting new directions. — By Alissa Falcone

THE STORY OF HOW Drexel came to be the home of an amazing new material that has sparked investigations all around the world dates back to 2011, when researchers in Drexel's Department of Materials Science and Engineering were working on a Department of Energy (DoE) grant to make electrode materials for batteries.

For over nine months, the two College of Engineering principal investigators on the grant, Distinguished Professor Michel Barsoum and Distinguished University and Charles T. and Ruth M. Bach Professor Yury Gogotsi, experimented with using the highly conductive MAX phases, layered materials with both ceramic and metal properties discovered by Barsoum in the '90s, as lithium anodes.

But nothing seemed to be working.

Everything changed, however, when graduate research student Michael Naguib (PhD '14), now an assistant professor at Tulane University, added hydrofluoric acid to one of the MAX phases. The combination created an atoms-thin material (also known as two-dimensional, or 2D, materials) composed of titanium and carbon that behaved like a conductive metal — a missing component in the world of 2D materials. The same acid process also worked with lithium. By the end of his doctorate studies, he had introduced more than a dozen new two-dimensional compositions from MAX phases precursors.

"As soon as we made this finding, we knew it was going to become important," says Gogotsi. "We just didn't know how important."

The researchers named their finding MXene, which is

pronounced like "Maxine" and gets its name from its chemical shorthand of "M" for metal (like titanium) and "X" (for carbon and/or nitrogen). Since the discovery — and the paper announcing the discovery, which has been cited over 1,000 times to date — the potential for MXenes has exploded. Researchers from more than 40 countries around the world (and several departments here at Drexel) are studying this family of materials. More than 600 international and U.S. patent applications related to the breakthrough material have been filed.

While discovering a new material is impressive enough to be considered a lifetime achievement, Gogotsi and Barsoum's labs have developed and tested dozens of new MXenes over the years. They've gained new insights into how the material behaves and can function, both in its originally intended use (improving energy storage) as well as other applications as far-reaching and wide-ranging as can be.

"The application space is absurd," says Barsoum. "There are so many opportunities, and this is just the beginning."

The University has worked with the researchers to protect the intellectual property related to MXene for present and future commercial use and licensing agreements. Drexel's MXene patent portfolio now includes four issued U.S. patents that cover broad composition of matter claims, with approximately 30 additional pending international and U.S. patent applications that cover systems, devices, applications and methods of manufacture.

What follows are just a handful of the potential applications for MXene being studied at Drexel.



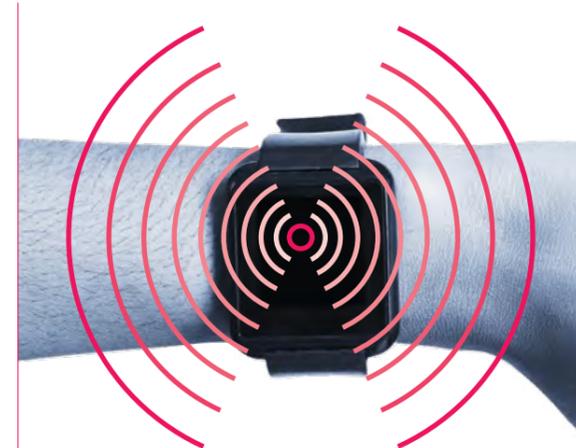
No More Electromagnetic Pollution



\_YURY GOGOTSI Distinguished University and Charles T. and Ruth M. Bach Professor and director of the A.J. Drexel Institute of Nanomaterials.

Did you ever notice your TV buzzing when your cell phone is near, or hear your engine rev through the radio? It's caused by radio waves stemming from devices that create, carry and/or use an electric current. This electromagnetic interference stops when MXene is sprayed on the components inside the devices.

"MXene can be made 10 times thinner as a protective layer in cables and devices compared to conventional metal, creating a thin and light shield," says Gogotsi, who proposed the idea and led this research in 2016. "We believe MXenes are going to be the next generation of shielding materials for portable, flexible and wearable electronics."



Spray-On Antennas



\_KAPIL DANDEKAR Professor of electrical and computer engineering in the College of Engineering



\_BABAK ANASORI Research assistant professor in the A.J. Drexel Nanomaterials Institute.

Installing an antenna could be as easy as applying perfume with MXenes. Invisibly thin, spray-on antennas could be used in new applications in smart technology, wearables and "internet of things" devices.

In 2018, Gogotsi and a team of researchers in the A.J. Drexel Nanomaterials Insti-

tute teamed up with Kapil Dandekar, director of the Drexel Wireless Systems Lab, to study how MXenes make antennas smaller and lighter than those made of traditional metals like gold, silver and aluminum.

"The ability to spray an antenna on a flexible substrate or make it optically transparent means that we could have a lot of new places to set up networks — there are new applications and new ways of collecting data that we can't even imagine at the moment," says Dandekar.

"Further research on using materials from the MXene family in wireless communication may enable fully transparent electronics and greatly improved wearable devices that will support the active lifestyles we are living," says Babak Anasori (PhD '14), a research assistant professor in the A.J. Drexel Nanomaterials Institute.



Conductive Clay



\_MICHAEL GHIDIU PhD '17



\_MICHEL BARSOUM Distinguished professor in the College of Engineering.

Michael Ghidiu discovered MXene clay in 2014 while testing a new method for making MXenes by using a fluoride salt and hydrochloric acid to etch aluminum out of MAX phases.

The resulting material could be easily molded into a variety of shapes and sizes like clay, and could also store an impressive electrical charge.

Potentially, this conductive clay could be used to improve batteries in cell phones and cars, as well as supercapacitors.

"It's basically something that never existed before," says Michel Barsoum.



Wearable Kidneys

Americans with kidney disease are forced to stay put, sitting for hours at a time for several days a week attached to a dialysis machine undergoing a very painful, expensive and time-consuming procedure.

For more than three decades, biomedical engineers and doctors have searched for a more portable version of the dialysis machine — but the large volume of water required to cleanse blood of urea, a waste product that builds in failing kidneys, has hindered their success.

In 2018, Drexel researchers working with colleagues in England and China found that MXenes can efficiently absorb urea. Being small and lightweight, it's possible they could also be incorporated into wearable artificial kidney applications, which would give dialysis patients the freedom to move around.

"Like a sponge can take and absorb everything, MXenes can absorb molecules," says Gogotsi.



Sensors That Sniff

Chemicals in the air can signal everything from fire to carbon monoxide to hidden explosive devices. With MXenes, they could signal the presence of disease in a person's breath, too.

MXene changes its electrical conductivity in the presence of the chemical it's designed to detect — and only when that particular chemical is present.

"If a molecule squeezes between two layers of MXenes and pushes them aside, the conductivity changes just because electrons have more difficulty jumping from layer to layer," says Gogotsi.

In 2018, researchers from Drexel and the Korea Advanced Institute of Science and Technology found that MXenes can pick up chemicals (like ammonia and acetone, which are indicators of ulcers and diabetes, respectively) in much lower traces than sensors currently being used in medical diagnostics. They can also detect multiple types of cancer, cirrhosis, multiple sclerosis and kidney disease. If MXenes can spot these diseases in lower concentrations during a patient's breath analysis, they are more likely to be diagnosed and treated at earlier stages.

# \_THE FLEXIBLE BRAIN

A new study suggests that the extent to which brain signals “stick” to white matter networks is associated with cognitive flexibility, or our ability to switch our focus from one concept to another.



**\_JOHN MEDAGLIA**  
Medaglia is an assistant professor of psychology in the College of Arts and Sciences.

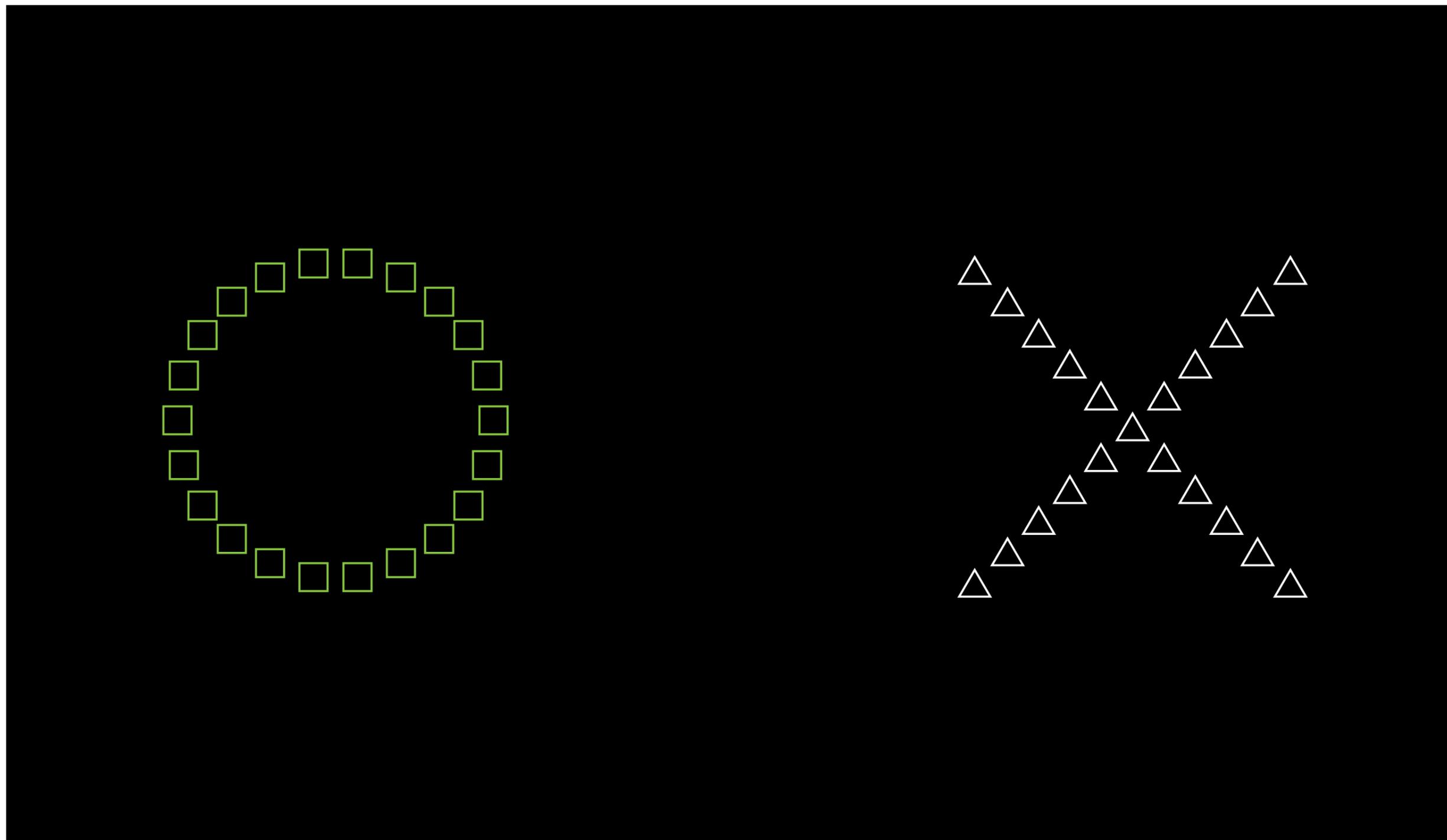
A HEALTHY BRAIN CAN quickly switch its focus from large shapes to individual parts that make up a bigger picture — but for some people, this is a very jarring, effortful task.

This skill is called cognitive flexibility, and it is involved in virtually every complex behavior we undertake — from mental arithmetic to driving a car, according to Assistant Professor of Psychology John Medaglia.

“How fast people can make that transition — from the global to the local — is the switch cost, and that’s our index of flexibility,” he says.

Research from Medaglia and his colleagues at the University of Pennsylvania shows that the extent to which brain signals “stick” to white matter networks — or the brain’s highway system — is associated with cognitive flexibility. This suggests that some brains are at a natural advantage to meet switching demands.

They also validate a new method for measuring cognitive flexibility and open a new door for better understanding neurological disorders.



The study, Medaglia says, provides a “big picture” of cognitive flexibility, which is essential for future research.

“When thinking about how flexible someone’s brain is, or treating someone who is suffering, we now have a new way to answer, ‘Where do I need them to go? What kind of brain do we want to have?’ Without a measure for that, you don’t know what to do next,” he says. “This study opened a new door.”

### BRAIN TEASER

In this cognitive flexibility test, study participants were asked to respond to the larger (or global) shape if the image was green and to the smaller (or local) shape if it was white, while researchers measured their brain activity with fMRI. Their results showed that the alignment between the most “liberal” functional signals and the architecture of the underlying white matter network was associated with greater cognitive flexibility. These findings suggest that some brains are actually at a natural advantage to meet switching demands.

### \_KIDNEY TRANSPLANT ACCESS

Medicaid expansion under the Affordable Care Act helped a significant number of minorities get timely access to kidney transplants.

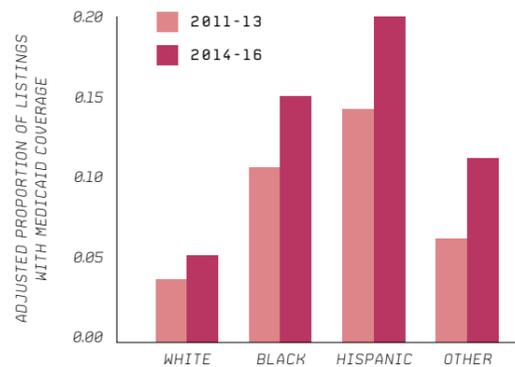
AFTER STATES expanded Medicaid to cover more low-income individuals under the Affordable Care Act (ACA), there was a significant boost in the number of chronic kidney disease patients with Medicaid coverage who were placed on the kidney transplant waiting list, according to a Drexel study.

The study, which appeared in the *Clinical Journal of the American Society of Nephrology*, suggests that Medicaid expansion disproportionately benefitted previously uninsured racial and ethnic minorities and may have helped to curb racial and socioeconomic disparities in pre-dialysis chronic kidney disease care in the United States.

While black and Hispanic Americans have higher rates of kidney failure than

white Americans, putting them at risk for organ failure, historically patients who were white or had private health insurance were more likely to receive timely access to kidney transplantation.

The researchers found that states that expanded their Medicaid programs experienced an increase in preemptive listings of Medicaid beneficiaries, particularly among minorities. After Medicaid expansion the proportion of new black listings with Medicaid coverage increased by 4 percentage points, and the proportion of new Hispanic listings with Medicaid coverage increased by 5.9 percentage points. In comparison, the proportion of new white listings with Medicaid coverage increased by only 1.4 percentage points.

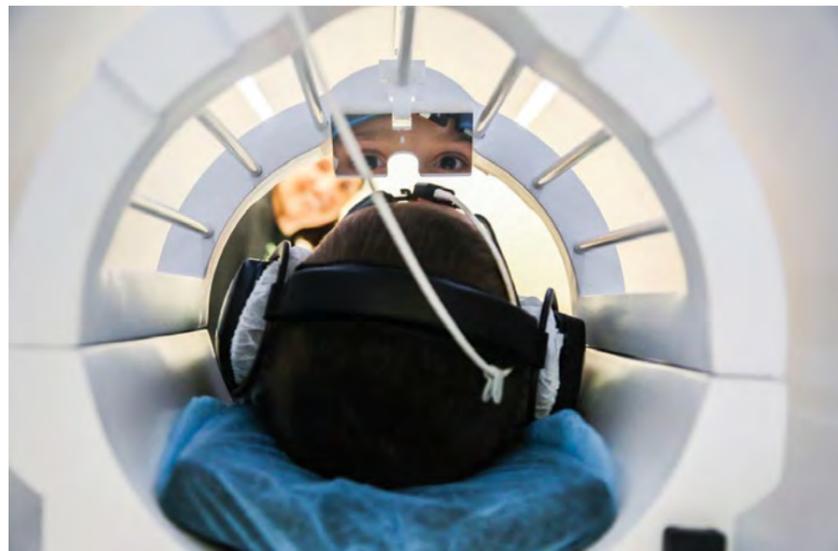


#### WAIT\_LISTED

Thirty-one states and the District of Columbia fully implemented Medicaid expansion under the Affordable Care Act after Jan. 1, 2014. Medicaid expansion after this period was associated with larger percentage-point increases in Medicaid coverage for preemptive listing among racial and ethnic minority listings compared to white listings.

### \_PHYSICS ON THE BRAIN

Physics – an ideal subject to study mental modeling – also engages parts of the brain not traditionally associated with learning science.



ERIC BREWE Brewe is an associate professor in Drexel's College of Arts and Sciences.

PARTS OF THE brain not traditionally associated with learning science become active when people are confronted with solving physics problems, according to a research collaboration between Drexel and Florida International University.

A study co-authored by Eric Brewe, an associate professor in the College of Arts and Sciences, and Jessica Bartley, a former Drexel student and current postdoctoral researcher at Florida International University, shows that the brain's activity can be modified by different forms of instruction.

#### IN\_THE\_TUBE

Individuals underwent fMRI brain scans, which indicated that learning physics lessons activated new parts of the brain.

Using fMRI (functional magnetic resonance imaging) to measure blood flow in the brain, the researchers mapped what areas become active before and after subjects complete a physics reasoning task.

"The neurobiological processes that underpin learning are complex and not always directly connected to what we think it means to learn," Brewe says of the findings, which were published in *Frontiers in ICT*.

Why physics? What makes this the ideal subject to study mental modeling in the brain?

Brewe said that there has been some research on the brain networks associated with learning math and reading. But mental model-

ing especially lends itself to physics, which has not gotten as much attention.

"Physics is a really good place to understand learning for two reasons," Brewe says. "First, it deals with things that people have direct experience with, making formal classroom learning and informal understanding both relevant and sometimes aligned — and sometimes contrasted. Second, physics is based in laws, so there are absolutes that govern the way the body works."

*"The neurobiological processes that underpin learning are complex and not always directly connected to what we think it means to learn."*

- Eric Brewe

COURTESY FLORIDA INTERNATIONAL UNIVERSITY

### \_HOW TO SPEAK CRISPR

When we can edit genes, how do we communicate the true risk of what happens if we don't?

FOR BRET ASBURY, it's not a matter of "if" but "when" gene-editing will allow parents to alter their children's DNA, at times before they are born. "The science is moving quickly," he says, specifical-

communications will be compounded, he warns. Genetic counselors' being more involved with patients earlier in the pregnancy, and having a better understanding of statistics, can help.

*"When genetic counselors come into the room and give parents a bunch of numbers, they should be more sensitive to the fact that the average person has no idea what these numbers mean. It's a communication problem that's easy to fix."*

- Bret Asbury

ly with respect to CRISPR, a technique of reprogramming DNA in plants, animals and humans. "It's going to happen at some point, and the new question will be, in situations where parents have the option of a fetal genetic intervention, what are the parameters for determining whether to intervene prenatally?"

In a recent article published in the *Stanford Technology Law Review*, Asbury raised this question in relation to prenatal genetic counseling, a field in which the literature has consistently described a marked lack of precision and helpfulness. Genetic counselors, Asbury maintains, often fail to explain the true risk of potential genetic abnormalities identified in screenings, and they at times push parents-to-be toward termination without giving them a true picture of the possibilities ahead.

With the emergence of CRISPR, the gravity of provider-patient mis-

Already, a researcher in China has claimed to use CRISPR on twin babies. While the technology is a long way from becoming widely available, Asbury says, he wants the medical community to be ready for these kinds of conversations when it is.

#### TERM:

**(CRISPR) CLUSTERED REGULARLY INTERSPACED SHORT PALINDROMIC REPEATS**

A specialized region of DNA with two distinct characteristics: the presence of nucleotide repeats and spacers.

#### CAS9

A protein enzyme that acts like a pair of molecular scissors, capable of cutting and rearranging strands of DNA.

### \_THE RIGHT BALANCE

Researchers were able to reverse symptoms of Alzheimer's disease in insect test subjects by restoring the balance between two epigenetic enzymes that regulate gene expression.

EARLY IN THE progression of Alzheimer's disease, difficulties with learning and memory may be tied to the presence of elevated levels of the HDAC2 enzyme, which helps control how genes linked to learning and memory are expressed.

It appears that when HDAC2 overwhelms the enzyme it is paired with, which is called Tip60 HAT, it represses genes and leads to problems with neuroplasticity — the brain's ability to adapt to

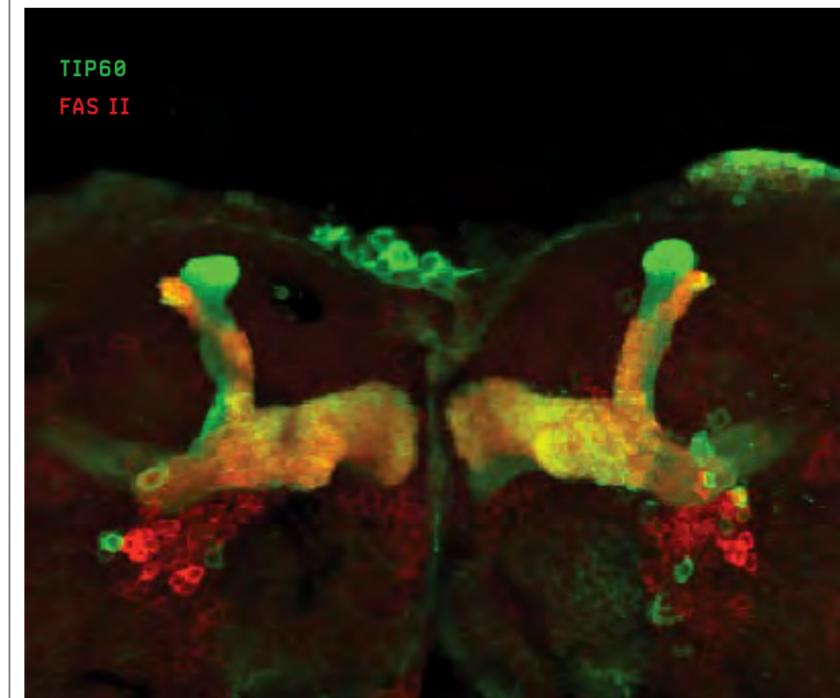
new stimuli or recall reactions to stimuli it already encountered.

But a research team led by Priyalakshmi Panikker, a Drexel PhD student at the time, and Associate Professor Felice Elefant, both in Drexel's College of Arts and Sciences, performed tests in flies and found that if they added extra Tip60 HAT in the brain of flies that displayed symptoms close to Alzheimer's disease, the balance between the enzymes could be successfully restored. When that bal-

ance came back, behaviors the team had taught the flies were able to be learned again and remembered.

More testing is needed, but Elefant's goal is to find new avenues for gene therapy.

"When people age, they have a loss of memory, but it's not because there are mutations in their genes," Elefant says. "It's the way they're packaged. They're distorted. And we're seeing non-invasive ways we might be able to prevent that early on."

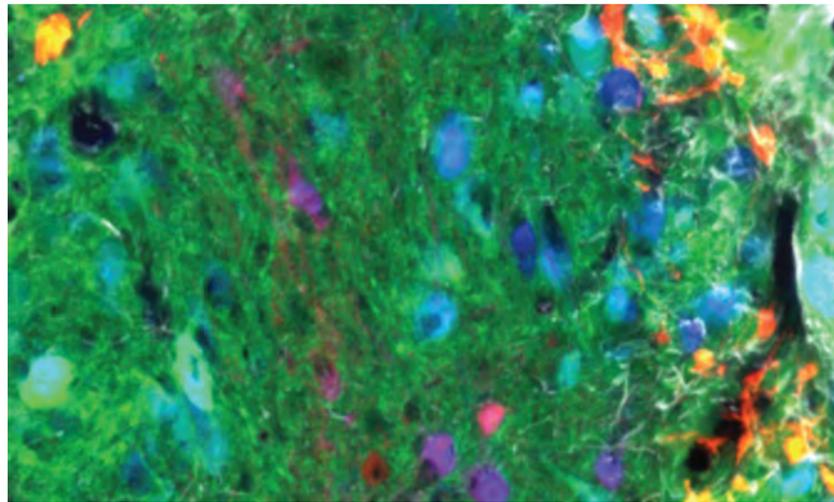


#### TINY\_MINDS

A region of the brain of a *Drosophila* fly termed the "mushroom body" is responsible for learning and memory. This region is considered analogous to the human hippocampus as both play similar roles in cognition. Sundowning, also known as "late-day confusion" is a symptom of Alzheimer's disease and results from disruption of sleep patterns in Alzheimer's patients. Researchers observed similar sleep disruption in the Alzheimer's fly model as a result of impaired outgrowth in *Drosophila* neurons, which can be restored by increasing Tip60.

NEUROBIOLOGY

\_BREATHING FREE



BREATHE\_EASY

Scientists at Drexel's College of Medicine and the University of Texas differentiated embryonic stem cells into V2a interneurons and combined them with neural progenitor cells from a rodent spinal cord. In green, neural progenitor cells that become neurons and glia; in purple, V2a interneurons that are maturing into neurons; in cyan, transplanted neurons that come from the neural progenitor cells.



\_MICHAEL LANE  
\_LYANDYSHA ZHOLUDEVA  
Lane is an assistant professor of neurobiology and anatomy and Zholudeva is a doctoral candidate in the College of Medicine.

PARALYZED PATIENTS are closer to one day breathing without a ventilator after Drexel's College of Medicine researchers showed they could improve respiratory function in rodents with spinal cord injuries by successfully transplanting a special class of neural cells, called V2a interneurons.

"Our previous study showed that V2a interneurons contribute to plasticity, or the ability of the spinal cord to achieve some level of self-repair. This study capitalized on those findings by demonstrating that we can grow these cells from stem cells, that they survive in an injured spinal cord, and that they can actually improve recovery," says Assistant Professor of Neurobiology Michael Lane, the principal investigator.

Though spinal cord injury impacts a wide range of motor systems, recent

evidence suggests the body is capable of spontaneous improvement, through growth of nerve fibers and the formation of new circuits. Lane's laboratory studies this natural phenomenon in hopes of treating a potentially fatal side effect of paralysis: poor respiratory health. Not only do patients with these injuries require mechanical assistance to breathe, but they are also prone to lung congestion and respiratory infections.

"By understanding the body's own attempt at repair, we hope to amplify that process therapeutically with cell transplantation and rehabilitation," says Lyandysha Zholudeva, the study's lead author and a doctoral candidate in the College of Medicine. "Now we've identified one of the cell types that contributes to the formation of new pathways."

ALZHEIMER'S  
\_CHALLENGING ALZHEIMER'S

A new study challenges widely held assumptions about how Alzheimer's works – and with it, that Alzheimer's drugs in clinical trials will be effective.

SCIENTIFIC DOGMA holds that the protein tau stabilizes microtubules within brain cells — but new research suggests just the opposite. Tau's actual role in the neuron is to allow microtubules to grow and remain dynamic, according to Liang Oscar Qiang, the study's lead author and a research assistant professor in the College of Medicine.

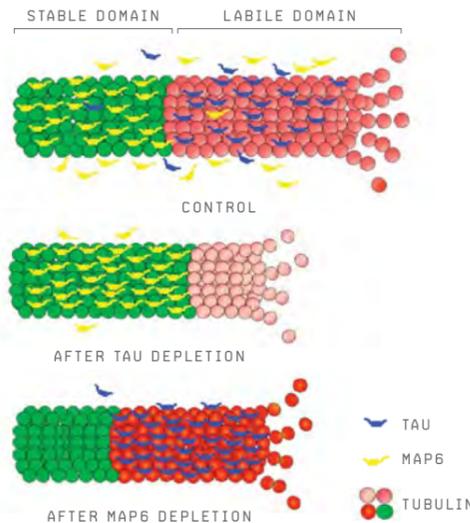
This is critical because both the stable and dynamic regions of the microtubule must be present in the brain for successful cognitive function.

Tau is one of the hallmark proteins of Alzheimer's disease. In the diseased brain, tau breaks away from microtubules and forms neurofibrillary tangles, blocking nutrient transport inside

of neurons and eventually killing them.

Drugs that affect microtubule stability are currently under investigation as potential therapies for Alzheimer's, because it is nearly universally accepted by the scientific community that the role of tau is to stabilize microtubules in neurons of the brain, specifically in nerve fibers called axons.

The implication of this new discovery is that microtubule-stabilizing drugs currently in clinical trials may not be effective in treating Alzheimer's and other tau-based neurodegenerative diseases, says Peter Baas, a professor in the Department of Neurobiology and Anatomy at the College of Medicine and the study's principal investigator.



TAU-ISM

Tau and MAP6 help regulate the stable (green) and dynamic (red) parts of a neuron's microtubules. Depleting tau from cultured rat neurons led to greater stability of the neuron's microtubules.

\_ATLAS OF HUMAN ANATOMY

This map of the "geography of the human body" helps researchers and clinicians better understand how the immune system works and how infections are controlled throughout the body.

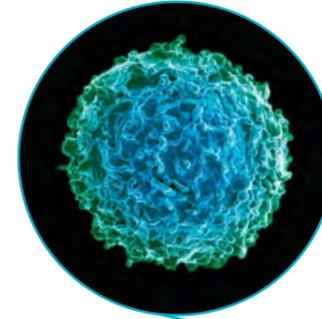
COMPUTATIONAL BIOLOGISTS have helped to create the first "anatomic atlas" of B-cell clone lineages, their properties and tissue connections.

The researchers revealed that the population of B-cells are split into two broad networks within the body. One spans the blood, bone marrow, spleen and lung, while the other is found in the gastrointestinal tract. This atlas of B-cell tissue distribution will be a resource for researchers and clinicians.

"The geography of the human body is important for how the immune system works, with B-cells operating differently depending on where they are located," says Uri Hershberg, an associate professor in Drexel's School of Biomedical Engineering, Science and Health Systems who collaborated on a report in Nature Biotechnology with Eline T. Luning Prak, MD, of the University of Pennsylvania Perelman School of Medicine.

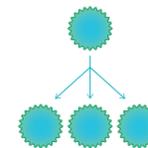
B-cells are key players in the body's protective immunity. When an infection is present, these cells clone themselves to fight the invader.

The tissue distribution and trafficking of these cells from the same clone are essential to understand, since these processes influence how infections are controlled in the body. The researchers' findings may help identify tissue-specific markers for B-cells, Hershberg says.



B-CELLS

Highly specialized immune cells that generate the antibodies that protect us from disease



CLONE\_WARS

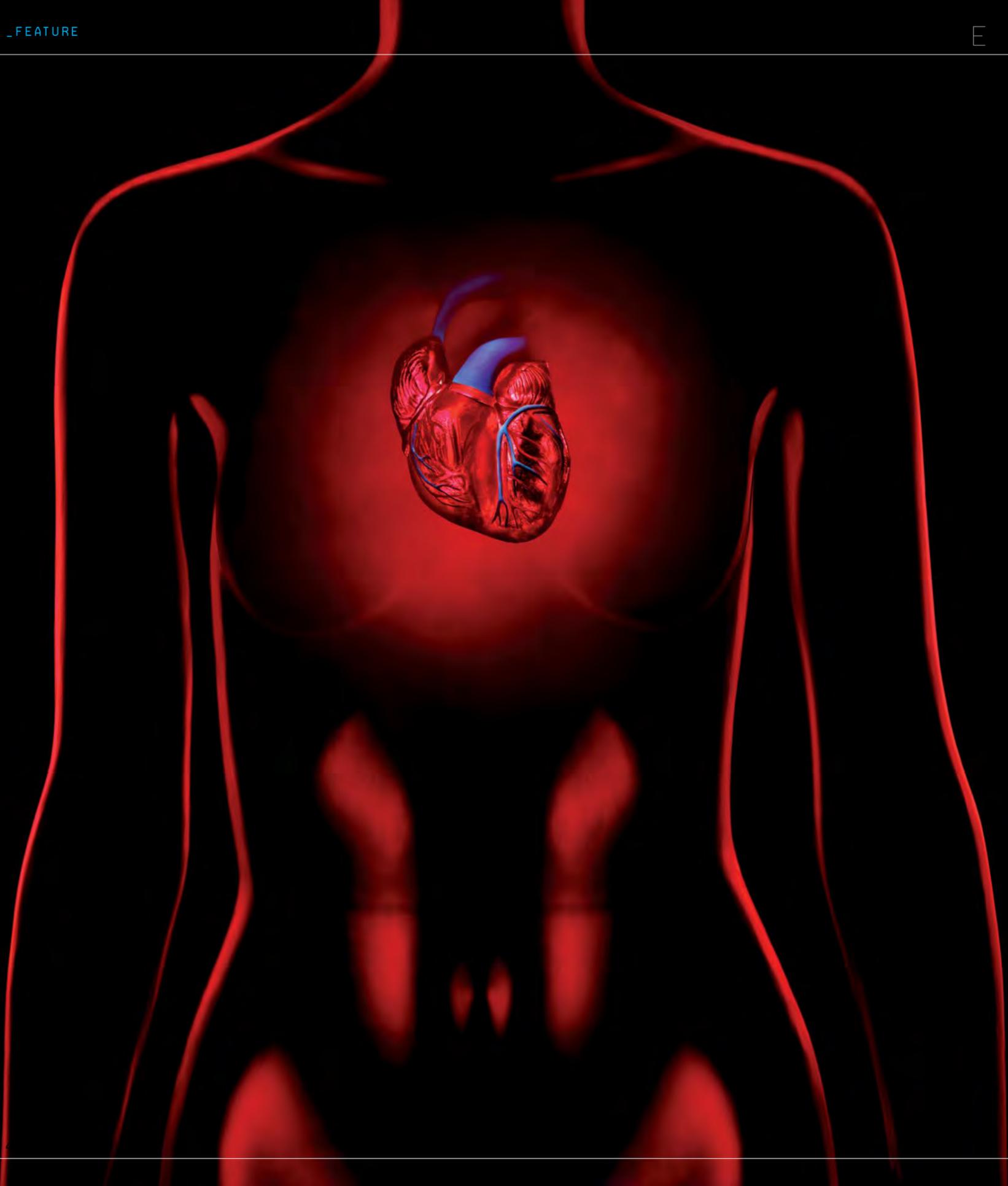
When your body is infected by a particular pathogen, B-cells respond by quickly cloning themselves to fight the infection. Special types of B-cells "remember" the invader, making you immune to a second attack.

ANTIBODY\_MAPPING

The human body has two distinct B-cell clonal networks. Drexel researchers and colleagues have discovered that one network spans the blood, bone marrow, spleen and lung, while the other is found in the gastrointestinal tract.



BODY NETWORK: ALEXANDER H. FARLEY



# GLOW WITH THE FLOW

IMAGINE IF DOCTORS COULD SCREEN FOR A HEART ATTACK BEFORE IT HAPPENS. A TEAM AT DREXEL IS WORKING TOWARD COMMERCIALIZING AN INVENTION THAT WOULD DO JUST THAT: ELECTRAST IS AN INEXPENSIVE, PAINLESS AND ACCURATE DIAGNOSTIC AGENT THAT ILLUMINATES BLOOD FLOW PROBLEMS LIKE A BRIGHT WARNING LIGHT.

\_by Wendy Plump  
\_photographs by Nick Cabrera



\_STEVEN WRENN  
\_BRETT ANGEL  
\_AARON FAFARMAN  
Wrenn is professor of chemical engineering in the College of Engineering's Department of Chemical and Biological Engineering. Angel is a cardiologist in the College of Medicine's Division of Cardiology. Fafarman is an associate professor of chemical engineering in the College of Engineering.

THE AMERICAN HEART ASSOCIATION'S numbers are staggering — 790,000 heart attacks each year; 10 million cardiac-related visits to an emergency room; 17 million deaths from cardiovascular disease worldwide in 2014. The numbers are nearly impossible to grasp...until the moment when a loved one clutches his or her chest and heads to the emergency room.

Even then, the diagnosis can be alarmingly inconclusive. Doctors must often resort to treatments that are radioactive, invasive and accurate in only about 70 percent of cases. Or they administer stress tests days later, sending a patient home from the emergency room with an uncertain prognosis and deep anxiety about their wellbeing. A spectrum of symptoms may muddy the diagnosis. Disease may hide in the heart's microvasculature that doctors are unable to detect.

In fact, this may be the most staggering number of all: It is the year 2019, and there is still no broadly reliable medical method to image an incipient heart attack.

But if that's the Holy Grail of cardiology — and it is — a team of researchers at Drexel may just have entered the shrine.

Researchers in the College of Engineering and College of Medicine have developed a groundbreaking invention that can help clinical teams spot a heart at risk before crisis hits.

They created a novel voltage-activated contrast agent that detects heart disease by "lighting up" healthy tissue, while leaving damaged or blocked tissue dark. Called Electrast, the agent responds to the heart's own electrical activity, rendering it visible with ultrasound when in the presence of the myocardium and providing instant, low-cost, bedside feedback on how efficiently blood is being pumped through the heart.

The journal *Applied Acoustics* called Electrast the first ultrasound contrast agent to take advantage of the electrical activity of the heart to provide selective activation in the coronary circulation.

**EARLY VALIDATION, CHECK**

Imagine a satellite image of planet Earth at night: Along the coast, major metropolises are lit up like Christmas trees while empty expanses across the heartland are dark voids. That's essentially what Electrast does for images of the heart: Areas of ample blood flow are brightly illuminated, while dark areas indicate a possible stoppage.

Electrast is essentially a contrast agent — that means it is used in conjunction with medical imaging tools like ultrasound to highlight the visibility of bodily fluids and structures. Iodine, for instance, is used in contrast agents injected into patients like a dye to illuminate bodily features within X-ray images.

But Electrast, also delivered by injection, is voltage sensitive so that it reacts to the electric field within the myocardium, the muscular tissue of the heart that keeps

blood pumping. It is a phase-change agent that comprises liquid droplets formulated with a novel dual-layer — or nested — architecture. This first layer prevents multiple droplets from sticking to one another; the second layer, the nest, keeps the droplets "silent," or invisible to ultrasound, until acted on by the electric field to selectively brighten blood flow and illuminate it on an ultrasound.

Electrast has performed superbly in early trials. It has been shown to selectively activate within the heart muscle during small animal studies and in closed-chest infarct validation surgeries in pigs. The latter were carried out by a Drexel team as well as by an independent research group at North American Science Associates Inc. (NAMSA), a contract laboratory in Minnesota.

Under the formal name "Electrophysiologically Activated Intravenous Ultrasound Contrast Agent for Imaging the Heart," the Electrast project has also received resounding support from the Coulter-Drexel Translational Research Partnership, which shepherds academic research ideas to market that have potential to fulfill unmet or underserved clinical needs. The program has funded Electrast research for three years, the highest level of support.

"We're hoping to give doctors a better tool so they can answer that question of detection quickly and inexpensively and with minimally invasive technology," says Steven Wrenn, who is a professor of chemical engineering in the College of Engineering's Department of Chemical and Biological Engineering and the principal investigator on the Electrast project. "This is not pie-in-the-sky. This is working, and the implications are huge. It doesn't seem far-fetched that we would totally change how chest pain is diagnosed and treated."

The medical industry already uses "microbubble" (imagine a soap bubble the size of a red blood cell) ultrasound contrast agents to monitor heart disease. However, these microbubbles have some drawbacks when it comes to evaluating blood flow in the muscle wall. For example, upon entering the body, the microbubbles immediately begin

*"This is not pie-in-the-sky, This is working, and the implications are huge. It doesn't seem far-fetched that we would totally change how chest pain is diagnosed and treated;"*

-STEVEN WRENN

contrasting everywhere so that dead or dying heart tissue is difficult if not impossible to distinguish. In addition, these fragile agents are so abased by ultrasound that their ability to highlight diseased tissue lasts only a couple of minutes.

Electrast surpasses existing agents on both of these scores. Its specificity of activation allows doctors to evaluate blood flow in the essential area — and only in the essential area — with imaging that is of unusually high quality and much longer lasting.

"Where Electrast differs dramatically from traditional microbubbles is that in the blood pool, it travels in a kind of 'echo stealth mode,' totally undetectable on ultrasound exam," says Brett Angel, MD, a cardiologist in the College of Medicine's Division of Cardiology. "The agent only becomes echogenic and therefore detectable in the small vessels of the heart muscle where it is activated specifically by the electrical activity of viable, living heart muscle cells and the concomitant ultrasound."

In essence, the Drexel team is coupling the technology of nested droplets with the electrical field of the heart and the acoustic signal of the ultrasound to highlight the myocardium with greater efficiency than ever before.

"If it's dark, that's a blockage — it's really that simple," says Michael Cimorelli, a graduate student who is pursuing his PhD under the mentorship of Wrenn. "That's basically what we've seen."

**THE HEART IS A MUSCLE**

To explain the challenge cardiologists have in tracking the onset of heart disease, Angel offers a well-used emergency room expression: time, he says, is muscle.

Heart disease can build slowly over years before symptoms appear. All too often, by the time a patient gets to the hospital, damage to the heart's muscle has advanced significantly. In addition, some 40 percent of these patients may have blockages that started in the heart's network of micro-vessels. Current detection technologies target only the larger vessels.

The ability to catch disease in smaller vessels early would be a huge step forward in cardiac care.

"Cardiovascular disease is ultimately a silent disease until someone has an event," says Angel. "To this date, there's very little that you can do to really try and screen for that in terms of imaging the actual blood flow through the heart muscle without exposing a patient to some degree of risk — and without exposing the patient to some degree of ambiguity in the results. There's a large false positive rate and false negative rate."

Unlike conventional microbubbles now in use, Electrast droplets can be formulated with a range of diameters in nominally hundreds of nanometers, giving them unprecedented access to the microvascular architecture of the heart.

Wrenn and Angel describe Electrast's utility as analogous to "silencing the noise in the room," so that doctors can hear that one voice in the back corner that has something important to say about heart health. The medical industry has been hammering away at techniques that accomplish this for some 30 years with only modest success, which is why Electrast could be a welcome disruption in the medical field.

"This ability to really discern different levels of tissue perfusion, viability and compromise by latching onto the most unique aspect of living cardiac muscle is what makes Electrast such a valuable and disruptive technology," says Angel.

"On top of that," says Wrenn, "what we're putting in — Electrast — is made of ingredients that are fully biocompatible."

**NESTING INSTINCT**

When Wrenn first came to Drexel in the early 2000s, he was working on biological colloids and membranes. He developed an interest in how these structures interacted with ultrasound and how microbubbles could be tethered to the outside of liposomes for controlled drug release within the body. He then had the idea to put the bubble — plus a drug — inside a liposome for a unique, dual-shell architecture now referred to as "the (Wrenn's) nest." That architecture allowed for a hardy drug delivery system.

But there was no interest commercially. "They said, 'that's encapsulation; there's nothing new here,'" says Wrenn. "But they were missing the fact that I have two coatings — I have a coating on the bubble at the interface between the gas and the water, but then I have a second

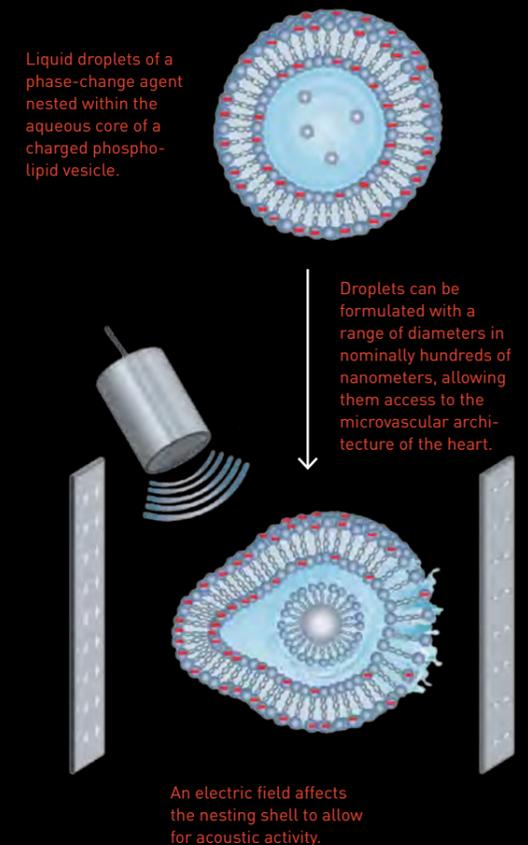
**Illuminating Electrast**

**WHAT IS IT?**

Electrast is a voltage-sensitive imaging agent that uses the heart's electrical activity to selectively contrast high and low regions of blood flow on an ultrasound.

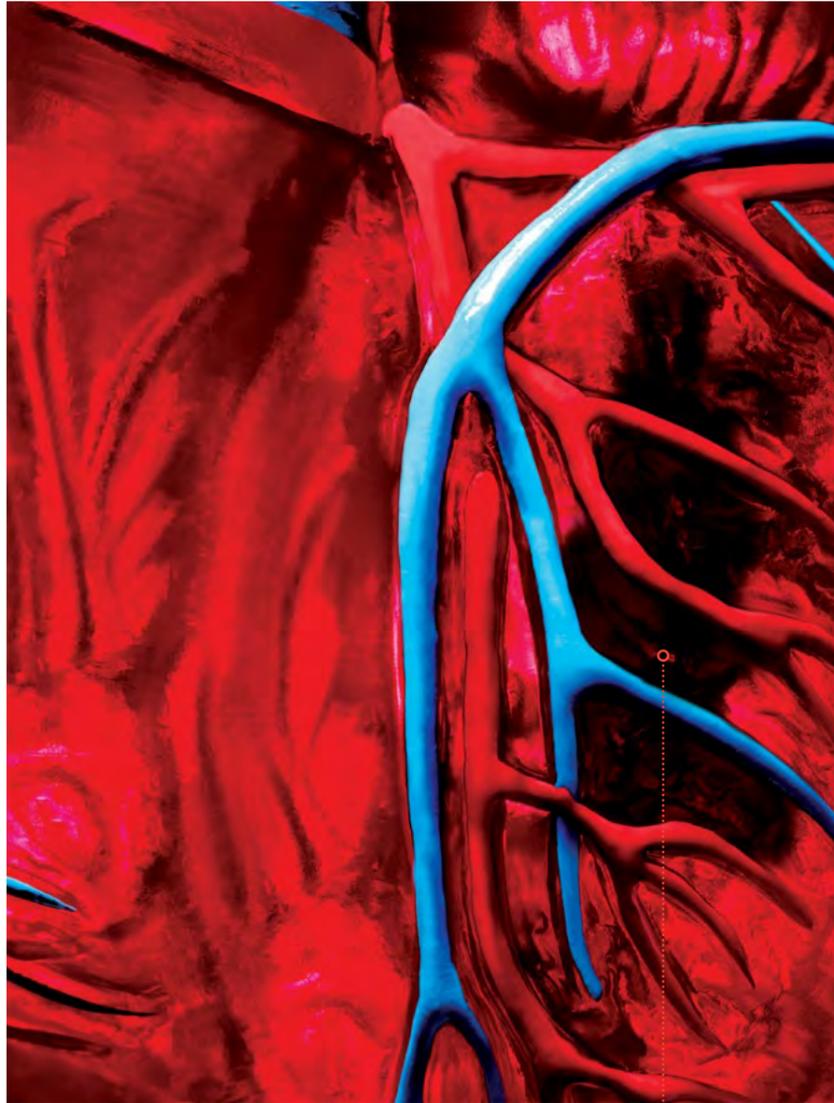
**HOW DOES IT WORK?**

Electrast becomes visible with ultrasound upon entering the coronary circulation and responding to the heart's own electrical activity. This provides instant, low-cost, bedside feedback on how efficiently blood is being pumped through the heart.



**BENEFITS OF ELECTRAST**

- Avoids ionizing radiation.
- Brightens the myocardium yet leaves the ventricle dark.
- Works within minutes and at the bedside.
- Can carry and deliver drugs (e.g., vasodilator) selectively.



shell that's separated from that coating with water in between — so I have free-floating, coated bubbles inside of a liposome.”

His “nested” structure meant that he could formulate bubbles that persisted indefinitely, instead of dissolving in a matter of minutes.

Wrenn continued studying nesting properties. He generated some 19 papers over eight years on the technology, unwittingly laying the foundation for Electrast.

Then, three years ago, Wrenn got a phone call from a stranger with a pressing question. That stranger was Angel, calling in his excitement from a CVS parking lot.

“It was June 3 of 2015,” Wrenn says. “Brett called me and I had no idea who he was. He was really excited. He had read some of my papers and wanted to know, could I create an agent that could let us see a heart attack in real time? And the main challenge was, could you make it so that it worked with the electrical activity of the heart?”

**BLACKOUT**  
Electrast spots an imminent heart attack by distinguishing between blood that is in the wall of the heart muscle from blood that is being pumped through the muscle. Electrast is activated only by blood in the muscle wall as the muscle contracts.

“So I met with him a few times. I began to read and learn about the heart’s physiology. I spent about six months thinking about it before arriving at an idea I thought could work,” says Wrenn. “Then I shared the idea with Aaron [Fafarman] because of his prior experience working with electric fields, and we sketched the idea out on the whiteboard in my office.”

The idea they sketched out on Wrenn’s whiteboard in smudged black ink was that nanodrops could be nested within a voltage-sensitive bilayer of FDA-approved ingredients to create an innocuous phase-change agent that could be deployed in the region cardiologists image to detect early-stage heart disease.

Research began almost immediately in Wrenn’s campus laboratory, the Wrenn Research Group.

In scientific terms, Electrast is an aqueous emulsion of surfactant-coated liquid perfluorocarbon droplets nested within a negatively charged phospholipid bilayer. What that means is that the nest is “decorated” with a charge to make it interactive with an electric field — in this case, the heart’s electric field. Nest sensitivity to voltage allows acoustic activation at an ultrasound intensity that is otherwise insufficient to cause activation. This keeps the droplets invisible to ultrasound until exposure to the electric field in the myocardium.

Thus, with Electrast, cardiologists get localized, high-resolution imaging exactly where it’s needed.

“The heart attack is happening due to a blockage in the muscle, so you want a way to distinguish the blood that’s in the muscle from the blood that’s being pumped by the muscle to keep the heart going. So, you need to be dark in the chamber, bright in the wall,” says Wrenn. “The heart’s depolarization wave [i.e. what makes the heart contract] is happening roughly once a second — lub-dub, lub-dub. It is confined to the tissue of the heart; it’s like dominoes falling, and that signal cascades down and it makes the muscle contract, and that makes the heart pump.

“So, if you can make an agent that is sensitive to that signal, then only the agent that’s in the muscle will be activated and not the stuff that’s farther away. That’s what we’ve done here.”

#### COULTER STEPS IN

The Electrast team formed in earnest in 2016 with the first installment of funding from the Coulter-Drexel Translational Research Partnership. Studies followed at Hahnemann, at the University of Pittsburgh, and in Minnesota, and began again at Pitt in late January.

The Coulter-Drexel partnership provides funding to between four and six promising Drexel inventions each year to de-risk them for funding milestones on the path to commercialization. “Because we fund early, we are a concierge service,” says Coulter Program Director Kathie Jordan. “What we do depends on what is needed, whether it’s regulatory consulting or finding a CEO — any number of things that it takes so that the project can hit a commercial market.

“Steve was exactly what we look for in projects,” she says of the Electrast. “He was incredibly engaged and excited in the project. One of the things we look for is the strength of the clinical and engineering collaboration, and it was clear right from the beginning that we had a top-notch team.”

Cimorelli says the project is advancing because it brings the problem-solvers, or engineers, together with the day-to-day practitioners, or doctors and medical staff, for maximum proficiency.

“We have two great doctors who really understand the disease states and two amazing engineers with great technical foundations,” Cimorelli says. “I think that’s why this project has been so successful in just two-and-a-half years.”

Coulter funding follows a six-month proposal process that seeks to gauge market need and commercial viability. Since the inception of the Coulter program at Drexel in 2005, 58 projects have received a total of \$9.4 million in support. However, the Electrast project is one of only a handful to receive three years of funding. The Coulter partnership has provided Electrast with about \$600,000 to date.

The Electrast team met with the Coulter oversight committee again in December to present a film of the surgery being performed at the lab in Minnesota. In the film, the research group performed a progressive series of animal studies to get a sharper image and demonstrate how effective Electrast is in predicting heart attacks. In one surgery, Electrast was deployed via bolus injection. It immediately brightened the subject’s myocardium, leaving an obvious dark spot where the “heart attack” had been created. The brightness was clear even to an untrained eye.

“What venture capitalists want to see is, can you detect a heart attack? They told us: replicate it in the lab, replicate it in the rat, replicate it in the pig. We’ve done all that now,” says Wrenn.

*“We have two great doctors who really understand the disease states and two amazing engineers with great technical foundations, I think that’s why this project has been so successful in just two-and-a-half years.”*

—MICHAEL CIMORELLI

#### A SUPER-FAST CAMERA

The next step for the Electrast research team is to introduce their phase-change agent at cardiology conclaves around the world and begin discussions with venture capitalists about funding.

They’re also working on a series of video microscopy studies at the University of Pittsburgh. There, one of the world’s fastest cameras (25 MHz, or 25 million pictures per second) will provide the team with a frame-by-frame view of exactly how their phase change agent changes.

Electrast is working, says Cimorelli. But there may be ways to tweak and modify the ultrasound’s impact for maximum clarity. They want to establish a nesting efficiency that will give them the best acoustic signature.

They also want to fully understand how it works scientifically, says Cimorelli. “How does the performance respond to all these changes in the chemistry? And then ultimately, we’ll know what combinations to use under certain circumstances.”

“The camera speed is tied to the speed and frequency of the ultrasound,” explains Wrenn. “Typically, when you’re looking at our samples, you’re seeing some brightness but you’re not seeing what’s providing that brightness. Our agent that’s providing the signal is doing things on a megahertz frequency scale — which means millions of times per second, but you’re not seeing that with your eyes, obviously. This camera at Pitt lets you see the actual oscillations, and then you can play it back frame-by-frame and see what is happening each cycle of ultrasound.”

With Coulter’s guidance, the contrast agent will proceed to commercialization at the same time that its mechanism is being more deeply investigated. As team members explain it, the FDA is less concerned with exactly how the phase change agent behaves than that it won’t cause any harm in the body and that it works better than anything else on the market.

For Cimorelli, it’s another matter. “It bugs me like crazy,” he says. “I’m spending 60 hours a week working on this. I want to figure it out. I think it’s valuable to know before it goes to a commercial step, but that’s me.”

Because Electrast is less expensive, non-invasive, portable and wielded with a minimum of training by medical technicians, Wrenn hopes it could someday be used as an annual screening tool. Instead of waiting for an ER episode, general practitioners might use it in office visits to track how a patient with cardiovascular vulnerability looks from year to year — spotting heart disease at much earlier stages than has ever been possible before.

Waxing poetic about the opportunities the team’s contrast agent could afford, Wrenn concludes, “I foresee a day when Electrast is as familiar as an EKG; when hearts brighten on the edge of darkness; and when patients leave a doctor’s office — amazed and perfused.” ✕

PALEONTOLOGY

# \_ART AND EXTINCTION

A 10-foot-long, torpedo-shaped fish lurks in murky freshwater, its body casting a shadow on the creatures below. The opened mouth reveals dagger-like fangs, some two inches long, perfect for lacerating the flesh of fellow stream-dwellers...This fierce prehistoric fish hasn't lived in many millennia, but art is bringing it to life. *\_by Mary Alice Hartsock*



**P**ALEOILLUSTRATOR Jason Poole dips the tip of his brush into a circle of white paint. Slowly and delicately, he dots the thickly painted canvas just beyond the predator's gaze. From the shadowy background, particles emerge, gleaming as if reflecting the sun. Complete with vicious grin, his predator swims down for the kill.

Poole was charged with depicting *Hyneria lindae*, the largest creature living in an ancient stream ecosystem in Devonian-age Pennsylvania, about 365 million years ago. This lobe-finned fish, belonging

to a group of back-boned animals called sarcopterygians, was at least twice the size of the largest of the other animals with which it shared the waters.

When he received the *Hyneria lindae* assignment, Poole wasn't concerned about the fish's size. As manager of the Academy of Natural Sciences at Drexel University's Fossil Prep Lab and Dinosaur Hall, he is used to depicting dinosaurs and other massive terrestrial animals. Tackling an aquatic monster — one without legs at that — was a challenge he eagerly accepted.



HYNERIA LINDAE: 2009 VS. 2018

The above image of *Hyneria lindae* was produced in 2009 by author and accomplished fish artist Flick Ford. Academy researchers Ted Daeschler and Jason Downs advised Ford on many of the details of his reconstruction based on what they knew then about this aquatic predator. By the time Jason Poole recreated the same fish nine years later (see inset at left), the scientists were able to share a wealth of new information about the fish they had gleaned from new fossils discovered in Clinton County, Pennsylvania. A side-by-side review also highlights the range of choices available to illustrators as they reconstruct a creature that scientists have never seen in life.

*Flick Ford '09*

PALEONTOLOGY

RETHINKING A PREHISTORIC FISH

The request came from Academy Vertebrate Paleontologist and Drexel Professor Ted Daeschler and Academy Research Associate Jason Downs, an assistant professor at Delaware Valley University.

The scientists have spent decades studying fossils to trace the evolution of life in the Devonian Period. One of their most productive research sites is located just a three-and-a-half-hour drive northwest of Philadelphia, at a highway roadcut in Clinton County, Pennsylvania. During the Devonian, subtropical streams flowed west through Pennsylvania toward a seaway in Ohio. These streams provided the ecological setting for plants, small invertebrates, armored fish, shark relatives and lobe-finned fish.

"The freshwater ecosystem in which *Hyneria lindae* lived was a hotbed of evolutionary change during the Late Devonian," says Daeschler. "It was during this timeframe that a closely related branch of lobe-finned fish developed the earliest limb-like appendages."

Eager to fit more pieces into the evolutionary puzzle, Daeschler and Downs studied fossils from the Academy's collection that were retrieved from a dig site in Clinton County by Academy teams during the past 25 years. They compared fossils of *Hyneria lindae* to closely related species to delineate the unique qualities of this predatory fish.

They built upon the work of Keith S. Thompson, the Academy's president from 1987 to 1995, who described and named *Hyneria lindae* in 1968 based on limited fossil material collected at the same site in the 1950s. Through the new fossils, scientists discovered that *Hyneria lindae* had a wider, more flattened head shape and a differently positioned and smaller eye than those of other similar creatures of its time. The group of bones that covers the gills and provides structure for the face was narrower than previously thought.

Daeschler and Downs also concluded that *Hyneria lindae* had an elaborate sensory canal system through its skull bones and scales, which enabled it to sense the movement of other organisms swimming nearby. This feature gave the fish a strong advantage for hunting and navigating deep channels within the sediment-laden streams. Daeschler and Downs' findings were published in the *Journal of Vertebrate Paleontology* in May 2018.

The scientists wanted an illustration of *Hyneria lindae* to help others visualize what the creature may have looked like in life. They didn't have to look far to identify their artist.



1

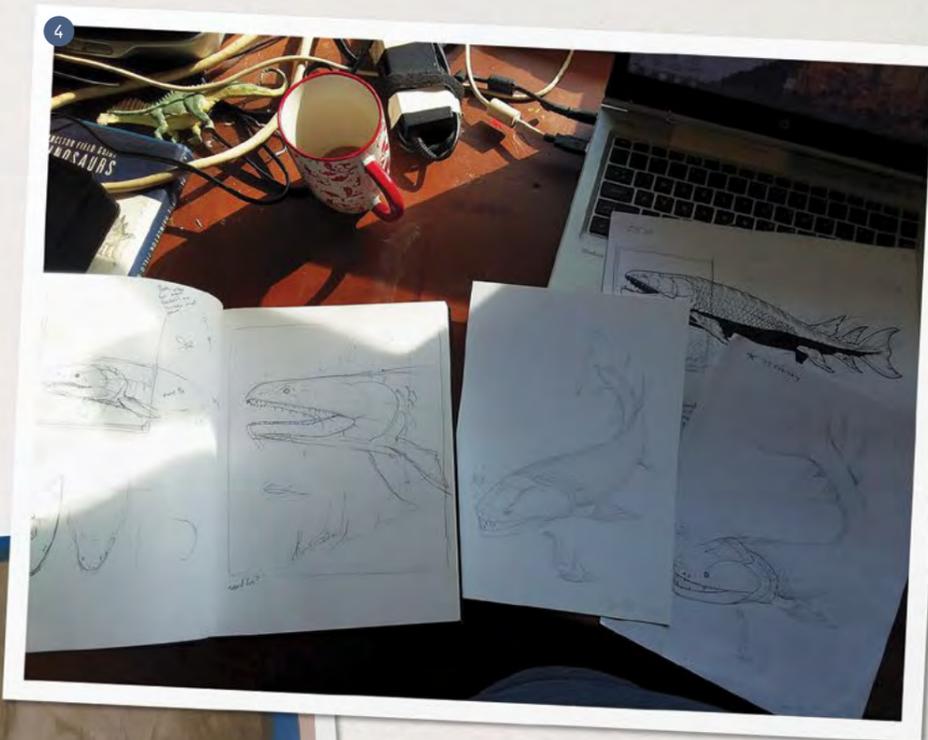


2

1 Clockwise from left: Ted Daeschler, Jason Downs and Jason Poole inspect fossils from *Hyneria lindae*, collected from roadcuts in Clinton County, Pennsylvania.

2 Poole inspects a fossil of *Hyneria lindae*. Real fossils and information gleaned from them played a significant role in Poole's depiction of the prehistoric predator.

3 Poole favored a life-like depiction of *Hyneria Lindae*. In his rendition, he arranged it in motion and placed it in a murky aquatic environment.



4

4 Early sketches of the *Hyneria Lindae* by Poole show him imagining the fish as it would have looked in nature.

5 Daeschler and Downs worked with author and artist Flick Ford in 2009 to create the first stunning illustration of *Hyneria lindae*. Comparing and contrasting this illustration with the 2018 painting by Poole demonstrates the wealth of information the scientists gathered since 2009.

PAINTING A MONSTER

An experienced paleoillustrator with a background in fossil excavation and preparation, Poole worked closely with Daeschler and Downs to depict this three-meters-long fish on an 11x14 canvas. He looked to fossils, modern-day fishes, previous illustrations of *Hyneria lindae* and his own imagination to bring life to the monster fish.

"This is a really beautifully ugly fish," Poole says. "It looks like it wants to bite something."

Poole's initial sketches perfectly captured the undulating movement of the fish through the water, but the scientists tweaked the predator's proportions. *Hyneria lindae*'s tail was too long, the fins needed to be moved and the curvature of its body was a bit off. Its skull was not shaped quite right, which threw off the placement of the eyes and nose.

"Good paleo-art is art by committee," Poole says. "I know what looks fun and cool and will grab the eye, and they know what's correct."

Where the fossil evidence is lacking, such as the fish's coloration, there is room for artistic interpretation, Daeschler notes. "In this case the artist can focus on bringing life to the image rather than making it a study," he says.

Poole was inspired by the pattern on the modern-day muskellunge, an aggressive freshwater predator found in North America that is the largest member of the pike family. Having seen fossils of *Hyneria lindae*'s scales, he was fascinated by their lacy margins. He made the body a silvery white color, allowing the scales to show through. Poole chose to make *Hyneria lindae*'s fins reddish to show that they are reflecting red light from the sun, which is penetrating the surface of the water. He added green spots to the body, helping the fish blend in with the murky water while waiting to ambush prey. White dots of paint in the water add sparkle as light bounces off the debris.

Is this exactly how Daeschler or Downs would have imagined *Hyneria lindae*? Probably not, but that's the beauty of paleo art. After all, nobody has ever seen *Hyneria lindae* in the flesh. With a partnership between a stellar paleoillustrator and accomplished scientists, the result is the best possible interpretation. Unless we figure out how to travel back in time, the canvas version will just have to suffice.

Originally published in the spring/summer 2018 edition of *Frontiers*, the magazine of the Academy of Natural Sciences of Drexel University.



#### WHAT IS IC@3401?

It is an innovation center for early-stage tech companies located at 3401 Market St. in West Philadelphia. It was jointly conceived and managed by Drexel Ventures, Drexel's startup and tech commercialization arm, in partnership with the University City Science Center. Everything from location to business model, layout, staffing and selection of members distinguishes ic@3401 from typical incubators.

# Not Your Ordinary Startup Incubator

*The Drexel campus incubator ic@3401 mingles entrepreneurs and researchers from campus and city, and acts as concierge to Drexel's multiple tech-transfer resources. Small wonder its tenants have achieved so much. \_story by Lini S. Kadaba \_photos by Jeff Fusco*

In 2017, eight employees of the startup HeavyWater moved into ic@3401 to complete development of a disruptive AI program that speeds the mortgage loan approval process. The founders quickly found collaborators with AI expertise among the faculty and students of Drexel's College of Computing & Informatics, also located in the building. They also received introductions to local angels and help with a crucial CFO hire from the incubator's organizers. Just 13 months later, the startup was acquired by publicly traded Black Knight and graduated to new offices in Center City Philadelphia with a team of 19.

Eamon Gallagher JD '13 leans into a conversation about HeavyWater's latest plans with its chief financial officer David Luk and takes a swig from a Tröegs Scratch 342, a lager from a Central Pennsylvania brewery that markets to those with a spirit of adventure and curiosity.

Fitting.

Those traits, after all, are hallmarks of successful entrepreneurs — and this unique incubator and accelerator for early-stage startups is all about that. But on this last Thursday of the month, the 36-year-old program director wants to encourage another quality, one arguably harder to come by among determined, heads-down techies but central to ic@3401's successes.

Shoptalk — and what better venue than a 5 p.m. happy hour.

"It fosters community," Gallagher, tall and lean, with a mop of light brown hair, says, talking a New York minute (though he hails from Maine). "We've made it a space where entrepreneurs can come and support each other."

Launched in the summer of 2014 by Drexel and the non-profit University City Science Center, the innovation center is building a reputation as the spot in the region for embryonic businesses, particularly those in digital health, educational and financial technologies, and the "internet of things" (i.e. connected devices).

Since 2016, 52 member companies have raised \$54 million, including \$21 million last year alone. It's "a concentration of capital being raised that you don't see anywhere else in the region," says Gallagher, who also directs Drexel's Entrepreneurial Law Clinic at the Thomas R. Kline School of Law. Nearly 40 percent of ic@3401 members have attracted investments from Ben Franklin Technology Partners of Southeastern Pennsylvania, one of the nation's longest-running tech-based economic development organizations. The incubator also boasts more than 300 jobs created locally since its inception in 2014 and a healthy waitlist.

A lot of credit goes to its unconventional model and its status as the linchpin of Drexel's ambition to increase the number of University-affiliated inventions that make it to market. Unlike the typical university incubator, ic@3401 co-mingles academic tenants and classrooms with entrepreneurs from the public. That means members come not only from Drexel and its wealth of commercialization and translational research programs (think seed-funder Drexel Ventures, degree-granting Charles D. Close School of Entrepreneurship, health care solutions-focused Coulter-Drexel Translational Research Partnership, etc.) but from other academic institutions, local industry and members of the city's startup community.

As Gallagher and Luk catch up, a steady flow of men and women unplug from laptops. They wear a path from the expanse of tables and swivel chairs that serve as shared offices to the snug kitchen cum break room on the second floor of 3401 Market St. There, food (Mediterranean from Mama's Vegetarian this day), beer, and most important, chatter all abound. A couple of employees from Drexel's transdisciplinary research ExCITE Center on the first floor wander up and ic@3401 alums such as Luk add to the mix.

It was at a similar happy hour that Gallagher played the matchmaker between Luk, then a principal at local venture firm Safeguard Scientifics, and HeavyWater's founder and CEO Soofi Safavi, who was looking to expand. The two men hit it off so well, Luk got the job of CFO and chief revenue officer and his venture capital connections started HeavyWater on its path to the big time.

"It would have never happened if I was not at 3401," Luk, who held office hours here, says of serendipity's role in the successful pairing. HeavyWater's legal team had emailed an ask a while back, he continues, but he ignored it at the time. "It didn't seem like a fit. ... I think Eamon did a better job of explaining why we needed to chat."

Says Safavi: "Eamon grasps at even the most complex level the mission of the company, and on its behalf articulates it and attracts other individuals."

ic@3401 helped in other ways, too. When HeavyWater needed private office space to meet Black Knight's security regulations, the large, third-floor game room was repurposed. When HeavyWater needed new hires, a "help wanted" sign on its door landed a graduate student from Drexel's College of Computing & Informatics next door. The company also partnered with Drexel's Xiaohua Tony Hu, an information science professor. Hu happens to be founding co-director of the National Science Foundation (NSF) Center for Visual & Decision Informatics, a program HeavyWater used to further develop its technology.

"Being part of an incubator like that," Safavi says, "allows you to augment efficiencies.... We were able to leverage resources to get a little forward momentum."

Christopher Wink is CEO and publisher of a network of news sites called Technical.ly that follow local tech startup scenes.

"Any city of any size in the world is talking about the tech renaissance," he says. "We know that innovation happens at the intersection of different communities. Universities are blessed with their own set of internal communities, students, professors, alumni. But critically, universities want opportunity for outside entities to be on campus, bump into each other."

ic@3401 is that type of ecosystem, according to Wink.

"We need spaces like this," he says, "to make sure Philadelphia is not a laggard but a leader."

**"We wouldn't have gone anywhere  
without Drexel Ventures and ic@3401.  
We would have had this great idea, and it  
would have just sat there."**

— LORI SEVERINO, ADOLESCENT COMPREHENSIVE EVALUATION

ROAR for Good graduated from a Dreamit Ventures' accelerator program with a prototype of a wearable personal security alarm and moved into the ic@3401 community in 2015. The company went on to raise more than \$300,000 through a massive crowdfunding campaign. It delivered its product Athena, a device used to call for help, and moved out of the incubator with a team of eight. Now, the company is developing a new panic button safety system for hotel housekeeping staff.

At first glance, the 7,625-square-foot ic@3401 looks like any coworking space. Walk past the reception desk, past the pillars plastered with company logos, and a collection of 58 desks fill the expanse, making for cozy shared offices. It also has two phone booths for private conversations, eight individual offices for rent, a few conference rooms with floor-to-ceiling whiteboards should inspiration strike, a kitchen with an espresso machine and on the third floor, and an 891-square-foot game room turned office.

But look closer, and it's clear ic@3401 — with the tag line "at the intersection of innovation and Market" — differs significantly from the many rent-a-shared-office options around the region.

"If you go to WeWork, or 1776 Startup Network, or Make-Offices, you're paying a market amount of rent to have a seat next to whoever else is paying rent," Gallagher says. "This space is very different. This space is only startup oriented."

An oft-shared story is how the incubator in 2014 was too heavy on service providers, including five law firms. "I went to every one of them," says Shintaro Kaido, who oversees the incubator for the university as managing director of venture commercialization at Drexel Ventures, "and asked, 'Have you met with any of our startups?' The answer across all five was 'No.'"

"So, it's like, what in the heck are you doing here?" he says. "At one point, the number of service providers exceeded people involved in startups."

Law firms were sent packing.

Startups capturing capital were invited to join, enticed by an attractive location near 30th Street Station, the campuses of Drexel, University of Pennsylvania and University of the Sciences, and below-market rents. At the same time, professors with sound concepts that had spinout potential were channeled to the incubator.

Since 2014, the number of companies based at ic@3401 has doubled. Admission is competitive, including a phone-screen and in-person interview that might involve a mixer "just to see how they interact," Gallagher says. He looks for

an entity of one or two founders who want to solve a problem, and know what product will accomplish it.

In addition, Drexel academics with a marketable idea get automatic admission — but only after Kaido signs off. He also puts the project through Drexel Ventures' Proof-of-Concept Academy, an accelerator program for high-growth startup teams that Kaido runs. Likewise, startups that go through the Science Center's Digital Health Accelerator, which helps companies grow in the U.S. health care market and increase revenue through sales, get a greenlight.

If Gallagher is the matchmaker, then Kaido is the visionary. "That curation we talk about is very intentional," Kaido says, giving off a Silicon Valley vibe with his short cropped black hair and gray beard, with his shorts and Phillies jersey



#### THE LONG VIEW

Shintaro Kaido came to Drexel in 2014 having previously launched a well-regarded accelerator program in the Midwest, with plans to recreate an entrepreneurial community at Drexel.

sey over a tee. "We're very keen to make sure the startups are synergistic to the community." He says some successful early stagers have been turned away because their ideas and products — in terms of technologies — were nothing new.

Keith A. Orris, senior vice president for corporate relations and economic development at Drexel and senior manager of Drexel Ventures, represents the University on the board of the Science Center, a long-time local hub for technology innovation. He brokered the deal with the center to share resources for a single incubator in lieu of two competing entities.

ic@3401, Orris says, fits perfectly into Drexel's DNA of translational research. "In order to have a successful commercialization program today," he says, "we not only want to license our technologies to existing companies, we also want to license them to startup companies around the principle investigator who invented it and support these academic innovators in standing up a company themselves. That takes services, mentoring and education. And that takes capital."

And, he adds, that takes ic@3401. He calls it a dynamic ecosystem "of like-minded thinkers and doers.... We expect you to fail fast or grow consistently, graduate and go to the next level of space."

In other words, sink or swim.

To his credit, more of the startups swim. In 2017, out of its 48 members, a dozen companies exited and three failed, Gallagher says. On average, companies graduate in

19 months, often with a team of eight to 12 "with legs firmly under them," he says.

One reason newbies stay above water is that ic@3401 comes with built-in coaches. That includes not only Gallagher and his connections, but other startup founders, some of whom have sold previous companies.

"This space has so many entrepreneurs," says computer scientist Zikria Syed '89, who is CEO of his third startup, PatientWing. The online system to facilitate patient enrollment in clinical trials has called ic@3401 home since its inception three years ago. "It's a great space to mingle and learn and share stories and experiences," says Syed.

PatientWing found its first pilot customer in then incubator member, The One Health Company, which enrolls dogs with cancer in trials. As PatientWing scales, it has partnered with a Science Center startup working on novel cancer treatments. So far, it has raised almost \$1 million in funds.

A decade ago, when Syed was launching his other companies, "incubators were really not there," he says. "We were much more isolated from other businesses."

ic@3401 — and Gallagher in particular — make connections to the larger business world happen, says Priya Bhutani, founder and CEO of REGDesk, a machine-learning platform that helps medical device companies navigate the regulatory process.

"Eamon goes out of his way to establish opportunities, which is what is needed in this space," she says. Quorum, a nearby Science Center event and networking space, put REGDesk in front of medical device and pharmaceutical leaders. "These types of introductions are a direct help to us."

Also, a Slack channel offers a platform for members to ask real-time questions and share industry news. Recently, a post about employee health/benefits plans for B2B customers got three swift responses. And Gallagher created a Takeout Kit, a vetted list of startup providers such as accountants, attorneys, software shops "and on and on."

Then there is the building itself. It houses myriad opportunities, starting with the presence of Ben Franklin Technology Partners. Because ic@3401 has proven a fruitful pipeline for the investor, it maintains an office onsite, with staff managers rotating through thrice a week.

"I think it's an ideal place to start a company," says Anthony Green, vice president of Ben Franklin's technology commercialization group. "When you cut to the chase, everybody needs money. They also need guidance, market strategies. Some are very early stage. They don't even know what company they are."

Dreamit Ventures is another funding source that has shifted from supporting back-of-envelope ideas to scaling companies. Based up the street at 36th and Market streets, the Science Center has additional commercialization programs and spaces to connect, including Quorum that's free and open to the public and Venture Café Philadelphia, a weekly gathering of entrepreneurs, creatives and those with an interest in out-of-the-box thinking.

"ic@3401," says Science Center president and CEO Steve Zarrilli, "leverages and builds on the success of both institutions' legacy of supporting startups and convening communities around innovation and entrepreneurship."

Even after companies graduate, the relationship continues.

"We caught up recently," says ROAR for Good's co-founder and CEO Yasmine Mustafa, who sought Gallagher's counsel on fundraising platforms for the company's new product. He always "lessens ... the degrees of separation from someone you want to meet. He's really amazing."

For "the matchmaker," it's just another day at ic@3401.

*Adolescent Comprehension Evaluation (ACE) began as a research project at Drexel's School of Education but evolved into an ic@3401 member thanks to Drexel Ventures' programs and a \$100,000 grant to develop a reading comprehension assessment tool for adolescents. The edtech company also won a prestigious, \$50,000 NSF I-Corps Team grant to do customer discovery. One reason: ACE gained an edge through networking with ic@3401 members who had participated in the NSF program for academic innovators.*

When Kaido was hired in late 2014, one of his early goals was to build a supportive, on-campus community of entrepreneurs to help Drexel innovators with their entrepreneurial endeavors. To the serial entrepreneur who launched and directed a nationally recognized accelerator program in the Midwest, that meant exposing Drexel academic innovators to an ecosystem that not only offered access to seed money and support but also to an innovation nexus.

"Many from Drexel are new to entrepreneurialism," Kaido says. "So ic@3401 was built so that there's a critical mass of active and successful entrepreneurs who Drexel participants



**READY\_TO\_LAUNCH**

Clockwise from top left: Eamon Gallagher '13, program director for ic@3401; Soofi Safavi and David Luk, CEO and chief financial officer, respectively, of HeavyWater; Yasmine Mustafa, co-founder and CEO of ROAR for Good; Lori Severino, assistant professor of special education and principal investigator for Adolescent Comprehension Evaluation.

can work alongside to move up the learning curve as fast as possible.”

When Drexel alumnus Johann deSa '10 looked to take his invention to market, he needed a company office.

He found it at ic@3401, where Instadiagnostics has lived since 2016. “The space is a great stepping stone for early-stage startups,” says deSa, now a Drexel visiting research professor of biomedical engineering and founder and director of the business that brings laboratory blood testing to point of care. “The practice pitches are really helpful.”

On a weekly basis, Gallagher and incubator members gather to offer feedback around pitches. “You learn a lot of things you wouldn’t see in academia,” he says. Instadiagnostics has won about \$1.5 million in grants from NSF, National Institutes of Health and others.

Kaido envisions an ecosystem with “a value proposition” of nurturing first-timers with urgency. “When we come to a problem, we need an answer now,” he says, speaking from experience. “Tomorrow is almost too late.”

Consider Sage Smart Garden, a University of Delaware spinout developing a smart irrigation system for landscapers and home gardeners. The startup joined the incubator last summer after going through the NSF I-Corps Team program. Almost right away — thanks to an encounter at one of Gallagher’s happy hours — Sage Smart partnered with fellow

Enter ic@3401.

“A lot of what we do is collapse that infinite paralysis into a few defined pathways,” he says. “Everybody else in this space has gone through that.”

Of course, like-minded colleagues only help if they intermingle.

To that end, Gallagher promotes regular luncheons, venture capital firm visits and, of course, happy hours. Even ic@3401’s physical design fosters serendipitous connections. “We’ve got one coffee machine,” he says. “Everybody is going to go to that coffee machine. We’ve got one water fountain. Everybody is going to go to the same water fountain.”

Perhaps most important, Gallagher added monthly one-on-one catch-up meetings with each member to assess needs.

As Kaido puts it: “He knows what keeps the members at ic@3401 up at night. They’re all different issues. When somebody comes along that either has something that can solve it

“I think it’s an ideal place to start a company. When you cut to the chase, everybody needs money. They also need guidance, market strategies. Some are very early stage. They don’t even know what company they are.”

—ANTHONY GREEN, BEN FRANKLIN TECHNOLOGY PARTNERS

tenants GrowFlux, run by two Drexel alumni building a horticultural lighting and sensing platform using similar technology.

“We were able to significantly cut down our product-development time,” says Sage Smart chief technical officer Trevor Stephens. After only a few months, the company graduated to NextFab in South Philadelphia to focus on hardware development and manufacturing.

Meanwhile, GrowFlux moved from a small office on the second floor to HeavyWater’s old digs. The ping-pong table now serves as work table, where tinkering and testing of the agtech lights marketed to growers of cannabis and agriculture takes place.

Before its May move to ic@3401, GrowFlux kept offices at various co-working spots. None proved an ideal fit, says CEO Eric Eisele '09 and Chief Technology Officer Alexander Roscoe '13.

That’s because none catered specifically to startups, Eisele says. “I think,” he says, “seeing other people at the same stage as us boosts our energy.”

For ACE, which has launched pilots in Philadelphia-area schools, it’s all about networks. “It’s a space where you can bounce ideas off one another,” says Lori Severino, an assistant professor of special education and principal investigator on the I-Corps grant. “We wouldn’t have gone anywhere without Drexel Ventures and ic@3401. We would have had this great idea, and it would have just sat there.”

After all, any startup has a lengthy to-do list: “I need to find an accountant,” Gallagher says. “I need to form an LLC. I need to find someone to help me with my search optimization and marketing and webpage. . . . You can go down a Google rabbit hole. You can be paralyzed by the infinite options sitting in front of you.”

or help solve it, then he knows to put them together.”

In many ways, Gallagher’s background has proven perfect for matchmaking.

After a liberal arts degree in “everything,” as Gallagher says, he worked as a recruiter in the Philly area for four years, focused on the IT and accounting fields. In 2010, he entered Drexel’s Kline School of Law and its business and entrepreneurship program. At the same time, he was a fellow at the Keiretsu Forum, an angel investment group where he helped conduct due diligence on early-stage businesses.

With his degree in hand, Gallagher worked as a full-time associate at a small firm that counseled startups and a couple of years in, also took a role as assistant director at the Innovation, Creativity and Entrepreneurship Institute at Villanova University.

In 2016, Gallagher was hired to manage ic@3401 and carry out Kaido’s vision of a beacon for local entrepreneurs and investors. The incubator “really builds on all of those relationships and experiences dating all the way back to tech recruiting,” he says. ✕

## \_THE MASKS THAT REVEAL

A study revealed that when asked to make masks, active military service members recovering from traumatic brain injuries created images with visual signals that correlated with the seriousness of their clinical symptoms.



**\_GIRIJA KAIMAL**  
Kaimal is an assistant professor in the College of Nursing and Health Professions.

AS PART OF THEIR medical protocol for recovering from traumatic brain injuries at Walter Reed National Military Medical Center's National Intrepid Center of Excellence (NICoE), 370 active duty service members were invited to create a simple facemask that showed how they felt as part of their art therapy treatment sessions.

More than 10 percent of the masks had symbols relating to the participant's military units (like a logo or unit patch), and the same percentage depicted fragmented representations of military symbols (like a faded flag). More than a quarter of the masks had a representation of psychological injury.

The colorful, and revealing, end result? Active service members recovering from traumatic brain injuries who made masks depicting psychological injuries like anxiety and depression in their artwork were more likely to have higher levels of post-traumatic stress symptoms.

Researchers on a team led by Girija Kaimal, an assistant professor in the College of Nursing and

Health Professions, and Melissa Walker, Healing Arts Program Coordinator and an art therapist at the NICoE, analyzed the different themes.

"Few studies in art therapy have linked visual symbols with existing standardized clinical measures," explained Kaimal. "This helps us see if there are patterns of visual representations that relate to psychological states."

Moving forward, with funding support from the National Endowment for the Arts Creative Forces initiative, Kaimal and colleagues are continuing to investigate the relationships between the visual imagery created in art therapy sessions and the artists' clinical symptoms, specifically focusing on whether there are signs in the art later in a patient's treatment that indicate healing and recovery.

*"Few studies in art therapy have linked visual symbols with existing standardized clinical measures. This helps us see if there are patterns of visual representations that relate to psychological states."*

- Girija Kaimal



KAIMAL, G., WALKER, M.S., HERRES, J., FRENCH, L.M., & DEGRABA, T.J. (2018). OBSERVATIONAL STUDY OF ASSOCIATIONS BETWEEN VISUAL IMAGERY AND MEASURES OF DEPRESSION, ANXIETY AND STRESS AMONG ACTIVE DUTY MILITARY SERVICE MEMBERS WITH POST-TRAUMATIC STRESS AND TRAUMATIC BRAIN INJURY. *BMJ OPEN*, DOI: 10.1136/bmjopen-2017-021448

HUNGER

MEDICINE

WELFARE

MICROBIOLOGY

EPIDEMIOLOGY

SCREENING

FOR OVER TWO YEARS, 7,000 families answered two questions at the Children's Hospital of Philadelphia (CHOP) as part of a food insecurity screening. The evaluation of the effort — organized by Mariana Chilton, professor in the Dornsife School of Public Health and director of the Center for Hunger-Free Communities in collaboration with CHOP and Benefits Data Trust — sought to identify any barriers that may exist to implementing regular screenings and how to make them successful.

More than half of the families who reported food insecurity were given referrals for further help. But researchers observed that after that step, those connections were dropped.

Red tape contributed to the broken link between struggling families and available resources. Plus, some parents were reluctant to admit to their pediatrician that they were struggling to feed their families, for fear that they'd be reported as unfit caregivers.

The study showed the need for better follow-through, as well as less stigma associated with admitting food struggles.

**15%**

More than 1,000 families (roughly 15 percent of those screened) reported food insecurity, or a lack of money for consistent meals. But many of the families that requested additional help weren't followed up with.

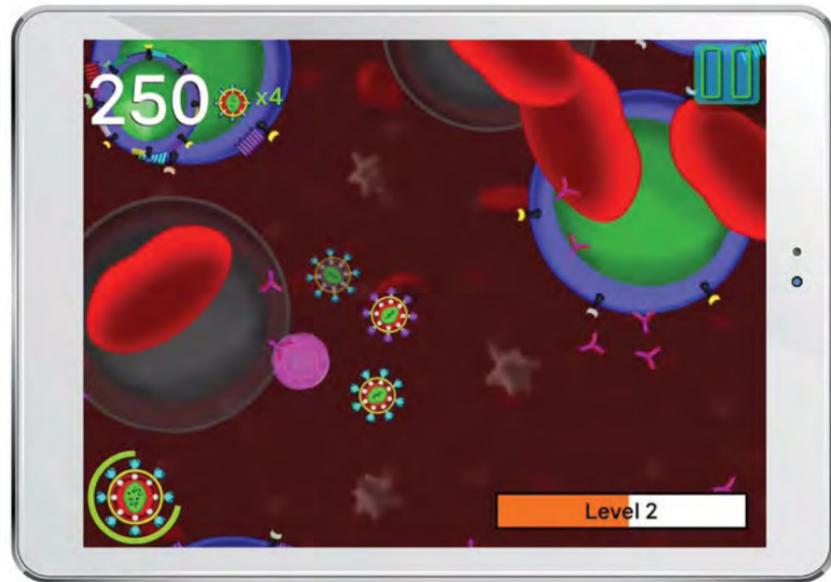
AHEAD OF THE GAME

Two educational mobile games developed by Drexel researchers turn players into microbes, providing new digital tools for teaching medicine.

IN CD4 HUNTER™, players enter the bloodstream as an HIV particle, hunting for and infecting CD4+ T cells, which are the white blood cells of the

faculty and of Drexel's co-op students from the Digital Media department to develop these games in-house," says Sandra Urdaneta-Hartmann, an

in the educational and gaming fields, with CD4 Hunter™ taking home a bronze medal in the 2018 International Serious Play Awards honoring com-



adaptive immune system. Another game, Malaria Invasion™, enables users to learn more about malaria by following Plasmo the Invader™ (named after the parasite *Plasmodium*) on his quest to infect a human.

Both of these digital games from the College of Medicine are making waves as new digital teaching strategies. Researchers from Drexel's Institute for Molecular Medicine and Infectious Disease (IMMID), expect to use these games as supplementary teaching tools for graduate students and undergraduates in advanced-level courses.

"We are thrilled to have been able to leverage the talent of our IMMID

assistant professor in the College of Medicine and director of the Center for Business and Program Development at IMMID.

"Extensive research shows that our games are meeting their intended learning goals and that students overwhelmingly welcome the interactive game-based learning platform," says Mary Ann Comunale, an assistant professor in the Department of Microbiology & Immunology in the College of Medicine and director of the Center for Scientific Communications and Outreach, who led the design of the game and assessment studies.

Already, the games are generating success both

**GAME\_ON**  
Two new video games developed in the College of Medicine are being used as supplementary teaching tools for medical students.

mercial and student titles used for training and/or educational purposes.

"These games will help to increase public awareness of the challenges faced by the biomedical research community and stress the importance of research to prevent and treat diseases caused by these devastating human pathogens," says Brian Wigdahl, professor and chair in the Department of Microbiology and Immunology and director of the IMMID.

WELFARE



MARIANA CHILTON Chilton is the director of the Center for Hunger-Free Communities and professor in the Dornsife School of Public Health.

THE STATE'S Temporary Assistance for Needy Families (TANF) program focuses on pushing welfare recipients into the workforce, with little support for conditions that might limit recipients' opportunities or ability to secure competitive pay. A new study led by the Center for Hunger-Free Communities of the Dornsife School of Public Health shows that there could be better outcomes for those participating in welfare if they received help addressing childhood traumas.

More than 100 TANF recipients who are caregivers to young children participated in the study. Those who received the trauma-informed peer support experienced improvement in self-confidence, mental health and economic security.

"Financial education without the trauma-informed peer support had virtually no impact on improving income and in promoting health," says Professor Mariana Chilton. "Once the trauma-informed peer support was mixed in, income started to improve and mental health for the parent really improved."

With the study conducted with encouragement from the state, Chilton hopes that it can be added to current TANF programming.

DIRTY GURNEYS

For the first time, researchers are taking a close look at the bacterial ecosystems in ambulances across the country.

AT HOSPITALS, diseases are often transmitted among patients — but patients might actually be exposed to these infections on their way to the hospital.

Using DNA analysis methods being popularized by a lab at Drexel, a group of medical and public health researchers at Weill Cornell Medicine are tracking the illness-causing agents hitching a ride in ambulances.

Associate Professor Gail Rosen and her Ecological & Evolutionary Signal-Processing & Informatics Laboratory analyzed DNA of nearly 400 samples from

137 ambulances in 19 cities in six states. The methods, based on "whole-genome shotgun sequencing," provide a thorough genetic-level look at collections of organisms — without having to collect, identify and count every organism in the group.

While the ambulance microbiomes differed by region, one of the findings the researchers discovered was an increase in antimicrobial resistant bacteria in ambulances from lower latitudes in the east.

"The methods we developed can be used for forensic analysis," Rosen says. "For example, we



GAIL ROSEN Rosen is an associate professor in the College of Engineering.

found that stethoscopes were more likely to have microbes that eat cleaning agents. It was fun to get a peek into microbial communities' lives, especially those that we cannot culture, to try to see how climate and geographic areas may affect ambulance microbiomes."



MOM, TAKE YOUR VITAMINS

Researchers have turned up one more reason pregnant women should take a multivitamin.

PREGNANT WOMEN are given lists of "do's and don'ts" for what to do, eat, drink and take during pregnancy — and a study led by the Dornsife School of Public Health adds one more item to that list. The study found that if an expecting mother

tween supplement use during pregnancy and autism is intriguing because it suggests a possible avenue for risk reduction," says Associate Professor Brian Lee, who is a fellow in the A.J. Drexel Autism Institute and senior author of the study. The study's lead au-



BRIAN LEE Lee is an associate professor in the Dornsife School of Public Health and a fellow in the A.J. Drexel Autism Institute.

took multivitamins during her pregnancy, her child was roughly 30 percent less likely to develop autism with a co-occurring intellectual disability.

"A potential link be-

thor is Elizabeth DeVilbiss, a recent doctoral graduate of the Dornsife School of Public Health.

The decline in risk linked to multivitamin use only seemed to be tied to autism with intellectual disabilities attached, since the odds of developing autism without an intellectual disability did not seem to be affected.

This study furthers research being conducted in the A.J. Drexel Autism Institute of the autism risk linked to diet during pregnancy, of which comparatively little is known.

BIG DATA

**\_GEOGRAPHY IS DESTINY**

Your ZIP code may have a bigger impact than you know on how long and how well you live.

WHERE YOU LIVE should not determine your lifespan, but it often does. Health disparities in neighborhoods result from access to transportation, limited supplies of nutritious food, poor access to

— from stores, to restaurants, parks and pools. Lovasi's team is mapping business of all types to create nationally linked datasets under an effort called the Retail Environment and Cardiovascu-

with partners from Drexel, Geisinger-Johns Hopkins University, New York University and University of Alabama, will use the retail environment data to understand geographic patterns of diabetes risk and related



**FOOD\_LANDSCAPE**  
Lovasi's team has done so much to clean up the retail environment data that other public health researchers are asking to use it.

primary care and unstable housing, among other factors. To address these issues, it's critical to assess all the factors impacting the health of a community — and that's where big data comes in. At the Dornsife School of Public Health, Associate Professor of Urban Health and co-director of the Urban Health Collaborative Gina Lovasi is culling information from some of the nation's largest databases on neighborhood resources

lar Disease study. They licensed and geocoded comprehensive business data from across the continental United States for each year in the period from 1990 to 2014, and created more than 100 health-relevant retail categories. Their goal is to use neighborhood data alongside health outcomes to inform zoning initiatives, policies and public health programs that increase healthy food availability, walkability and proximity to medical facilities. They've done so much to clean up the accuracy of the data that other groups are asking for the resource. For instance, the CDC-funded Diabetes LEAD Network,

health complications. In addition, the National Institutes of Health funded an extension of the project to investigate new aims on independent aging and cognitive function. "One of the major limitations of earlier work [of this type] was relying on a snapshot in time," Lovasi says. "We're [now] able to look over a long period for changes. This helps us make sure we're measuring the environment at the right time. We are also looking at trajectories of change and whether those trajectories affect health. That's why we want to go back to 1990. It takes decades to accumulate enough cases to do this work."

OBESITY

**\_SLOW AND STEADY**

Shedding consistent pounds each week is linked to long-term weight loss.

TRYING TO LOSE WEIGHT? Aim for consistency. That's what principal investigator Michael Lowe and lead author Emily Feig found was associated with the best maintenance of weight lost in a weight loss program. Out of 183 participants, those whose weights fluctuated the most during the initial weeks of a behavioral weight loss program ultimately had poorer weight loss outcomes both one and two years later, compared with those who lost consistent weight each week. For example, someone whose weight yo-yo'd over the course of several weeks tended to fare worse than someone who lost one pound consistently each week for three weeks.



**\_MICHAEL LOWE**  
**\_EMILY FEIG**  
Lowe is a psychology professor in the College of Arts and Sciences. Feig '17 is a clinical research fellow in the Department of Psychiatry at Massachusetts General Hospital.

"It seems that developing stable, repeatable behaviors related to food intake and weight loss early on in a weight control program is really important for maintaining changes over the long term," says Feig. Hesitant to equate correlation and causation in

this case, Lowe said the study illuminates a potential method for sticking to weight loss goals. "Settle on a weight loss plan that you can maintain week in and week out, even if that means consistently losing 3/4 of a pound each week," he says.



**\_ONLINE**  
This video from the DeCarlo Laboratory shows how particles from third-hand smoke collect indoors: <https://vimeo.com/268404346>.

**\_ 'NON-SMOKING' DOESN'T MEAN SMOKE-FREE**

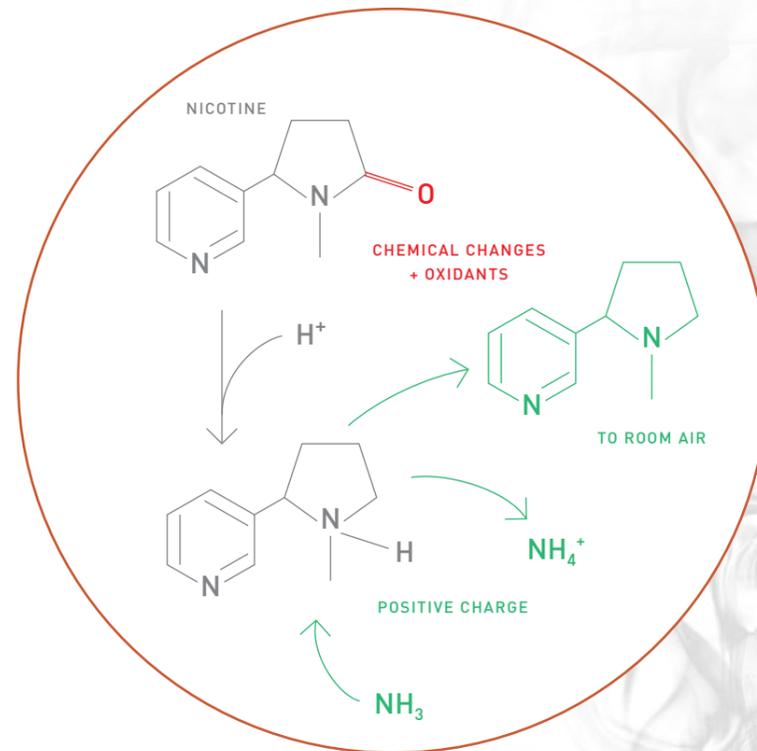
Smoking bans may prevent exposure to second-hand smoke but they do nothing to protect the occupants of buildings from the lingering particles of so-called "third-hand" smoke.

MOST PEOPLE are aware of the dangers of exposure to second hand smoke. But researchers have found that a surprising quantity of "third-hand" smoke — the lingering chemical residue of tobacco that clings to surfaces long after a cigarette is extinguished — can also be found indoors where there has been no active recent smoking.

"Third-hand smoke, which we are realizing can be as harmful to health as second-hand smoke, is much more difficult to avoid," says Associate Professor Michael Waring.

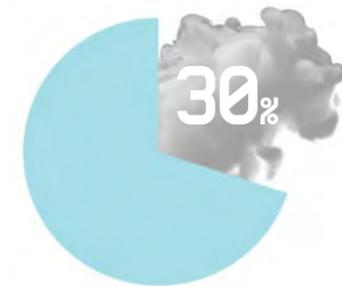
To investigate this surprising finding, Waring teamed up with Associate Professor Peter DeCarlo and graduate student Anita Avery to simulate third-hand smoke exposure in a lab. In their controlled test using a closed container, they found a 13 percent increase in third-hand smoke chemical species, which meant that, though it seemed as though the smoke had cleared, a residue remained.

"Aerosol particles are ubiquitous particles suspended in the air — they come from a variety of sources and are known to be detrimental to health," DeCarlo says. "The fact that third-hand smoke can attach to them, like it would to the clothing or furniture of a smoker, means that the potentially toxic chemicals associated with third-hand smoke are found in places we wouldn't have expected."



**TRACE\_TOBACCO**  
Air quality measurements taken from an unoccupied, nonsmoking classroom indicated that almost 30 percent of the particulate matter small enough to be absorbed by the human lung was associated with smoke residue.

**LAB\_EXPERIMENT**  
Researchers pumped cigarette smoke into a Pyrex container and then pumped it back out and cleared the container with fresh air. A day later, they circulated filtered outdoor air through the container and measured the aerosol particles inside. Compared with outdoor air, the container had 13 percent more third-hand smoke chemicals.



**\_PETER DeCARLO**  
**\_MICHAEL WARING**  
DeCarlo is an associate professor in the College of Engineering and in the College of Arts and Sciences. Waring is an associate professor and associate department head for undergraduate programs and director of the Architectural Engineering Program in the College of Engineering.

# THE LONG SHADOW OF CHILDHOOD



\_ FÉLICE LÊ-SCHERBAN  
\_ IRENE HEADEN  
\_ ROBERTA WAITE  
Lê-Scherban is an assistant professor of epidemiology and a researcher in the Dornsife School of Public Health's Urban Health Collaborative (UHC). Headen is a postdoctoral research fellow in the Urban Health Collaborative in the Dornsife School of Public Health. Waite is director of the Drexel-operated Stephen and Sandra Sheller 11th Street Family Health Services.



EVIDENCE IS GROWING THAT TRAUMAS EXPERIENCED IN CHILDHOOD CAN HAVE A LIFELONG AND POSSIBLY EVEN MULTIGENERATIONAL IMPACT ON PHYSICAL AND MENTAL HEALTH.

\_by Deborah Shelton

\_photographs by Jeff Fusco

**C**rystal Wyatt's childhood memories include an eviction, her mother's crack cocaine addiction, violent fights between family members and hearing gunfire in her southwest Philadelphia neighborhood. Even a stroll down the street could be harrowing. "I can't even tell you how many dead bodies I've seen," Wyatt says.

The constant stress took a toll. Throughout her life, she has battled anxiety and reproductive health problems. When she was 40, she was diagnosed with Type 2 diabetes.

Though her childhood is far behind her, the health problems she's experiencing now may have roots in her upbringing. A growing body of research indicates that traumatic events early in life, such as emotional, physical or sexual abuse, referred to as adverse childhood experiences, or ACEs, greatly increase a person's risk of developing health problems in adulthood.



85%

Overall, 85 percent of the parents in a Drexel study reported at least one adverse childhood experience; 18 percent had six or more.



### HOW CHILDHOOD IMPACTS ADULTHOOD

Studies have linked ACEs to risky behaviors, chronic health conditions and premature death, ranking it as one of the nation's leading public health issues.

"The higher the ACEs score, the more disabled people become," says Sandra Bloom, associate professor of health management and policy at the Dornsife School of Public Health. "The risk is significantly increased for a wide variety of problems, and it leads to a lack of overall health in the population as a whole."

How common are childhood traumas? One landmark study by the Centers for Disease Control and Prevention and health care provider Kaiser Permanente surveyed more than 17,000 mainly white, middle-class, college-educated adults in California about their ACEs exposure up to age 18. The study defined ACEs as psychological, physical or sexual abuse; emotional or physical neglect; violence against one's mother; parental separation or divorce; or living with a household member who is a substance abuser, mentally ill or suicidal, or who has ever been imprisoned. Almost two-thirds of participants reported at least one ACE, and more than 1 in 5 reported three or more.

The study confirmed what some health professionals already knew, says Bloom, a psychiatrist who for 20 years ran a short-term psychiatric unit for adults abused as children. "This is where a lot of psychiatric disorders and a lot of physical illness is coming from," she says. "We saw it in our patients and the study confirmed it and gave us research-based evidence that this is a real epidemic."

Two recent studies by Drexel researchers show that the health consequences of adversity can be so long-lasting that they are passed from one generation to the next.

Research led by Assistant Professor of Epidemiology Féllice Lê-Scherban linked parents' exposure to trauma during

childhood to worse overall health, including asthma, in their children. The study, published in the journal *Pediatrics*, linked data from two population-based, cross-sectional telephone surveys in Philadelphia that asked parents about their past exposure to adversity and their children's health, respectively. Participants were 350 parent-child pairs. Researchers used logistic regression models, adjusted for parent and child characteristics, to examine associations between the parents' past traumas and the health of their children.

Overall, 85 percent of the parents had at least one ACE; 18 percent had six or more. For every type of adverse event that parents experienced, their children had 19 percent higher odds of having poorer health and 17 percent higher odds of having asthma.

"There are a whole host of socioeconomic, psychological and physical effects of trauma exposure on parents that can affect the context in which they live their lives," says Lê-Scherban, who is a researcher in the Dornsife School of Public Health's Urban Health Collaborative (UHC). Lower education and income have also been linked to adverse childhood experiences, for example, which can shape the circumstances in which children grow up.

"Also, there's evidence documented in other studies of physical changes caused by adverse childhood experiences, like developmental, epigenetic and physical changes in the womb," she says.

The findings suggest that intergenerational processes are at work and that health providers need to think about families holistically. Interventions could promote resilience and improve the well-being of parents and their children.

"When we talk about epigenetic differences, it appears fatalistic, like the story is written before the child is born," Lê-Scherban says. "But that's not the case. This is more about being aware when you are working with a child that there needs to be support for the whole family — and the whole community."

+19%

For every type of adverse event that parents experienced, their children had 19 percent higher odds of having poorer health and 17 percent higher odds of having asthma.

7/10

In Philadelphia, almost 7 in 10 adults reported at least one adverse childhood experience.

4+

Almost 40 percent of surveyed Philadelphians had experienced four or more community-level adversities.

### HOW CHILDHOOD ADVERSITY AFFECTS PREGNANCY

Some researchers are widening their lens beyond the family circle. A study led by Irene Headen, a postdoctoral research fellow in the Urban Health Collaborative, examined adversity from a neighborhood perspective. In the first study to investigate associations between cumulative neighborhood deprivation and non-optimal pregnancy weight gain (less than 25 pounds or more than 35 pounds in most cases), Headen found that the longer a woman resided in a disadvantaged socioeconomic area, the less likely she was to gain a healthy weight during pregnancy.

In a study published in the journal *Health & Place*, she analyzed data on 3,300 women and 5,700 pregnancies from a nationally representative survey taken between 1979 and 2012.

Neighborhood deprivation was measured on a socioeconomic scale that included poverty, unemployment and other factors. Living in a neighborhood with higher deprivation was the most important factor linked to increased risk of gaining too little weight during pregnancy. The findings have important implications for understanding how social environment affects health across the life course, especially during the critical time of pregnancy.

"When we're thinking about how to help support women in achieving healthy weight gain and supporting the next generation of children, we need to think about how to support equitable neighborhood development — now," Headen says. "Equitable neighborhood development not only has implications for helping women and children growing up today, but it will help the next generation of women and children."

Neighborhood is an overarching context that affects many aspects of a woman's life, Headen says. "Studying environment allows us to bring nuance to or expand this narrative that often comes up that it's (solely) genetic or biological differences that drive all the racial inequities that we see."

### HOW CHRONIC STRESS AFFECTS COMMUNITIES

Children are particularly vulnerable to trauma from birth to age 5, says Roberta Waite, director of the Stephen and Sandra Sheller 11th Street Family Health Services that is run by Drexel and the Family Practice and Counseling Network. "Their brains are still developing, and they might not have the language to talk about the trauma they've experienced or have coping mechanisms," she says. "It can be hugely detrimental to a child's brain, developing immune system and overall mental status."

Residents of the four public housing developments in the 11th Street corridor make up the target population of the health center that Waite oversees. In a study of adverse childhood experiences that Waite conducted with two colleagues some 49 percent of the 801 patients surveyed had been exposed to four or more adversities. That compares to 12 percent in the CDC-Kaiser Permanente study cited earlier.

Although adversity crosses the socioeconomic spectrum, people living in low-income communities are at higher risk due to violence, high unemployment, food and housing insecurity and other hardships. In Philadelphia, where a quarter of residents live in poverty, almost 7 in 10 adults reported at least one adverse childhood experience and 1 in 5 had experienced four or more, according to the Philadelphia Expanded ACE Survey, based on data from almost 1,800 Philadelphia adults.

Conducted between November 2012 and January 2013, the expanded survey added five community-level adversities not included in the CDC-Kaiser Permanente study: witnessing violence, living in foster care, being bullied, experiencing racism or discrimination, and feeling unsafe in your neighborhood. Almost 40 percent of surveyed Philadelphians had experienced four or more of these.

"We are looking at the first generations to possibly not live as long as their parents," says Peter Cronholm, MD, an associate professor of Family Medicine and Community Medicine at the University of Pennsylvania who helped to develop the Philadelphia Expanded ACE Survey. "I wonder if some of that is because of the impact of adversities over the generations."

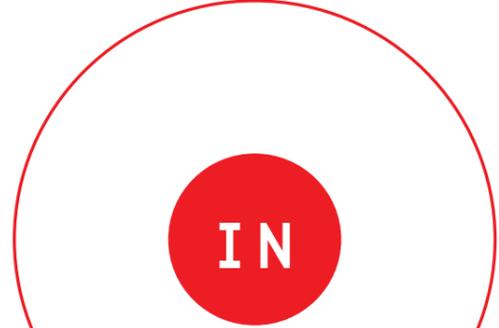
Just as trauma can change the brain in unhealthy ways, minimizing adversity and intervening services and treatment can help repair it. Some physicians are rethinking how they conduct social histories to better identify individuals who need trauma-related treatment and support.

Wyatt, who owns a business that transports women to prisons to visit loved ones, created a program called "Real Resilience" that provides the women with workshops and social support.

Many of her clients have experienced multiple traumas. She also got involved in community-based participatory research to help raise awareness about adverse childhood experiences.

"It's important to me," Wyatt says, "because in my heart, deep down inside, I want the world to be healed." ✕

**SYNOPSIS** "C'est La Vie" revolves around a community health center in the fictional village of Ratagna and the everyday health challenges of the inhabitants. The story is set in motion by the tragic deaths of a 15-year-old mother and her baby during delivery. The event shatters Ratagna and becomes a catalyst for the community and the health center staff to grapple with issues such as maternal and child health, family planning, gender-based violence and reproductive rights.



**LIVING ROOMS** Across French-speaking Africa, a new evening ritual has emerged: family members gather to watch a half-hour soap opera created both to entertain and to educate.

There, they meet 20-year-old Émadé, who was forced into marriage at 15. Already the mother of two young children and pregnant with a third, she is determined to learn how to read and write, free herself from the homemaking demands of her mother-in-law, adopt family planning techniques and become economically independent.

Then there's Assitan, an idealistic 25-year-old beauty who has recently taken her first job, as a midwife at the Ratanga Health Center. Assitan learned the best medical practices during her training, but must now cope with the unexpected complexities of a real-world environment. Adding to the stress is her own HPV diagnosis.

Émadé and Assitan are just two among a palette of characters whose lives continue to unfold as the third season of "C'est la Vie" gets underway.

As entertaining as "C'est la Vie" is, the series' producers have bigger goals besides having a hit show. It is produced by Réseau Africain d'Éducation en Santé (RAES), a nongovernmental organization with the mission of advancing health, education and citizenship in Africa. In a part of the world where young women often lack basic knowledge about their bodies, "C'est la Vie" translates research-based messages about sexuality and reproductive rights, maternal and child health, and gender violence into captivating story lines.

In doing so, "C'est la Vie" brings the tradition of telenovelas, pioneered in Mexico by Miguel Sabido in the 1970s, to Africa. "This is a powerful way to get many millions of people focused on the stories we tell," says Alexandre Rideau, the program's French producer, who studied under Sabido. "Soap operas allow repetition, take time for characters to evolve, learn the consequences of their choices, and maybe not repeat the same mistake if they are wise or lucky enough."

"C'est la Vie" has been adapted for radio, the internet and streamed through YouTube. It has also spawned youth clubs and public screenings and engendered vigorous discussions in community settings and through social media. "We are informing the public and we are putting in space for dialogue and brainstorming and reflection," Rideau

PHOTOS: @KHALIFA\_HUSEIN

**C'EST LA VIE** | A PUBLIC HEALTH DRAMA IN AFRICA

*A group of researchers are investigating the power of a broadcast soap opera to spread health messages to francophone communities in West Africa.*

*\_by Karyn L. Feiden*

says. “It is a combination of mass media and community activity that will really have an impact on the population.”

The show’s capacity to make audiences tune in and discuss public health issues is why Philip Massey, assistant professor in the Department of Community Health and Prevention at the Dornsife School of Public Health, is partnering with Deborah Glik, a professor in the Department of Community Health Sciences at the UCLA Fielding School of Public Health, to test the salience and impact of the series.

If packaging information of public interest into an entertaining format is a successful way to improve community health, it’s a model worth studying.

**THE SCIENCE OF AUDIENCE**

Dornsife and UCLA have each received \$300,000 over three years from the Bill & Melinda Gates Foundation to evaluate “C’est la Vie.” Building on digital research, the Dornsife component neatly weaves together the many strands of Massey’s expertise. Fluent in French and knowledgeable about the public health and the health care systems of West Africa, he has a longstanding interest in how technology can build connections among peers and spread knowledge.

A combination of opinion polling, surveys, media surveillance and Google analytics data will inform the research. “The evaluation uses a mixed-method approach,” Massey explains. “In ‘media-effects research’ it is nice to have different types of data to help tease out and identify different mechanisms and pathways from exposure to outcomes.”

Despite the breadth of the measures, however, one hard

most “liked” YouTube comments were those that expressed pride in seeing African actors on the screen. Later in the season, people gave a thumbs-up to requests for two shows a week. “People are wanting more, that tells us we are hitting on areas that matter,” says Massey. A third popular set of comments directly engaged the issues covered by “C’est la Vie,” such as a lively debate about why one character stayed with the husband who beat her.

The researchers use a pyramid to visualize the many components of the evaluation, with their differing sample sizes. Every sample includes baseline questions — who knows about “C’est la Vie,” who watches it and how often, what do they like or dislike about the program? Moving up the pyramid, a smaller number of people are asked how much they understand and agree with the program’s messages, and how much they discuss them with others. At the pinnacle are questions about the intention to act, or actual action, in response to altered views of social norms.

Although the ultimate goal is to influence action and decision making, no one expects that to happen overnight. “Absolutely, we will measure norms, but we have to be sure to walk it back and look at shorter-term outcomes that we can measure, given our understanding of theory and human behavior,” Massey says. “We know, for example, that messages start to stick when people talk about them with others, so we want to know are you talking about the themes of ‘C’est la Vie?’ With whom?”

“I want to be very humble about getting to behavior change, but we are researching strategies with Drexel to make sure they will learn something,” Rideau says.



PHILLIP MASSEY  
Massey is an assistant professor in the Department of Community Health and Prevention at the Dornsife School of Public Health.



“We are informing the public and we are putting in space for dialogue and brainstorming and reflection. It is a combination of mass media and community activity that will really have an impact on the population.”

– ALEXANDRE RIDEAU, PRODUCER



number is not easy to come by: viewership. Because the show’s messages filter out through so many different media, “it is very difficult to say how many people have watched the episodes,” says Rideau. He is sure that millions, and perhaps dozens of millions, have encountered “C’est la Vie,” which has been broadcast on Pan African TV networks and on national television stations across the continent. The show has also been widely distributed to local stations in at least 15 countries and the series is being dubbed in English, Housa, Swahili and other local African languages.

As part of the strategy for capturing audience responses, Massey’s evaluation team is analyzing “likes,” “shares” and comments on Facebook, Twitter, Instagram and YouTube. After the first few episodes of season one, for example, the

**JOBS AND MENTORSHIP**

Along with influencing attitudes toward health, “C’est la Vie” helps to grow a trained workforce.

“One of the exciting things is that it is African through and through,” says Massey. The writers, producers and actors are all drawn from Senegal, Mali, Burkina Faso, Côte d’Ivoire and other countries in West Africa. The training and practical experience they gain on the set helps to create a cultural and film industry in Senegal and West Africa, according to Mbathio Diaw Ndiaye, executive director of RAES, “C’est la Vie’s” parent organization. “The program offers work to 150 people each year, and helps empower a local elite,” says Ndiaye, who holds a master’s degree in organizational management.

**ANATOMY OF A SCENE**



Magar is asking one of the girls in the village if she has seen her daughter, Caro, unaware that Caro’s grandmother Rokoba has taken Caro to a faith healer to perform female circumcision.



Caro’s friend covers for Rokoba at first, but eventually admits to Magar that Caro and Rokoba are at the faith healer’s. She points the direction they left in.



At the faith healer’s house, Magar finds several young girls awaiting their operation, but Caro is already inside.



Magar finds that she was too late to stop the operation. She carries Caro out of the house, angrily brushing past Rokoba.



Magar climbs into a car and rushes Caro to a hospital.



Caro arrives at the hospital and is wheeled inside by a doctor. Magar is filled with regret that she didn’t do enough to protect her daughter.



The doctor has bad news: Caro did not make it.



Magar says goodbye to her daughter, and prepares to tell Caro’s father that the girl has passed away.



Afterward, one of Caro’s friends has questions about what happened, and the women discuss the health implications of female circumcision.

In another capacity-building component, graduate students at the Université de Cheikh Anta Diop (UCAD) in Dakar, Senegal, play key roles in the evaluation. “We saw a really great opportunity to partner with the university to train these students,” Massey says.

Matthew D. Kearney, a doctoral candidate at Dornsife, works with Massey, who is his advisor, to help teach a research methods workshop in Senegal. As the team developed sampling techniques and began collecting data, “we could all see where the rubber hits the road,” he recalls.

Gning Abdou, a UCAD post-doc, is among the students collaborating with Drexel and UCLA on formative research to test the program’s health messages and storylines and ensure they are culturally competent and accurate. That, he says, allowed him to have wider scope and much more accuracy in evaluating themes related to sexual and reproductive health, and to violence. “This varied experience has allowed me to now feel more at ease in research,” he

says. “I make use of this experience in both academic and intervention-based research.”

Going forward, the U.S. evaluators plan to create deep mentoring opportunities for a small cadre of UCAD doctoral students.

**TV AS A TOOL**

When Rideau first began talking with the Gates Foundation about possible support, he emphasized the challenge of repurposing television as a tool for health communications. “No one knows exactly how to use television correctly,” he says. “We are really innovating here.”

“What we agreed on with the Gates Foundation is to use this opportunity to not only measure the impact of ‘C’est la Vie,’ but also to contribute to new strategies using digital tools,” says Rideau. “We need evaluation to find out what we are doing correctly, and what we need to refine. That is the only way to be relevant.” ✕

### \_ DATA FOR SOCIAL ACTION

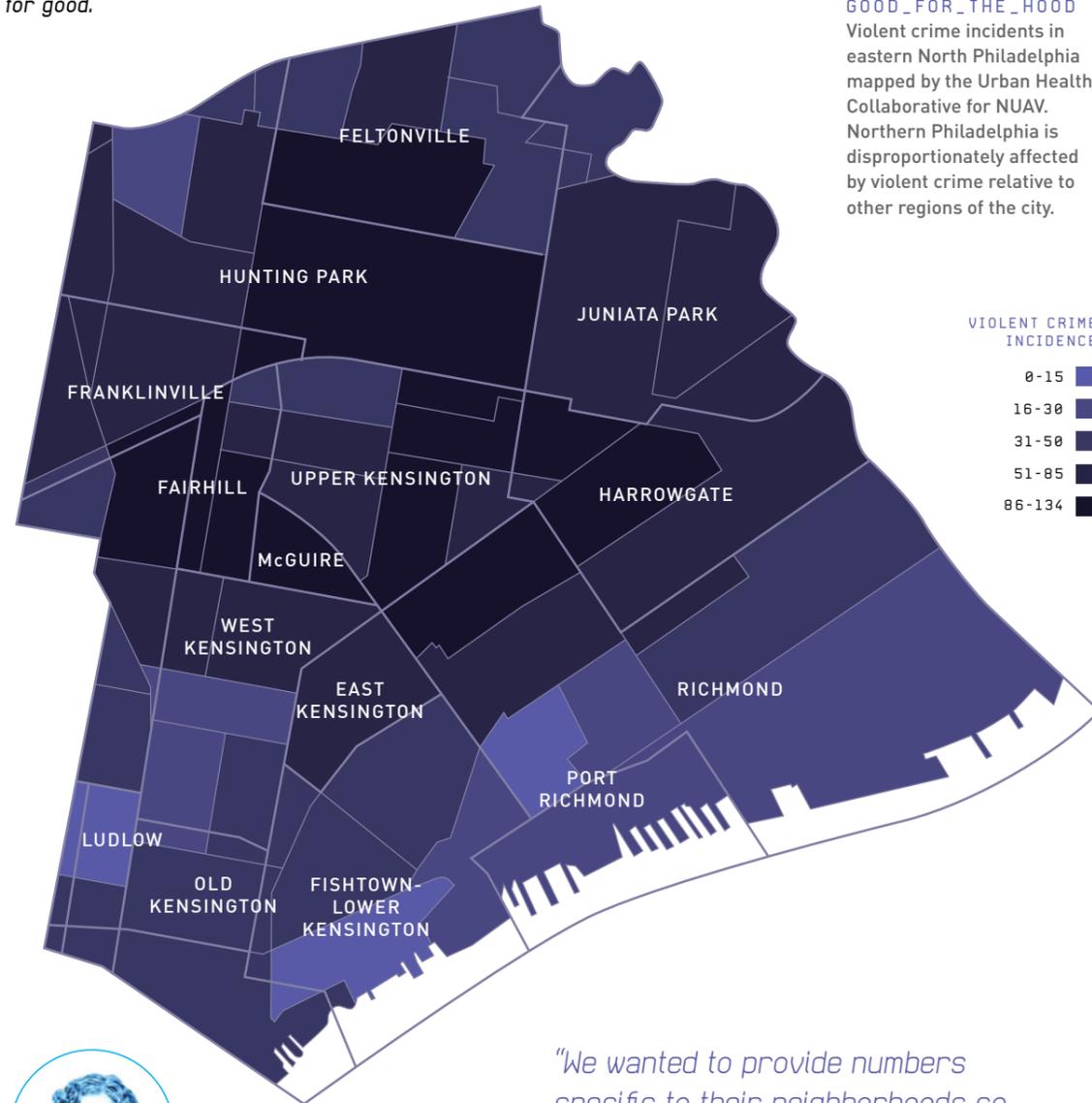
Neighborhood-specific data for eastern North Philadelphia has been collected under a single source, to be used for good.

**I**N A CITY OF neighborhoods like Philadelphia, it can be challenging for social organizations and nonprofits to collect data on specific populations to whom they want to provide services because demographic information is widely dispersed among different agencies and public health districts.

A partnership between Philadelphia nonprofit Congreso de Latinos Unidos and Drexel's Urban Health Collaborative seeks to address that. They've charted data on neighborhood-specific violence in eastern North Philadelphia — the nexus of the city's Latino population that includes neighborhoods like Kensington, Port Richmond and Juniata Park.

Those numbers were unveiled publicly on a new website, NUAVNow.org — an instant boost to the many neighborhood-based community organizations that operate on limited funds and require grants to survive. Standing for "Neighborhood United Against Violence," NUAV presents data from multiple sources, mapped to describe violence rate, related risk factors and violence prevention assets in eastern North Philadelphia.

This project comes at an important time for the area. Securing grants is hyper-competitive. The data and maps NUAVNow provides at the neighborhood level will give nonprofit organizations an advantage.



**GOOD\_FOR\_THE\_HOOD** Violent crime incidents in eastern North Philadelphia mapped by the Urban Health Collaborative for NUAV. Northern Philadelphia is disproportionately affected by violent crime relative to other regions of the city.



**\_ AMY CARROLL-SCOTT** Carroll-Scott is an assistant professor in the Dornsife School of Public Health and co-lead of the Policy and Community Engagement Core of the Drexel Urban Health Collaborative.

*"We wanted to provide numbers specific to their neighborhoods so that community-based organizations have what they need, at the ready, when they write grants or advocate for programs or policy changes."*

- Amy Carroll-Scott

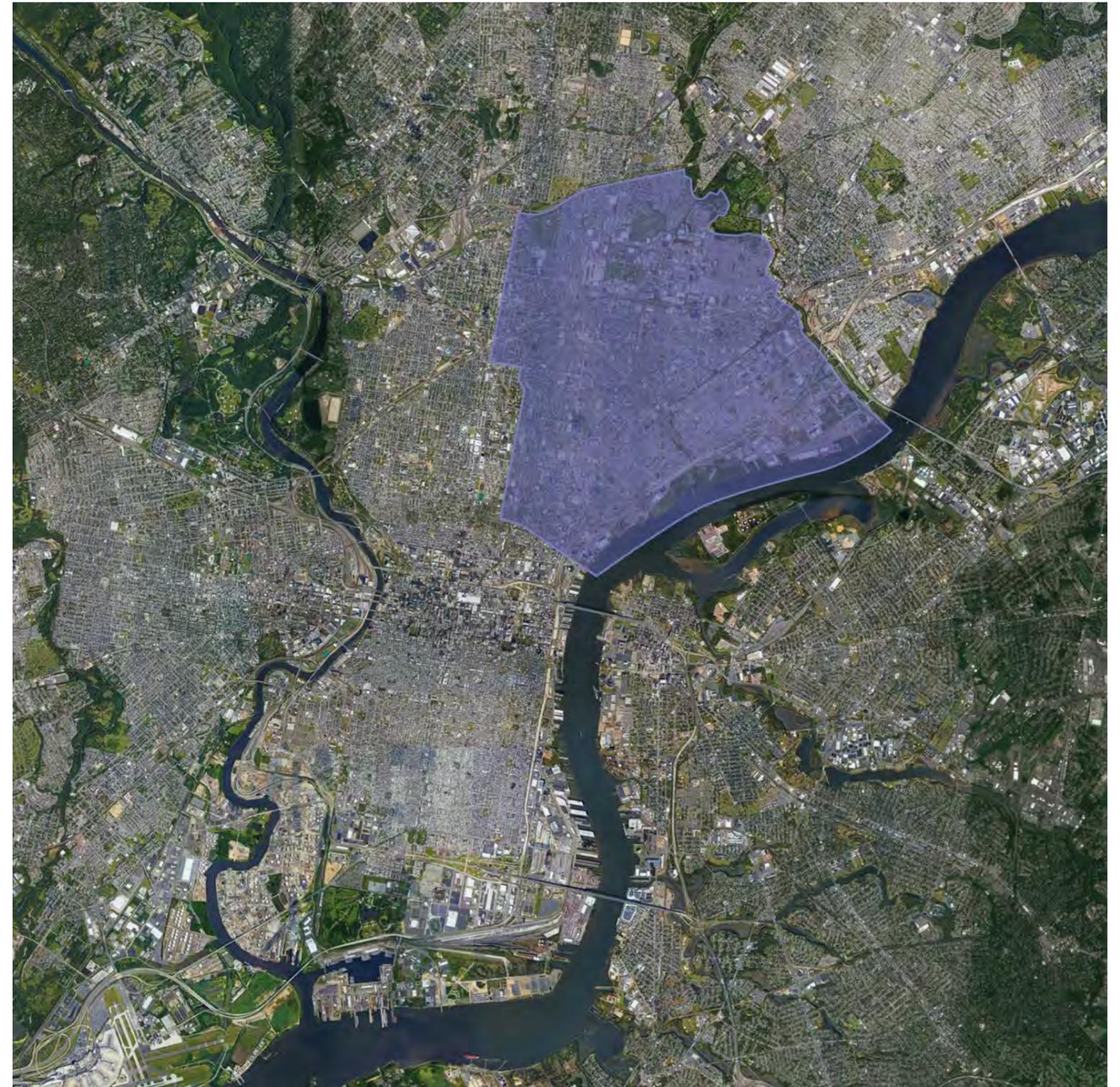


IMAGE © GOOGLE, GRAY BUILDINGS © SANBORN

EQUALITY

LAW

MANAGEMENT

BIG DATA

SOCIAL MEDIA

\_ GATED ATHLETES

Are exclusive, player-only villages a good thing? According to Drexel research, these coach-supported "athletic villages" have drawbacks for individual players and universities.



\_ KAREN WEAVER Weaver is an associate clinical professor in the LeBow College of Business' Sport Management Department.

Weaver and co-author Jordan Tegtmeier observed that while these villages are flashy and enticing, they reduce the amount of interaction a student-athlete has with the rest of the student body.

Weaver's research was cited in the plaintiff's opening arguments in the 2018 Alston v NCAA trial in Oakland, California. This case was brought to the court by former Division I athletes who believe the NCAA's restrictions on college athlete compensation are an illegal restraint of trade. Weaver's research was included by the players' counsel because it demonstrated the isolation and segregation that athletes can experience when coaches expect athletes to spend their non-class time with their teammates inside these restricted communities.

The federal judge issued a ruling in the winter that was favorable to college athletes; an appeal to a higher court is anticipated.



\_ SIT AND SUE

Sitting for long periods has been linked to a number of health negatives; now, a Drexel specialist-authored paper claims employers should be held liable for harms caused to employees.

AFTER AN ANALYSIS OF potential workers' compensation claims in sedentary environments across several states, two Drexel researchers claim employers should be held accountable because it will force them to mitigate such harms in their work environments.

Associate Professor of Legal Studies in the LeBow College of Business Natalie Pedersen and Lisa Eisenberg, a 2017 graduate of the Thomas R. Kline School of Law and current deputy attorney general in the Fair Labor Section of the Pennsylvania Office of the Attorney General published an analysis in the Lewis and Clark Law Review that looked at the issues of sitting in the workplace and accompanying medical problems, and examined the structure of liability in the United States for workplace injury.

"As our workplaces have become more sedentary, our risk of adverse health outcomes has increased," says Pedersen. "Increases in technology have only exacerbated an already dire situation leaving a large portion of the American workforce sitting for most of the workday."

Establishing that the workplace is a cause of the harm can be a minefield. Sedentary workplace claims were rejected in most of the unusual exertion or special rules jurisdictions, according to



\_ NATALIE PEDERSEN \_ LISA EISENBERG Pedersen is an associate professor of legal studies in the LeBow College of Business and Eisenberg '17 is a graduate of the Thomas R. Kline School of Law and deputy attorney general in the Fair Labor Section of the Pennsylvania Office of Attorney General.

the authors, but there have been cases that show courts may be willing to find that claimants have satisfied the requirements.

"Companies who are adopting methods of mobilizing their otherwise sedentary workplaces are certainly ahead of the curve," says Eisenberg.

\_ FOCUS ON THE FAMILIAR

If you want people to embrace change, don't preach change's positive impact.

NEW RESEARCH FINDS that, contrary to common wisdom, the more effective way for organizations to get employees to embrace change is to emphasize what will remain the same.

According to research published by LeBow College of Business Professor Daan van Knippenberg and his co-authors, people fear that after change, the organization will no longer be the organization they value and identify with. The higher the uncertainty surrounding the change, the more they anticipate such threats to the organizational identity they hold dear.

this theory in a survey of organizations going through change and an experimental study, the implications of which are straightforward. Unless they are able to assure people that "what defines the organization's identity — what makes us who we are — will be preserved despite the changes, leaders may have to brace themselves for a wave of resistance," they wrote.

The paper, co-authored by Merlijn Venus of the University of Amsterdam and Daan Stam of Erasmus University Rotterdam, was published in the Academy of Management Journal.

"Effective change leadership has to emphasize continuity—how what is central to 'who we are' as an organization will be preserved, despite the uncertainty and changes on the horizon."

-study authors

"Change leadership that emphasizes what is good about the envisioned change and bad about the current state of affairs typically fuels these fears because it signals that changes will be fundamental and far-reaching," they wrote. "Effective change leadership has to emphasize continuity — how what is central to 'who we are' as an organization will be preserved, despite the uncertainty and changes on the horizon."

The researchers tested



\_ DAAN VAN KNIPPENBERG Van Knippenberg is a professor in the LeBow College of Business and academic director of the Institute of Strategic Leadership.

\_ CODE 101

Do computer algorithms perpetuate built-in biases?

PROFESSOR OF SOCIOLOGY Kelly Joyce wanted to find out who makes computer algorithms and how values translate into the work they do.

Joyce partnered with Kristene Unsworth, a visiting assistant professor at Stockton University. They studied teams of computer scientists and engineers who build big data sets — conducting interviews and sitting in on dozens of meetings. Based on that, they wrote data-driven scenarios that engage future computer scientists in ethical problem solving.

The result was a study on "The Ethics of Algorithms," funded by the National Science Foundation. It is one of the first studies to create scenarios specific to algorithms and big data, employing a critical "upstream" approach that focused on education.

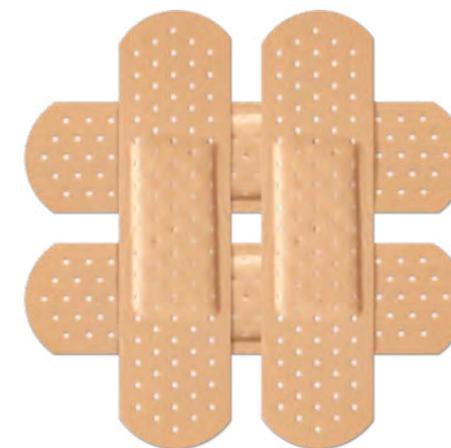
The decision to focus on big data was influenced by examples of algorithms' increasing inequalities in a variety of fields — from health care to law enforcement and business.

As Joyce says, although data about humans may be perceived as "neutral, inclusive or representative," it is often more complicated than it appears. To be meaningful, data needs context.

"We don't know the decisions that were made about what to include or exclude in an algorithm — we just encounter the effects of them," Joyce says. "We don't want to keep reacting. We want to figure out what is causing the effects and try to prevent them."

\_ #HEALING

Drexel researchers observed women who announced pregnancy losses on Facebook to study why and how people use social media to share their traumatic experiences.



AN EXAMINATION OF how and why women decide to disclose pregnancy loss on Facebook — led by Drexel researchers who study human relationships with social network sites — has shed light on how social media platforms make it easier for people to share their painful, personal and often stigmatized stories.

"While many use Facebook to largely talk about happy and light topics and believe that to be the expected norm on this platform, some people make complicated decisions to talk about things that are not all that happy," says Nazanin Andalibi, a graduate of Drexel's College of Computing & Informatics and lead author of the study.

Andalibi and co-author Andrea Forte, an associate professor in the College of Computing & Informatics, chose to focus on pregnancy loss disclosures because 1 in 5 pregnancies

in the United States lead to a pregnancy loss, yet most people — approximately 55 percent — still think it's a rare occurrence.

One motivation for women to turn to social media, according to the research, is the benefit of sharing with a large network of people. Many women found it to be a highly efficient way of sharing a painful story once instead of repeating it over and over again in individual conversations. This also makes it easier for others to express support or share a similar story.

The researchers call this behavior "Network-Level Reciprocal Disclosures." They suggest that by seeing others post, people knew and felt pregnancy loss was not unique to them.

This behavior is at the heart of the sexual assault awareness movement that organically coalesced on social media via the hashtag #MeToo.

RECIDIVISM

\_ CORRECTIONS CLARITY

The solution to prison recidivism may be to improve communication and consistency in how rules violations are addressed.

JORDAN HYATT believed that high national prison recidivism rates could be due to a lack of communication and consistency, so he did something about it.

Hyatt began working with the Pennsylvania Department of Corrections in 2014 to replicate innovative criminal justice interventions from around the country. One successful program he observed was in Hawaii.

Hawaii's Opportunity Probation with Enforcement (HOPE) program created more opportunities to avoid incarceration, and it made it clear to each probationer exactly what would happen if they violated the conditions of their supervision.

Hyatt saw this as a program that could also work in Pennsylvania's halfway houses because it provided a clear set of rules, regulations and reactive consequences — as opposed to Pennsylvania's existing inconsistent procedures.

Since working with the Department of Corrections to monitor the program, called State Intermediate Punishment-HOPE, Hyatt and his colleagues have found an impressive 13 percent reduction in re-arrests among participants.

"Further, SIP-HOPE participants spent fewer days in prison or jail, demonstrating the ability of this approach to not only reduce crime, but also to reduce the use of costly prison beds," says Bret Bucklen, director of research and planning for the Pennsylvania Department of Corrections.



\_ JORDAN HYATT Hyatt is an assistant professor in the Department of Criminology and Justice Studies in the College of Arts and Sciences.



EQUALITY

\_ SIGNED, DR. MISTER

Researchers found female physicians were underrepresented as authors in high-impact pediatric journals, despite dominating the field.

A NEW JAMA STUDY undertaken by researchers at Drexel's College of Medicine and Harvard Medical School found that female physicians are underrepresented as opinion article authors in the four highest-impact pediatric

Spector and her colleagues point to the well-documented issue of gender disparity on journal editorial boards and unconscious bias as possible reasons for the findings.

Spector serves as executive director of the Execu-

"Intentional inclusion and solicitation of women authors by medical journals is a concrete and immediate action that can be taken to rectify some of the imbalance that we found in this study. Inclusion needs to be a standard that is upheld by journal editors and society leaders."

-Nancy Spector

journals — even though most (around 62 percent) pediatricians are women.

The researchers identified 336 "perspective-type" articles written by physicians of known genders that were published between 2013 and 2017 in the four highest-impact general pediatric journals: Academic Pediatrics, JAMA Pediatrics, The Journal of Pediatrics, and Pediatrics. Out of those articles, almost 60 percent were written by men, with just 140 (42 percent) authored by female physicians.

Nancy Spector, MD, professor of pediatrics and associate dean of faculty development at Drexel's College of Medicine, co-authored the study with Julie Silver, MD, an associate professor and associate chair in the Department of Physical Medicine and Rehabilitation at Harvard Medical School.

tive Leadership in Academic Medicine (ELAM) program, a one-year fellowship aimed at expanding the national pool of qualified women candidates for leadership positions in health care.



\_ NANCY SPECTOR - JULIE SILVER Spector, MD, is a professor of pediatrics and associate dean of faculty development at the College of Medicine. Silver, MD, is an associate professor and associate chair in the Department of Physical Medicine and Rehabilitation at Harvard Medical School.

MARKETING

\_ THE VALUE OF REPUTATION

A country's rising or falling reputation has direct economic impact.



HARRY CAMPBELL

ROLE MODELS

Below are the worldwide reputation rankings according to the 2018 Anholt-GfK Nation Brands Index. The U.S. came in 6th.



1. Germany



1. Japan



2. United Kingdom

MARKETING PROFESSORS Daniel Korschun and Boryana Dimitrova and economics professor Yoto Yotov from the LeBow College of Business found that something as intangible as a country's "reputation" can, in fact, have very tangible economic consequences.

The researchers chose to use the 2008 Anholt-GfK Nation Brands Index to determine reputation and compared it to corresponding trade data from the United Nations Statistical Division Commodity Trade Statistics Database for 2010. They specifically looked at the impact on exports between 861 pairs of countries.

The results showed a 2 percent decrease in

export volume for each spot a country dropped in the reputation rankings. Conversely, the study found that an increase in reputation had an equally positive impact on exports.

What this means in a practical example is that if the United States were to drop by just one place in a world ranking among Canadians, the model would predict a drop of more than \$5 billion in U.S. exports to that country.

"Countries ignore their international reputations at their peril," says Korschun. "If the current administration is serious about increasing U.S. exports, a good place to start would be improving America's standing in the world."

AUTISM

\_ WORK ON THE SPECTRUM

Very few adults on the autism spectrum who use developmental disability services are employed in paid jobs in the community.

A QUARTER OF ADULTS with autism who use developmental disability services are not working or participating in other structured activities during the day, with only 14 percent holding a paying job in the community, according to research from the A.J. Drexel Autism Institute.

Since 2015, the institute has produced a National Autism Indicators Report. The past two reports showed that adults with autism have difficulty transitioning into jobs.

"Billions are spent each year on services for people on the autism spectrum," says Paul Shattuck, associate professor in the Dornsife School of Public Health and director of the Autism Institute's Life Course Outcomes program, which produces the annual reports. "Relatively little is spent trying to understand the types and amount of services people need, as well as the services they actually end up getting or the outcomes of them."

For the 2017 report, Anne Roux, a research scientist on Shattuck's team, led a group that looked at data from 3,500 adults with autism who used developmental disability services and took the 2014-15 National Core Indicators Adult Consumer Survey. This is a survey used by some states use to monitor the effectiveness of their services.

In addition, the research team found that 25 percent did not feel they were receiving all of the services they needed.

"This dovetails with our team's earlier reports on the 'services cliff' that transition-age youth encounter when they leave special education but have difficulty accessing services they may need to become employed, continue their education, or live more independently," Roux says.



\_ PAUL SHATTUCK - ANNE ROUX Shattuck is an associate professor in the Dornsife School of Public Health and director of the A.J. Drexel Autism Institute's Life Course Outcomes program. Roux is a research scientist for the Autism Institute's Life Course Outcomes program.

ADULTS WITH ASD WHO RECEIVED DD SERVICES

27%

had no work or activity

14%

had a paid job in the community

LEGALIZATION

FOOD ACCESS

\_MARIJUANA STUDY BLOOMS

Now that California has legalized recreational marijuana use and sales, a researcher is examining how the state's young adults are being impacted by the new laws.

A FEW YEARS before California legalized recreational marijuana use in 2016, Stephen Lankenau, a professor in the Dornsife School of Public Health, was studying medical marijuana use among young adults in the state, which had established a medical marijuana program in 1996.

His controversial investigation was one of the first large-scale research studies into marijuana's impact on public health funded by the government, which still criminalizes possession and distribution of marijuana.

At the time, there were only 15 active studies related to marijuana nationwide.

Now that the Golden State has also legalized the sale of recreational marijuana in 2018, Lankenau is leading a team of researchers working to better understand how the new laws are affecting the health and social wellbeing of the state's residents, particularly its 18- to 30-year-olds.

Lankenau is the principal investigator of the Cannabis, Health, and Young Adults (CHAYA) research project, which was first funded by the National Institutes of Drug Abuse (NIDA) with a five-year, \$3.3 million grant in 2013.

This past November, CHAYA received another five-year grant for \$4.1 million from NIDA to continue studying that first group of young adults, some of whom are now ages 25 to 30, as well as recruit a new cohort of study volunteers.



\_FAMILY FARMING

A low-cost, indoor farming system being developed at Drexel promises to introduce fresh, self-sustaining produce gardens to residents living in food deserts.



WESTPHAL Assistant Professor Diana Nicholas and Shivanthi Anandan, interim vice provost for undergraduate education and associate professor of biology in the College of Arts and Sciences, are developing a project to improve the place where we spend most of our time: our homes.

Garden Fresh Home is a water-based, hydroponic device (with patent pending) that uses algae for fertilizer to grow everything from greens to tomatoes to strawberries — without soil.

"It started out as a sort of STEM to STEAM teaching project that's turned into a transdisciplinary collaboration where we have a patent pending on several

units," says Nicholas.

Garden Fresh Home combines Nicholas' work in relieving stress in urban environments with Anandan's knowledge of photosynthetic organisms. It's an idea that promises to beautify urban homes, improve healthy eating habits through fresh produce and help to mitigate the impact of food deserts.

Together they developed a prototype unit using 3D printing and are refining the design.

"It can't look industrial," says Anandan. It also couldn't require major renovations to the home, and had to be either wall mounted or appropriate for a countertop. They expect to be making commercial units

HOME\_GROWN

The researchers are perfecting a prototype of the system, which they expect will be commercially available in under two years.

in under two years, and the project has received \$100,000 in funding from Drexel Ventures, Drexel's tech-commercialization arm.

Neither researcher thinks that these will be the magic bullet to bring fresh foods to everyone who lives in urban environments, but they hope it can be part of a multi-pronged approach. "It's a piece of a much bigger, nuttier problem, but it's doable by normal, everyday people," Anandan says.

\_PENNSYLVANIA'S GOIN' TO POT

A study of young people in Pennsylvania found that although people are becoming more accepting of marijuana, use has not increased.

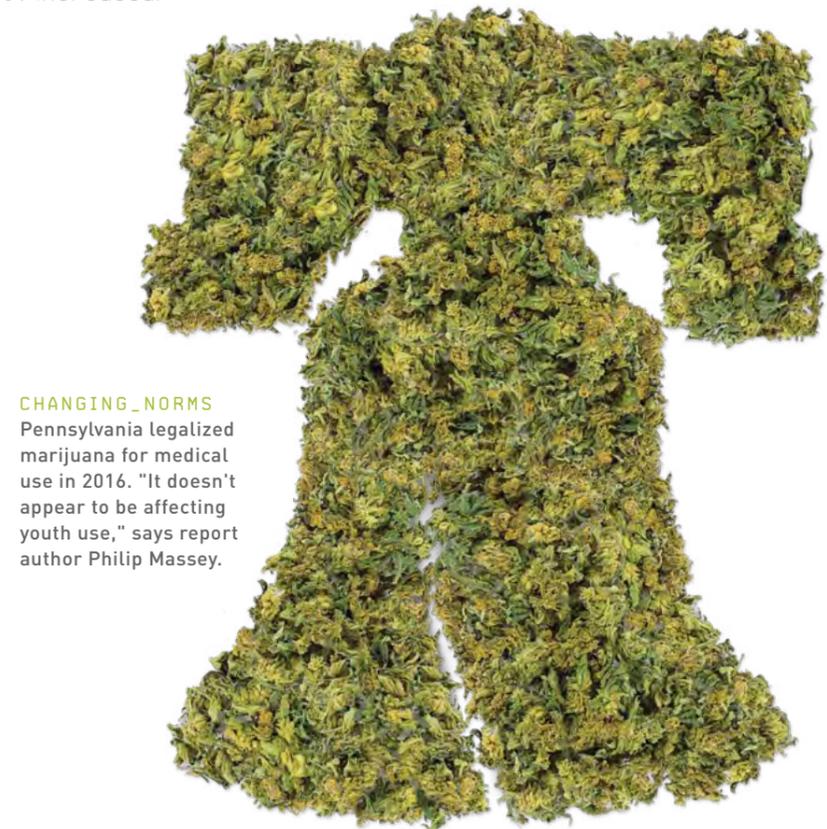
YOUNG PEOPLE'S attitudes toward pot have become more positive in Pennsylvania now that the state is among those legalizing medical marijuana, but that shift in attitude doesn't seem to have affected use.

"This is important because many people fear that legalizing marijuana will lead to greater use and potential abuse," says Philip Massey, an assistant professor in Drexel's Dornsife School of Public Health, who headed up the report.

The report explored attitudes about marijuana in the years before and after it was legalized for medical use in 2016. Among Pennsylvanians age 12 to 17, the rate of those who strongly disagreed with marijuana use dropped from 60.7 percent in 2013 to 53.3 percent in 2017. Over the same period, the rate of Pennsylvania youths who thought their parents would feel that it was "very wrong" to smoke marijuana dropped from 81.2 to 75.4 percent.

Additionally, the rate of young people who said they would never try marijuana dropped from 71 percent in 2013 to 62.2 in 2017, with those unsure about whether or not they would want to try it growing from 6.7 to 10.3 percent.

"Of course, we need to continue to monitor this trend, but these preliminary data tell me that the people who need marijuana for medical purposes are the ones benefitting from this law," Massey says.



CHANGING\_NORMS Pennsylvania legalized marijuana for medical use in 2016. "It doesn't appear to be affecting youth use," says report author Philip Massey.



2013



2017

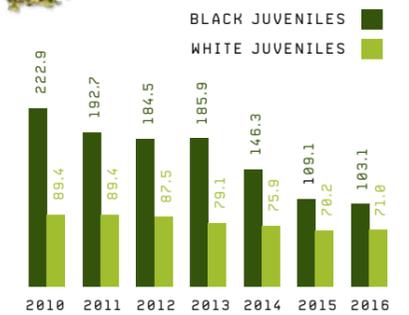
RELAXED\_IDEAS

Among Pennsylvanians between the ages of 12 and 17, the rate of those who strongly disagreed with marijuana use dropped from 60.7 percent in 2013 to 53.3 percent in 2017.



MED\_HEADS

Distribution of approved medical marijuana dispensaries and health care practitioners.



MARIJUANA POSSESSION ARRESTS (PER 100,000)

ON\_THE\_STREET

Blacks have been consistently arrested at higher rates than whites since 2010, but this disparity began to narrow in 2014, which coincides with the decriminalization of marijuana in Philadelphia (2014) and Pittsburgh (2016).

# \_ABOUT DREXEL



**WORKING\_REMOTELY**  
During the winter, Academy of Natural Sciences paleontologist Ted Daeschler and colleagues traveled to Antarctica to collect fossils from an area around Deception Glacier. This was shot on one of their final working days on Mt. Ritchie.

**F**OUNDED IN 1891 in Philadelphia, Drexel is a comprehensive urban university of more than 24,000 students, and it is one of Philadelphia's largest private employers.

Drexel is a leader in experiential, technology-infused education, enriched by the nation's premier cooperative education program. The University's recognized excellence in translational research is supported by the Coulter Foundation through the Coulter-Drexel Translational Research Partnership and by nearly \$124 million in sponsored research awards last year.

Drexel enrolls students in on-campus and online programs leading to associate's, bachelor's, master's, doctoral and professional degrees (including MDs and JDs) in 17 colleges and schools. Drexel also has some of the richest specimen and artifact collections in the world through the Academy of

Natural Sciences of Drexel University, America's oldest natural history museum.

Drexel advances its culture of innovation by encouraging multidisciplinary collaboration, technology commercialization and entrepreneurship — an approach exemplified by the ExCITE Center, the interdisciplinary A.J. Drexel Institutes, Drexel Ventures, the Innovation Center @ 3401 Market Street, the Close School of Entrepreneurship and the Baiada Institute for Entrepreneurship.

Drexel operates out of its 123-acre University City Campus in West Philadelphia and at four additional locations: the Center City Campus for the College of Nursing and Health Professions and the Academy of Natural Sciences; the Queen Lane Campus in East Falls for the College of Medicine; and through its online platform, Drexel Online.

**\_ONLINE**  
Learn more about Drexel University at [drexel.edu](http://drexel.edu)

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THIS UNIVERSITY IS DESIGNED  
TO CHANGE WITH IT.

Because discovery can't wait.

Drexel's unique design combines academic rigor with a transformative cooperative education program, positioning students alongside expert faculty and professionals tackling today's most complex issues. By constantly learning and evolving as the world moves forward, Drexel produces visionary leaders equipped to anticipate and address the challenges of the future. This is experiential education.

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AMBITION  
CAN'T  
WAIT



