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Free to Play
After a number of parts in "big-swing comedies," Kathryn Hahn '95 moved to more substantial roles that cemented her place as a sought-after star. It's clear now that she's in love with her work: the deep dives into character, the exploration and messiness each role brings, the dedication to her fellow actors — and the creative magic that results.
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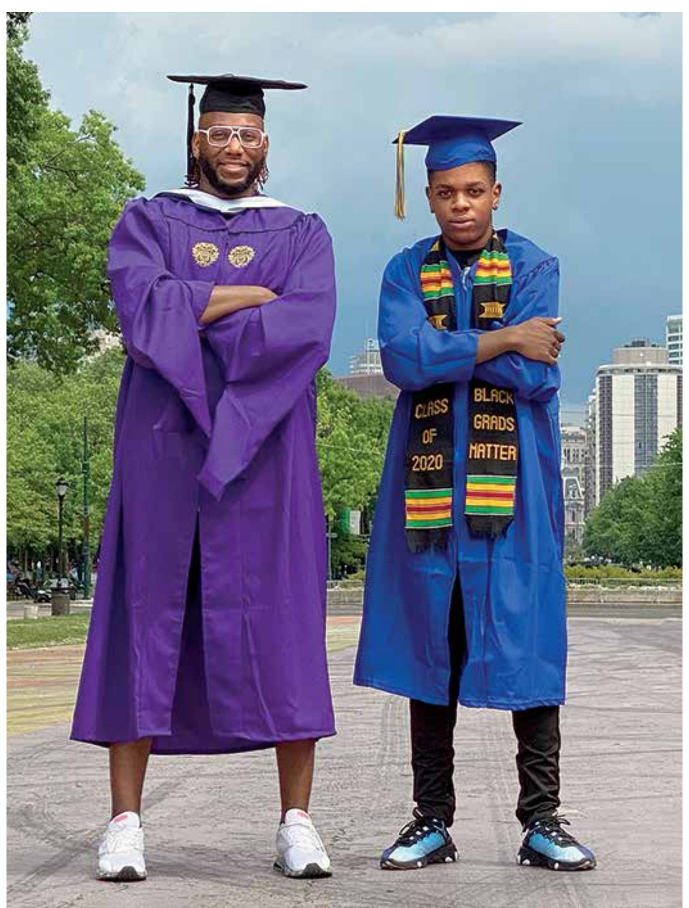
Northwestern Medicine surgeons perform double-lung transplants, giving new life to seven COVID-19 survivors.



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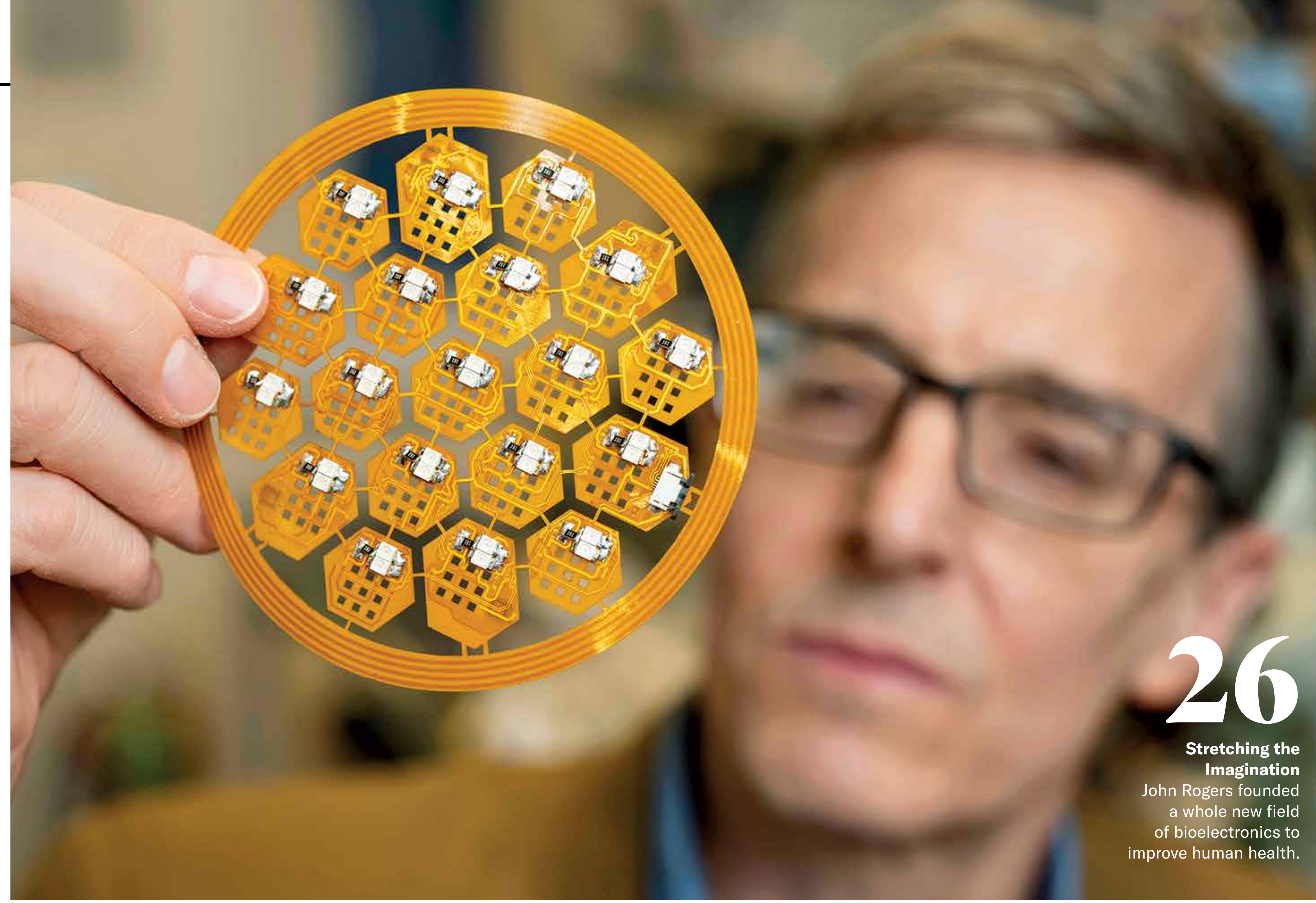
← "We have a responsibility to situate all of our work in a historical context so we can realize that history isn't this thing of the past, but it's something that we experience now."

—Evanston Township High School history teacher Corey Winchester '10, '20 MA, left, with his brother, Jason Deas, who graduated from high school in 2020

HAHN: BRIAN HIGBEE; WINCHESTER: ANYA WINCHESTER



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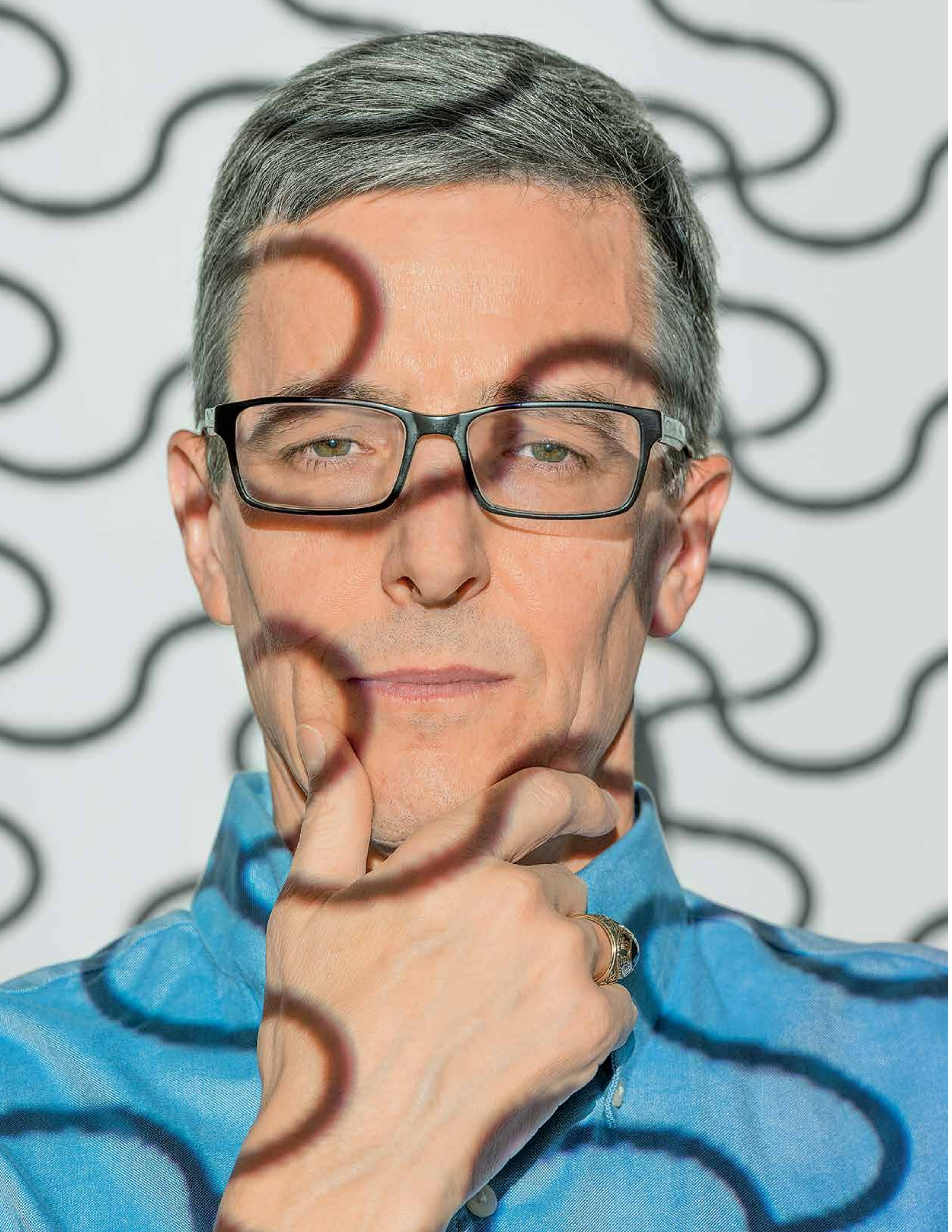
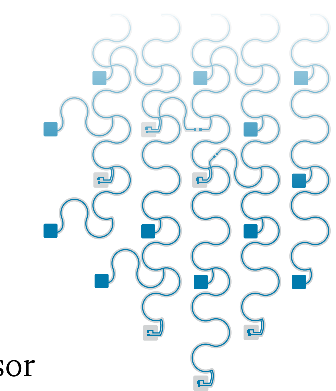


JIM PRISCHING

STRETCHING THE iMAGINATION

Pioneering professor **John Rogers** founded a new field of bioelectronics to improve human health, making devices that bend, twist, stretch, or melt away.

BY AMANDA MORRIS



← John Rogers developed the fundamental geometry that is the foundation of his stretchable electronic devices. By making the electrical components wavy, Rogers ensures that his devices can withstand stretch and strain, enabling otherwise rigid electronics to move and flex with the human body.

Watch an interview with John Rogers at alummag.nu/john-rogers.

John A. Rogers has invented a mind-boggling number of electronic devices. Do you want to measure your sweat's chemistry to check hydration? There's a device for that.

Monitor exposure to harmful levels of ultraviolet radiation from the sun with a sensor smaller than an M&M? There's a device for that.

Jump-start your heart with an ultrathin, stretchable "sock" that acts as a pacemaker? There's a device for that.

Or map your brain's electrical signals with a sensor that softly laminates onto the organ's wrinkled, folded surface and then harmlessly dissolves, making a second surgery to remove the sensor unnecessary? There's a device for that, too.

How about "artificial skin" that creates the sensation of touch in virtual reality environments? Or an implant that senses when the user has ingested a fatal level of opioids, delivers a lifesaving antidote and calls emergency responders?

Yes. Believe it or not, Rogers has developed bioelectronics for all these applications and more.

When talking to Rogers, it's clear that research is not just an exercise of the mind. It's a highly competitive, full-contact sport. It's an arena where boundaries are pushed to extreme limits and electronics become impossibly thin, flexible, stretchy and smart — blurring the distinction between body and device.

"I'm not competitive against other people, necessarily, but competitive with myself," says Rogers, who directs Northwestern's Querrey Simpson Institute for Bioelectronics. "In my lab, we want to go as high as we can go in terms of rigor and impact. We want to do more and get to the endpoint faster."

With more than 750 published journal papers, more than 100 patents and more than 130,000 citations, Rogers is playing his best game. He is the Michael Jordan of technology — unstoppable, unflinching and agile enough to pivot his research when a medical need unexpectedly arises.

"John is truly motivated by his desire to help people," says longtime collaborator Yonggang Huang, the Jan and Marcia Achenbach Professor of Mechanical Engineering at Northwestern. "The faster he can move from idea to invention, the faster he can get his devices onto the patients who need them. John's vision is to create a new field that benefits society."

DISCOVERING RESEARCH Rogers, who is the Louis A. Simpson and Kimberly Querrey Professor of Materials Science and Engineering, Biomedical Engineering and Neurological Surgery, doesn't just lead the field of stretchable bioelectronics — he founded it. But with his mild demeanor and subtle Texas lilt, Rogers is so unassuming that people might not expect such extraordinary achievements. He is a highly decorated researcher, with a MacArthur "genius grant" to his name. He also is just one of approximately two dozen people in history to be elected to all three national academies: The National Academies of Sciences, Engineering and Medicine.

"You might expect someone with as many awards and honors to have a big ego. But he is a humble, pleasant, caring colleague," says collaborator Amy Paller '83 GME, the Walter J. Hamlin Professor of Dermatology.

Rogers caught the research bug while an undergraduate at the University of Texas at Austin. He grew up outside Houston, where his mother wrote science-inspired poetry and his father was a physicist. A double-major in physics and chemistry, Rogers pursued an undergraduate research position in the laboratory of Professor Richard "Dick" Lagow, who was famous for "extreme chemistry," or research into highly reactive compounds, with a focus on the most reactive element of them all, fluorine.

"He was energized not only by the research but also by the competitive landscape of academic science," Rogers says of Lagow. "I thought that being an academic meant that you sat in an ivory tower and thought big, profound thoughts. I didn't fully appreciate that it was also so competitive. Dick enjoyed competing against other labs, trying to do something better or something different. I found that whole environment exciting."

From there, Rogers pursued a doctorate at the Massachusetts Institute of Technology, where he met Lisa Dhar, who he married in 1996. (She is now director of New Business Ventures for Engineering at Northwestern.) Then Rogers became a Harvard Junior Fellow, studying with materials science great and renowned chemist George Whitesides '20 H. Rogers quickly built a reputation for himself. Fellow postdoc Joanna Aizenberg remembers review meetings in which group members presented their research results.

"Nobody wanted to present after John," says Aizenberg, who is now a materials science professor at Harvard. "We constantly fought about it. His presentations were awe-inspiring. It was embarrassing to follow that. It was obvious, even back then, that he would do great things."

After their postdoctoral fellowships ended at Harvard, Rogers and Aizenberg reconnected at the storied Bell Labs, where they shared an office. By this time, Rogers — who grew up playing with Legos and Erector Sets — had realized that he enjoyed building things and designing gadgets, so he expanded his research focus from chemistry and physics to various aspects of engineering. At Bell Labs, he worked on the backplane circuits for electronic paper displays, which became the basis for e-readers such as the Kindle, and on advanced fiber-optic devices for data communications, which became cornerstones for the fastest networks at that time.

Aizenberg describes Rogers as someone who loved his work so thoroughly that he spent days and nights in his

> "The faster he can move from idea to invention, the faster he can get his devices onto the patients who need them. John's vision is to create a new field that benefits society." — **Yonggang Huang**

JIM PRISCHING

Inspiring the Next Generation

During his five years at Bell Labs, John Rogers relished working at the interface between science and engineering, in a highly collaborative mode with an eye toward broader impact. Now that he runs his own lab, he aspires to emulate that model. Rogers has one of the biggest labs on campus in terms of the number of students, consisting of approximately 100 postdocs, graduate students and undergraduates — equally split between men and women.

"We give students freedom to choose their own projects and develop a sense of ownership," Rogers says. "Then they bring their own creativity and come up with new ideas, and they work on interdisciplinary research, interacting with experts in multiple fields of study — the Bell Labs way. That's an important part of the education process."

Rogers' lab model is clearly working. Throughout his career, all but two graduate student mentees have pursued careers in science or engineering. And 117 have become faculty members at universities around the world, including Princeton, Cornell, Duke, Stanford, MIT — and Northwestern.

"He's trained some wonderful progeny who carry his work forward in many different ways," says University of Pennsylvania researcher Brian Litt. "There's a piece of John in all these people, and they will go on to inspire the next generation." — *A.M.*

↑ Top, Rogers works with students in his lab in the Technological Institute. Above, Rogers and postdoctoral researcher Roy Cho examine a component of the "virtual skin" device, which incorporates a sense of touch into virtual and augmented reality systems. Rogers believes it's important to allow students in his lab to select their own research projects. "When students enjoy what they do, they are more productive," he says.

office, listening to heavy metal on his headphones and fueling himself with iced tea. "I don't think he ever slept," says Aizenberg. "It was clear that he truly enjoyed his work and being in the office. And for me, it was like being next to greatness. He's absolutely unmatched."

BENDING MATERIAL TO MEET NEEDS After the dot-com bubble collapsed, taking Bell Labs with it, Rogers came home to academia, joining the University of Illinois at Urbana-Champaign and the Beckman Institute for Advanced Science & Technology in 2003. In 2005 a single thread of silicon changed the direction of his research — and his life.

Rogers sought to develop a hybrid material that could transform brittle, rigid silicon into a flexible and stretchy rubber band. The U.S. military funded Rogers' lab to create large-format electronic wireless communication systems that could be unfurled in a battlefield situation and then rolled up and tossed into a backpack for urgent, easy transport.

"Prior to that, our work focused on plastic-based materials as the basis for such types of flexible electronic systems," Rogers says. "That approach can work pretty well for simple devices like displays, but the performance tends to fall short for more demanding applications."

Rogers knew that thinner materials, by nature, become increasingly flexible. It's like the thickness of a sheet of paper versus that of a two-by-four. Both are the same material — wood fiber — but their geometries dictate their mechanics. Rogers' team was exploring silicon ribbons, each just one-thousandth the thickness of a strand of hair. After a serendipitous accident, a postdoc noticed that under certain conditions these silicon ribbons spontaneously adopted rippled or wavy shapes when bonded to a rubber substrate in the right way.

"We immediately realized that if silicon was in that configuration, we could stretch it back and forth like an accordion," Rogers says. "We could twist it, bend it, crumple it up. It was almost indestructible."

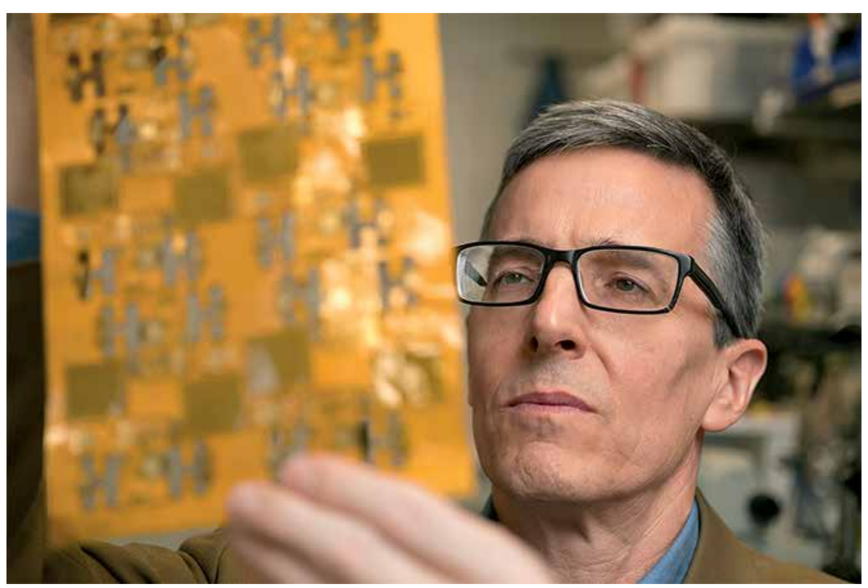
Rogers leveraged the discovery to build the first-ever stretchable transistor as a key building block for integrated circuits. When the research was published in the journal *Science* in 2006, the paper hit *MIT Technology Review*'s top-10 list of best discoveries that year and was downloaded tens of thousands of times.

"John was the first person to change the geometry of electronics," says Northwestern colleague Yonggang Huang, who has published more than 300 papers over 15 years with Rogers. "He made the silicon wavy, and he coiled the wires like a spring. He's very clever."

THE EYE-OPENING BRAIN Like many researchers around the globe, Brian Litt, a professor of neurology and bioengineering at the University of Pennsylvania, took note of Rogers' discovery.

Litt has devoted his life to better understanding the brain in order to treat epilepsy patients. To further this work, he envisioned implantable devices to map epileptic networks. He saw the potential for Rogers' electronics to perhaps achieve the impossible — to monitor select, localized areas of the brain without causing damage. Litt and his team approached Rogers after a presentation.

"They asked if I ever thought about putting my flexible electronic systems onto the brain to monitor electrical activity or stimulate it for treatment," Rogers says. "That was an eye-opener for me. It represented a new direction, much different than our work on displays and communication systems. A bio-interface sounded really interesting, with clear potential for tremendous societal value in human health."



↑ **The copper circuit board that underlays John Rogers' COVID-19 monitoring device is flexible and sheetlike.**

JIM PRISCHING

HEAD TO TOE

Throughout his 25-year career, John Rogers has developed 20 categories of ultrathin, stretchable devices that push the boundaries of engineering and medical technology. Here are a select few.

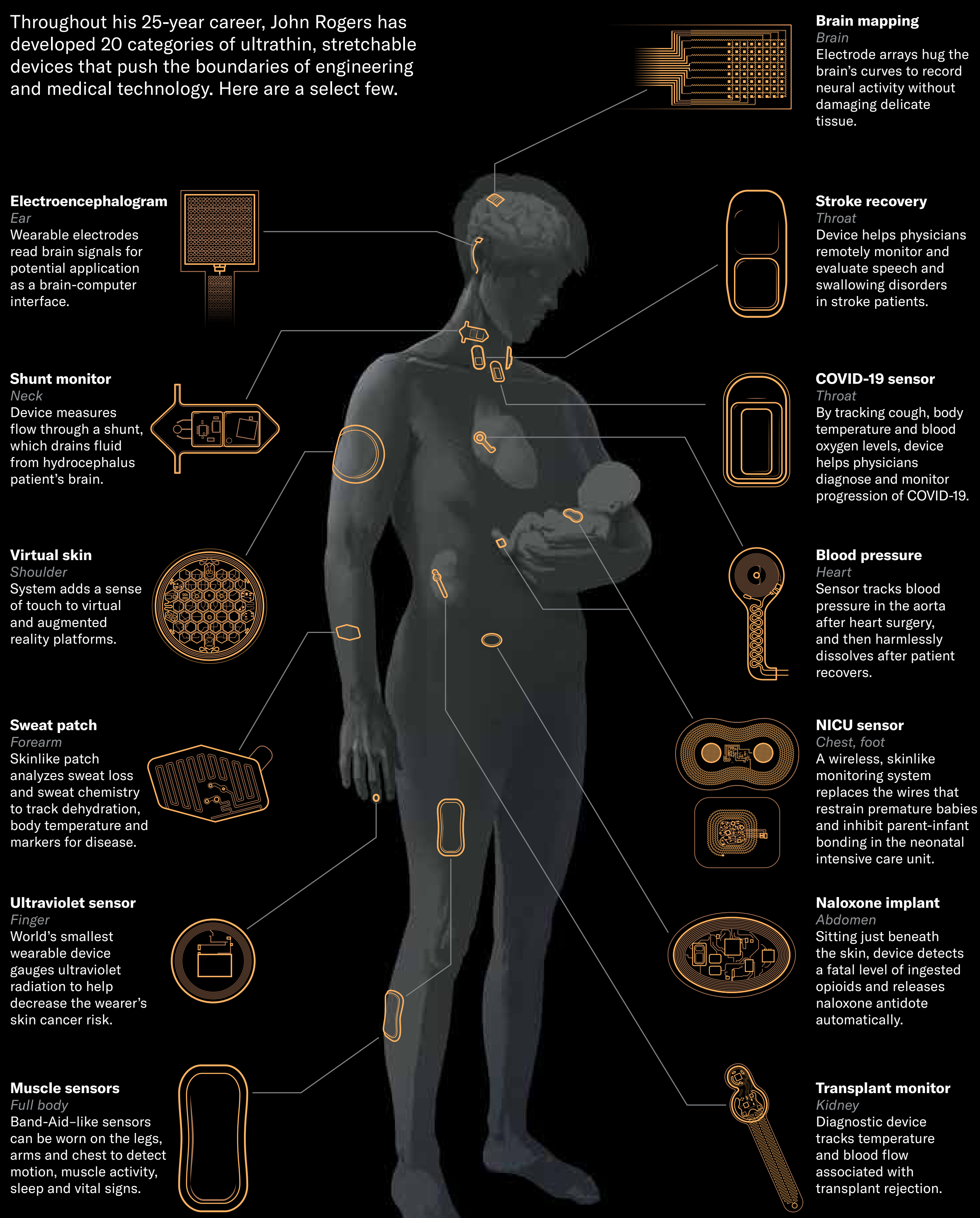


Illustration by Matthew Twombly

← John Rogers' sensors monitor a newborn's vital signs. One of the sensors wraps around a baby's foot, while the other is placed on the chest. The wireless, battery-free sensors are thin and gentle on a baby's delicate skin. The elimination of wires promotes bonding between newborns and their parents.

ALYSSA SCHUKAR

The challenge of engineering a device for the brain, however, is enormous and daunting. The human brain is a jiggly maze of wrinkled peaks, shallow grooves and deep fissures. With the consistency of gelatin, it can be depressed by the most delicate touch. Finding new tools to map and stimulate the brain could unlock the potential to restore lost brain function or cure debilitating disease. But failure carries the risk of hemorrhage or even permanent damage to the organ that houses intellect, creativity, emotions and memories.

"This presented a whole new set of challenges from a fundamental materials-science standpoint," Rogers says. "To integrate an electronic device onto a very complex topographical surface like the brain, and to do so in a manner that doesn't damage the fragile tissues or the technology, you have to build devices that can contort in very complex ways to follow the irregular geometry — in materials that both are biocompatible and enable high-performance operation."

THE SKIN IS IN Rogers joined Litt and his team to develop wireless, skinlike, biocompatible monitors for the brain that could last many decades without degrading — or that would, after a set number of days, harmlessly dissolve. After this initial project, Rogers was hooked on designing devices for other organ systems of the body. Next, his team tackled the heart, developing devices that softly adhere to the surface to monitor activity or even jump-start it like a pacemaker.

"John recognized that medical devices were the right direction for the group," says Tony Banks, who has worked in Rogers' labs at both the University of Illinois and Northwestern. "It very quickly became apparent that our group's research on medical devices could help someone's life. That became a huge driving motivation not only for John but for everyone in our group."

After innovating for the heart and brain, Rogers decided to tackle the body's biggest organ: the skin. "We didn't need animal models to test the devices or collaborators to perform surgeries," Rogers says. "With skin, we could build devices in our own lab and test them on ourselves."

Before the Fitbit or smart watches, Rogers' team invented the first wearable device to monitor health in 2007. Called epidermal electronics, the platform showcased a wireless, tattoo-like device that easily adhered to the skin to measure simple vital signs, such as cardiac activity and body temperature. The research marked a conceptual breakthrough and presented a road map for developing thin, high-performance electronic systems integrated with the body.

"John always has a keen sense of what will happen next in science — before it starts to happen," says Banks, one of Rogers' closest friends. "He has the ability to predict the next big thing."

UNPREDICTABLE APPLICATIONS Oftentimes, Rogers develops new devices without knowing what future problems the technology might solve. His team developed a sensor to measure blood flow, for example, and then learned it could be used for hydrocephalus patients. Much like the serendipitous interaction with Litt some years before, this opportunity developed from a discussion with Matthew Potts, assistant professor of neurological surgery at the Feinberg School of Medicine, and Amit Ayer '19 MBA, a recent neurosurgery resident at Feinberg, following a Rogers neurosurgery seminar.

Hydrocephalus, a potentially life-threatening condition in which excess fluid builds up in the brain, affects nearly 1 million Americans. Treatment includes surgically implanting a brain shunt, a straw-like catheter that drains fluid from the brain. Shunts have a nearly 100% failure rate over 10 years, and a malfunctioning shunt can cause headaches, fatigue and even death, if left untreated.

Rogers repurposed his blood-flow sensor to instead gauge the flow of fluid through a shunt. The Band-Aid–like sensor could revolutionize the way patients manage hydrocephalus and potentially save the U.S. health care system millions of dollars. Beth Meyer, whose son Willie was diagnosed with hydrocephalus as an infant, is keenly aware of how life-changing the device might be. Over the past 28 years, Willie has undergone more than 190 surgeries to diagnose or repair a malfunctioning shunt.

"Shunts work fine for a lot people, but when they don't, you're in big trouble," says Beth, who lives in Arlington Heights, Ill. "Dr. Rogers' device is a game changer. It's painless, it's noninvasive, and you can quickly determine whether the shunt is working properly or not. It could potentially save lives and money — and anxiety."

Similarly, Rogers re-engineered his epidermal electronics to monitor premature babies, following a discussion with Amy Paller after a presentation at the annual meeting of the Society of Investigative Dermatology. His team's resulting wireless device — designed with preemies' fragile skin in mind — carries the promise of removing the tangle of wires that restrict movement and prevent parent-baby bonding. A father himself, Rogers profoundly understood the project's potential impact.

After launching the devices in Chicago-area hospitals, the wireless monitoring systems for premature babies have been deployed to families in 26 countries, including resource-poor settings in Zambia, Kenya and Ghana. Now the devices exceed the capabilities of existing, wired monitoring technologies to provide information beyond traditional vital signs, including a baby's crying, movement, body orientation and heart sounds. With support from the Bill & Melinda Gates Foundation and Save the Children, Rogers' team will complete a program of testing the sensors on 15,000 pregnant women and 500 babies by the middle of 2021.

PANDEMIC PIVOT In March 2020 the accelerating momentum of Rogers' research slammed into the same wall that hit the rest of the world. The coronavirus pandemic shut down Northwestern, and the University's research operation ground to a halt.

As the Technological Institute's hallways grew quiet, Rogers continued to visit his office and lab every day. Then his collaborators from the Shirley Ryan AbilityLab called, wondering if it might be possible to re-engineer a Band-Aid–sized device that he developed to track swallowing and speech sounds in recovering stroke patients to instead monitor cough, shortness of breath and vital signs in COVID-19 patients and front-line health care workers.

Two weeks after the phone call, Rogers' team had already produced a working device. A month later, they launched a pilot program to test the device on health care workers and patients at Shirley Ryan AbilityLab and Northwestern Memorial Hospital. Rogers applied for essential status (exemption from the Illinois' stay-at-home order), and his team manufactured each device in the lab.

"John didn't miss one day of work," says Banks. "Before students and postdocs returned, John and I were in the lab making COVID sensors. We personally went down to the hospital to put them on patients and work with the doctors."

This is no surprise to Shuai "Steve" Xu, medical director of the Querrey Simpson Institute for Bioelectronics.

"I don't think John gets enough credit for his empathy," says Xu '18 GME. "Beyond his technical brilliance, he puts himself in others' shoes to genuinely understand their problems. And then he will do anything in his power to solve those problems."

Amanda Morris '14 MA is senior editor of science and engineering in Northwestern's Office of Global Marketing and Communications.

Celebrity Sensors

It's one thing to see your device on a patient in a laboratory. It's another thing entirely to see it on Serena Williams.

Gatorade is one of the many companies that has licensed inventions from Rogers' laboratory. The sports-drink giant is currently commercializing a skinlike, wearable device that measures electrolyte levels in sweat in tiny fluidic channels. Gatorade teased the product, which will be widely available in 2021, in a string of television commercials that began airing in 2019, showing world-class athletes such as Williams and NBA stars Jayson Tatum and Paul George wearing the device while training.

"It's super cool, obviously," Rogers says. "Some of the athletes are publicly sharing their thoughts about the importance of quantitative approaches to hydration management enabled by our device. That's more exciting than seeing the commercials."

More than 70 of Rogers' patents have been licensed through both large companies — such as L'Oreal and E Ink — and lean startups, some of which he co-founded. — *A.M.*