THE Physiologist MAGAZINE
JULY 2025

THE BREAKING POINT

Science funding is under attack, leaving researchers bracing for what's next.

PLUS: **EVANGELINE MOTLEY-JOHNSON CHAMPIONS MENTORSHIP 16** | **PIG ORGAN TRANSPLANTATION IN HUMANS 22**

New Trends in Sex Differences and Women's Health Research

October 2025

New Orleans, Louisiana

Advance Registration Deadline:
August 29

Join us for this biennial event gathering leading experts in sex differences and women's health. Engage with renowned scientists, expand your network and discover cutting-edge research. Don't miss this chance to be part of groundbreaking discussions shaping the future of sex and gender medicine.

Submit your abstract and register at physiology.org/SexGenderConf25.

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women's health research initiative

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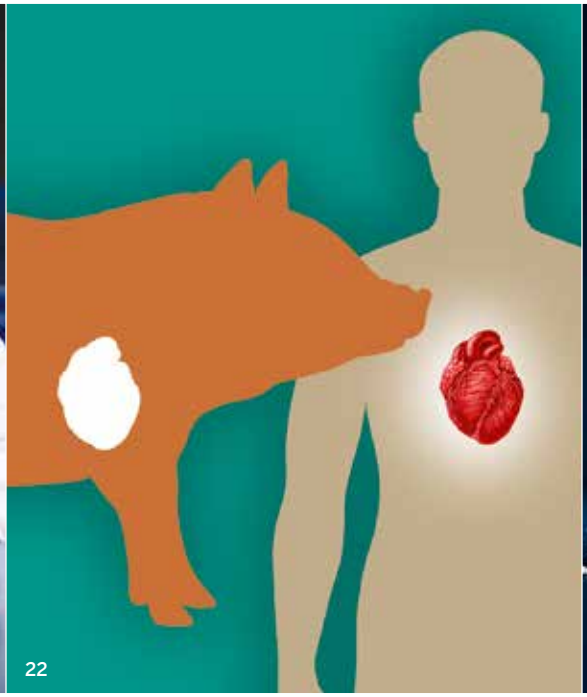

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american physiological society®

CALL FOR APPLICATIONS
EDITOR-IN-CHIEF

American Journal of Physiology-Renal Physiology®

Applicants are invited for the position of editor-in-chief of the *American Journal of Physiology-Renal Physiology* (**journals.physiology.org/journal/ajprenal**) to succeed Heddwen L. Brooks, PhD, who will complete her term as editor on June 30, 2026. The American Physiological Society (APS) Publications Committee plans to interview candidates in the fall of 2025.

Applications due: August 15, 2025

Journal of Neurophysiology®

Applicants are invited for the position of editor-in-chief of the *Journal of Neurophysiology* (**journals.physiology.org/journal/jn**) to succeed Jan-Marino (Nino) Ramirez, PhD, who will complete his term as editor on June 30, 2026. The APS Publications Committee plans to interview candidates in the fall of 2025.

Applications due: August 15, 2025

Strength in Numbers

BY AMANDA BERTHOLF, MA

In today's challenging environment, it is more important than ever for the scientific community to come together, raise our voices and know that we are not alone. And that sense of connection was clear among attendees at this year's American Physiology Summit. There was a feeling that there is power and strength in numbers—in showing up together and for each other. And as the future of federal research funding continues to be an ongoing topic of discussion, APS members are making sure their voices are heard.

At the start of the Summit, more than 75 members, including Society leaders, met with congressional offices in Washington, DC, during a Capitol Hill event to advocate for ongoing investment in biomedical research. These conversations underscored what is at stake. Funding disruptions can delay progress in medical advancements and treatments, harm local economies, derail careers—particularly for early-career scientists—and deepen persistent gaps in critical areas such as women's health.

"As the future of federal research funding continues to be an ongoing topic of discussion, APS members are making sure their voices are heard."

In this issue, we examine how significant changes to research funding will affect labs, scientific discovery, innovation and the future of the field. Amid a flurry of fast-moving policy decisions that seem to change weekly, we wanted to zoom out and take a macro look at the potential effects on science now and in the years ahead. Look for our feature article on page 28.

On another note, we continue to cover innovative science, and the article on page 22 explores exciting developments in xenotransplantation. Earlier this year, the U.S. Food and Drug Administration approved the first clinical trial testing whether doctors could safely transplant genetically modified pig kidneys into humans. Researchers have made tremendous strides in recent years combatting the three primary challenges of xenotransplantation: rejection, infection and disease transmission. As more than 100,000 people in the U.S. await a lifesaving organ transplant, safely using pig organs could transform lives—and the field of transplantation.

On page 16, we hope you enjoy this month's profile on Evangeline Motley-Johnson, PhD, FAPS, who is a longtime professor and researcher at Meharry Medical College, a historically Black college in Nashville, Tennessee. I am always intrigued by the winding, often unexpected paths our members' careers take, and Motley-Johnson's story is no different.

While the research climate is full of uncertainties right now, at APS and through *The Physiologist Magazine*, we will continue to bring you stories that inform and inspire you and always celebrate the power of science.

Amanda Bertholf, MA, is APS director of communications and the editor-in-chief of *The Physiologist Magazine*. Send questions or comments to the editor at tphysmag@physiology.org.

P.S. We want to hear from you. What topics do you want to read about? What scientific ideas excite you? Tell us what's on your mind at **tphysmag@physiology.org**.

THE Physiologist MAGAZINE

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APSselect

Activity Breaks + HIIT = Better Cardiovascular Health

Short activity breaks throughout the day combined with high-intensity interval training (HIIT) every other day can counteract negative changes in heart health associated with a sedentary lifestyle. The study, published in the *Journal of Applied Physiology*, supports the World Health Organization's 2010 guidelines, which for the first time included recommendations that people limit sedentary time in addition to engaging in physical activity. Researchers measured glucose and cholesterol levels, blood flow, arterial stiffness and cardiorespiratory fitness in volunteers who participated in three random-order trial conditions, each lasting two weeks. The volunteers experienced significant increases in blood flow and VO2max when they engaged in a combination program of HIIT every other day and hourly 2.5-minute light-intensity walks to interrupt sitting time. These benefits were greater than either HIIT or the short activity breaks alone. In addition, a participant survey showed the combined regimen to be "most enjoyable [and] beneficial to energy levels, productivity and overall health" as compared to either of the activities on their own.

Source: doi.org/10.1152/japplphysiol.00484.2024

All images: iStockphoto

IN BRIEF

The Latest Research from APS Journals

Explore new peer-reviewed findings published across the Society's journals.

A review of biomarkers in aging explores current knowledge of molecular and physiological aspects of aging, anti-aging strategies and how to use physiological biomarkers in human aging.

doi.org/10.1152/physrev.00045.2024

A learning activity about generative artificial intelligence (AI) helps students make informed decisions about AI use and potential benefits.

doi.org/10.1152/advan.00245.2024

Beetroot extract may help reduce or prevent carotid artery stiffening in postmenopausal women by increasing production of nitric oxide.

doi.org/10.1152/ajpheart.00065.2025

APSselect

Look Beyond Estrogen in Menopause Heart Failure

Heart failure with preserved ejection fraction (HFpEF) is a common form of heart failure in older adults. The number of women diagnosed with HFpEF rises sharply after menopause, but the reasons for this aren't well-explained simply by chronological age. Occurrences increase more gradually for men of the same age.

A mouse model of HFpEF showed that postmenopausal females that had intact and functioning ovaries had a higher risk for developing heart failure compared to premenopausal mice or postmenopausal animals without ovaries—because the ovaries continued to produce the androgen hormone testosterone even after menopause. These findings encourage further research and a different way of looking at menopause. Although low estrogen is a primary focus of most menopausal research, menopause should be viewed as the imbalance of estrogen and androgen hormones.

Source: doi.org/10.1152/ajpheart.00575.2024

APSselect

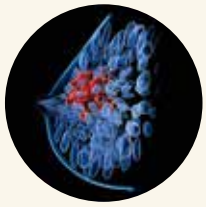
Cannabis in Pregnancy May Harm Infant Lungs

New research in nonhuman primates finds prenatal exposure to tetrahydrocannabinol (THC), the active ingredient in cannabis products, impairs lung development as early as the second trimester of pregnancy. Imaging tests of pregnant mothers who ate a daily THC cookie containing a "heavy human medical cannabis dose" in addition to their normal diet showed reduced fetal lung volume. In addition, examination of the newborn offspring found a significant decrease in key growth factors for lung development and altered expression to more than 700 genes compared with infants not exposed to THC before birth. THC edibles is the second most common form of cannabis used during pregnancy, even though American College of Obstetricians and Gynecologists guidelines strongly recommend avoiding using THC-containing products while pregnant.

Source: doi.org/10.1152/ajplung.00360.2024

Study compares vertical sleeve gastrectomy and semaglutide effects on heart and bone health as well as effectiveness for weight loss.

doi.org/10.1152/ajpendo.00521.2024



Breast tumors disrupt liver function due to inflammation, fibrosis and metabolic disturbances, and highlight organ crosstalk.

doi.org/10.1152/ajpendo.00498.2024

People with obesity have more calf muscle-tendon stiffness, which can be a contributing factor of reduced exercise tolerance.

doi.org/10.1152/japplphysiol.00702.2024

Guinea pig model to study airway hyperresponsiveness in asthma highlights the importance of mast cells in the development of asthma.

doi.org/10.1152/ajplung.00422.2024

LAB NOTES

MENTORING Q&A YOUR QUESTIONS ANSWERED
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UNDER THE MICROSCOPE OUR MEMBERS, UP CLOSE
PUBLISH WITH POLISH BUILD A BETTER RESEARCH PAPER
IN DEPTH DIVING DEEP INTO SCIENCE
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Upendra Chalise, PhD

Taben M. Hale, PhD

MENTORING Q&A | EARLY CAREER

Burnout Busters

How to design a successful career and stay motivated for the long term.

Each issue, we ask a student or early-career member to pose their career questions to an established investigator and mentor. Here, **Upendra Chalise, PhD**, a postdoctoral fellow at the University of Minnesota, asks **Taben M. Hale, PhD**, how to build a successful academic career and avoid burnout. Hale is professor and vice chair in the Department of Basic Medical Sciences and associate dean of graduate studies at the University of Arizona, College of Medicine-Phoenix.

Illustrations by Kagan McLeod

Q: What is one thing you wish you knew when you started your career?
A: I was unprepared for the amount of time that I would spend not doing science. There is nothing I love more than mentoring the students and postdocs in my lab. So, as the administrative and teaching tasks accumulate, I have discovered that I need to remember to always maintain the time on my calendar for lab meetings and individual mentoring meetings. If I'm not intentional about prioritizing those, the calendar will get filled with other meetings. Not only are these interactions with the team critical for maintaining progress in our research, but they are also the highlights of my week.

Q: What one non-scientific skill should trainees learn to succeed in their career?
A: Learning how to effectively communicate with people and identify what motivates them. You will interact with many different personality types, and sometimes it can seem like you just can't click with someone. But ultimately everyone is looking to succeed and to do a good job.

Everyone has different styles, and the sooner you can understand how best to communicate with them, the easier it is to either help them move forward on their project, collaborate more successfully or negotiate effectively. We are negotiating all the time—not just for salary increases and start-up funds. Discussions with your chair about teaching load or committee service, or conversations with a mentee about how to work together to meet a deadline, are all negotiations.

Q: How do you fight against burnout and stay motivated in the lab's long-term mission?
A: This is a major struggle for me. As for my team, I encourage them to take vacations and enjoy time together with friends and loved ones. Open communication in my lab about how they are doing and if they are feeling overwhelmed is essential.

Learning how to prioritize is also important. Sometimes the best thing to reduce that feeling is to sit down and make lists together about what is urgent and important and what can wait a little longer.

Q: What do you attribute your academic success to? And how can trainees focus on being successful?
A: Persistence and collaboration. You will need to figure out your own definition of success. But ultimately, any success I have achieved is because I have worked really hard, and I've been lucky to work with great people. I include in this my mentees as well as research collaborators. Doing good, solid work and being a kind person really goes a long way. That's the legacy you leave behind. Our research discoveries wwill fade and be replaced by new ones. It's the impact on the people that is lasting.

"Open communication in my lab about how they are doing and if they are feeling overwhelmed is essential."

Q: What was a challenge when you transitioned from trainee to faculty?
A: When I began my own research program, the weight of everything falling to me felt very heavy. Imposter syndrome was through the roof. But I also knew that the only way through it was to do good work and to surround myself with good people.

Got a career question you'd like to submit? Email it to tphysmag@physiology.org. We may use it in an upcoming Mentoring Q&A.

STATS & FACTS

$92.9 billion

in economic activity in 2023 was generated by National Institutes of Health (NIH) funding.

Research America

412,000

U.S. jobs are supported by NIH funding, including 300,000 researchers at more than 2,500 institutions across 50 states.

Research America

Cuts to NIH-funded research could lead to an estimated $16 billion in economic loss and 68,000 jobs lost nationwide.

Science & Community Impacts Mapping Project (SCIMaP)

Less than 1%

of the federal budget is spent on biomedical research.

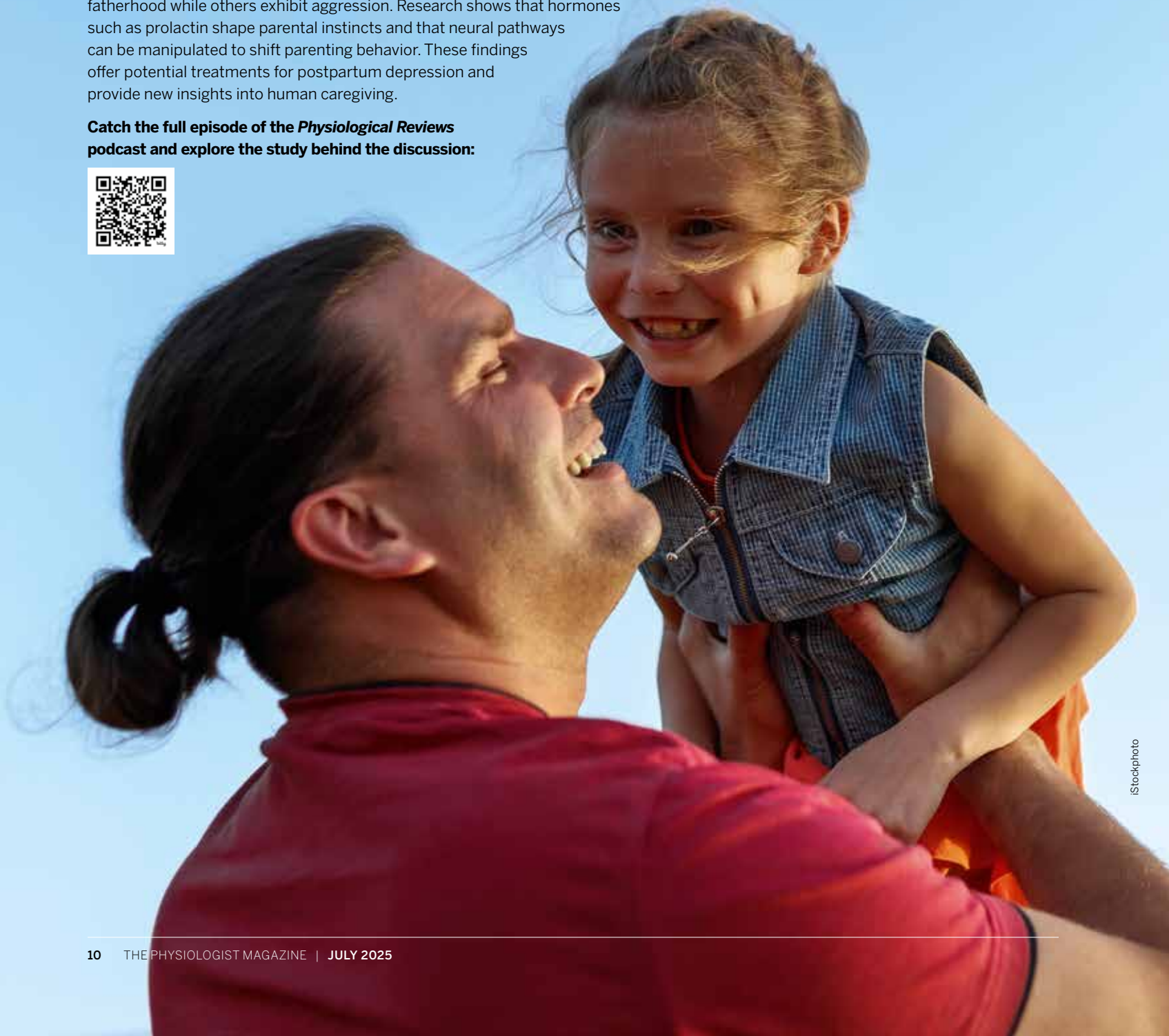
Research America

STREAMING SCIENCE | SOUNDBITES FROM APS JOURNAL PODCASTS

The Science of Parenting

What makes a parent nurture—or, in some cases, attack—their offspring? Neuroscientist Katherine Dulac, PhD, explores the complex neurobiology behind parenting behavior. "Parenting is thought to be the first time an animal will take care of the well-being of others without necessarily including their own well-being or even sacrificing it," Dulac says. Examining the differences in brain circuits, hormone receptors or even environmental factors could reveal what drives caregiving and why some males display devoted fatherhood while others exhibit aggression. Research shows that hormones such as prolactin shape parental instincts and that neural pathways can be manipulated to shift parenting behavior. These findings offer potential treatments for postpartum depression and provide new insights into human caregiving.

Catch the full episode of the *Physiological Reviews* podcast and explore the study behind the discussion:



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POLICY IQ | FEDERAL BUDGET

Science Spending Is an Investment

Federal funding for science generates economic growth and prosperity.

BY RYAN KING, PHD

If I offered you an investment with a 156% return, would you take it? This is exactly what you get when investing in the National Institutes of Health (NIH), according to the 2024–2025 United for Medical Research's report "NIH's Role in Sustaining the U.S. Economy."

Despite this economic reality, the Trump administration has proposed cuts to federal scientific research, characterizing the reductions as a way to reduce waste and improve efficiency. While fiscal responsibility matters, the historical record is clear: Investing in science is not a waste. Federal investment in science yields an unparalleled return on investment, generating economic growth and prosperity that pays dividends far exceeding the initial outlay.

After World War II, the U.S. made a significant commitment to scientific research through agencies such as the National Science Foundation and NIH. The investment contributed to one of America's greatest periods of economic expansion. Similarly, according to a report from Battelle, the Human Genome Project, a $3.8 billion federal investment, generated an estimated $796 billion return as of 2020. That's more than 200 times the initial investment.

While private industry excels at applied research and development that can generate near-term profits, it underinvests in basic research. Basic research produces what economists term "positive externalities"—benefits that cannot be fully captured by the entity funding the research. When a company invests in basic research, competitors can often freely benefit from the resulting knowledge. Even though such investment would benefit society, it's not often good for shareholders. Federal funding addresses this gap in the pipeline by supporting research that would otherwise go unsupported.

Furthermore, significant research funding helps create a highly skilled workforce by supporting graduate education and scientific training. These human capital investments pay long-term dividends, as scientifically trained individuals entering the workforce enhance productivity across sectors and drive increases in gross domestic product.

The evidence is clear: Few government expenditures generate economic activity comparable to investments in scientific research.

Federal research funding also plays a crucial role in maintaining U.S. global economic competitiveness. Between 2000 and 2021, China increased its research and development spending from $33 billion to over $667 billion annually, fueling its economic rise and threatening the U.S. position as the world's leading economy. If the U.S. hopes to maintain its economic leadership, robust federal investments in science are not optional.

Advocating for federal science funding does not mean advocating for unlimited or unaccountable spending. Taxpayer dollars should be managed responsibly, with clear reporting requirements and performance metrics.

We must also shift our perspective. Rather than viewing federal investment in science as an expense to be minimized, we should recognize the spending as a high-yield investment in our future. The evidence is clear: Few government expenditures generate economic activity comparable to investments in scientific research. For lawmakers seeking to enhance economic growth and prosperity, maintaining and expanding federal science funding is not just good policy but good economics. Our economic future depends on the scientific seeds we plant today.

Ryan King, PhD, is innovation manager at Carilion Clinic and assistant professor of medicine at the Virginia Tech Carilion School of Medicine. He represents APS on the FASEB Training and Career Opportunities Subcommittee. Email questions or comments to tphysmag@physiology.org.

UNDER THE MICROSCOPE | DISCOVERING SCIENCE

Battling Malaria

Childhood experiences shaped this researcher's perspective.

Lilian Nyindodo, PhD, MPH, is chair of the Biomedical Sciences Department and professor of molecular biology and epidemiology at Baptist Health Sciences University College of Osteopathic Medicine in Memphis, Tennessee. She leads faculty and curriculum development, aligns biomedical education with clinical practice and mentors future health care professionals. Nyindodo is a dedicated advocate for diversity in health care and has a passion for mentoring.

CHAMPION FOR CHANGE. From a young age, I was naturally curious, always eager to explore and understand how things worked. Recognizing my potential, my dad encouraged me to take science courses to nurture my love for discovery. However, my true passion for science was sparked by my personal experiences with malaria. Born in Kisumu, Kenya, a city by the shores of Lake Victoria where malaria is endemic, I battled the disease more times than I could count and witnessed firsthand the immense burden it placed on my community. Seeing families suffer due to limited treatment options fueled my determination to become a champion for change. I was inspired to pursue science with the goal of finding better treatment solutions and contributing to the fight against malaria and other infectious diseases.

WESTERN BLOT QUEEN. One of my most unforgettable lab mishaps happened while running a Western blot. I had spent days preparing my samples, carefully lysing cells, quantifying protein concentrations and setting up my gel. In my rush, I accidentally assembled the transfer sandwich backward. Instead of my proteins transferring onto the membrane, they migrated into the blotting paper. After going through the immunodetection process, I was met with complete silence. No bands, no signals—just a blank membrane staring back at me. Confused, I retraced my steps, and that's when it hit me. I peeled back the blotting paper and, sure enough, my precious proteins were imprinted there instead. It was a frustrating but hilarious moment and a lesson I never forgot. From that day on, I triple-checked my sandwich assembly before every transfer and became so meticulous that I earned the title of "Western Blot Queen" in the lab.

A TRUE LEGEND. If I could meet any scientist, it would be Rosalind Franklin. Her groundbreaking work in X-ray crystallography was instrumental in uncovering the structure of DNA, yet her contributions were largely overlooked during her lifetime. I would love to hear firsthand about her experiences as a woman in science during a time when recognition for female scientists was rare. Her resilience, dedication to meticulous research and commitment to scientific integrity are incredibly inspiring. I would ask her about the challenges she faced, how she stayed motivated despite obstacles, and what she envisioned for the future of molecular biology. Meeting her would be an opportunity to honor her legacy and gain insight from a scientist whose work continues to shape modern genetics and medicine.

"I love the interdisciplinary nature of my work. Combining molecular biology and epidemiology allows me to bridge the gap between bench research and public health."

BRIDGING THE GAP. I love the interdisciplinary nature of my work. Combining molecular biology and epidemiology allows me to bridge the gap between bench research and public health, directly impacting disease prevention and treatment strategies. Leading a department gives me the opportunity to foster a collaborative environment and advocate for resources that support faculty and students.

Do you know someone we should meet? Email us at **tphysmag@physiology.org** and tell us more.

Courtesy of Lilian Nyindodo, PhD, MPH

PUBLISH WITH POLISH | OPEN ACCESS

How to Navigate Public Access Requirements

Staying up to date on research access rules.

As immediate access to federally funded research becomes the new standard, APS is streamlining compliance with tools and support to make the process easier for authors.

Mandates to access for research have evolved, with requirements differing by funder. Some, such as the 2008 National Institutes of Health (NIH) Public Access Policy, allow for a 12-month embargo. And others—such as the European Union's Plan S, implemented in 2021—require publication in open access journals. In 2022, the U.S. Office of Science and Technology Policy made waves with the Nelson Memo, calling for immediate, unrestricted access to federally funded research. Implementation of the policy has been accelerated, and the shift to immediate public access is now underway. APS has kept pace with these changes and is ready to support journal authors in this transition.

In April, NIH announced that its 2024 Public Access Policy will now take effect for manuscripts accepted on or after July 1. What does this mean for authors? Any manuscript resulting from NIH funding—whether in whole or in part—must be made publicly available immediately without embargo upon the official date of publication (defined as "the date on which the final published article" appears online). Authors must deposit the accepted manuscript in PubMed Central (PMC) via the NIH Manuscript Submission (NIHMS) system. Once submitted, the file is converted and prepared for public access through PMC.

To reduce the burden on authors, APS Publications has implemented an automated process to deposit files in PMC on behalf of authors. We compare each manuscript's listed funders against those supported by the NIHMS system. If a match is found—such as NIH or the Gates Foundation—the accepted manuscript, along with tables and figures, is packaged and submitted directly to NIHMS for processing. However, this process depends on authors providing complete funding information in the online manuscript submission system. A green checkmark confirms that the funder has been successfully added, so be sure to look for it when updating your funding details during revised submission.

Once APS completes the initial submission, the next step falls to the author. NIHMS will contact the corresponding author by email to confirm that all content—text, tables and figures—is included. The email includes a link to the NIHMS review site, and authors should log in using the portal associated with their funder, such as eRA Commons for NIH-funded research. If needed, a different reviewer can be designated with assistance from NIHMS Help. To support authors through this process, NIHMS provides step-by-step tutorials and a helpful video guide. After conversion to the PMC format, authors will receive a second email to review and approve both the online and PDF versions of the accepted manuscript before it is posted.

APS aims to ease funder compliance for authors wherever we can, thus enhancing the overall experience with APS journals. We also have an automated deposit workflow for some European funders that require deposit to Europe PMC plus. For funders not covered by these processes, authors may deposit their accepted manuscript to the repository designated by their funder.

Send questions or comments to tphysmag@physiology.org.

Understand Your Funder's Open Access Requirements

Need help navigating public access policies? APS has you covered. Learn how to meet your funder's requirements and explore our submission workflows. Visit **journals.physiology.org/open-access**.

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STATS & FACTS

356

new drugs were funded by NIH and approved by the U.S. Food and Drug Administration between 2010 and 2019.

JAMA Health Forum

NIH-funded research has contributed to reducing deaths from heart disease by approximately 50% since 1924.

Research America

103,223

children and adults are on the national transplant waiting list.

Health Resources & Services Administration

A majority of Americans, regardless of political affiliation agree it is important for the federal government to fund basic scientific research.

Research America

IN DEPTH | PREGNANCY RESEARCH

Moving for Two

Research shows the effects of maternal exercise.

Kristin Stanford, PhD, is a professor in the Department of Surgery, General and Gastrointestinal Surgery, at The Ohio State University Wexner Medical Center. Her work explores how maternal exercise affects offspring health through collaborative studies in people and animal models. By uncovering these connections, her research could help guide future recommendations on staying active during pregnancy and reveal new ways to boost maternal health for people unable to exercise.

How did you get interested in studying the benefits of physical activity during pregnancy?
I've always been interested in exercise, including how it can improve human performance and using exercise as a tool to improve metabolic and cardiovascular health. When I was in Laurie J. Goodyear's lab at the Beth Israel Laney Health Joslin Diabetes Center, she and I started talking about maternal exercise. We realized that at that point—about 15 years ago—there wasn't a lot of research mechanistically looking at how maternal exercise could affect offspring metabolic health. So, we began to develop a rodent model that could be used to study this. Today, my lab uses the rodent model we developed to study the effects of maternal exercise. We also collaborate with other research groups to analyze samples from people to achieve a truly translational approach.

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What have you discovered?
Initially, we examined whether exercise affected the offspring. Using our rodent model, we followed the offspring of mothers who exercised only before pregnancy, only during pregnancy, both prior to and during pregnancy, or performed no exercise. We also gave some rodent mothers a relatively high-fat diet or a moderately high-fat diet.

What we saw was really striking: As long as the mom was exercising, ideally before and during pregnancy, we saw profound metabolic changes in the offspring. The male offspring especially showed improved metabolic health, glucose tolerance and liver function, as well as less accumulation of excess body fat. If the moms were also on the higher-fat diet, we also saw these effects in the female offspring.

Since then, we've branched out to figure out why these benefits occur. We've found a correlation between exercise and

changes in the mom's breast milk. Specifically, we identified a compound called 3'-sialyllactose that is increased with exercise in the rodent model and increases with physical activity in humans. More recently, we also started studying cardiac function in a rodent model, finding that maternal exercise helps preserve cardiovascular health in female offspring as they age.

"We're tackling fundamental questions about how maternal exercise benefits both mother and baby—questions that resonate with both scientists and the public."

What makes your research a game changer for maternal and child health?
We're tackling fundamental questions about how maternal exercise benefits both mother and baby—questions that resonate with both scientists and the public. By exploring multiple pathways, we hope to uncover the precise mechanisms behind these benefits.

Based on our findings, we think that exercise can be used to improve both the mom's health as well as the health of her children as they age. We hope that our research will encourage women who are pregnant to exercise, with the recommendation from their physician.

However, we know that not everyone can exercise during pregnancy. One of the things we see in our animal model is that even moderate exercise can help. We're also trying to better understand how the exercise-induced benefits work so that we might be able to confer some of the beneficial effects to those who can't exercise so that their children can still benefit.

What's next for your research?
We're now exploring how maternal exercise shapes the offspring microbiome and its role in metabolic health. We're also examining some other factors such as maternal stress. We know that a high percentage of women in the United States are stressed during pregnancy or have a stressful life event prior to pregnancy, so we're looking at how exercise mitigates some of those effects of stress.

Why is collaboration so important for your work?
We work with many research groups, including groups conducting human clinical trials, which has allowed us to analyze metabolomics and fat accumulation throughout pregnancy, with or without an exercise intervention. We're also collaborating with engineers who are thinking about various tools we could use to perhaps transfer the effects of maternal exercise without having the animals exercise to study whether this brings similar effects.

I've learned that it is very important to surround yourself with people who do good science, ask good questions and can complement and strengthen your work. When we compare our data with findings from other groups' complementary studies and see similar results, it's truly exciting. We do have the rodent model that we can use to study exercise, but because exercise is so multifaceted, collaborating with people who have expertise in different tissues and different organs has been very powerful for us to be able to think bigger and hopefully get at more translational questions.

What advice do you have for researchers just starting out?
My advice is to find what you enjoy studying. Find questions you are interested in and passionate about and then follow the data and see where it takes you. I've been at Ohio State for 10 years, and it's taken us all kinds of places that I would have never expected when we started here.

Interview conducted by science writer Nancy D. Lamontagne. Send questions or comments to tphysmag@physiology.org.

STATS & FACTS

More than 48,000

transplants were performed in 2024.

Health Resources & Services Administration

"Pigs have substantial potential as biomedical models for studying human developmental processes, congenital diseases and pathogen response mechanisms in addition to utility as xenotransplant organ donors and tools for vaccine and drug design.

Lunney et al., *Science Translational Medicine*, 2021

86%

of patients waiting for an organ transplant in the U.S. are waiting for a kidney.

Donate Life

17 people

die each day waiting for an organ transplant.

Health Resources & Services Administration


MEHARRY
EDICAL COLLEG

MORE THAN A MENTOR

Evangeline Motley-Johnson, PhD, FAPS, is a champion for the next generation, especially Black physiologists.

BY MELANIE PADGETT POWERS

Evangeline Motley-Johnson, PhD, FAPS, has long been committed to both Meharry Medical College and mentoring young researchers, especially Black graduate students and early-career physiologists.

As a Black physiologist and first-generation college student from rural Virginia, she knows the value of mentors who believe in you and support you along the way. Meharry Medical College, a historically black college (HBCU) in Nashville, Tennessee, and the first medical school in the South for African Americans, has been Motley-Johnson's home for 32 years. She is currently a professor in the Department of Microbiology, Immunology and Physiology, teaching physiology to medical and dental students and conducting cardiovascular disease research.

Photo by Tausha Dickinson

Clockwise from top left: Motley-Johnson (right) with fellow APS members Annet Kirabo, DVM, PhD, and Mark Cunningham, PhD, at the 2023 American Physiology Summit; gathering with relatives; with her twin sister, Jacqueline, on the right; dinner with former PhD students during APS' 2025 American Physiology Summit in Baltimore.

Photos courtesy of Evangeline Motley-Johnson, PhD, FAPS

Motley-Johnson and her twin sister, Jacqueline, grew up in Dry Fork, Virginia, a rural community in south-central Virginia. Their father served in the U.S. Army, worked at Dan River Mills and later became the first Black supervisor at the nearby Corning Glass Works plant. When the twins were old enough to start elementary school, their mother took a job as their school bus driver. She was their bus driver until junior high school, then continued driving that bus for almost 50 years.

The twins were interested in science as kids and set their sights on college. Their mother encouraged them to seek out a health care career because, she reasoned, "you'll always have a job." Motley-Johnson was valedictorian of her high school class, while Jacqueline was salutatorian. After high school, they headed to the University of Virginia (UVA) as pre-med students.

UVA was only about a two-hour drive north, but it was another world to the Motley girls. Going to a big university in the North, and as first-generation college students, was a culture shock. "It was hard because we were coming from the South, and most students at the school were coming from Northern Virginia," Motley-Johnson says. "We'd never heard of calculus, and we were taking all these science classes at

the same time and they were really difficult. So, we struggled."

But they were determined and smart, and with help from professors, the twins persevered. After hearing a presentation from a pharmaceutical company representative, Motley-Johnson decided to work toward a career with a pharmaceutical company. After graduation, the twins took jobs as research technicians at the UVA Medical Center. (Jacqueline stayed at UVA, managing a research lab for decades.)

BUILDING A RESEARCH CAREER

As a research tech, Motley-Johnson monitored the blood pressure in rats as part of studies on hypertension, which introduced her to physiology. Although she still planned to work at a pharmaceutical company, she applied to graduate school at Howard University in Washington, DC. She had intended to get a master's degree, but she followed the advice of a UVA colleague, who encouraged her to aim higher. She was accepted into Howard's PhD program—but on probation because of her lower grade point average due to her initial struggles at UVA.

She quickly excelled at Howard though, earning a 98% on her first physiology exam. In 1989, she received the APS Porter Physiology Development Fellowship, which encourages diversity among graduate students in physiological science fields. She considered the fellowship a tremendous financial gift—plus it introduced her to the world of APS.

After a summer research program at the pharmaceutical company SmithKline Beckman (now GSK), she moved to King of Prussia, Pennsylvania, to do her dissertation on signal transduction in alpha receptors with the company. She conducted her postdoctoral research at the University of Cincinnati and began looking for a job.

After applying for positions both in industry and academia, she was offered a job as an assistant professor of physiology at Meharry Medical College. Although it didn't meet her original goal of working at a pharmaceutical company, she decided not to turn down a good job. That was 1993. She's been there ever since, finding a home she didn't know she was looking for.

At Meharry, while seeking a National Institutes of Health (NIH) K01 Mentored Research Scientist Career Development Award, Motley-Johnson was paired up with cardiovascular research pioneer Tadashi Inagami, PhD, DSc, from nearby Vanderbilt University. She began working with Inagami's postdoctoral fellow Satoru Eguchi, MD, PhD, to train her students and write papers together, as they researched G protein-coupled receptors in vascular signal transduction. In her own cardiovascular research lab today, Motley-Johnson studies the role of protease-activated receptor 4 (PAR4) in the migration and proliferation of vascular smooth muscle cells.

COMMITTED TO HBCU STUDENTS

Mentoring and supporting students of color has long been important to

INSIDE STORY

8 Questions with Evangeline Motley-Johnson

1. **What is your best piece of career advice or leadership tip?**
   Work hard and persevere. Don't give up. If you have a dream, you need to pursue it.
2. **What is your idea of happiness?**
   My family is having a big family reunion this summer. We haven't had one in many years, since before COVID. So, I'll be excited when I'm able to see them.
3. **What's your favorite spot on the Meharry campus?**
   My office and lab.
4. **What's the best part about being around students?**
   They keep you young, and they keep you informed about technology. My students tell me about Instagram and TikTok.
5. **What three traits do you value in a colleague?**
   Motivating and energetic around students. And hard-working.
6. **What talent would you most like to have?**
   Being able to talk on the spot without thinking about what to say.
7. **What do you consider your greatest achievement so far?**
   Training my PhD students. All the ones I've trained have very successful careers and are doing very well. I'm very proud of them.
8. **What's one of your treasured possessions?**
   I like plants, and I have an orchid that blooms again and again, which is unusual.

During the COVID-19 pandemic, Meharry was an important voice for Nashville's Black residents. Motley-Johnson was involved in discussions about creating drive-through and walk-up COVID-19 testing sites, and she volunteered at the sites three days a week.

Motley-Johnson, as she recognizes the mentorship she received at UVA, Howard and beyond. She is a fellow of the American Heart Association (AHA) and, through the AHA Scholars Program, she welcomes undergraduate students—many of them international students—into her lab from Nashville HBCUs Fisk University and Tennessee State University.

The AHA program assigns two students a year to her program, but the students often ask her if they can bring along their classmates. She finds that she can't say no. "So last semester, I ended up with about nine students in the lab," she says, laughing.

It can be a bit crowded, and sometimes the extra students end up mostly observing. But depending on a student's initiative and what's on the docket for the day, they might get some hands-on experience. "One day a freshman came in by herself, so I put her to work, and she was all excited."

Motley-Johnson says the students often ask interesting questions. "I learn from them, while they're learning from me."

These experiences—and HBCUs in general—have always been important, Motley-Johnson says, but that's even more true today with the attacks on science and diversity, equity and inclusion (DEI).

During the COVID-19 pandemic, Meharry was an important voice for Nashville's Black residents, building partnerships to address Black health disparities. Motley-Johnson was involved early on in the discussions about creating drive-through and walk-up COVID-19 testing sites. In 2020, she volunteered at the sites three days a week.

As of April 2025, Meharry Medical College had lost $9.22 million in NIH grants, according to the *Nashville Business Journal*. Those grants funded research projects, helped with infrastructure and supported PhD students. Meharry President and CEO James E.K. Hildreth, PhD, MD, told the *Journal* he anticipates next year losing $30 million of the $50 million the school receives in NIH research and training grants.

Motley-Johnson witnessed the impact of the hits, as her PhD students lost their funding. "It seems to me all the funding for the Black colleges will probably be cut. … If all of that money gets cut, it's really going to hurt us. We don't have a big endowment like the majority schools."

CONNECTING THROUGH APS

Through the years at APS meetings, Black students and early-career professionals have often approached Motley-Johnson, sharing the struggles they have faced finding mentors and being the only, or one of a few, Black people in their physiology programs or research labs. She always encourages them to hang in there, but she has watched as some students have left to seek roles outside academia.

Motley-Johnson has firsthand experience of the importance of HBCUs, DEI programs and mentorship, as a UVA student, Howard PhD student, Porter Fellow, physiologist and Meharry professor. She has excelled in her career and at APS. In 2022, she became the first Black woman elected to the APS Council (now the APS Board of Directors). "Being on the Council was really a learning experience," she says.

She is also a past member of the APS Porter Committee (now the Diversity, Equity & Inclusion Committee) and the Trainee Committee of the Cardiovascular Section. She has served on NIH review panels and is a past member of the Student Affairs and Minority Affairs committees of the Endocrine Society.

In 2020, she got involved when a group of Black APS members formed the Black in Physiology community to provide mentorship, support and resources to Black physiologists. She names several APS members whom she got to know when they were PhD students and postdocs. It's been thrilling, she says, to see them succeed. "I keep up with their careers and look forward to seeing them at APS meetings."

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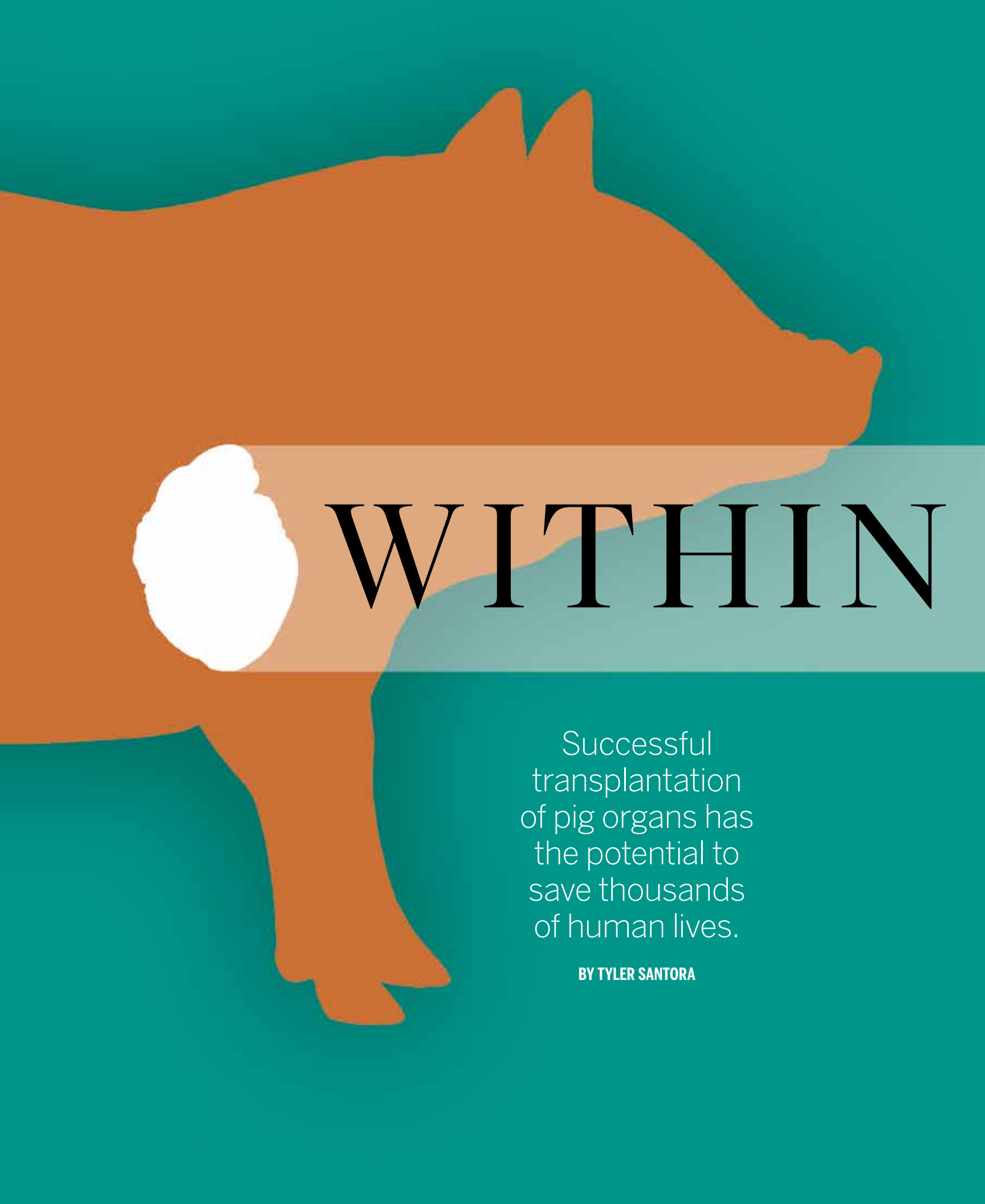

WITHIN

Successful transplantation of pig organs has the potential to save thousands of human lives.

BY TYLER SANTORA

REACH

More than 103,000 people in the U.S. are waiting for a lifesaving organ transplant, and many of them will never have one. Every day, 17 Americans die while still on the waitlist. But a burgeoning field of medicine might be able to save these lives—and transform the field of transplantation in this country—by giving humans organs from animals, in a process called xenotransplantation.

"If we can provide this option, that will definitely meet the shortage of organs," says Muhammad Mohiuddin, MBBS, director of the cardiac xenotransplantation program at the University of Maryland School of Medicine.

In some cases, these "xeno" organs could be used as a lifeline until a human organ is available, Mohiuddin says. But the goal is that this won't be necessary, and the non-human organs would last for years, even decades.

Xenotransplantation has been around since at least 1682, when doctors replaced part of a Russian nobleman's skull with a canine graft. Today, modern medicine is using gene-edited pig organs such as the heart, kidney and liver to transplant into people.

FAST FACTS

Xenotransplantation Milestones

1960s	Immunosuppressive drugs are identified. Xenotransplantation research with primate organs into humans becomes popular. Most were unsuccessful, with infections, organ rejection and ethical concerns.
September 1965	First pig aortic valve transplanted into a human.
1990s	Pigs become ideal choice for xenotransplantation.
2013	Several research teams announce gene editing success using CRISPR–Cas9 system.
2019	A macaque survives more than one year with a kidney from a genetically edited pig.
September 2021	NYU Langone Health and University of Alabama both successfully transplant a genetically modified pig kidney into brain-dead humans.
January 2022	University of Maryland successfully transplants genetically modified pig heart into a living human.
June and July 2022	NYU Langone Health transplants two genetically engineered pig hearts into recently deceased humans.
March 2024	Massachusetts General Hospital successfully transplants a genetically edited pig kidney into a living adult with end-stage kidney disease.
April 2024	NYU Langone Health successfully performs the first combined heart pump and pig kidney transplant.
February 2025	The U.S. Food and Drug Administration approves the first clinical trial testing whether genetically modified pig kidneys can be safely transplanted into humans.

Sources: NYU Langone Health and National Kidney Foundation

The modern study of xenotransplantation picked up in the late 1990s. Back then, Mohiuddin transplanted hamster hearts to rats and rat hearts to mice. After achieving success in small animal models, he moved to transplanting pig hearts to baboons.

At first, animal trials ended in organ rejection within minutes. But with recent advances in gene editing and immunosuppression, Mohiuddin and his contemporaries have completed pig-to-primate transplants over the past few years. Now, the field has turned to transplanting pig organs into humans. Pigs are good sources for organs because they grow fast and have large litters. They also have a well-studied genome and organs that are fairly compatible with humans.

THE CHALLENGES OF XENOTRANSPLANTATION

There are three aspects of xenotransplantation that make it challenging: rejection, infection and disease transmission.

Rejection is a challenge with all transplants, even within the same species. But it's more complicated in xenotransplants because humans have antibodies that attack pig organs and their byproducts. Additionally, the techniques that allow doctors to catch rejection early in typical human-to-human transplants, allowing them to take life-saving measures, don't work as well in xenotransplants, Mohiuddin says.

Physicians typically prevent rejection with immunosuppressive drugs, dulling the recipient's immune system so it doesn't attack the transplanted organ. For a long time, doctors thought the drugs they prescribe for typical transplant rejection wouldn't work for xenotransplants. But United Therapeutics, a biotechnology company leading the xenotransplantation race, recently

"Maybe not in my lifetime, but we will get to a stage where we can modify the pig to an extent that we will not have to even use immunosuppressive drugs."

—Muhammad Mohiuddin, MBBS

demonstrated that the medications used for human-to-human transplants work with a largely normal protocol in xeno recipients.

"We have learned a lot about these drugs … and we now have a way of monitoring them and giving just enough so we can prevent rejection," Mohiuddin says. That's crucial because there's a delicate balance between dampening the immune system enough so that it doesn't attack the xeno organ and keeping it active enough to prevent infections.

Scientists can also use an additional approach with xeno organs that they can't with human ones: genetic engineering. For example, researchers have knocked out three pig genes that create sugars people have antibodies to. This reduces the chance of acute organ rejection—and how much immunosuppression recipients need.

"We overcame the risk of acute rejection. The challenges are mostly now in the long term. How will the immune system react months after a transplant?" says Leonardo Riella, MD, PhD, medical director of kidney transplantation at Massachusetts General Hospital.

Researchers have also added human genes related to blood clotting and immune function to the pig genome. This is important because complement activation systems—in which proteins called complements mark pathogens for destruction by other immune cells—are incompatible between pigs and humans. "We realized that by introducing some human regulatory genes … the survival of these kidney transplants were significantly greater," Riella says.

With further research, scientists may be able to pinpoint and deactivate every last pig gene that contributes to organ rejection. "Maybe not in my lifetime, but we will get to a stage where we can modify the pig to an extent that we will not have to even use immunosuppressive drugs," Mohiuddin says.

This would also eliminate the second major risk—infection—since immunosuppression increases the risk of infection in all transplants. "In human-to-human transplant, we see lots of infection because of the immunocompromised state of the recipient, and we have learned to overcome those infections. We hope that in xenotransplantation, it'll be the same," Mohiuddin says. However, it's no guarantee that these techniques will work in xenotransplants, and they may even trigger rejection.

The third challenge, unique to xenotransplants, is preventing transmission of pig diseases to human recipients, which could then spread to the health care team, friends and family. The U.S. Food and Drug Administration (FDA) requires strict protocols for raising and testing donor pigs and monitoring recipients and their contacts post-transplant. The worry includes diseases that could be lying dormant in the pig DNA, so some pigs are genetically edited to inactivate these genes.

In cases so far, disease transmission hasn't been an issue, and Mohiuddin doesn't think it will become one. "But we don't know what we don't know, so that's why we need to follow [patients]," he says.

PIG HEARTS TO HUMANS

In 2022, a team at the University of Maryland Medical Center performed the first ever gene-edited organ xenotransplant—of a heart—into a living human. The FDA granted compassionate use clearance to transplant a pig heart into David Bennett, a 57-year-old man with terminal heart disease. He had been admitted to the hospital, was bed-ridden for two months and was not eligible for a typical transplant.

"We were not sure whether, after putting in this pig heart, this patient would even wake up," says Mohiuddin, a member of Bennett's xenotransplant team.

The transplant went well, and Bennett did not suffer acute rejection. He lived for 60 days post-transplant. For nearly 50 of them, he was healthy and even began regaining strength in physiotherapy, Mohiuddin says. But after a short decline, Bennett died from heart failure. His care team found evidence of a dormant pig virus in his system, raising questions about whether it could have contributed to the transplant failure. However, they

> **"We want to create an unlimited supply [of organs] and give patients another option other than, in some cases, death, and in some cases, a lifetime of dialysis."**
>
> **—Leigh Peterson, PhD**

found no proof of this, and that virus isn't able to infect human cells.

Another potential contributor: Bennett's doctors twice administered IVIG antibodies to him to help fight infection and rejection—typical protocol in transplant patients. However, they realized later that the antibody mixture contained anti-pig antibodies that may have aggravated Bennett's heart.

Mohiuddin's team was hopeful that the second heart xenotransplant would be a greater success because Lawrence Faucette, age 58, despite having terminal heart disease, was healthy enough to walk when they began applying for compassionate use clearance from the FDA. Unfortunately, Faucette declined quickly, and his original heart arrested twice before the transplant. He suffered post-surgical complications and blood loss, and the blood transfusion he received contained high levels of anti-pig antibodies, as his doctor later discovered, which worsened his condition. Additionally, Faucette's xeno heart couldn't reach a heart rate that would perfuse his whole body, so his care team had to artificially increase it, which may have damaged it further. He died from organ rejection 40 days later.

Mohiuddin's team is now seeking a healthier patient to see how a xeno heart functions when the original heart is the only damaged organ a person has. But volunteers must have no other options to qualify for compassionate use, so they must be really sick. "We will never get a perfect patient because a perfect patient will first opt in for a human heart," Mohiuddin says.

United Therapeutics is finishing a baboon study that should provide the data necessary to apply for a xeno heart clinical trial, which the company hopes to complete within the year. If approved, a clinical trial would allow for dozens of more people to receive a xeno heart, giving researchers the opportunity to tweak the process.

For now, xeno heart researchers must look to the first clinical trial in kidneys for steps to improve survival and fight rejection.

PIG KIDNEYS TO HUMANS

Compassionate use cases are critical for learning how to make xenotransplants successful, but scientists can't use them alone as evidence to convince the FDA of their safety or efficacy—or to convince the agency to approve a clinical trial.

For this, the FDA requires controlled studies of the genetically engineered organ in baboons that mimic a proposed clinical trial, to the extent possible. Earlier studies were conducted using pig organs with various gene edits, different immunosuppression regimens or other uncontrolled factors.

"There was a lot of mixing and matching to determine the best combination. That's the nature of how science is done at that stage," says Leigh Peterson, PhD, executive vice president of product development and xenotransplantation at United Therapeutics.

In a lead-up to applying for a clinical trial, United Therapeutics consulted with the FDA and ran a comprehensive 14-baboon kidney xenotransplant experiment—to successful results. After the company submitted a 1,200-page application on New Year's Eve in 2024, the FDA granted it clearance for the first clinical trial of a gene-edited pig organ transplant to people. Around the same time, the FDA also cleared Massachusetts General Hospital to begin a small study using pigs with more gene edits, provided by another biotech company called eGenesis.

The United Therapeutics trial will begin with two transplants, each followed by a 12-week waiting period to analyze safety and efficacy. Then four more patients will receive a xeno kidney, followed by another 12-week waiting period. If the results are encouraging, the trial will continue until up to 50 xenotransplants are conducted. Along the way, United Therapeutics may amend the protocol based on what its researchers learn to reduce chances of rejection and reverse it if it occurs. "We are learning more and more

how to identify and treat xeno organ rejection episodes," Peterson says.

Part of why Peterson is so confident is that compassionate use cases have met success. Of the five people who have received xeno kidneys through compassionate use, three are still alive: 53-year-old Towana Looney, 66-year-old Tim Andrews and a 69-year-old woman in China about whom less is known. Looney received her new kidney on November 25, 2024, after waiting seven years for a transplant. However, in March 2025, her body began to reject the organ for unknown reasons, and she had it removed on April 4 to go back on dialysis. Andrews received his pig kidney on January 25 this year and is still healthy and free from dialysis.

Xeno kidneys appear to function well, especially in filtration and urine production. But there could be some physiological challenges, says Kelly Hyndman, PhD, a medicine professor specializing in nephrology at the University of Alabama at Birmingham School of Medicine. For example, kidneys are important for regulating blood pressure, and it's unclear how xeno kidneys will fare doing this in the long term. If blood pressure rises, clinicians will need to test whether common medications are safe and effective for xenotransplant patients.

Additionally, kidneys must produce and respond to various hormones, and it's unclear whether the xeno organs will be able to do so effectively. Preliminary research shows that the hormone renin produced by the pig kidney may not be able to interact correctly with the hormone angiotensin produced by the human liver—which is crucial for maintaining sodium and water balance and regulating blood pressure, Hyndman says.

Furthermore, it's unknown how well the xeno kidney-produced hormone erythropoietin will be able to perform its function of spurring bone marrow to make red blood cells, crucial for preventing anemia.

However, these potential complications are easily monitored, Hyndman says, and can be treated by giving the patients exogenous hormones. Nephrologists are already well-versed in doing so. "Dialysis does not help with any of those things; all dialysis does is remove things from your blood," Hyndman says.

NO MORE WAITLISTS

If clinical trials succeed and xenotransplants become available to the public—a future that might be just a few years away for the kidney and heart—innumerable lives will be saved. "We want to create an unlimited supply [of organs] and give patients another option other than, in some cases, death, and in some cases, a lifetime of dialysis," Peterson says.

It's not only patients with heart and kidney failure who could benefit from xenotransplants. Researchers are studying xenotransplantation of the liver and lungs, too. In March, Chinese researchers reported the first xeno liver transplant to a brain-dead recipient. Instead of removing the human liver, they placed the pig liver beside it, and it survived for the 10 days of the experiment with no signs of rejection. The xeno liver produced bile and albumin, though less than a human organ would.

There's still a long way to go before scientists xenotransplant a liver into a living human because the organ has many additional functions—from removing waste to fighting infection to storing iron and more—and it's unclear how well a xeno liver would perform these functions. But even if the xeno liver survives only a few days, it could save patients' lives. "When patients develop liver failure, they sometimes need an organ right away," Riella says. "To even have a liver working for a few days, until the patient either recovers or receives an offer from a human," could be the bridge that keeps them alive, he says.

Researchers are also studying xeno lungs, although they haven't yet moved from the animal model stage to humans, and the complex anatomy of the lung poses challenges. Eventually, other organs could be xenotransplanted as well, such as pig skin for burn victims and pancreatic islets for people with diabetes.

Researchers are already considering the ethical concerns of scaling up xenotransplants for widespread use. For instance, United Therapeutics is trying to limit the environmental impact of raising pigs with plans to use one pig for multiple organs. The company is also anticipating ethical concerns from the public. However, the ethical issue is another reason pigs are good donors: About 1.4 billion pigs are slaughtered every year for meat, which for many people is not necessary for survival, whereas pigs killed for xenotransplantation will directly save lives. Mohiuddin says even leaders of religions that don't allow pork consumption have said they would allow practitioners to accept a xenotransplant to save their life.

And many, many lives it could save. "If we can get this right, this is really going to help a lot of people," Hyndman says.

Listen to xenotransplantation experts in the *Physiological Reviews* podcast episode "Xenotransplantation from Genetically Modified Pigs to Humans."

bit.ly/xenotransplantationpod

The BREAKING POINT

Science funding is under attack, leaving researchers bracing for what's next.

BY DARA CHADWICK

Physiologists are no strangers to uncertainty. After all, ambiguity, complexity and variability are inherent in science. Yet amid scientific uncertainty, researchers and laboratory teams have long been able to rely on the mostly predictable system of federal research funding.

Until now, that is. Researchers, trainees and institutions across the U.S. have been reeling from the effects of the new administration's actions changing how scientific research is prioritized and funded. In the administration's first six months, researchers faced everything from efforts to cap indirect cost funding at 15% to workforce reductions and cancellations or delays in federal research grants.

Image created using Adobe Firefly AI tool

Litigation to block these actions has further clouded the horizon for researchers. Carrie Wolinetz, PhD, senior principal and chair of the Health and Biosciences Innovation Policy Practice Group at Lewis-Burke Associates LLC, a Washington, DC-based government relations firm, likens this uncertainty to a "sword of Damocles" hanging over the heads of researchers.

Early in the new administration, we saw "rapid-fire executive action," says Wolinetz, a longtime senior government official in biomedical research who previously held roles at the National Institutes of Health (NIH) and the White House. "Researchers don't know the fate of their future funding. Institutions are being incredibly cautious about the future, which means everything from hiring freezes to rescinding offers to graduate students. The longer this period of uncertainty stays in place, the less likely it is that the damage can be reversed."

POTENTIAL EFFECTS ON SCIENCE

Uncertainty around research funding can lead to decreased innovation, according to Daniel Michele, PhD, professor and chair of the Department of Molecular and Integrative Physiology at the University of Michigan in Ann Arbor and chair of the APS Science Policy Committee. Michele emphasizes that he speaks as a scientist and chair of the APS committee and not on behalf of the university.

"When funding is tight, scientists become more conservative," he says. "They cannot risk the remaining funding they have left for their lab, so they have to propose and do the safest experiments that are most likely to be productive. As a consequence, innovation is stymied. Many groundbreaking discoveries are made by creative experiments that require exploratory funding."

Exploration and innovation often take years. When it comes to bringing new drugs and treatments to market, funding is critical. Michele cites a study published in the April 2023 *JAMA Health Forum* that showed 356 new Food and Drug Administration-approved drugs between 2010 and 2019 were funded by NIH.

"Most of those drugs took almost 15 to 20 years to move from basic research discovery to a new drug," Michele says. "A reduction in funding not only slows the development of new drugs but could also lead to projects being canceled and a huge loss of a 15- to 20-year investment in that discovery."

Science is not quick, particularly for physiologists who are conducting whole system and whole

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organism-level experiments. "They're planned out for weeks, months and years at a time," Wolinetz says. "It's hard to imagine these actions won't slow the pace of research enormously and potentially delay the outcomes of that research for years."

Michele also says his laboratory's research has benefited from the creativity of early-career researchers, who are often much better at ignoring barriers or seeing beyond them and embracing new technologies. "An established investigator typically likes to lean on approaches that they have experience with and that they view as more likely to succeed," he says. "We need early-career scientists from all walks of life to enter careers in science and bring their innovative ideas to our laboratories."

New Editorial in *Function*: A Call to Action for Physiology's Future

In an editorial in *Function*, APS CEO Scott Steen, CAE, FASAE, builds on the message he delivered at the 2025 American Physiology Summit. Steen confronts the mounting threats to biomedical research—from political interference and misinformation to funding instability and challenges to academic freedom. He urges the physiology community to remain bold, vocal and unified in defending science and the essential role of physiologists in improving health and understanding life. Read the full editorial in *Function*: **doi.org/10.1093/function/zqaf025**.

A DISAPPEARING PIPELINE

Research funding uncertainties affect more than the pace of innovation. They also affect the career paths of future innovators.

Jeremy Berg, PhD, has held roles in academia prior to and after his role as former director of the National Institute of General Medical Sciences. Berg, who lives in the greater Pittsburgh area, is also the former editor-in-chief of *Science*.

Much academic biomedical research is conducted by trainees, according to Berg. "Young scientists who are learning are often eager, hard-working, smart and creative. They don't yet know what's impossible, so they just go ahead and do it anyway."

Changes in grant funding directly affect graduate students and postdocs. Currently, NIH hasn't been making awards at its typical pace, according to Berg. "As of March 1, the amount of money that hadn't been received across the whole system was about $1.85 billion," he says.

Berg compares the situation to a landlord whose tenants pay rent each month. "As a landlord, you know the rent is coming on a specific date," he says. "Now, the money isn't coming in and it's stressing out the academic institutions. Some graduate programs are being downsized. Some are in sort of [a limbo] where nobody knows whether they're accepting students."

Fewer graduate students and postdocs means labs won't have the people they need to conduct funded research. As the problem gets bigger, the flexibility of institutions to handle it may decrease, Berg says.

"If you have a hundred labs in your institution and five of them hit a rough patch, it's not that hard to figure out how to put together a bridge funding program and find institutional sources or other sources of funding to keep people going through an interruption in grant funding," he says. "If you have more labs being hurt and you're also short tens of millions of dollars, your flexibility to do something about it is more limited."

FROM THE EXPERTS

3 Tips for Managing Uncertainty

There are strategies researchers can employ to get through challenging times.

Stay informed. Jeremy Berg, PhD, recommends physiologists stay informed about what's happening so they can prepare. "With research that involves mouse lines, you can freeze embryos if you have to," he says. "You can interrupt experiments and eventually have a path to restart."

Focus on collaboration. Daniel Michele, PhD, recommends increasing collaboration among labs. "One way to strategize for a reduction in funding is to have several labs capitalize on the unique skills of a talented scientist," he says. "If the institution has core facilities, in some cases it can be cost-effective to access existing experts for critical experiments compared to hiring the expert into your laboratory."

Diversifying funding sources. Carrie Wolinetz, PhD, says diversifying funding when possible may be a smart move. "It's an opportunity to think about sharpening your research focus," she says. "Is there enough bridge funding to collect more preliminary data or think about different experimental approaches? It's potentially an opportunity to get out of this cycle of chasing the next grant. But not every researcher or institution is going to have that luxury, unfortunately."

> **"The longer this period of uncertainty stays in place, the less likely it is that the damage can be reversed."**
>
> **—Carrie Wolinetz, PhD**

Not securing an expected grant and grant terminations can create a sense of discouragement, mistrust and despair, Berg says.

Fewer supported students and fellows could result in less research and in projects being canceled, Michele says. "Most academic labs are run like small businesses of five to 10 people," he says. "Graduate students and postdoctoral fellows are the lifeblood of most academic research laboratories, typically representing 50% to 75% of the workforce in a lab."

Yet Michele says what worries him the most is the future of scientists. "Running a laboratory has never been easy," he says. "In the current uncertain funding environment and with possible future reductions in funding on the horizon, a career as a laboratory scientist may seem improbable."

INSTANT INSIGHTS

STAY INFORMED AND ENGAGED

In a shifting research landscape, staying connected to science policy is more important than ever. The APS advocacy hub offers opportunities for you to take action and stay informed. It's a resource for researchers who want to understand what's happening—and have a voice in what happens next. Learn more at **physiology.org/advocacy**.

DECREASING GLOBAL STRENGTH

Early-career scientists leaving research and potentially not returning represents a "generational problem" that could ultimately make the U.S. less competitive globally, according to Wolinetz. Spontaneous firings, an even more competitive funding environment and limited freedom to follow the science in certain areas may have long-lasting ripple effects.

"Smart, talented young people have a diversity of options, and it becomes difficult to imagine a future where people will actively choose this pathway," Wolinetz says. "That ends up being a huge loss for the country. While the U.S. is going through this period of immense transition and challenge, the rest of the world is seeing that as an opportunity and thinking, 'How do we attract all that talent to our country?'"

Berg says the U.S. has already been losing postdocs for a while. "Opportunities to do research in China, India, Europe, Australia and the U.K. have been getting better over time," he says. "All of a sudden, the U.S. is basically walking off the field saying, 'We're not going to compete in this space anymore.'"

Some early-career scientists are pursuing careers outside laboratory science, even during PhD training, according to Michele. "While it may seem counterintuitive, I encourage early-career scientists to make the most of the training they are getting in the laboratory doing experiments," he says. "Future employers are looking to hire PhD scientists because they're trained to be experts and innovators in laboratory science."

Despite all these pressures, science has always shown a remarkable ability to flex and adapt to the current environment. One bright spot? Wolinetz says this period of uncertainty may come to an end as new leadership emerges at NIH. "We could see some of these pipelines that have been clogged begin to get unclogged relatively soon," she says.

Ultimately, science has always been shaped by both funding priorities and politics, according to Michele.

"The HIV pandemic and the COVID pandemic first caused a lot of political and public turmoil but eventually resulted in a tremendous mobilization of resources and science to develop effective therapies and vaccines," Michele says. "The ethical and political challenges of using human embryonic stem cells in research led to the discovery of induced pluripotent stem cell technologies that have revolutionized the study of human disease and new therapies.

"The past would indicate that science has continued to innovate in the face of political change or public disagreement, as well as changing funding priorities. We must continue to adapt and innovate."

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physiology.org/jobs

2025 AMERICAN PHYSIOLOGY SUMMIT

Summit Draws Crowd, Builds Momentum for 2026

With more than 3,000 attendees, the 2025 American Physiology Summit in Baltimore brought together researchers, educators and trainees from around the world for four days of scientific exchange and connection. Attendees shared their research, built professional relationships and explored the future of physiology. From packed sessions to networking events, the Summit showcased the strength and vitality of the APS community.

Building on this momentum, mark your calendar for the 2026 American Physiology Summit, to be held in Minneapolis, April 23–26.

Stay tuned for more details at **physiology.org/APS2026**.

Clockwise from left: Dorothy Erlanger presents Past President Tim Musch, PhD, FAPS, and APS CEO Scott Steen, CAE, FASAE, with her grandfather's Nobel medal. Panelists participate in a discussion about women's health research, Steen delivers his opening address, and APS members enjoy opening festivities.

Photos by Brian O'Doherty

At a panel discussion on women's health research, attendees discuss how they can use their voices to bring attention to the gaps in women's health research and how to advocate for funding.

SOCIAL CHATTER @ THE SUMMIT

Songyoung Park
linkedin.com/in/songyoung-park-5b2165207

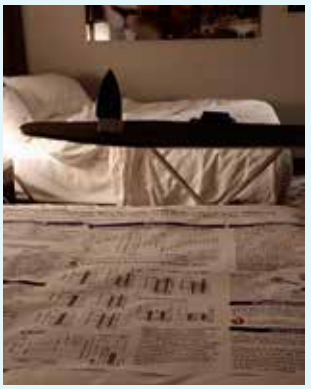
University of Nebraska at Omaha Vascular and metabolic phenotyping lab! 2025 at American Physiological Society

Dr. Cristina Espinosa-Diez
x.com/Krispy_ed

The happiness of physiology I guess #APS2025 @APSPhysiology

P.S I also did science and stuff... but kittens...

Dr. Jess Hebert
bsky.app/profile/jesshebert.bsky.social



Dear #APS2025 poster presenters: remember to iron your fabric posters. If you folded your paper poster, you're out of luck. Love, Your Science Aunt

CAPITOL HILL DAY

Researchers Rally in DC

More than 75 APS members, including Society leaders, gathered in Washington, DC, on April 23 to advocate for robust federal investment in research during APS' in-person Capitol Hill Day. The event was held ahead of the American Physiology Summit, which took place April 24–27 in Baltimore.

Participants met with congressional offices to highlight the critical need for consistent funding for federal research agencies. These investments power biomedical research, foster innovation and train the next generation of scientists.

APS members also addressed how funding disruptions delay scientific progress, affect state and local economies, and jeopardize career development, especially for early-career researchers. In support of the Society's Women's Health Research Initiative, members also called attention to longstanding funding gaps in women's health research and the effect of these disparities on health outcomes.

Top right: Steve Elmer, PhD; Manda Keller-Ross, PhD; and Morgan Zumbaugh, PhD, discuss their meetings in front of the U.S. Capitol.

Center right: Jennifer Zeitzer, PhD; Alexandra Medcalf; Sue Bodine, PhD, FAPS; and Benjamin Miller, PhD, FAPS, meet with a staff member in the office of Rep. Stephanie Bice.

Bottom right: Mike Sturek, PhD, FAPS; Tim Musch, PhD, FAPS, Farah Sheikh, PhD; Meeghan DeCagna, MSc, CAE; Robert Hester, PhD, FAPS; Paul Welling, MD; and Rick Samson, PhD, FAPS, meet with staff of Sen. Patty Murray, the minority leader on the Appropriations Committee.

Bottom left: Nathaniel Jenkins; Rashaun Williams, PhD; and Kelsey Schwartz, PhD, discuss their day in front of the U.S. Capitol.

Photos by Anthony Bolognese

APS GOVERNANCE

New Section and Interest Group Chairs Take Office

Three new APS section group chairs and one new interest group chair have taken office for the 2025–2028 term. These member leaders help organize scientific activities, foster networking opportunities and promote collaboration among physiologists working in related research areas.

Cardiovascular Section

Julie Freed, MD, PhD
Associate Professor, Executive Vice Chair, Director of Clinical Research
Medical College of Wisconsin

"These are unprecedented times. As the scientific landscape changes, it is more important than ever to focus on our academic community and support one another."

Cell & Molecular Physiology Section

Ian Thornell, PhD
Research Assistant Professor of Internal Medicine-Pulmonary, Critical Care and Occupational Medicine
University of Iowa

"My two core motivations for my ongoing support of APS are it is a supportive community of scientists and there are opportunities for all its members to make an impact."

Renal Section

Michelle Gumz, PhD
Professor, Department of Physiology and Aging
University of Florida

"It is more important than ever to invest in our community, and I am excited to continue our section's tradition of providing a scientific home for all renal physiologists, from every background and across all career stages."

Translational Physiology Interest Group

Christos Katsanos, PhD
Associate Professor, School of Life Sciences
Arizona State University

"I plan to facilitate meaningful dialogue in translational physiology, support APS' scientific and organizational efforts, and organize networking activities that foster collaborations and career development."

OUTGOING SECTION CHAIRS

APS thanks outgoing chairs who have completed their terms.

Cardiovascular Section

Farah Sheikh, PhD
Professor, Medicine
University of California, San Diego

Cell & Molecular Physiology Section

Sandrine Pierre, PhD
Associate Professor, Department of Biomedical Sciences
Marshall University

Renal Section

Robert Fenton, PhD
Professor, Department of Medicine
Aarhus University, Denmark

Translational Physiology Interest Group

Julie Freed, MD, PhD
Associate Professor, Executive Vice Chair, Director of Clinical Research
Medical College of Wisconsin

Learn more about the Society's sections and interest groups at **physiology.org/community**.

MEMBER NEWS

The following APS members have been named to the **Fellows of the American Association for the Advancement of Science (AAAS) Class of 2024**. Fellows are elected to this lifetime distinction by their peers serving on the AAAS Council.

Joshua C. Brumberg, PhD, professor of psychology and biology, Queens College; president, Graduate Center of the City University of New York

Thomas J. Roberts, PhD, professor of ecology, evolution and organismal biology; senior associate dean for the program in biology, Brown University

Zhongjie Sun, MD, PhD, professor and chair, Department of Physiology, University of Tennessee Health Science Center

Kezhong Zhang, PhD, Distinguished Professor of Molecular Medicine and Genetics and of Biochemistry, Microbiology and Immunology, Wayne State University

Gina L.C. Yosten, PhD, has been named the Kummer Endowed Department Chair of biological sciences at Missouri University of Science and Technology. Yosten is a member of the APS Board of Directors and an editorial board member of *Physiological Reviews* and the *American Journal of Physiology-Regulatory, Integrative and Comparative Physiology (AJP-Regu)*. She is also the past editor-in-chief of *AJP-Regu*. Yosten began her new role on July 1.

DATES & DEADLINES

AWARDS

Award deadlines vary and may be subject to change. For the latest information, including award descriptions, amounts, eligibility requirements and to apply, visit ***physiology.org/awards****.*

JULY 1

Ernest H. Starling Distinguished Lecture of the APS Water & Electrolyte Homeostasis Section

JULY 15

Claude Bernard Distinguished Lectureship of the Teaching of Physiology Section

JULY 31

Solomon A. Berson Distinguished Lectureship of the APS Endocrinology & Metabolism Section

AUG. 31

Anne R. Crecelius High Impact Scholar Award

SEPT. 16

APS Fellows (FAPS)

OCT. 4

Henry Pickering Bowditch Award Lectureship
Physiology in Perspective: The Walter B. Cannon Award Lecture

CALLS FOR PAPERS

CROSS-JOURNAL CALL FOR PAPERS

Explore our ongoing cross-journal calls for papers on key women's health research topics:

- Alzheimer's disease
- Autoimmune diseases
- Breast cancer
- Cardiovascular disease
- Hormone replacement therapy and menopause
- Migraines
- Novel perspectives on sex as an investigative variable
- Pregnancy and postnatal conditions:
  - Endometriosis
  - Gestational diabetes
  - Preeclampsia
  - Polycystic ovary syndrome

Join APS in advancing our mission to improve health care outcomes and promote greater scientific understanding of women's health. Learn more about this special call for papers at journals.**physiology.org/womens-health-research-initiative**.

American Journal of Physiology-Regulatory, Integrative and Comparative Physiology

- Integrative Physiology of Gut-Brain Communication (Sept. 30)
- Physiological Adaptations to Environmental Stressors and Challenging Conditions (Sept. 30)

American Journal of Physiology-Renal Physiology

- Epigenetics in Kidney Health and Disease (Oct. 1)
- Cardiorenal Physiology (ongoing)

Function

- Neuroscience (ongoing)

Journal of Applied Physiology

- Physiological Responses to Psychosocial Stress (Sept. 30)
- Experiments of Nature (ongoing)

Journal of Neurophysiology

- Integrative Research on the Functional Logic of Neural Circuits (July 25)
- Now and Then (Nov. 30)
- Neuroimaging Meets Neurophysiology (Dec. 31)

Physiological Genomics

- Nutrigenomics (Dec. 1)

Physiological Reports

- The Physiology of Breathlessness (Sept. 1)
- Tissue Fibrosis Through the Life Course and in Transplanted Organs (Dec. 31)

MEETINGS & EVENTS

2025

New Trends in Sex Differences and Women's Health Research
Oct. 23–25
Tulane University Medical Campus
New Orleans
physiology.org/APSSexDiff2025

SAVE THE DATE: 2026 CONFERENCES

American Physiology Summit
April 23–26, 2026
Minneapolis

Control of Renal Function in Health and Disease
June 2026

Comparative Physiology Conference
September 2026

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Spot Physiology in Everyday Life

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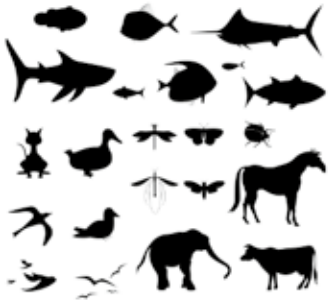

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Hear from Experts Advancing the Discipline

Tune in to podcast discussions of the latest and most impactful discoveries published in APS Journals. Listen as we spotlight research from our family of 16 journals at **journals.physiology.org/podcasts.**

Interested in contributing? Email **communications@physiology.org**.

Seize the Opportunity

BY BERRY PINSHOW, PHD

There have been moments in my life when I've made snap decisions that profoundly affected my entire future. These impulsive choices spawned life-changing opportunities for me and my family.

The first such decision came at 14 when my high school headmaster in Johannesburg, South Africa, where I grew up, threatened to expel me for refusing to participate in daily prayers.

"What will you do next year?" he asked disparagingly.

"Go to Israel," I replied instinctively. So, I did.

This seemingly vacuous adolescent statement stemmed from growing up in a family of liberal Zionists. In 1962, I traveled to Israel alone to attend boarding school. My family followed later.

After high school, military service and undergraduate biology studies at Tel Aviv University (TAU), I met my first mentor, Professor Amiram Shkolnik. Following a lecture on desert animals, I asked him how Negev Desert fat sand rats survive on salt bush alone. His flattering response—inviting me to investigate the question as his master of science student—precipitated another pivotal decision.

Based on my father's advice, I applied to five prestigious universities and was accepted by Duke University in Durham, North Carolina, where I would study under the legendary Professor Knut Schmidt-Nielsen. My wife, Hana, and I went to Durham in spring 1972.

For a year Hana worked in a shoe store. After Schmidt-Nielsen and I submitted a proposal to study emperor penguins in Antarctica, Hana was employed as a technician by my adviser, which made her eligible to work with me in Antarctica if the grant was awarded. In fact, Hana became the first Israeli woman to set foot on that continent.

Following my PhD and a postdoc at the University of Wisconsin-Madison, I took a position at Ben-Gurion University in Israel in 1977. During a 1983 sabbatical, I attended a conference in Honolulu, where, after the first session, I approached the well-known avian physiologist, Professor William Dawson, to ask a question. I was nervous and asked without properly introducing myself. Dawson did not know the answer and suggested I ask an Israeli named Berry Pinshow (me!) who was attending the meeting. I thanked him and walked away. Little did I know what would ensue as a consequence.

Months later, Dawson invited me to visit him in Ann Arbor and present a seminar at the University of Michigan. There, he unexpectedly asked me to attend his evening class, where he announced that I had kindly offered to give that evening's lecture. I faced a burning choice: chicken out or rise to the challenge.

I chose the latter, delivering a 50-minute lecture on a paper I was drafting about birds flying at high altitudes. This spontaneous performance was one of the best snap decisions of my career, leading to a decades-long friendship with Dawson.

With hindsight, I realize that my readiness to seize opportunities shaped not just my professional path but my entire life. Each occasion required a gut decision with far-reaching consequences. It was about having the chutzpah to seize opportunities when they presented themselves, regardless of how unprepared I felt. That's the essence of both scientific discovery and personal growth: the courage to act affirmatively when opportunities arise, even if—or especially when—they catch you completely off guard.

For better or for worse, to seize not just the day, but the moment, is the advice I've passed on to every one of my prospective students.

Berry Pinshow, PhD, is professor emeritus of physiological ecology in the Mitrani Department of Desert Ecology and Jacob Blaustein Institutes for Desert Research at Ben-Gurion University of the Negev in Israel. Pinshow continues to teach biophysical field methods once a year. His research interests include energy and water exchange between animals and the environment, burrow architecture, and physiology of thermoregulation and osmoregulation in desert animals.

Illustration by Brett Affrunti

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Access awards and fellowships designed to move your work and career forward. Apply for American Physiological Society (APS) awards to gain recognition in your field and access new and meaningful opportunities.

Learn more about all award opportunities and apply for the awards highlighted below at physiology.org/awards.

Claude Bernard Distinguished Lectureship of the Teaching of Physiology Section	$1,000	Honors an established investigator with a history of excellence in education who is making outstanding contributions to teaching and learning	July 15
Solomon A. Berson Distinguished Lectureship of the Endocrinology & Metabolism Section	$1,000	Recognizes a distinguished scientist for their outstanding contributions to the areas of endocrinology and metabolism physiology research	July 31
Anne R. Crecelius High Impact Scholar Award	$5,000	Honors a member who demonstrates sustained high quality of work, consistency in effort and a commitment to advancing the physiology educator community	Aug. 31
Fellow of the American Physiological Society	Society Recognition	Provides an individual with the ability to develop innovative and potentially widely applicable programs for teaching and learning physiology	Sept. 15

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physiology.org/renew