

THE Physiologist MAGAZINE

MAY 2026



Keep on Moving

New APS President
Sue Bodine is no
stranger to change.

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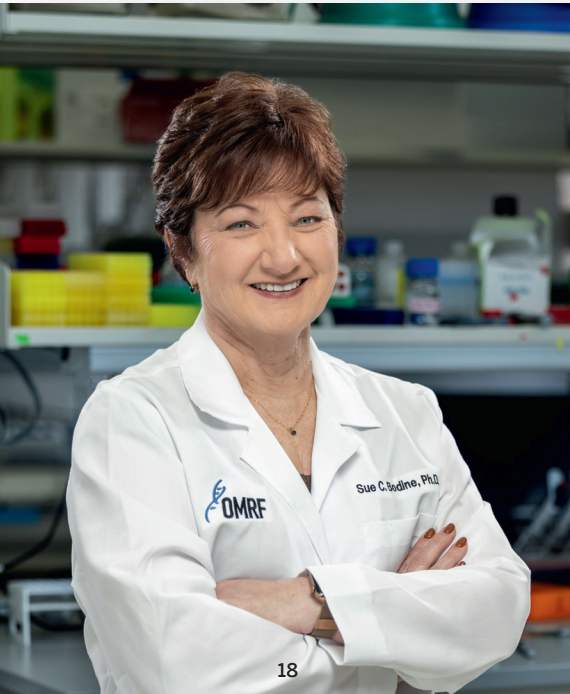
Pre-applications due August 1
Full applications due September 1



Visit our website to submit your application

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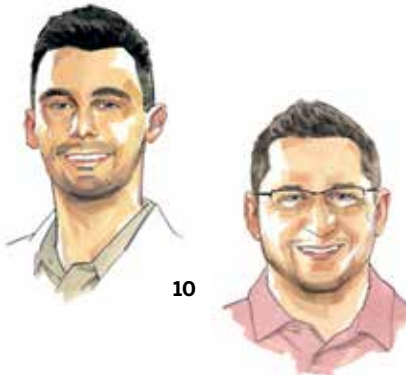
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Walk This Way

BY AMANDA BERTHOLF, MA



If you're an introvert like me, you're probably still recovering from the American Physiology Summit. Four days of sessions, posters, networking events and a packed schedule will do that. My colleagues and I wore holes in the soles of our shoes logging hundreds of thousands of steps over the course of the event, and while it feels good to be home, there's often a strange quiet that follows. The calendar clears (for the moment). The inbox refills. And our work continues.

But while the ideas are still fresh and the conversations are still top of mind, now is the best time for you to act on what you experienced. There are likely sessions that sparked new thinking, gaps in the science you want to see addressed or discussions you wished had gone deeper. That's exactly the kind of insight that makes for a compelling session proposal.

Next year's Summit heads to Denver. The call for session proposals is open now, and we

“While the ideas are still fresh ... now is the best time for you to act on what you experienced at the Summit.”

want to hear your ideas. Think about what you heard this year, what energized you, what questions the discipline still needs to wrestle

with and let that shape what you pitch. The best Summit programming comes from people who were in the room. This is your chance to help shape the science people will be talking about next year.

One of the highlights of this year's Summit was the chance to meet (or get to know better) new APS President Sue Bodine, PhD, FAPS, a professor at the Oklahoma Medical Research Foundation. Bodine has spent four decades studying muscle. In this issue, we get a chance to go deeper into her story. On page 18,

you will read about how Bodine discovered her research focus and how it led her to where she is today.

It's a story worth knowing and one that will resonate with many of you. When you say yes to an opportunity or take on a challenge you weren't sure you were ready for, it can open doors you didn't know were there. It can lead your career and research in directions you never anticipated. Those stories are some of my favorites to tell.

Bodine has worked in both academia and industry, which is becoming more common in science. Today, many PhD graduates head straight into industry roles rather than embarking on the tenure track. On page 24, we hear from other physiologists who have built meaningful careers in industry. They share what it takes to thrive in the for-profit sector, along with the challenges and rewards.

Also in this issue, we take a deep dive into a deadly condition that rarely gets the attention it deserves: sepsis. Sepsis kills 30% to 40% of its victims—and you may be shocked to learn it is the leading cause of death in children across the globe. On page 28, learn how researchers are working hard to change those odds.

The best thing about a meeting like the Summit is that the conversations don't end when you get on the plane home. They show up in your research, your collaborations and your next big question. We hope this issue picks up where a few of those conversations left off.

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 tpysmag@physiology.org.

P.S. Submit your Summit session proposal today!



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Abstract Deadline: May 8

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Learn more at
physiology.org/comparative2026.

SUMMIT ABSTRACT

AI Offers Mixed Learning Results Among Nursing Students

Can artificial intelligence (AI) help nursing students learn anatomy and physiology? Educators put that question to the test with first-year nursing and non-nursing students. They compared traditional instructor-written multiple-choice questions on a midterm exam with those generated by ChatGPT5 across four areas: vascular physiology, blood, immune system and respiratory physiology. Nursing faculty and their research assistants reviewed all AI-generated questions for clarity, accuracy and relevance and made corrections for grammatical issues or incorrect answer keys. Interestingly, the generative software developed some questions the professors never thought to ask the students.

The results were mixed. Students scored higher on instructor-written questions in vascular physiology. But AI-derived questions boosted performance in the blood, immune system and respiratory topics. AI seems to be beneficial for learning anatomy but did not enhance academic performance or critical thinking in physiology. Some students found the generated questions unclear or overly open-ended. Overall, AI-generated questions did not significantly improve learning, but they revealed something valuable about gaps in critical thinking and how assessments shape it.

Source: Raj Narnaware, PhD, Taij Mann, et al. "When AI Meets Physiology: Do Nursing Students Really Benefit?" American Physiology Summit, 2026



SUMMIT ABSTRACTS

Spotlight on Summit Science

Highlights from research abstracts presented at the 2026 American Physiology Summit



Four hours of undersea operations may leave Navy divers dehydrated. Replacing most of the lost fluid is more important for maintaining performance over any specific type of drink.

Source: Hayden W. Hess, PhD, et al. "Hydration Considerations for Combat Divers"



Obesity decreases lung function in older adults despite sex differences in fat distribution, highlighting obesity as a clinical concern even in older adults.

Source: Sarah Skillett et al. "Effects of Obesity and Fat Distribution on Pulmonary Function in Older Men and Women"



Sleep disruption during pregnancy is more than just uncomfortable—it may significantly affect how the heart adapts, with potential future maternal health risks.

Source: Iona Palmer et al. "Impact of Extrinsic Sleep Disruption During Pregnancy and the Postpartum Period on Systemic and Cardiovascular Adaptations"

SUMMIT ABSTRACT



Better Questions for Future Physicians

Physiology can be difficult for medical students because they must quickly master concepts across interconnected organ systems. In addition, National Board of Medical Examiners (NBME) licensing exams often look very different from course tests. NBME Step-1 questions feature long clinical scenarios and complex reasoning, yet classroom exams often focus on simpler concepts.

Faculty tested whether artificial intelligence (AI) could help them create questions that better match Step-1 style and difficulty. After training on AI tools, they used it to revise existing practice and exam questions. They realized they had been overestimating exam difficulty: Before the study fewer than 7% of questions matched Step-1 levels; afterward about 40% did.

The software dramatically reduced the time spent writing clinical vignettes while requiring only minor edits and review. It also helped faculty examine accuracy and consistency of the clinical details in each question, think more creatively, and devote more energy to teaching, mentoring and directly supporting students.

Source: Alex Shefflette Svendsen et al. "Faculty Development on Artificial Intelligence Improves Incorporation of Complex Assessment Questions in Medical Physiology." American Physiology Summit, 2026

SUMMIT ABSTRACT

Heart Function Moves with the Tides

Just as ocean tides rise and fall under the pull of the moon and sun, the human heart may follow similar rhythms. Researchers tracked the heart rate and blood pressure of volunteers living in Almaty, Kazakhstan—about 1,400 miles from the Arabian Sea—for a week. Many of them showed repeating patterns that matched both the 24-hour day and gravitational cycles that occur roughly every 12 and 25 hours. Volunteers lived far from the ocean, showing tides aren't required. The tiny gravitational pull itself may be enough.



The changing tides preceded blood pressure changes by a couple of hours, and there was no evidence that the alterations were harmful. But the findings suggest the body may be attuned to even the subtlest of environmental signals. Learning more could help explain patterns in sleep, daily performance and cardiovascular function and opens a new direction for physiology research.

Source: Guadalupe Rodríguez Ferrante, PhD, et al. "Tidal Rhythms in Human Cardiovascular Function." American Physiology Summit, 2026

All images: iStock



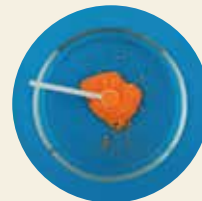
Curcumin (which is found in turmeric) improves blood sugar levels, reduces low-grade inflammation, restores cellular responses, and preserves both structure and function of the aorta in Type 1 diabetes.

Source: Swasti Rastogi et al. "Curcumin Rescues HSP70 Profile in Type 1 Diabetes and Mitigates Aortic Vascular Dysfunction"



Shifts in sleep schedules surrounding collegiate sports travel may affect athletic performance more than the total amount of hours slept.

Source: Caroline Penner et al. "Home Versus Away: Differences in Sleep and Athletic Performance in NCAA Division I Women's Soccer Players"



"Safe" levels of the food coloring tartrazine alter gut microbiota and growth patterns. Evaluation of long-term effects of common food additives on children's health is needed.

Source: Ali Do an Dursun, MD, PhD, et al. "Food Colorant Tartrazine Causes Weight Loss in Emerging-adulthood Male Rats Correlated to Microbiota Dysbiosis"



Semaglutide does more than promote weight loss. It enhances blood vessel relaxation in response to insulin.

Source: Augustine Udefa, MSc, et al. "Semaglutide Enhances Vascular Relaxation to Insulin in Western Diet-fed Female Mice"

LABNOTES

MENTORING Q&A YOUR QUESTIONS ANSWERED
STREAMING SCIENCE APS JOURNAL PODCASTS
POLICY IQ PHYSIOLOGY ON THE HILL AND IN THE HALLS
UNDER THE MICROSCOPE OUR MEMBERS, UP CLOSE
PUBLISH WITH POLISH BUILD A BETTER RESEARCH PAPER
IN DEPTH DIVING DEEP INTO SCIENCE
STATS & FACTS PHYSIOLOGY BY THE NUMBERS



Eric R. Albuquerque



Adam J. Case, PhD

MENTORING Q&A | EARLY CAREER

Lab Priorities

What to embrace (or reform) for a modern, successful academic career.

Each issue, we ask a student or early-career member to pose their career questions to an established investigator and mentor. Here, **Eric R. Albuquerque**, an MD/PhD candidate at the University of Miami Miller School of Medicine, asks **Adam J. Case, PhD**, several future-focused questions. Case is associate department head for basic research and an associate professor in the Department of Psychiatry and Behavioral Sciences and Department of Medical Physiology at the Texas A&M University Naresh K. Vashisht College of Medicine.

Q: Artificial intelligence (AI) applications and models are extremely powerful tools that can have real benefit, but also pitfalls. How should trainees use these tools?

A: We have all experienced ways in which AI is incredibly impressive, but also how it can be unhelpful, frankly terrible, or outright wrong. Even with these experiences, it is likely that AI will become more prevalent in our lives, both personally and professionally. In research, staying on top of technology is

“Your time will be stretched thin, so personnel are essential to research productivity and growing your program.”

essential to remain competitive. I recommend trainees embrace AI workshops, training courses or other opportunities to become proficient (at least comfortable) with the technology. At a minimum, these skills may allow you to save time on tasks and accelerate your research, but they may also allow you to create a tool or opportunity in your own niche that could launch your research program into a new direction.

Q: When transitioning into a new faculty position, what strategic areas should new researchers capitalize on to ensure their lab’s successful launch and sustainable growth?

A: Every early-career

investigator’s situation is going to look different depending on factors such as funding already received, how much data they have already collected from a previous position, or whether their new position is at a new location.

That said, one of the first critical steps for a new investigator is growth, which in research usually means people and equipment. As a faculty member, your time will be stretched thin with many commitments, so personnel are essential to research productivity

and growing your program. Regarding equipment, consider what is a “need” versus a “want” and what you will use on a routine basis. Big equipment can be expensive to maintain and service, so if using it at a core facility or third-party vendor can suffice, it sometimes is better than investing your precious start-up dollars.

Q: What self-imposed expectations helped you establish and sustain your career?

A: The biggest expectation I put on myself was never forgetting that I am in academia to train scientists—not just publish papers or get grants. Some may think that hinders productivity, but by developing and supporting

my trainees, I have found they put in as much or more effort into the work.

Trainees enjoy my lab environment because they see me putting my all into their career development, which makes the job enjoyable. In contrast, the expectation that I could handle everything became unsustainable, and I am still learning this lesson today. Strategic focus on your strengths leads to excellence. Maximal output across everything leads to burnout.

Q: Fewer graduates seem to be choosing academia compared to industry or government. What needs to change to make academia more appealing?

A: Funding reform. Full stop. While “more funding” would also be appealing, I have more discussions with my colleagues about factors that need reformed, such as how funding is distributed, funding restrictions, peer review and funding decisions, salary coverage requirements from funding, and indirect funding to universities.

These factors often come across as daunting to trainees, and when they see PhD-level careers that do not require traversing the nebulous funding landscape, the perception is those careers are more stable and safer (whether accurate or not).

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

1 in 3

people who dies in a hospital had sepsis during their hospital stay.

Centers for Disease Control and Prevention

Sepsis is the highest-cost reason for hospitalization in the U.S. Costs for acute sepsis hospitalization and skilled nursing are estimated to be \$62 billion annually.

Sepsis Alliance

1.7 million

adults develop sepsis each year in the U.S.

Centers for Disease Control and Prevention

The average cost per hospital stay for sepsis is double the cost per stay for another diagnosis.

Sepsis Alliance



STREAMING SCIENCE | SOUNDBITE FROM APS JOURNAL PODCASTS

AI in the Classroom

Generative artificial intelligence (AI) is already shaping how students prepare for assessments—but what does that mean for learning, equity and evaluation in physiology education?

A recent study of undergraduate students in a second-year human pathophysiology course examined how large language models such as ChatGPT were used when AI was explicitly sanctioned as part of an assignment. Students reported using AI to support idea generation and refine their work while still engaging in critical thinking and creativity. The findings suggest that, when thoughtfully integrated, AI tools may help reduce learning inequities—particularly for students new to academic English.

In this APS Publications Podcast episode featuring *Advances in Physiology Education*, the authors discuss what they learned and what it means for assessment design moving forward.



Listen to the full podcast episode:



The Fight for Funding Isn't Over

Advocacy continues after Congress rejected proposed cuts to federal science programs in 2025.

Earlier this year Congress completed work on legislation to fund federal agencies and programs for the remainder of the 2026 fiscal year (FY). This includes the National Institutes of Health (NIH), National Science Foundation (NSF), Veterans Affairs (VA) Medical and Prosthetic Research Program and NASA. In doing so, lawmakers rejected proposals for deep cuts to scientific research and addressed the concerns of the scientific community by limiting the use of multiyear funding and prohibiting changes to indirect cost rates.

Among the outcomes signed into law:

- \$48.7 billion for NIH, an increase of \$415 million and a rejection of the proposed nearly \$19 billion cut.
- \$9.06 billion for NSF, a \$310 million decrease, but a rejection of the proposed \$5 billion cut.
- \$945 million for VA Medical and Prosthetic Research, a \$10 million increase—exceeding the administration's request.

- \$24.4 billion for NASA, a \$400 million decrease, but a rejection of the proposed \$6 billion cut.

While APS asked for higher funding levels for these agencies, the political environment in 2025 proved to be challenging. The final approved funding levels were the result of bipartisan support in Congress for biomedical research. This could not have been achieved without the advocacy efforts of the physiology community.

Whether you participated in APS' 2025 Capitol Hill Day as part of the American Physiology Summit in Baltimore, or responded to an APS Action Alert, your advocacy made a real and measurable difference for the scientific community and for the future of biomedical research.

As attention turns to the next appropriations cycle, APS is joining with other advocacy organizations to communicate the needs of the scientific community. While the president's FY 2027 budget proposes drastic cuts to federal



science agencies, APS is requesting the following funding levels:

- At least \$51.3 billion for NIH, an 8.7% increase. After multiple years of sub-inflationary budget growth, an increase of 8.7% would represent real growth in the agency's budget.
- At least \$9.9 billion for NSF, an increase of 9.3%. After a cut in FY 2026, an increase of this amount would allow the agency to get back on track.
- \$1.2 billion for VA Medical and Prosthetic Research, an increase of 27%. This level of funding is necessary to continue to support

vital research that improves the lives of veterans and all Americans.

- Increased funding for research at NASA.

It will be crucial to advocate for science funding throughout the appropriations process. APS advocacy continues to focus on the importance of support for basic research, which generates knowledge and paves the way for translational and clinical research discoveries.

As APS advocates for science in the months ahead, you can join the effort. Visit [physiology.org/advocacy](https://www.physiology.org/advocacy) to see how you can get involved.

Send questions or comments to tphysmag@physiology.org.

UNDER THE MICROSCOPE | EXERCISE PERFORMANCE

Motion Is His Mission

A childhood love of cycling led this researcher to study performance, recovery and health.



Steven Elmer, PhD, is an associate professor in the Doctor of Physical Therapy Program at St. Catherine University in St. Paul, Minnesota. His research goals include finding better ways to restore musculoskeletal function, maintain health, and improve performance in healthy and clinical populations. Elmer engages in K–12 outreach and advocacy to support biomedical research.

FROM BIKE TO BENCH. One of my favorite activities as a kid was riding my bike. While I played many different organized sports, I was better at endurance sports so I kept riding my bike. My passion for human health

was inspired through my love for cycling, desire to train better and numerous sport-related injuries I sustained. In college, I took courses in human biomechanics and theory of exercise training and planning. From there, I volunteered in the Neuromuscular Function Laboratory, where I started to assist graduate students with their research. I started to see how my interests in sport, health and science could align. My mom encouraged me to pick something I love and make it part of my career.

SPECTACULAR FAIL. During my master's thesis, I spent several months

carefully setting up my exercise model, calibrating equipment and piloting the experimental protocol. For my formal thesis experiment, I was so excited that I invited my entire committee to visit the laboratory on the first day of my data collection. While testing the first few subjects, two key pieces of laboratory exercise equipment failed spectacularly—right in front of a committee member who happened to be the dean of the College of Health. Quickly I learned about the element of surprise in research, fixed the equipment and kept the project moving. For years to come my thesis adviser found tiny ball bearings on the floor from my mishap.

TIME TRAVEL MEETUP. As a huge “Back to the Future” fan, I would love to meet Doc Brown! Using his time machine, I would go back to the late 1800s and visit Fridtjof Nansen, a scientist, polar explorer, diplomat and humanitarian. I appreciate how Nansen leveraged his athletic abilities and passion for science to produce new knowledge in a variety of fields, including neurology and oceanography. His book “The First Crossing of Greenland” is one of my favorites. I also admire his public service and humanitarian efforts to help refugees after World War I, which earned him the Nobel Peace Prize in 1922.

VARIETY: THE SPICE OF SCIENCE. The best part about my job is the variety of things I get to do every day, week and month. One minute I am team-teaching in the classroom, and the next I am conducting research in the laboratory or field. In between, I am mentoring students, preparing manuscripts for publication and securing funding to support our research. I also enjoy the opportunities to lead new initiatives, collaborate with experts around the world, engage with K–12 students and educators, and advocate for health science. There is truly never a dull moment.

SCHOLARS AND TEACHERS. I often emphasize that research and teaching are truly integrated. To be a good researcher you must be able to teach and communicate your findings to a range of audiences that includes both scientists and nonscientists. To be a good teacher you have to keep up on the literature, think outside the box, try new things and write about it to share what has worked and not worked so well.

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

PUBLISH WITH POLISH | OPEN ACCESS

Expanding Access to Physiological Science

The Society's open access models hit another milestone.



APS journals met their subscription thresholds for Subscribe to Open (S2O) again this year. Thanks to our institutional and library subscribers, authors and Society members, 10 research journals will remain fully open access for 2026. That participation drove a milestone: 97% of the entire APS journals portfolio, including partner journals, was open access in 2025. Here's how it all works.

Subscribe to Open

S2O is a subscription model that converts to open access once a journal meets its annual threshold. Authors pay a flat publishing fee, but there is no article processing charge (APC). If a journal does not meet its threshold, it remains

gated with continued access for paying subscribers.

Subscribers to the APS Digital Library package, which includes the 10 S2O journals plus two review journals, receive an open access publishing guarantee for corresponding authors, even if a journal remains gated. S2O journals include all seven *American Journals of Physiology*, plus *Journal of Applied Physiology*, *Journal of Neurophysiology* and *Physiological Genomics*.

Gold Open Access

In a gold journal, all authors pay an APC to publish open access, with waivers sometimes given for invited content, such as reviews. *Physiological Reports* and *Function* launched as gold journals from the start. *Physiological Reports*, jointly owned by APS and The Physiological Society, publishes research from submissions that have "cascaded" from the societies' other journals or been submitted directly. *Function* was conceived as a research and review journal and moved fully under APS' self-publishing umbrella at the end of 2025.

Hybrid Open Access

Physiological Reviews, *Physiology* and *Comprehensive Physiology* operate on a hybrid model: subscription based, but with an opt-in open access option for authors willing to pay an APC. Because these are review journals with commissioned content, there is no flat publishing fee. However, authors who want their work seen by all readers have a clear route to get there.

Diamond Open Access

Advances in Physiology Education is APS' diamond open access journal. It is fully open access with no fees for readers or authors. The journal operated for years without such fees, but it wasn't until 2024 that the journal became fully open, delivering a Creative Commons CC BY-NC (Attribution-Noncommercial) license for all articles. In doing so, the content was made open for educators while protecting commercial rights for authors.

These models reflect APS' commitment to expanding access to physiological science. S2O, together with our other open access programs, is making this happen.

STATS & FACTS

72,000+

kids are hospitalized with sepsis each year in the U.S.

Children's Hospital Association

Sepsis is the leading cause of death among children worldwide, causing more than 3 million deaths annually.

International Consensus Criteria for Pediatric Sepsis and Septic Shock, *JAMA*, January 2024

7,000

children die from sepsis each year in the U.S.—more than from cancer.

Children's Hospital Association

350,000

adults in the U.S. who develop sepsis die during their hospitalization or are discharged to hospice.

Centers for Disease Control and Prevention

Most people who develop sepsis have at least one existing medical condition such as chronic lung disease or a weakened immune system.

Centers for Disease Control and Prevention

If you are interested in submitting a manuscript to APS journals, visit journals.physiology.org/submit.

Ready to Strike

Extreme regenerative physiology of snakes points to new possibilities for gut healing and improving insulin sensitivity.

Todd Castoe, PhD, professor at the University of Texas at Arlington, explores genome biology and evolutionary genomics using snakes as model systems. His work to understand how vertebrates control regenerative growth could lead to new ways to treat type 2 diabetes, colon cancer and chemotherapy-induced damage in the human gut. He was a presenter in the Game-changer session “Regeneration Reimagined” at the American Physiology Summit in April.

How did you get interested in using snakes as model systems?

I’ve been captivated by the extreme physiological shifts that happen in snakes. Stephen Secor and Jared Diamond,

while at the University of California, Los Angeles were the first to realize that snakes underwent extreme physiological shifts when they fasted and then were fed. They also observed huge changes

in metabolism—the most extreme shifts of any vertebrate measured—that coincided with extreme organ growth after feeding.

I was completing a postdoc around the time that genomes could

first be sequenced. We purchased some new genome sequencers and began an effort to establish the python as the first reptile genome available. Although the green anole lizard genome was sequenced first, the python came shortly after, giving us a foundation to study their extreme phenotypes.

How does your research tie into regeneration?

We think of regeneration as being in response to an injury, such as losing a tail. However, in snakes, this regeneration is triggered without an injury to be fixed. When fasting, snakes’ guts become dormant and are almost difficult to even identify as guts. Then, within 24 hours after feeding, it changes to a thickened tissue that expands over 150% in mass. And the cell types, structure and gut physiology all fundamentally change extremely rapidly. These coordinated changes show that the python gut undergoes true regeneration—rebuilding tissue structure and function.

Understanding how to modulate the kind of proliferative cell growth and differentiation we see in snakes could have implications for understanding things like colon cancer and how the gut responds to chemotherapies, which are very destructive to the gut in humans.



What have you learned?

We discovered that combinations of growth and stress response pathways that weren't previously known to be co-activated are activated during the intestinal regeneration process in pythons. Normally, a very strong cell growth signal triggers cell death to prevent cancer, but when paired with a strong stress response in the python gut, we found it flips into a synergistic switch that enables massive, protected proliferation and tissue redifferentiation.

“Using model systems with very extreme phenotypes gives us a chance to watch genes and gene-expression programs operate in ways that may be different than we appreciate.”

Although nearly all the genes for these pathways are present in humans, we didn't have an example of them working in concert like we had observed in snakes. Then, when we applied new single cell sequencing approaches, we found that different cell populations played different roles in controlling the regenerative process, by priming different cells to respond to stimuli differently. This work was published in a 2024 *PNAS* paper.

We also realized that mouse models lack a type of intestinal cell that

expresses bestrophin-4 (BEST-4), which is present in humans and snakes. We found that these cells coordinate key signals essential for regenerative growth. This means that the model scientists have relied on for decades lacks a major piece of the biology when it comes to gut physiology.

How is this linked to type 2 diabetes?

We became interested in Roux-en-Y gastric bypass surgery, which has a mysterious ability to induce remission of type 2 diabetes. The surgery triggers a phase of intestinal redifferentiation that doesn't appear to be specific to BEST-4

positive cells because it also happens in mice. What's striking is that the genes turned on after this type of gastric bypass surgery—in humans and mice—closely mirror those activated during gut regeneration in pythons, suggesting a poorly understood, but deeply conserved, regenerative and metabolic program.

This was surprising because we didn't think humans had this kind of regenerative capacity. It seems there is a backdoor way to activate gut regeneration in humans too, and all vertebrates

might possess this capacity if they can orchestrate the staging upfront in a certain way. This means there might be a way to not only control medically relevant gut shifts to reduce proliferation in cancer or promote regeneration after chemotherapy damage, but that also modulates insulin sensitivity in type 2 diabetes.

What makes your work game changing?

I see “game changing” as something that comes as a surprise or catches you off guard, and in doing so, changes perspectives. Our work fits that idea because we found that the potential for regeneration was already in our genomes and that it might be more straightforward to activate than we thought.

Using model systems with very extreme phenotypes gives us a chance to watch genes and gene-expression programs—ones we think we understand in vertebrates or in humans—operate in ways that may be different than we appreciate. In doing so, we start to see new opportunities for how those same programs might be manipulated in humans to address health problems.

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

STATS & FACTS

68%

of PhD recipients in the biological and biomedical sciences committed to an industry position in 2022.

National Academies of Sciences, Engineering, and Medicine

\$120,000

is the median salary for a postdoc in industry, compared to \$60,000 in academia.

National Center for Science and Engineering Statistics, Survey of Earned Doctorates, 2024

20%

of new PhD recipients in biological and biomedical sciences committed to academic employment in 2022—down from more than 40% in 2002.

National Academies of Sciences, Engineering, and Medicine

Only 20%–25% of PhDs secure tenure-track positions in the U.S. and Canada.

doi.org/10.1080/07294360.2025.2515211



 **OMRF**

Sue C. Bodine, Ph.D.



Keep on Moving

New APS President Sue Bodine is no stranger to change, whether in the muscles she studies or in her own career path.

BY MEREDITH SELL

Sue Bodine, PhD, FAPS, was an undergraduate kinesiology major when she saw cadavers for the first time—limbs with the skin removed to reveal the structures underneath, muscles varying in size and shape. She was struck by how intricate everything was. “People sometimes visualize muscle as very simple, but it actually is a quite complex tissue,” she says.



Left to right: Bodine (wearing the scarf) with other members of Reggie Edgerton's lab. (Edgerton, with the beard, is in the back row.) Bodine in her borrowed Russian clothes in front of the Kremlin; with her beloved golden retrievers, Piper (right) and Brodie. Brodie, now 13, has been enrolled in the Golden Retriever Lifetime Study since he was six months old.

Bodine, now in her fourth decade studying muscle, is the new APS president and professor in the Aging and Metabolism Research Program at the Oklahoma Medical Research Foundation (OMRF). “I have found muscles fascinating because they are so plastic,” she says. “They adapt; they respond to everything. Most tissues in the body try to maintain, don’t grow or atrophy constantly, but muscle has been designed to be responsive.”

As she has sought to understand how muscles adapt, Bodine has adapted too. She has worked in academia and the biotech industry, navigated challenging work settings, and continually learned new skills to support her research endeavors.

Her CV is marked by major moves as she took up new opportunities. Everywhere she went, she learned something—from colleagues with different specialties and from experiments she worked on. The one constant has been her interest in muscle, the tissue that makes us move.

FINDING HER FOCUS

When Bodine started her studies at the University of California, Los Angeles (UCLA) in 1976, the former high school athlete was interested in movement and the human body. She excelled in her courses and became fascinated by anatomy and physiology. Before long, her professors were asking if she’d like to help with

research in their labs. She ended up participating in UCLA’s Departmental Scholar Program, which enabled students to pursue a bachelor’s and master’s simultaneously. Initially, she thought she would study biomechanics for her master’s, but her first research project with animal models and muscle contraction shifted her focus to physiology.

The project was looking at the role of muscle structure in muscle function. The researchers isolated an animal’s hamstring muscle, stimulated the nerve with electrodes, and recorded the contractile response. Bodine was responsible for filming the contractions and taking measurements related to muscular stress and strain.

When she saw the muscle contract in real time, she got excited. “It wasn’t some abstract thing you were learning in class,” she says. “You’re actually seeing it with your eyes.”

The project ended up being her master’s thesis. It confirmed her interest in research and led her to pursue her PhD.

Throughout her studies, Bodine worked with Reggie Edgerton, PhD, an exercise physiologist and longtime UCLA professor. He was her thesis adviser and mentor and provided an example of how to let big questions guide her science.

“The thing that Reggie taught me more than anything is: You ask the question and then you find the techniques that you need to answer that question,” Bodine says. “Don’t be confined by what you don’t know.”

When Edgerton wanted to understand how the spinal cord controlled movement, Bodine says, he took a sabbatical and learned the techniques he needed to study the spinal cord. Working in his lab—first as a student and, after finishing her PhD in 1985, as a research scientist—required a similar openness to learning new methods.

In the 1980s, the U.S. was collaborating with the Soviet Union on a space program called Bion that sent animals to space in an unmanned capsule for two weeks at a time. Edgerton, who had done some research with NASA, wanted the Soviets to let American scientists take biopsies from their space monkeys and assess any changes from their time in space.

“He sent me to Moscow to convince them,” Bodine says. She learned how to take biopsies so she could demonstrate to the Soviets how the procedure would be done, and in 1988, she flew to Moscow on Pan Am with another researcher from

NASA. Initially, Bodine’s first trip outside the U.S. didn’t go as planned. “They lost my luggage, so one of the scientists’ wives brought me a bunch of clothes,” she says. “I have this picture of me in front of the Kremlin in my Russian outfit.”

Despite the luggage mishap, the trip was a success. The Soviet space researchers agreed to the Americans’ proposal. Over nine years, Bodine was involved in three flights, traveling multiple times to Moscow to work with the animals.

INDUSTRY COMES CALLING

Shortly after the Bion project kicked off, Bodine took a job at the University of California San Diego in the Department of Orthopedic Surgery. It was her first tenure-track job and her first time in a clinical setting. “It was very instructive in seeing the real-life concerns of physicians,” she says, “and seeing how your research could be applied to real medical problems.”

Through her conversations with hand surgeons, Bodine started wondering what happens when a peripheral nerve gets damaged and later needs to reattach to muscle. “The hand surgeons were often having to resuture nerves that were injured, and so people were looking at different ways of suturing the nerve ends back,” she says. She wondered: How do the nerve axons know which muscle to connect to? What happens if they connect to the wrong muscle?

She knew that the time needed to recover from orthopedic surgery could cause muscles to shrink from disuse and make it harder for nerves to reconnect. She was curious about how muscle could be kept in better shape while the nerve was regrowing.

In 1996, Regeneron called. The biotech company “had identified one of the receptors in muscle that was responsible for forming the neuromus-

cular junction,” Bodine says, “so they were interested in nerve regeneration and reinnervation.” They wanted to know if she’d join their team.

Bodine wasn’t sure. Though she was looking for a change, she hadn’t planned on leaving academia. But she saw that Regeneron was publishing in major scientific journals, and her research interests lined up nicely with their work. “It looked like a great place to do science,” she says. She interviewed and took the job.

Over her six years at Regeneron, Bodine dove into molecular biology for the first time. She ran a lab and became co-director of a research program. Free of teaching responsibilities or the need to write grants, she spent most of her time focused entirely on research.

“We were able to use the most advanced technologies,” she says. “Making genetically modified mice was just taking off, and Regeneron had developed new technologies, so I had access to all these genetic models. ... It also taught me the value of teamwork, the idea of working in a team of people with different expertise to tackle a problem that any one person can’t do by themselves.”

Her team identified new genes involved in muscle atrophy and published major papers in *Science* and *Nature Cell Biology*, two of Bodine’s top-cited papers today. The findings went on to be replicated by other scientists and then translated to humans, laying the groundwork for the development of drugs to either slow muscle atrophy or support muscle recovery.

EMBRACING NEW OPPORTUNITIES

In 2003, after a brief stint at another biotech startup, Bodine returned to academia at the University of California, Davis and set up her new lab with intentions to build on those genetic discoveries at Regeneron.

6 Questions with Sue Bodine

In your role as APS president-elect and now president, you've been heavily involved in the Physiology: The Science Life Depends On campaign. What has that been like?

It's been a really rewarding experience. One of the things that struck me is that physiologists are doing extraordinary work that shapes medicine, public health and everyday life, but the field itself isn't always visible outside our community. This effort is about changing that. What I've appreciated most is that it helps connect physiology to the real-world outcomes people care about. It's helping us articulate something we've always known: Physiology sits at the center of understanding how the body works and how we can improve human health.

Why is this work so important?

When the audiences we're talking to hear directly from researchers about how physiology drives discoveries in areas like heart disease, kidney health or frailty, it becomes very clear how foundational this science is. For me personally, being involved has reinforced how important it is for our community to speak with confidence about the value of physiology. The science really does underpin so many advances people depend on every day, and this campaign helps us make that visible.

What has APS meant to you?

It's been my scientific home. Because I've moved around a lot, it's been the one constant. ... I listen to some of the trainees now or even early-career scientists and they talk about their experience. It's like a family. They get mentored. They have a network. People move around a lot in academia, and the Society is one place where we can all come together again.

What is your best career advice for someone considering leaving academia?

If you have the opportunity to move and you really like the place—if you think you might want to come back to academia, keep that option open. Stay engaged in your academic networks. Go to meetings. And the No. 1 thing is you need to publish if you think you might want to come back to academia.

What is something most people don't know about you?

I am the oldest of seven, with five brothers. I am one of 99 Bodine grandchildren. My Grandmother Bodine was named National Mother of the Year (by American Mothers Inc.) in 1968.

What question should we have asked you?

What's your favorite animal? Answer: golden retrievers. One of my goldens is a "Hero" and part of the Golden Retriever Lifetime Study.

"I had identified these genes, and there were still lots of questions as to what they did," she says. Regeneron sent her the mice they'd developed for her previous studies, and Bodine set to work looking at how the genes involved in muscle atrophy were turned on and what they were responsible for.

Several years into those explorations, Bodine attended a workshop about exercise hosted by the National Institutes of Health. Three of the institutes wanted to start a Common Fund program to better understand exercise's health benefits. Bodine's lab was one of three chosen for the initial preclinical research.

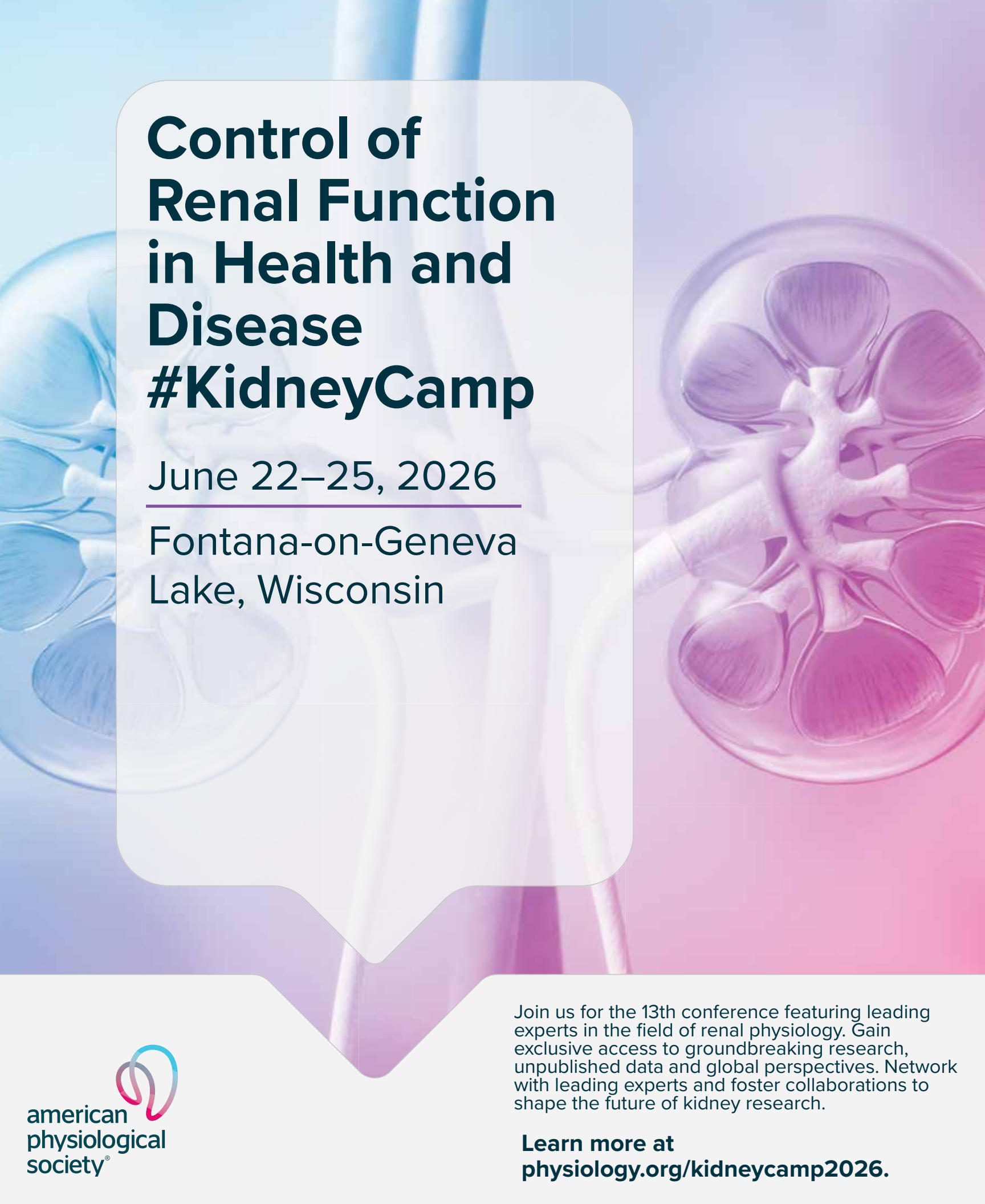
Starting in 2017, the project, called MOTRPAC (Molecular Transducers of Physical Activity Consortium), had labs across the country gathering and analyzing data from human and animal trials for a giant database that will eventually be publicly accessible. Bodine's lab—which moved to the University of Iowa in 2017 and to OMRF in 2023—carried out animal trials, collecting and analyzing 19 tissues from different organs after acute and chronic exercise programs.

Through the project, Bodine observed that exercise's effects extended beyond muscle to the kidneys, adrenals, colon, intestines, lungs and even different parts of the brain. "Every organ that we took out responded," she says. They finished the trials in 2019; now, MOTRPAC is working on the analysis.

"It's the era of big data," Bodine says, and MOTRPAC has reams of it. "You have the whole lifespan, and looking at the effects of exercise training at different ages, and males and females, so it's a tremendous resource."

The project has been a sort of homecoming for Bodine, a return to her initial studies in exercise physiology and another way she's adapted herself to opportunities in her field. Her adaptiveness has helped her make the most of her experiences. She's been able to take what was useful—whether experimental techniques or a better understanding of an area of science—while leaving behind what wasn't and may have actually been harmful, such as the all-too-common experience of gender bias.

"I have moved around a lot in my career, some by choice and some by necessity," she says, "but I've always landed on my feet. And I pat myself on the back that I can overcome adversity." That takes some muscle. 🐾



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BEYOND ACADEMIA

More physiologists are building careers in industry. They share what they've learned about navigating a scientific career outside academia.

BY DEBORAH LYNN BLUMBERG

O N D E M I A

For physiologists in industry, the science is rarely the hard part. It's everything else. Compared to academia, the job titles are unfamiliar, the definitions of success are different, and corporate cultures don't run on publications and grant cycles. Industry careers demand the same qualities that make a good scientist, such as critical thinking, rigor and adaptability, but the environment operates on different terms. Whether an individual is arriving straight from graduate school or after years in academia, the learning curve isn't scientific.

The numbers reflect the growth. National Science Foundation (NSF) data show nearly half of recent PhD recipients across science and engineering fields take their first job in industry—in biotech, pharma and medtech, in roles ranging from medical science liaison to product development and strategy.

NSF data show roughly 70% of PhDs never enter the tenure-track pipeline or leave it within nine years, while about 65% of those who start

their careers in for-profit research are still in that sector a decade later. Yet training programs that narrow the gap between academic training and industry expectations are slow to catch up and remain fragmented across sectors, leaving many researchers to navigate the landscape largely on their own.

Scientists who've done exactly that share what they've learned about networking, navigating corporate culture, redefining success and building a career without a fixed plan to follow.

A DIFFERENT PATH

Michelle King, PhD, knew early in her career that she wanted to conduct research with real-world applications. After completing her postdoc at the U.S. Army Research Institute of Environmental Medicine, she joined the Gatorade Sports Science Institute—a natural fit for an endurance runner who's studied exertional heat stress and heat stroke. "I knew I wanted to do research in an environment that drove consumer goods," she says.

King has also held industry roles at Unilever and most recently was senior principal scientist for Kraft Heinz.

For Lara DeRuisseau, PhD, MBA, the pivot to industry came after 15 years in academia. She was publishing, teaching and tenured at Le Moyne College in New York state, but she was increasingly drawn to a question she couldn't answer from a faculty position: What are the broader ways she could help the patient population? Interested in the interaction between business and physiology, in 2020, she enrolled in a part-time MBA program.

Last year, she joined Eli Lilly as an associate director, neuroscience medical science liaison, where she educates clinicians and scientists on Alzheimer's disease. "In academia, we're often told tenured positions are so hard to find, why walk away? But I felt it was time for a new chapter."

Bryan Wilson, PhD, MBA, pursued a joint PhD-MBA degree at Wake Forest University with industry in mind, but knowing where his education might take him in his career was a challenge. "I didn't know the best role for me in crossing over into industry," he says. "It took a while to find the right fit."

After starting at Merck as an associate director medical science liaison supporting the cardiometabolic medical affairs division, he's now a regional medical director for rare disease at Genentech, covering half of the U.S.

THE POWER OF NETWORKING

Networking looks different depending on where you are in the search for an industry role. For King, it was a mentor who spotted a Gatorade job listing during her postdoc and passed

it along. "Your colleagues are your best network," King says. "Share your interests and your goals—you never know who is paying attention."

DeRuisseau turned to LinkedIn, seeking out PhDs already working in roles she was curious about and asking them for informational calls. "The more connections I made, it got easier," she says. "People were so generous with their time and willing to talk."

Wilson advises putting yourself where the action is: Attend industry conferences. Talk to exhibitors. "You have to have this exploratory, grit-like mentality that enables you to truly put yourself out there," he says. "Focus brings confidence."

Building an active presence on social media can help forge connections, says Cassie Briggs, PhD, who founded and runs Success in Science Career Coaching. Briggs is a STEM coach who guides students and early-career scientists as they explore a wide array of science career possibilities. A former self-described die-hard academic, Briggs left a faculty position as a biology professor to become an entrepreneur.

When Briggs began exploring her career switch, she took full advantage of social media, setting a goal of talking to 10 career coaches a week that she found through LinkedIn. Online interactions should be about getting to know people, their struggles, what they need help with, what their goals are, she says. "It helps you stay in touch with what's going on beyond your own circle."

Briggs says consistency and timing are key to building a network. She recommends for every hour spent applying to jobs, spend an hour networking. Those connections are critical, she says, because a portion of hires comes from personal referrals. "The strongest networks are built

FROM THE EXPERTS

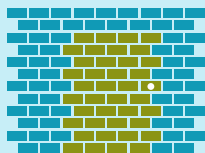
3 Doorways to a New Career

When it comes to changing careers, there is no single path that could lead to the next opportunity. Cassie Briggs, PhD, a STEM career coach, says there are three different "doors" to consider.



The front door. This is the most visible route: applying to posted openings on job boards or platforms such as LinkedIn or Google Jobs. Check out physiology-specific job openings at [physiology.org/jobs](https://www.physiology.org/jobs).

The garage door. Other opportunities that aren't as obvious open through relationships. Informational interviews, networking conversations, and introductions from people inside an organization can provide the "remote" that helps you access roles not widely posted.



The hidden door. The least obvious path is one many job seekers never consider. Instead of waiting for a role to appear, Briggs says you can propose a position to an organization that could benefit from your skills. Or, create the job yourself by launching a new venture.

before the job search begins and they continue long after the job is secured.”

LEARNING THE NEW RULES

While the scientific skills transfer, the industry culture can take longer to learn. Career ladders are not as clearly defined as they are in academia, titles vary widely across companies, and organizations can reorganize with little to no warning. “Flexibility is key,” Briggs says.

One adjustment that catches many scientists off guard is that visibility matters in ways it didn’t in academia, which is why social media such as LinkedIn is so important.

Recruiters and hiring managers actively search LinkedIn profiles, Briggs says. “You want to be discoverable. Optimizing your profile is really important.” That means making sure your LinkedIn headline includes the keywords people would use to find someone with your expertise, she says. Choose a banner image that reflects the direction of your career, not just something that looks attractive. Add the pronunciation feature for your name so that people feel more comfortable reaching out. And use your “About” section to clearly explain who you are now, the experience that shaped you, and where you’re headed, ending with a simple invitation to connect.

For King, one of the learning curves has been communicating science to executives who don’t have a research background. “Your job is to help them understand why what they’re asking isn’t the best question, or to say, ‘OK, we can test this,’” she says. “You have to put on your critical thinking hat.” She’s also found the cross-functional collaboration in industry—working with marketing, product development and other teams—to be a fulfilling aspect of the role.

DeRuisseau was surprised by how seriously her company invests in employee development. At quarterly meetings, individual goals are set, with coaches available to employees to work toward achieving those goals. The company also provides annual training courses and has funds for individual professional development.

“Career development is a major part of performance management and how we progress within the company,” DeRuisseau says. She and King both advise: Don’t chase titles. Chase the opportunities that build the skills you want.

MEASURING PROFESSIONAL SUCCESS

In academia, success is largely evaluated by publications and grant funding. In industry, success is judged by execution and results. For academics moving to industry, this shift often requires recalibrating what success looks like and how it’s measured.

“For me, it’s really about, are you proud of the work you’re putting out every day?” King says. “Are you producing good work? It’s about showing the business the experiment you ran or clinical trial you did and demonstrating your productivity and that your work has value.” That can also mean helping executives make that connection themselves.

For DeRuisseau, success means reducing clinical care gaps and getting medical information to providers faster.

For Wilson, it’s about influence. “What defines success from a medical standpoint is your ability to interact with stakeholders, influence standards of care, and influence clinical decision-making in unbiased ways to ensure patient access to the right medications at the right time,” he says.

Briggs says she sees a reorientation around the definition of success in nearly every researcher she coaches. “As an academic, your values are knowledge, credibility and recognition,” she says. “In industry, it’s about efficiency, innovation, scalability and return on investment.”

The metrics aren’t better or worse; they’re just different. Scientists who make the transition successfully are the ones who can hold both sets of values and know which one the moment calls for.

LONG-TERM CAREER PLANNING

Industry careers may not follow a straight line, and physiologists who thrive in them understand that. King focuses on goal setting. One of her more deliberate choices has been keeping a foot in academia by teaching as an adjunct. “Students ask the best questions,” she says. “They’re always so in touch with what’s going on in the media and in current events, and that helps keep you fresh and sharp,” she says. For King, the two worlds complement each other.

To continue developing in his career, Wilson leans into formal leadership development, completing executive training through McKinsey & Company, the Center for Creative Leadership, and the Columbia School of Business. “It was great to see how these really strong leaders navigated their careers and made a name for themselves,” he says.

Briggs sees adaptability in scientists who work in industry. “If you want a fruitful industry career, make sure you can build new skills and that you show your worth,” she says. The rest will follow, including an opportunity to represent the discipline in places scientists never expected to find themselves. 📍



WHEN THE BODY ATTACKS

Researchers are trying to understand—and stop—the body’s immune system from overreacting to infections that lead to sepsis.

BY ISOBEL WHITCOMB

It begins with an assault to the body. Perhaps a bacterial infection: A burst appendix leaks bacteria throughout the abdominal cavity, or a urinary tract infection travels to the kidneys and enters the bloodstream. But it’s not always that clear-cut. Sometimes, the infection is viral, parasitic or fungal. Sometimes, there’s no infection at all—just an injury.

In response to the initial insult, the immune system launches its defense. Neutrophils and macrophages engulf invading pathogens and foreign debris. They release an arsenal of inflammatory mediators. Some of these chemicals dilate blood vessels and increase their permeabil-

ity so that white blood cells can slip through. Others are toxic to invaders.

Ideally, the immune response works properly. The body clears the threat, and immune cells release inhibitory proteins and lipids to stop the inflammation. But sometimes, the response never slows. Those toxic chemicals,

meant to kill invaders, fail at their job and instead turn against the body. The result is sepsis.

Colloquially called “blood poisoning,” sepsis was once defined as an infection that had spread to the bloodstream. That explanation gets it only partially right. While sepsis does usually result from an infection, scientists now realize that the real cause of sepsis isn’t the pathogen itself, but the body’s response to it.

As the immune system spirals out of control, it floods the body with inflammatory chemicals that damage blood vessels and organs. Often, that hyperinflammatory phase is followed by a crash, leaving the body vulnerable to both the primary and secondary infections.

In severe sepsis, organs begin to shut down one by one—most commonly beginning with the lungs. In septic shock, which is the most advanced and dangerous stage of sepsis, blood pressure drops catastrophically, leading to death in 30%–40% of cases, according to an analysis published in *Critical Care Medicine*.

“Think of the immune system like a car,” says Antonio De Maio, PhD, a professor of surgery at the University of California San Diego. “You accelerate, but at the same time, you need to use the brakes because too much inflammation is bad.”

In sepsis, the brakes fail. Physiologists are working to figure out why this happens, develop treatments to rein in runaway inflammation, and improve quality of life for survivors.

A MULTIFACTORIAL SYNDROME

It’s been nearly four decades since scientists first came to a consensus on the role of the inflammatory system in sepsis. Despite advances in their understanding of the condition, treatment consists entirely of supportive care.

Regardless of whether a patient has a positive blood culture for sepsis, all patients receive antibiotics to treat any underlying infection and to get ahead of other infections that may emerge during immunosuppression. Patients may also receive fluids or medications to support blood pressure, ventilation when the respiratory system fails, or dialysis when the kidneys fail.

There have been many attempts to develop drugs that directly counter inflammation in sepsis, but none have successfully resolved it. Immunologist János G. Filep, MD, PhD, calls this lack of progress in treatment a “unique failure.”

The problem is that the physiology of sepsis likely varies from person to person, with inflammation driven by many molecular pathways and feedback loops, says Filep, who directs the Innate Immunology and Vascular Immunology Research Unit at the University of Montreal. For example, free radicals produced by white blood cells wreak havoc on organs and the immune system, altering DNA and accelerating inflammation. Nitric oxide floods the body and binds with those free radicals to produce compounds that destroy the lining of blood vessels. Meanwhile, the exaggerated immune response demands tremendous amounts of oxygen—oxygen that would otherwise support organ function.

Another potential driver of inflammation in sepsis, Filep says, is the mitochondrion. “The mitochondria are, in fact, ancient bacteria,” he says. Hundreds of millions of years ago, these bacteria lived in symbiosis with our eukaryotic ancestors, generating energy for us. Although mitochondria are no longer independent organisms, they still contain DNA that closely resembles that of bacteria. If damaged mitochondria release their contents, Filep says, the

immune system may mistake them for pathogens. In research published in 2020 in the *Proceedings of the National Academy of Sciences*, Filep’s lab found that fragments of mitochondrial DNA can alter the behavior of immune cells, both weakening their ability to fight bacteria and causing erratic signaling.

Because of this variability—in the drivers of inflammation, the initial insult, the patient’s genetics and more—developing a targeted treatment for sepsis is like a game of Whac-A-Mole. “If you’re looking at the clinical appearance, it’s straightforward,” Filep says. “But are we really looking at the same disease with the same molecules driving it? I tend to believe not.”

THE GOLDEN HOUR

Better outcomes for sepsis aren’t just about finding the right treatment; they also depend on speedier diagnoses. Treating sepsis is a race against the clock. A retrospective study of 35,000 patients published in 2017 in the *American Journal of Respiratory and Critical Care Medicine* found that for every hour in which antibiotics are delayed, sepsis patients had a 9% higher risk of dying.

De Maio has identified a “golden hour,” an early window in sepsis when treatment is most effective—during the initial hyperinflammatory phase, before the immune system collapses. In a 2012 study published in the *Journal of Biological Chemistry*, he and his colleagues produced sepsis in mice and then removed the source of infection at different time points. When the scientists intervened within six hours, 80% of the mice survived; when they intervened later, survival dropped to less than 40%. Inflammation closely tracked these outcomes, peaking at six hours before rapidly declining.

More recently, De Maio tested the golden-hour hypothesis using a new therapy: hyperbaric oxygen, which delivers 100% oxygen inside a pressurized chamber. “This allows us to deliver oxygen fast to every single organ,” he says. The hope was that improving oxygen delivery might reduce tissue damage and the ensuing inflammatory cascade. The results, published in 2019 in the *American Journal of Physiology (AJP)-Regulatory, Integrative and Comparative Physiology*, found that about half of mice treated an hour after sepsis onset were still alive three days later. “But if it was done late, there was no recovery,” De Maio says.

The problem is that sepsis can be difficult to spot early on, says Cuthbert Simpkins, MD,

the Sosland-Missouri Endowed Chair in Trauma Services at the University of Missouri-Kansas City School of Medicine. Sepsis’s symptoms are wide-ranging and non-specific: fever, disorientation, lethargy, shivers, perhaps a cough. “A lot of things cause fevers; a lot of things cause a cough,” Simpkins says.

He remembers a patient coming into the emergency department (ED) acting erratically. A frequent visitor to the ED, her behavior was familiar to staff. Simpkins thought she was in a mental health crisis. But she had sepsis. Simpkins was an intern at the time and “too inexperienced” to recognize her condition, he says. One of his superiors spotted sepsis and began treatment immediately. With prompt care, the patient survived.

LIFE AFTER SEPSIS

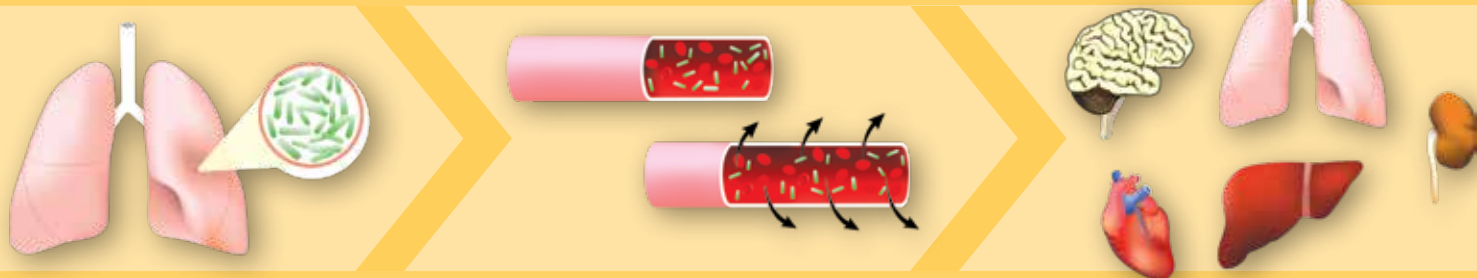
When a patient survives sepsis, their fight doesn’t end at discharge. The consequences can be lifelong: depression, impaired cognition, reduced mobility and a compromised immune system, says Orlando Laitano, PhD, a skeletal muscle biologist and exercise physiologist at the University of Florida.

Laitano’s research focuses on the long-term impacts of sepsis on what he calls “the forgotten organ”: skeletal muscle. “For many years, we didn’t know about the physiology of muscles in sepsis survivors,” he says. So Laitano began asking physical therapists what they were seeing in sepsis survivors. “They told me these patients don’t tolerate exercise.” Rather than growing stronger with rehabilitation, many became weaker.

A CLOSER LOOK

The Stages of Sepsis

Sepsis can tear through the body quickly, damaging organs and healthy tissue.



1 Infection. A pathogen—bacterium, virus or fungus—enters the body and triggers a chain reaction in immune response.

WHAT HAPPENS: The body releases chemical or protein immune mediators into the blood to combat the infection.

2 Sepsis. The immune response becomes dysregulated, no longer confined to the infection site, and inflammation spreads throughout the body.

WHAT HAPPENS: Immune mediators trigger widespread inflammation, blood clots and leaky blood vessels. Blood flow is impaired, depriving organs of nutrients and oxygen and leading to organ damage.

3 Septic Shock. The most severe complication, when circulatory, cellular and metabolic abnormalities become severe enough that the risk of death increases sharply, even with treatment.

WHAT HAPPENS: Vasodilation overwhelms compensatory mechanisms. Despite fluid resuscitation, blood pressure collapses. Cells switch to anaerobic metabolism, generating lactate as oxygen delivery fails. Multi-organ dysfunction follows.

Sepsis can be difficult to spot early on because its symptoms are wide-ranging and non-specific: fever, disorientation, lethargy, shivers.

To investigate, Laitano mimicked intensive care unit conditions in septic mice. He induced sepsis and simulated bed rest in the mice, a method he initially characterized in *Physiological Reports* in 2021. The researchers then compared these mice to a healthy group who were also immobilized. Their results, presented at the 2025 American Physiology Summit, showed that while both groups experienced similar muscle atrophy, sepsis survivors had significantly greater weakness—even after controlling for muscle size.

The team hypothesized that while disuse probably played a major role in degeneration, something else was likely going on in the muscles of the sepsis survivors. In earlier work published in *AJP-Regulatory, Integrative and Comparative Physiology*, they identified epigenetic changes in satellite cells—the immune cells responsible for muscle repair—in mice following heat stroke. (Laitano has found that sepsis is a common complication of heat stroke and is often what leads to death.)

These epigenetic changes were likely caused by the “absurd” amount of free radicals released during sepsis, Laitano says. “After sepsis, the satellite cells proliferate some, but don’t fully engage in the repair cycle,” he says. In other words, while healthy muscle responds to stress by growing stronger, the muscles of sepsis survivors continue to break down.

Laitano has found that 75% of patients experience abnormal muscle

function after sepsis. This loss of strength leaves them extra vulnerable to falls and rehospitalizations—and each hospitalization increases the risk of a second bout of sepsis due to their already-dysregulated immune systems.

While Laitano hasn’t identified avenues to restore normal muscle function in sepsis survivors, his research does point to a simple intervention to improve survivors’ quality of life post-discharge: Keep patients moving. His lab is currently exploring early mobility and electrical stimulation to preserve strength. “What you want is to slow down the rate of atrophy and weakness so that if the patient survives, they’ll have some level of function that’s compatible with daily activities,” he says.

THE FUTURE OF SEPSIS

Insights into sepsis physiology are beginning to translate into real interventions. In Phase 2a clinical trial findings published in 2024 in *The Lancet*, a team led by Simpkins tested a new drug that redistributes blood concentrations of nitric oxide, a gas that contributes to vascular and organ damage in sepsis. Twenty patients with severe septic shock were given the drug; all experienced increased blood pressure within 90 minutes and improvement in the function of multiple organs within 48 hours. This allowed for a decrease in the dose of vasopressors, a drug given to patients in septic shock that elevates blood pressure but that can have

life-threatening complications. In the end, survival was greater than expected based on the severity of their condition.

Meanwhile, researchers are finding other potential avenues for therapy, including specialized pro-resolving mediators, which are lipids mainly produced by dietary omega-3 polyunsaturated fatty acids that help the body fight infection and return to baseline levels of inflammation. “These could be a game-changer in sepsis management,” Filep says.

Researchers at the University of California San Diego Department of Emergency Medicine have developed an artificial intelligence (AI) algorithm that monitors patients for sepsis using 150 different variables, including lab values, vital signs, demographics and medical history. In a 2024 study published in *npj Digital Medicine*, the team tracked the outcomes of 6,000 ED patients before and after deploying the AI tool. The algorithm resulted in a 17% decrease in deaths.

Sepsis outcomes are gradually improving, says Christopher Gayer, MD, PhD, chief of the Division of Pediatric Surgery at Children’s Hospital Los Angeles. Forty years ago, only 20% of people with septic shock survived, according to an article in *The New England Journal of Medicine*. Today, survival approaches 70%, but it still remains the leading cause of death in children globally. Better screening, imaging, a wider array of antibiotics and awareness about the importance of early diagnosis and intervention with IV fluids to improve blood volume are starting to make a difference, Gayer says.

Gayer is hopeful gains will still be made. “If you can treat it a little bit better, diagnose it a little bit earlier, have some better tools to support people while they’re getting treated, that can be enough to tip the balance in favor of overcoming this.”



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Cell & Molecular Physiology Section Hugh Davson Distinguished Lectureship	\$1,000	Honors a distinguished scientist who has made meritorious contributions to the scientific areas represented by the APS Cell & Molecular Physiology Section	May 15
Comparative & Evolutionary Physiology Section Scholander Award	\$500	Honors a trainee presenting research in the Scholander Award Poster Session Competition at the APS Comparative Physiology conference	May 15
John F. Perkins Jr. Research Career Enhancement Award	up to \$20,000	Honors a member with the ability to receive special training or development of new skills in areas of developing interest	June 27
Teaching Career Enhancement Award	up to \$10,000	Provides an individual with the ability to develop innovative and potentially widely applicable programs for teaching and learning physiology	June 27
Ernest H. Starling Distinguished Lecture of the APS Water & Electrolyte Homeostasis Section	\$1,000	Honors an APS member recognized for exceptional contributions and lifelong dedication to water and electrolyte homeostasis research	July 1

BEYOND THE LAB

Physiology on the Hill

APS brought Nobel laureates, researchers and lawmakers together to make the case for federal investment in foundational science.

In March, APS convened leading scientists and congressional representatives and staff at the U.S. Capitol Visitor Center in Washington, D.C., for a briefing and science fair. The event underscored the importance of federal investment in physiological research and protecting the scientific discoveries of the future. Nobel laureate Jack Szostak, PhD, joined panelists Kathryn Sandberg, PhD, and Michael Caplan, MD, PhD, FAPS—moderated by APS Chief Science Advisor Dennis Brown, PhD, FAPS—to address the role of basic science in driving biomedical innovation. Rep. Zoe Lofgren (D-CA) offered remarks from the congressional perspective. An accompanying science fair gave attendees an up-close look at physiology-powered discoveries in progress, from treatments for childhood leukemia and preeclampsia to advances in healthy aging and neuromuscular rehabilitation. The event is part of the Society’s national campaign *Physiology: The Science Life Depends On*, which advocates for sustained funding and broader recognition of the foundational science behind every health breakthrough.

THE SCIENCE
Life
DEPENDS ON

moderated by APS Chief Science Advisor Dennis Brown, PhD, FAPS—to address the role of basic science in driving biomedical innovation. Rep. Zoe Lofgren (D-CA) offered remarks from the congressional

Learn more at fightforphysiology.org.



Clockwise from top: Rep. Zoe Lofgren (D-CA) offers remarks; Gordon Mitchell, PhD, FAPS; Denise Cornelius, PhD; and Mark Frey, PhD.



Clockwise from top: Panelists (left to right) Michael Caplan, MD, PhD, FAPS; Kathryn Sandberg, PhD; and Nobel laureate Jack Szostak, PhD, facilitated by Dennis Brown, PhD, FAPS, discuss why physiology research is essential to advancing human health and biomedical discovery; the group gathers on Capitol Hill; Sue Bodine, PhD, FAPS; Jan Williams, PhD; and Fong Lam, MD, PhD.



APS COMMUNITY

APS Launches Volunteer Engagement Initiative

APS has launched a Volunteer Engagement Initiative designed to make it easier for members to find, explore and participate in opportunities across the Society. The effort is in direct support of APS' Strategic Plan, which calls for cultivating a welcoming and inclusive home for all life scientists and strengthening programs and leadership by bringing more voices to the table. It also responds to member feedback—many members have shared that they are interested in serving but aren't always sure where to start. This initiative is designed to create clearer, more visible pathways to engagement.

As part of the rollout, APS has developed a webpage highlighting volunteer opportunities across divisions, committees and programs. Members can also complete a new interest form to indicate how they would like to contribute, helping APS better connect volunteers with roles that align with their expertise and interests.



Whether you're looking to serve a committee, support a program or explore leadership pathways, the goal is simple: to make it easier to get involved.

Learn more and express your interest in volunteering at [physiology.org/engagement-opportunities](https://www.physiology.org/engagement-opportunities).

APS TASK FORCES

APS Interest Group Task Force Created

Building on insights from two focus groups held at the 2025 American Physiology Summit, the APS Board of Directors approved the creation of an Interest Group Task Force. The group will examine the current structure and function of APS' eight interest groups. The review reflects a broader effort to ensure that interest groups remain dynamic, relevant and well-positioned to support the Society's strategic priorities and the evolving interests of APS members and the discipline at large.

The task force will develop criteria to guide the evaluation of existing groups. These criteria may include measures of participation, programmatic or scholarly output, and collaboration, with the aim of ensuring groups continue to provide meaningful value and a professional home for APS members.

The task force will also examine how interest groups can help the Society respond to emerging and cross-disciplinary areas in physiology, including new scientific directions and future workforce needs. The review will consider types of content, programs and engagement formats that could enhance visibility, build community and ensure sustainability of interest groups.

The task force will be composed of six to eight members, including individuals who have served or are serving in interest group leadership roles. A progress report will be submitted this spring, with a final review and recommendations by the summer Board meeting.

APS ELECTIONS

Results in for New APS Leaders

The results of the 2026–2027 leadership election results are in. The new president-elect and three Board directors began their terms in April 2026 at the conclusion of the American Physiology Summit.

PRESIDENT-ELECT

Lacy Alexander, PhD, FAPS, professor of kinesiology at Pennsylvania State University



Lacy Alexander, PhD, FAPS

Julie Freed, MD, PhD, senior associate dean and director of the Clinical & Translational Research Institute at the Medical College of Wisconsin



Julie Freed, MD, PhD

BOARD DIRECTORS

Kirsteen Browning, PhD, FAPS, professor of neural and behavioral science at Pennsylvania State University College of Medicine



Kirsteen Browning, PhD, FAPS

L. Bruce Gladden, PhD, FAPS, professor of kinesiology at Auburn University



L. Bruce Gladden, PhD, FAPS

APS TASK FORCES

New Task Force to Examine FAPS Program

At the summer 2025 APS Board of Directors meeting, the Board established a task force to conduct a comprehensive review of the Fellow of the American Physiological Society (FAPS) program and provide recommendations to the Board. FAPS was established in 2015, and over the past 10 years, APS has conferred 372 FAPS designations. Of those, 300 remain active members of APS.

The task force is charged with evaluating several key areas, including how well the FAPS program aligns with APS' mission and strategic priorities, the impact of the FAPS designation on a designee's career, and how the FAPS program compares to similar recognition programs in related scientific societies.

The review will also examine whether the current nomination and selection process effectively supports the intent of the program and advances the broader goals of the Society.

The task force consists of three FAPS Committee members, three APS Board members and a designated chair. This balanced composition is intended to bring a range of perspectives and experience to the review process; all task force members hold the FAPS designation. The task force is expected to provide a progress report this spring and final review and recommendations by the summer Board meeting.

MEMBER NEWS

Meena Madhur, MD, PhD, has been elected to the Association of University Cardiologists, a national organization limited to 175 active academic cardiologists. Madhur is director of the Division of Clinical Pharmacology in the Department of Medicine at Indiana University School of Medicine. Her research focuses on immune mechanisms of hypertension, including its effects on the kidneys, blood vessels, heart and brain.



Patricia Silveyra, PhD, has been chosen as president-elect for the Society for Advancement of Chicanos/Hispanics and Native Americans in Science (SACNAS). She has previously served as treasurer of SACNAS and is looking forward to expanding mentorship opportunities for students and early-career scientists. Silveyra is chair of the Department of Environmental and Occupational Health in the School of Public Health at Indiana University Bloomington.



PUBLISHING

2026 Subscribe to Open Goals

For the second consecutive year, APS has achieved its Subscribe to Open (S2O) goals, making 10 of its primary research journals open to readers worldwide with no article processing charges for authors.

S2O is a publishing model built on institutional commitment. It works when enough libraries choose to maintain their subscriptions, allowing APS to open its journals to everyone, regardless of whether a reader's institution holds a subscription. Every year, that threshold has to be met.

"Subscribe to Open requires real commitment—from our institutional partners, our editorial community and the Society itself," says Colette Bean, MA, chief publishing officer at APS. "Qualifying again in 2026 reflects the trust our partners have placed in APS and the value they see in supporting society-led publishing."

For APS members, open access means greater visibility for published work—

research that is freely available gets read more, cited more and used more. For the discipline, it means physiology research reaches the scientists, clinicians and students who need it, anywhere in the world.

As a nonprofit society publisher, APS reinvests publishing revenue into scientific meetings, career development, advocacy and programs that support physiologists at every stage of their careers.

Institutions subscribing to the APS Digital Library or *American Journal of Physiology* packages receive full journal access for affiliated researchers and open access publishing benefits for corresponding authors, whether or not S2O thresholds are met. Read more about how open access works on page 15, and learn more about APS Subscribe to Open at journals.physiology.org/subscribe-to-open.

DATES & DEADLINES

AWARDS APPLICATION DEADLINES

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](https://www.physiology.org/awards).



MAY 15

CELL & MOLECULAR PHYSIOLOGY SECTION

Hugh Davson Distinguished Lectureship

COMPARATIVE & EVOLUTIONARY PHYSIOLOGY SECTION

Scholander Award

JUNE 27

John F. Perkins Jr. Research Career Enhancement Award

Teaching Career Enhancement Award

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American Journal of Physiology-Cell Physiology

Jan. 4, 2027

- Cellular Dysfunction in Cardiovascular Diseases
- Decoding Fibrosis
- Exploring Autonomic Signaling and Cell Physiology
- Mechanisms Underlying Diversity in Cancer Cachexia
- Mitochondrial Channels/Transporters: From Physiology to Pathophysiology
- Myogenic Stem Cells: From Single Cell Biology to Muscle Physiology

Jan. 5, 2027

- Crosstalk of ECM and Cellular Metabolism in Development, Aging and Disease
- Metabolic Syndrome and Cancer

American Journal of Physiology-Endocrinology and Metabolism

Jan. 4, 2027

- Clinical Metabolism
- Exercise Metabolism
- Immunometabolism
- Liver Metabolism

American Journal of Physiology-Gastrointestinal and Liver Physiology

July 31

- Cell and Animal Models of Gastrointestinal Disease
- The Microbiota-Gut-Brain Axis

American Journal of Physiology-Heart and Circulatory Physiology

Feb. 2, 2027

- Interorgan Communication in Cardiovascular Disease
- Core Skills in Cardiovascular Research
- Emerging Technologies in Cardiovascular Physiology
- Stress, Exercise and Cardiovascular Disease
- Role of Leukocytes in Cardiovascular Disease
- Spotlight on Cardiovascular Health Disparities
- Transformative Cardiometabolic Advancements

American Journal of Physiology-Lung Cellular and Molecular Physiology

June 30

- Exploring Macrophages and Environmental Exposures in the Lung

Jan. 15, 2027

- Artificial Intelligence and Machine Learning Approaches in Respiratory Research

American Journal of Physiology-Regulatory, Integrative and Comparative Physiology

Sept. 30

- Integrative Physiology of Gut-Brain Communication
- Physiological Adaptations to Environmental Stressors and Challenging Conditions

Dec. 15

- Integrative Physiology of Gut-Brain Communication

American Journal of Physiology-Renal Physiology

June 30

- Mechanism of Renal Ion Transport and Sensing in Health and Disease in Honor of Dr. Steven Hebert
- Epigenetics in Kidney Health and Disease

Dec. 31

- The Impact of Obesity and Hypertension on Kidney Disease

Comprehensive Physiology

June 30

- Kidney-Heart-Lung Axis Communication in Health and Disease
- Gut-Brain Communication in Metabolic and Cognitive Control
- Heart-Lung Interactions in Pulmonary Vascular Disease

July 31

- Liver-Lung Interactions in Health and Disease

Dec. 28

- Microbiome: A Critical Modulator of Multiple Organ Cross Talk in Health and Disease

Function

Oct. 1

- Circadian Biology: Timing Matters in Physiology and Pathophysiology
- Immunobiology and Inflammation: Emerging Roles in Physiology and Pathophysiology
- Obesity and Metabolic Physiology: From Molecular Mechanisms to Systemic Implications

Journal of Applied Physiology

Jan. 15, 2027

- Physiological Impacts of Modern Environmental Exposures

Jan. 29, 2027

- The Physiology of Exercise Limitation in Chronic Obstructive Pulmonary Disease

Journal of Neurophysiology

June 1

- Sleep Disorders

June 30

- Human Cellular Neuroscience and the Uniqueness of the Human Brain
- Integrative Research on the Functional Logic of Neural Circuits
- Neuroimaging Meets Neurophysiology
- Neurophysiology of Exposure to Extreme Environments—Pressure, Temperature and Microgravity

Physiological Genomics

June 30

- Environmental Effects on Physiological -Omics
- Spatial -Omics

Nov. 6

- Single Cell Analysis

Dec. 4

- Gene Therapy and Multi-Omics Approaches for Precision Medicine

MEETINGS & EVENTS

2026 CONFERENCES

Control of Renal Function in Health and Disease

June 22–25

Fontana-on-Geneva Lake, Wisconsin

Comparative Physiology Conference

September 17–20

Orlando, Florida



The Fight That's Worth It

BY DENNIS BROWN, PHD, FAPS

I'll be honest with you. There are days when it feels like I'm shouting into a very large, very indifferent room, so why do it at all?

I moderated a panel at the U.S. Capitol in March. Nobel laureates, leading researchers, congressional staffers—serious people having serious conversations. We made the case,

I believe clearly and carefully, for why sustained federal investment in foundational science is not optional if this country wants to remain a global leader in biomedical innovation.

The congressional staffers listened. Some asked good questions. And then they went back to their offices where the budget fights continued. The uncertainty that is grinding down laboratories, stalling careers and threatening the next generation of scientists did not let up, as witnessed by the latest proposed slashing of federal agency science budgets.

I know many of you are exhausted and angry; frankly, so am I. Reduced and unstable funding, along with draconian federal policy decisions, interfere with important research directions and have real consequences for real people. A postdoc considers whether to stay in science; a lab pauses research and may never again be productive; a graduate student watches this disarray and wonders if science is a career worth pursuing. We are not imagining these scenarios. They are happening in real time and before our eyes.

So why keep pushing? Why go to the Hill? Why write to your representatives?

Not because I can promise you it will soon get easier. Not because naysayers will suddenly come to their senses and recognize how foundational science contributes to their health and well-being. That realization may happen slowly and perhaps not on our preferred timeline. Sadly, I cannot in good faith tell you the

cavalry is coming over the hill with flags flying and bugles ringing.

But here is something worth remembering: Last year, despite a presidential budget proposing deep cuts to federal research, Congress held the line. That is not nothing, and it is precisely why we keep showing up.

What we need right now is endurance. Our scientific environment may not improve soon, but we need to keep going anyway. The history of our discipline is filled with examples of endurance—investigators working on questions nobody else thought were worth asking that led to breakthroughs and Nobel prizes even decades later. Sometimes those questions were pursued for longer than seemed reasonable—until the answers changed everything.

I currently sit in an office once occupied by Joel Habener, co-discoverer of the GLP-1 agonist anti-diabetic and anti-obesity drugs. His 30-year legacy of brilliant research and hard work, coupled with federal support over decades, contributed to a medical breakthrough that has improved the lives of millions.

Stories like this are what I keep coming back to and what stimulates me to keep advocacy for science on the front burner.

When I was in that room on Capitol Hill, looking at the scientists beside me and the exhibits behind us (see page 34), I felt proud of my colleagues for showing up. I was also reminded of exactly what is at stake if we walk away. Not something abstract, but real people. Patients who do not yet have the treatments they need, scientists struggling to gather critical resources to explore their groundbreaking ideas, and perhaps most importantly, trainees who deserve to inherit a thriving field that fought for itself. The next generation.

The room may be large. It may be indifferent. We keep talking anyway.

Dennis Brown, PhD, FAPS, is the chief science advisor at APS. The views expressed here are those of the author. Send questions or comments to tphysmag@physiology.org.





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