

UCSF MAGAZINE

Touch of Nobel-ity

The prize-winning science illuminating heat, touch, pain, itch, and much, much more



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Ever wonder why eating chili peppers makes you sweat? David Julius's spicy science reveals the answer.



A surfer for over 40 years, Thane Schultz feels just as stoked now as the day he first picked up a board. After a severe hamstring injury, surgery and physical therapy got him back on the water.



Karen Meckstroth is the director of the UCSF Center for Pregnancy Options, which cares for people having miscarriages and abortions. She is preparing for an influx of patients from states that ban abortion.

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Abortion Rights Are Health Care Rights

As *UCSF Magazine* went to press, the U.S. Supreme Court released its decision overturning *Roe v. Wade*.

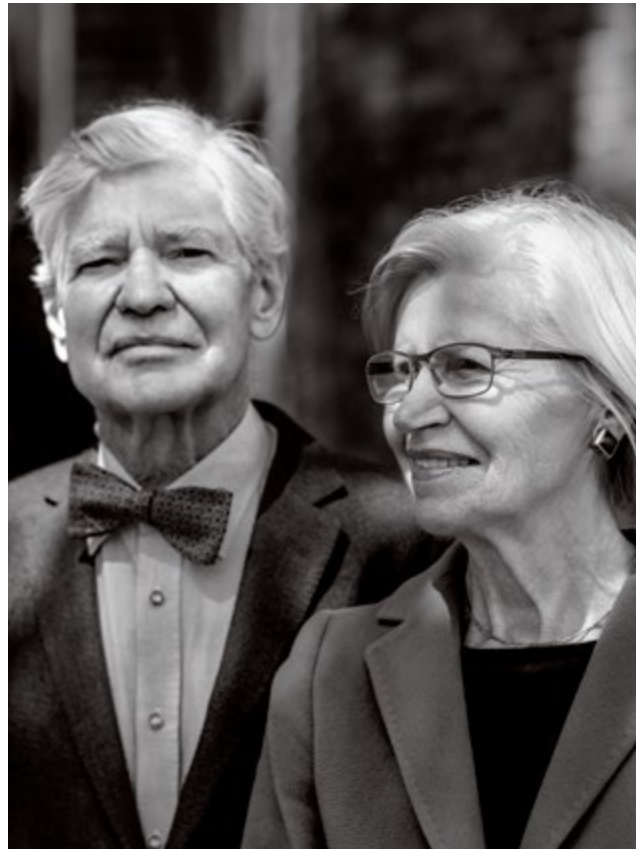
The ruling means that abortion will soon be banned or extremely limited in at least 26 states, infringing on the basic human right to reproductive autonomy and disproportionately affecting low-income people and people of color.

UCSF has a long history of advocating for reproductive health and education, including serving as a model for providing access to abortion. For decades, our faculty members have been providing exemplary care to all patients, especially those who face barriers due to systematic bias, while also training leaders in ob-gyn and improving policy and practice through research.

In the face of the court's decision, the health care leadership of UCSF's Bixby Center for Global Reproductive Health has taken on renewed importance, as you will read in this issue.

Their work is not only critical for people's lives and well-being, it also embodies UCSF's values of health equality, dignity for all, and evidence-based care. History shows that laws restricting or banning abortion result in greater numbers of women managing their own abortions – putting them at risk of criminalization or of the health and economic perils of carrying an unwanted pregnancy to term. I thank our institution's experts in this field for their unflinching leadership.

Given the concerning news about *Roe*, we are all the more grateful to have something to celebrate in this issue: the Nobel Prize-winning work of UCSF scientist David Julius and postdoc alumnus Ardem Patapoutian. Our cover story explores David's scientific journey



Philip Darney and Uta Landy of the UCSF Bixby Center for Global Reproductive Health helped integrate abortion care and training into mainstream medicine. Thanks to their pioneering work, support for equitable access to abortion within the medical community is stronger than ever.

and the powerful ripple effect his and Ardem's discoveries have had on our understanding of how we sense the world around us.

We hope you find these stories intriguing and enlightening.

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Five Questions for the New President & CEO

Suresh Gunasekaran, MBA, recently assumed the helm of UCSF Health, which includes about 18,000 staff and physicians; it admits 41,000 patients and handles more than 2.5 million outpatient visits yearly.

Why health care?

My first job was at Vanderbilt University Medical Center in Nashville, where I grew up. Then I worked as an IT consultant in Silicon Valley during the dot-com boom. I learned a lot about innovation and business management. But as exciting as that work was, I realized that my real calling was in health care, because of the impact it has on the community and on individuals. Making that difference for someone can be a life-changing experience.

You've also worked at university health systems in Texas and Iowa. Why academic medicine?

You're training the next generation of learners in the best possible way, you're solidly committed to advancing medicine and sharing those breakthroughs with patients, and you're focused on clinical excellence in all that you do. Truly special things are possible when you do all that. This motivates me and gives me great passion for this job.

Best advice you ever got?
Love the people you work with.



First steps as a leader?

Like any new employee, it starts with listening. What's on the minds of people who are doing the work? What are their hopes? Fears? What's going well? What are the major barriers? It's been a long pandemic, especially for health care workers. As we consider the future of UCSF Health, we're going to think deeply about how they can have a better work-life balance and about the resources and support they need to succeed.

What drives your dedication to health equity?

We've long been committed to achieving the best outcomes for our patients. What has been troubling for me during my career is our lack of progress as an industry in addressing health disparities across communities. We must challenge ourselves to think differently: meet people where they are, have our own teams represent the communities we serve, and partner with community organizations that can help us deliver innovative solutions.

Leadership lesson to live by?

Have the humility to know that I'm not always going to get it right, and that when I don't, I can learn from that experience and move forward.



Vice President Kamala Harris meets with patient Hope Williams, who is expecting her fourth child.

VP Harris Visits UCSF to Support Black Maternal Health

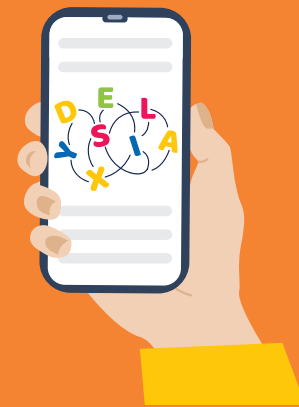
Vice President Kamala Harris visited UCSF in April to spotlight the critical need to address nationwide disparities in health care for Black people during pregnancy. She met with leaders of and participants in EMBRACE, a nearly four-year-old clinical program that was developed to provide perinatal care for Black pregnant people, Black mothers, and their families, with an intentional focus on racial consciousness.

For Black women across all backgrounds and socioeconomic levels, pregnancy and postnatal care are widely linked to inequities in access, outcomes, and patient experiences. Harris's visit brought visibility to those stark disparities by showcasing the enhanced care and support offered by EMBRACE, which Harris called "a national model." Committed to providing an experience grounded in dignity and respect, the program engages participants from their 12th week of gestation and continues to support them through their infant's first year of life.

Racial Inequities in Pregnancy and the Postpartum Period

Black women are:

- Three to five times more likely than white women nationwide to die during or after pregnancy.
- More likely to suffer from disorders like postpartum depression without being offered clinical care.
- Subject to more discrimination within the medical field.



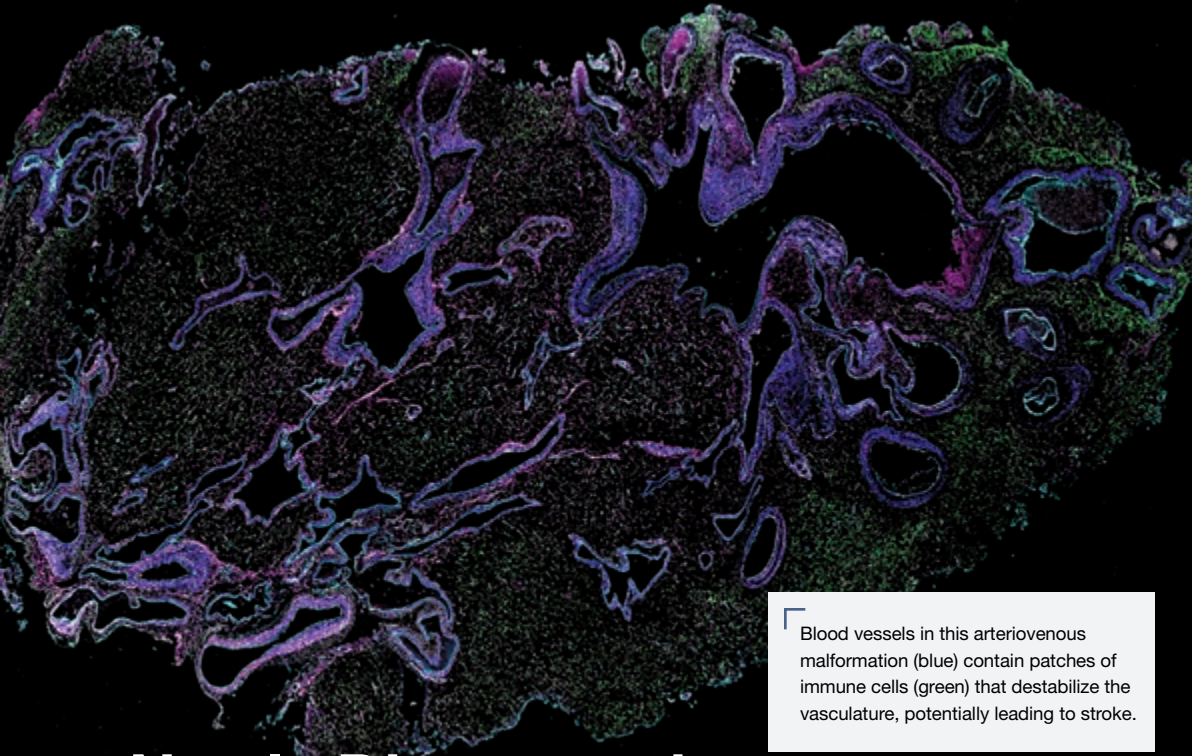
Tool May Detect Dyslexia Early

A UCSF-developed tool to detect early signs of literacy weaknesses that may lead to dyslexia could be in widespread use in the state's public schools by 2023.

The free digital assessment, which has been piloted with 2,000 students at dozens of California schools to date, is meant to spot pre-reading challenges in kindergartners and first graders so educators can intervene before dyslexia is typically diagnosed, says Marilu Gorno Tempini, MD, PhD, the Charles Schwab Distinguished Professor of Dyslexia and Neurodevelopment and co-director of the UCSF Dyslexia Center and the UCSF-UC Berkeley Schwab Dyslexia and Cognitive Diversity Center.

"We don't usually diagnose dyslexia in kindergarten – kids are not expected to read fluently yet," Gorno Tempini says. "But we know there are risk factors, and the hope is that if we address those factors earlier on, the kids will not develop the difficulties with written language associated with dyslexia."

"By the time dyslexia is recognized in third or fourth grade," she adds, "kids have suffered through feeling incapable or being bullied for years. In a worst-case scenario, these kids fall further behind and eventually drop out. So we are really creating a prevention tool here."



┌ Blood vessels in this arteriovenous malformation (blue) contain patches of immune cells (green) that destabilize the vasculature, potentially leading to stroke.

Newly Discovered Immune Cells Promote a Type of Stroke

In work that will bolster the study of strokes, as well as dementia and other brain conditions, researchers at UCSF have cataloged all the cells that form the blood vessels in the human brain, along with their locations and the genes transcribed in each.

The catalog characterizes over 40 previously unknown cell types, including a population of immune cells whose communication with the brain's vascular cells contributes to the bleeding characteristic of

hemorrhagic strokes. This devastating form of stroke accounts for 10% to 15% of all strokes in the U.S., mostly among younger people. About half of hemorrhagic strokes are fatal.

"This research gives us the map and the list of targets to start developing new therapies that could change the way we treat a lot of cerebrovascular diseases," says neurosurgeon Ethan Winkler, MD, PhD, a research associate at the UCSF Weill Institute for Neurosciences and one of the lead authors of the study.

CELL: JAYDEN ROSS AND ETHAN WINKLER

Treating Tough Tumors by Exploiting Their Iron 'Addiction'



Tumors driven by mutations in a family of genes known as RAS are famously difficult to treat and account for about one in four cancer deaths. Now, researchers at UCSF have successfully reengineered an existing FDA-approved drug to halt the growth of such tumors. The investigators discovered that these cancer

cells have an appetite for a reactive form of iron, so they tweaked an anticancer drug to operate only in these iron-rich cells, leaving other cells to function normally. The achievement could open doors to more tolerable chemotherapy against many cancers for which current treatments can be as challenging as the disease.

Recommended: Books, Videos, & Podcasts



Why Cope When You Can Heal? How Healthcare Heroes of COVID-19 Can Recover from PTSD

Diana Hendel, PharmD '89, and psychiatrist Mark Goulston, MD, share empathetic advice and tangible tools in this guide for health care professionals and leaders. Hendel's perspective on trauma and healing stems from her journey leading a hospital through the aftermath of a deadly workplace shooting.



The Bandaged Place: From AIDS to COVID and Racial Justice

This award-winning documentary explores grief, rage, and identity through the stories of three men, all Asian American artists, including producer, director, and UCSF resident alum Ravi Chandra, MD. Find it on Vimeo.



As Prescribed

This weekly podcast features conversations with UCSF luminaries on breaking research ranging from sleep genetics to screen time for kids to COVID surges. Find it on audacity.com.

Detoxing: Can You Buy Your Way to Better Health?

Companies claim there's bad stuff in our homes and bodies, and we should pay to purge it. What's worth worrying over?

By Elizabeth Daube

Concerned about cancerous compounds in your lotion? How about air pollution? Or indestructible chemicals in fast-food wrappers? There's a whole detoxification industry ready to help!

For your body, there's the \$195 Goop 7-Day Reset Kit, which features a vitamin “superpowder” and a dry brush to achieve “rewarding whole-body wellness.” Or you can try “teatoxing”: In 2018, Americans spent more than \$62 million on teas that claim to clean you from the inside out. For your home, products like the \$320 Blueair Blue Pure 211+ promise to “create the best breathing space possible.” Schools alone have spent millions on air purifiers in response to COVID-19, despite concerns that some devices have created other health hazards.

We asked UCSF experts about “detoxing” and health – and whether there are smarter ways to spend your time and money.

MYTH #1: I stay inside a lot and use water filters and air purifiers, so I'm super safe.

Nope. To be clear, some of these products perform important jobs. For example, anyone who's lived through California's fire season has probably heard of particulate matter: microscopic particles in smoke and other hazy pollution that can find their way into your lungs and even your bloodstream. The health impact of particulate matter can range from coughing to heart problems. The good news: HVAC filters and portable air cleaners can remove a lot of it.

Alas, the bad news: The Environmental Protection Agency estimates that indoor air is two to five times worse than outdoor air – and particulate matter is far from the only pollutant.

For example, your home can easily trap volatile organic compounds (VOCs). You can't see VOCs, but you might smell them; they have many sources, from paint to perfume. Even new furniture, carpets, and mattresses can release VOCs. Some VOCs, like formaldehyde, increase your odds of getting cancer. More immediate effects can range from headache to memory loss. Unfortunately, many indoor air cleaners don't remove VOCs. And even among devices that claim to neutralize them, there's no reliable rating system.



Yikes. So what should we be doing? Prioritizing prevention, according to Tracey Woodruff, PhD '91, MPH.

“If you can buy it in a store, people assume it's safe, and that's not true,” says Woodruff, the Carlson Professor and director of UCSF's Program on Reproductive Health and the Environment (PRHE). She also directs the UCSF Environmental Research and Translation for Health (EaRTH) Center. “What should we do about these exposures? Systemic change is the most effective approach. In the end, the government needs to do its job. People shouldn't have to worry about toxic chemicals.”

For example, PRHE researchers studied chemicals used in common plastic items, including baby bottles and food containers. They found that substances like bisphenol A (BPA) can interfere with human hormones and alter a child's development. Armed with this data, experts from PRHE and elsewhere pushed for better regulation of BPA – and won.

MYTH #2: Toxic stuff is in my food/home/air/water, but there's nothing I can do.

Changing government policies can take a long time, but you have options now.

Woodruff's team put together advice on avoiding harmful chemicals and other environmental health hazards. Among her top tips: Skip harsh cleaning products and opt for milder ones (like diluted vinegar)

instead. If it's got a strong smell, reconsider spraying it in your home and/or on your body. And never microwave anything in a plastic container.

Some of Woodruff's suggestions require ongoing effort, like following environmental health news and advocating for improved policies. If you find the to-do list daunting, you're not alone.

"It's not a sprint, it's a marathon," says Woodruff. "You can start making choices and replacing things over time. You shouldn't take it on all at once."

What if, despite knowing better, you make a mistake that unleashes VOCs? Let's say you blast your cat's litter box with air freshener, or bleach your bathtub, or otherwise behave like a human with hard-to-kick habits. Now what? Open a window. The EPA seconds this strategy for removing indoor air pollution.

As far as your tap water goes, it's probably safe if you're in California. But you can visit ewg.org/tapwater to look up your zip code and learn more about water filters.

MYTH #3: This juice/sauna/colonic is going to cleanse me!

Actually, a healthy body can clear out plenty of problematic stuff without much assistance.

"A lot of the chemicals – like phthalates and BPA – if you just get exposed once, they'll leave your body in a day or a week," says Woodruff. "Even mercury – you can stop eating big fish, like tuna, and reduce your mercury by half in about three months."

But preventing chronic exposure is key. Faced with high levels of harmful substances again and again, your body's ability to detox declines.

"You have to change your diet and other exposures," Woodruff says. "Other things, like massage and sweating? I don't know of scientific evidence that those are effective."

So what you eat matters. Woodruff recommends fresh, organic fruits and vegetables. If you're on a tight budget, Amber Smith, MBA, RD, the director of nutrition services at UCSF, suggests buying the "dirty dozen" – produce easily penetrated by pesticides, like strawberries, leafy greens, and tomatoes – organic. The origins of your onions and pineapples don't merit as much concern.

Smith says if someone eats a lot of processed foods, a "detox" diet filled with fruits and vegetables might help them feel healthier – say, more energetic. But she has warnings. Make sure a dietician endorses the meal plan. Don't severely restrict calories and protein, or you'll feel weak and lose muscle; most people need at least 1,200 calories a day. And stay away from enemas and laxatives, which can lead to cramping and heart palpitations.

"Try making small adjustments instead," Smith says. "For example, it's hard for our bodies to break down packaged carbohydrates. Look at the ingredient list. The first word should be 'whole.' If not, skip it. We all want quick fixes, but healthy eating doesn't have to be extreme."

What Causes Post-COVID 'Brain Fog'?

Sluggish thinking, memory problems, and attention challenges are some of the symptoms reported by patients with post-COVID "brain fog." Clues to its cause may have been found in fluid surrounding the brain. A small study by experts at UCSF's Memory and Aging Center and Weill Cornell Medicine in New York revealed that patients with these issues were more likely to have unexpected antibodies in their blood and brain fluid, or just their brain fluid, suggesting inflammation. Patients with these thinking difficulties were also likely to have more cognitive risk factors – among them ADHD, diabetes, high blood pressure, depression, and anxiety – than patients who'd also had COVID-19 but were cognitively fine.

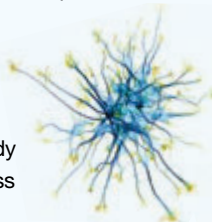
Breakthroughs and Other Buzz

Estrogen and exercise:

Estrogen appears to have effects on the brain that may promote physical activity, according to a new UCSF study that examined DNA, hormones, and brain cells in mice. The findings may suggest why women tend to exercise less after menopause, as their estrogen levels drop.

Neurons, not naps:

A new UCSF study showed that a loss of neurons, not a lack of sleep, makes Alzheimer's patients drowsy. Treatments to revive the brain's "awake" neurons might be better than a nap.



Lung cancer trouble for women:

Lung cancer is now more common in women than in men, according to researchers from UCSF and Stanford. The team found sex-based differences in cancer development, screening, treatment side effects, and other factors.

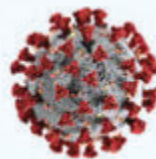
Birth control surprise:

When women's health researchers analyzed Medi-Cal data to see how two long-term contraceptives performed in the real world, they were surprised to find that IUDs (intrauterine devices) work at least as well as tubal ligation, while causing fewer side effects.

Mental health woes:

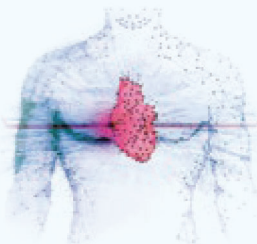
UCSF research reveals that 48% of young adults struggled with depression and/or anxiety in mid-2021, and more than a third of them were unable to access care.

Counteracting COVID: A team led by UCSF researchers identified a protein that's a potential drug target for preventing infection of human cells by SARS-CoV-2. The protein, called BRD2, regulates cells' ACE2 receptors, which the virus that causes COVID uses to gain entry to host cells.



Race-based BP prescriptions not effective:

Generations of physicians have been taught that Black people with high blood pressure should be treated with a narrower range of medication options than other racial groups. This race-based approach to prescribing has no apparent patient benefit, a UCSF study found.



AI may help ID serious heart problem: An abnormally thick heart muscle is a leading cause of sudden death in adolescents. UCSF scientists and their collaborators found that artificial intelligence may help identify the condition in its earliest stages.

UCSF is tops in NIH funding and education:

In 2021, for the 15th year in a row, UCSF garnered the top spot among public institutions in funding from the National Institutes of Health. And UCSF's medical and nursing schools were again ranked among the nation's leaders in their fields in the latest U.S. News & World Report survey of the nation's best graduate and professional schools.

U.S. NEWS & WORLD REPORT RANKINGS, SPECIALTY AREA STANDOUTS:

School of Medicine:

#1 Obstetrics and gynecology
#3 Internal medicine
#4 Anesthesiology, psychiatry, radiology

School of Nursing:

#3 Family nurse practitioner
#4 Adult/gerontology nurse practitioner (primary care and acute care), psychiatric/mental health nurse practitioner

Overdoses more deadly than coronavirus: For those experiencing homelessness in San Francisco, drug use – not the coronavirus – has been the big killer during the pandemic, according to research by UCSF and the San Francisco Department of Public Health.

Beware of binge drinking:

New Year's Day, Super Bowl Sunday, and other days when people imbibe more copiously than usual are associated with more emergency room visits for atrial fibrillation, an often-deadly heart rhythm disorder, according to a new UCSF-led study.



Concussions may diminish brainpower:

Car accidents, falls, and sports-related thumps to the head can all result in concussions. A new UCSF-led study found that mild traumatic brain injuries may also take a long-term toll on cognition.

Attacking asthma:

If children received the follow-up care after asthma-related emergency department visits that experts recommend, 72,000 subsequent ED visits could be prevented and millions of dollars saved, UCSF researchers determined.

Psychedelic promise:

When combined with talk therapy, the psychedelic drug MDMA (Ecstasy/Molly) can be effective for those with PTSD, new UCSF research has found. MDMA helps in a therapeutic setting by releasing oxytocin, creating feelings of trust and closeness.



Minding moms and babies:

Infants whose mothers attended a mindfulness program during pregnancy had a healthier stress response when they were 6 months old, a UCSF study found. An ability to bounce back from stress is tied to better health outcomes later in life.

The Case of the Curious Clots

A less meticulous physician might have mistaken the man's complaints for run-of-the-mill vascular disease. Not UCSF resident Ori Lieberman.

By Jill Sakai



ON A FOGGY DAY LAST JUNE, a 57-year-old man limped into the emergency department at the San Francisco VA Medical Center. His legs had been hurting for weeks, he told Ori Lieberman, MD, PhD, a UCSF resident who had just reported to the hospital for his first day of training. Initially, it sounded like a classic case of peripheral artery disease, in which fatty deposits in the blood vessels cause poor circulation. Sure enough, the patient's legs showed the hair loss and shiny skin characteristic of the condition.

But Lieberman and the other doctors on his team – Professor Kathryn Eubank, MD, and Maria Duarte, MD, a fellow – hesitated to send the man off with just a prescription for blood thinners and a recommendation to get more exercise. He had other symptoms that didn't add up: a recent loss of about 20 pounds, for instance, and signs of systemic illness – fever, an elevated heart rate, and a high white blood cell count. He also mentioned having experienced some chest discomfort and nausea the week before.

An EKG confirmed the team's worries: The man had suffered a heart attack. Could that explain his leg pain and flu-like symptoms?

It's common during a heart attack for a blood clot to form in one of the heart's lower chambers; when the heart starts beating again, the pressure can break up the clot and send pieces of it into the limbs and organs, causing pain and inflammation. A CAT scan revealed clots in the man's legs and one in his kidney. Surgeons removed a particularly large clot from his leg and placed a stent in his heart to prevent another attack.

But the medical team believed the clots were a red flag. Oddly, some showed signs of having formed recently, while others were clearly much older, so the team concluded that they couldn't all have originated from a single heart attack. An echocardiograph to image the patient's heart added yet another surprise – no evidence of clotting there. “Then we were really stumped, because we didn't know where the clots in the rest of his body were coming from,” Lieberman recalls.

Maybe, he realized, the heart attack wasn't the main culprit but a symptom of a larger underlying problem. As the man recovered from his surgeries, Lieberman noticed the level of platelets in his blood rising. Platelets are key in clot formation, and their numbers can go up due to many causes, including simple ones like stress. But Lieberman, suspecting a more serious cause, ordered an extensive workup – including a genetic test, which revealed a mutation in a gene called *JAK2* that's linked to some blood cancers. A biopsy of the man's bone marrow finally gave a clear diagnosis: essential thrombocytosis, a rare cancer in which the body overproduces platelets.

There's no cure, but the condition can be treated with medication. Without it, Lieberman says, the man almost certainly would have ended up back in the hospital with new clots, a more severe heart attack, or worse. Instead, as of December, at his latest checkup at the VA, he remained clot-free.

Nurses Needed Now

Decades in the making, the nursing shortage that's hammering hospitals everywhere is also challenging UCSF, where – despite low turnover rates – administrators are hustling to fill ranks depleted by the pandemic and an aging workforce. Along with her executive nursing team, veteran nurse **Gina Intinarelli-Shuler, PhD '13, RN**, is tackling the crisis.

By Katherine Conrad

UCSF Health offers competitive salaries and benefits along with low nurse-to-patient ratios to attract and keep nurses, yet nurses are still in short supply. What do you see?

Across the country, nurses are leaving the bedside in droves. The nursing shortage has been coming for a long time and is expected to exceed 500,000 nurses by 2030. We knew going into COVID that a significant portion of the workforce was over age 50. Now we see nurses who are close to retirement – and who don’t want to work in the COVID environment anymore – leaving sooner than expected. One key part of the shortfall is that nursing schools can’t grow their programs because of faculty shortages.

How big a role has COVID played?

The stressors of the unrelenting pandemic – such as PPE (personal protective equipment) and social distancing requirements – have compounded the difficulties in the work environment. Staffing shortages, potential exposure to COVID, and significant moral distress were all cited as key reasons nurses shortened their careers, according to a survey of critical care nurses. COVID accelerated something that was slowly simmering. We would have seen the same workforce changes, but they would have taken longer, and we would have had more time to respond.

Can you discuss the consequences for nurses of caring for patients who have chosen not to vaccinate?

It’s really tough. Compassion fatigue is a factor. You’re putting not just yourself at risk but also the family you go home to. I think that nurses are compassionate in the day-to-day, but it’s a moral struggle to care for people who have chosen not to vaccinate – especially if you’re in a hospital where you couldn’t take care of *other* patients because COVID patients were taking all the beds. Nurses and physicians really wrestle with that.

How has UCSF addressed burnout?

One solution was brilliant. In the beginning, our psychiatry colleagues rolled out the Cope Program. We gave employees front-of-the-line access to therapists to help them cope with all the dilemmas of COVID – not just burnout at the bedside but also managing work-from-home stresses and illness in their own families. Next, we worked closely with managers to ensure that we’re having wellness conversations, looking at people’s schedules, and offering flexibility. Another benefit offered across UCSF, which was groundbreaking, was ensuring that every employee had 128 hours of COVID leave to remove the stress of using up vacation or sick time.

Hospitals have long turned to traveling nurses, contractors who sign up for three-month gigs and can earn \$6,000 a week or more, to fill gaps. Do you see travelers as a long-term solution or more of a temporary fix?

Like hospitals everywhere, we use traveling nurses to manage our shortages. But if the past is any predictor, eventually travel nurses tire of “gig” work and choose to stay on as career employees. I expect as the pandemic wanes, this phenomenon will occur again.

Looking back, were there other steps you should have taken?

UCSF has a large population of retired nurses, and I think we could have done a better job with calling on retirees. While many may not have worked at the bedside, they could have handled contact tracing, vaccine delivery, and symptom screening to free up staff nurses for bedside work. We are doing that now and have found that many retired nurses are willing to help.

Given that more than 500,000 nurses in the U.S. are expected to retire this year, what can UCSF’s School of Nursing do to tackle a shortage that shows no sign of abating?

We have expanded our training programs for entry-level nursing and our new nurse-residency programs. For example, we had one graduate training program a year for 74 nurses, and now we are training over 150 per year. But schools have been unable to meet all the demand because we cannot recruit faculty to teach the students – clinical nurses earn significantly more than the teachers who instruct them.

Everyone’s going to see a shift in the experiential level of the nursing workforce as long-time nurses retire. At UCSF, we see the most difficult patients with the most complex diseases. We want the challenge of healing the sickest patients. My job as the associate chief nursing officer for nursing excellence is to ensure that our nursing workforce of over 4,000 is supported in a way that makes this a great place to work and that we are recruiting the cream of the crop. It’s challenging, but our senior nursing leaders are putting together a comprehensive workforce recruitment, retention, and training plan. I feel confident that UCSF will rise to the challenge; we have been training nurses for over 100 years.

Gina Intinarelli-Shuler is an associate dean at the UCSF School of Nursing and associate chief nursing officer for nursing excellence at UCSF Health.



THE HOT-SAUCY SCIENCE THAT NABBED A NOBEL



**How David Julius and Ardem Patapoutian
found the molecules in our bodies that sense
heat, cold, touch, and pain – and transformed
sensory neuroscience.**

By Ariel Bleicher



Close your eyes. What do you feel? Maybe the sun's warmth on your face or the chill of a draft on the back of your neck. Perhaps your clothes grazing your skin, an ache in your shoulders, or the rise and fall of your belly as you breathe. We often take such sensations for granted, but without them we would be helpless. **Touch** lets us navigate the physical world, use tools, avoid dangers, and even discern what's going on inside our bodies.

For thousands of years, philosophers wondered **what mechanisms underlay this vital sense**. In the 17th century, René Descartes imagined threads joining points on the skin to the brain, like tiny bell pulls. He wasn't too far off. Science later revealed these "threads" to be networks of sensory neurons, which relay information about all sorts of stimuli, from a poke to a burn, through electrical impulses. But how, researchers asked, were those impulses generated? They tried for decades to find the answer, but even as recently as the mid-1990s, it remained stubbornly out of reach.

It was then that **David Julius, PhD**, who last year became UC San Francisco's sixth Nobel laureate, found himself **zoning out in the hot sauce section** at Whole Foods. Back then, Julius was a rookie professor with a young lab and a nose for interesting problems. Although he understood little about sensory systems, as a molecular biologist, he was **fascinated by the idea of using natural products** to learn about molecules in the body. He knew, for instance, that scientists had used morphine to discover opioid receptors in the brain. And he'd read that capsaicin, the chemical that makes **chili peppers** spicy, can activate some sensory neurons. He figured that if he could find the molecule in those neurons that responds to capsaicin – the **elusive "capsaicin receptor"** – it might help solve the puzzle of how touch works.

"It was a risky project," he remembers. "It would take months of hard work, and I worried it was just a wild goose chase," so he had been stalling on getting it underway. But as he stared at the array of hot sauces at Whole Foods, he confessed to his wife, a fellow UCSF scientist, that he felt in his gut the risk would be worth it. "I mean, look how many people consume this stuff," he recalls saying to her. "Then why don't you get on with it?" his wife replied. So he did.

He convinced Michael Caterina, MD, PhD, then a fellow in his lab, to run the experiments. As Julius had predicted, it took many months and several more collaborators to refine their approach. It began with a library of about 3 million genes that are expressed in sensory neurons. Caterina divided the genes into 130 batches – with roughly 23,000 genes per batch – and, one by one, added each batch to a dish of cells and then dosed the dish with capsaicin. The cells were engineered to fluoresce when a receptor was activated, so if the gene for the capsaicin receptor was in a particular batch, the cells would glow in the presence of capsaicin.



It happened on the 11th batch: a field of blue speckled with yellow stars. "Like Van Gogh's 'Starry Night,'" recalls Caterina, who is now at Johns Hopkins. After that, rooting out the capsaicin receptor was just a matter of whittling down the size of the batch – first to 15,000 genes, then to 5,000, then to 300, and so on – until one candidate remained. **The victorious molecule, named TRPV1** (pronounced "trip vee one"), proved to respond not only to hot peppers but also to hot temperatures and to increases in acidity, which occur when an injury or infection causes inflammation in the body.

"It was a watershed moment," says Alexander Chesler, PhD, a sensory neuroscientist at the National Institutes of Health (NIH) and an alum of Julius's lab. "They had taken an experience as common as the spiciness of a chili pepper and used it to gain deep insight into sensory biology." The resulting paper, published in the fall of 1997, made the cover of *Nature*, one of the world's most prestigious scientific journals. The cover image was a photograph of bright red peppers printed on a black background, and every *Nature* subscriber knew who else was reading the capsaicin paper because they would be walking around with smudges of black ink on their fingers and faces.

Not long after, in 2002, Julius and **Ardem Patapoutian, PhD**, a neuroscientist at Scripps Research and a UCSF postdoctoral alum, independently identified a related receptor, TRPM8, that responds to both menthol and cold temperatures. Patapoutian's team then went on to unearth a family of receptors that respond to pressure, such as from a hug or the stretch of your esophagus when you swallow, using a method that involved jabbing cells' membranes with the tip of a pipette. The team called these receptors piezo channels after the Greek word *piezein*, meaning to press or squeeze.

In December 2021, Julius, who holds UCSF's Morris Herzstein Chair in Molecular Biology and Medicine, and Patapoutian received the **Nobel Prize in Physiology or Medicine** for these discoveries of the first known molecular sensors for temperature and touch. During the awards ceremony in Stockholm – as Swedish pedestrians' TRPM8 receptors warned them to brace against the subzero air – the emcee commended the scientists for having "unlocked one of the secrets of nature."

But the prize-winning revelations, made some two decades ago, did more than crack a fundamental mystery of the human experience. They **opened the floodgates** to new avenues of inquiry that are illuminating not just how we sense the world around us but also how internal sensations work – including processes beyond our conscious perception, such as skeletal development and brain repair. The following pages will take you on a tour of some of the most impressive of these insights – from culinary curiosities to warnings about e-cigarettes to better understandings of pain, itch, and other sources of anguish.

Temperature

FEELING THE HEAT

The heat receptor TRPV1 and the cold receptor TRPM8 aren't the only molecules of their ilk. Since Julius and Patapoutian's Nobel-winning discoveries, scientists have identified close to a dozen mammalian receptors that act like tiny thermometers. Some of them are found in sensory neurons and play a role in how we perceive temperatures, from glacially cold to fiery hot. Each receptor – and the neurons that express it – is tuned to a different temperature range, allowing us to tell a balmy breeze from an icy gale or a tepid sip of tea from a scalding gulp.

FIERY TRIFECTA

As many as three receptors may be responsible for signaling painful heat. When scientists breed mice that lack the gene for TRPV1, the animals only partially lose this sense. Knocking out either TRPM3 or TRPA1 similarly suppresses just some burning sensations. “Only when you eliminate all three receptors do you completely eliminate the ability to sense painfully hot temperatures,” says Julius lab alum Michael Caterina, now at Johns Hopkins.

WARM FUZZIES

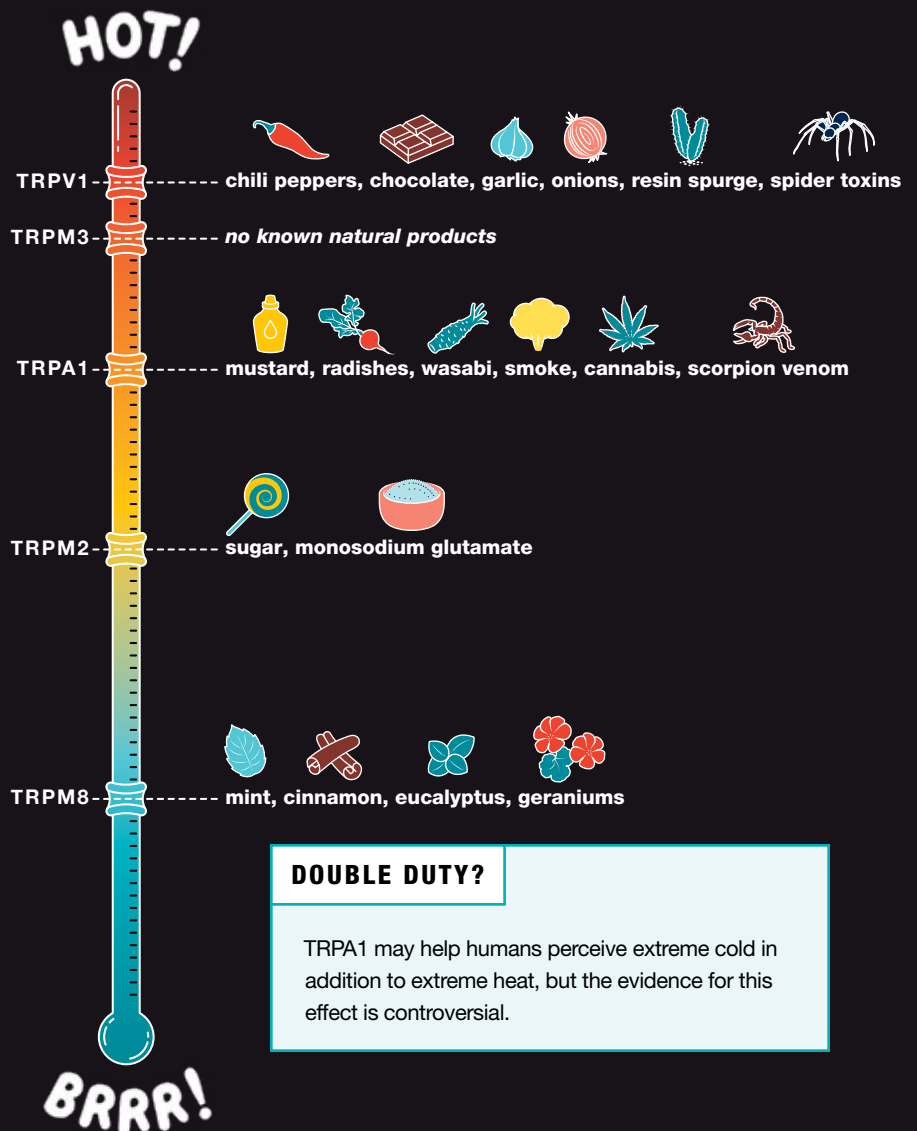
Scientists are still working out which receptors elicit feelings of warmth. TRPM2 is the strongest candidate so far.

THE COLD KING

Cold sensation is dominated by one receptor: TRPM8. Neurons expressing it sense temperatures from pleasantly cool to downright Siberian. Understanding this wide-ranging response could help explain why we experience pain from things that are dangerously cold differently than pain from things that are dangerously hot. “When you grab a hot rock from a fire, you know it's hot,” explains David McKemy, PhD, who co-discovered TRPM8 when he was a fellow in Julius's lab and is now a neurobiologist at the University of Southern California. “Cold is different. Even if you're holding a piece of ice, which is literally freezing, you might get aching or tingling, but the pain is more diffuse.”

NATURAL MIMICS

Ever wonder why eating chilies makes you sweat or chopping onions makes you cry? Capsaicin, the pungent chemical in chili peppers, and syn-propanethial S-oxide, which onions release as they are sliced, activate the same sensory receptors in your tongue or eyes that respond to painful heat, causing a sensation of burning. “Everyone thinks we taste spiciness, but we don't,” Julius says. “We *feel* it.” Many other substances produced by plants or animals – including the menthol in mint and certain toxins in the venom of spiders and scorpions – similarly trigger feelings of fieriness, warmth, or coolness, depending on which temperature sensors they stimulate.



DOUBLE DUTY?

TRPA1 may help humans perceive extreme cold in addition to extreme heat, but the evidence for this effect is controversial.

Touch

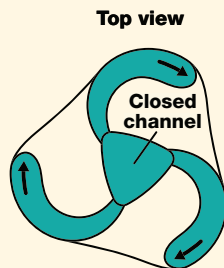


UNDER PRESSURE

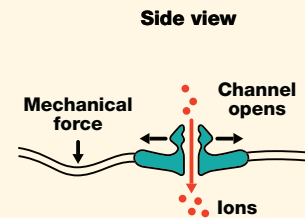
Arguably our most intimate sense, physical touch lets us feel the embrace of a lover, the brush of a cat's tail, or a tap on our shoulder. We experience such mechanical encounters thanks to piezo channels, sensory receptors that are unlike any others in our bodies. "They are quite extraordinary," says Julius lab alum Alexander Chesler of the NIH. "If you take your fingers and rub them together, think about how light that force is. How can we possibly detect that? It's because of the biophysical properties of these very beautiful and unusual molecules."

HOW PIEZOS WORK

A piezo molecule forms a pore, or channel, encircled by propeller-like blades in the membrane of a sensory nerve fiber. "The current thinking is that the blades grab the membrane and curve it around the channel," like a wound spring, Chesler explains.



The spring's tension keeps the channel closed until a poke or pull stretches the membrane and thereby unwinds the spring. As a result, the channel opens, initiating a signal to the brain.



INTERNAL IMPRESSIONS

Piezo channels don't just detect external forces. They also give rise to internal sensations, including proprioception (your awareness of where your limbs are in space) and interoception (your awareness of bodily functions, such as your heartbeat, breathing, or digestion).

In collaboration with Patapoutian, Chesler now studies patients who have inherited defects in the gene for PIEZO2, one of two known piezo channels in humans. These rare mutations cause a surprising assortment of symptoms. Patients can't feel gentle touches or vibrations, nor can they feel their lungs inflating or their bladders filling. "They have to schedule going to the bathroom because by the time they feel it, it's usually too late," Patapoutian says. Strangely, though, such individuals can still detect painful forces. "If you pinch them, they can feel it," Chesler says. (See "The Mystery of Mechanical Pain" on page 19.)

People with PIEZO2 mutations also are highly uncoordinated, which makes it difficult for them to walk, and they may suffer muscle or skeletal problems, such as scoliosis, hip dysplasia, or club feet. Most of them were born breech. "Even the coordination of turning around in the birth canal requires proprioception," Chesler says.

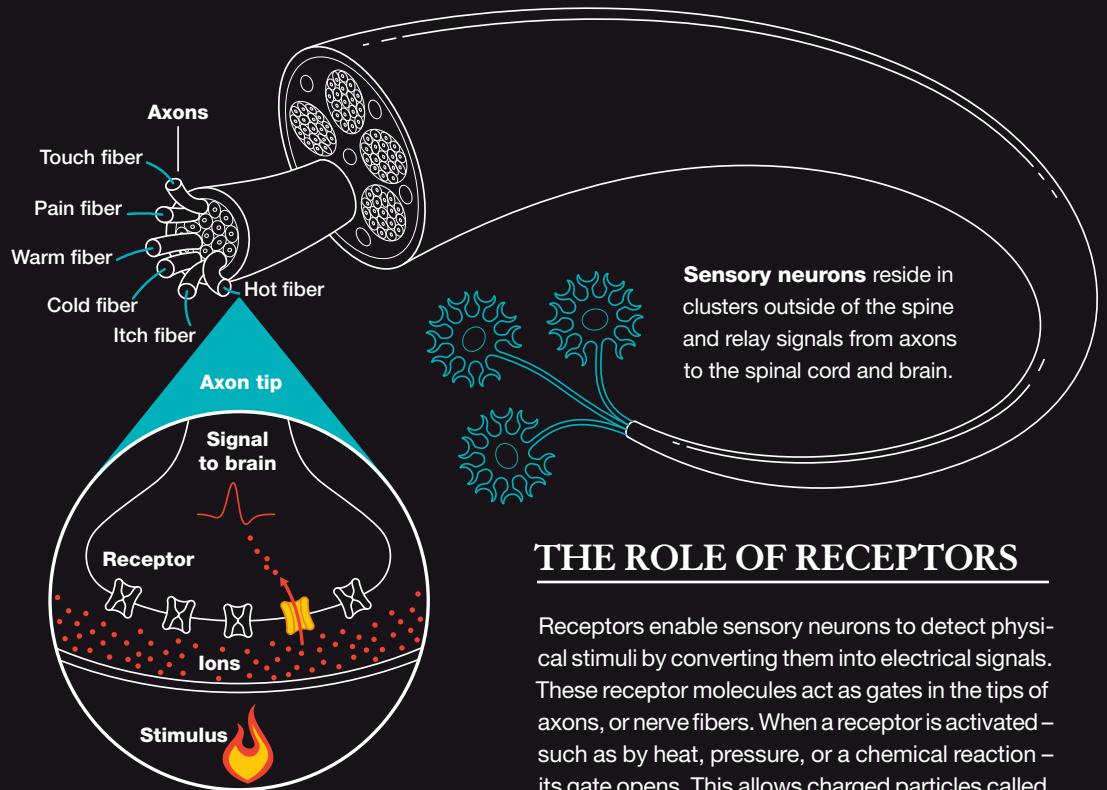
Such insights are challenging assumptions about the role of piezo channels and other sensory receptors in development and disease. "Most clinicians look at these patients and say, 'This is a motor neuron disease,'" Patapoutian says. "It's not – it's a sensory disease. Almost everywhere we look, we are finding that mechanosensing is playing some important function we take for granted."



ANATOMY OF A NERVE

SENSORY SMORGASBORD

Sensory neurons come in many “flavors.” Different types respond to different stimuli – kisses, cuts, tickles, burns, baths, bug bites, buzzing cell phones, and on and on – and their specialties can be remarkably nuanced. “There are touch neurons, for example, that sense a hair moving and others that sense a hair being pulled,” explains Chesler of the NIH. Some neurons sense only one stimulus, such as an itch or a pinch, while others sense multiple stimuli, such as both the coolness and the caress of a fall breeze. One class of sensory neurons, known as polymodal nociceptors, responds to just about anything that hurts. “You can burn your hand, or somebody slaps you – doesn’t matter,” Chesler says. “They’ll respond no matter what it is, as long as it’s nasty.”



A **nerve** contains bundles of axons, tendril-like fibers extending into the skin and other organs from sensory neurons.

Sensory neurons reside in clusters outside of the spine and relay signals from axons to the spinal cord and brain.

THE ROLE OF RECEPTORS

Receptors enable sensory neurons to detect physical stimuli by converting them into electrical signals. These receptor molecules act as gates in the tips of axons, or nerve fibers. When a receptor is activated – such as by heat, pressure, or a chemical reaction – its gate opens. This allows charged particles called ions to flow into a neuron, creating an electrical current that sets off a signaling cascade.

PHOTO: MARK JOSEPH STUDIOS; ILLUSTRATIONS: CHRIS PHILPOT (NERVE), LUO GUTIERREZ (ITCH)

Itch



Diana Bautista, PhD

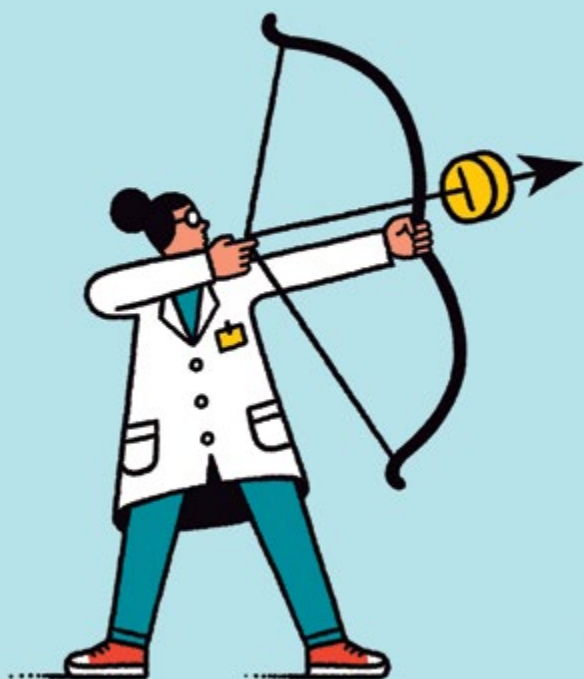
WHY WE SCRATCH

“It was thought for a long time that itch was just a mild form of pain,” says Diana Bautista, PhD. More than 15 years ago, as a fellow in Julius’s lab, she showed that the sensory receptor TRPA1 responds to wasabi and other substances that evoke pain. Now a neuroscientist at UC Berkeley, she studies the molecular underpinnings of itch, which are, in fact, very different from those of pain. Itchy things excite different sensory neurons than painful things, Bautista points out, and interact with sensory receptors in different ways.

Her lab has found, for example, that in mouse models of eczema, itchy chemicals called pruritogens can activate TRPA1 and other sensory receptors directly, the way pain stimuli do, as well as indirectly, through a “complex wave of activity” involving many cells and signaling pathways. “Eczema is the most common chronic itch disorder,” Bautista says, and current treatments like antihistamines and corticosteroids are often ineffective. “There is a real need for new therapeutics; we think these receptors could be potential targets.”



Pain



THE PROMISE OF BETTER PAINKILLERS

The holy grail of pain medicine is a drug that can alleviate agony without creating trouble elsewhere in the body. The problem with opioids, for instance, is that they act indiscriminately. Opioids not only numb nerves but also activate the brain's reward centers (which causes a sense of euphoria that can lead to addiction) and suppress respiration (which is why an overdose can be fatal). "The pill doesn't know where to go," explains Allan Basbaum, PhD, a UCSF neuroscientist who specializes in pain physiology.

So when Julius's lab discovered the capsaicin receptor, TRPV1, Basbaum says, the pain field was ecstatic. TRPV1 does more than trigger sensations of heat. It also plays a role in pain caused by inflammation, a hallmark of chronic conditions like arthritis, asthma, and inflammatory bowel disease. Most importantly, the receptor is found primarily in peripheral sensory neurons – those outside the central nervous system. Many pain scientists therefore believed that TRPV1 would lead them to an analgesic drug with few, if any, dangerous side effects.

Finding that drug, however, has been harder than they had thought. "Many groups tried to go after it and failed," Basbaum says. Some candidates that made it to clinical trials flopped at relieving pain as well as animal models had predicted; others caused slight fevers or increased the risk of burn injuries because they prevented patients from feeling

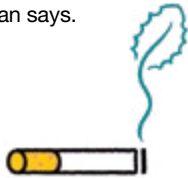
anything hot. But experts haven't lost hope. Several promising compounds are still in various stages of testing, Basbaum says, and recent advances in molecular imaging may enable scientists to find ways of targeting TRPV1 that allay pain without interfering with important functions, like regulating body temperature and sensing heat. (See "How the Chili Pepper Sparked a Breakthrough in Molecular Imaging" on page 20.)

Other receptors in peripheral neurons besides TRPV1 could also make good targets for new pain drugs. Blocking the cold receptor TRPM8, for example, could bring relief to cancer patients taking the drug oxaliplatin, which causes hypersensitivity to cold. Another receptor, TRPA1, is especially intriguing. It responds to all sorts of piquant and painful things – garlic, wasabi, wildfire smoke, animal venoms, tear gas, and the byproducts of chemotherapy drugs, among other substances – and has been implicated in a variety of pain syndromes, including diabetic neuropathy, sickle cell disease, and a rare genetic disorder called familial episodic pain syndrome. Biochemist Candice Paulsen, PhD, an alum of Julius's lab who now studies TRPA1 in her lab at Yale, calls it "a gatekeeper to the development of chronic pain." Like TRPV1, the receptor reacts to inflammation but, unlike TRPV1, is not involved in regulating body heat. "The hope is that TRPA1 may be a better drug target because it doesn't have the temperature side effects," Paulsen says.



THE MYSTERY OF MECHANICAL PAIN

The most frequent form of pain is mechanical – stubbing your toe, say, or slicing your finger, or slipping a disc. Some injuries, including nerve damage caused by conditions like multiple sclerosis and stroke, can cause what’s known as hyperalgesia, in which pain becomes more intense. In many cases of chronic mechanical pain, such as back or knee pain, even slight movements hurt considerably. Scientists have yet to find a mechanism that explains these phenomena. “It’s still a big question mark,” Patapoutian says.



THE PAINFUL TRUTH ABOUT MENTHOL CIGARETTES

Menthol cigarettes are the most popular kind of smokes – and not just because menthol is a nice flavor, says Sven-Eric Jordt, PhD, a biochemist and physiologist at Duke University and an alum of Julius’s lab. “It’s a potent pharmacological agent,” he explains; the menthol activates cold-sensing receptors in sensory neurons, thereby suppressing pain and cough. Jordt’s research shows that menthol causes mice exposed to cigarette smoke to breathe quicker and thus absorb more nicotine into their bloodstreams. “Menthol makes cigarettes more palatable,” he says. “You inhale more nicotine, and you get addicted faster.”

And now, makers of e-cigarettes are sneaking menthol-like chemicals into their products, Jordt says. “They’re adding these cooling chemicals to candy and fruit flavors that kids like.” While the synthetic mimics don’t share menthol’s minty taste or smell, he points out, they have a similar addictive effect.

HIDDEN WORLDS OF HURT

Surprisingly, neurons are not the only cells in your body involved in pain. Do your teeth twinge when you bite into ice cream? A recent study suggests that tooth cells called odontoblasts could be the culprit. These cells express the cold receptor TRPC5, the activation of which may make teeth extra sensitive to frosty food or drink, particularly when they are inflamed.

Enterochromaffin cells, cells in the lining of the digestive tract, are another suspected pain accomplice. Known as EC cells, they express the receptor TRPA1, which responds to mustard, radishes, and other spicy fare, explains James Bayrer, MD, PhD, a pediatric gastroenterologist at UCSF. Working with

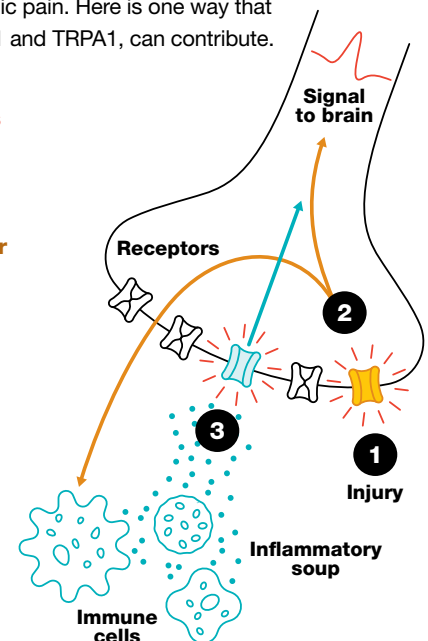
Julius’s lab and the lab of Holly Ingraham, PhD, UCSF’s Herzstein Professor of Molecular Physiology (and Julius’s wife), he has found that EC cells communicate with neurons to amplify sensory signals from the gut. When they’re activated, they can make normally benign sensations – such as a stretch of your intestine as food passes through it – feel painful.

Bayrer suspects this signal amplification is behind abdominal pain disorders like irritable bowel syndrome, which afflicts up to 30% of people and lacks a silver-bullet treatment. “If we could use what we’re learning to find a drug that could turn the volume knob down on the pain,” he says, “that would be fantastic.”

HOW IT BECOMES CHRONIC

Many pathways play a role in chronic pain. Here is one way that sensory receptors, including TRPV1 and TRPA1, can contribute.

- 1** An injury **activates receptors** in sensory neurons.
- 2** The activated receptors **trigger pain signals** and prompt the neurons to **recruit immune cells** to repair the damage.
- 3** The immune cells release molecules known collectively as **inflammatory soup**; the “soup” **further activates the receptors**, amplifying pain signals.



This process, called **sensitization**, can make harmless stimuli, like warmth or gentle touches, feel painful. Some forms of chronic pain develop when sensitization occurs in the absence of an injury – or continues after an injury has healed.

RESOLUTION REVOLUTION

HOW THE CHILI PEPPER SPARKED A BREAKTHROUGH IN MOLECULAR IMAGING

About a decade after Julius made history by locating the capsaicin receptor, the molecule in human nerve cells that gives chilies their kick, his team had examined it in every way they could think of – except for one. They had cloned the gene that codes for it. They had bombarded it with all matter of stimuli to see what sets it off. They had even mutated it in mice and created animals that were immune to spice and some amount of heat and pain. “They had studied this protein six ways from Sunday,” says Yale’s Candice Paulsen. “But they had never *seen* it.”

For a molecular biologist, seeing the structure of a molecule is revelatory. Suddenly you grasp how the thing is put together – and how you might heal it or cripple it or use its parts for other purposes. Such scrutiny allows researchers to know a molecule intimately, pinpoint its vulnerabilities, and promptly find drugs that target it by testing up to billions of compounds virtually using computer simulations.

Until recently, the best way to image molecules was with X-ray crystallography; scientists coax a molecule to form a crystal, blast it with X-rays, and then reconstruct its structure from the radiation patterns. When Erhu Cao, PhD, joined Julius’s lab in 2007, he tried to use this technique with the capsaicin receptor, to no avail. “He toiled away for three, almost four years, trying to get crystals,” Julius says. “Many proteins are just very difficult to crystalize,” explains Cao, now a biochemist at the University of Utah. He needed a new tool.

Meanwhile, two floors above Julius’s lab, UCSF biophysicists David Agard, PhD, and Yifan Cheng, PhD, were working to improve what was then a relatively obscure technology called cryo-electron microscopy, or cryo-EM. Invented in the 1970s, cryo-EM

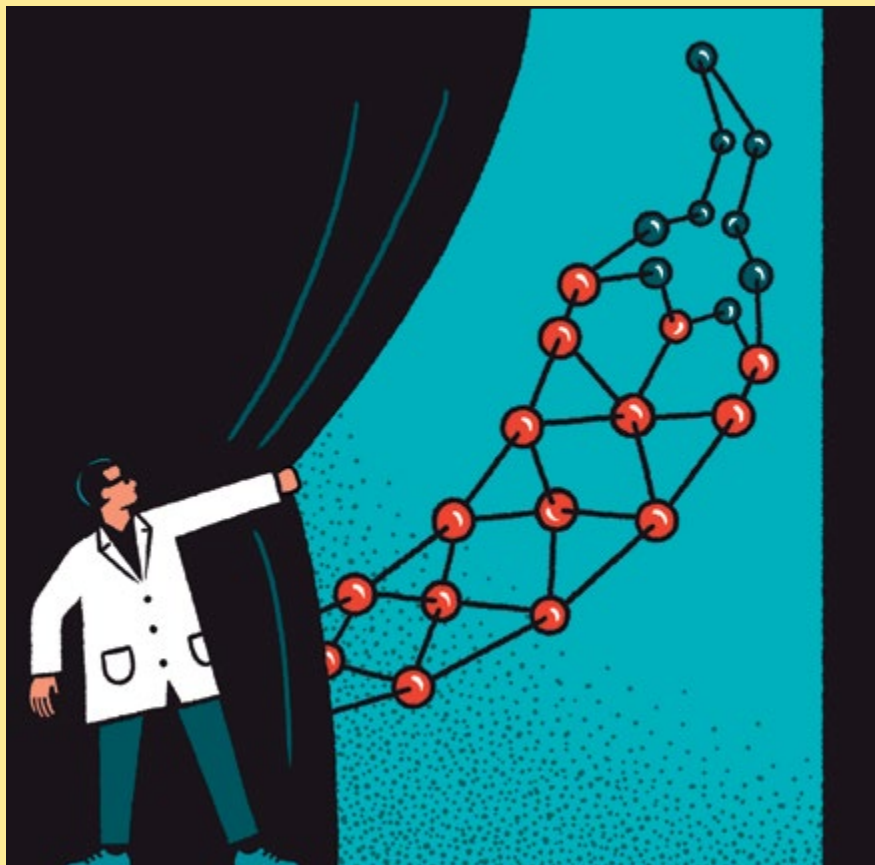
uses beams of electrons fired at frozen molecules to photograph their structures. For decades, however, the resolution was laughably poor. Most photographs came out looking like blobs, Cheng says. “That’s why, at the time, people doing cryo-EM were called ‘blobologists.’”

The cryo-EM pioneers believed they could do better. Digital cameras had made the process more efficient, but because the first-generation cameras worked with light, the electrons had to be converted to photons, which blurred the images. Hence the blobs. So Agard and his colleagues, including scientists at Lawrence Berkeley National Laboratory and the Massachusetts Institute of Technology, set about building a new kind of camera that detects electrons directly, resulting in sharper pictures. Agard enlisted Cheng to test and refine the prototypes, and Julius’s lab provided the perfect subject: the capsaicin receptor.

By the end of 2013, the team had published the first cryo-EM portraits of the famed

receptor. The resolution was so good that you could make out the placement of each atom. “That sent a shock wave through the field,” Cheng says, because it showed that medically important molecules that resisted crystallization, like the capsaicin receptor, could be imaged with cryo-EM. “Almost every structural biology lab switched to doing cryo-EM overnight,” he says.

Today, more than 90% of molecular structures are solved using cryo-EM – including viruses. “After the first SARS outbreak, in 2003, it took years to work out the virus’s structure using X-ray crystallography,” Cheng points out. “With SARS-CoV-2, it took weeks.” Detailed cryo-EM images have allowed experts to track the evolution of coronavirus variants and quickly develop vaccines and therapies. “All this was done thanks to cryo-EM,” Cheng says. “If we did not push for this technology – if the field did not progress in this way – our understanding of the virus and our capability to fight it would lag way behind.”



Survival



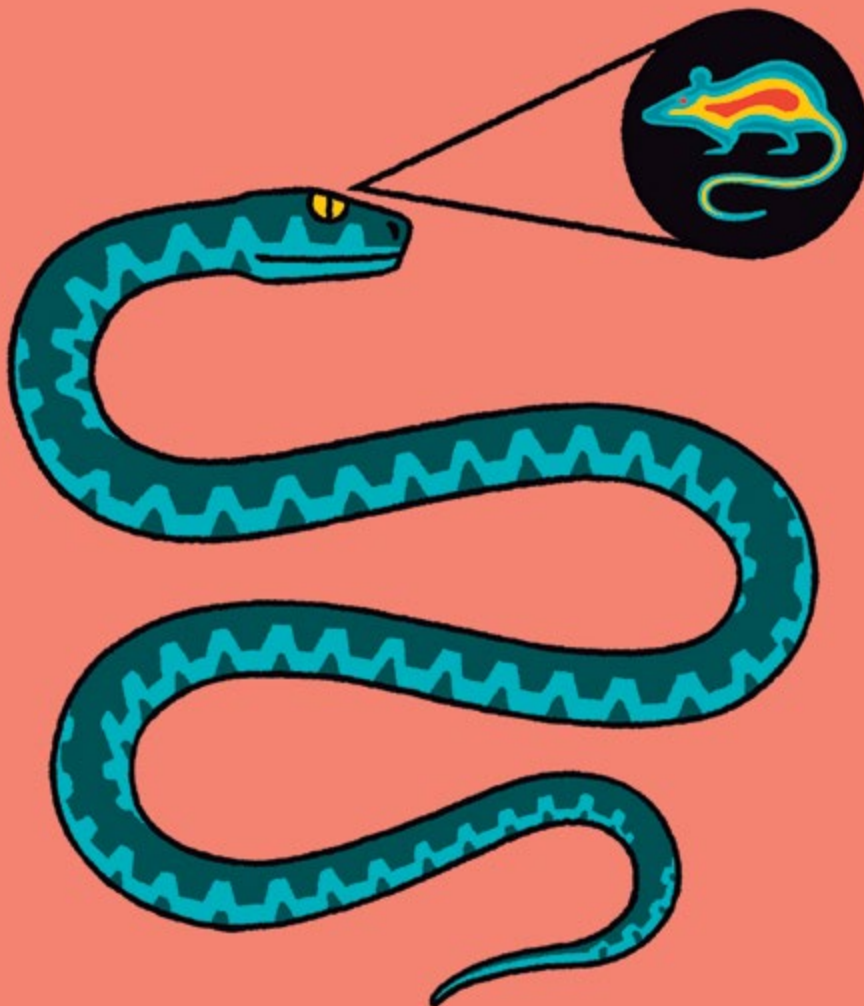
SUPER SENSORS

When Elena Gracheva, PhD, was a fellow in Julius's lab, she went to Texas to dissect some rattlesnakes. In a building with no windows ("so the snakes didn't escape"), she cut from each viper's brain a bundle of nerves projecting to organs in its face called pits. Pits allow rattlers and other snakes, including boas and pythons, to "see" the warm bodies of their prey via infrared radiation. Gracheva carried the snakes' neurons in a cooler back to UCSF, where she isolated the molecule responsible: TRPA1.

In humans and other mammals, TRPA1 plays a role primarily in sensations of pain and itch. (See "The Promise of Better Painkillers" on page 18 and "Why We Scratch" on page 17.) But in snakes, the receptor evolved to detect radiant heat. "This is the beauty of evolution," says

Gracheva, now a physiologist and neuroscientist at Yale. "One molecule can take on many different functions." She has since discovered other extraordinary adaptations, which, besides being just plain cool, could reveal ways of tweaking sensory molecules for therapeutic purposes.

Hibernating squirrels and hamsters, for example, have evolved TRPM8 receptors that are not sensitive to cold, as they are in humans, enabling these creatures to survive frozen winters quite comfortably. Similarly, a modification in the receptor TRPV1, which in humans responds to relatively modest heat, allows desert camels to withstand extremely hot climates. Another variant of TRPV1 endows vampire bats with an infrared sense like that of rattlesnakes. This sense is so acute that the blood-drinking bats can make out veins under the skin of their prey.



BEYOND SENSATION

One of the next frontiers of sensory-receptor science is understanding the impact of these molecules on human health beyond perceptions of pleasure or pain. For instance, piezo channels, which detect pressure, also regulate bodily functions like blood circulation and bone maintenance that have nothing to do with conscious feeling. Meanwhile, TRP channels, the family of receptors that sense temperatures, also contribute to heart rhythm, kidney filtration, insulin secretion, immune response, and the development of cancer, among many other processes.

Physiologist Makoto Tominaga, MD, PhD, of Japan's National Institute for Physiological Sciences—an alum of Julius's lab who helped identify the capsaicin receptor, TRPV1—is investigating the role of temperature receptors in brain repair. Recently, his team showed that when temperatures in the brain rise in response to an injury, support cells called glia sense the change via TRP channels and rush to fix the damage.

"There are sensory receptors regulating the gut, probably regulating development, procreation, spermatogenesis, you name it," says UCSF's Allan Basbaum. "The list goes on and on, and there's a lot more to discover. We're just at the tip of the iceberg, really."



PREPARING FOR A POST-*ROE* AMERICA.

What happens once
abortion is illegal in
half the country?

By Ariel Bleicher



Biftu Mengesha chose to become an ob-gyn to “help elevate the quality of care for people who share my identities.” Without the protection of *Roe*, she fears, “it’s going to be marginalized communities that suffer the most.”

PHOTO: LISA WISEMAN

IT'S A BAD TIME

to need an abortion in the United States. For nearly 50 years, *Roe v. Wade*, the landmark Supreme Court decision that guaranteed a constitutional right to an abortion, prevented states from banning the practice outright. No more. The court's June 24 ruling on a Mississippi abortion case is as abortion advocates had feared: *Roe* has been overturned, and states now have carte blanche to regulate or ban abortion as they please.

The near future of abortion access is certain to be bleak. Anticipating *Roe*'s demise, Texas, Idaho, and Oklahoma had recently enacted laws prohibiting an abortion as early as six weeks, before many women are able to get one. Now that *Roe* has fallen, so-called "trigger bans" have outlawed all abortions in those states and 10 others, and more bans will likely follow. Abortion will effectively become illegal in half the country, according to the Guttmacher Institute, which researches and supports abortion rights.

Practically speaking, an abortion was already difficult if not impossible to obtain in wide swaths of the U.S., even with *Roe* intact. Since 1973, the year *Roe* was decided, statehouses placed over 1,300 restrictions on the practice, compelling more and more clinics to slash their services or shut down. As of 2021, fewer than 800 abortion clinics remained nationwide – down from 2,700 in the 1980s. Several states had only one left; almost 90% of counties had none.

Without *Roe*, this patchwork will be stretched even thinner. More than a quarter of U.S. abortion clinics will be forced to close, primarily those in the South and Midwest, according to a new study from UC San Francisco. Waves of people seeking abortions will spread across the country, flooding clinics in states that continue to allow the practice, including California. Many more people will resort to illegal abortions or will try to manage them on their own, without medical supervision. Others – primarily poor women of color – will carry to term pregnancies they didn't want, which will threaten their physical health, financial stability, and personal ambitions and the well-being of their families, as UCSF research has shown.

Behind the scenes, abortion providers and activists have been gearing up – fundraising, establishing care networks, and passing bills to protect and expand access to abortion in "haven" states. ("We'll be a sanctuary," Governor Gavin Newsom declared of California.) Medical academics, too, are rallying – including at UCSF, which has long been a model for abortion provision and training and one of the few institutions to study abortions and their impact on people's lives.

Abortion experts at UCSF's Bixby Center for Global Reproductive Health are arranging to serve more patients and are pioneering new means of delivering care. They are documenting the impact of the

growing number of restrictions and bans, showing who is most endangered and how the damage can be lessened. And they are working to ensure that the next generation of providers – ob-gyns, family doctors, nurses, physician assistants, and emergency room staff – learns the skills necessary to care for pregnant people, whether or not they choose an abortion.

"It's going to be bad for a while," says Jody Steinauer, MD '97, PhD '19, the Bixby Center's director and UCSF's Philip D. Darney Distinguished Professor. "But hopefully, the harm that's done will make people come to their senses. I have to believe we can turn the tide."

BRACING FOR A TSUNAMI

The most urgent problem is logistical. Across the country, clinics in states where abortion will stay legal are scrambling to figure out how to accommodate the influx of patients that could start as early as July. "The word we keep hearing again and again is 'tsunami,'" says Carole Joffe, PhD, a UCSF sociologist who has been collaborating with Drexel University law professor David Cohen, JD, to interview abortion providers. Many foresee the surge sweeping up even women who live in haven states, as streams of abortion seekers from the South already are. "Before Oklahoma banned almost all abortions, so many Texas women had gone into the state that Oklahoma women couldn't get an appointment for three or four weeks out," Joffe explains. So they tried Colorado or New Mexico instead, displacing women there. "There's a domino effect."

California could see especially large abortion-related migration. "We're already getting calls from Texas and other states," says Karen Meckstroth, MD, MPH, who runs the UCSF Center for Pregnancy Options, which cares for people having miscarriages and abortions. She has

**WITHOUT *ROE*,
MORE THAN
36 MILLION
WOMEN IN
26 STATES
WILL LOSE
ACCESS TO
ABORTION
CARE.**



Jody Steinauer, director of the UCSF Bixby Center, also runs the Ryan Residency Training Program, which has helped more than 100 obstetrics and gynecology departments train over 7,000 residents in abortion care. She estimates that abortion training is now in jeopardy for 44% of U.S. ob-gyn residents.

started to extend the clinic's operating hours and to recruit providers who work in labor and delivery and high-risk pregnancy care to perform abortions. She is also partnering with other abortion clinics and nonprofits – including Access Reproductive Justice, a hotline in Oakland – to help callers who can't come to UCSF find care closer to home. "Even with financial support, there are people who can't travel," Meckstroth says. "They might have childcare issues, or they can't take time off work."

Those forced to travel may find it takes them longer to come up with funds or to make arrangements. That means providers will see more patients later in their pregnancy, raising a risk (albeit small) of complications, says UCSF's Eleanor Drey, MD, EdM, who directs the Women's Options Center, the abortion clinic at Zuckerberg San Francisco General Hospital. (Major complications of legal abortion occur in barely one-quarter of 1% of cases, making the procedure safer than having a wisdom tooth removed.) Although most abortions (over 90%) take place in the first trimester, Drey's clinic regularly serves patients past that mark, including some from out of state, because they have few other places to go. "People often are quite judgmental about anyone needing a later



Ushma Upadhyay's research shows that providing abortions remotely, with video or chat visits and provision of pills by mail, is safe and effective. Her findings informed the FDA's recent decision to allow telehealth abortion care. "Health care policy should be based on evidence," she says.

abortion," she says. "Even if they support abortion overall, they're like, 'But why did she wait so long?'"

Drey's research shows that usually a woman seeking a later abortion doesn't know she's pregnant for weeks or even months; she may mistake bleeding for menstruation, for example, or think a missed period is normal. "Once she realizes she needs an abortion beyond the first trimester, suddenly everything snowballs," Drey says. The procedure gets more medically complex, the cost goes up, and finding a provider willing or able to do it gets much, much harder. Many people who seek abortion care don't make it to a clinic in time. And with clinics becoming fewer and farther between, abortion experts are having to think creatively about how to increase access in other ways.

One approach gaining ground is telemedicine. Early in pregnancy, an abortion can be done with a simple procedure to evacuate the uterus (what's known as manual uterine aspiration) or with medication (typically, a two-drug combination of mifepristone and misoprostol). Until recently,

the U.S. Food and Drug Administration (FDA) required patients to pick up mifepristone in person at a medical facility, purportedly as a safety precaution. “It was very paternalistic,” says Ushma Upadhyay, PhD, MPH, a reproductive health scientist at UCSF. She points out that mifepristone, which blocks a hormone that maintains a pregnancy, is safer than many drugs available in pharmacies, like Viagra. But when the COVID-19 pandemic curtailed in-person visits, the FDA lifted that requirement, paving the way for many people to get abortion care entirely online.

Since then, Upadhyay’s research team has followed more than 3,000 patients across the U.S. who used a telehealth service for a medication abortion. These virtual clinics, which proliferated during the pandemic, allow patients to consult with providers through an app or video call and then receive their abortion pills by mail. The researchers are still processing the study data, but an early analysis of 141 California participants found that medication abortion through telehealth is safe and effective; many patients, several of whom were already parents, said they appreciated being able to fit the care into their busy lives. “One woman who is a driver for Amazon just pulled over and had her video visit from her truck,” Upadhyay says. The FDA considered that study’s findings in a recent decision, announced in December 2021, to permanently allow pharmacies to dispense mifepristone by mail after the pandemic ends.

But even with the FDA’s blessing, telehealth for medication abortions won’t be allowed everywhere, as 19 states already forbid or restrict its use. Still, there may be legal strategies for navigating this new landscape. California, for instance, is considering bills that would protect its abortion providers from being held liable in civil court or from losing their medical licenses if they care for patients living in states where abortion is illegal. “There may be an opportunity for providers in California to step up and serve patients across state borders,” says Daniel Grossman, MD, who leads UCSF’s Advancing New Standards in Reproductive Health (ANSIRH, pronounced “answer”), a research group that includes Joffe and Upadhyay. He and other ANSIRH researchers are also exploring the feasibility of making abortion pills available over the counter or of prescribing them to people who aren’t pregnant but are worried about that possibility – a strategy called advance provision. “I see this as a wraparound service,” Grossman says, “where patients might be given abortion medication ahead of time and told they can always call the clinic or have a telehealth visit if they’re considering using it.”

Meanwhile, if you Google “what to do if my period is late,” you may come across an ad for a newly launched study led by Upadhyay of what she calls the late-period pill. It’s an option for people who think they might be pregnant and don’t want to be. The regimen is three doses of misoprostol alone, which is commonly used to prevent stomach ulcers and to treat miscarriages, taken up to 14 days after a missed period. “It causes the uterus to contract and empty,” Upadhyay says, and won’t harm someone who isn’t pregnant. She is recruiting early adopters in hopes that their experiences will prove the late-period pill to be one more accessible, dignified choice at a time when many people will have so few options open to them.

BEARING WITNESS

Whatever you believe about when life begins and what it means to end a pregnancy, the reality is that making abortions hard to get hurts women. Between a quarter and a third of women in the U.S. have an abortion during their lifetimes. Yet every year, thousands of women carry undesired pregnancies to term because they can’t afford an abortion or – for more than 4,000 women a year, according to a UCSF analysis – because they can’t get to a clinic that performs abortions at their gestational point. Diana Greene Foster, PhD, a UCSF demographer and member of ANSIRH, estimates that with *Roe* now vacated, the number of people who want an abortion but can’t obtain one could be as high as 100,000 a year.

Foster understands better than most the impact this scenario will have on women’s lives – and the lives of their children. In 2007, she embarked on a decade-long study involving more than 40 researchers and about 1,000 women – some who’d received abortions, often after barely making it to a clinic, and others who’d arrived too late. She called it the Turnaway Study “because ‘turnaways’ is what [my UCSF colleague] Dr. Drey calls women who are too far along in their pregnancies to receive an abortion at her hospital,” Foster writes in her book *The Turnaway Study*. It was the first study of its kind and, by scientific standards, exceptionally robust. And the results were a bombshell.

Compared with women who got an abortion, Foster’s team found, women denied one were worse off on just about every measure. Their physical health was worse. Their mental health was worse for a time. They had fewer life aspirations. They had contact with abusive partners or ex-partners for longer. They were more likely to be single parents with no family support. They were less likely to have full-time employment and be able to make ends meet. And those who were already mothers – more than half the sample pool – had a harder time providing for their other children. “It’s not pro-child to prevent people from getting abortions when they feel they need them,” Foster says. “It’s making people have kids under worse circumstances than they’d want.”

Of course, losing access to legal abortion care won’t stop everyone who wants an abortion from having one, and Foster is planning and fundraising for a study that will document what happens to people trying to get abortions in states that will ban them now that *Roe* has been toppled. “I would like to know who is affected by these laws,” she says. “Who is able to get an abortion by traveling? How much does it delay them, and at what cost, physically and financially? Who tries to have an abortion by themselves? Who is at risk of doing self-harm? If we can identify those people, we can tailor outreach to them.”

The vast majority of people who manage their own abortions will probably use medication, which is “extremely safe,” Drey says. Those who can afford it can buy pills from websites that offer them without a prescription or can go to Mexico, where misoprostol is sold over the



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—Diana Greene Foster, PhD

Foster led the Turnaway Study, a groundbreaking investigation into the effects of unwanted pregnancy on women’s lives.



Daniel Grossman, the director of UCSF's Advancing New Standards in Reproductive Health research group, is exploring the feasibility of making abortion pills available over the counter or via advance provision – the strategy of prescribing the pills to people who aren't pregnant but are worried about the possibility.



Jennifer Kerns directs a UCSF fellowship in family planning for ob-gyns. If many medical schools are forced to stop teaching abortion, she worries, "what's going to happen to abortion training?"

counter. (Researchers who analyzed pills sold illegally online found that their contents were as advertised, though sometimes in weaker doses.) "It's not going to be like before *Roe*," Drey says, when medication abortion didn't exist and at least 1,000 women a year died from botched, back-alley surgical abortions. That's not to say there won't be tragedies. "We know people do things that are desperate," she says, although very rarely. "Even in California, we see patients who ask their boyfriends to hit them in the stomach," she notes, and others who ingest toxic substances or stick instruments into their uteruses.

But the symbol of post-*Roe* America won't be the coat hanger – it will be the jail cell. Even with *Roe* in place, feticide laws and other punitive provisions were used against women thought to have self-induced an abortion. "There already have been arrests," Joffe says. "I foresee a lot more." People will be investigated not only for having an abortion themselves or helping someone else have one but even for spontaneously miscarrying or suffering a stillbirth, as is sometimes the case even today. "There are people who have the tragedy of losing a pregnancy and then are accused of having caused the loss," Joffe says.

In general, the consequences of abortion bans will fall most heavily on people who are the least advantaged. Minors and people who are poor or undocumented often won't be able to travel, to pay for a procedure or pills (by law, federal Medicaid cannot cover abortion), or to reach providers online. Women of color will be more likely than white women to continue an unwanted pregnancy, because they are more likely to live in states where abortion rights are threatened or where access is scarce. And they will be more likely to die in childbirth. On average in the U.S., 24 women die for every 100,000 live births,

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far more than from legal abortions. In many states where abortion is now or will soon be banned, rates of maternal mortality are even higher, especially among Black and Indigenous women.

“It’s going to be marginalized communities that suffer the most,” says UCSF ob-gyn Biftu Mengesha, MD, MAS ’17. “For me, as a Black woman who came to this work to help elevate the quality of care for people who share my identities, ... honestly, it’s terrifying.”

CONFRONTING THE TRAINING CRUNCH

The reversal of *Roe* won’t just upend abortion provision. It will also mean there will be fewer doctors well-trained to care for patients who are or might get pregnant. (In some states, including California, nurses and physician assistants can also provide early abortions.) Studies show that medical residents who train in abortion as part of their regular rotations are better able to counsel patients about birth control and pregnancy options and to handle complications of pregnancy loss. “The skills that we use for early abortion care are the same skills used for contraceptive services and miscarriage management,” says Lealah Pollock, MD ’11, MS ’08, who oversees abortion training in the family medicine residency at UCSF and holds the Vitamin Settlement Professorship of Community Medicine.

Today, more than 90% of ob-gyn residents in the U.S. have access to some level of abortion training. That was not always the case. In the decades after the *Roe* decision was issued, stigma and anti-abortion violence helped drive the practice out of many hospitals, including at teaching hospitals affiliated with medical schools; abortions increasingly became the purview of freestanding clinics, such as those run by Planned Parenthood. By the mid-1990s, few teaching hospitals performed abortions, and as a result, few medical residents pursued abortion training.

The Bixby Center’s Jody Steinauer and others at UCSF have led the charge in reversing that trend. In 1993, Steinauer took a year off from medical school to start Medical Students for Choice, a group that has advocated for the inclusion of lectures about abortion in medical school curricula and that now has over 220 chapters worldwide. Around the same time, Bixby co-founder Philip Darney, MD ’68, together with Uta Landy, PhD, a senior adviser to the Bixby Center (and Darney’s wife), launched programs that help medical schools integrate abortion training into ob-gyn residencies and establish fellowships in complex family planning – an ob-gyn subspecialty that focuses on abortion and contraception. Through these programs, one of which Steinauer now runs, more than 100 campuses in the U.S., Canada, and Puerto Rico have trained over 7,000 residents and 600 fellows. Many of them have gone on to lead abortion training and research at universities and to provide abortions across the continent, including in conservative states.

“We’re everywhere,” says Sanithia Williams, MD, a former UCSF fellow who is one of only a handful of abortion providers in Alabama. She worries about what she will do if her clinic has to close. “It’s fundamental to my philosophy as a provider to be able to give people the options to make the decision that’s best for them,” she says. “If my hands are tied by the state, I don’t know how I’m going to process that.” She might fly in to help in clinics where abortion is still legal, she thinks, or look into telehealth opportunities. “I don’t think I would leave,” she adds.

But other providers are already moving out of anti-abortion states, including two former UCSF trainees who recently relocated from Texas to Montana and Colorado. “Talented, excellent doctors are going to be leaving states that need them,” says Mengesha, who directs UCSF’s complex family planning fellowship with Jennifer Kerns, MD ’04, MPH. Many states trying to ban abortion already have a shortage of physicians, she notes. With even fewer providers available, access to high-quality health care will only get worse, particularly in poor and rural areas.

Compounding the problem, states that outlaw abortion will also be less capable of training new doctors to replace the ones that flee. If medical schools in anti-abortion states are forced to stop teaching the practice, 44% of ob-gyn residents (more than 2,600 of them) won’t have access to abortion training, according to an analysis by Steinauer and others. Many trainees and future applicants will thus look for education elsewhere. UCSF has begun welcoming visiting residents from Texas, but capacity is limited. “Training someone is a big task,” Mengesha says. “There’s going to be a huge pool of people who want to get trained in abortion and not enough bandwidth to support them.”

The exodus of abortion providers from restrictive states will leave abortion there largely in the hands of primary care and emergency physicians. “It’s going to be critically important for family doctors to connect people with services,” says Christine Dehlendorf, MD, MAS ’08, the director of a UCSF fellowship for family physicians who want to specialize in abortion and contraception care. “Even if we can’t provide abortions ourselves, then we should be able to facilitate people getting the care that they need.” ER doctors will also see more abortion-related visits, either because of complications or because some people who self-manage an abortion might worry about how much bleeding is normal or whether their method has worked. “Are our emergency medicine colleagues ready to deal with this?” Steinauer asks.

But if there is a silver lining in the dark morrow of abortion care in America, it is that the systems put in place to support access to it are here to stay. “We’ve integrated abortion into mainstream medicine in a way that you can’t take away anymore,” Landy says. She and Darney, who began their careers before *Roe*, are optimistic that the pendulum swing of abortion rights will again be reversed. Because however contentious the political battle becomes, they point out, the medical community at large remains committed to the belief that abortion is an essential part of reproductive health.

There’s no denying that the Supreme Court’s decision to overturn *Roe* endangers women’s health and livelihoods, Darney says. “But our capacity to do something about it is a lot better.”

Envisioning the Operating Room of the Future

From a robot that assists in brain surgery to an instrument that can remove a brain tumor without an incision, through your nose, neurosurgery in 2022 is enabled by incredible technologies. But the future holds even more. Here, neurosurgeons Doris Wang, MD '11, PhD '09 (right), and Ezequiel Goldschmidt, MD, PhD, share a vision of future operating rooms at UCSF's planned new hospital at Parnassus Heights – with advanced MRI that will provide real-time, three-dimensional brain imaging as a surgical procedure unfolds. This will allow surgeons to perfectly target the placement of electrodes that can prevent seizures, cure movement disorders by infusing therapeutic genes exactly where they are needed, safely use lasers to stop seizures by calculating the temperature of brain tissue pixel by pixel, and perform many other procedures with ever greater precision and safety. ■ Cyril Manning





PHOTO: NOAH BERGER



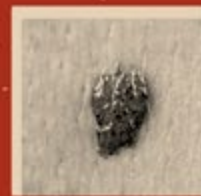



ILLUSTRATION: MARK HARRIS

Training the Eye to See Disease On Dark Skin

By Maria C. Hunt

Most dermatologists aren't adequately taught to treat patients of color. UCSF's Jenna Lester wants to fix that.



Jonas wears the close-shaved natural hairstyle that's on-trend for many Black men. He's been styling his hair this way for years, but during the pandemic he noticed, a few days after each shave, some spots on his scalp that hurt or even bled a little. When the pain and bleeding started to spread, he searched for Black dermatologists and found Jenna Lester, MD. "I wanted someone that had familiarity with my skin," he says.

Lester directs the Skin of Color Program at UC San Francisco, which includes a training clinic that specializes in treating dark skin. There are just a handful of such clinics across the country, and Lester's is the only one in Northern California.

Sporting pink glasses, black Nikes, and a white lab coat, Lester greets Jonas with the warmth of an old friend. She listens to his concerns and then asks a series of detailed questions: What kind of razor do you use? Any creams or lotions? How about aftershave? When you shower, what kind of soap do you use? Do you have a rash anywhere else? What have you tried to resolve this?

Soon enough, she determines the cause of his ailment: Pseudofolliculitis barbae. Also known as ingrown hairs or razor bumps, the condition is especially prevalent in Black people. "We have curly hair," Lester explains to Jonas, "and so our hair can lose its way as it's about to erupt out of the skin," leading to inflammation.



Jenna Lester founded the UCSF Skin of Color Program to improve dermatological care for people with dark skin, whose images are often excluded from training literature. “I’m here to make a difference,” she says.

She swabs his scalp for a lab test and recommends a treatment plan that includes washing his head and then applying benzoyl peroxide, an antiseptic. If that doesn’t help, she tells him, he might have to consider giving himself a less close shave in the future.

People of color often seek out specialists like Lester because they’ve been misdiagnosed in the past or suspect their doctors are missing something. They’re right to be skeptical. In a survey of U.S. dermatologists, nearly half said their training left them feeling unqualified to diagnose disease in Black or brown skin.

Some skin conditions show up on different parts of the body or look different on light and dark skin. White people, for instance, tend to develop melanoma on their chest, face, or back. For Black people, melanoma often first appears on their palms or the soles of their feet or as a dark stripe down a fingernail. Other examples include psoriasis, dermatitis, and COVID-19 rashes, which look pink or red on light skin but can be purple or brownish on dark skin.

Lester recalls an incident during her training when a Black patient sat in the emergency room for hours because no one knew

what to make of the person’s peeling, blistering skin. The ultimate diagnosis was toxic epidermal necrolysis, a life-threatening disorder that can result from a drug reaction. On white skin, one of its hallmarks is redness, but the coloration can be more subtle on darker skin. “You have to train your eye to see things in all skin tones,” she says.

Unfortunately, most medical students and dermatology residents rarely see examples of dark-skinned people in their curricula. When Canadian researchers analyzed more than 4,000 pictures in mainstream medical textbooks, they found that 74.5% of the images showed light skin, 21% showed medium skin, and just 4.5% showed dark skin. Lester

PHOTO: SARAH BETH MANEY

recently reviewed 130 images of COVID rashes published in academic journals and found they too were overwhelmingly of light skin, even though the coronavirus has disproportionately sickened people of color.

But, as Lester noted in a widely viewed TED talk and in a paper in the *British Journal of Dermatology*, one of the only contexts in which dark-skinned people appear regularly is in chapters on sexually transmitted infections. “What does this do to impressionable learners?” Lester asks in her 2021 TED talk on the subject. “Does it make them think that someone with dark skin is more likely to have a sexually transmitted infection?”

Inadequate training also intersects with myths about Black people that pervade American popular culture. For instance, the saying “Black don’t crack” is a nod to the observation that Black people often look much younger than white people the same age. Some think that’s because Black skin is thicker or oilier than white skin. But that’s not the case, Lester says. The likely reason, she explains, is the fact that Black people have more melanin, the substance that gives skin its color, and it acts as a natural sunscreen and prevents some skin damage.

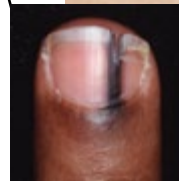
Other myths aren’t so benign – like the misconception that dark-skinned people don’t get skin cancer. Black and Latinx people are less likely than white people to get melanoma (and other skin cancers). But they’re much *more* likely to die from it. One reason is delayed treatment, Lester says. Studies show that patients of color receive fewer referrals to specialists and endure longer waits for follow-up visits than their white counterparts. While some providers may discriminate outright, others don’t recognize early signs of cancer on dark skin or don’t think to look for it or to warn their patients about risk factors. “It’s dangerous when our lay thoughts encroach on our clinical decisions,” Lester says.

She sees it as part of her mission to educate her dermatology colleagues, the vast majority of whom are white, about how to spot conditions on dark skin and how to ask questions to make culturally aware diagnoses. Black people make up 14% of the U.S. population but only 3% of dermatologists, and similar gaps exist for Latinx, Asian, and Indigenous groups. At a recent conference, Lester told the story of a Black patient whose previous dermatologist had recommended daily hair washing to help with scalp irritation and dandruff. That may be sound advice for some people, but, Lester jokingly informed her audience, it’s the “fastest way to lose credibility with a Black woman.” She explained that frequent hair-washing can dry out the hair and lead to damage or breakage in Black patients.

And many Black women suffer from alopecia, or hair loss, which can result from techniques used to achieve hairstyles that reinforce Eurocentric standards of beauty. So Lester also encouraged her colleagues at the conference to ask their senators to support the CROWN Act, which bars discrimination against people with braids,



COVID rashes look purple or brownish on dark skin and pink or red on light skin.



Melanoma often appears on the chest, face, or back of people with light skin and on the feet, hands, or fingernails of people with dark skin.

Afros, and other natural hair styles. “I’m not sure they were expecting that,” Lester says. “But I’m here to make a difference.”

As a doctor, Lester is following a path set by her mother, a geriatrician, and her grandmother, one of New York’s first Black nurse practitioners. Initially, she thought primary care would give her the best opportunity to combat the inequities in medicine that have led to poorer outcomes for Black patients. “I am a person who is tired of oppressive systems,” she says. But she decided to pursue dermatology after an internship with veterans showed her that access to high-quality skin care was sorely needed. “Jenna is an idealist,” says Nina Botto, MD, a fellow UCSF dermatologist. “She wants the world to be right and people to have the care that they need and deserve – and not just the people that are in the textbooks.”

Lester is proud to follow in the footsteps of pioneering Black dermatologists such as Susan Taylor, MD, at the University of Pennsylvania. Taylor opened the nation’s first skin of color clinic in New York in 1998 and created the Skin of Color Society to promote dermatology research and education focused on patients with dark skin. “There’s an accomplished group of Black dermatologists who paved the way for me to do the work I’m doing now,” Lester says.

Now she herself is a mentor to a new generation of dermatology residents, who rotate in her clinic once a week. Besides teaching them practical skills for treating dark skin, Lester hopes to impart the knowledge and cultural sensitivity they’ll need to care effectively for their patients of color – which includes understanding the importance of advocating for patients and making them feel valued and respected. “When patients have been excluded from a health care environment for so long,” she says, “showing them that they are welcome and their concerns will be addressed is critical.”

C.A. DE NAISSANCE AQUA KICKBOXER AGE 50

When De Naissance joined a master's swim team in 2015, it changed her life. She discovered that she had the heart of a competitive swimmer and wanted to give back to the swim community that had embraced her. She quit her job to become a YMCA lifeguard and youth swim coach and eventually an aqua kickboxing instructor. After her shoulder froze, sports medicine physician Carlin Senter and physical therapist Harvey Brockman, DPT, helped put the pop back in her punch.



GET BACK IN THE GAME

Insights from sports medicine to help you overcome injuries and stay active for life. By Silver Lumsdaine

You may not serve like Serena or sink three-pointers like Steph, but if you're an athlete, you likely have one thing in common with those superstars. No, it's not a Twitter account. It's injuries. But rest assured, you're in good company. An estimated 8.6 million sports- and recreation-related injuries occur in the U.S. every year. Ouch. Big ouch.

Fortunately, sports medicine experts at UC San Francisco are happy to share their savvy on how to run, ski, swim, bike, kick, and hike forever. OK, maybe not forever, but perhaps long enough to embarrass your kids or grandkids when you slip into your spandex workout shorts or running tights. If being and staying active sparks joy in your heart, read on. There's hope of keeping you in the game, on the trails, in the water, and on the courts.

KIDS ARE NOT LITTLE ADULTS

When orthopaedic surgeon Nirav Pandya, MD, started his practice a decade ago, he rarely saw 11- or 12-year-olds with torn knee ligaments. Now, several times a month, he sees 9- or 10-year-olds with ACL (anterior cruciate ligament) tears.

Pandya, UCSF's chief of pediatric orthopaedic surgery, has also witnessed an uptick in young athletes with cartilage injuries – damage to the smooth endcaps on bones that allow joints to glide normally. Damaged cartilage is like a pothole – the joint can't move easily – and it causes pain, swelling, and stiffness.

Why the rise in blown ACLs and prematurely pitted cartilage? Pandya attributes this to early single-sport specialization. Instead of playing for fun, kids now train like adults, concentrating on just soccer or just basketball, for example, and getting adult-type injuries.

"We're doing these major reconstructive procedures on very young children," says Pandya. "It's a warning sign for parents out there."

Alan Zhang, MD, an associate professor of orthopaedic surgery, says overtraining while a child's skeleton is still maturing can affect the growth plate and hip joint, too. "It can cause the hip to form an abnormal shape, with excess bone," says Zhang, who directs UCSF's Hip Preservation Center. "This can lead to additional friction or impingement in the joint, with wear and tear of the hip labrum, which is crucial for maintaining hip stability. This can even potentially lead to early arthritis."

Until a decade ago, kids with hip injuries or labral tears had few treatment options. The advent of advanced hip arthroscopy technology and surgical techniques – Zhang's specialty – now allows younger athletes with hip injuries to return to sports. Zhang hopes they'll also prevent future hip arthritis.

Likewise, ACLs can be reconstructed and small cartilage defects repaired. "There are a lot of new options for placing lab-grown cartilage into the knee or doing cartilage transplants," says Pandya. Surgeons can harvest cartilage from cadavers, or from patients themselves, and transplant it into a damaged knee. It's like biological spackle – instead of patching divots in your wall, you're smoothing living tissue over cratered cartilage.

"We should be trying to create a culture that allows kids to be healthy and active for their whole lives."

NIRAV PANDYA, MD

Of course, avoiding such injuries altogether is better yet. "The best cartilage is the one that you're born with," Pandya says. "When kids damage their cartilage, it can be really limiting. They have a lifetime of high-impact activity ahead of them, even if they're not playing sports." This can spell trouble if injuries aren't managed by pediatric specialists.

"Children are not little adults," says Pandya. "If you try to use adult principles to treat these young athletes, you're going to fail." Not only are their bodies still growing but their emotional needs also differ from those of older athletes.

Pandya, a competitive long- and triple-jumper in college, directs the UCSF Sports Medicine Center for Young Athletes, which offers care exclusively for kids and adolescents. Now in its 18th year, the center has a half-dozen locations around the Bay Area and includes initiatives such as the PlaySafe Sports Medicine Program, which sends athletic trainers into Bay Area schools to help young athletes from diverse socioeconomic backgrounds get the care they need.

His advice for keeping young athletes healthy? "Make sure your kids are engaged in multiple activities, and let them figure out what they're passionate about on their own," Pandya says. "We should be trying to create a culture that allows kids to be healthy and active for their whole lives. Sports are supposed to be fun and joyful."

JAMES BELAY

SKATEBOARDER

AGE 14

An avid skateboarder, Belay is currently focused on a move called a "tre flip," which combines a simultaneous 360-degree flip and rotation of the board in midair. After he broke his ankle performing a trick, physical therapy at the UCSF Sports Medicine Center for Young Athletes got Belay back on his board. Now he dreams of learning new tricks and traveling with his friends. His motto: "Have fun, don't stress too much, and just be chill."



WHAT FEMALE ATHLETES FACE

Sara Edwards, MD, knows the agony of being a sidelined athlete. A traumatic car accident during her senior year of high school ended her high-jumping career. Told that she might never walk again, the tenacious teenager defied expectations by running a lap around the track a year to the day after her accident. Once an athlete, always an athlete, she says.

Edwards, who eventually became a competitive triathlete, is in good company as the director of the UCSF Women's Sports Medicine Center. Her colleagues include a former collegiate national rowing champion, a former Cirque du Soleil acrobat, an avid beach volleyball player, a scuba diver, and a skier – all women.

"We have more female orthopaedic surgeons and primary care sports medicine doctors than any other facility in the country," she says. The center has also piloted several studies that focus on the role gender plays in sports injuries, such as why women have more trouble with shoulder rotation after shoulder replacement surgery than men do.

"There are multiple problems that occur either specifically or more commonly in female athletes," says Edwards. For example, female basketball or soccer collegiate athletes are two to eight times more likely to injure their ACL and nearly twice as likely to get a bone stress reaction as males.

Also, estrogen levels, which are key to maintaining bone density, drop as women age. After menopause, this drop accelerates, and women become more susceptible to what are known as fragility fractures. Counterintuitively, high-impact exercise helps maintain bone strength after menopause. But Edwards cautions that it's important to gradually build up your activity level. Additionally, she suggests weight lifting and strength training to prevent aging-associated bone loss, and balance exercises such as tai chi or yoga to help prevent falls.

The center's primary care sports medicine physicians evaluate all of the factors that might affect a female athlete – bone health issues, hormonal changes, and nutritional needs, to name a few – and develop a comprehensive plan for each woman. "I try to understand what athletics means to each patient," says Carlin Senter, MD, the director of primary care sports medicine. "Together, we weigh risks and benefits and decide how to move forward."

Movement is a key ingredient in the secret sauce for becoming a sassy septuagenarian. "When we see people who are aging well, they all exercise," says Edwards. "Our goal is to keep people active for life."

PHOTOS: ELENA ZHUKOVA



"When we see people who are aging well, they all exercise."

SARA EDWARDS, MD

JANICE MORGAN

CYCLIST

AGE 80

Road biking has been Morgan's passion for 40 years. "Biking clears my mind, reduces stress, and brings me a feeling of optimism and joy," she says. She often goes on organized rides in beautiful parts of the state with a group of close women friends. When a chronic shoulder injury needed repair, she turned to surgeon C. Benjamin Ma at the UCSF Orthopaedic Institute, which also houses the Women's Sports Medicine Center.

THE CUTTING EDGE IS CUTTING LESS

So maybe you've done everything right. You did your core work. You cross-trained. Perhaps you even endured the foam roller. And yet you're sitting there, annoyed and in pain with an achy knee, a torn meniscus, or a busted shoulder.

Though there are no quick fixes, sports medicine specialists are pursuing new ways to solve these woes. Internationally recognized surgeon and researcher C. Benjamin Ma, MD, UCSF's V-Nee Yeh Professor of Orthopaedic Surgery, is optimistic that it may soon be possible to regenerate injured tissue. "That's going to be the future – doing restorative and maintenance treatments instead of damage-control surgeries," says Ma, who as former chief of sports medicine at UCSF was instrumental in building up the program.

So, what about those achy knees? Osteoarthritis, the most common form of arthritis, affects over 32.5 million people in the U.S – frequently their knees, hips, and shoulders. The resulting swelling, stiffness, and pain can make activity uncomfortable or even impossible.

"Osteoarthritis is more than just the loss of cartilage," says Brian Feeley, MD, chief of sports medicine and shoulder surgery and the Ron Conway Family Professor of Sports Medicine Research. "It's also structural changes to the bone underneath the cartilage, plus inflammation within the joint."

So why can't we just insert filler or stem cells to Zamboni the damaged cartilage? Unfortunately, the reality is much more intractable.

While small areas of damaged cartilage can be patched with a transplant, it's not possible to fill in large swaths. "Even if we were to stimulate growth in an area that has lost cartilage," says Feeley, "it won't solve the other underlying problems that have been going on for decades."

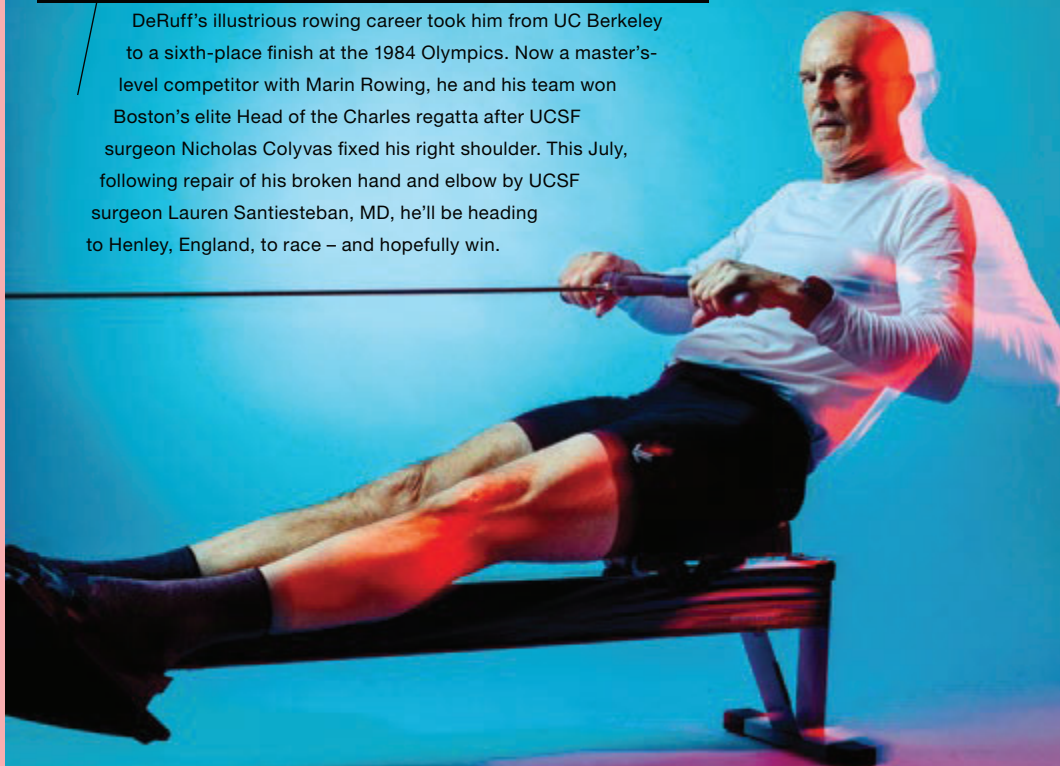
One solution might involve retraining the body to move with less pain and greater efficiency, a goal of the UCSF Human Performance Center. Using sophisticated tools such as motion capture systems (think Marvel movies), Google sensors, and Apple Watches, researchers explore how to maximize function and how activity improves overall health.

"A lot of the same technologies that we use for elite athletes should actually be used for everyday athletes because they function the same way, just at a different level," says Anthony Luke, MD, MPH, the center's director. He also sees promise in platelet-rich plasma (PRP), which involves processing the patient's own blood to concentrate platelets and growth factors in plasma. Luke, the Lynne and Marc R. Benioff Distinguished Professor of Sports Medicine, studies how PRP works at a cellular level in osteoarthritis and whether there's a way to optimize its effects.

For advanced osteoarthritis, a joint replacement is often almost a miracle cure, notes Feeley. Getting an artificial hip or knee isn't "giving up," he says. "It is one of the wonders of the 20th century that will lead to a successful and active next 15 to 20 years." Modern implants usually allow patients to go home within a day of surgery, if not the same day, and return to activities sooner and with less pain.

DAVID DERUFF OLYMPIC ROWER AGE 61

DeRuff's illustrious rowing career took him from UC Berkeley to a sixth-place finish at the 1984 Olympics. Now a master's-level competitor with Marin Rowing, he and his team won Boston's elite Head of the Charles regatta after UCSF surgeon Nicholas Colyvas fixed his right shoulder. This July, following repair of his broken hand and elbow by UCSF surgeon Lauren Santiesteban, MD, he'll be heading to Henley, England, to race – and hopefully win.



Meniscus issue? You're not alone. Meniscus surgery is one of the three most frequently performed arthroscopic procedures in the U.S.

"Forty years ago, the meniscus was considered completely useless, and surgeons just removed damaged ones," says Nicholas Colyvas, MD, a professor of orthopaedic surgery and the director of UCSF's Meniscus Preservation Center. The meniscus – a tough, rubbery, C-shaped piece of cartilage – acts like a shock absorber between the upper and lower leg bones. It protects the smooth articular cartilage that caps each bone. Meniscus removal can be very effective for reducing pain, but risks include developing arthritis later in life. "Now, where possible, we repair it rather than removing it," says Colyvas.

"That's going to be the future – doing restorative and maintenance treatments instead of damage-control surgeries." C. BENJAMIN MA, MD

But meniscus repair isn't a slam dunk. Not all damaged menisci are candidates for repair. Recovery from a repair takes longer than from a removal, and sometimes a repair simply doesn't heal. However, UCSF is creating novel techniques that improve the odds of success.

Meniscus transplants may be an option when repairs aren't possible, especially for younger patients, to avoid the risk of arthritis due to removal. But transplants come from cadaver tissue, and thus are scarce and hard to size properly. They can also have a high failure rate, although UCSF is researching ways to improve transplant outcomes. Colyvas is optimistic about an artificial meniscus currently in clinical trials in the U.S., particularly for patients too young for joint replacement.

There's hope on the horizon for injured shoulders, too. Anyone who's had a rotator cuff injury knows it makes a tennis serve or a freestyle stroke excruciating. For such injuries, biologics – medicines derived from living cells or containing components of living organisms – hold great promise for speeding up healing.

Feeley's research team discovered that special stem cells called fibro-adipogenic progenitors (FAPs) can stimulate muscle regeneration during rotator cuff repairs. Eventually, it may be possible to influence patients' own stem cells in their rotator cuff to regenerate healthy muscle.

"I can now take stem cells from a patient during rotator cuff repair and determine how many specific stem cells they have and what capabilities those cells have for regeneration," says Feeley. "In the next five to 10 years, we'll be able to add pharmacologic agents that will stimulate those stem cells to promote regeneration at the time of surgery in a manner that's time- and cost-effective."

Regenerative techniques might also work for other injuries. Using animal models, Feeley's team found FAPs in spinal muscles that are similar to those in the rotator cuff. If present in humans, these stem cells could offer a way to stimulate muscle regeneration in patients recovering from spinal surgery or suffering from low back pain.

Knowing which treatments will work best for which patients is key. In the near future, the power of big data will make it possible to personalize treatments based on an individual's genetic makeup and a multitude of other factors. Unfortunately, big data can't help you serve like Serena. Yet.

BROOKE SCHULTZ

YOGI

AGE 39

"My ability to exercise is critical to my physical, mental, and emotional health in addition to my professional passion," says Schultz, a biomechanist who manages UCSF's Human Performance Center.



TOP TIPS TO STAY ACTIVE FOR LIFE

- Continue the habits that kept you healthy when you were younger. Play a variety of sports or pick up a new one.
 - Strive for at least 150 minutes a week of moderate-intensity exercise to improve cardiovascular fitness and decrease the risk of cancer, dementia, diabetes, and high blood pressure.
 - Do strength training two to three times a week to improve bone health and balance.
 - Work on balance and flexibility to reduce the risk of falls and improve sciatica and knee arthritis.
 - After an injury or break, start slowly and gradually increase your intensity as you resume exercising.
 - Modify your activities as you age so you can remain active without pain – or with an acceptable amount of pain.
 - Maintain a healthy weight. Walking and running exert pressure on your knees equivalent to nearly three to four times your body weight.
 - Get a good night's sleep to assist in recovery.
 - Have fun!
- For Kids:**
- Keep sports fun and joyful. Make sure kids engage in multiple activities and let them discover what they're passionate about on their own.
 - Don't let kids specialize too early. Give their bodies a chance to mature.
 - Don't let kids push through pain. If something hurts, have a physician check it out.
 - Keep an eye on the long game – help kids establish a healthy lifestyle that will carry into adulthood.

ALUMNI HUB

They're harnessing Twitter, creating Insta posts, and producing podcasts to educate, connect, and delight. Meet five influencers in science and health.

SCHOOL OF MEDICINE

Cleavon Gilman, MD '16

The Man Who Would Not Be Silenced

Courage drives emergency room physician Cleavon Gilman. Born into poverty in Long Branch, New Jersey, he escaped its rough streets by enlisting in the Navy. He was soon treating battle-wounded soldiers as a corpsman in Iraq. Then he faced a new conflict back at home – COVID exploded while he was chief resident at NewYork-Presbyterian Hospital.

"It was like I was in a war zone again," recalls Gilman, an alumnus of UCSF's PRIME-US program for students committed to working in underserved urban communities. The virus killed three of his Manhattan colleagues and his cousin, and he saw patients die every day. Diagnosed with PTSD after his Iraq tour, Gilman felt its symptoms returning. "I've always known I was a strong person, and I've been able to get through this," he says.

A lifelong stutterer, he had discovered at age 12, while attending rap star LL Cool J's summer camp, that his malady vanished when he rhymed to a beat. So as a resident, he asked himself, "How can I marry these two – music and medicine?" He made rap videos to raise awareness on topics ranging from tachycardia (high heart rate) and bradycardia (low heart rate) to immigration, gun violence, and burnout, as well as one on COVID whose lyrics go "Worst case scenario/There's some things you gotta know/This is not your common cold/Affects adults, not just the old."

In 2020, Gilman won the Society for Academic Emergency Medicine's Innovative Educator award and was the keynote speaker at the National Stuttering Association's annual conference. Those honors followed on the heels of his 2019 selection by the Emergency Medicine Residents' Association as a "45 Under 45" young influencer.

Overcoming his speech disability helped give Gilman the determination to be a public-health advocate in other media. To share word of COVID's dangers, after his 12-hour shifts he poured his heart into Facebook, his personal website, and Twitter (where he soon had 175,000 followers).

But going public had consequences. After leaving Manhattan, he took a position as an ER doctor at a Yuma, Arizona, hospital, where he clashed with the management. After he tweeted that the ICU was overwhelmed, to inform people about COVID's impact, the hospital fired him. Weeks later, they said the matter was "a misunderstanding" and rehired him.

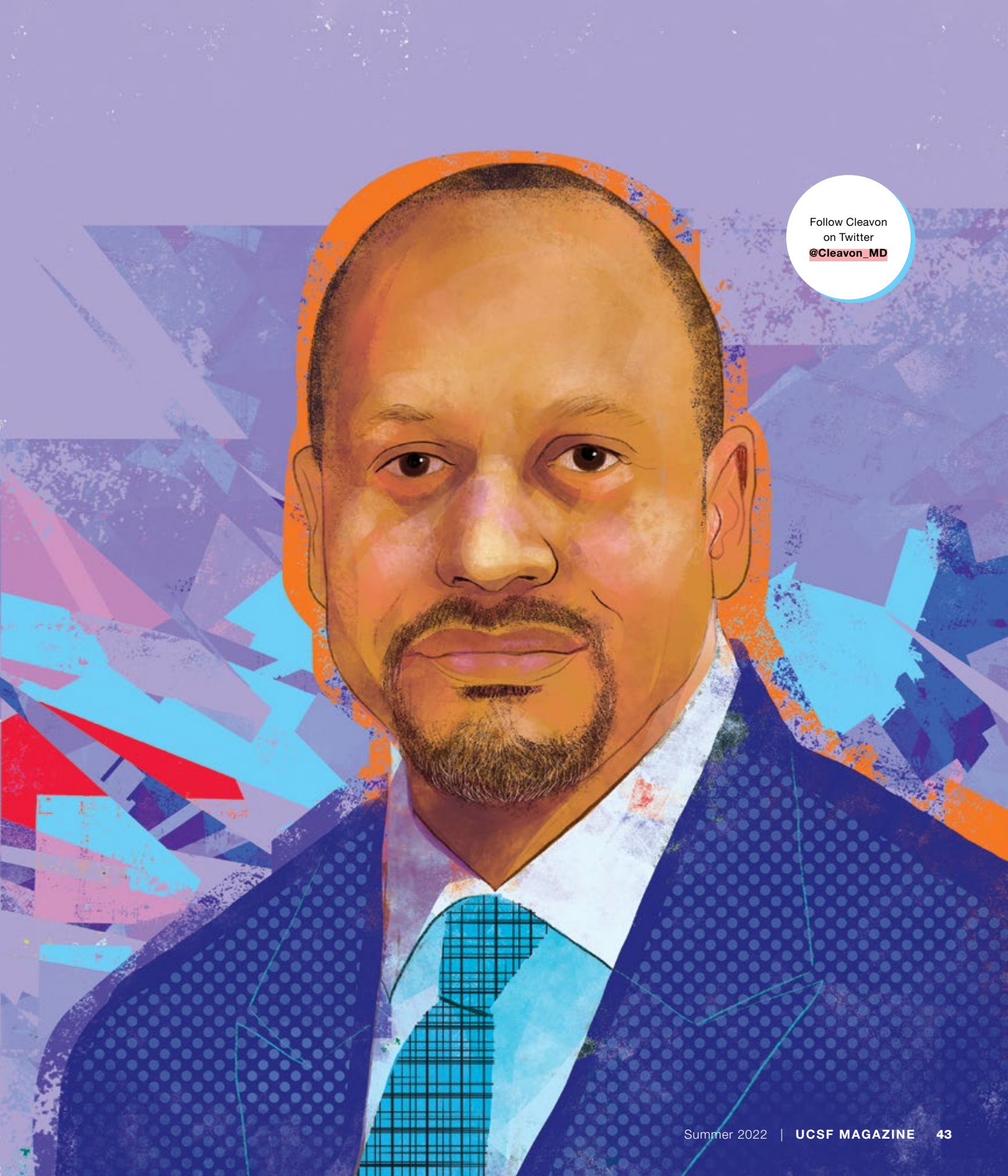
"I felt I was one of the first people to speak up about the virus," he reflects. "I was just being honest with people, saying, 'Hey, there're no ICU beds, y'all. This is a real thing.' You get backlash. It's like, well, you know, there's always a cost, right?" Gilman, who also received online death threats because of his posts, now works in the emergency department at another hospital.

Looking back, he credits his Navy service with sparking his desire to become a doctor. His odyssey began in New Jersey when police saw him walking down the street carrying license plates and questioned him. (The plates were his.) "I was sitting there, and over by a junkyard was this billboard that said 'Join the Navy. See the World.' I was, like, 'Man, I gotta get out. This is ridiculous. There's no future here for me.'" In Iraq, for the first time he met doctors, physician assistants, and nurses of color. "They planted a seed. You start seeing people who look like you in those positions, and you think it's a possibility," he says.

Later, at Southwestern College in San Diego County and UC Berkeley, Gilman buckled down big-time. "I was on campus 12 hours a day. I deployed," he told the online publication *STAT*, explaining that he took all his meals and a gallon of water with him when he left his apartment for school every morning.

"I came from poverty," he says, "and I've worked hard to get to where I am. I'm always trying to be the best person I can be. There's a quote from Gandhi on my phone: 'Be the change you want to see in the world.' That's how I live my life."

■ *George Spencer*



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GRADUATE DIVISION

Florie Mar, PhD '15

Creating a Picture-Perfect Way to Explain Biomedical Research

Follow Florie's team
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Florie Mar is making her mark on science – with a Sharpie. Ten years ago, as a PhD student at UCSF, she founded Youreka Science, a company that makes hard-to-grasp discoveries and facts easy to understand, thanks to its entertaining whiteboard videos.

At the time, Mar was conducting basic research on how telomeres, the structures at the ends of chromosomes, contribute to early cancer development. But she also wanted to share how such research could impact society. “I’m a very visual person,” she says, “and part of my motivation was ‘How do I explain the impact of basic science, not just to understand it, but also for understanding human health?’” She started animating whiteboard videos in her bedroom. But she hit a roadblock. “My handwriting was terrible,” she says, “and I needed a better setup and a larger team.”

Fast-forward to today. Mar has built her company into a thriving part-time business for herself and her team of six science writers, illustrators, and animators (including seven UCSF interns in recent years). Together, they have created nearly 100 educational videos deciphering subjects ranging from spinal cord damage to drug development. Youreka Science has partnered with 20 nonprofits like UCLA and iBiology; has over a million views to its credit; and has won a following of thousands of subscribers, mostly teachers, college and high school students, and patients.

“There’s so much excitement, motivation, and reward when you see the impact you’re having,” she says, “and when you read comments like ‘You’ve saved my semester in school’ and ‘This video made me fall in love with genetics.’”

Like any other Silicon Valley start-up, the early days were tough. “We needed to find our niche. It took trial and error and a lot of effort to identify, reach out to, and build our Youreka community,” Mar recalls. She’s particularly proud of the work her company has done for the CDG community – children affected by a group of rare genetic diseases. Youreka Science’s CDG videos have been subtitled in 10 languages and reach thousands of people around the world.

“We stay true to our roots,” says Mar. “We still produce videos with a physical whiteboard using a camcorder set-up in my garage... We get to give back to the community. Together, we’re a well-oiled machine with a shared ambition to make science accessible for the curious mind.”

■ *George Spencer*



Ifeyinwa Asiodu, RN, MS '12, PhD '14

Social Media's Starring Role in the Health of Black Women and Infants

After three years as a critical care nurse, Ifeyinwa Asiodu knew she wanted to go back to school. Less clear was what to study – until her passion for tackling maternal and infant health disparities affecting Black communities was ignited at UCSF's Summer Research Training Program.

She soon homed in on the breastfeeding inequities she observed as a public health nurse in San Mateo County's Black Infant Health program: "Nine out of 10 of our clients said they were hoping to breastfeed," says Asiodu, an assistant professor in the UCSF Department of Family Health Care Nursing. "But there were barriers."

The challenges her clients faced included living in communities where formula feeding was more normalized than breastfeeding; having to go back to school or work shortly after giving birth; working for employers who offered limited or no lactation accommodations; and seeing health providers who were less likely to talk about the benefits of breastfeeding with Black women than any other population.

To better understand and address those disparities, Asiodu returned to UCSF to earn her MS and PhD, recruiting pregnant Black women for her dissertation research. What was the most important educational resource they used during pregnancy? she asked them. "I expected it to be a book or pamphlet. Everyone pulled out their phones."

Her findings, published in the *Journal of Obstetric, Gynecologic, and Neonatal Nursing* in 2015, were among the first highlighting the importance of social media use by first-time Black mothers. Online, says Asiodu, they found support, information, and "women who looked like them who were breastfeeding."

She dove into social media to shift the narrative about lactation, highlighting the contributions of Black board-certified lactation consultants and the importance of diversifying lactation specialists. Asiodu also advocates on other health equity issues affecting Black communities and birth workers. "I really appreciate the opportunity to engage, educate, and communicate," she says.

During the pandemic, social media became an even more vital lifeline for Asiodu: "Before, we would recruit study participants at community support groups, hospitals, clinics, but suddenly there wasn't in-person activity. Being able to engage with pregnant and postpartum people through social media in real time allowed us to continue our work."

■ Janet Wells



Helen Mo, DMD, MS '19, Resident Alum

Caring for Kids Who Can't Tolerate Dentist Visits

Pediatric dentist Helen Mo believes in baby steps for the kids with autism spectrum disorder and other neurodevelopmental conditions she treats at UCSF Benioff Children's Hospitals.

Mo gradually introduces these children to dental care through the award-winning desensitization program that she founded. "It's challenging for them to tolerate sensations like toothbrush bristles, the taste of toothpaste, or someone touching their face," she says. Historically, many special-needs children were traumatized by being swaddled for cleanings and exams. But today "there are ways to expose them to things and change their behaviors without having to hold them down," says Mo, who is also in private practice and teaches at UCSF.

To transform a fearful dental visit to something fun, she may spend more than a year working with an autistic child, their parents, and a behavioral therapist. The goal of a first appointment might be just visiting the office without having a meltdown. Ultimately, she wants patients to tolerate routine dental care with a positive outlook.

Mo grew up knowing her life's work would involve caring for children. In high school, she volunteered with the Special Olympics. As an undergrad on a mission trip to Nicaragua, she assisted pediatric dentists in caring for underserved children. "My passion in pediatric dentistry is reaching as many children as early as possible," she says. "Many adults are already set in their ways, but with children you have the potential to change their oral health experience."

When COVID hit, Mo found herself unable to work. Restless, she jumped into action. To deliver the message of good oral hygiene to as many parents as possible, she created the Instagram account [@the.dentistmom](https://www.instagram.com/the.dentistmom). Posts show her and her 3-year-old daughter, Olivia, role-modeling brushing and flossing. With 240,000 followers, Mo attracted the attention of children's educational toy maker Lovevery, which will soon publish a picture-book titled *Olivia Goes to the Dentist*. She's also been featured on *Good Morning America*, in *Women's Health*, and elsewhere.

Mo's message to parents is "Start early and have faith in yourself. Children take time to learn everything." One thing they do quickly learn is the benevolence of a certain nocturnal harvester of baby teeth. "I personally love the concept of the tooth fairy," says Mo. "I'm all for supporting that magical experience for them."

■ George Spencer



Mehr Virk, PharmD '21

Podcasting a Road Map for the PharmD Journey

Mehr Virk hadn't even listened to many podcasts, much less hosted one, before launching her own *Life on the Pharm* podcast.

In June 2020, as she was starting her final year in the UCSF's PharmD program, Virk found herself with some unexpected free time — as a result of having two fewer clinical rotations due to COVID-19 restrictions.

She tapped into her creative side, she says, to develop an autobiographical audio journal as well as a road map for her peers: “No one tells you how to navigate the world of pharmacy.”

In early episodes, Virk shared personal insights — on her short-lived TikTok career, pandemic lockdown blues, and participation in Black Lives Matter protests (including their relevance to patient care and health care disparities) — as well as professional observations. She took listeners along on her clinical rotations in the ICU and ED, recounting milestones: making her first recommendation to a physician, attending a trauma call, counseling a patient being discharged, giving an impromptu presentation on urinary tract infections during rounds.

Season two moved with Virk to the UC Davis Health acute care pharmacy residency. Recent topics have ranged from “Bugs and Drugs” and “Med Safety First” to “I need a NAPlex” (a nod to the rigors of preparing for and taking the North American Pharmacist Licensure Examination).

Life on the Pharm sometimes diverges from her own narrative, with Virk interviewing other pharmacists “to hear and share their advice and the stories of people who come from different walks of life.” With about 4,000 streams of more than three dozen episodes so far, Virk has found an “incredibly supportive, kind, and positive audience,” she says.

“It's been a cool way of building a pharmacy community that I don't get to meet or see but I can connect with,” she adds. “I've heard from PharmD students who said it made them feel less stressed and anxious about rotations and excited about starting their PharmD journey.”

Life on the Pharm also helped Virk make the “big jump” from student to practicing clinician. “It's so hectic and chaotic as a resident. This podcast has made my perspective shift on a lot of things. I'm taking time to process what I saw about myself as I became a pharmacist and remembering why I got into pharmacy. It's a constant reminder that obstacles and challenges are also opportunities for growth.”

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Finding a Mooring in My Values

By Jeremy Pivor

“Joy is a terrifying emotion, don’t trust it.” Those words from the memoir *Between Two Kingdoms*, by cancer survivor Suleika Jaouad, stuck in my mind as I sat in my neuro-oncologist’s sterile, white-walled office, waiting for the results of my latest MRI.

Every nine weeks, I come to Dana-Farber Cancer Institute in Boston for a scan to check on my brain tumor and see if the experimental treatments I receive – the immunotherapy infusions pumped into my veins every three weeks and the molecular-targeted pill I swallow every night – are doing their jobs. The nine weeks since my last appointment were admittedly great: soaking in love from my nephews; going on dates; working in global health, a field that I am passionate about; and fulfilling a lifelong dream of buying a sailboat. Now, however, sitting in my doctor’s office, all that joy has turned to dread. Two decades of living in the world of cancer – and in a realm of perpetual uncertainty – have taught me how easily joy can be snatched away. The subsequent feeling of loss is sometimes impossible to bear. Was it time for my doctor to deliver me bad news, and bring back the loss I have all too frequently had to confront?

“Your MRI looks good,” says my neuro-oncologist. “Everything remains stable.” Though I keep a public blog about my experience living with cancer, I have not posted updates from my recent scans, even though the news was good. I know that the further the pendulum swings toward joy, the further it can swing in the other direction – and that possibility is terrifying. Publicly announcing the good news feels like dancing with the devil.

But while uncertainty can be paralyzing, it can also be a catalyst to live life as fully as possible. Though I have lived with cancer for most of my life, I came to this realization only recently. I was diagnosed 18 years ago, when I was 12, with a rare, octopus-like tumor called an oligodendroglioma, located in the left motor cortex of my brain. I had a recurrence 10 years later and another regrowth four years after that. That medi-

cal history translates to several periods of my life getting interrupted: first my childhood, then my dream job working in ocean conservation in Indonesia, and then my training at UCSF to become

a physician. During the most recent recurrence – when I transitioned from medical student to patient – I realized that I needed to align my life more closely with the things I valued most: presence, quality of life, and time for relationships. Why did my day-to-day life not fully reflect that?

It was a hard but intentional choice to leave medical school and move back to Boston, closer to my family – and a choice I was thankful to have the option to make. Living true to my values does not remove the uncertainty – and today, with the ongoing threats of the pandemic, global conflict, and climate change, there are even more reasons to feel unmoored.

But while I still worry that my joy will be all too quickly extinguished, I also know that I have constructed my life in a way such that I can go out sailing on the water to silence the noise of the unknowns; that I have the balance I need to pursue my passions without sacrificing my health; and that I can easily snuggle with my nephews or get a home-cooked meal from my mom, both of which make my soul glow. There is some contentment in knowing that I can always fall back on my values. That they can serve as a guiding light even when clouds of uncertainty loom. That I can feel less afraid to lean into and to trust joy.

Jeremy Pivor is committed to health equity and environmental justice and advocates for others with cancer through writing, speaking, fundraising, and lobbying. His work has been featured in the *Washington Post*, *Cure*, and other publications.





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