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TRAILBLAZERS
Celebrating chemistry's diversity

OUT AND PROUD: CELEBRATING LGBTQ+ CHEMISTS

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Editorial

Celebrating LGBTQ+ chemists

We are proud to dedicate the 2022 edition of C&EN's Trailblazers to LGBTQ+ people. C&EN's Trailblazers issue celebrates the diversity that drives chemistry forward.

As in past Trailblazers issues, we have invited a guest editor to help us curate this important double issue. University of Wisconsin–Madison synthetic chemist Tehshik P. Yoon partnered with C&EN staff to highlight a diverse group of 17 trailblazing LGBTQ+ chemical scientists. We are grateful to Yoon for his insight and his perspective not only as a brilliant scientist but also as a gay man and a powerful advocate for LGBTQ+ people. Yoon was instrumental in selecting a group of Trailblazers that represents the diversity of the LGBTQ+ community in terms of identity, area of research, and career stage. Some of our Trailblazers work in industry; others innovate in academic labs and in the classroom.

You can also read about a selection of historic LGBTQ+ scientists whose work and activism helped shape our discipline and society. Read more about these figures online at **cenm.ag/historiclgbtq**.

This issue also uplifts the voices of LGBTQ+ science journalists, photographers, students, and scholars. All the profiles are written by LGBTQ+ writers, and all newly commissioned photographs were captured by LGBTQ+ photographers. Some of my favorite stories in the issue were contributed by chemistry graduate students and postdocs, who conducted interviews and wrote one-on-one portraits of seven of the Trailblazers. These scholars represent the next generation of LGBTQ+ chemists.

Yoon is the subject of one of the Trailblazers profiles (see page 26), written by project colead Katherine Bourzac. The profile illustrates that for Yoon, his gay identity is an integral part of his scientific success. He tells Bourzac about how his experiences as a gay man have influenced and continue to influence his work.

Others also point to a connection between personal identity and work. Kelly N. Chacón, a chemist at Reed College, says, "The things that I'm interested in and the changes that I want to effect, a lot of that comes out of my lens of being queer" (page 36).

But sharing one's identity at work is not always easy. In a Q&A between York University PhD candidate Ali McKnight and Pomona College's Nicholas Ball (see page 32), Ball says, "As queer people, we are persistently subjected to physical, emotional and societal violence." Ball hopes LGBTQ+ people recognize their value and work in places that affirm that value. "My wish . . . is that we lean into our worth, practice boundaries with our work, and preserve our magic."

Earlier I described this edition of Trailblazers as important. It is also timely and necessary. In celebrating these LGBTQ+ chemists and amplifying their voices, we have an opportunity to invite and encourage others to be their authentic selves and, in doing so, improve the scientific well-being of our discipline. As Yoon says, "The real impact of an academic's career is measured in the people you get to work with." For C&EN, the real impact of our work can be measured by the careers we help nurture and the power of our journalism to help individuals fulfill their potential. We aim to foster a community in which LGBTQ+ people can bring their whole selves forward, uninhibited by bias or discrimination. That is our commitment.

C&EN's 2023 Trailblazers issue will highlight the lives and contributions of groundbreaking Hispanic and Latino chemists. You can nominate candidates at **cenm.ag/2023tbz**.

Editor in chief
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OUT
AND


PROUD
Celebrating
LGBTQ+ chemists

c&en's TRAILBLAZERS

TEHSHIK P. YOON, special to C&EN

The queer liberation movement has for decades celebrated pride, deliberately denouncing the shame and secrecy that were characteristic of LGBTQ+ life into the late 20th century. I echo this sentiment when I say that I am very proud to introduce this special issue celebrating trailblazing LGBTQ+ chemists. As a gay man working in chemistry, I am proud to be a member of this community of scholars, educators, and researchers, and I am delighted to have guest edited this issue highlighting our contributions to the field.

Trailblazers 2022 guest editor Tehshik P. Yoon is a professor of chemistry at the University of Wisconsin–Madison. An innovator in photochemistry, he is the recipient of numerous awards for his scholarship and teaching, including the American Chemical Society Cope Scholar Award, the Friedrich Wilhelm Bessel Research Award, being named an American Association for the Advancement of Science fellow, and the Cottrell Scholar Award.

This collection gives voice to LGBTQ+ members of the chemistry community and celebrates their contributions. Our hope is to provide visibility to a population that has been marginalized for far too long and whose basic human dignity is only beginning to enjoy legal protection in some countries.

You may not know who we are, but we work beside you. We are your students, your collaborators, and your colleagues. The insights in our papers and seminars inform your own research daily. Science must create a place for queer people. The inclusion of all our voices in research and education benefits us all.

I'd like to open this essay by confronting a question that inevitably gets asked whenever the chemistry community does something to feature its LGBTQ+ members: Why do we need to highlight LGBTQ+ scientists? The question is raised both by critics and by well-meaning allies. I have been asked this question more times than I can remember. My answer is that a focus on LGBTQ+ chemists is warranted, timely, and critically necessary. My own story and others in this issue together make a strong argument for the power of LGBTQ+ representation in chemistry. But as scientists, we are particularly persuaded by facts and data. So let me paint you a picture of the current landscape facing LGBTQ+ people in the US.

A 2019 Pew Research Center poll shows that acceptance of gay and lesbian people in the US is at an all-time high. About 72% of people in the US said homosexuality should be accepted by society. This is a relatively recent change: the value is up from 60% in 2013 and from 49% in 2007, suggesting that attitudes toward LGBTQ+ people—or at least lesbian and gay people—have evolved rapidly in the US.

But we are still far from full equality under the law. As I write this, Florida's "Don't Say Gay" bill has just been signed into law. Among other provisions, the law intends to prohibit classroom discussion and instruction about sexual orientation and gender identity. Texas has just decreed that gender-affirming care for transgender minors constitutes child abuse, and laws banning this health care—which medical organizations consider necessary—are already on the books in Arkansas and Tennessee. Since 2020, the number of laws introduced in state legislatures targeting trans rights has been nearly doubling annually, according to the American Civil Liberties Union. Nearly 300 were in progress in 2022 as of publication. Many of these laws target trans youth. They ban or criminalize young trans people's health care, restrict their access to bathrooms, and prevent them from safely participating in school sports. For LGBTQ+ people like me, whose identities have been the subject of political attack and debate for our entire lives, it seems self-evident that efforts to recognize the contributions of LGBTQ+ members of society are an important step toward liberation.

LGBTQ+ identities differ from other marginalized identities in that they are often not evident without disclosure. The choice to be out—that is, to publicly disclose one's sexual or gender identity—remains a difficult and radically transgressive choice for many people. LGBTQ+ people in the US were not federally protected from losing their jobs because of their identities until 2020, when the Supreme Court extended federal civil rights protections to LGBTQ+ employees. Many LGBTQ+ people remain concerned about the consequences to their careers if their identities are revealed to employers and colleagues.

This is, unfortunately, a very reasonable fear. A 2021 study found that nearly half of LGBTQ+

CREDIT: LIDIA SHARAPOVA

workers in the US report experiencing employment discrimination at some point in their careers. And sadly, many LGBTQ+ people risk losing their connections to their religious communities, their friends, and their families by disclosing their identities. The University of Chicago's Chapin Hall estimates that one in five adults in the US aged 18 to 25 who reported experiencing homelessness in the past 12 months identifies as LGBTQ+. Queer culture has long celebrated "chosen families" that provide emotional or financial support when families of origin cut or attenuate ties after a family member comes out.

The social and cultural disincentives against being out are significant, and they have a continuing impact on the choices LGBTQ+ people make in every aspect of their lives. The most recent employment survey by the Human Rights Campaign (HRC) found that 46% of LGBTQ+ employees in the US were not out at work in 2018. Troublingly, this statistic is essentially unchanged since the 2008 HRC survey.

Despite the significant federal protections that LGBTQ+ people in the US have secured in the past few years, fears of persecution prevent queer people from fully being themselves in the workplace. For closeted LGBTQ+ scientists, holding back an important part of their identity creates psychological stresses that their straight and cisgender peers generally do not have to consider. These cognitive burdens can prevent smart, well-trained scientists from being as productive as they might otherwise be in their intellectually challenging, creative fields. A recent study by Jeremy B. Yoder of California State University, Northridge, and coworkers found that LGBTQ+ scientists, including asexual scientists, who are not out at work publish fewer papers than a comparison group of straight and cisgender scientists (*PLOS One* 2022, DOI: 10.1371/journal.pone.0263728). Scientists who were out had publication rates similar to those of their straight and cisgender peers. The consequences of the closet, therefore, are real and measurable, and they impede scientific progress.

One way to help young LGBTQ+ scientists feel more comfortable sharing their identities is to highlight role models who are out and accepted. The preponderance of scientists who aren't out

at work may make it harder for students beginning their scientific educations to find LGBTQ+ role models—or, worse, it may send the message that queer folks should not be in science. Personally, I gravitated to science relatively late in my education in part because I saw so many more models of successful queer professionals in the arts and the humanities. It is, unfortunately, difficult to determine whether LGBTQ+ people are being excluded from science, technology, engineering, and mathematics (STEM) professions because demographic data about LGBTQ+ people are hard to come by. Most schools, employers, and federal agencies do not collect these data.

Globally, LGBTQ+ people have very different legal and social statuses in different countries. As a Korean American, it pains me to note that my marriage would not be recognized in my parents' native country. Same-sex marriage is legal in only about 30 countries, homosexuality is still punishable by imprisonment or death in 69 countries, and trans people are specifically criminalized under the law in 13 countries and persecuted by de facto anti-trans applications of other laws in many more. The uneven acceptance of LGBTQ+ people in different countries restricts the free flow of scientists and scientific thought across national borders, to the detriment of scientific progress.

Moreover, even as the status of cisgender gay, lesbian, and bisexual people in Western democracies has improved significantly in the past decade, attacks on transgender people—both legal and literal—have surged in the past few years. In addition to the many anti-trans laws being advanced in statehouses across the US, there is an underreported epidemic of violence against trans people, especially Black and Latina trans women, who are victims of assault and murder at a disproportionately high rate.

There is a long way to go before the entire LGBTQ+ community can be free to contribute to all areas where straight, cisgender people are welcome.

So, to readers who question why a special feature on LGBTQ+ trailblazers in C&EN is valuable: LGBTQ+ people still face significant challenges in STEM fields and beyond, even if these struggles may not be evident in everyone's daily work. Visibility is a central concern for LGBTQ+ people, who typically must choose whether to face social and political opprobrium by revealing their gender and sexual identities or endure psychological distress from withholding an essential part of themselves. We deserve the right to bring our whole selves to work every day without having to justify our identities.

This celebration of out, proud, successful LGBTQ+ chemists provides role models for young queer scientists early in their training, and I hope it will encourage them to persist in STEM careers. We all do our best science when we can fully express our complete selves. Being proudly out is still a radical act of self-empowerment that enables us to live up to our full potential. I celebrate the spectrum of out and proud LGBTQ+ scientists featured in this issue—and the many we did not have space to include.

It was quite easy to compile a long list of candidates to profile in this feature—a remarkable fact in itself. When I began graduate school 26 years ago, I don't think I could have named more than three or four LGBTQ+ chemists. In assembling this list, my partners at C&EN and I found that we had many more people we wanted to highlight than we had space for in this issue. Even as we acknowledge how much more work needs to be done, it's worthwhile noting how many more out, highly visible LGBTQ+ chemists there are than even just a few years ago.

The process of narrowing down our list was guided by several considerations. First, much of the work carving out a place for LGBTQ+ people in the chemistry community was carried out by a generation of true trailblazers who are now well into their careers or approaching retirement, and I wanted to acknowledge with gratitude our debt to them. We also honor a group of historic or recently deceased trailblazing scientists. Their inclusion is balanced by featuring several up-and-coming early-career scientists.

Second, until recently, the construction of LGBTQ+ community in chemistry has been ad hoc and based largely on personal connections. I thought it important to stretch beyond my personal networks and enrich this list with people outside my scientific field of expertise. The Diversify Chemistry website and the 500 Queer Scientists campaign were very helpful in this context.

Third, it was important to all of us to resist the worrying trend of centering LGBTQ+ narratives on the perspectives of White, cisgender gay men. We tried as best we could to make sure that a multitude of LGBTQ+ identities were included in this feature.

This issue provides perspectives on queer experiences through the voices of members of the LGBTQ+ community. I am proud to note that all the profiles included in this feature were written by LGBTQ+ science writers, and all photographs commissioned for this issue were made by LGBTQ+ artists. I'm particularly excited to note that seven of these stories feature conversations between LGBTQ+ chemistry professionals and LGBTQ+ graduate students or postdocs.

Our hope is that this issue will catalyze a needed conversation about the status of LGBTQ+ scientists in chemistry. This may be an uncomfortable dialogue for many of us. It will touch upon matters that we often consider to be profoundly private, and it is always difficult to grapple with the realization that some of our cherished scientific peers struggle in ways that are not immediately obvious to the rest of us. The result, however, can be a stronger, more productive, and more welcoming science community. I am proud to highlight the excellence of this small selection of proudly out LGBTQ+ chemists, and I hope that you enjoy reading it as much as I have enjoyed putting it together.

MORE ONLINE

Nominate for C&EN's 2023 Trailblazers issue, which will profile the lives and work of groundbreaking Latino and Hispanic chemists, at **cenm.ag/2023tbz**.

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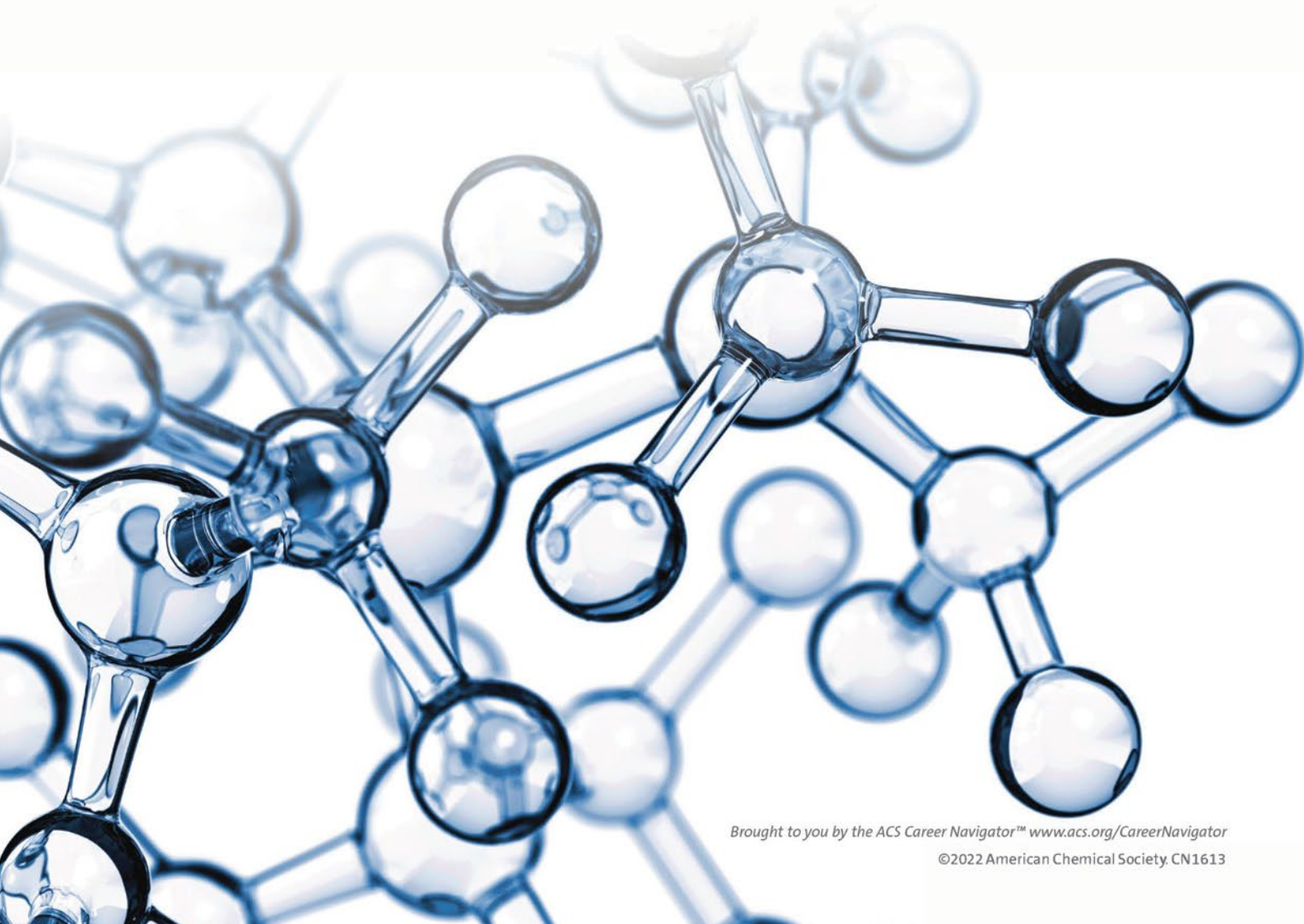

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CATALYSIS

TEHSHIK P. YOON

This year's Trailblazers guest editor wields light to open new possibilities for organic synthesis while also advocating for LGBTQ+ inclusion in chemistry

VITALS

- **HOMETOWN:** Blacksburg, Virginia
- **EDUCATION:** AB, Harvard University, 1996; MS, 1998, and PhD, 2002, California Institute of Technology
- **CURRENT POSITION:** Professor, University of Wisconsin–Madison
- **LGBTQ+ IDENTITY:** Gay man
- **ROLE MODEL:** Among my favorite moments as a new faculty member was getting to thank Carolyn Bertozzi during her seminar visit to Wisconsin. I can't overstate how eye opening it was for an impressionable graduate student to see an unapologetically out, gay academic achieving at the highest level in our field.
- **BEST PROFESSIONAL ADVICE YOU'VE RECEIVED:** The consistent message I've gotten from every mentor I've had is that no matter how successful your research might be, the real impact of an academic's career is measured in the people you get to work with.
- **GO-TO STRESS RELIEVER:** Classical music remains my emotional center. How amazing that the internet gives us immediate access to live performances by masters like Jessye Norman and Itzhak Perlman at their best.

KATHERINE BOURZAC, C&EN staff

Tehshik P. Yoon is fascinated by photochemistry. He investigates how the energy-packed punch that photons deliver can open new realms of organic reactions. The University of Wisconsin–Madison professor specializes in developing photochemical techniques that drive a reaction to produce a desired molecule.

This type of photochemistry has become a popular area of research over the past decade, according to David MacMillan, an organic chemist at Princeton University. "It's now used all over medicinal chemistry, agrochemistry, everywhere." And, he says, "it's all germinating from the early studies that Tehshik did."

Yoon, the guest editor of C&EN's LGBTQ+ Trailblazers special issue, says his identity as a gay man is an integral part of his scientific success. "I could probably draw a straight line from the self-preservation mechanisms I put in place as a queer youngster all the way to where I am now," he says. Stories like his highlight the fact that identity is not incidental to a chemist's scientific work, he says. For him, it is central.

Yoon knew he was gay from a young age. It wasn't easy for a gay kid growing up in the 1980s in Blacksburg, Virginia. Media representations of LGBTQ+ people were mostly negative, particularly once the AIDS epidemic took hold. Media coverage of the disease—which was initially called gay-related immune deficiency—perpetuated stereotypes about gay men and blamed them for their own deaths. Discrimination was rampant, with no legal protections to keep people from losing their jobs, housing, or medical care because of being gay.

"At that impressionable age, I internalized the message that this was something to be ashamed of; this is something you can't talk about," he says. "This is something that if you are open about it, it will impact your career."

But he could see a place for himself in the arts. "The arts were a safe space for the outcasts," he recalls. He played violin, oboe, flute, "everything I could get my hands on," he says. "I had never heard of a queer scientist before. But I could see what my life could be like in the arts."

When he went to Harvard University in 1992, his parents told him he could major in whatever he wanted—as long as he completed premed requirements.

Much to Yoon's surprise, he fell in love with organic

CREDIT: LIDIA SHARAPOVA

chemistry. "There's a creativity to it. I found all the things in organic chemistry that I had been seeking in music and the arts," he says. "The idea that you would be the very first person to try something, to make something that never existed before, I found that wonderfully stimulating."

Yoon continued to pursue his interest in music, too, and sang in the Harvard Glee Club. "We made beautiful music, but you know, it was pretentious," says Jake Yeston, who went to college with Yoon and is now editor of physical science research at *Science*. "We wore tailcoats and white bow ties like we were still living in the 1920s. Tehshik thrived a little on the pretentious aspect, and he had this dry, sharp sense of humor."

Science seemed to bring out a different side of Yoon. "When it came to chemistry, Tehshik was always thoughtful and generous and curious. It was so refreshing," Yeston says.

To this day, Yeston says, "he is the most successful person I can think of who is really interested in a rising tide that lifts all boats. He is interested in being supportive to everyone around him."

Yoon's first exposure to photochemistry was at the California Institute of Technology, where he was a graduate student working in the lab of Erick Carreira. Yoon was working on a complex synthesis of a molecule with a very long name (welwitindolinone A isonitrile). The synthesis included a photochemistry step. He put a yellow solution in a photoreactor chamber and turned on the light for 20 min, and the mixture turned clear. "The only reagent was light. I thought that was so cool. There's no workup. There's nothing to throw away," Yoon says. That efficiency and lack of waste is why chemists like Yoon are drawn to the power of photochemistry.

When Carreira moved his lab to Switzerland, Yoon left Caltech with a master's degree and moved to the University of California, Berkeley, to work on a PhD with MacMillan. Yoon started there in 1999, when MacMillan was a first-year assistant professor.

"If he hadn't been there, I'm pretty sure my group wouldn't have made it," MacMillan says. Yoon drew on his lab experience from his undergraduate years and his master's work to mentor other students in MacMillan's lab. "Even though he was a grad student, he would sort of tell people what to do," MacMillan says.

MacMillan shared the 2021 Nobel Prize in Chemistry for the development of asymmetric organocatalysis, a way of nudging reactions to produce a desired enantiomer. MacMillan recalls working with Yoon on an early paper related to this work, in which MacMillan coined the term *organocatalysis*. Yoon scratched it out every time he reviewed a draft, pointing out that it wasn't a real word.

Tehshik P. Yoon (left) with his husband, Michael Velliquette

"After the prize I got a message from a technical dictionary that *organocatalysis* is now in the dictionary, so I sent it to him. See, it's now a real word!" MacMillan says. "Every time we get together we crack up telling that story."

While Yoon was having great success during his PhD work, he was struggling personally. He believed he had to hide that he was gay. He carried with him the message he'd internalized growing up that it was not possible to be out and have a career in science, or any professional field.

"I keenly remember feeling this incredible psychological strain of holding back part of my identity from anybody I worked with," he says. "I can't imagine if I had kept that going for the last 20 years. At some point I would have broken."

Yoon's perspective began to shift when he met Carolyn Bertozzi, a prominent chemical biologist and out lesbian who was then at UC Berkeley. "She was the first out queer faculty member I'd ever met. And not just any queer chemist. She's Carolyn Bertozzi," he says. Even as a junior faculty member, he says, Bertozzi, now at Stanford University, was a star.

"It's an eye-opening experience where you meet somebody and you find out that they're queer and you just realize, 'Holy shit, anything is possible,'" he says. "And you realize, all of these assumptions you'd internalized about what was possible and what was not—they simply weren't true." For Yoon, staying in the closet didn't seem necessary anymore. And soon, he began demonstrating how a gay scientist could be open about his identity and flourish. Yoon went back to Caltech in 2000 when the MacMillan lab relocated, and he completed his PhD there. Then he moved back to Harvard for a postdoc. In 2005, he started his own lab at the University of Wisconsin, where he soon began making major contributions to photochemistry and organocatalysis.

Yoon's Wisconsin lab understands that light is a powerful tool for chemists. "When a molecule absorbs a photon of light, it gets pumped up to a highly energetic, highly reactive state," Yoon says. For example, a photon of blue light packs a very useful amount of energy, 75 kcal per mole. "That's on the same order of magnitude as a carbon-carbon bond—it's larger than the strain energy of cyclopropane," Yoon says. But the energy difference between two enantiomers might be only a single kilocalorie per mole, so delicate tuning of reaction conditions is required to get the desired enantiomer. That kind of careful control is what Yoon and his lab have been working on as they apply photochemical techniques to asymmetric catalysis.

"It was thought that you would need different strategies from other areas of asymmetric catalysis to really achieve the same levels of selectivity" with photochemistry, Yoon says. "Several of us have been discovering that asymmetric catalysis of photochemical reactions is possible and, more importantly, that the catalyst designs you would use are not completely different."

CREDIT: COURTESY OF TEHSHIK YOON (ALL)

Sarah Reisman, a synthetic chemist at Caltech, says one of Yoon's major contributions to the field is the development of techniques and photocatalysts that can drive reactions with visible, rather than ultraviolet, light (*J. Am. Chem. Soc.* 2008, DOI: 10.1021/ja805387f). With visible light, chemists can more carefully target particular functional groups, giving greater control over the synthesis of organic molecules. Systems that use visible light should also be easier to scale up for use in industry, Reisman says.

Reisman also admires Yoon's advocacy work. She says Yoon "thinks really deeply about issues related to diversity, equity, and inclusion" and uses his stature—and substantial Twitter following—to advocate for those issues. She collaborated with Yoon on a 2020 editorial affirming the importance of diversity and inclusion in organic chemistry (*ACS Cent. Sci.* 2020, DOI: 10.1021/acscentsci.0c01027). It was a response to an infamous essay in the chemistry journal *Angewandte Chemie International Edition* that criticized efforts to diversify organic chemistry. (The original essay was removed from the journal's website.)

The editorial in response, which Yoon and Reisman coauthored with Richmond Sarpong and Matthew Sigman, pulls no punches. "At the outset, we find it morally unjustifiable to remain silently complicit with a system that has historically disenfranchised multiple subgroups within our community," they write. "Working to dismantle structural barriers that have prevented equitable participation of marginalized groups in STEM should be a mandate."

Students also admire Yoon's advocacy for diversity, equity, and inclusion. Seeing someone like Yoon, a brilliant, Korean American organic chemist who loves art and fashion and music and invites students to the home he shares with his husband, "abolishes the sense that any identity is a monolith," says Stephanie Knezz, now a chemist at Northwestern University. Yoon was on Knezz's PhD thesis committee.

From top, Tehshik P. Yoon singing with the Harvard Glee Club (back row, third from left) and playing violin in his high school senior recital

"He was a prevalent force in my development, in figuring out what a professional chemist is," she says. "Tehshik exemplified queer excellence." Knezz, who is pansexual, sees a ripple effect from Bertozzi to Yoon to herself.

"I feel a strong obligation to try to support and mentor queer students," Yoon says. It's a way of paying forward what Bertozzi's presence at Berkeley meant for him. He says it also brings him great joy. Talking to 20-year-olds, he says, helps him appreciate how quickly things have gotten better for LGBTQ+ people during his lifetime. Yoon points to legal victories such as the Supreme Court's 2015 decision to uphold marriage equality and the fact that mainstream movies and TV shows now feature positive queer and transgender characters played by queer and trans actors.

But the fight is far from over, Yoon says. The scant data on representation in academia suggest that STEM fields have an LGBTQ+ retention problem on the same scale as that for women and for underrepresented racial and ethnic groups, Yoon says. LGBTQ+ people still face discrimination and marginalization in the larger society, and recent legislation targets children in particular. "State governments are trying to prevent us from talking about queer people in schools," he says, referring to a recent education law in Florida. And in February, Texas governor Greg Abbott directed state agencies to designate gender-affirming care for transgender and nonbinary children (which is upheld by medical and mental health organizations) as a form of child abuse. These are just two recent examples that have made the national news. According to the American Civil Liberties Union, 147 anti-trans laws were debated in state legislatures in 2021; the organization is tracking 280 such laws already in 2022.

"There are real consequences for the lives, the safety, the employment of queer people right now," Yoon says. "How can you think that this is not an important issue for scientists right now? I think as human beings, we have to have these discussions."

Also, for many people, Yoon included, identity is interwoven with their scientific success. He says a great part of his photochemical intuition comes from the musical sense he developed as a young gay man drawn to the arts.

"We talk about wave functions, we talk about resonance, and those are all concepts that make sense to a musician," he says. "I draw on all of my background in the work I do on a daily basis."

"It's an eye-opening experience where you meet somebody and you find out that they're queer and you just realize, 'Holy s---, anything is possible.'"

SYNTHESIS

POLLY ARNOLD

This Lawrence Berkeley National Lab chemist explores the chemistry of rare earths and radioactive elements

KATHERINE BOURZAC, C&EN staff

VITALS

- **HOMETOWN:** London
- **EDUCATION:** BA, University of Oxford, 1994; DPhil, University of Sussex, 1997
- **CURRENT POSITION:** Professor of chemistry, University of California, Berkeley, and director of the Chemical Sciences Division, Lawrence Berkeley National Laboratory
- **LGBTQ+ IDENTITY:** Queer woman
- **FAVORITE LAB TOOL:** A torch. Oops, flashlight. Are there actually crystals forming in the bottom of that dark solution, or is it a pale precipitate to be thrown away?
- **GO-TO STRESS RELIEVER:** A run in the Californian sunshine and 180 bpm hard-core techno

Polly Arnold is drawn to challenging problems at the far reaches of the periodic table. "It's all about the f block," she says of the work in her group, which is split between the University of California, Berkeley, and the Lawrence Berkeley National Laboratory, where she heads the Chemical Sciences Division.

This outpost of the periodic table collects the lanthanides (including most of the rare earth elements) and the actinides. These elements are difficult to separate from one another and challenging to study, and until the past couple of decades, many scientists had assumed it wasn't possible to do interesting chemistry with the f-block elements. "Now my friends and I are showing you can do redox chemistry with all of them—you just have to choose your ligands carefully," Arnold says.

Arnold doesn't mind working in the esoteric realms of chemistry; in fact, untrodden paths are sort of her specialty. She grew up in England, and for the last 2 years of education before attending university, she went to an all-boys' school that allowed a few girls. "It was like a fishbowl," she says. One of her summer jobs in college was in Jim Henson's Creature Shop, where she worked on Muppet fur and eyes. "I loved it. It was making stuff, it was a lot of fun, and the people were weird, in a good way," she says. "I knew I didn't want to wear a suit."

She was ultimately drawn to the research lab. In graduate school at the University of Sussex, she worked on making new molecules by co-condensing volatile organic compounds with vaporized lanthanides. She worked with late transition metals, but it wasn't as challenging as working with the f-block elements, "so it caught my attention less," she says. The toughest stuff was what captured her focus.

f-Block chemistry is difficult, but it offers new possibilities. The reactivity of compounds containing f-block elements means they're promising for activating inert molecules such as carbon dioxide and nitrogen gas without the need for high temperatures and pressures, which require large amounts of energy to generate. In 2020, Arnold showed that a uranium complex can catalyze the reduction of N_2 to make ammonia under ambient conditions. Because uranium, an actinide, is radioactive, she hopes to adapt this process to work with one of the lanthanides, which should be safer.

"Many people talk about diversity, but she did something."

—Tom Welton, professor, Imperial College London

CREDIT: SALGU WISSMATH

The f block has long been seen as "a weird little island at the bottom of the periodic table," says Tom Welton, a chemist at Imperial College London and the president of the Royal Society of Chemistry. "Polly is part of a generation of chemists who have changed that idea, to show, 'No, it's really interesting.'"

Arnold moved her lab to Berkeley from the University of Edinburgh in late 2019. Before the move, Welton says, Arnold helped level the playing field for women and other underrepresented people in science, technology, engineering, and mathematics (STEM) in the UK. "Many people talk about diversity, but she did something," he says. Among other activities, she made a documentary about female scientists at the University of Edinburgh. She also helped expand the efforts of the Royal Society of Chemistry's diversity committee.

Arnold was awarded the prestigious Order of the British Empire (OBE) in 2017 for this community service. "For her science to be recognized at such a high level while at the same time doing the diversity stuff that led to her getting the OBE—it's pretty unique," Welton says.

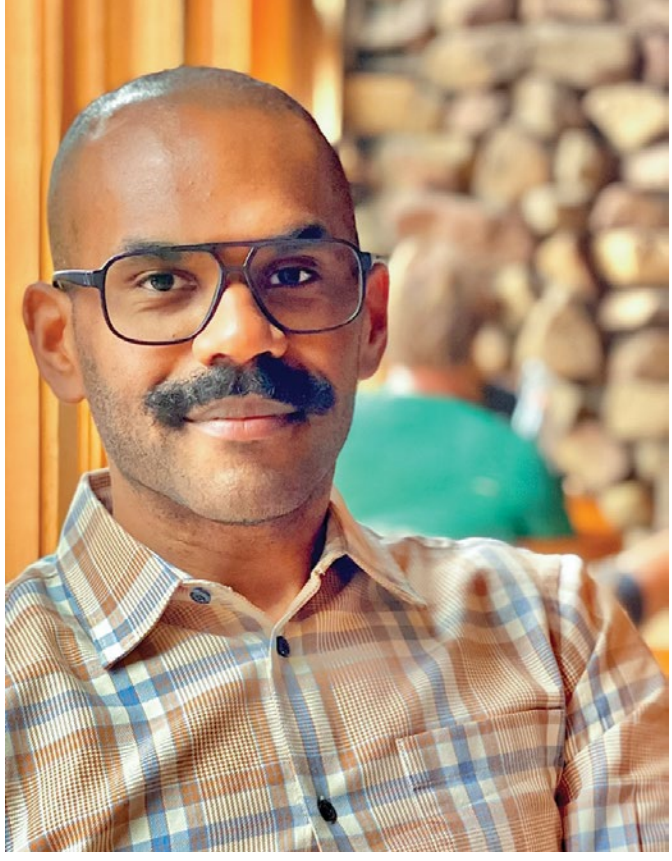
Arnold says that now that she's more established (tongue in cheek, she refers to herself as "the elder scientist"), she's trying to not only level the playing field in STEM but also be more open about her identity as a queer woman. She says she doesn't want everyone she works with to know everything about her personal life but that being open helps put students and others at ease. It "makes me less frightening to students, and that's fantastic."

Jenifer Shafer, an f-block chemist at the Colorado School of Mines, met Arnold at a conference around 2015, shortly after Shafer had come out herself. She says it's inspiring to have such a luminary of f-block chemistry as an out, female role model.

Arnold's work at Berkeley had a slow start because of the pandemic—the campus and national lab went into lockdown before she could get her equipment set up and her students situated. Now that things are up and running, she hopes to use her new role to advocate for more US Department of Energy grants for scientists from underrepresented groups, and she and her team are excited to work on new experiments. One project she's particularly excited about is the opportunity to work with one of the rarest f-block elements—the radioactive metal berkelium, first made in 1949 at her new home institution. She has received a milligram of a short-lived isotope of the radioactive metal from Oak Ridge National Laboratory this year and is eager to study it.

CATALYSIS

ONE ON ONE WITH NICHOLAS BALL



Graduate student **Ali McKnight** talks with this organic chemist about mentoring students and advocating for yourself

Nicholas Ball is training a new generation of chemists and developing new methods for the synthesis and activation of sulfur(VI) fluorides, a class of compounds used as reactive probes for protein identification and as inhibitors in chemical biology. Ali McKnight spoke with Ball about his work as an educator at a predominantly undergraduate institution (PUI). This interview has been edited for length and clarity.

Ali McKnight: How did you get into chemistry?
Nicholas Ball: My introduction to chemistry was in high school in Tennessee. My high school teacher, Mr. Odom, really wanted to give students a sense of how you can manipulate compounds and make cool things. So we made wintergreen flavoring from aspirin with windshield wiper fluid as our solvent.

When I went to Macalester College, I went to a bridge program for students of color during the summer before we matriculated. I took a class in organic chemistry, and when fall came, the professor, Ronald Brisbois, was like, "Hey, you want to work in a research lab instead of working in a cafeteria for your work study?" And I said, "Sure."

AM: Can you speak about your thought process for picking your current research area?
NB: So I dealt with fluorine in graduate school doing organometallic chemistry with Melanie Sanford. I wrote an original research proposal on sulfur dioxide insertion into useful materials, then completely forgot about it. By happenstance, I found out about phenylmethylsulfonyl fluoride—a S(VI) fluoride—during my postdoc with David Tirrell while doing protein overexpression. What finally clicked all the pieces together for me was the paper that Barry Sharpless published on the use of sulfonyl fluorides as synthetic tools. It has been a trove of really cool fundamental scientific questions that has really kept my lab and collaborators busy.

AM: What was the appeal of working at a PUI?
NB: Chemistry provides a lot of opportunities. If you are able to tap into that, it really provides a broad range of experience that can transfer to anything. I want to help students see and gain those opportunities. The best place that I thought that I could do that is in a non-PhD-granting institution. Now, if I were going to work at an R1 institution [a large research-focused institution], I would want a good work-life balance. I think that's why a lot of queer people of color go into industry. There is HR [in industry], while faculty regulation at an institution can vary a lot. There can be clearer structures of how to get promoted, versus tenure and promotion in academia.

AM: As someone who also went to a PUI, I have benefited from the environment of professors focusing on developing the skill sets of students. In that vein, what does your advocacy for students look like?
NB: As a tenured faculty member, I have a lot of privilege. I mean, it is supreme job security. On the other hand, as someone who identifies as a Black man, anything I critique is going to be considered an attack, and that is exhausting.

VITALS

NICHOLAS BALL

- **HOMETOWN:** Chattanooga, Tennessee
- **EDUCATION:** BA, Macalester College, 2005; PhD, University of Michigan, 2011
- **CURRENT POSITION:** Associate professor of chemistry, Pomona College
- **LGBTQ+ IDENTITY:** Gay man
- **I OVERCAME ADVERSITY WHEN:** There are too many to articulate, but I will say for me, my Blackness has always been more of an issue than my queerness. The oppression, bias, adversity, etc. that I have faced is more due to how people process my skin color and our enterprise to suppress and devalue it than my queerness. This is true in my work, walking down the street, existing.
- **GO-TO STRESS RELIEVER:** I really enjoy working out and wheel throwing. One strengthens my mind and body; the other taps into my creativity.

CREDIT: BRENDEN GRIMMETT

VITALS

ALI MCKNIGHT

- **HOMETOWN:** New York City
- **EDUCATION:** BA, Reed College, 2020
- **CURRENT POSITION:** PhD candidate, organic synthesis, York University, Christine Le's lab
- **LGBTQ+ IDENTITY:** Queer and genderfluid
- **FAVORITE LAB TOOL:** The rotovap! It is the workhorse of our lab, and it does not get the respect and recognition it deserves.
- **BEST PROFESSIONAL ADVICE YOU'VE RECEIVED:** Don't go to graduate school just because you have no other job offers.

Ali McKnight's current work focuses on the development of novel catalytic systems for the synthesis of complex organofluorine molecules. When they aren't in the lab, they are a practicing artist.

CREDIT: COURTESY OF WEND YASEN

I have had to advocate for myself really strongly. I think that is a really important skill to have because if you can't be a strong advocate for yourself, then you are not modeling that behavior for others. My model for advocating for students is to meet them where they are: listen to their story, have them think about the challenges they are facing and what resolution they want, be there to work with them, but set boundaries. My voice means something, and I am not going to advocate for something that I do not believe in or feel comfortable with. For me, advocacy is about clear communication of responsibilities and needs, making it clear how to gain resources, and having empathy with how challenging it can be to navigate systems.

I'll say this: as a queer Black person who did not grow up with wealth, it is challenging to hear my colleagues ask, "What about the most vulnerable community members? What about these resources they don't have?" Even if it is not the intent, it comes across as if someone is deficient, less than. Why? Because I was that person. There are a lot of things I did not know or have because of my background. What was transformational for me was to know what I did have, what I was capable of, and how to find people and resources to support that. However, I choose now to move away from a deficit model in my mentoring. Instead, I'm working toward advocating for what people deserve and desire and to work with them toward those goals. In this regard, I am constantly failing, learning, and growing, but it is worth it to me.

AM: It's an interesting paradigm that you see frequently in conversations about accommodation and accessibility in higher education. It is White saviorism. A person in power not asking what you need in order to be successful but dictating what they think you need to be successful based on biases that they have.
NB: Yeah, you're absolutely right. If you really want to get into it, the longer that me and my Black queer body are part of the institution of higher education, the more I'm going to be a part of the system. I'm trying to recognize that this is happening and make sure I'm aware of it. That's why I'm constantly trying not to take on the habits of those who have tried to prevent us from being in these spaces. I don't want to become a person who cannot stand having their ideas being questioned or challenged.

How have things been going for you in your work?
AM: In my search for a grad program I was really interested in working for an early-career woman who was doing interesting synthetic chemistry, and that is exactly what I got. But it's all the trials and tribulations of working for an unestablished lab. And while I enjoy the work and who I work with, it can be a lot.
NB: Yeah, it's a marathon.

My wish for you, myself, and our queer scientific community is that we lean into our worth, practice boundaries with our work, and preserve our magic.

AM: What do you want your legacy to be like in 20 years' time?
NB: That I had a voice, and I used it for myself and for others; that I was always there for folks who needed me. I know the core of my truth and the essence of what I bring to the table is beyond what I can do scientifically. My legacy will be my students. I am bringing in a lot of students who have not had any previous research experience whatsoever and want to give them the opportunity to tap into the fun of chemistry. But quite frankly, I'm not really thinking about my legacy right now. I'm just trying to do good work and get my bills paid.

AM: I really resonate with that. I want to get my bills paid. I want to be able to have fun doing my job and enjoy what I'm doing. Anything else that comes after that is just a bonus.
NB: It is important to be where I am wanted. I really enjoy my job. I enjoy where I live. I enjoy where I work. My institution and I both benefit from each other. Although I have come to understand that with my Black queer body, the benefit is not always equal. My institution benefits more from the value I bring than the other way around. And it's not being conceited. It is not being overinflated. It's just a fact. There's a lot of things that our employers, your department, my college is gaining for our Black and Brown and queer bodies being in that space. The minute they're not appreciating that, it is time to direct our value elsewhere.

This is a very big paradigm shift, especially in academia, because people stay in a job for forever and put up with a lot. As queer people, we are persistently subjected to physical, emotional, and societal violence. My wish for you, myself, and our queer scientific community is that we lean into our worth, practice boundaries with our work, and preserve our magic.

ANALYTICAL CHEMISTRY

BARBARA BELMONT

This analytical chemistry lecturer is devoted to nurturing the next generation of scientists

GIULIANA VIGLIONE, special to C&EN

VITALS

- **HOMETOWN:** Pasadena, California
- **EDUCATION:** BA, La Verne College, 1977; professional science master's, Illinois Institute of Technology, 2004
- **CURRENT POSITION:** Lecturer, California State University, Dominguez Hills
- **LGBTQ+ IDENTITY:** Lesbian cisgender woman
- **FIRST JOB:** Driver for a quadriplegic person, and reader and notetaker for a partially sighted science, technology, engineering, and mathematics student
- **FAVORITE LAB TOOL:** Screw-cap graduated test tubes and duct tape. Don't make me choose.

Barbara Belmont is always trying to be the role model she never had. "I never saw any queer folk in a lab anywhere," she says about when she started out in science. That's one reason that she's been such a long-term presence in LGBTQ+ activism—to be a role model for younger people "so they don't have to navigate it by themselves."

Belmont, an analytical chemist and a lecturer at California State University, Dominguez Hills, grew up in a working-class family in Southern California. "Professional careers were not in the discussion" for families like hers, she says.

But in eighth grade, she fell in love with algebra—the "solving for *x* stuff," as she puts it. The only way that she could take more algebra in high school, she learned, was to take the college-prep track—so she did.

Belmont attended La Verne College, now the University of La Verne. She initially did a double major in biology and math, then added a chemistry major, which she completed during her last three semesters. She graduated in 1977 with the goal of becoming a chemistry professor, but that dream had to wait. She dropped out of graduate school at the University of California, Riverside, just 3 months in. Cramming an entire chemistry major into three semesters, she says, had left her "inadequately prepared" for the rigors of graduate school. "All I wanted was cheerleading. I wanted somebody to say, 'This happens to everybody,'" she recalls. That encouragement was not forthcoming.

After leaving school, Belmont briefly worked as a technician in a clinical laboratory, then as a formulation chemist for 3 years. Then she switched to analytical chemistry. In 1983, she became the lab director at American Research and Testing, an analytical testing laboratory.

It was at American Research and Testing that Belmont says she began to shine as a "chemical detective." Although the company was mainly doing quality assurance testing when Belmont arrived, the lab later used Belmont's analytical expertise to shift into problem-solving. She developed the lab's capability to investigate what she calls "chemical formulatory failure"—the root causes of defective coatings and failed adhesives. The lab also started analyzing the volatile organic compound

"She is really the engine behind everything that Out to Innovate does."

— T. J. Ronningen, president, Out to Innovate

emissions from consumer products.

Leaving formulation chemistry for the analytical lab wasn't just a career move for Belmont. "I kind of needed a change," she says. "I didn't have the nerve to actually come out in my prior job." Changing jobs allowed her to make a clean break and start anew, living her life as an out lesbian.

At the same time, she started looking around for other people like her in science. She got involved with a local organization of gay and lesbian scientists in Los Angeles in the early 1980s and made a lot of friends there, she says. Many of the volunteers in that group were those spearheading the push for a national organization—what was to become the National Organization of Gay and Lesbian Scientists and Technical Professionals.

"I was helping," she says, "and then I helped some more, and then somebody who was helping dropped the ball. And so I helped some more." The organization is now known as Out to Innovate; she has served as its treasurer since 1986.

Out to Innovate partnered with the American Association for the Advancement of Science early on, using the association's national meetings to highlight issues critical to LGBTQ+ scientists. The group has presented symposia on AIDS research, transgender studies, health-care disparities for LGBTQ+ people, and diversity and inclusion, among many other topics. Today, some of Out to Innovate's key programs include a biennial career summit, a mentorship program, and scholarships and grant programs.

Belmont "keeps Out to Innovate going," says T. J. Ronningen, an engineer at the Ohio State University and the president of the Out to Innovate board. "She is really the engine behind everything that Out to Innovate does."

In 2002, Belmont got the chance to rekindle her first passion—teaching. She was in the middle of a professional science master's degree at Illinois Institute of Technology when her boss at American Research and Testing asked her if she could teach the laboratory section of a general chemistry class at CSU Dominguez Hills. As the years went on, Belmont took on more and more teaching responsibilities, and by 2016, she was teaching full-time.

She recently completed a certificate in higher education from the Association of College and University Educators and is always looking for ways to implement pedagogical best practices in her classes. Although she doesn't have any research

CREDIT: TARA PIXLEY

funding, she encourages students to approach her with analytical chemistry research questions that they're curious about.

Belmont was "one of my favorite instructors," says Elizabeth Grotemeyer, a fifth-year PhD candidate in bioinorganic chemistry at the University of Kansas. Grotemeyer took Belmont's analytical chemistry class as an undergraduate and went on to do undergraduate research with her. Grotemeyer credits Belmont's "hands-off" mentoring style with helping her develop her creativity as a scientist.

"She'll give you enough to get going. And then she's there if you need her, but I think she likes to let people work stuff out on their own," Grotemeyer says.

Belmont was elected as a fellow of the American Association for the Advancement of Science in 2002 and as an ACS fellow in 2013. She was the recipient of Out to Innovate's Walt Westman Award, the organization's highest national honor, in 2017.

"She is definitely a role model to the people she interacts with," Ronningen says. "I have been just so impressed at how Barbara has been able to be an out professional and the way she lives her life and the commitments she makes to the causes she believes in."

BIOLOGICAL CHEMISTRY

KELLY N. CHACÓN

This bioinorganic spectroscopist characterizes enzymes that break down toxic metals

GIULIANA VIGLIONE, special to C&EN

VITALS

- **HOMETOWN:** Astoria, Oregon
- **EDUCATION:** GED, Clatsop Community College, 2003; BS, Portland State University, 2009; PhD, Oregon Health and Science University, 2015
- **CURRENT POSITION:** Associate professor, Reed College
- **LGBTQ+ IDENTITY:** Queer/bisexual woman
- **ROLE MODEL:** [My Abuela] Mama Cande married at 14 and was illiterate and had a very difficult life, yet never lost her faith or love of humanity. My Gramma Jan was a daughter of an early feminist and lived life on her own terms. Both taught me so much, and their love keeps me going, even though they are gone. I am driven to achieve because they were not allowed to do so many things that are open to me now.
- **GO-TO STRESS RELIEVER:** Talking to my therapist! And honestly, so much TV, since the pandemic started. I admit it, TV is now officially my friend.

The first time Kelly N. Chacón went to the synchrotron at the SLAC National Accelerator Laboratory during graduate school, they were hooked. All that time spent in their home laboratory preparing samples, freezing them with liquid nitrogen, and shipping them to the national laboratory was about to pay off.

Before starting the experiments, Chacón was "not really sure" what they were going to see, they say. But when the beam was fired up and the data started coming in, they could "literally see the atoms interacting with other atoms." The minute that happened, Chacón says, "I just knew that this was what I wanted to do."

Chacón describes themself as "very nontraditional—in a lot of senses of the word." A desire for independence led them to drop out of high school at age 15. They worked in food service for a number of years before—and while—getting their GED. A high score on the GED exam pushed them to attend community college and, later, to transfer to Portland State University, where they got their first taste of chemistry.

That same independent streak drew Chacón to academia. They liked the idea that "you could kind of work for yourself," they say. Chacón started working at Reed College in 2015—straight out of their PhD at Oregon Health and Science University.

Now Chacón is an innovator in bioinorganic spectroscopy, using light-based measurements to study enzymes that digest toxic metal ions.

In 2020, Chacón received the National Science Foundation's Faculty Early Career Development Program (Career) award—an early-career grant that the NSF describes as its most prestigious award. The grant includes funds both for Chacón's scientific work and for their work supporting students who are underrepresented in science.

Chacón will use the funds to carry out their research on a class of bacterial proteins known as tellurium ion resistance (Ter) proteins. Ter proteins are widespread in the world's microbes despite the relative rarity of tellurium. Bacteria use the proteins to reduce toxic tellurium ions to elemental tellurium, which is much safer. But scientists' understanding of this biochemistry is extremely limited. "We don't understand thing 1 about the fundamental chemistry of tellurium in living systems," Chacón says.

Tellurium is found in all sorts of electronics, including

"As a professor, I feel like it's my job to really make huge changes while I'm here on this earth."

solar panels and cell phones. Beyond the basic-science appeal of uncovering the unknown, the project could have several practical applications. Chacón hopes that a better understanding of Ter proteins could be used in the bioremediation of contaminated soils and help scientists develop safer ways to mine this valuable metal.

The project "really was starting from complete scratch," Chacón says. As a professor at a liberal arts school, Chacón does a lot of their own lab work. For 5 years, they worked alongside their undergraduate thesis students and students in their laboratory classes to gather the data that underpinned their NSF award.

Chacón is "not afraid to tackle hard problems" and is "really creative about the kinds of problems" their lab focuses on, says Hannah Shafaat, a bioinorganic chemist at the Ohio State University. "There are a lot of challenging aspects about working on that project, and they're not afraid to just do it." Shafaat first met Chacón at a bioinorganic chemistry symposium in 2014, and their paths have crossed numerous times since. Shafaat still remembers the "incredibly compelling" talk Chacón gave, she says.

Chacón's NSF award also includes funding for them to create and organize an annual 2-day symposium at Reed that will bring together graduate students from historically marginalized backgrounds, including students of color, LGBTQ+ students, first-generation college graduates, and those from low-income families, including people with intersecting marginalized identities. This symposium, which has been derailed for the moment by the COVID-19 pandemic, will create space for these students to share their science and experiences with one another and with undergraduate students at Reed. Chacón also intends the symposium to help students learn more about what it's like to be an academic.

As a self-described "White-passing Brown person," Chacón has always been keenly aware of their identity. As a child, they noticed how they were treated differently from their father, who immigrated to the US from Mexico. Chacón describes the lasting impact of seeing the prejudice that their dad faced. "From an early age, I always was advocating for people to look past what they think someone is and really just look at the person," they say.

Chacón says they bring "vulnerability and belongingness" to their work—being open about their identities and honest about their struggles creates a space where everyone feels welcome. It's an approach that certainly resonates with the students Chacón interacts with. They are "a really talented mentor," says Gavin Dury, a senior who has worked in Chacón's laboratory for nearly 3 years.

"It's been pretty incredible to see how powerful Kelly is." They have "this confidence and also this vulnerability," Dury says. Chacón "makes it really clear" that doing science can be difficult, they add. But at the same time, Chacón makes Dury feel welcome in science—reminding them that they're "smart and talented and deserving to be there."

In their research, their teaching, and their mentorship, Chacón is always trying to push the boundaries of academia—making academia assimilate to a new, diverse generation of scientists rather than the other way around.

"As a professor, I feel like it's my job to really make huge changes while I'm here on this earth," Chacón says. This goal is inextricably tied up with their multiple intersecting identities of being a "queer Latino that grew up poor," they add. "The things that I'm interested in and the changes that I want to effect, a lot of that comes out of my lens of being queer."

CREDIT: PEDRO OLIVEIRA

BIOLOGICAL CHEMISTRY

ONE ON ONE WITH CAROLYN BERTOZZI

Postdoc **Pauline Navals** talks with this glycoscience expert about what has changed about inclusion in chemistry and what has stayed the same

Stanford University biochemist Carolyn Bertozzi is a highly admired scientist, entrepreneur, and advocate for diversity, particularly for LGBTQ+ people. She's been out since the late 1980s, when being a lesbian could have jeopardized her career. This year, she was awarded the prestigious Wolf Prize in Chemistry for founding the field of bioorthogonal chemistry. Pauline Navals spoke with Bertozzi about her translational research in glycoscience, her work on bridging the gap between chemistry and biology, and her journey as a proud, out gay woman in academia. This interview has been edited for length and clarity.

Pauline Navals: Could you describe your main area of research for the readers who don't know you?
Carolyn Bertozzi: I'm a chemical biologist, and the area of biology that my lab is primarily interested in is glycoscience. For the first half of my career, our focus was on the development of new chemical tools and reactions that could be performed in biological settings. In the most recent decade or so, our focus has been more on trying to understand the role of cell-surface carbohydrates in tumor and cancer immunology. Even more recently, we've been studying certain classes of glycoproteins that are distinctly altered in cancer biology and have been trying to figure out how important they are.

PN: From an undergraduate degree in chemistry at Harvard University to a PhD on oligosaccharide synthesis at the University of California, Berkeley, when did your interest in the interdisciplinarity between chemistry and biology first begin?
CB: I actually started as a premed. I really enjoyed the biology courses and was a bio major, but I kind of got hooked on organic chemistry. It's the chemistry of biology, after all. It was so interesting to me that I switched my major to chemistry. That's where the action is happening, you know? When it was time to look for a PhD, I wanted to orient my career toward biochemistry, and that's how I got into carbohydrate chemistry. Did you work with carbohydrates during your grad school?
PN: My PhD focused on peptide formulation, so yes, I've been playing with them a bit. But you know what they say, carbohydrate chemistry is usually not the organic chemist's favorite!
CB: Well, you know, it's sad! Sugar chemistry can certainly be very frustrating, but if you study it well and invest the time to get the skills to become good at it, everything else becomes boring. Carbohydrates are fun and challenging molecules!
PN: So this shift toward chemical biology wasn't a surprise?

VITALS

CAROLYN BERTOZZI

- **HOMETOWN:** Palo Alto, California
- **EDUCATION:** AB, Harvard University, 1988; PhD, University of California, Berkeley, 1993
- **CURRENT POSITION:** Director, Stanford Chemistry, Engineering, and Medicine for Human Health; professor of chemistry, Stanford University; and investigator, Howard Hughes Medical Institute
- **LGBTQ+ IDENTITY:** Gay cis woman
- **MENTOR:** Mark Bednarski, my PhD adviser, introduced me to the field of glycoscience, thereby changing my life forever. He passed away in 2006. I am aiming to carry on his legacy.
- **PRECIOUS PETS:** Two fish surviving more than 5 years now is some kind of miracle for me.

CREDIT: LAURA MORTON

VITALS

PAULINE NAVALS

- **HOMETOWN:** Fonsorbes, France
- **EDUCATION:** BSc, 2013, and MSc, 2015, University of Montpellier; PhD, University of Sherbrooke, 2021
- **CURRENT POSITION:** Postdoctoral fellow, bioorganic chemistry, University of Ottawa, Jeffrey Keillor's lab
- **LGBTQ+ IDENTITY:** Gay cis woman
- **RECENT FUN PROJECT:** I started drawing again and am now in charge of doodling characters of our lab members to post on our website!
- **BEST PROFESSIONAL ADVICE YOU'VE RECEIVED:** When you feel like you have too much going on, you only need to trust that everything will be done and under no circumstances should you ask yourself how. One thing at a time.

CREDIT: SARAH WATT

Pauline Navals began studying chemistry as an undergraduate in France. She moved to Canada to complete her PhD. Like Carolyn Bertozzi, she also hopes to one day help bridge the gap between chemistry and biology.

CB: After I finished my PhD, I really felt that biology was changing, moving, and accelerating so quickly. I went to grad school from '88 to '93, and the molecular biology revolution was in full steam. There was so much going on, and I realized that if I wanted to bridge the gap between chemistry and biology, I would have to get more training in the latter. I then jumped out of chemistry and went to a glycoimmunology lab for a postdoc.

PN: In a 2020 interview for *ACS Axial*, you talked about the challenges you had to face being a woman and a member of the LGBTQ+ community. What challenges remain today?

CB: In college, around the age of 18, I became self-aware that I was gay. At the time, there was plenty of homophobia, as it was right when the AIDS crisis was really heating up. I came out at a time when people were really mobilizing to try and exact political change, but also at a time when coming out could keep you from getting a job. So when it was time to look for grad schools, I needed to go to a place where there was a strong gay community, because safety in numbers, right? I knew Berkeley had a great chemistry department, and when you live in the Bay Area, you are in a generally supportive environment. I know from my friends who work in other places that there were (and still are) a lot of stigmas for gay people in the United States. At least now, we have civil and legal rights that give us some sort of equality in the eyes of the law, but casual homophobia still exists. I've been relatively privileged and shielded from it, but step outside of the United States, step outside of Canada, there are places where you're still punished for being gay, even sometimes by death. We should never lose sight of the fact that science is international.

PN: You are right, our work is international and therefore brings together different cultures and ways of life. I imagine that it is not a simple thing to juggle with being an openly gay woman.

CB: When I present, if someone from the audience asks a question like, "Tell us about your experience as a lesbian scientist," you can feel the temperature in the room drop a few degrees. But I've certainly never been the guest of an institution or program in a homophobic environment, and the immediate people around me have always been very professional. I definitely have trolls on Twitter; any woman on social media does. But nothing compared to the blatant outward homophobia of my college years. Surprisingly, though, being a woman was and still is worse than being a lesbian.

PN: Really?

CB: Oh yes. You know, in the late '80s, maybe 10% of the students were female. That meant that when you joined a lab, there were maybe one or two other women. We were such a minority, so we tried to support each other by starting a monthly get-together for all the women students in the department. To advertise it, we put up posters, as the internet didn't exist back then. Within a few hours, they were vandalized with sexist insults. It was so hostile. Today, we get to deal with Twitter trolls.

PN: We've been seeing a change lately in the importance of diversity, equity, and inclusion in STEM [science, technology, engineering, and mathematics]. What is your take on this?

CB: You know, we are living in the wake of some racist events that took place last year, and the murder of George Floyd cast yet another flashlight on the systemic racism built in our history. On one hand, I think it's very positive that people are trying to build awareness, and individuals who've had more privileged backgrounds are being asked to understand this privilege. I certainly would like for my lab to reflect social justice. But on the other hand, I think there's a lot of cynicism around it.

People are also frustrated with how slow actual change occurs and how behaviors don't seem to change alongside the rhetoric. The interesting question is, How do we make a change? How do we make our actions reflect our words? For example, if you take a look at C&EN 20 years ago, they didn't dedicate entire issues for the LGBTQIA+ community. Actually, in 1999 I won the MacArthur award at 32 years old, after only 3 years into my assistant professor position, and they decided to interview me for a "day in the life of" project alongside two other female peers (C&EN, Jan. 31, 2000, page 25). We three had partners, and I had been with mine for over a decade. During the interview, their husbands had the opportunity to talk about what it was like being married to an academic professor. My wife wasn't interviewed and wasn't even included in the article. I know the writer had the intention to include us, but unfortunately, at the time it was judged too "bold." This was C&EN in 2000.

PN: And here we are in 2022!

CB: Here we are!

MATERIALS

BENNY C. CHAN

This collaborative inorganic chemist and teacher is reshaping STEM education and thermoelectric materials

"You can't change the system by yourself."

VITALS

- **HOMETOWN:** Ewing, New Jersey
- **EDUCATION:** BA, Franklin and Marshall College, 1996; PhD, the Pennsylvania State University, 2003
- **CURRENT POSITION:** Professor of chemistry and chair of the Chemistry Department, the College of New Jersey
- **LGBTQ+ IDENTITY:** Gay cisgender male/nonbinary
- **IMPACTFUL BOOK:** The genre that has had an impact on me is all the superhero comics and movies, in particular the mutants in the X-Men and Marvel universe because they were born with their powers and many times treated poorly by society. They were allegory for my experiences growing up and coming to terms with my sexuality.
- **BEST PROFESSIONAL ADVICE YOU'VE RECEIVED:** True innovation comes when you are working at the fringes. Sit in that discomfort.

BRYN NELSON, special to C&EN

The traditional approach to teaching college chemistry, which includes in-class lectures and expectations of hours of individual study, often acts as a roadblock for underrepresented students seeking a career in science. Traditional thermoelectric materials, which include bismuth tellurides and selenides, can act like heat pumps in cooling systems when jolted by an electrical current. Benny C. Chan has applied his love of problem-solving to change the structures of both. Through an interdisciplinary approach to research, he has helped fill gaps in chemistry education as well as in the published crystal structures of thermoelectric compounds.

Chan, an inorganic chemist and chair of the Chemistry Department at the College of New Jersey, studies how adding elements to bismuth telluride compounds might disrupt their structures and change their thermoelectric properties. Students in his lab have published the structures of a wide variety of chemical compounds, including organic compounds that had been overlooked in the chemical literature. The College of New Jersey has limited lab space, so Chan relies on numerous collaborations. For example, he works with colleagues at Princeton University to help measure the thermal properties of the compounds his lab resolved structurally.

Former student Marisa Sanders says Chan had a major impact on her career path. She took two of his classes and conducted research in his lab that led to publications on the crystal structures of three compounds. "If you had a particular thing you enjoyed doing in the lab, he would just let you go for it," she says. Sanders received her doctorate in solid-state inorganic chemistry in the lab of Chan's Princeton collaborator. She is still writing about science as a patent agent while pursuing her law degree.

Chan has also worked with scientific partners to expand educational opportunities for science, technology, engineering, and mathematics (STEM) students from underfunded school systems. Many of these students are people of color, and Chan feels that they are owed a debt because of that lack of resources. "As a faculty member, I actually have a lot of control in paying that debt back," he says.

J. Lynn Gazley, a sociologist of science and medicine at the College of New Jersey, worked with Chan to overhaul what

CREDIT: TIPH BROWNE

is now the college's Summer Scholars Program. The monthlong program helps incoming STEM students from under-resourced schools develop the skill sets they need to thrive in college. "Benny was absolutely in the forefront of that," Gazley says. "He was very clear on where he saw students struggling in first-year classrooms." One solution has been to provide a space for the students to practice problem-solving and act as scientists by analyzing their own learning. They test new approaches to studying and retaining information, see what approaches work, and adapt accordingly.

That joint project led to a restructuring of the college's general chemistry course to better meet the needs of incoming students. Many campuses try to "fix the students" to fit their structure, Gazley says. "The way Benny really redesigned general chemistry was he flipped that: it's our responsibility to create a structure that supports students so that they can thrive." So Chan and Gazley developed a model of teaching in which students watch videotaped lectures and review other course materials ahead of meeting together. Class time itself is then reserved for highly structured activities that guide them through the process of learning and developing good study habits.

Chemistry students have embraced this model. Across the board, the redesign has dramatically reduced the number who receive a D or F grade or withdraw from the class. The new model has also erased the performance gaps between White students and their Black and Latine counterparts. "So it benefited everyone," Chan says.

In 2019, the National Organization of Gay and Lesbian Scientists and Technical Professionals (now known as Out to Innovate) selected Chan as its LGBTQ+ Educator of the Year. T. J. Ronningen, who is an electrical and computer engineer at the Ohio State University and led the awards committee, said the committee was particularly impressed by Chan's ability to apply his research background toward improving chemistry education far beyond his own classrooms. "It really set him apart," Ronningen says.

Chan is still expanding his reach. He has been active in Safe Zone training, which helps allies learn how to create safer spaces for members of the LGBTQ+ academic community. From that experience, Chan realized that much of the work on creating an inclusive and welcoming atmosphere also applies to students of color. He now conducts workshops and seminars at his institution and others on a wide range of race, LGBTQ+, gender, and socioeconomic issues. "All of those interplay together," he says. As a gay man, a child of emigrants from Hong Kong, and a first-generation college graduate, Chan understands firsthand the importance of emphasizing intersectionality—the complex ways in which someone's overlapping social identities can shape how that person experiences discrimination. This emphasis helps ensure that discussions of one issue don't ignore intersecting ones.

Through all these efforts, Chan says, he's realized that he couldn't have had as much of an influence on students on his own. "I like broader-impact kind of things and changing the system," he says. "You can't change the system by yourself." In his push to resolve structural issues, fortunately, this chemist is attracting quite a crowd.

PHYSICAL CHEMISTRY

ONE ON ONE WITH MELISSA GISH

Graduate student **Matthew A. Wiebe** talks with this physical chemist about finding community at a national laboratory

As a staff scientist at the National Renewable Energy Laboratory (NREL), Melissa Gish uses ultrafast spectroscopy to study the fundamental properties of charge- and energy-transfer processes to improve renewable energy technologies. Gish also helps build community support systems at NREL—for example, she cofounded the Full Spectrum Network, an employee resource group for LGBTQ+ people. Matthew A. Wiebe interviewed Gish about her work and career path and then sought advice for the future. This interview has been edited for length and clarity.

Matthew A. Wiebe: What's a research project you're on at NREL that excites you?
Melissa Gish: I've started working with organic lanthanide complexes, which is pretty new to me. I'm learning a lot of things about f orbitals that I haven't really had to think about before. My experience in the past is transition metals and totally organic molecules. I'm still learning brand-new things and just using my expertise in the techniques to apply them to different systems, which is exciting and new.

MAW: For sure! I've always been interested in f-block elements, so I can see how fulfilling that curiosity would be exciting. How did you end up studying ultrafast spectroscopy?
MG: It was kind of an accident. Going into grad school, I knew that I wanted to do experimental physical chemistry, which led me to [John] Papanikolas's group at the University of North Carolina at Chapel Hill. I would go to the group meetings, and I would be really excited and engaged in discussing ultrafast microscopy. I was drawn immediately to the renewable energy side and developed my expertise in ultrafast lasers. Also, in my graduate research I learned how to build all different types of optical setups and developed my expertise through really being engaged in that type of fundamental renewable energy research. That engagement is what kept me working in renewable energy and led me to apply for a postdoc at NREL.

MAW: Can you think of a specific obstacle you overcame on this journey to becoming this awesome researcher?
MG: Yeah, in my first year I was working with an instrument that had a misaligned single crystal. So I was pushed into the lab, and they were like, "First year, you can go fix this alignment." It took me, I think, 2 or 3 weeks to get only kind of back to it [realignment of the crystal]. I ended up having to ask a postdoc for help. But I

VITALS

MELISSA GISH

- **HOMETOWN:** Rockville Centre, New York
- **EDUCATION:** BS, University of Southern California, 2011; PhD, University of North Carolina at Chapel Hill, 2018
- **CURRENT POSITION:** Research scientist, National Renewable Energy Laboratory
- **LGBTQ+ IDENTITY:** Queer cis woman
- **ROLE MODEL:** Annie Greenaway, a fellow research scientist at NREL and chair of the Full Spectrum Network employee resource group, is my role model because she constantly works to create spaces in science that are accessible for everyone while doing groundbreaking work in renewable energy.
- **RECENT FUN PROJECT:** My New Year's resolution is to improve my dumpling-making skills, and my first venture was pierogi!

CREDIT: WERNER R. SLOCUM

VITALS

MATTHEW A. WIEBE

- **HOMETOWN:** Selkirk, Manitoba
- **EDUCATION:** BSc, University of Winnipeg, 2017; MSc, York University, 2019
- **CURRENT POSITION:** PhD candidate, inorganic chemistry, University of Victoria, Ian Manners's lab
- **LGBTQ+ IDENTITY:** Gay cis man
- **FIRST JOB:** Bingo card checker for bingo night at the local community center
- **RECENT FUN PROJECT:** I've recently taken interest in playing pinball. I don't have any high scores on any of the machines around town yet, but I am getting better every week!

CREDIT: UNIVERSITY OF WINNIPEG

Matthew A. Wiebe is a PhD candidate studying main-group chemistry with Ian Manners at the University of Victoria. He is passionate about cooking, pinball, and hiking the many beautiful spots on Vancouver Island.

built a new one in my second or third year that I could align in 15 min, compared to a 2- or 3-week time window. Yeah, that seems triumphant. Even I would say that's quite the accomplishment.

MAW: Definitely! I think all scientists want to make things as efficient as possible. You've lived in several places for your studies and work; where did you feel most at home?

MG: Hmm, that's a good question. I would say professionally, I feel most at home where I currently am at NREL. It's been a really supportive environment. I have a lot of mentors who advocate for me and try to make sure that I have everything I need to be successful. I moved in 2018, so I had 2 years before the pandemic to get to know Colorado. It's the furthest inland I've ever lived. I'm not used to mountain terrain. I'd never been skiing before I moved here. So it's sort of like trying to learn all those new things and trying to fit in. In terms of my personal life in Colorado, being sort of in Denver, where it's kind of on the smaller side but still a big city, has been nice.

MAW: Yeah, I've landed in Victoria for now, where it's a nice in-between too. Can you tell me about the Full Spectrum Network at NREL and your involvement in it?

MG: Full Spectrum was cofounded by myself; a motivated grad student, Kate Doubleday; and several others when we were looking for an LGBTQ+ community at NREL. The goal of Full Spectrum is to provide that community for LGBTQ+ NRELiens [employees of NREL] and try to educate and be a resource for people. One of my ideas was to celebrate Pride in some way. That first year, we had an art installation, and we did a bake sale where we raised money for a local LGBTQ+ charity. In January 2020, we were planning to march in the parade, got everything ready for that, and then the pandemic hit. So the in-person stuff was canceled, and we had to make it a virtual event. But we were able to have NREL march in its first (virtual) Pride parade. That's something I'm really proud of that I was able to lead. We did it again last year. This year, we're hoping to march in the parade in person, so that's exciting.

MAW: It's always nice to build a sense of community in any sort of work space. I really appreciate what you're doing for your fellow NRELiens. How has your identity as an LGBTQ+ chemist impacted you as an energy research scientist?

MG: Yeah, so this is a funny story. I kind of didn't realize that I was queer until I joined Full Spectrum. Like, I've always sought out queer spaces, which I now realize is not a thing that straight people do. But I've always been around cis gay men and not a lot of queer women. So Full Spectrum, at the time that we started, it was a lot of queer women getting together and trying to get things done. Being in that space made me realize that I was bisexual, and I'm still working out the label. So at my desk at NREL, I have a Pride flag and all sorts of rainbow-type things. I just try to make it seem like there's at least a safe space for someone to go to. Or at least they can see it when they walk by my desk and know that someone else is there for them and not feel so alone.

At my desk at NREL, I have a Pride flag and all sorts of rainbow-type things. I just try to make it seem like there's at least a safe space for someone to go to.

MAW: Totally. I think just providing that space or just that comfort has value. I don't think it's uncommon for scientists to discover themselves later in life. Last question, from someone looking forward to the next step: What in your life has changed from being a graduate student to being a professional research scientist?

MG: I would say, as time goes on, you really start to trust yourself and trust your instincts. I think, in a PhD, you're learning to trust that you know what you're talking about and realizing what areas you could learn to grow. Transitioning to a postdoc, then to a staff scientist, you're sort of just increasing that trust in yourself and knowing that you were chosen for a reason, and you are the expert in your topic. There are other experts, of course, but you are one of them. So it's definitely a journey of, I guess, self-love.

OUTREACH

ANDRE ISAACS

This College of the Holy Cross professor inspires future chemists on social media and on campus

TARA SANTORA, special to C&EN

A tall, thin Black man slides into frame. He's in a chemistry lab and is wearing a tie-dye rainbow lab coat. He points at a sleek machine and dances, shimmying from side to side. The video is captioned, "Seducing our $550K NMR 4 good data on NYE." He did, in fact, get good data.

The dancing scientist is Andre Isaacs, a star on the science, technology, engineering, and mathematics (STEM) side of TikTok (@drdre4000), with nearly 355,000 followers. He's also a chemistry professor at the College of the Holy Cross. Both on social media and on campus, Isaacs strives to mentor future scientists and advocate for queer students.

Isaacs's colleagues describe him as a first-rate chemist. He uses copper-mediated reactions to synthesize nitrogen-containing heterocycles—the backbone of many compounds, such as penicillin—in a more efficient way than is currently done. Part of the reason he chose this project is because it's an appropriate level of difficulty for undergraduates, and it allows them to practice a wide range of lab techniques.

"My job at a liberal arts college is to educate the next generation of scientists," he says. "My research is the vehicle by which these students are going to go into graduate school extremely prepared."

Isaacs takes a similar student-oriented approach when teaching organic chemistry, one of the most notoriously intimidating college subjects. He quickly puts his students' minds at ease with jokes, impromptu dancing, and his overall approach to teaching. "I try to let them realize that it's not them against the professor—against me. It's them and me against the material."

Isaacs's approach works. Josie Ascione, a junior at Holy Cross who works in Isaacs's lab, started college wanting to major in biology, and she was terrified of organic chemistry. But after taking the introductory course with Isaacs, she switched her major to chemistry and took all the organic classes she could. "He presented the material in a way that was like, 'I want you guys to see how cool and exciting this is' rather than 'I need you guys to memorize this for a test,'" she says.

It's not just STEM students who are fans of Isaacs. He's extremely popular on campus. "I mentor, like, every single student," he says. Some are chemistry majors, some aren't, and

VITALS

- **HOMETOWN:** Kingston, Jamaica
- **EDUCATION:** BA, College of the Holy Cross, 2005; PhD, University of Pennsylvania, 2011
- **CURRENT POSITION:** Associate professor, College of the Holy Cross
- **LGBTQ+ IDENTITY:** Gay cisgender man
- **IMPACTFUL BOOK:** *Lost Prophet: The Life and Times of Bayard Rustin*. As a gay man, I've been inspired by his commitment to civil rights in the face of rejection by many of the people whose lives he was impacting positively.
- **GO-TO STRESS RELIEVER:** Tennis! I love getting on the court and hitting forehands. Beware of a stressed Andre on the court.

"My job at a liberal arts college is to educate the next generation of scientists."

many are queer and people of color. “It’s really rewarding when a student trusts you to help them navigate more than just the course, like applying for a job. Sometimes students even ask me for dating advice,” he says. “They’re like my children.”

Isaacs’s interest in chemistry stems from his high school years in Jamaica, where he grew up. After his regular school day, Isaacs would sit in evening chemistry and math classes taught by his uncle. Tragically, his uncle died during his senior year of high school, and Isaacs took a year off to cope with the loss before attending Holy Cross for his own undergraduate education.

Isaacs then started his PhD at the University of Pennsylvania, where he worked with chemistry professor Jeffrey Winkler, who became one of Isaacs’s biggest fans. “He was just a charming, erudite, thoughtful person in the way that he approached everything,” Winkler says. “It was clear to me, always, that Andre was this jewel, that he was this unusually talented and special person.”

While at Penn, Isaacs came out to his friends and family. Not all of them were accepting, and he struggled with his mental health in the aftermath. His productivity tanked. Winkler noticed and, to give Isaacs a break, suggested he go to San Francisco for a month to do research with a pharmaceutical company that partnered with Winkler’s lab. “It was the most rejuvenating month of my life,” Isaacs says. “I got to step away from everything.”

To pay it forward, Isaacs prioritizes the mental health of his students. “I check in with my research students, even students in my class,” he says. He makes it clear that if they are dealing with something tough, he is dedicated to finding ways to help them.

He also cofounded Outfront, an LGBTQIA+ faculty and staff alliance, after being hired by Holy Cross in 2012. The organization advocates for and supports LGBTQIA+ staff and students and increases their visibility on campus. “We are at a very queer Jesuit Catholic institution,” Isaacs says. “We queered up this space.”

Isaacs’s students value how he cares for them, how he teaches them, and how he provides a role model for queer students by simply being himself. From the comments on his social media posts, it’s clear that the future scientists who follow him are inspired by his openness, even though they’ve never met him. They’re encouraged by the life he shares on social media as a chemist who doesn’t fit the mold—one of the things his students love about him the most.

CREDIT: VANESSA LEROY PHOTOGRAPHY

HISTORIC TRAILBLAZERS

In this issue, C&EN honors the contributions of trailblazing LGBTQ+ scientists from history. These scientists had major impacts on environmental regulations and our understanding of the brain and made contributions to agriculture and other fields. For some, it was not safe to be out in their lifetimes. Others were activists, advocating for LGBTQ+ rights and AIDS research and mentoring LGBTQ+ students. Read more at **cenm.ag/historiclgbtq**.

BEN BARRES

Ben Barres, the first openly transgender member of the US National Academy of Sciences, is remembered not just for his groundbreaking work on glial cells in the brain but also as a champion for women in science.

Barres was born Sept. 13, 1954, in West Orange, New Jersey, and assigned female at birth. His interest in science developed while he was in school, but because he was perceived as a girl, he was discouraged from taking math and science courses. Despite this, he earned a place at the Massachusetts Institute of Technology and went on to Dartmouth Medical School for his medical degree.

In the early 1980s, while Barres was doing his neurology residency, glial cells in the brain caught his attention. Glial cells had previously been thought of simply as the brain's biological glue, but Barres showed they play an active role in brain function. His work changed the way we understand the cells' interactions with neurons.

Barres transitioned in his 40s and spoke openly about the sexism he had faced as a woman in science and how that changed after transitioning. Right after he transitioned, a colleague remarked about him, "His work is much better than his sister's," not realizing they were the same person.

He continued to advocate for women scientists and debunked the notion that innate ability lay behind their low numbers in scientific careers.

In 1993, Barres joined Stanford University's Department of Neurobiology, and in 2008, he became its chair. He published 167 peer-reviewed papers, won many awards, and served on numerous editorial boards. He died of pancreatic cancer in December 2017, aged 63.—PAYAL DHAR, special to C&EN

CREDIT: ASSOCIATED PRESS (BOTH)

RACHEL CARSON

If inspiring the global environmental movement can be credited to one individual, that person is marine biologist Rachel Carson. Her work on how pesticides damage natural habitats had a lasting impact on government, industry, and society. A 1985 article in the *EPA Journal* calls the US Environmental Protection Agency "the extended shadow of Rachel Carson." Her 1962 book, *Silent Spring*, on the detrimental effects of pesticides, significantly affected the way people think about the environmental impact of chemical use, and regulators subsequently banned many of the pesticides she wrote about in the book.

Born May 27, 1907, in Springdale, Pennsylvania, Carson was fascinated by the natural world from a young age. She won a scholarship to attend Pennsylvania College for Women and in 1929 was accepted to Johns Hopkins University's zoology graduate program. Two years after earning her degree, Carson quit school to support her family. In 1935, she joined the US Bureau of Fisheries.

Around this time, she started writing about aquatic life, and she produced a trio of books: *Under the Sea-Wind*, *The Sea around Us*, and *The Edge of the Sea*.

But Carson is best known for penning *Silent Spring*, which raised public consciousness about pollution from the uncontrolled use of chemicals in agriculture and industry. Carson advocated for government regulation of persistent pollutants, including DDT. She faced severe backlash from the chemical industry for her stand.

In 1953, Carson met Dorothy Freeman. Though they saw each other infrequently, they exchanged around 900 letters over 12 years. Carson destroyed most of these letters before her death. Those that remain, published decades later in a collection edited by Freeman's granddaughter, allude to the romantic nature of the relationship.

Carson, who was diagnosed with breast cancer and had a respiratory illness late in life, died from a heart attack in 1964. In addition to numerous honors in her lifetime, she was a posthumous recipient of the Presidential Medal of Freedom.—PAYAL DHAR, special to C&EN

CREDIT: LIBRARY OF CONGRESS LC-USZ62-114302 (CARVER); UNIVERSITY OF WASHINGTON (GOUTERMAN)

GEORGE WASHINGTON CARVER

George Washington Carver's work revolutionized agricultural science in the US. Born into slavery in Missouri in 1864, Carver showed an interest in botany at an early age. Although he initially enrolled in college to study the arts, he transferred to Iowa State College of Agriculture and Mechanic Arts in 1891 and was the first Black person in the US to earn a bachelor of science degree, in 1894. He stayed on in Iowa to complete his master's degree before the Tuskegee Institute in Alabama hired him to head its Agriculture Department.

While at Tuskegee, Carver championed the use of crop rotation as a way to restore nutrient-depleted soils. In addition to his teaching and scientific studies, he traveled the countryside teaching farmers his soil restoration methods.

Carver was also a pioneer in the field of chemurgy, which aimed to find industrial uses for surplus crops using the power of chemistry. He found around 300 uses for the peanut, one of the crops he recommended be rotated with cotton plants. Carver's work was named a National Historic Chemical Landmark by the American Chemical Society in 2005.

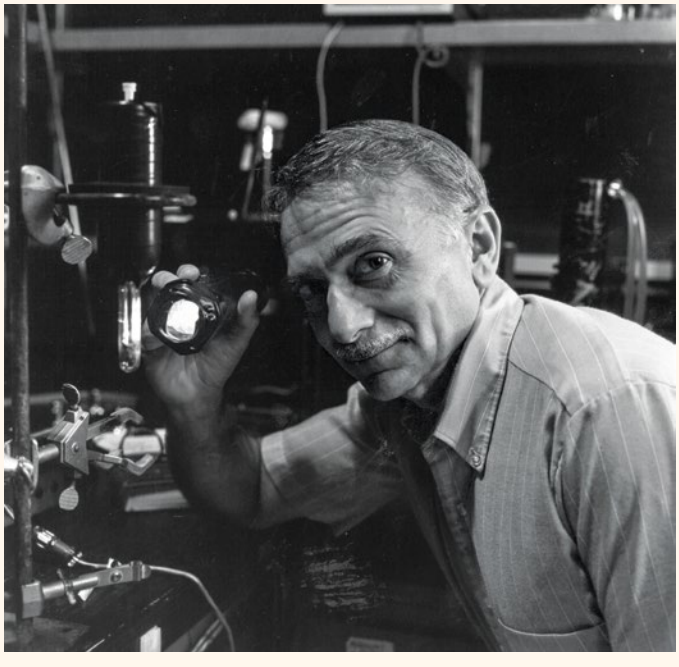
Carver never married, and his sexuality is a matter of ongoing—and often heated—debate. Historian Christina Vella, in her 2015 biography of Carver, scrutinized his relationships with his research associates and students at Tuskegee and concluded that he was likely bisexual. He had a close relationship with his research assistant Austin W. Curtis Jr. from 1935 until Carver's death in 1943, and he granted Curtis one-quarter of the royalties from the sale of an authorized biography published in 1943.—GIULIANA VIGLIONE, special to C&EN

MARTIN GOUTERMAN

Martin Gouterman, an out gay man at a time when few scientists were open about their sexuality, discovered why blood is red and grass is green.

Gouterman was born on Dec. 26, 1931, and died Feb. 22, 2020, at 88. He was a University of Washington chemist who became an expert in porphyrins, large ring molecules consisting of four smaller rings formed by four carbons and a nitrogen. They're essential to much of life, helping form both the red hemoglobin in blood and the green chlorophyll in plants. In 1963, Gouterman, then at Harvard University, and his colleagues developed a model of porphyrins' physics to explain the molecules' properties (*J. Mol. Spectrosc.* 1963, DOI: 10.1016/0022-2852(63)90011-0). His four-orbital model describes metallic porphyrins as having two highest occupied molecular orbitals that have nearly the same energy levels, or are "near-degenerate," and two exactly degenerate lowest unoccupied molecular orbitals.

Closeted at Harvard and briefly married to DeLyle Eastwood, a scientist and one of his sometime coauthors, Gouterman blossomed when he moved to Seattle in 1966. There, he lived in the historically gay Capitol Hill neighborhood and helped found the Dorian Society, a pre-Stonewall rights group that sought to portray gay men and lesbians as respectable citizens. He also worked to end the war in Vietnam and joined Kadima/New Jewish Agenda and the International Jewish Peace Union, campaigning to end the 1967 Israeli occupation of the West Bank and the Gaza Strip. During the AIDS epidemic, he opened his home to young, sick gay men with nowhere else to go, and he later volunteered at Seattle's Bailey-Boushay House, the nation's first AIDS hospice.—NEIL SAVAGE, special to C&EN



GREGORY L. HILLHOUSE

Scientists long considered nitrenes, highly reactive molecules based on nitrogen, too difficult to use. It seemed impossible to isolate a stable nitrene based on late transition metals because those metals are so rich in electrons. Gregory L. Hillhouse, born March 1, 1955, showed he could make nitrenes with late transition metals, opening up new reactions for creating important organic molecules.

Hillhouse called his first such molecule, constructed in 2001, double nickel—a name that his colleagues at the University of Chicago also conferred on him (*J. Am. Chem. Soc.* 2001, DOI: 10.1021/ja010358a). His work won Hillhouse the ACS Award in Organometallic Chemistry in 2013.

He'd been fascinated by energy-rich nitrogen compounds since his PhD thesis at Indiana University Bloomington in 1980. After postdoctoral work at the California Institute of Technology, Hillhouse settled at the University of Chicago, where he is remembered not only as an innovative scientist but also as a warm friend to students and colleagues alike, a gourmet cook and collector of wines, a talented painter, and an organizer of intramural basketball and softball teams. His role as a mentor was so significant that the University of Chicago's undergraduate chemistry society named its annual lecture in his honor.

Hillhouse took many years to come out as gay, afraid it might hurt his career, according to a remembrance in *The Chemists Club*, a University of Chicago publication. In the 1990s, shaken by a close friend's death, he began volunteering at a Chicago AIDS hospice, where he prepared gourmet meals each weekend. He also became a role model for younger LGBTQ+ chemists. "While I wasn't out in college, Greg helped me feel OK being myself and feel comfortable being out in the chemistry community now," says Matthew Joannou, who took Hillhouse's class as a University of Chicago undergraduate.

Hillhouse died of pancreatic cancer in 2014 at age 59.—NEIL SAVAGE, special to C&EN

LOUISE PEARCE

Louise Pearce was an adventurous scientist whose work contributed to a cure for the painful and deadly African sleeping sickness (trypanosomiasis).

Born March 5, 1885, in Winchester, Massachusetts, she earned degrees from Stanford University and Boston University and studied medicine at Johns Hopkins University. In 1913, she became the first woman researcher to be appointed to the Rockefeller Institute (now Rockefeller University), where she worked with four other scientists to develop arsenic-based compounds to treat trypanosomiasis.

Six years later, Pearce and her colleague Wade Hampton Brown landed on a drug called tryparsamide, which showed promising results in animal models. Pearce traveled to the Belgian Congo (now Democratic Republic of the Congo) to conduct human trials and found that the drug cured 80% of patients. Tryparsamide remained the standard treatment for the disease until the 1960s.

After her successful Congo mission, Pearce was promoted to associate member of the Rockefeller Institute and received the Belgian Order of the Crown. She went on to win many other awards and honors—although the institute never conferred the status of a full member to her. Pearce's subsequent research focused on developing animal models for the study of human cancers. She also studied the role of viruses in spreading cancer.

Pearce was a member of Heterodoxy, a feminist club for "unorthodox" women, including many lesbian and bisexual women; fellow scientist Sara Josephine Baker and author Ida A. R. Wylie were members as well. The three women lived together in New Jersey, where Pearce died in 1959.—PAYAL DHAR, special to C&EN

CREDIT: J. MONTGOMERY (HILLHOUSE); ACC. 90-105 - SCIENCE SERVICE, RECORDS, 1920S-1970S, SMITHSONIAN INSTITUTION ARCHIVES (PEARCE)

JEMMA REDMOND

As a child, Jemma Redmond loved to take things apart and put them back together again, trying to improve on the design as she did so. Born in 1978 in Tallaght, a Dublin suburb, Redmond studied electronic engineering before earning her undergraduate degree in applied physics at Robert Gordon University. She then went on to complete a master's degree in nanobioscience from University College Dublin in 2012. She began making her first bioprinters at her kitchen table, and her master's thesis focused on 3D printing finger bones from mouse-derived bone cells.

Redmond was intersex and infertile, and part of her interest in biological 3D printing stemmed from a desire to print herself working reproductive organs. She cofounded a 3D-printing start-up called Ourobotics in 2015. Her work caught the eyes of several venture capital firms, as well as a start-up incubator in Cork, Ireland.

Redmond served as Ourobotics' CEO, and under her leadership, the company developed the first 3D printer capable of using 10 different biomaterials at once. She was also a firm advocate for affordable and open science, and Ourobotics' second 3D printer was entirely open source—and an order of magnitude cheaper than the first design. Her hope was that one day, every hospital and university in the world would have a bioprinter on-site that could print new organs for patients on the transplant list. She also envisioned melding the biological and the technological, such as by implanting sensors in organs to monitor health.

Redmond died in 2016 at age 38. She was survived by her partner, Kay Cairns, a journalist and activist.—GIULIANA VIGLIONE, special to C&EN

NINA VEDENEYEVA

Born in 1882 in Tbilisi, Georgia (then part of the Russian Empire), Nina Vedeneyeva was a preeminent crystallographer. Her accolades include the Stalin Prize, the Order of Lenin, and several other medals awarded by the Soviet Union.

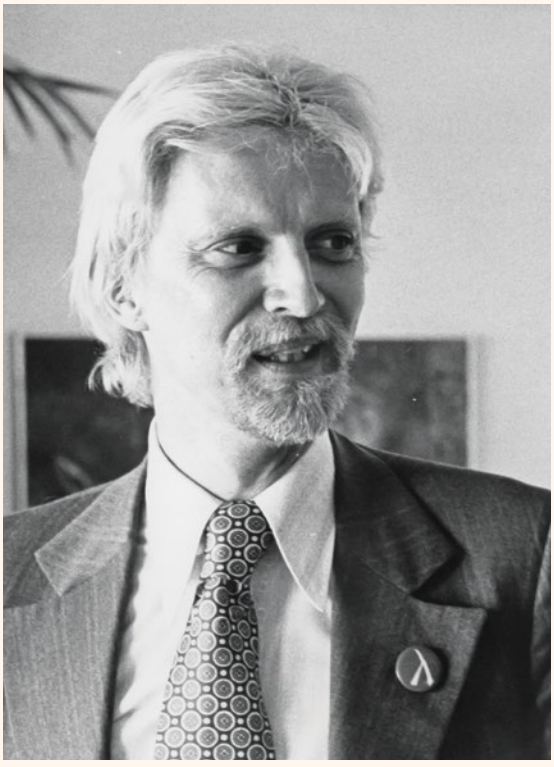
Vedeneyeva began her studies at the Liège Polytechnical School in Belgium but returned to Russia after only 1 year. After graduating from the chemistry department of the Bestuzhev Courses, a top women's university, in 1913, she began to teach at the Second State University and the Institute of Fine Chemical Technology, both in Moscow.

She married a man, whom she later divorced, and later in life, she fell in love with the famed Russian lesbian poet Sophia Parnok. Over the course of their relationship, which lasted until Parnok's death in 1933, Parnok wrote 32 poems inspired by Vedeneyeva.

Vedeneyeva earned her doctorate in physics and mathematics in 1937 and was hired to head the Optical Sector of the Institute of Geological Sciences in 1941. There, she worked on problems of camouflage for the Red Army and developed a method of analyzing optical properties of materials while in the field.

In 1945, Vedeneyeva founded the Laboratory of Crystal Optics at the Institute of Crystallography, part of the USSR Academy of Sciences; she headed the laboratory until her death in 1955. Among other contributions, her research proved that the coloration of different types of quartz is due to lattice defects.—GIULIANA VIGLIONE, special to C&EN

CREDIT: YOUTUBE (REDMOND); WIKIMEDIA COMMONS (VEDENEYEVA)



BRUCE VOELLER

A prominent figure in the struggle against the AIDS epidemic, Bruce Voeller was a scientist and activist whose work helped prevent transmission of HIV and advance gay rights. In fact, he coined the term *acquired immunodeficiency syndrome* (AIDS) as a replacement for the inaccurate and stigmatizing moniker *gay-related immune deficiency disorder*.

Voeller was born in 1934 in Minneapolis and grew up in the small town of Roseburg, Oregon. He excelled in his undergraduate studies at Reed College and earned his PhD in developmental biology, biochemistry, and genetics from Rockefeller University in 1961. After graduating, he stayed on as a research associate at Rockefeller. According to an obituary published at the time of his death in the *Journal of Sex Research*, Voeller was the youngest person to be promoted to associate professor at the university.

However, he paused his research career in order to focus on campaigning for gay rights. Voeller cofounded the National Gay Task Force in 1973 and served as its executive director until 1978.

In the late 1970s, Voeller cofounded the Mariposa Education and Research Foundation, which studied sexuality and sexually transmitted infections. As the AIDS epidemic raged across the US in the 1980s, Voeller and the Mariposa Foundation were at the forefront of research on preventing transmission of the virus later identified as HIV. He was one of the authors of a 1985 study in the *Lancet* showing that a popular spermicide, nonoxynol-9, could inactivate HIV (*Lancet* 1985, DOI: 10.1016/s0140-6736(85)92584-x).

Voeller died in 1994 of an AIDS-related illness. In 2019, he was one of the 50 inaugural people memorialized on the US's National LGBTQ Wall of Honor.—GIULIANA VIGLIONE, special to C&EN

WALTER WESTMAN

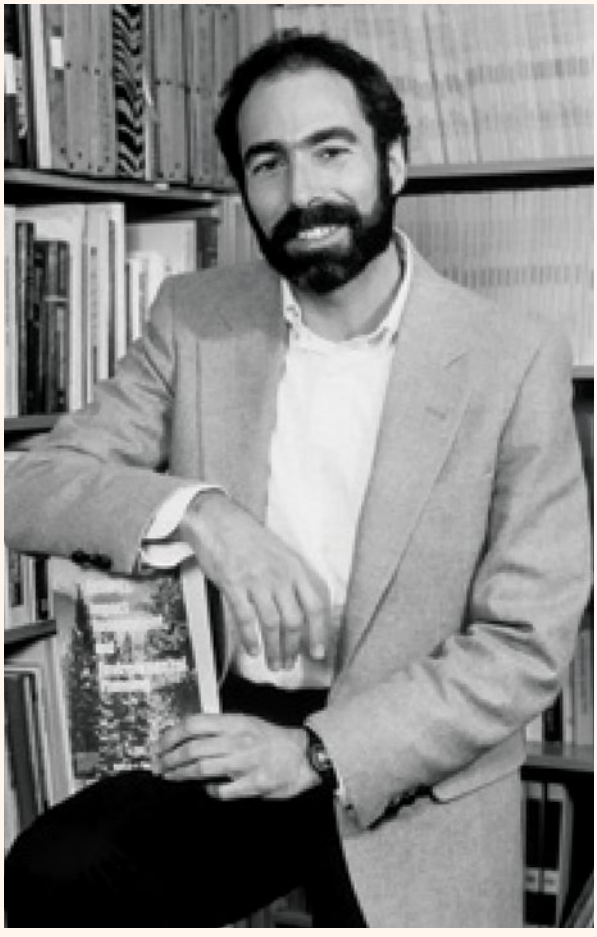
Walter Westman made an impact on both ecology and public policy, helping write environmental legislation and working to combat homophobia in the sciences.

Westman, who was born in New York City on Nov. 5, 1945, studied botany and ecology in the US and in Australia. For his PhD work at Cornell University, which he completed in 1971, he studied an unusual ecosystem of stunted trees thriving in poor soils in Northern California. During a fellowship with the US Congress, Westman helped write amendments to the Federal Water Pollution Control Act, which became the Clean Water Act in 1972.

Then he returned to academia, moving to the University of California, Los Angeles, in 1975. His work as a professor of geography was wide ranging, encompassing biogeography, the effects of fire and air pollution on vegetation, and the use of remote sensing to study ecosystems. In 1984, he moved to Lawrence Berkeley National Laboratory, where he could be close to San Francisco's burgeoning gay community.

Though he'd been open about his sexuality for some time, Westman's professional coming out was at the 1980 meeting of the American Association for the Advancement of Science. He organized a special session at the conference about homophobia in the scientific workplace and how it affected researchers as well as what science was being done. Another session he helped organize in 1985 addressed how homophobia was affecting AIDS research.

Also at that 1980 meeting, he founded the National Organization of Gay and Lesbian Scientists, now called Out to Innovate. He was on the group's board of directors until 1988, when he resigned to focus on AIDS activism. He joined Project Inform, an advocacy group empowering people with HIV and hepatitis C, and remained active with the organization until his death from AIDS on Jan. 3, 1991, at age 45.—NEIL SAVAGE, special to C&EN



CREDIT: NATIONAL GAY AND LESBIAN TASK FORCE RECORDS, #7301/DIVISION OF RARE AND MANUSCRIPT COLLECTIONS/CORNELL UNIVERSITY LIBRARY (VOELLER); COURTESY OF ROBERT WESTMAN (WESTMAN)

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RNA

JENNIFER PETTER

Entrepreneurial chemist wants to interfere with RNA to discover new drug targets

NEIL SAVAGE, special to C&EN

VITALS

- **HOMETOWN:** Stow, Massachusetts
- **EDUCATION:** AB, Dartmouth College, 1978; PhD, Duke University, 1983
- **CURRENT POSITION:** Founder and chief innovation officer, Arrakis Therapeutics
- **LGBTQ+ IDENTITY:** Transgender woman
- **FAVORITE LAB TOOL:** Lab tool? Oh, honey, if I walk into the lab, someone rushes up and asks me, "Can I help you? Don't touch that! Are you looking for somebody?"
- **PRECIOUS PETS:** I have 17 dogs, 16 of them collies. I breed them and show them.

Jennifer Petter was trying to decide what her next career move should be when she sat in on a 2015 conference session about small molecules interacting with folded RNA. The talk described how such molecules could interfere with the folding of RNA before it even produced a protein, possibly providing a new way to find drug targets for previously undruggable diseases.

"I decided instantly that I wanted to do that because it seemed like an interesting problem," says Petter, who soon thereafter founded Arrakis Therapeutics, where she is chief innovation officer. What made the problem interesting to her was, in large part, how difficult it seemed. "You really want to be out there solving problems that other people have not solved and blaze new trails," she says. "Well, this was as new as they come, honey."

Petter moved into industry in 1991 after 7 years as an assistant professor at the University of Pittsburgh. In 2012 she was at Avila Therapeutics when Celgene bought the company and made her vice president of chemistry.

Although she enjoyed the job, it involved a lot of travel, and eventually she decided she'd rather do something that kept her close to home with her teenage children. That led to her founding Arrakis, named for the planet in *Dune* with the giant sandworms. "Arrakis is the planet that produces precisely one thing," she says, explaining the name choice. Arrakis is mined for spice, a drug that's orally active and can penetrate the central nervous system—both qualities Petter hopes her company's RNA-degrading therapeutics will share.

Traditional small-molecule drugs work by binding to a protein involved in a disease process and altering that protein's activity. Arrakis, on the other hand, wants to find molecules that will stop the production of a target protein by binding to its RNA and locking its structure in place. RNA often has a folded structure that must unfold for messenger RNA to be translated into a protein. "RNA is upstream of all biology," Petter says. "So insofar as you can solve this problem, you have the potential to address pretty much any disease."

For instance, the company is studying Myc, a protein that plays an important role in cancer. Scientists have not yet developed any drug that can effectively target it. "It's a classic undruggable, but we sort of hit the reset button," Petter says. "We're going after the RNA that makes the Myc rather than the Myc itself."

"You really want to be out there solving problems that other people have not solved and blaze new trails. Well, this was as new as they come, honey."

CREDIT: VANESSA LEROY PHOTOGRAPHY

Arrakis has not yet proved that its small molecules can target and lock up RNA sequences. And when it does, it will need to show that these molecules can significantly affect disease. But Petter says she's encouraged by the company's internal data and hopes to have a candidate molecule for development by the end of this year.

Other pharmaceutical companies are also encouraged. In January, Amgen announced it would pay the company $75 million to research targeted RNA degraders for five diseases yet to be selected. Last year Arrakis signed a similar development collaboration agreement with Roche, for $190 million.

Michael Gilman, CEO of Arrakis, says he was skeptical when Petter first came to him with the idea for the company. "At the time, the idea that you could identify drug-like small molecules that bind RNA seemed like a crazy flyer—that's certainly what most investors told us," he says. "But I knew from my experience with Jen—I'd known her for over 15 years at that point—that if she thought it could be done, it could."

The pair had been friends for a long time. In March 2018, as the company was preparing for its B round of fundraising, Petter had dinner with Gilman and told him her news. Though at that point she presented as a man, she'd been on hormone replacement therapy for over a year and would soon be publicly transitioning. That dinner with Gilman was followed by a board meeting in April and a party in May, when she came out to the entire company as transgender. She'd told her three children a few months earlier. By June, she was showing up to work as Jennifer.

Her decision to come out was triggered by her wife's 2011 diagnosis of breast cancer. Her wife ultimately survived, but the "near-death experience" changed Petter's thinking. "This event affected me deeply, in ways that took time to understand, most notably realizing that none of us is granted forever," she says.

Transitioning while fundraising was challenging. She felt anxious in the moments before stepping into meetings with potential investors who thought they were going to be seeing a man. "There are a number of rooms you're going to walk in, and you just have to suck it up and be who you are, present your slides, and present the science and answer the questions," she says. "Once you're there, it's like, 'Well, you pulled the trigger, honey. We're doing this.' "

The B round was successful, raising $75 million.

And overall, Petter says colleagues have been supportive of her transition. "It would be difficult to imagine how it could have gone better," she says. "And for that, I'm deeply appreciative."

The fact that there are few openly trans people at senior levels in science and industry makes the process of coming out somewhat challenging, Petter says. "The pathway is sufficiently unknown that you don't know which of your anxieties are real and true and worth worrying about, and which ones are nothing to get worked up about," she says. She has no particular advice for younger LGBTQ+ people in the sciences because everyone's path is so different. "I try to take people where they're at, hear what their stories are," she says. "To the extent that my story is of any help to them, I'm delighted to tell it."

GREEN CHEMISTRY

ONE ON ONE WITH CAROLYN L. LADD

Graduate student **Kirstin S. Bode** talks with this organic chemist about queer advocacy in industry

After completing their PhD at the University of Montreal and a postdoc at the California Institute of Technology, Carolyn L. Ladd began working for Dow, developing sustainable technologies to reduce the carbon footprint of industrial processes. Kirstin S. Bode spoke with them about Ladd's career path and queer activism. This interview has been edited for length and clarity.

Kirstin S. Bode: Can you tell me a little bit about the research you did for your PhD?
Carolyn L. Ladd: For my PhD, I worked for André Charette at the University of Montreal. I spent some time working on C–H activation, specifically of cyclopropanes, as well as asymmetric catalysis. I guess that's when I first fell in love with homogeneous catalysis, and it also made me fall in love with palladium, my absolute favorite transition metal. That experience kind of just got me hooked into doing that type of work.

KSB: Did you choose the Charette group because you were interested in the research? Or did you choose that group because you liked the lab culture and the principal investigator's personality?
CLL: The thing I loved about working with André is he really embraced creativity and gave his students a lot of freedom to pursue things they were interested in. I talked to a lot of students before I joined, and that was what they experienced. André always told us, "When you run your research, it's like you're running your own business." He encouraged that type of entrepreneurial spirit and made you take ownership of your projects. So yeah, I liked that.

KSB: Was your goal throughout your academic career to end up in industry? Or were you planning to stay in academia?
CLL: During my PhD, I wanted so badly to be an academic! I really loved teaching and ingraining students with concepts like social responsibility and getting them to think holistically about their research. Everyone always seems to think that industry is the alternative if you don't go into academia, but I think what I've realized is that I'm so much happier in industry. I still get to do research, but I feel like I have a lot more opportunity. I love learning new things, and I love being able to talk with people who are doing new things, and I think there's just a lot of opportunities to do those things in industry, especially working at a company like Dow.

VITALS

CAROLYN L. LADD

- **HOMETOWN:** Edmonton, Alberta
- **EDUCATION:** BSc, University of Calgary, 2011; PhD, University of Montreal, 2018
- **CURRENT POSITION:** Senior research specialist, Dow, and site implementation lead, GLAD Collegeville
- **LGBTQ+ IDENTITY:** Nonbinary, genderfluid, neuroqueer person
- **FAVORITE LAB TOOL:** My favorite small, scooped spatula: it's the first thing I build a relationship with in the lab. Also, electrical tape and 1-dram vials. Supply chain shortage makes you appreciate the little things!
- **I OVERCAME ADVERSITY WHEN:** During my BSc I had some student loan issues and couldn't pay my tuition. I worked part-time at an Italian market and mentioned to my manager my plans to quit school. The owner loaned me the money, we worked out a payment plan, and I repaid him after I solved my loan issue. If this stranger hadn't stepped up, I wouldn't have finished my BSc.

CREDIT: COURTESY OF CAROLYN L. LADD

VITALS

KIRSTIN S. BODE

- **HOMETOWN:** Cleveland
- **EDUCATION:** AS and AA, Lakeland Community College, 2017; BS and BA, Kent State University, 2021
- **CURRENT POSITION:** PhD candidate, organic chemistry, Princeton University, Erik Sorensen's lab
- **LGBTQ+ IDENTITY:** Nonbinary
- **FIRST JOB:** My first job was as a phlebotomist at the Cleveland Clinic. It was originally just a job to put myself through undergrad, but I found that I loved patient care, and I gained a lot of health literacy. I still catch myself looking longingly at people's veins.
- **MENTOR:** My undergrad principal investigator, Jeff Mighion, really transformed my life as a chemist and as a person. He was a talented and deeply intelligent chemist, gave great advice about research and life in general, and was always

Kirstin S. Bode is a first-year PhD student at Princeton University. In addition to organic synthesis, they enjoy philosophy, fiber arts, and taking care of their many plants.

CREDIT: JESSICA NOVAK

To be honest, though, when I went recruiting, I actually thought I was going to go into pharma. I didn't even know Dow did organic chemistry! I went to that recruiting session being like, "This is just a practice. I'm not serious about this. I'm just going to ask them a bunch of ridiculously hard questions and see how they answer." And I got some very genuine and authentic answers, and they were willing to say, "Hey, we know we're not there yet [in terms of diversity, equity, and inclusion]. But we're working on it." So, yeah, I would say ending up at Dow was kind of a happy accident.

KSB: It sounds like you have a really supportive work environment. Can you talk a little bit about the "green flags" you look for when it comes to finding that kind of positive work environment?

CLL: I would say I think it comes down to the leaders; that is really the top priority. You want to look for people who exhibit inclusive leadership characteristics. You want somebody who is really self-aware, somebody who's curious about your experiences. One thing that I've thought about a lot lately is working for somebody who has good empathy and is compassionate. When you're talking to somebody, are they really hearing what you're saying? Are they asking you questions? Or is it all about them?

In terms of LGBTQ-specific things, I think being at a company that has openly out LGBTQ+ leaders is really important. And being in a place where they actually have LGBTQ+ advocacy groups or support groups is good. At Dow, our GLAD group [Dow's LGBTQ+ employee resource group] has an executive sponsor, so the fact that this group has someone in power behind it is really important. Oh, and people who put their pronouns in their email signature! That seems like a really small thing, but it's really not.

KSB: You mentioned being involved in queer advocacy groups at Dow. Could you speak about what kind of activism you do both within and outside of your work?

CLL: During my PhD, I was very into my research. That was my priority—I compartmentalized myself into a little box and said, "I'm going to do chemistry, and that's all I'm going to do." Even though I was experiencing issues related to my identity at the time, I didn't do anything about it. Then I started getting more involved at the Caltech Center for Inclusion and Diversity, and I started realizing that these things matter. If you want people to do their best work and reach their fullest potential, the first step has to be creating a healthy, inclusive culture.

Today, I do a lot of activism work. Last year, I started volunteering for this amazing grassroots crisis text line called Thrive Lifeline. They recruit crisis responders who are from marginalized identities and focus specifically on people in STEM [science, technology, engineering, and mathematics], but the line is open to anyone. I think supporting people at a mental health level is so important because we need trans people to make it to the other side; we need them to be supported.

At Dow, I'm starting a collaborative project with our trans allies, parents of trans kids, and trans employees. We're making a working group at Dow called Transform. That's going to hopefully make sure that trans voices are heard, and we're trying to figure out where the gaps are, what problems we're not solving related to trans inclusion at Dow. I guess that my hope is just to make things better for the next generation so that they feel more included and supported and feel like they're going to end up working in a workplace where they can thrive.

KSB: I really relate to what you said about your activism during grad school because I'm in my first year, and I realized I didn't know any other queer people at Princeton. So we started a group called Queer in Chemistry—our main mission is to make a space for queer people and allow people to feel like we have a community here in the Chemistry Department. And here I am thinking I'm doing so much, and you've listed so many different things you've been involved in! I'm very impressed, honestly. But that makes me think, How do you handle activism burnout and finding a healthy level of engagement?

CLL: I think the first step is prioritization. Think about the things that you want and make a list of the things that you get the most joy from doing. So for me, mentoring other LGBTQ+ folks, I love that service. But I know that the crisis line is really emotionally draining on me. Especially working with youth—it's hard because they talk about self-harm and suicidal thoughts and that sort of thing. And some of those things hit me in a really hard place, and then I have to really make sure I've structured some time for me to do self-care, giving my brain time to recover. I think being aware of how you're feeling and checking in with yourself is really important.

I also think that work just needs to get spread around, quite frankly. That's what we need our allies for. It's OK to pull back if you feel like you've taken on too much. It's OK to say to yourself, "OK, I made a commitment to this thing. Can I give this to somebody else?" If there are some things on that list that you want to do for activism that maybe you could delegate to someone else, find an ally and work with them to come up with a plan.

NANOMATERIALS

DAVID SMITH

This supramolecular chemist builds self-assembling nanogels for regenerative medicine

PAYAL DHAR, special to C&EN

VITALS

- **HOMETOWN:** Manchester, England
- **EDUCATION:** BA, 1993, and DPhil, 1996, University of Oxford
- **CURRENT POSITION:** Professor of chemistry, University of York
- **LGBTQ+ IDENTITY:** Gay man
- **FAVORITE ELEMENT:** Nitrogen—I love that this most inert of elements, once incorporated into molecules, often gives them much of their character in terms of reactivity and noncovalent interactions. It has been an ever-present element throughout my career, and the way its initially conventional exterior hides deeper secrets really speaks to me.
- **GO-TO STRESS RELIEVER:** Cooking. Not only is it like those practical skills I used to employ in the lab, only with tastier end results, it's a kind of therapy for me. Also my son is at his most settled and happy when he sees me busy in the kitchen, cooking something (hopefully) delicious to eat.

For David Smith, a professor of chemistry at the University of York, the personal, political, and professional are inextricably interwoven. As an out gay man leading a team of student researchers, Smith knows that visibility is critical to diversity. If you can't be authentic about who you are, you thrive less at work, he says, which is not conducive to belonging in the workplace or to good science.

Smith works with self-assembling nanogels that can be used for drug delivery, tissue engineering, and environmental remediation. "We develop gels that assemble from small-molecule building blocks," he says. Using chemistry, his team programs these gels to be dynamic, so they respond over time or change in response to stimuli. For example, his group made a gel that can pull precious metals out of electronic waste and become a conductive material.

His team also shapes and patterns gels in water to direct the growth of different kinds of tissues, like bones and nerves, from stem cells. "The next stage will be to bring them all together into a single material," Smith says, "where a particular region of the material stimulates bone and another region stimulates nerves and maybe something else connects them together." That way, one day they could perhaps build a whole new organ to be transplanted into a patient.

Smith has a personal connection to his work in regenerative medicine. His husband, Sam, had cystic fibrosis and died when his body rejected a lung transplant—a common problem with the procedure. "If you could generate an organ from a patient's own stem cells, then they wouldn't have to wait for a donor," Smith says, "and they wouldn't reject the organ because it would be grown from their own cells."

Smith's work blends biology, chemistry, and engineering. His research team includes people with backgrounds in chemistry, pharmacy, and biology. But he doesn't just support scientific diversity—Smith is also an advocate for LGBTQ+ people in science, and he is on the Royal Society of Chemistry's Inclusion and Diversity Committee. His advocacy began in 2005 when a student at the University of York went to the head of the Chemistry Department to report that there was homophobic gossip about Smith, who wasn't out at work at the time. The department head didn't know how to broach the subject, and "ultimately, it convinced me that it was worth being out and being more vocal about things," Smith says.

Years later, Smith's openness had a direct impact on Charlie Wand, a trans man who is now a lecturer in natural sciences at the University of Exeter. He did his PhD at the University of

"I'm very interested in how we make culture change in science in a whole range of ways."

CREDIT: WATSAMON JUNE TRI-YASAKDA

York because he knew about Smith and his efforts at inclusion. "I'm sure that Dave Smith probably doesn't remember who I am," Wand says, "but I certainly knew who he was before I started. And the fact that he was out and there and succeeding was definitely a good plus point for going to York."

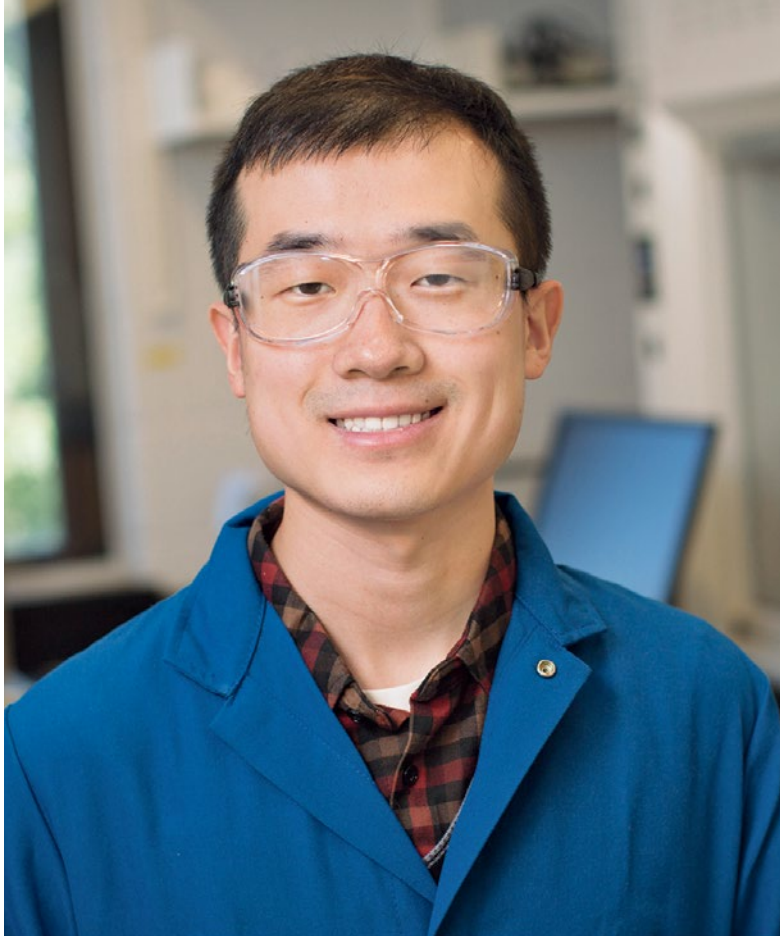
Similarly, Kirsty Ross, a scientist who works at the University of Strathclyde as an outreach officer supporting researchers in their public engagement activities, was inspired by listening to David Smith speaking at an equality, diversity, and inclusion initiative for UK universities. Ross, who is bisexual, says that seeing how Smith interweaves his identities as a gay man, father, husband, and researcher made her think there was more she could do to support others. "I decided after that session to become more visible, more vocal, more out there in terms of my identity," she says.

Smith, a single dad to a 9-year-old, has been advocating for flexible working arrangements for scientists. He is also the author of *Tw-eat Together*, a collection of Twitter-style recipes along with stories of his adventures in cooking with Sam. Plus, he is a proficient tweeter. He says he finds Twitter to be "useful for speaking about all aspects of equality and diversity in science and in the workplace." He posts about politics, food, and the culture of science as well. "I'm very interested in how we make culture change in science in a whole range of ways."

He wishes that scientists would also listen to lived experiences as much as they are swayed by data. Smith says that when he does outreach education for schools, he talks about how Sam motivated his lab's work on tissue engineering. "I think it's a really nice way of demystifying that there's been all these gay scientists, and in some cases, they've actually investigated science that is relevant to gay people as well."

ELECTROCHEMISTRY

ONE ON ONE WITH SONG LIN



Graduate student **Alby J. Joseph** talks with this organic chemist about the people and experiences that shaped his career

Reimagining what is possible: in both his scientific pursuits and his personal life, Song Lin is doing just that. Growing up in Tianjin, China, Lin was fascinated by the bizarre chemical reactions he saw in cartoons as a child. Now, Lin is using electrochemistry to power new chemical transformations. Alby J. Joseph spoke with Lin about what inspired his interest in electrochemistry and about what it means to be an out gay chemist in academia. This interview has been edited for length and clarity.

Alby J. Joseph: Tell me about your research at Cornell University.
Song Lin: As an organic chemist, a couple of things really excite me: one, how molecules come together to form new bonds in different reactions, and two, how we can utilize these reactions to make complex molecules, like natural products or pharmaceuticals. In our research, we develop new organic reaction methodologies. In other words, we invent new chemical reactions that we hope will help people make pharmaceuticals faster and more efficiently. A special feature of our research program is the use of electrochemistry. It's relatively new. Instead of using chemical oxidants and reductants to power reactions, we insert electrodes and use current to drive chemical reactions. Once you replace chemical reagents with electricity, you potentially make the reaction greener and more sustainable. Pharmaceutical companies are very interested in this. One aspect that fascinates me is whether we can achieve new chemical transformations with electricity that we could not do using traditional chemical approaches.

AJJ: That sounds exciting! Is that thought what brought you to the field of organic electrochemistry?
SL: Yes! I was trained as an organic chemist in graduate school. In my postdoc, I joined an inorganic chemistry lab where I happened to learn electrochemistry. We were doing electrochemical energy conversion, which had nothing to do with synthesis. When I started my independent career, I thought about merging the expertise I had from my grad school and postdoc training by asking if we could use electrochemistry to promote chemical synthesis.

AJJ: Now looking back, what first inspired your interest in chemistry? Were there any mentors that were especially impactful?

VITALS

SONG LIN

- **HOMETOWN:** Tianjin, China
- **EDUCATION:** BS, Peking University, 2008; PhD, Harvard University, 2013
- **CURRENT POSITION:** Associate professor, Cornell University
- **LGBTQ+ IDENTITY:** Gay man
- **FAVORITE MOLECULE:** TEMPO (tetramethylpiperidine-1-oxyl): it is a stable radical, how fascinating! It has also led to many interesting discoveries in my lab's research.
- **MENTOR:** My first research adviser was Zhangjie Shi when I was an undergraduate at Peking University. His passion for chemistry, his perseverance, and his unwavering support to his students are things that I will strive to emulate in my own career.

CREDIT: CORNELL UNIVERSITY

VITALS

ALBY J. JOSEPH

- **HOMETOWN:** Westbury, New York
- **EDUCATION:** BS, Massachusetts Institute of Technology, 2021
- **CURRENT POSITION:** PhD candidate, chemical biology, Stanford University, Lingyin Li's lab
- **LGBTQ+ IDENTITY** Gay man
- **FAVORITE MOLECULE:** My favorite molecule is 2'3'–cyclic GMP–AMP (cGAMP). This cyclic dinucleotide activates the innate immune STING (stimulator of interferon genes) pathway to trigger an anticancer immune response. The role of this molecule has led to discoveries that may transform cancer immunotherapy.
- **IMPACTFUL BOOK:** *The Autobiography of a Transgender Scientist*, by Ben Barres. It was a very impactful book for me.

Alby J. Joseph is studying the regulatory mechanisms underlying the cGAS-STING innate immune pathway (which involves cyclic GMP-AMP synthase and stimulator of interferon genes) with the goal of advancing cancer immunotherapy.

CREDIT: NINA FATUZZO

SL: I was fortunate to have some great mentors, even since elementary school. I was always a curious child, so simple experiments, like dripping hydrochloric acid onto limestone and seeing it bubble, were really fascinating to me. I think the biggest influence, or when I decided to be a chemist, was in high school. I had this phenomenal chemistry teacher. It was a life-changing experience to learn chemistry from him; he was so passionate, not only about teaching but also about chemistry itself. My undergraduate adviser also influenced my life a lot. He was super passionate about chemistry and encouraged all his students to become professors.

AJJ: What was it like navigating an academic career as a gay chemist? How has this experience intersected with your identity as a Chinese immigrant?

SL: Throughout my career, I had the fortune of being in very open environments: Boston as a grad student, the Bay Area as a postdoc, and now Ithaca, New York, as a professor. I have also had supportive colleagues, including my supervisors and lab mates. I haven't had many bad experiences, but there were still challenges. I came out in my last year of grad school. It was very hard to figure out my own identity while dealing with the stresses of grad school. Also, being a gay chemist, you confront coming out whenever you enter a new environment. Psychologically, it is a burden to always think about how to come out, how your friends will react, or how it could influence your career. I guess that is compounded by the fact that I'm a Chinese immigrant. I think that Chinese society is a little bit less receptive to the idea of being gay. Before I accepted the invitation to do this interview, I was a little worried about how friends and colleagues in China would perceive this. I decided that I should be truthful to myself and to the community. Representation is so important. I think if it weren't for the success of people like Tehshik Yoon and Carolyn Bertozzi, who are out and loud, I probably would've hesitated more before pursuing this career.

AJJ: Thank you for sharing that. I can relate to those feelings about coming out. Is there any advice you would give to young LGBTQ+ scientists?

SL: I see how the coming out process can still be daunting for young scientists. I think the obstacles I faced were more mental. It was helpful for me to talk to people that were supportive. I think my advice is to find someone you trust. I had a friend that I came out to first, and she helped me in coming out to other people in the lab. I would say coming out is entirely your decision. Don't feel pressure to come out to anyone or not. In an ideal world, everyone should be out, and everyone should be accepting, but because of the challenges, I think we have to take care of ourselves and know what makes us happy.

AJJ: How has your identity shaped your goals as a professor?

SL: We talk about all the challenges, but I think being a gay person comes with an opportunity and responsibility to be a role model for the next generation. It's an opportunity that you don't have if you're not part of the community. That responsibility feels very important to me. Obviously, I love the science. I want to focus all my energy on the science, but at the same time, I want to advocate for my students, many of whom come from immigrant or underrepresented backgrounds.

I think being a gay person comes with an opportunity and responsibility to be a role model for the next generation.

I want to learn more about you as well. Tell me a little bit about yourself.

AJJ: I'm a first-year chemistry student in Lingyin Li's group at Stanford University. We study this pathway in the innate immune system that is important for cancer and autoimmune disease. I really enjoy thinking about the mechanisms underlying the pathway, how it's regulated at a molecular level, and what that means therapeutically. I hope to have an impact on human health.

SL: Have you thought about what you want to do?

AJJ: I would love to be a professor. My passion for chemistry and chemical biology, and science research in general, was inspired by the teachers, professors, and research mentors I had. I like the idea of being in that role one day.

One last question: What keeps you motivated in your day to day—both in and out of the lab?

SL: Just thinking about chemistry ideas and how to make projects work. When I get stressed out, I like to strip down the other aspects of my job and focus on what I love—the chemistry. Talking to students about ideas and getting their feedback is also really rewarding. Outside the lab, my family is what keeps me going. Knowing that every day, no matter how the day went, I can come home to my husband and our two dogs is especially nice.

PROCESS CHEMISTRY

JASON S. TEDROW

Sanofi's head of process chemistry mixes traditional chemistry with flow chemistry and new biocatalysts to improve synthesis efficiency

NEIL SAVAGE, special to C&EN

VITALS

- **HOMETOWN:** Salem, Massachusetts
- **EDUCATION:** BS, Trinity University, 1995; PhD, Harvard University, 2001
- **CURRENT POSITION:** Global head of process chemistry, Sanofi
- **LGBTQ+ IDENTITY:** Gay cisgender man
- **IMPACTFUL BOOK:** *And the Band Played On*. Ultimately this is a story about where science and humanity intersect. Really how marginalized communities become further demonized due to lack of empathy and social understanding.
- **RECENT FUN PROJECT:** My partner and I built a victory garden in our backyard at the start of the pandemic. Making gazpacho and cucumber salads is quite rewarding in the summertime.

Jason S. Tedrow's chemistry journey started in a class he had to take. He was a premed student at Trinity University in San Antonio, and one of the course requirements was to take an organic chemistry class.

One day the professor, Michael Doyle, told the class that residency programs would look for academic papers that the students had contributed to, and since there wouldn't be much time for research in medical school, the premed students should consider a research position in his laboratory. So after class, Tedrow went to the teacher and asked if he could join the lab. That day led him down a path to a career in the pharmaceutical industry developing new approaches to making drug molecules on large scales.

"It completely transformed me and what I wanted to do," Tedrow says of the experience in Doyle's lab. The group was studying chemical transformations catalyzed by the metal rhodium, and the work fascinated him. Instead of continuing to medical school, Tedrow decided to study organic chemistry as a graduate student at Harvard University.

Though he initially thought he'd stay in academia as a researcher, by the time he'd earned his PhD in 2001, Tedrow had decided he'd rather go into the pharmaceutical industry, where he could tackle the problems of manufacturing drugs at a scale no academic lab could approach. "There's something just innately sexy about looking at a drum of drugs that you made and saying, 'I had my hand in that. I designed the chemistry to do that.'"

His first job was in process chemistry research at Abbott Laboratories. Process chemists take the drug compounds that company researchers have identified and develop efficient methods for making the molecules in large amounts. "You don't get to design the molecule, but you get to design the chemistry around it, and that's what I really, really love," Tedrow says.

That love, it turns out, was requited. Since April 2021 he's been global head of process chemistry at Sanofi, a French pharmaceutical company, at its research facility in Cambridge, Massachusetts. He leads the team that designs the synthetic pathways the company uses to make small-molecule drugs. The team is trying to develop chemical processes that will reduce manufacturing costs and speed up production while being more environmentally conscious.

"It's really exciting that we as leaders can set up programs, set up employee resource groups, really reach out and mentor younger LGBTQ people as they evolve in their careers."

CREDIT: VANESSA LEROY PHOTOGRAPHY

To achieve those green goals, the company does a lot of work on processes that rely on biocatalysts, which are enzymes derived from living organisms, like bacteria. These enzymes can run specific chemical transformations. "They're infinitely tunable," Tedrow says. "You can change the amino acids and really tailor the enzyme to do exactly what you want it to do." Unlike some metal catalysts, the enzymes tend to be nontoxic and inexpensive.

While learning tricks from nature is valuable, Tedrow says, more traditional chemistry is still necessary when process chemists need to run a reaction that nature never intended. Sanofi, like other drugmakers, is also increasingly turning to continuous manufacturing, in which reagents and starting material flow through a reactor to continuously make product, rather than running reactions in batches. This method can reduce costs and production times. "We're looking to blend traditional chemistry, continuous manufacturing, and biocatalysis in the same toolbox," Tedrow says.

This focus on expanding the set of drug synthesis tools is nothing new, says Alan Cherney, a senior scientist at Sanofi who had previously worked with Tedrow at the biotechnology company Amgen. Tedrow was at Amgen for 17 years, spending his last 5 years as a scientific director. Early in his time at Amgen, Cherney says, Tedrow "recognized the growing complexity of our synthetic portfolio and responded by becoming a major advocate for technology development and continuous improvement within the department," Cherney says.

In fact, Tedrow's promise was apparent even in his undergraduate days, says Doyle, now a professor at the University of Texas at San Antonio. Doyle remembers Tedrow as one of the top students in his classes. "When I wrote recommendations for him when he was applying for employment after graduate school, I stated, 'He has what it takes to be the very best. I'd bet my career on his success,'" Doyle says. "And I have not been mistaken in this assessment."

One thing Tedrow did not do as an undergraduate was come out as a gay man. Texas in the early 1990s did not seem to him to be a welcoming environment, he says. "It was something that I actively tried to hide."

And there was a lack of role models. "Searching for gay people in the sciences has been relatively difficult until recently," he says, "so I didn't have a gay mentor in the sciences."

Things began to change when he moved to more liberal Cambridge for graduate school. He began to meet more LGBTQ+ people, including Tom Stilling, now his partner of 22 years.

Life for LGBTQ+ people in the US has changed so much since his days as an undergraduate, Tedrow says, pointing to the legalization of marriage and the adoption of many legal protections. It's also not as difficult to find a gay scientist, he says. In fact, he tries to be an example and a mentor, taking part in LGBTQ+ employee groups and going to events sponsored by OUTbio, a group for Boston-area biotech employees.

"It's really exciting that we as leaders can set up programs, set up employee resource groups, really reach out and mentor younger LGBTQ people as they evolve in their careers," Tedrow says. "It's a great time to be an out, proud chemist."

SYNTHESIS

ONE ON ONE WITH RAUL NAVARRO

Graduate student **Grace Wang** talks with this organic chemist about developing an identity as a queer scientist

Raul Navarro develops new chemical reactions in the synthesis of biologically active natural products as an assistant professor. Grace Wang spoke with Navarro, who was at the California Institute of Technology for graduate school roughly a decade before Wang. They discussed shifts in graduate school culture, balancing personal identities and research life as scientists, and their chemistry origin stories. This interview has been edited for length and clarity.

Grace Wang: When you were just starting graduate school at Caltech around 2008, it was an interesting time, right? Proposition 8, which was intended to ban same-sex marriage, was passed in the state of California elections; on the other hand, Barack Obama had just won the [presidential] election, and during his presidency, gay marriage was legalized nationwide by the Supreme Court. Was coming out a decision you felt like you had to make on a daily basis at a place like Caltech? Was it a difficult decision?

Raul Navarro: Yes, it was an interesting time and certainly feels like very long ago. It's amazing to me how much the graduate student culture has changed and how much the discussion has really shifted. For example, mental health was not something we talked about when I was in grad school.

Going back to your question about coming out, as someone who identifies as LGBTQ, you kind of have to do this every time you go through transitions, are in new surroundings, and are meeting new people. When I moved across the country from LA to go to Yale, in my head I was walking up to people saying, "Hi, my name is Gay." At Caltech, I had to navigate this space of coming out again, and now in the context of a really scientifically driven community. In retrospect, I made it such a big deal coming out to my friends and colleagues during graduate school. But that was something that I really had to do, like number 1 [priority]. It was part of being authentically myself, and to acknowledge that and to celebrate that aspect of me contributes to my scientific well-being as well.

GW: You kind of mentioned or hinted at this culture in academia, especially for scientists, of feeling the need to compartmentalize your personal identities and your scientific life. Could you elaborate a bit on your experience balancing the two?

VITALS

RAUL NAVARRO

- **HOMETOWN:** Los Angeles
- **EDUCATION:** BS, Yale University, 2008; PhD, California Institute of Technology, 2014
- **CURRENT POSITION:** Assistant professor, Occidental College
- **LGBTQ+ IDENTITY:** Gay cisgender man
- **RECENT FUN PROJECT:** I recently took up sewing! I've always been drawn to fashion and like the idea of one day making all of my own clothing. The most complicated thing I've made so far is a button-up shirt. It took a surprising amount of time, but I wear it proudly.
- **GO-TO STRESS RELIEVER:** Running! I've been running since I was in high school. Although it started out as a way to get good exercise, it has since evolved into meditation of sorts. That might sound odd, but I often find my brain at peace in the middle of a long run.

CREDIT: MARC CAMPOS

VITALS

GRACE WANG

- **HOMETOWN:** Boynton Beach, Florida
- **EDUCATION:** BS, Duke University, 2017
- **CURRENT POSITION:** PhD candidate, chemical biology, California Institute of Technology, David Tirrell's lab
- **LGBTQ+ IDENTITY:** Gay/lesbian woman
- **FAVORITE MOLECULE:** Pyocyanin. It is a pigment produced by the opportunistic pathogen *Pseudomonas aeruginosa* and makes the bacterial cultures appear a gorgeous cobalt–aquamarine color.
- **GO-TO STRESS RELIEVER:** Hiking in the Angeles National Forest

Grace Wang uses chemical tools to study polymicrobial systems. Her thesis focuses on chemoselective proteomic analysis of bacterial interspecies interactions.

CREDIT: COURTESY OF GRACE WANG

RN: The reality was that when I first started, those parts of myself weren't things that I deliberately celebrated or acknowledged to be a significant part of who I was. I was very much concerned with developing as a scientist, and at a place like Caltech, you come here to focus on doing that. However, what I ultimately realized was that there are these parts of myself that influence [my scientific work]. Like, there's no way for me to necessarily navigate being a scientist without being someone who identifies as queer, without being someone who is Mexican American, right? Who I am as a scientist, ultimately, is inextricably tied to all of that.

GW: I happen to know your PhD adviser, Sarah Reisman, to be a great LGBTQ+ ally and very supportive of inclusivity in STEM [science, technology, engineering, and mathematics]. How did having a mentor who values diversity impact your experience in graduate school?

RN: This brings up a good point in terms of active allyship from mentors. Something Sarah said that tipped me off—I forget what we were talking about, but Prop 8 came up, and she clearly expressed vocal support for the LGBT community. That was such a small gesture on her part, maybe, but to me, it spoke volumes of the kind of support system that I had that gave me a lot of confidence to let her know a little bit more about myself and be more personal.

Now, as a mentor myself, I think a part of me wants to be that sort of representation to students that I didn't quite get growing up. It makes me really sad that growing up, I never had that sort of coalescence of a scientist who is someone that identifies as queer. This is part of the reason that I do what I do. I love being able to teach, certainly, and I think another big motivation for me is to be that representation.

GW: You mentioned you really love teaching—do you have a favorite reaction to teach in organic chemistry class?

RN: I personally love when I get to teach the Diels-Alder reaction because it brings in so many elements of fundamental organic chemistry reactivity, but it also gets a bit into physical organic chemistry in terms of thinking about orbitals. I enjoy teaching how to visualize that stuff. There was one semester where one of the students I was teaching was a dancer, so I was trying to show her how things that I was drawing in one plane move in certain ways, and we started playing with our hands. I came up with a little dance move to make sense of the reaction; it was just really fun.

There's no way for me to necessarily navigate being a scientist without being someone who identifies as queer.

GW: What is your origin story as a chemist?

RN: I didn't have an upbringing where I had the privilege to understand what it really means to do research or graduate school or anything like that. Those were such foreign words to me when I first went to Yale as an undergrad. I had no idea. I wanted to be a doctor, to give you a sense for what I wanted to do. I saw a flyer somewhere on campus, and it was advertising a research program for the summer. And I was like, Well, medical schools look for research experience. I just had zero clue.

A week before the program was supposed to start, I still had no idea which lab to join. The program director basically had to choose for me and drop me off at John Hartwig's lab, and I was assigned a grad student. I just remember seeing fume hoods, seeing all the chemicals, the glove boxes, and I was just like, I can't believe you can do this for a living! I thought it was just so cool to be in the lab mixing things, even though when I first started taking organic chemistry, I hated it.

How about you?

GW: I can relate to the no-upbringing part, but I had the opposite experience choosing a lab. I was like you, premed, never did research, but I had just taken organic chemistry and really liked it, so I went on the Duke chemistry website looking for a lab. I distinctly remember when I saw on the website that there was a new chemistry faculty studying malaria, I felt like something in me clicked. My undergraduate adviser, Emily Derbyshire, initially turned me down—her lab was too popular. I went back and argued for myself because I just had such a gut feeling that this is the research I want to do, at a unique niche intersecting chemistry and microbiology.

COMPUTATIONAL CHEMISTRY

CHARLIE WAND

This computational chemist uses simulations to study molecules' behavior

PAYAL DHAR, special to C&EN

VITALS

- **HOMETOWN:** Swindon, England
- **EDUCATION:** MChem, University of Oxford, 2009; PhD, University of York, 2013
- **CURRENT POSITION:** Lecturer in natural sciences, University of Exeter
- **LGBTQ+ IDENTITY:** Bisexual trans man (queer as an umbrella)
- **RECENT FUN PROJECT:** Last year I set myself a New Year's resolution to draw something every day, and I'm pleased to say I managed to do it for the whole year! The hardest part was deciding what to draw.
- **PRECIOUS PET:** I have a 10-year-old golden retriever named Beatrix. Her favorite pastime is sleeping on the sofa with her latest toy. At weekends we often go for a walk along the river, where she enjoys snuffling along the bank and saying hello to everyone we pass.

Charlie Wand was always going to be a scientist. When he was 4, he would set up "experiments" all around the house—things like dishes of water to see which would evaporate first. His mother, a university lecturer in mathematics, "put up with me doing all sorts of things like that," Wand says. She encouraged him, telling him anyone can do science.

Today, Wand is a computational chemist and a lecturer in the department of natural sciences at the University of Exeter. He works at the intersection of chemistry, physics, and engineering, using computers to look at the physical properties of molecules and how they behave on the nanoscale.

"I look at things like polymers and how water diffuses through a polymer at the molecular level," he says. He can follow a water molecule through the polymer system to see what motifs in the polymer structure affect the water diffusion. For example, Wand says, "if you have this amount of whatever polymer and this amount of copolymer and mix them together, you get really high diffusion. So perhaps that's not going to be very good for making plastic packaging."

What fascinates Wand about computer modeling is the possibility of prediction. During his PhD at the University of York, he predicted a phase transition that proved to be true experimentally a few years later.

As a bisexual trans man, Wand knows that identities intersect, and his identity as a scientist is connected to his other identities. He is also committed to promoting equality, diversity, and inclusion within academia and in science, technology, engineering, and mathematics (STEM) fields in particular.

Wand transitioned during his doctoral studies at York. Even with the support of his department and the university's having procedures in place to enable his transition, he still found life at his workplace lonely and had to take a year off for mental and physical health reasons.

Having spent the first 21 years of his life being perceived as female, Wand says he has a unique perspective on how different people are treated. So when he started his postdoctoral position at the University of Manchester, he decided to do outreach work about LGBTQ+ inclusion in STEM. Wand says that by doing so, he's "letting people know that you can be a trans person, especially a transmasculine person in STEM, and actually hopefully succeed."

CREDIT: HENRI T

Support for LGBTQ+ scientists has improved a lot with social media since he came out, Wand says, and it's no longer so lonely. "I'm aware of a much larger community out there." He's found LGBTQ+ scientists on Twitter, "and there's also things like the LGBT seminars and just spaces where you can be queer and scientists together, and not having to sort of separate the two."

Getting ahead in academia is difficult, which makes it even more important to see "people like you doing science," Wand says. He applied for numerous positions before getting his lectureship at the University of Exeter, and he found the process discouraging at times. If you don't see people like you in your field, he says, you think, "Maybe I need to be cis, maybe I need to be straight to have a chance of doing this." Being visibly queer in academia, he adds, shows others that you can be queer and still succeed.

If you don't see people like you in your field, he says, you think, "Maybe I need to be cis, maybe I need to be straight to have a chance of doing this."

Wand acknowledges the support of his former principal investigator, Flor Siperstein, a chemical engineer at Manchester, for getting the job at Exeter. She believes that Wand has what it takes to be a successful researcher, whether in academia or industry. "Charlie has an enormous passion for research and teaching," she says, adding that he is doing exciting work applying molecular simulation tools to solve problems in the chemical industry.

"More importantly, he can work with people from different backgrounds, working on different techniques, and deliver interesting insights," Siperstein says.

When he is not predicting chemical structures, Wand likes to cook. "Cooking is just chemistry, but you can eat the product," he says. And his allergy to tomatoes doesn't stop him from exploring new foods. "On average, I try about one new recipe a week just to see what things are like, so I'm quite adventurous."

CATALYSIS

ONE ON ONE WITH ALISON WENDLANDT

Graduate student **Bec Roldan** talks with this organic chemist about her calling to the research lab and how being queer emboldens her academic endeavors

Fascinated by the power of organic synthesis and catalysis, early-career Massachusetts Institute of Technology chemist Alison Wendlandt is solving cutting-edge questions. Wendlandt is pushing the boundaries of selective, catalytic chemistry in alkene isomerization reactions and carbohydrate and complex molecule synthesis. Bec Roldan spoke with Wendlandt about her journey to leading her own research lab and how being queer has been integral to that journey. This interview has been edited for length and clarity.

Bec Roldan: So, how did you find your way to organic chemistry?
Alison Wendlandt: I initially entered college as a math major and quickly realized what real math was, and that was not my thing. Then I found organic chemistry, and that language of organic chemistry really made sense to me. I fell in love with that class. Once I managed to find my way into a research lab, I realized I really enjoyed the day-to-day work of organic chemistry much more than any other lab experience I ever had. If you can find some joy in running a column, then it's OK if that reaction failed in the end, right? That really sustained me through graduate school and my postdoc, just loving the actual work.

BR: I can definitely relate to that. Being in the research lab as an undergraduate felt so right to me. There's a real art to organic chemistry and an opportunity to be creative, which I always loved. So you're now an assistant professor of chemistry at MIT—what was an influential moment or two that got you to where you are now?
AW: I remember publishing my first paper; it was a really [bad] paper, but I was like, I'm going to make it work. I just remember when that paper was done and finished, I thought to myself, I can do this. I can do chemistry research, and I can publish papers. And I can think of projects and drive them through to completion. And then I was like, Well, now I want to write good papers.

BR: Yeah, just getting that first bit of validation is so important. Knowing that somebody thinks what I'm doing is at least good enough to be published.
AW: Yeah, it was a real confidence boost as a first-year graduate student. I remember thinking, I can push myself now that I know where my feet are. Another great experience I had was getting an opportunity to work with my heroes. I really love

VITALS

ALISON WENDLANDT

- **HOMETOWN:** Golden, Colorado
- **EDUCATION:** BS, University of Chicago, 2007; PhD, University of Wisconsin–Madison, 2015
- **CURRENT POSITION:** Assistant professor, Massachusetts Institute of Technology
- **LGBTQ+ IDENTITY:** Queer
- **FAVORITE LAB TOOL:** Acetone wash bottle: for all the amazing reaction ideas that are not such amazing reaction ideas.
- **PRECIOUS PETS AND PLANTS:** We have a neurotic dog, an 18-year-old cat, and something of a plant-hoarding situation.

CREDIT: JUSTIN KNIGHT

VITALS

BEC ROLDAN

- **HOMETOWN:** Saint Francisville, Louisiana
- **EDUCATION:** BS, Rhodes College, 2019
- **CURRENT POSITION:** PhD candidate, synthetic organic chemistry, University of Michigan, Corey Stephenson's lab
- **LGBTQ+ IDENTITY:** Queer, nonbinary person
- **FAVORITE ELEMENT:** Carbon, easy. Can't mess with perfection.
- **FAVORITE LAB TOOL:** Post-it notes, definitely. Is that a lab tool? It's a lab tool for me, at least. They're all over my desk and bench space. Without them, my ADHD brain would get the best of me and I would never remember anything. Oh and the speaker in my bay because that's how I get my Taylor Swift fix.

CREDIT: COURTESY OF BEC ROLDAN

Bec Roldan uses the power of radical chemistry in the synthesis of biologically relevant organic molecules. They are a cohost of the podcast *My Fave Queer Chemist*.

Shannon Stahl's work. I really love Eric Jacobsen's work, and so to get the chance to do my training in their labs was incredible. For some people, opportunities like that are all around them, and for others of us, we see a lot of closed doors. And then when you see an open door like that, for me anyway, I was going to make the most of it.

BR: I definitely get what you're saying of feeling like doors are just automatically closed to you and not knowing if you're going to have a chance in this field. That was a big thing for me in graduate school, and joining Corey Stephenson's lab, getting the validation that I can actually do this, was so important to me. Really excelling in graduate school was never something I saw for myself, so just having someone say, "I think that you're good enough to be here, and I'm going to actively support you by opening these doors that you never knew were possible" was huge.
AW: That's exactly right. Can I ask, what are you hoping to do after graduate school?

BR: That's a big question. I would love to go into the field of science communication, although I'm not quite sure what that looks like yet. I love getting people excited about science and making it more accessible. I also really enjoy just talking with people. If I could do something where I just talk to different people every day, I'd be so happy.
AW: That's awesome. Yeah, I wanted to tell you that I'm a huge fan of your podcast [*My Fave Queer Chemist*]. You're pretty famous for it.

BR: I'm flattered, really. Doing the show has been one of the highlights of my graduate career. We'll have to have you on sometime.
AW: I'd love that.

BR: Switching back to you, has your identity as an LGBTQ+ person influenced or impacted your career so far?
AW: I'd say on the positive side. I think being different, whatever that means—in my case, being LGBTQ—has been like a superpower. It's granted me the opportunity to reflect on my interests, my desires, and my life. It's allowed me to pursue a career that's very honest to my own needs. And it's also given me the permission to not care about what other people think about my work.

BR: I feel like LGBTQ+ people do a lot of self-reflection and internal work to really figure out, Who am I, as a person? We're already forced to think past what is "normal" or "acceptable" in our society, so we're able to reach a different level of understanding of ourselves. I think it complements chemistry and the STEM [science, technology, engineering, and mathematics] fields in general well, because we're able to think deeply and creatively and differently about things because we've had to do that with ourselves.
AW: Exactly. It's allowed me to see the structures, to see heterosexism, to see patriarchy in a way that you just don't see if you never have to confront those things in such a personal way. It allows us, as you were saying, to do creative and boundary-pushing work. That said, you know, every day slamming your head again and again into the heterosexism of the patriarchy is hard.

BR: Definitely. Just existing in a field that was honestly not built for us and that isn't always necessarily the most supportive of us is hard. I've experienced some of the worst transphobia of my life in the chemistry field since I came out a few years ago. We end up pushing through a system that was not really intended for us to succeed, which is why I love talking to you and other LGBTQ+ people who have just excelled so much in their careers. It's so inspiring to me, and hopefully the people who are reading this issue, knowing that despite all the horrible things that not only the chemistry field but also the society that we live in throws at us, being able to still push through that and be successful is just one of the best things in the world. That's why I just love queer and trans people so much.
AW: You know, we're so awesome. We really are.

BR: Do you have any advice for younger LGBTQ+ chemists who want to pursue a career in academia?
AW: It's cheesy, but I think being yourself is so huge. Be out and loud if you're able to. Otherwise, it's just going to create friction. And any place that's not prepared to accept you is not a place where you want to be. The other thing I'll say is that there's still a lot of work that needs to be done. It's sort of borne on the backs of individuals, every time you confront a structure that's not working, and you fight through it, it does take a little piece of your energy and a little piece of you, but it's making the path a little bit better for people behind you. I do think we have to have that sense of purpose and history. We still need to be doing that work.

SYNTHESIS

NANCY SCOTT BURKE WILLIAMS

This inorganic chemist has unraveled platinum's abilities to make and break bonds

HELEN SANTORO, special to C&EN

VITALS

- **HOMETOWN:** Puyallup, Washington
- **EDUCATION:** BS, Harvey Mudd College, 1995; MS, 1997, and PhD, 2000, University of Washington
- **CURRENT POSITION:** Associate professor of chemistry, W.M. Keck Science Department, Claremont McKenna, Pitzer, and Scripps Colleges
- **LGBTQ+ IDENTITY:** Queer trans woman
- **FIRST JOB:** Picking raspberries in the Orting Valley
- **BEST PROFESSIONAL ADVICE YOU'VE RECEIVED:** Write your own narrative, or else other people will write it for you, and you won't like what they write.

Some carbon-carbon and carbon-hydrogen bonds are incredibly difficult for chemists to make and break. But metals like platinum can help create and shatter these stable bonds. Understanding how platinum can accomplish this feat has been the focus of Nancy Scott Burke Williams's career.

Over the past 3 decades, Williams, a chemistry professor in the W.M. Keck Science Department of Claremont McKenna, Pitzer, and Scripps Colleges, has greatly contributed to scientists' understanding of platinum's special bond-breaking and bond-making qualities. She has also redefined how inorganic chemistry is taught in colleges across the US and—as a transgender woman—helped pave the road for future queer chemists.

Williams, who is a mechanistic organometallic chemist, first fell in love with chemistry in high school. Yet when she set foot on Harvey Mudd College's campus in California as an undergraduate, she wasn't completely sure she would major in the field. "I had a real interest in music and history and a bunch of other things besides chemistry," Williams says. As the semesters passed, however, she found many amazing chemistry mentors who solidified her passion for the elements. "It just seemed like the path that was right for me."

In graduate school at the University of Washington, Williams researched how complexes made up of platinum and other compounds form carbon-oxygen bonds. After receiving her PhD, she returned to California to start a lab at Claremont McKenna College, where she and her group of undergraduate students research making and breaking carbon-carbon and carbon-hydrogen bonds using platinum compounds.

"I got really intrigued by the larger problem of: How is it that these transition metals are capable of effecting these reactions, and can we actually control the way that these reactions happen?" Williams says. A big part of this work involves designing ligands—molecules or ions that latch on to a central atom (in this case, platinum) and change a metal complex's structure and reactivity. The group synthesized a new metal-ligand pairing in 2019 and thinks it will excel at breaking carbon-hydrogen bonds. Williams hopes that her work will inspire future

"Flipping the script and celebrating visibility means something in the trans and queer community that is unique."

CREDIT: LIAM WOODS

chemists to develop even better pairings that can break these bonds more efficiently.

The way in which Williams designs new ligands is extremely impressive, says Irving Rettig, who studied under Williams as an undergraduate student and is now a postdoctoral researcher at Reed College. Williams has wonderful chemical insight into how metals and ligands might behave, Rettig says. "Nancy has been able to construct these things with her undergraduate students that perform amazingly."

Williams's passion for inorganic chemistry has also led her to recognize how out of date undergraduate curricula are, particularly in how they teach chemical bonding. Many courses still cover old bonding models, she says. "I'm not satisfied with how we teach fundamentally what holds atoms and molecules together."

She helped found the Interactive Online Network of Inorganic Chemists (IONiC), a community dedicated to improving liberal arts inorganic chemistry education. The group's website, called Virtual Inorganic Pedagogical Electronic Resource (VIPEr), is filled with ready-to-use tools and documents that can help professors teach sophisticated bonding theories in simpler ways.

"The founding and nurturing of the IONiC VIPEr has been transformative for inorganic chemistry education," says Mir Bowring, a chemistry professor at Reed College. "A theme of Nancy's contributions is connecting human relationships to the practice of inorganic chemistry."

In 2013, Williams came out publicly as transgender. She says she had a realization: "I could be a professor and a chemist and be trans. That those were not mutually exclusive." This was huge for Williams, as visibility as a transgender person often comes with the threat of harm and violence. "Flipping the script and celebrating visibility means something in the trans and queer community that is unique," she says. Since coming out, Williams has been a vocal trans activist and has dedicated much of her time to transforming the political landscape in California and other states through canvassing and talking to voters about LGBTQ+ issues. Over the years, she has campaigned for nondiscrimination legislation for trans people, particularly trans students.

For Rettig, a transgender man, Williams's decision to come out has had a hugely positive impact on the field of chemistry. "She really has inspired a lot of younger chemists to find a united identity in being a chemist and being an activist," he says. Currently, Rettig is working with other queer scientists to set journals' policies that allow trans authors to update their names after publication.

Yet even with all her accomplishments, Williams believes there is still much more to be done. "I don't see trans people of color celebrated in our field like I know they should be," she says. "I know they love chemistry. I know they've taken these classes. I know that some of them have gotten those degrees. And if they're not out, that's a very troubling judgment on our field."

CONTRIBUTORS

The creative minds behind this year's issue

Katherine Bourzac

Katherine Bourzac is a senior correspondent at C&EN and is based in San Francisco. Bourzac coleads the Trailblazers project, writes about the environment and materials science, and edits news. Before joining C&EN, she wrote for *MIT Technology Review, Nature,* and *IEEE Spectrum,* among other outlets.

Tiph Browne

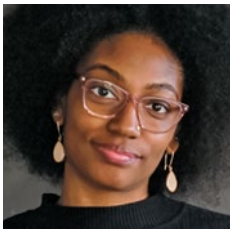
Tiph Browne is a Brooklyn, New York–born freelance photojournalist based in the DC, Maryland, and Virginia area whose portrait and event work focuses on celebrating Black Queer and Trans joy. They are a graduate of Corcoran College of Art and Design at George Washington University and a member of Authority Collective.

Payal Dhar

Payal Dhar is a freelance journalist writing on the intersection of science, technology, and society. Her work has been published in *Wired,* the *Washington Post,* the *Guardian, Discover, Astronomy, Slate,* and others. She lives in Bangalore, India.

Alex Kapitan

Alex Kapitan is a trainer, speaker, consultant, editor, and activist who left the world of nonfiction book publishing to start Radical Copyeditor (radicalcopyeditor.com), an antioppressive language project that helps writers, editors, activists, academics, museum professionals, media workers, helping professionals, and many others align their words with their values.

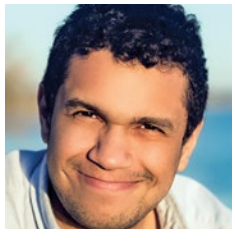


Vanessa Leroy

Vanessa Leroy is a freelance photographer based in Boston who holds a BFA in photography from Massachusetts College of Art and Design. She sees photography as a tool for social justice, and with it, she hopes to create worlds that people feel as though they can enter and draw from, as well as provide a look into an experience that they may not personally recognize. Her work has been featured in the *New York Times*, the *Washington Post*, NPR, *Stat News*, and *Bloomberg* and exhibited at Gallery Kayafas in Boston.

Bryn Nelson

Bryn Nelson is an award-winning science writer and former microbiologist based in Seattle. He has accumulated more than 2 decades of science journalism experience, including 7 years at *Newsday* in New York. Since then, he has written for dozens of other outlets, including the *New York Times*, NBCNews.com, the *Daily Beast*, *Nature*, and *Science News for Students*.



Pedro Oliveira

Pedro Oliveira is a Brazil-born American editorial, documentary, and advertising still and motion director based in Portland, Oregon; Orange County, California; and Dallas. His humble upbringing by a widowed mother in the countryside of Brazil, the Latino spices of the Brazilian lands, and the sense of still being a kid trapped in this adult's world are what make Oliveira's work so fresh and real. Living in Portland for most of his adult life, Oliveira has grown to become a kombucha and coffee snob! You can lure "de Oliveira" to work for you with a bowl of peanut M&Ms.

Tara Pixley

Tara Pixley is a queer, Jamaican American photographer, curator, and journalism educator based in Los Angeles. She was a 2021 International Women's Media Foundation Next Gen Safety Trainer fellow, a 2020 awardee of the inaugural World Press Photo Foundation's Solutions Visual Journalism Initiative and a 2016 visiting Knight Fellow at Harvard University's Nieman Foundation for Journalism. Her writing and photography have appeared in the *New York Times*, the *Wall Street Journal*, NPR, *Newsweek*, ProPublica, HuffPost, *Nieman Reports*,

ESPN Magazine, Canon Europe Pro, and the *Black Scholar*, among many others. She is on the board of stock photo co-op Stocksy United, serves as secretary of the National Press Photographers Association Board, and is a cofounder of Authority Collective—an organization dedicated to establishing equity in visual media.

Tara Santora

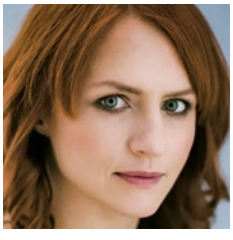
Tara Santora is the health and science editor at Fatherly and a freelance science journalist based out of Colorado. They have written for publications such as *Scientific American*, *Nature Medicine*, *Popular Science*, and more.

Helen Santoro

Helen Santoro is a science journalist based in Gunnison, Colorado. Her work focuses on health, medicine, and LGBTQ+ communities—particularly health-care discrimination faced by the transgender community—and has appeared in publications including *Wired*, *Slate*, Kaiser Health News, and *Scientific American*.

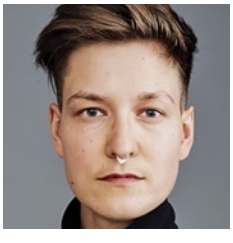
Neil Savage

Neil Savage is a freelance science and technology writer near Boston. He is a former newspaper journalist and has written for publications that include *Nature*, *Scientific American*, and *IEEE Spectrum*. He is a longtime member of NLGJA: The Association of LGBTQ Journalists.



Lidia Sharapova

Lidia Sharapova is an editorial and documentary photographer based in Milwaukee. Sharapova uses documentary photography to explore issues of social identity, gender, minorities, and small communities. She believes in the power of photography to change and empower people.



Henri T

Henri T is a visual storyteller who works with photography, moving image, and performance. They are interested in documenting, exploring, and celebrating queerness and dismantling the many barriers our constructed social world consists of. At the heart of their practice is the exuberant celebration of life and the endless possibilities of individual identity and expression.

Giuliana Viglione

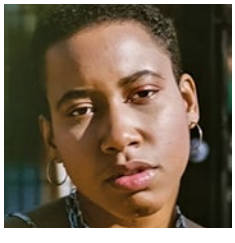
Giuliana Viglione is a PhD oceanographer turned science journalist based in Washington, DC. Viglione has a particular interest in climate change, the geosciences, and very cold oceans and has previously written for numerous outlets, including C&EN, *Nature*, and Gizmodo.

Watsamon Tri-yasakda

Watsamon Tri-yasakda, also known as June, is a Thai queer photographer and visual storyteller. June has been actively documenting issues of human rights for the LGBTQ+ community in Thailand and Southeast Asia for over 7 years. She is a member of Women Photograph.

Salgu Wissmath

Salgu Wissmath is a nonbinary Korean American photographer based in Sacramento, California. Their personal work explores the intersections of mental health, queer identity, and faith from a conceptual documentary approach. Wissmath is currently the communications director for Diversify Photo and is proud to be a member of collectives dedicated to diversifying and decolonizing the photo industry, such as Women Photograph, Authority Collective, and Asian American Journalists Association.



Liam Woods

Liam Woods is a trans and nonbinary Image Maker based out of Los Angeles. Their work is characterized by the vulnerable, candidly intimate storytelling of Queer people, people of color, and other marginalized communities. In their 5-year experience as a photographer, Woods has partnered with brands such as Apple, Adidas, and Warby Parker. They have also shot for publications such as *Vogue Paris*, the *New York Times*, *Los Angeles Times*, *Cosmopolitan*, and *Playgirl Magazine*. The main mission in their work is to continue to build upon community and provide resources and access for the betterment of BIPOC and queer creatives as a whole.

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