c&en
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SEPTEMBER 16/23, 2024

TRAILBLAZERS

The REVOLUCIÓN/ REVOLUÇÃO

C&EN celebrates chemists and engineers with Latin American roots
P.20

ACS
Chemistry for Life®

SPECIAL ISSUE

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"We as instructors have to innovate and adapt so we can inspire new generations of scientists."

—Juan Paulo Hinestroza, professor of fiber science and apparel design, Cornell University

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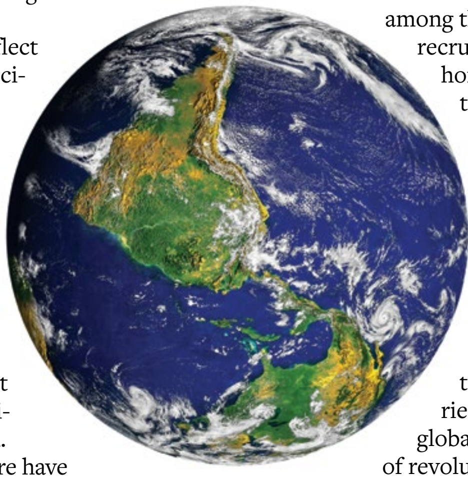
Editorial

Don't look down

Take a look at this year's edition of C&EN's Trailblazers featuring chemists with roots in Latin America, and you'll see that we open with a map of the Americas oriented with south pointing up. The decision is a wink at the theme of "The Revolución/Revolução"—both the turning of the planet and a subversion of expectations—but it also means something more profound.


CREDIT: SHUTTERSTOCK

Maps have and reflect power. It is not by accident that the Mercator projection of the globe makes Latin America look puny relative to the hulking US and Europe, yet that map has maintained its popularity for centuries even though few still use it for its intended applications in navigation.

But ever since there have been maps prescribing a worldview, there have surely been dissenters. In a 1935 manifesto, the Uruguayan artist Joaquín Torres-García says European artists laid claim to modernism when in fact many of the movement's aesthetic elements were universal. To underscore his point, he began drawing maps with the Southern Hemisphere on top as a jab at European claimed superiority. He writes, "Now we know what our true position is, and it is not the way the rest of the world would like to have it."

In this Trailblazers issue, we wanted to elevate the stories of researchers from and working in Latin America, whose triumphs and struggles the global research community doesn't properly recognize. This lack of recognition occurs for several reasons. For instance, their research is often regionally focused. So when they transform natively grown materials into technological marvels or study environmental issues that plague their local communities, the rest of the world can easily dismiss their work as niche or not generalizable.

The inequity is also rooted in more systemic issues. Governments don't give researchers in Latin America the funding or the freedom of movement that their colleagues to the north get; globally, researchers cite papers less if they're not written in English; and Latin American scientists devote more of their time to maintaining their footing in shifting political landscapes.

A few things stuck out to us about our cohort of Trailblazers. First is their desire to build up their region and mentor other Latine scientists. Even the expats among them are trying to recruit students from their home countries to build talent pools in Latin America. It seems that our Trailblazers value generational growth as much as they value their individual progress.

Second, many of our Trailblazers mentioned a language barrier to participating in global science. In the spirit of revolution and change, perhaps those who speak only English should start branching out linguistically. But at the very least, supporting those trying to hurdle language barriers is and will be instrumental to nurturing scientists in Latin America and ensuring they can collaborate effectively abroad.

We feature a healthy selection of computational chemists that are leading a revolution of their own. This group uses quantum computing, cutting-edge simulations, and artificial intelligence—often combining these with experimental techniques—to enhance and make safer the materials and molecules that our lives depend on. This is a vibrant community that the broader field of chemistry often doesn't adequately recognize.

A scientific revolution is more than a new medicine or experiment. It's about people coming together and challenging established practices. Labs in Europe and the US would do well to shed any elitism they feel about their own research. Taking a note from our map, when they look south, instead of looking down on that research, they should try looking up.—C&EN editorial staff

Reactions

▶ *Letters to the editor*

More on *Loper Bright* decision

Contra the opinions expressed by recent observers (C&EN, July 8/15, 2024, page 3, and Aug. 12/18, 2024, page 3), I fully support the recent Supreme Court decision on Loper Bright Enterprises.

My reading and experience are that regulatory agency officials will essentially always act to expand the scope of their authority, their powers, and their budgets. To allow such officials to unilaterally determine that scope seems very unconstitutional. The Constitution is a system of enumerated powers. It is not a blank check to agencies that get to unilaterally decide the extent of their authority. Or to redefine words (e.g., *pollutant*) beyond the meaning intended by Congress.

Whatever happened to concepts like separation of powers and checks and balances? Perhaps with the *Loper Bright* decision we can start in some small way to get back to a state in which the Constitution actually matters.

If that causes a problem with some agencies, here's the solution: stop overreaching your clear authority. If an interpretation of a statute is vague, how about deciding on the other side of your own vested power interests?

After all, Abraham Lincoln's Gettysburg Address did not say, "Government of the administrative state, by the administrative state, and for the administrative state." No, I'm pretty sure "the people" were mentioned in there somewhere.

Alex Schuettenberg
Bartlesville, Oklahoma

Corrections

▶ **March 25, 2024, page 25:** The Periodic Graphics infographic on cast-iron pans doesn't acknowledge the uncertainty around why cast-iron pans are nonstick. While some authors believe that the polymerized layer makes the pan nonstick, researchers have not definitively proved this.

▶ **Aug. 26, 2024, page 21:** The Periodic Graphics infographic on airplane air has an unbalanced equation. It should be $2NaClO_3 \rightarrow 2NaCl + 3O_2$, not $2NaClO_3 \rightarrow NaCl + 3O_2$.

▶ **Sept. 2, 2024, page 10:** The caption in the news story about US government efforts to support biomanufacturers misstates the size of a US Department of Agriculture–backed loan to Liberation Labs. The loan is for $25 million, not $30 million.

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Concentrates

Chemistry news from the week

Highlights

PUBLISHING

Academic publishers face antitrust lawsuit

Suit claims collusion against researchers, but some experts doubt its merits

Six scholarly publishers have been hit with an antitrust lawsuit for allegedly appropriating billions of dollars in public funds that the plaintiffs argue would otherwise have been used to carry out scientific research.

The complaint was filed in the Eastern District of New York by plaintiffs that include a researcher who says they conducted peer review for all six companies: Elsevier, Springer Nature, Taylor & Francis, Sage Publications, Wiley, and Wolters Kluwer.

The complaint alleges that the publishers engaged in a scheme that, in addition to diverting taxpayer money, has prevented scholars from freely exchanging information and created a peer-review crisis. "The Scheme has held back science, delaying advances across all fields of research," it says.

The suit lays out three main claims. One is that the six publishers colluded to fix the price of peer review at zero by linking researchers' unpaid labor to their ability to get manuscripts published.

Second, it alleges the six agreed not to compete with one another by requiring that researchers submit papers to one journal at a time. Finally, it says the publishers bar researchers from freely sharing the research reported in their submitted papers while they are under review.

Herbert Hovenkamp, a professor of legal studies and business ethics at the University of Pennsylvania, says the case may be the first that alleges a cartel among scholarly journals. "It's a suit that presents some risk for the publishers of the journals," he says.

Hovenkamp says the claim that publishers agreed to coerce reviewers to work without compensation is the most serious one. Though it's legal for a journal or publisher to decide in isolation not to pay peer reviewers, multiple publishers agreeing with one another not to compensate referees is not allowed. "The question is not how much they will pay," Hovenkamp says, but "whether it's legal for them to agree with each other not to pay."

Requiring authors to submit papers to one journal at a time may be justifiable, as it can be seen as a reasonable way to make submissions manageable, Hovenkamp says. "You have to show something is anticompetitive, and the fact is that multiple submissions can be extremely wasteful."

Hovenkamp sees a stronger argument in the complaint that researchers are not allowed to share research elsewhere while it's being considered for publication at one journal. "That sounds suspicious and perhaps illegal," he says. "It's possible that the journals can come up with a good justification for it, but I don't know what it would be."

Dorothy Bishop, a developmental neuropsychologist who recently retired from the University of Oxford and now spends her days as a research integrity sleuth, writes on her blog that she doesn't think the case challenges publishers on sufficient grounds.

"It's not true that there is an express link between peer review and publishing papers in the pre-eminent journals," Bishop writes. "In fact, many journal editors complain that some of the most prolific authors never do any peer review."

Springer Nature is one of six publishers targeted in an antitrust lawsuit.

CREDIT: JENS KALAENE/DPA/PICTURE-ALLIANCE/NEWSCOM

Bishop also notes that most journals allow researchers to post their papers on preprint servers, which undermines the argument that publishers prohibit academics from disseminating research while it is being considered for publication.

Lisa Janicke Hinchliffe, an information scientist at the University of Illinois Urbana-Champaign who monitors scholarly publishing, questions whether everyone who has done peer review has been harmed in the same way.

"It is very easy to find people who say that they are paid for peer reviewing because, as a tenure-line faculty member, it is part of the service expectations for their job," Hinchliffe says in an email. "Similarly, has every scholar who submitted a manuscript to only one journal at a time been harmed?"

Hovenkamp suspects that the first course of action from the defendants will be a motion to dismiss the lawsuit. "The important thing about a motion to dismiss is that the only thing you look at in a motion to dismiss is the language of the complaint itself," he says. "That could happen in less than a year."

If that motion is denied, Hovenkamp says, the case then goes into discovery, where records are checked and experts are brought in. That process could take significantly longer, he says.—DALMEET SINGH CHAWLA, special to C&EN

DRUG DISCOVERY

Drugging GTPases beyond KRas

Researchers discover a druggable cryptic pocket in this enzyme family

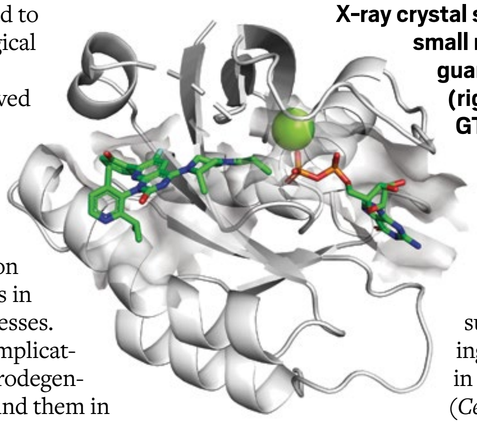
Although there are more than 150 guanosine triphosphate (GTP)–binding proteins, or GTPases, only the GTPase KRas G12C is susceptible to small-molecule drugs. That's because it's tough to find a spot for small molecules to bind to GTPases. Now, researchers have used what they know about the weak spot in KRas G12C to locate a toehold for small molecules on other GTPases. The finding could lead to new drugs and biological probes.

GTPases are involved in many cellular processes. They bind GTP and hydrolyze it to guanosine diphosphate. In doing so, they function as molecular switches in many biological processes. GTPases have been implicated in cancer and neurodegeneration. "You could find them in almost any disease area," says Kevan M. Shokat, a chemical biologist at the University of California, San Francisco, who led the research.

GTPases were considered undruggable until 2013. That's when scientists in Shokat's lab showed that the GTPase mutant KRas G12C—in which a glycine is replaced by a cysteine at position 12—has a cryptic binding pocket. This area, dubbed switch II, is invisible if nothing is bound to the enzyme. But Shokat's team showed that a small molecule can slip into this pocket and shut the enzyme down. Since then, the US Food and Drug Administration has approved two drugs, Amgen's Lumakras (sotorasib) and Bristol Myers Squibb's Krazati (adagrasib), as treatments for non-small cell lung cancer that target KRas G12C.

Shokat says that even though scientists have been studying the biology of other GTPases, there has been no pharmacology for these enzymes. "There have been no chemicals developed to perturb them, so it's sort of like a wealth of biology but pent-up chemistry," he says.

To see if cryptic pockets were also present on other GTPases, Shokat and coworkers overlaid the sequence of these enzymes onto KRas G12C. They then made mutant versions of these enzymes, inserting a cysteine at the same position the mutant cysteine appears in KRas G12C. This cysteine was able to latch on to molecules designed to make covalent bonds with sulfur, thereby revealing the cryptic pocket in several GTPases (*Cell* 2024, DOI: 10.1016/j.cell.2024.08.017).



X-ray crystal structure of a small molecule (left) and guanosine diphosphate (right) bound to a GTPase reveals a cryptic pocket in its switch II region, a druggable site in this family of enzymes.

CREDIT: JOHANNES MORSTEIN

The cryptic pockets in these GTPases are surprisingly similar. Johannes Morstein, a postdoctoral researcher in Shokat's lab and the paper's first author, says it wasn't obvious that this would be the case. "We did sequence alignments, and some of the residues are quite different," he says. What's more, molecules can bind to some of the pockets and not others. This suggests that drugs could be designed to specifically target certain GTPases.

Victor Cee, who was on the team that developed Lumakras and is now senior vice president of drug discovery at Hexagon Bio, says in an email that the study reaches "the tantalizing conclusion that many members of the GTPase superfamily contain potentially druggable switch II pockets." Like Shokat's earlier work with KRas G12C, Cee says, "it is not a stretch to suggest that this new understanding will spur screening campaigns and medicinal chemistry efforts directed toward generating therapeutic inhibitors of the less well-studied, but no less important, members of the GTPase superfamily."—BETHANY HALFORD

BIOLOGICAL CHEMISTRY

Testosterone's role in immunity

Transgender men shed light on the hormone's role

A new study in *Nature* examines the role of testosterone in the immune system.

The immune systems of cisgender men and women are often associated with different health outcomes. The rate of autoimmunity is higher in cisgender women, but cisgender men are more likely to die from SARS-CoV-2 infection. The underlying causes of these differences have evaded understanding. They could be caused by differences in sex hormones, genetic factors like X chromosome inactivation, social factors that bias the results, or a combination of factors.

This new study, published on Sept. 4, isolates one of these variables—the presence of testosterone—to try to tease out the effect of the hormone on immunity (DOI: 10.1038/s41586-024-07789-z). The researchers studied the immune systems of 23 transgender men who were receiving gender-affirming hormone therapy (GAHT) with testosterone undecanoate. They collected blood samples over a year, starting at the beginning of GAHT. Then they analyzed how the participants' immune systems changed during that time, comparing the immune system components with those of cisgender women and cisgender men.

The most dramatic differences after a year of testosterone-based GAHT were observed in the interferon and tumor necrosis factor (TNF) pathways, which have implications for both autoimmunity and fighting acute infections. The type 1 interferon pathway, which is usually upregulated in cisgender women compared to cisgender men, was downregulated in this cohort. Meanwhile, the TNF pathway, an inflammatory pathway, was upregulated in this cohort.

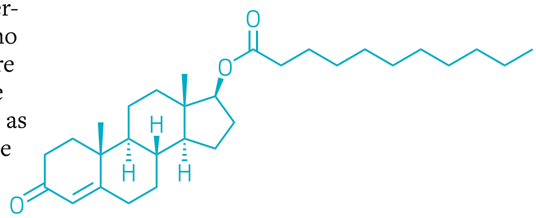
Nils Landegren of Uppsala University, one of the senior authors of the paper, says this aligns with what is known about the relatively increased risk of death from COVID-19 in cisgender men.

When their immune systems would try to fight the virus, "if the interferon response failed early during the infection, then you would instead see this uncontrolled overactivation of the immune system," he says. Scientists have noted overactivated immune systems in people who died from COVID-19. "So basically, we're seeing that testosterone plays a key role in this [immune system overactivation] as well. Testosterone is downregulating the interferon response but upregulating this inflammatory response," he says.

Autoimmune disorders like lupus often involve overactivation of the interferon pathway, Landegren says. These disorders are less common in cisgender men, so testosterone downregulating the interferon pathway may be part of the explanation.

Co-senior author Petter Brodin, of the Karolinska Institutet and Imperial College London, says that these dramatic effects in the interferon and TNF pathways were caused by the increased presence of testosterone rather than the lack of estradiol (a form of estrogen) that can result from GAHT. The researchers tested whether in vitro blood samples from cisgender women exhibited the differences observed in the transgender group when the cisgender women were deprived of estradiol versus when they were exposed to testosterone; only the testosterone test aligned with the results in transgender men.

This study raises the possibility of developing treatments that take advantage of these hormone-based differences, says Margaret McCarthy, an endocrinologist who wrote an accompanying viewpoint (DOI: 10.1038/d41586-024-02432-3) but was not involved in the research.



Testosterone undecanoate

TNF and interferons could be therapeutic targets, she says, noting that future therapies for conditions like lupus could increase the amount of TNF in certain tissues, mimicking the protective effect that TNF seems to have in cisgender men.

"It just gives us so many more targets to work with," she says.—SARAH BRANER

NOBEL PRIZES

Sign up for a #ChemNobel prediction party

Who will win this year's Nobel Prize in Chemistry? We don't know, but we can make some educated guesses.

Join Executive Editor Laura Howes and a panel of guests for our annual #ChemNobel webinar, coproduced with ACS Webinars.

Chibueze Amanchukwu of the University of Chicago, Steven Suib of the University of Connecticut, and Stacey Paiva, a senior editor at *Nature Chemistry*, will join in the crystal ball gazing and share their picks for this year's prize.

The panelists will also be joined by Ching Jin of the University of Warwick, who will present his analysis of the effects of winning prizes on scientific networks.

CREDIT: SHUTTERSTOCK

You can join us and take part in the fun as well. During the interactive broadcast, cast your virtual vote and ask the panelists questions about Nobel-worthy science. Then check back on Oct. 9 to see who, if anybody, predicted correctly.

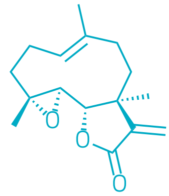
The webinar will take place at 2 p.m. EDT on Sept. 26 and is free to attend. Register at cenm.ag/nobelwebinar-2024.—LAURA HOWES

SYNTHESIS

Enzymes aid molecular diversity

Researchers transform natural product precursor into 51 new molecules

Nature is the undisputed champion of creating complex organic molecules, many of which humans have used for many years to create medicines. Chemists have spent over a century honing their ability to make molecules that mimic certain properties of natural products and tinkering with natural products to fine-tune their function.



Parthenolide

A team of chemists led by Rudi Fasan of the University of Texas at Dallas have now taken riffing on natural products to a whole new level (*Chem* 2024, DOI: 10.1016/j.chempr.2024.08.003). The researchers took parthenolide, a component of the medicinal herb feverfew, and remixed the molecule's carbon skeleton using engineered enzymes and additional chemical modifications to create 51 completely new compounds with high structural diversity and intriguing anticancer properties.

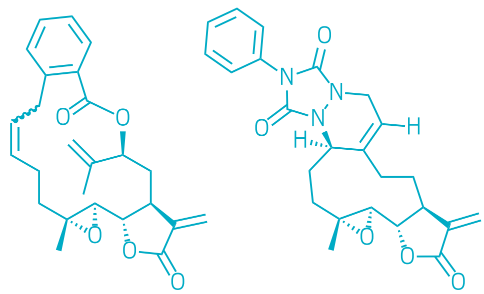
"Instead of making analogs of the parent molecule, we can create entirely new scaffolds," Fasan says, adding that this is one of his favorite projects to have come out of his lab.

Parthenolide's biological activity arises from an α-methylene-γ-lactone "warhead" that covalently binds to target proteins. The researchers aimed to keep the lactone intact while playing with the rest of the carbon skeleton. They used three different engineered P450 enzymes to carry out selective C–H oxidations and epoxidations. Fasan says those enzymatic transformations provided a "springboard" to additional structural rejiggering using more traditional chemistries such as ring-closing metathesis or Diels-Alder cycloadditions.

In many cases they could predict the products that would result from a particular sequence of transformations, but there were some surprise rearrangements, Fasan says.

All but one of the new molecules had higher molecular diversity than the original parthenolide, and all scored well on the "rule of five" properties that medicinal chemists often look for. "They're all druglike," Fasan says.

The researchers tested the compounds against eight human cancer cell lines and found that several molecules had promising anticancer activity. Some of them worked against multiple types of cancer, while others were more selective. Fasan says these molecules could be potential drug leads or could work as chemical probes to discover new proteins and pathways to target for cancer drug development.



Novel anticancer compounds

Robert Huigens III, a medicinal chemist at the University of Georgia who was not involved with the work, called it "elegant, creative, strategic and innovative . . . a must read for anyone interested in chemical biology and drug discovery." Huigens says he's excited to see more work to develop the cancer-targeting properties of these new molecules.

Fasan says his group's next steps are to follow up on the new molecules they have made and to extend the strategy to more enzymes and parent molecules to continue exploring new natural product–like structures.—BRIANNA BARBU

> "Instead of making analogs of the parent molecule, we can create entirely new scaffolds,"
>
> **—Rudi Fasan,** chemist, University of Texas at Dallas

POLYMERS

A synthetic polymer can clear biofilms

The polyester mimics barnacle secretions that clean surfaces

A new polymer removes biofilms—mats of microbes and their exuded substances—by mimicking a fluid oozed by barnacles (*J. Am. Chem. Soc.* 2024, DOI: 10.1021/jacs.4c09311). The material could provide a new strategy for cleaning the places where bacteria build up on medical or industrial equipment.

Before establishing a life on the rocks, barnacles clean their settling spot. "Mr. Clean is a barnacle," says Dan Rittschof, a marine biologist at Duke University who wasn't part of the new work. "We know that barnacles hate bacteria." When juvenile barnacles are settling, part of their cleaning process involves exuding a fluid that is rich in lipids and phenolic compounds and removes biofilms.

A synthetic polyester mimics how barnacle glue displaces biofilms.

CREDIT: SHUTTERSTOCK

Biofilms allow bacteria to cling to surfaces, such as those of medical devices or parts of the body, and can make for difficult-to-treat infections. Many researchers try to kill the bacteria to get rid of the biofilm, according to study coauthor Abraham Joy, a bioengineer at Northeastern University. "Oftentimes it doesn't work because the bacteria are dormant inside the biofilm," he says. Antibiotic efficacy often depends on the microbes having an active metabolism.

Amal Narayanan, a biomaterials scientist at the University of Florida, noticed that a polymer he had worked on with Joy could flow underwater like the surfactant that barnacles produce. The two materials also have similar phase separation behavior in water. That led the researchers to wonder whether their polymer—a polyester they had created to encapsulate and deliver proteins—might be similarly effective at clearing biofilms. When it turned out to be, Narayanan was shocked. "There's no reason for it to work from a rational design point," he says.

The researchers grew biofilms of the pathogen *Pseudomonas aeruginosa* in a glass channel underwater. They added their polymer to one end of the channel and tilted it. The polymer flowed through slowly and removed 99% of the biofilm as it slid along. But the liquid's biofilm clearing power wasn't just due to its thickness; other viscous polymers that were even more resistant to flowing failed to clear the biofilm. Additional experiments revealed that the polyester weakens the biofilm interaction with the glass surface, but it's not yet clear what's happening at the molecular level, Narayanan says.

The team also tested its polyester against biofilms of *Klebsiella pneumoniae*, *Staphylococcus aureus*, and *Escherichia coli*—other microbes that can cause infections in people. The polymer didn't fare as well against these: it removed around 70% of the *K. pneumoniae* biofilm and didn't even make a dent in the other biofilms. But Joy says the team may be able to target the approach for other microbes by tweaking the physical, chemical, and mechanical properties of the fluid.

"It's a great study," says Tagbo H. R. Niepa, a bioengineer at Carnegie Mellon University who wasn't involved with the work. The chemical's design could allow for cleaning of pipes, tubes, and surfaces. "You can think about a way of cleaning a catheter, for instance, that is fully infected with bacteria," he says. But he adds that the approach should be tested in animal models to see what happens to the bacteria and biofilm that are removed.

The polymer was designed to have low toxicity, Joy says. And it could be delivered with an antimicrobial to kill bacteria that are released by displacing the biofilm.—CAROLYN WILKE, special to C&EN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Lygos aims to work with CJ Bio to produce 40,000 metric tons of biobased chemicals annually at a facility in Iowa.

CREDIT: CJ BIO

BIOBASED CHEMICALS

Lygos plans commercial plant for biobased chemicals

CJ Bio will produce malonic acid and aspartic acid for use by Lygos

Lygos is taking a stab at large-scale biobased chemical production. The 13-year-old specialty chemical firm is partnering with CJ Bio to build a facility in Fort Dodge, Iowa, that will produce 40,000 metric tons (t) per year of polyaspartates and malonates from aspartic acid and malonic acid.

Lygos has developed yeast strains that can convert sugar into the two organic acids, which are normally derived from fossil fuels.

CJ will use that technology to produce the acids at a plant in Fort Dodge, where it already makes fermentation-derived amino acids. Lygos will build adjacent facilities that chemically transform the acids into products with applications in personal care, coatings, and agriculture. The company says the site could eventually produce up to 100,000 t per year of biobased chemicals.

The initial phase of Lygos's project would result in one of the largest biobased chemical plants in the US. Qore is building a facility that will produce 65,000 t per year of biobased 1,4-butanediol using technology from Genomatica. Solugen is building a plant to make 75,000 t per year of biobased glucaric acid, gluconic acid, and hydrogen peroxide.

CEO Eric Steen says Lygos works with customers to design specialized formulations of its biobased materials. For example, polyaspartates can be used to make products as diverse as fertilizer additives to increase nutrient uptake and corrosion inhibitors for water treatment. "This isn't just making a bulk ingredient," he says.

Steve Slome, a chemical industry analyst with the research firm NexantECA, says the approach differentiates Lygos from previous biobased chemical firms that failed to commercialize molecules such as succinic acid.

Like aspartic acid and malonic acid, succinic acid can be transformed into multiple derivatives. Firms such as BioAmber and Myriant argued that the chemical could be a platform for a biobased chemical industry. But they struggled to match the price of fossil-derived alternatives, and customers willing to convert succinic acid into useful products never materialized.

By going a step further and producing those derivatives itself, Lygos could become a different story, Slome says. "They're not waiting for somebody else to do something interesting with this," he says.—MATT BLOIS

START-UPS

Mantel raises $30 million for borate carbon capture

The start-up will use the funds to build a demonstration at a pulp and paper mill

Mantel Capture, a start-up founded by researchers from Alan Hatton's lab at the Massachusetts Institute of Technology, has raised $30 million in series A funding to develop a carbon capture technology based on a novel sorbent: molten borates.

The company says the system can reduce costs by more than half compared to the most mature carbon capture technology, which is based on amine solvents. Mantel will use the funding, which was co-led by Shell Ventures and Eni Next, to demonstrate the technology at a pulp and paper mill.

Mantel says its system can reduce carbon capture costs by more than half.

In industrial carbon capture, carbon dioxide is captured from an emission source in a sorbent; it's later removed in an energy-intensive and expensive regeneration step. Reducing the cost of carbon capture is necessary to help the planet reach net-zero emissions by 2050, Mantel says.

Mantel's technology takes advantage of the fact that carbon capture produces energy when CO_2 is removed from the emission source. At high temperatures, like the ones at which Mantel plans to operate, this energy can be recovered as convective heat and repurposed to create steam. The company says its approach is more energy efficient than lower-temperature carbon capture technologies since the heat they produce is harder to redeploy.

$$A_3BO_3 + CO_2 \rightarrow ABO_2 + A_2CO_3$$

A = alkali metal

Scientists have tried to apply this concept in the past but have struggled to find sorbents that don't degrade at high temperatures. Cameron Halliday, a chemical engineer and Mantel's CEO and cofounder, said he and his colleagues were "playing with chemistry" in Hatton's lab to solve the problem when they observed that a borate salt performed better than expected. The team learned that the material is a liquid at higher temperatures, meaning it can withstand conditions that might degrade solid sorbents.

The team launched Mantel in 2022. The firm uses a mixture of alkali metals to form an orthoborate salt. When CO_2 is captured, the orthoborate forms a metaborate salt and a carbonate salt. So far, the team has built a system the size of a shipping container, Halliday says.

"What we're doing is a little bit outside of the box for this industry," he says. "We have done all of the work to show that it works other than actually build the full thing."

Mantel will begin building the demonstration project at a North American site later this year, Halliday says. It's looking to partner with companies across different sectors, he says, including the cement, steel, chemical, and power industries.

Mukunda Kaushik, a senior analyst who leads carbon economy coverage for the consulting firm Lux Research, says he is intrigued by the approach. "As far as we're aware, they're the only company today that is developing the molten borate technology," he says. "But that also comes with its own challenges because you don't necessarily have a blueprint from anyone else to work out of."—ALEX VIVEROS

CREDIT: BUSINESS WIRE

START-UPS

Candid Therapeutics launches to harness T-cell engagers

The specialized antibodies could fight autoimmunity

Candid Therapeutics launched Sept. 9 with $370 million in funding. Its goal is to manufacture bispecific T-cell engagers (TCEs) to combat autoimmune disorders. The company has not only raised a huge series A fundraising round but also acquired two clinical-stage TCE antibody assets—CND106 and CND261—by merging with biotechs Vignette Bio and TRC 2004.

Candid is led by President and CEO Kevin Song, who previously led the radiopharmaceutical firm RayzeBio. He says he sees an opportunity for TCEs to act as simpler and more scalable alternatives to cell-based therapies for autoimmunity.

In autoimmune disorders like rheumatoid arthritis and myasthenia gravis, a person's B cells create antibodies to self cells, or they can present antigens to T-cells, which induces autoimmunity. So, depleting these offending B cells is an attractive treatment option. While some companies want to use CAR-T cells to do this, Candid plans to use TCE antibodies that bind to two targets: one on the surface of a target B cell and the other on a T cell, resulting in the death of the B cell. "Rheumatologists and neurologists are not familiar with cell therapy," Song says. "Whereas [they] prescribe antibodies all the time, so we're able to provide a drug format that's very familiar."

Ken Song

Song says that CAR-T therapies are expensive and difficult to manufacture, while producing antibodies is much easier.

After treatment, it is important to reset the immune system so that once defective B cells are cleared, new ones are generated that work properly. A study from Germany published early this year showed that this was possible with CAR-T cell therapy (*N. Engl. J. Med.*, DOI: 10.1056/NEJMoa2308917). But the patients in the German study were preconditioned with chemotherapy to make room for transplanted T-cells, which would be difficult for autoimmune patients and make redosing pretty much impossible. In contrast, Song says this would not be necessary for TCEs, which should make them more scalable as a therapy for autoimmunity compared with CAR-T cells.

Candid is not the only company operating in the TCE space. Clasp Therapeutics launched earlier this year to treat cancer with TCEs.

Song says the company's goal is to file investigational new drug applications with the US Food and Drug Administration by early 2025 and get these candidates into clinical trials.—SARAH BRANER

ENERGY STORAGE

Northvolt is backing out of battery chemicals

The European battery leader is cutting costs because of low demand

Because of the slow adoption of electric cars, Northvolt is canceling plans to make cathode materials at this Swedish site and closing a cathode plant in the country.

The European battery leader Northvolt is scaling back plans to manufacture battery chemicals and will focus instead on producing finished battery cells. The company's retrenchment because of slow growth in electric vehicle sales follows similar decisions at other battery players, such as BASF and Umicore.

Northvolt is closing its cathode material plant in Sweden, canceling plans for a second plant in the country, and laying off workers. The firm says construction of a Canadian battery cell plant and design work for cathode and recycling plants in Canada will continue.

In August, Northvolt also closed down Cuberg, the US lithium-metal battery start-up it acquired in 2021, and moved its lithium-metal research to Sweden.

Northvolt is continuing a strategic review of its business and could streamline further. But CEO Peter Carlsson says he still believes that the long-term outlook for the battery industry is promising. "There remains no question that global transition towards electrification . . . is strong," he says in a press release.

The changes are a big shift for Northvolt—the firm secured a $5 billion loan to expand cathode and cell production in Sweden earlier this year—but are in line with industry trends.

BASF says it will build battery material plants only after securing long-term agreements with customers. The firm decided not to invest in an Indonesian nickel refining project and has delayed a recycling project in Spain. Umicore paused construction on a cathode material plant in Ontario and is delaying a European recycling project.

Evelina Stoikou, a battery industry analyst with the research firm BloombergNEF, says Northvolt faced a particularly challenging road because it was trying to scale up both battery chemicals and cells while also pursuing next-generation technology like lithium-metal and sodium-ion batteries.

"Everyone is feeling the pressure," Stoikou says. "It makes sense to narrow down on the area that you think is going to be the most successful."—MATT BLOIS

CREDIT: CANDID THERAPEUTICS (SONG); NORTHVOLT (PLANT)

FINANCE

Dow lowers Q3 expectations

Unexpected factors have forced Dow to lower its guidance for third-quarter performance. The company expects sales of $10.6 billion for the period, down from the $11.1 billion it forecast in July. Dow also predicts that earnings before taxes will be $1.3 billion. The company says it suffered an unplanned outage at one of its ethylene crackers in Texas in late July and has been hit by higher input costs in Europe, which are pinching profit margins. But Dow is getting a lift from higher selling prices and lower feedstock costs in North America.—ALEX TULLO

PETROCHEMICALS

Motiva advances aromatics project

Motiva, Saudi Aramco's US refining business, has executed a license from Honeywell UOP for aromatics technology to make benzene and *p*-xylene at its complex in Port Arthur, Texas. The company had been planning an aromatics complex and ethylene cracker for the site since 2018 but put that project on the back burner. Motiva hasn't made a final investment decision. "The demand growth for petrochemical feedstocks is expected to continue to outpace that of gasoline and diesel," Motiva CEO Jeff Rinker says in a statement.—ALEX TULLO

AGRICULTURE

USDA backs fertilizer projects

The US Department of Agriculture is giving $35 million in grants to seven US-based fertilizer projects. The USDA created the program in 2022 to help domestic fertilizer producers expand plants or adopt new technologies; it has so far awarded $287 million. The latest round includes $4 million to expand a California facility where Nitricity produces low-carbon fertilizer using a plasma reactor. AdvanSix will receive $12 million to increase production of ammonium sulfate, a coproduct of nylon production.—MATT BLOIS

MERGERS & ACQUISITIONS

OCI to sell methanol unit to Methanex

Continuing its liquidation program, OCI Global has agreed to sell its methanol business to rival Methanex for nearly $2.1 billion. The company stands to rack up $11.6 billion in proceeds from this sale and other recently announced divestitures. Those include the sales of its Fertiglobe fertilizer joint venture stake to Abu Dhabi National Oil Co., a US fertilizer plant to Koch Industries, and its US clean ammonia project to Woodside Energy. The deal with Methanex is for $1.2 billion in cash plus 13% of Methanex's stock. The OCI business generated nearly $1.1 billion in sales in 2023. It operates a methanol and ammonia facility in Beaumont, Texas, and owns a methanol plant in Delfzijl, Netherlands, that is idle because of high prices for European natural gas. The OCI business also has a 50% interest in the Natgasoline joint venture with Proman that started up in Beaumont in 2018. But the future of that facility is subject to a lawsuit between the two partners. Methanex had sales last year of $3.7 billion. It says that the purchase will give it additional low-cost methanol production and a low-risk entry into the ammonia business.—ALEX TULLO

ELECTRONIC MATERIALS

Shokubai plans big electrolyte plant

Nippon Shokubai plans to spend about $265 million to build a plant in Japan that makes lithium bis(fluorosulfonyl)imide, an electrolyte for lithium-ion batteries. The firm says the Japanese government will provide a subsidy covering one-third the cost. The plant will open in 2028 and will be able to make 3,000 metric tons per year of the electrolyte, enough for 210,000 electric vehicles. Many chemical companies have been delaying or canceling investment in battery materials because of slower than expected consumer adoption of electric vehicles.—MICHAEL MCCOY

BIOFUELS

Gevo to buy Red Trail ethanol, CO_2 assets

The biofuels maker Gevo has agreed to purchase an ethanol plant and connected carbon capture and sequestration operation from Red Trail Energy for $210 million. The facility, in North Dakota, can make 256 million L of ethanol per year and has permits to inject 180,000 metric tons per year of carbon dioxide into geological storage. Gevo says it plans to use the ethanol in the low-carbon jet fuel technology it is commercializing in South Dakota and may look to sequester other CO_2 at the site.—CRAIG BETTENHAUSEN

BIOBASED CHEMICALS

Braskem completes Massachusetts R&D center

Braskem has completed its renewable innovation center in Lexington, Massachusetts. The company will conduct research into biotechnology, catalysis, and process engineering at

Braskem's new biotechnology R&D center

CREDIT: BRASKEM

the 3,300 m² facility. Its focus will be on using sugar, cellulose, oils, and lignin to make chemicals. The company chose the location for its proximity to Boston's biotechnology ecosystem.—ALEX TULLO

DRUG DISCOVERY

▶ Gilead, Genesis partner for AI drug delivery

Gilead Sciences has partnered with Genesis Therapeutics to use its artificial intelligence–powered drug discovery technology, GEMS (Genesis Exploration of Molecular Space), to find new molecules for targets provided by Gilead. Gilead will pay Genesis $35 million for three targets. There could also be further payments if more targets are identified, along with milestone payments. Genesis previously collaborated with Genentech in a deal worth an undisclosed amount and with Eli Lilly and Company in a deal worth up to $670 million. It raised $200 million in a series B round in 2023.—SARAH BRANER

BIOBASED CHEMICALS

▶ ResiCare, Stora Enso, make bio-5 HMF

ResiCare, a subsidiary of the French tire producer the Michelin, and IFP Energies nouvelles produced the first samples from a biobased process for making 5-hydroxymethylfurfural (5-HMF) from fructose they have developed. 5-HMF is an intermediate chemical for many products, including adhesives and polymers. It is

Hydroxymethylfurfural may be used as a nylon intermediate.

typically made from fossil fuel. ResiCare says it is planning commercial production in the near future. 5-HMF could one day be used to make nylon, according to Stora Enso, a Finnish wood products firm that is selling 5-HMF.—ALEX SCOTT

FINANCE

▶ Lilly, Nvidia back biotech firm Superluminal

Biotech start-up Superluminal Medicines will develop six new small molecules with the help of $120 million in new funding. Superluminal is using generative artificial intelligence to help design small-molecule medicines that target G protein–coupled receptors, as well as ion channels and transporters. The firm has not disclosed any specific disease areas. Superluminal is based in Eli Lilly & Company's incubator space in Boston. Lilly participated in Superluminal's series A financing round, as did NVentures, the venture capital arm of the tech company Nvidia.—ROWAN WALRATH

INVESTMENT

▶ Novartis invests in radiopharmaceuticals

Novartis is making two investments in new radiopharmaceutical manufacturing sites in the US. The Swiss pharmaceutical giant will open a third US radioligand plant in Carlsbad, California, to serve the West Coast. The company also plans to add a new radioligand facility at its site in Indianapolis. Novartis currently has two radiotherapies on the market, Pluvicto and Lutathera, which last year generated revenue of $980 million and $458 million, respectively.—AAYUSHI PRATAP

START-UPS

▶ Pfizer to collaborate with Bertozzi start-up

Acepodia, a start-up developing cell therapies, is collaborating with Pfizer Ignite, which will offer research and development support for drug candidates targeting autoimmune diseases. Acepodia is also developing potential cancer drugs. The two companies did not disclose financial terms. Acepodia is a spinoff from the lab of Nobel laureate Carolyn Bertozzi and is building on her click chemistry work to create off-the-shelf cell therapies with few side effects.—ROWAN WALRATH

Business Roundup

▶ **Clariant** has agreed to sell Industrial Park Fechenheim, an industrial park producing and developing chemicals near Frankfurt, Germany, to the real estate firm Lugman Group for $106 million. Clariant intends to use the proceeds from the sale of the park, where it currently has no operations, to reduce its debt.

▶ **Brookfield** will invest between $200 million and $1.1 billion in the low-carbon fuel maker Infinium. The start-up is building multiple plants that will make jet fuel, diesel, and naphtha from hydrogen and captured carbon dioxide.

▶ **EasyMining** has won approval from the German government to build a phosphorus recovery plant at a wastewater treatment plant in Schkopau, Germany. The firm says its process extracts 90% of the phosphorus from sewage sludge and will displace imports from Russia and Morocco.

▶ **Kemira** is expanding its coagulant capacity in Fredrikstad, Norway, in response to growing demand from water treatment utilities in Europe. It will add a reactor and build more storage for aluminum hydroxide.

▶ **Sumitomo Chemical** is selling a 7% stake in Sumitomo Bakelite to the Singapore investment firm GIC for $160 million. Sumitomo says the sale is meant to strengthen its financial position so it can undertake structural reforms.

▶ **Abu Dhabi National Oil Co.** has agreed to purchase a 35% stake in the clean hydrogen and ammonia complex that ExxonMobil plans to build in Baytown, Texas. ExxonMobil intends to make a final investment decision for the complex next year.

▶ **FSG** has raised $100 million in a round led by the AMR Action Fund. The money will be used for clinical trials testing olorofim, an oral antifungal candidate. The US Food and Drug Administration rejected olorofim in 2023, requesting more data.

▶ **MinervaX ApS**, a privately held Danish biotechnology company developing a vaccine against group B *Streptococcus*, has partnered with Wacker Biotech. Wacker will manufacture MinervaX's active protein ingredients in the vaccine.

CREDIT: RESICARE

POLLUTION

52 million tons of plastic slips into the environment every year

Researchers estimate that most of this litter and uncollected waste is set on fire

An estimated 52 million metric tons of plastic is spilling uncontrolled into the environment every year, according to a new study (*Nature* 2024, DOI: 10.1038/s41586-024-07758-6).

By weight, 43% of this waste ends up as litter. People dispose of the other 57% by burning it in waste pits or by other unregulated methods that lack environmental controls. This uncontrolled waste accounted for over 20% of all of the plastic waste generated from municipal sources in 2020.

"The global plastic pollution crisis is the most important emergent global challenge of our times," says Costas Velis, an environmental engineer at Leeds and one of the authors of the paper. To solve the problem, policymakers need to know how much plastic pollution is generated, where it comes from, and where it goes, he says.

Velis and coworkers Ed Cook and Joshua Cottom created a model to answer this question. They looked at plastic that's disposed outside of regulated channels such as city-run landfills or recycling centers. This includes litter, uncollected waste from areas that don't have regulated trash or recycling pickup, and plastic that recycling centers can't process.

Around 57% of uncontrolled plastic waste is burned worldwide, according to a *Nature* study.

The researchers, at the University of Leeds, used a machine learning model to find that the amount of such plastic pollution was highest in southern and southeast Asia and sub-Saharan Africa. According to this model, the world's biggest emitter of plastic pollution was India at about 9.3 million metric tons of plastic pollution per year. India is also the world's most populous country, with around 1.43 billion people in 2023, according to the World Bank. In lower-income countries, uncollected trash tends to be the biggest source of plastic pollution, while littering is often the main source in higher-income countries.

"We took the data from about 500 to 600 municipalities, which represent around 12% of the global population, and we extrapolated that to just over 50,000 municipalities," Cook says. From this city-to-globe approach, the researchers were able to pinpoint areas where government action on plastic pollution is most needed.

"From our model, we think that for around 1.2 billion people worldwide, their waste just isn't collected," Cook says. And if your waste isn't collected, what would you do with it? People in this situation tend to burn it, he says.

The high amounts of plastic pollution in lower-income countries are fundamentally associated with the failure of governments to provide waste collection services to people, Velis says. "And most of it happens in the least affluent places in the world and in the least affluent communities in the world," he says. "Less-privileged people are those who are really affected by this lack of services."

This is one reason why India produces so much plastic pollution, the authors say. "The rate of waste collection in India is very low, particularly in some of the rural areas," Cook says. Past models have put China at the top of this list, but many of them don't include open burning as a fate of plastic waste, Velis says. "A lot of it is happening in India," he says. In addition, the Leeds researchers used data that reflects how much the population of India has grown, Velis says.

David Wilson, an expert in resource and waste management at Imperial College London who was not involved in the research, says the information fills a gap. "This work is important because it is the first comprehensive attempt to build an inventory based on an understanding of the different mechanisms by which wastes leak into the environment," and to add them up from the local to the global level, he says.

The model confirms some things scientists and policymakers have long suspected, Velis says. But now they have quantifiable evidence for the size of the plastic pollution problem and the extent of open burning, he says.

The plastic pollution problem will not be solved unless policymakers prioritize plastic policies at the local and national levels and ensure they are monitored and enforced, Velis says. This model gives a baseline for plastic pollution, allowing policymakers to focus attention and resources where they're needed the most, he says.—LEIGH KRIETSCH BOERNER

CREDIT: SHUTTERSTOCK

LEGISLATION

House passes act aimed at 5 Chinese drug services firms

The Biosecure Act must also pass the Senate before it can become law

The US House of Representatives passed the Biosecure Act on Monday, increasing the controversial legislation's chance of becoming law.

The legislation is intended to prevent US pharmaceutical companies that receive federal funding from working with five Chinese services firms—WuXi AppTec, WuXi Biologics, BGI Group, MGI, and Complete Genomics—citing concerns about national security.

CREDIT: MADELINE MONROE/C&EN/SHUTTERSTOCK

The bill, which has received solid bipartisan support since its introduction in January, passed by a vote of 306 to 81. Among legislators, 195 Republicans voted in favor and 2 in opposition, while 111 Democrats gave it a thumbs-up, and 79 rejected it. A similar bill has been introduced in the Senate and must pass there before the legislation can be sent to the president for passage or veto.

The bill claims that BGI, MGI, and Complete Genomics—all genomics companies—have ties to the Chinese government and potentially dangerous access to the genetic data of US citizens.

Meanwhile, the allegations against WuXi AppTec, a leading contract development and manufacturing organization and one of the world's largest employers of chemists, are that the company has sponsored "military-civil fusion" events in China and received investments from a military-civil integration investment fund. The bill says WuXi Biologics CEO Chris Chen was previously an adjunct professor at the People's Liberation Army Academy of Military Medical Sciences.

House Oversight Committee Chair James Comer (R-KY) said on the House floor on Monday that the companies named in the bill have conducted research alongside the Chinese military. He added that both WuXi companies operate genetic testing centers established in coordination with the Chinese Communist Party (CCP); they've conducted research to promote the Chinese military; and they've stolen US firms' intellectual property.

> "This bill is a necessary step toward protecting Americans' sensitive health-care data."
>
> —**James Comer (R-KY),** chair, House Committee on Oversight and Accountability

"This bill is a necessary step toward protecting Americans' sensitive health-care data from the CCP before these companies become more embedded in the US economy," Comer said.

The act is supported by the Biotechnology Innovation Organization, a leading US trade group. But the Chinese companies have repeatedly denied the allegations. Complete Genomics says in an email that geopolitics instead of facts drove the House passage of the Biosecure Act.

"The Senate should slow the haphazard and unconstitutional approach the House has taken and fix the BIOSECURE Act. It's now up to the Senate to consider how the entrenched monopolist in genomic sequencing in the U.S. is entirely excluded from the BIOSECURE Act despite their heavy investment in the Chinese market," the company says in an apparent reference to the sequencing giant Illumina.

WuXi AppTec earlier told C&EN that it does not have a human genomics business and does not collect human genetic data. "Like many across the industry, we have concerns about the bill's broader impact on U.S. leadership in biotechnology innovation, drug development, and patient care," a spokesperson said in an email.

Industry executives have mixed thoughts on how the bill might affect the US pharmaceutical industry. While some biotech companies say they rely heavily on WuXi AppTec for their research and manufacturing needs, others are scouting for alternatives in India, Europe, and North America.

How the bill will affect the named Chinese firms remains to be seen. But so far, WuXi Biologics' business doesn't seem to have slowed down. In August, the company said it added 61 new projects in the first 6 months of 2024, half of which came from the US. Likewise, WuXi AppTec says it added over 500 new customers in the first half of 2024.

Even if passed into law, the bill would give companies with federal funding until January 2032 to disassociate from the Chinese firms.—AAYUSHI PRATAP

Scientists at the Holistic Drug Discovery and Development Centre

CREDIT: HOLISTIC DRUG DISCOVERY AND DEVELOPMENT CENTRE

Rewriting the script in Africa

The continent's scientists are making real health-care advances; the rest of the world needs to know

KELLY CHIBALE, SPECIAL TO C&EN

I grew up in Muwele, a small village in northern Zambia where the schools had no laboratories and we learned science solely on the blackboard. But thanks to some excellent teachers, I earned the opportunity to study and work abroad at well-endowed institutions like the University of Cambridge and the Scripps Research Institute.

My appointment as a lecturer at the University of Cape Town in 1996 was a return home in more than one way. Unlike at the bustling research hubs of Cambridge and Scripps, resources at the university were scarce, and infrastructure to conduct drug discovery was limited. These challenges, while daunting, ignited a fire within me to make a difference. I found a continent brimming with untapped potential, a rich tapestry of biodiversity, and a burning desire in its research groups to tackle the health challenges plaguing our communities.

Inspired, I embarked on a journey to build a drug discovery ecosystem in Africa. The creation of the Holistic Drug Discovery and Development Centre (H3D) at the University of Cape Town in 2010 was a pivotal moment. Our early days established the relentless pursuit of excellence that continues to drive our work. Supported by various research and funding partners, H3D has emerged as a state-of-the-art facility (*Nat. Med.* 2022, DOI: 10.1038/s41591-022-01885-1).

Today, our team of 75 researchers investigates novel chemical compounds that could become lifesaving medicines, with a focus on malaria, tuberculosis, and antibiotic-resistant microbial diseases. We're also developing preclinical tools to better understand the variability of drug response in the genetically diverse African populations, addressing a critical gap in global drug development. We've invested in training young African scientists, nurturing their talents, and empowering them to become leaders in their fields.

These efforts have borne fruit. Considering that we had to build drug discovery infrastructure from scratch, one of our proudest achievements has been the development of MMV390048, the first ever small-molecule clinical candidate, for any disease, discovered by an Africa-led international team. This first-in-class antimalarial drug candidate reached Phase 2 human clinical trials, a milestone that represents not only a major scientific breakthrough but also what is possible when African scientists have the necessary resources and support.

But our work is far more than individual projects. We are constructing a self-sustaining ecosystem, investing in both cutting-edge infrastructure and the next generation of African scientists. Through comprehensive training and mentorship programs, we empower scientists with the skills and knowledge to become leaders in their fields. Our

> To my fellow African scientists, I would like to say: We are trailblazers.

commitment extends beyond the laboratory; we are actively shaping a culture of innovation that generates high-skill jobs, combats the brain drain, and nurtures a thriving scientific community on the African continent.

Despite our progress, African scientists continue to be relegated to the sidelines of global drug discovery. Our achievements are overlooked, and our potential is underestimated. This must change.

It's time for the world to recognize the transformative power of African-led science. We're not just tackling diseases; we're also leading the charge in pharmacogenomics by recognizing and tapping into the genetic diversity of the African population. Through initiatives like Project Africa GRADIENT (Genomic Research Approach for Diversity and Optimizing Therapeutics), we're partnering with global pharmaceutical companies like GSK and Novartis to harness the power of artificial intelligence and develop tailored treatments for diverse African populations.

This is a new era for African science. We're not catching up; we're leading the way in precision medicine. The recent multimillion-dollar investment by LifeArc and the Bill and Melinda Gates Foundation in the Grand Challenges African Drug Discovery Accelerator program is a testament to the pharmaceutical world's growing confidence in African science. This investment is a financial boost as well as an endorsement of African scientists' ability to tackle global health challenges. It signifies a new era of pan-African collaboration, in which researchers from different countries and institutions join forces to accelerate drug discovery and development.

Do you have a story you want to share with the chemistry community? Send a submission of about 800 words to cenopinion@acs.org.

But we need more than just financial investment. We need the global scientific community to embrace African expertise, collaborate with African researchers, and champion our cause for equitable representation in global health initiatives.

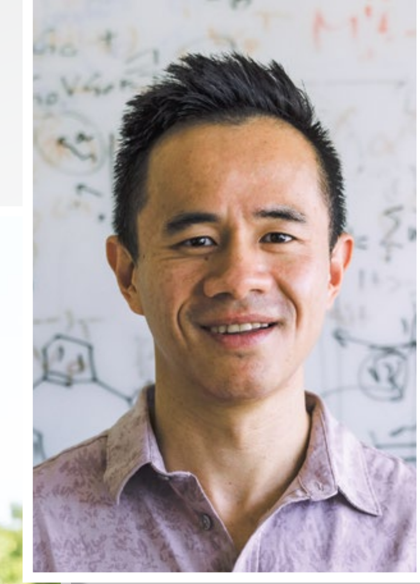
To my fellow African scientists, I would like to say: We are trailblazers. We are the architects of our own scientific destiny. Let us continue to push boundaries, challenge norms, and strive for excellence. Let us embrace our unique perspectives and leverage our diverse strengths to solve the most pressing health challenges of our time.

To the global scientific community, I would like to say: Do not overlook our achievements. Together, let us forge collaborations that transcend continents, invest in research that addresses the needs of diverse populations, and amplify the voices of scientists from all corners of the globe. In doing so, we can foster a truly inclusive scientific community that harnesses the power of diversity to drive innovation and improve lives worldwide.

The time for African drug discovery is now. We have the talent, the ambition, and the determination to make a lasting impact on global health. Let us seize this moment and create a brighter future for Africa and the world.

CREDIT: COURTESY OF KELLY CHIBALE

Kelly Chibale is a professor of organic chemistry and Neville Isdell Chair in African-centric Drug Discovery and Development at the University of Cape Town. He is also founder and director of the University of Cape Town Holistic Drug Discovery and Development Centre (H3D).



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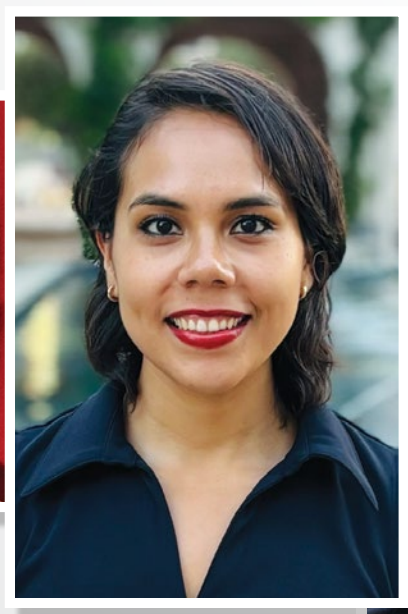







C&EN celebrates chemists with Latin American roots




TRAILBLAZERS

ALÁN ASPURU-GUZIK, special to C&EN

Latin America is a testament to resilience, a narrative of struggle and hope. It's a story of shattered dreams that rise from the ashes and of rebuilding our region repeatedly. From the Indigenous nations that first inhabited the region, crafting civilizations that spanned its breadth, to the complex interplay with Europe and so many other regions of the world, the strength of Latin America's history and culture is part of our DNA.

Scientists in Latin America struggle through and emerge from this unending line of political and often violent revolutions. Theirs is a history of ingenuity, and each generation brings a scientific revolution of its own.

In this Trailblazers issue, we want to give you a window into not just the science of 18 Latin American researchers but their stories—celebrating their cultures and natural warmth as well as their personal successes and impact. Together with the C&EN staff, I have carefully selected a sliver of the fantastic work our community has done from over 100 nominations. And to ensure that scientists and students who are hispanohablantes and lusófonos can read about the Trailblazers who share their origins, C&EN has translated these profiles into Spanish and Portuguese.

We tried to spotlight stories of the younger generation leading the next revolution in science, but before you read on, I would like to highlight the work of three individuals whose contributions deserve special attention. They have paved the way for advancements and are among the most critical contributors to global health:

- Colombian scientist Nubia Muñoz discovered the human papillomavirus and contributed to developing the first vaccine against it. This work led to her recognition with a prestigious BBVA Foundation award.
- Luis Miramontes, a Mexican chemist, carried out the first total synthesis of norethisterone, a first-generation contraceptive still used today. The discovery and use of birth control substances have helped empower individuals with their reproductive rights across the globe.
- Hailing from the Southern Hemisphere, Argentine Luis Leloir was awarded the Nobel Prize for elucidating the biochemical pathways for synthesizing carbohydrates. This fundamental discovery opened up many therapeutic opportunities, such as biotechnology for the synthesis of glycopeptides.

The shakiness of Latin American democracies has hindered this scientific progress as the world faces a massive, looming ecological crisis that threatens the livelihoods of millions. This is the enduring fight of the Latin American people, who constantly battle to assert their civil rights and secure critical natural resources.

This battle has surely slowed our region's science, but science also gives us the power to fight back.

In Chile, the mining industry is a pillar of the national economy—most famously, copper mines, but increasingly, lithium operations. Privatizing and nationalizing these mines played a crucial role in the 1973 US-backed coup d'état against President Salvador Allende and the dictatorship that followed.

Today, the mines remain, and Chilean scientists study their chemical legacy and present-day impact. These researchers trace where runoff goes, figure out how metal-laden wastewater affects the public, and use those data to inform regulators and hopefully make that industry less harmful.

As another example, Central America's coffee crops are quickly declining because of increasing temperatures and droughts brought on by the worsening climate crisis. This decline sparks migration

More online

Read the Trailblazers package in Spanish and Portuguese.

Spanish

Portuguese

CREDIT: CARLOS OSORIO

patterns that force farmers to abandon their crops and homes, resulting in poor living conditions in overcrowded cities. Revolutions triggered by that displacement could be on the horizon.

Simultaneously, scientists are seeing this problem and trying to make crops like cacao and coffee more resilient. They're developing new varieties that grow in warmer, drier conditions and have the potential to save those industries.

The ecological devastation of the Amazon, often accelerated by political regimes' economic interests, has global ripple effects. Alongside political and policy solutions to this problem, science emerges as a critical enabler of technologies that could help solve these problems locally.

One crisis on my mind now is water. Because of mismanagement of water resources, and lousy and underfunded maintenance of the water supply, Mexico City, where I grew up, expects a "day zero"—when no water will be available—as soon as this year.

It makes me think back to the bloody revolt that happened in Cochabamba, Bolivia, in 2000, when the people had to fight against an international conglomerate's privatization of their water supply. I only hope the revolution that saves Mexico City will be purely scientific rather than violent.

But that innovation requires a swift change of direction. Industrial and government support for science has been lackluster for all countries in Latin America. This has meant low salaries for scientists and relatively limited access to modern equipment, travel funds, and other means necessary to conduct research. Modest funding and cumbersome, bureaucratic mechanisms to dispense that money haven't helped either.

Meanwhile, global competition for scientific talent is intense. Several factors have attracted substantial numbers of Latin American scientists to power the technological engines of Canada and the US. This migration can be seen either as a direct brain drain from the region or, if the scientists abroad remain connected to their home, as an opportunity to enrich the science of their countries of origin.

I am an example of that scientific exodus, having done research in Mexico, the US, and now Canada. Over the years, I have remained connected to Mexico and have had several graduate students and postdoctoral scholars from there come to my lab and move on to academia and industry globally. For example, Andrés Aguilar Granda and Martha Flores Leonar are professors at the National Autonomous University of Mexico. I have also helped Mexican scientists and officials devise science policy, craft and review research proposals, and develop scientific exchange programs.

To discuss Latin American scientists, we must also discuss those of Latin American origin who were born outside the region—for example, in the US and Canada. These groups' relative economic and social disadvantages have led to lower representation in academia and the broader tech economy. To solve this problem at its root, academic, policy, and business leaders need to take many actions. For example, significantly increased social and economic support for Latin American communities at a local level, as well as further scholarships and educational programs, is necessary to reach demographic parity in these northern countries.

If humanity is to take on these problems, we'll need US- and Canada-based researchers with Latin American roots and their counterparts in Latin America to form networks from Tierra del Fuego to Nunavut. Our Bolivarian scientific alliance should demand proper funding and support from our ailing governments. These networks will help train, mentor, and champion new generations of scientists who will continue to build the foundation for a competitive revolutionary force in the Americas.

Finally, I want to end this essay on a musical note. Jorge Drexler, an Uruguayan musician, actor, and doctor, gave a masterful TED Talk in 2017 in which he delves into the topic of the décima. This poetic and musical stanza, whose variations were created in Spain, is rooted in different continents via Europe, Africa, and Latin America. Many musical and poetic forms we call our own, such as the tango in Argentina, repente in Brazil, bachata in the Dominican Republic, and son jarocho in Mexico, share their complex origins in the décima.

Like the décima, a dialogue between Latin America's cultures and an ode to our mixed origins, creative force is infused into Latin American science. Our science is vibrant, eclectic, and essential. As "La Bamba," sung in a décima, says, we, the Latin American scientists, are not sailors. We are captains. ¡Viva nuestra ciencia! Viva a nossa ciencia!

"Los científicos dicen que estamos hechos de átomos, pero a mí un pajarito me contó que estamos hechos de historias."

"Scientists say that human beings are made of atoms, but a little bird told me that we are also made of stories."

—Eduardo Galeano

Para subir al cielo
Para subir al cielo se necesita
Una escalera grande
Una escalera grande y otra chiquita.
Arriba y arriba
Arriba y arriba y arriba iré
Yo no soy marinero
Yo no soy marinero, soy capitán
Soy capitán, soy capitán.

To climb to heaven
To climb to heaven one needs a big staircase
A big staircase and a little one.
Up and up
Up and up I'll go
I am not a sailor
I am not a sailor, I am a captain
I am a captain, I am a captain.

—Excerpt from "La Bamba," popular Mexican son jarocho

▶ COMPUTATIONAL CHEMISTRY

Alán Aspuru-Guzik

This year's Trailblazers guest editor blurs the boundaries between chemistry, AI, and robotics

VITALS

▸ **HOMETOWN:** Mexico City

▸ **EDUCATION:** BSc, chemistry, National Autonomous University of Mexico, 1999; PhD, physical chemistry, University of California, Berkeley, 2004

▸ **CURRENT POSITION:** Professor of chemistry and computer science, University of Toronto; CIFAR AI chair, Vector Institute

▸ **START-UP COMPANIES FOUNDED:** Axiomatic AI, Calculario (now part of Kyulux), Intrepid Labs, Kebotix, and Zapata AI

▸ **MEMORABLE MENTOR:** Carlos Amador-Bedolla, my undergraduate adviser

▸ **PROFESSIONAL ADVICE:** A quote from my PhD adviser, William A. Lester Jr.: "People do science. Don't forget that scientists are people."

▸ **NICKNAME:** Nopal, after Nopal BBS, a bulletin board system I ran from 1992 till 1994

▸ **HOBBIES:** Street art, photography, and running

▸ **I AM:** Mexicano, Latino, Chilango, a secular Jew

BEC ROLDAN, special to C&EN

Alán Aspuru-Guzik's nearly 2 decades of research can't be narrowed down to a single scientific field. But the flurry of ideas coming from his lab fits, if precariously, under a grander theme: expansion. "I'm very interested in exploring life," he says. "When there are opportunities that expand my horizon, I will take them."

For Aspuru-Guzik, a professor of chemistry and computer science at the University of Toronto, the possibilities of the unknown are what have driven his laboratory to the interfaces of quantum computing, machine learning, and chemistry.

Aspuru-Guzik blurs the lines between everything: theoretical and experimental chemistry, art and science, and creativity and stiffness. "For Alán, disciplines are artificial," says Joel Yuen-Zhou, who received his PhD from Aspuru-Guzik's lab in 2012 and now serves as an associate professor of chemistry at the University of California San Diego. Aspuru-Guzik's interests span art, literature, music, and science, which made him an "infinite source of creativity and vision," Yuen-Zhou says. "He empowered us to think outside of the box."

This attitude came out of a near-death experience in a car crash when he was 19. As a friend drove him back from a party in Cuernavaca, the friend hit the side wall of the freeway with the car. "I had this major operation and started thinking that life is very finite," he says. "I have a sense of urgency. You could die tomorrow, so if you want to try something, you should try it now."

> **"Life is very finite. I have a sense of urgency. You could die tomorrow, so if you want to try something, you should try it now."**

Aspuru-Guzik's introduction to computers came when he was a kid. He would engage in phreaking, a form of hacking into telecommunication systems to make free calls. He says that while he used this technique to download software from abroad, he also had some fun with it. When Mexico beat Argentina in a 1990 soccer game, "my friends and I would call a bunch of people in Argentina to remind them of the loss."

After his undergraduate studies at the National Autonomous University of Mexico (UNAM), Aspuru-Guzik went on to complete his graduate studies in quantum computing in the lab of William A. Lester Jr. at the University of California, Berkeley. Aspuru-Guzik had a "profound effect on reshaping the mode of operation for the computational research in my group," says Lester, noting how Aspuru-Guzik took a leadership role in the lab early on.

Since Aspuru-Guzik started his independent career at Harvard University in 2006, he has been constantly widening his group's research focus. He initially studied quantum mechanics and has expanded his research to include artificial intelligence and self-driving labs. "I always wanted to be at the interface of technology and chemistry—to ride technological trends in order to open up the path for these new fields to develop," Aspuru-Guzik says.

He led the founding of the Harvard Clean Energy Project, an open-access project designed to search for possible molecules that could be used in organic solar cells. When his research team invented new algorithms for near-term quantum computers, or computers that are available but not totally accurate, he cofounded a start-up, Zapata AI. The company, which is named after Emiliano Zapata Salazar, a Mexican revolutionary of the early 1900s, went public in March. He describes being at the New York Stock Exchange as a surreal moment. "It's a huge achievement and something I hope for all of my companies."

He thought he was going to stay at Harvard for the rest of his career, but in the 2010s, the changing political

Alán Aspuru-Guzik's lab built Medusa, an open-source, open-design self-driving system for organic synthesis. No experiments were running at the time this photo was taken, and the equipment was turned off.

CREDIT: CARLOS OSORIO

landscape in the US disturbed him—at the time, he cited the 2016 election of Donald J. Trump and overpoliticized funding mechanisms for science. Aspuru-Guzik sought opportunities for new growth and decided to move to the University of Toronto in 2018.

The move has allowed him to expand his focus beyond just theoretical chemistry. After receiving funding from the Canadian government as a Canada 150 Research Chair, Aspuru-Guzik was able to build an experimental side to his lab. "We needed to close the gap between what is theoretical chemistry and what is experimental chemistry and use computers to drive experiments rather than use humans," he says.

Aspuru-Guzik says he's been happy with the social and political climate in Canada, along with the Canadian government's approach to funding research. "I'm funded in a way that allows us to write less grants and focus more on science," he says.

In addition to running a research lab, he serves as the director of the Acceleration Consortium, a University of Toronto–based initiative that aims to use self-driving labs (SDLs) to rapidly design, make, and test new materials. In April 2023, the consortium received a $200 million grant from the Canada First Research Excellence Fund, the largest federal research grant ever awarded to a Canadian university. "It's an honor to lead the project," Aspuru-Guzik says. "The project is a platform to build people's careers and take us into new research directions that will hopefully take Canada into a leadership position on the topic of SDLs."

As part of a federal mandate to engage with Indigenous communities, the Acceleration Consortium engages in research on ethics and Indigenous science and technology with Indigenous scholars. The goal is to ensure it designs new technologies, like SDLs, with equity and sustainability in mind. Research into new technologies raises questions about governance, access, and possible weaponization. "Our team started thinking, 'How do we accelerate science while at the same time slow down to think about how to do this in an ethical manner?'" Aspuru-Guzik says.

When M. Murphy first met Aspuru-Guzik, "we instantly got into the questions of what's exciting and what's scary about the creation of SDLs and substance discovery," says Murphy, who coleads the Technoscience Research Unit, serves as a main social science researcher at the consortium, and is Red River Métis. Murphy wants researchers to integrate questions around chemical risk management into substance discovery at the front end, before those substances end up harming lands, waters, and communities. The two discussed how researchers of substance discovery and SDLs could learn from Indigenous knowledges and perspectives and integrate that information into the consortium workflows.

"Alán was never intimidated by me bringing up questions that might challenge the foundations of the project," Murphy says. "There was an enthusiasm for learning across differences."

As his research efforts expand, Aspuru-Guzik is always thinking about how he can be a better leader. He takes concepts from *X-teams*, a book by MIT Sloan School of Management's Deborah Ancona, to run his lab. "The whole idea is to have resources for all the scientists to be creative and work together," he says. "I want to build as multidisciplinary and diverse a set of training as possible for my group. I give them multidisciplinary missions and empower them to come up with solutions."

He thinks about both the scientific and social diversity of his group, which now includes organic chemists, AI scientists, robotic scientists, computational chemists, and inorganic chemists. Also, students from Latin America make up 20–25% of his group at any given time, and he maintains a relationship with UNAM, inviting visiting students to work in his lab and making annual visits to give research talks.

Pushing the boundaries of fields and scientific questions has defined Aspuru-Guzik's careers. As his lab ventures into new fundamental questions about the capability of AI and robot chemists, the possibilities of the unknown continue to guide him. "To be open to colearning across differences, you have to have a real depth of curiosity," Murphy says. That curiosity, they say, is what has made Aspuru-Guzik such a visionary scientist.

▸ SAFETY

Varinia Bernales

This computational chemist develops safer chemicals and makes science more equitable

VITALS

▸ **HOMETOWN:** Santiago, Chile

▸ **EDUCATION:** BSc, chemistry, 2009, and PhD, chemistry, 2014, University of Chile

▸ **CURRENT POSITION:** Lead research scientist, UL Research Institutes

▸ **NICKNAME:** Avecilla (little bird). It was given to me by a dear friend who claims that I always flutter here and there.

▸ **IMPACTFUL BOOK:** *Las venas abiertas de Latinoamérica* (*Open Veins of Latin America*), by Eduardo Galeano. I keep several copies at home, both in English and Spanish, to offer to friends as presents. It is my way of sharing my origins and a piece of my world with them.

▸ **I AM:** Chilean, American (as I was born on this continent), and a Latino woman

MYRIAM VIDAL VALERO, special to C&EN

Growing up, Varinia Bernales had a family that instilled in her a commitment to devote one's career to protecting humankind. She especially looked up to her aunt Belgica, who worked with the World Health Organization, doing research and developing policies on asbestosis to improve worker safety. Bernales couldn't fathom it when she was a kid in Chile, but that family credo has guided her through a thriving career in science and advocacy.

Today, Bernales is one of the lead research scientists at UL Research Institutes, just outside Chicago, where she works on simulating and creating materials to make the world a cleaner, safer place.

Starting as an undergraduate at the University of Chile, Bernales fell in love with chemistry and was always looking for new research opportunities. She volunteered in laboratories that ran the gamut of the central science: supramolecular chemistry, inorganic synthesis, solid-state chemistry, and quantum physics.

As she approached the end of her undergraduate years, she read a paper that broadly changed how she saw chemistry. The paper explained how ionic liquids, a type of solvent that is easier to contain and recycle than more common solvents, could be modeled computationally.

The paper was entirely in English, so it took Bernales a while to get through because she grew up speaking Spanish, but by the end, she realized two things: not only could ionic liquids reduce the waste that chemical reactions create, but computational models could cut waste even further.

These models would give her the flexibility "to explore all the possibilities without having an immediate impact on the environment," she says.

But as she began combining green chemistry with computational chemistry, she found that very few scientists in Chile were familiar with either field at the time. "People thought that we were just playing video games," Bernales remembers.

Encouraged by her teachers, Bernales did a 4-month stint at the University of Minnesota (UMN) Twin Cities in the middle of her PhD in computational chemistry. The way chemists at UMN approached science was revolutionary to her. Instead of everyone being siloed into their own projects, students and professors regularly gathered to share their results and generate new ideas as a group, and academia partnered with industry to advance research.

She went back to UMN for her postdoctoral studies and decided to step out of her comfort zone in ionic liquids. She collaborated with labs working on new problems to clean up the earth. She researched issues as diverse as developing materials for the recovery of nuclear waste and metal-organic frameworks that could transform harmful molecules into environmentally beneficial ones.

Her skills in computational chemistry enabled her to work on various models and calculations simultaneously; she could seamlessly transition between different fields as she learned how each laboratory conducted experiments.

During this time, Laura Gagliardi, a quantum chemist now at the University of Chicago, started mentoring Bernales. Gagliardi is originally from Italy, and Bernales says the mentorship by an immigrant woman who had assembled a multicultural working group helped her build the confidence she didn't find doing research back home.

As a woman starting a career in a male-dominated field in Chile, Bernales navigated situations that threatened her mental health and career advancement—some of her male peers harassed and invalidated her. But in Gagliardi's lab, Bernales flourished.

"She really brought this research to the next level," Gagliardi says. Bernales developed and used computational methods that combined classical molecular simulations and state-of-the-art approaches to study materials with complex electron behaviors. She became the face of UMN's Inorganometallic Catalyst Design Center, an energy-focused research institute, Gagliardi says.

CREDIT: SARA STATHAS

Gagliardi remembers Bernales as a bridge between those creating the models and those conducting the experiments. “She was my second-in-command,” Gagliardi says.

Regardless of whether she was on the computer or in the lab, Bernales was willing to experiment with new fields and solve the puzzle in front of her. “I’m a researcher; I do whatever it takes to solve a problem,” she says.

“I’m a researcher; I do whatever it takes to solve a problem.”

Today Bernales has moved into a leadership role at the safety science nonprofit UL Research Institutes, where she’s using computational chemistry to develop new materials to remediate and protect the environment. Her position allows her to combine her passion for helping remove toxic chemicals from the environment with her dedication to developing products that are safer for human health and the world.

Her projects at UL Research Institutes include developing cutting-edge protective materials that would keep firefighters from inhaling toxic chemicals and devising materials to improve batteries’ safety. She’s also working with other scientists to design materials that can help remove heavy metals from water or filter out pollutants like benzene from the air.

Bernales’s contribution to improving the world doesn’t end with her research. She’s also a strong advocate for women in science and tries to help other scientists access the same opportunities she had. “She builds trust relationships very quickly,” says Peter Margl, a senior research scientist at Dow, where Bernales worked before taking the position at UL Research Institutes. “She is incredibly passionate about women’s rights, about equal opportunities for everyone.”

In 2018, Bernales began volunteering with FIRST (For Inspiration and Recognition of Science and Technology) Robotics Competition to encourage girls to become interested in science. She says she wants to support the women she works with—and scientists in general—whether as a colleague or a mentor, in the same way that Gagliardi did for her.

She has also spoken at Current Trends in Theoretical Chemistry conferences in Peru and Ecuador about quantum chemistry and how it can help provide a more accurate description of molecules. She hopes to organize her own initiative to continue bringing quantum chemistry conferences to Latin America and conduct them in Spanish to lower the language barrier surrounding computational chemistry. As Margl says, Bernales is on a mission to fix the things that are not right in the world.

Along her journey, Bernales remains in touch with her roots and the family that inspired her to improve the world. Her aunt Belgica felt particularly happy when she learned that Bernales would be working with renewable energy projects at UL Research Institutes, Bernales says. “She told me that it was wonderful that I could dedicate myself to something with so much purpose,” Bernales says.

Her aunt had encouraged Bernales to pursue her dreams and get a PhD despite the advice of other family members to specialize in a seemingly more pragmatic field, like engineering. Ultimately, following her passion paid off.

▶ NANOMATERIALS

Sarah Briceño

This Venezuelan expat turns Ecuador's natural resources into nanomaterials

VITALS

▸ **HOMETOWN:** Valera, Venezuela

▸ **EDUCATION:** BS, chemistry, 2007, and PhD, applied chemistry, 2010, University of the Andes in Venezuela

▸ **CURRENT POSITION:** Associate professor of physical sciences and nanotechnology, Yachay Tech University

▸ **PROFESSIONAL ADVICE:** It is not the subject area but the teacher that is going to make a difference in your career.

▸ **FAVORITE MUSICIAN:** Manu Chao

▸ **WHAT REMINDS ME OF HOME:** Cachapas

▸ **I AM:** Latina, Venezolana

ANDRÉS VELÁSQUEZ-GÜECHÁ, special to C&EN

In 2014, Sarah Briceño was finally seeing the fruits of her labor. She had been promoted to a higher-level research job at the Venezuelan Institute for Scientific Research (IVIC), one of the leading scientific institutions in her home country. She held a PhD in applied chemistry and had published a variety of articles on the synthesis and characterization of magnetic nanomaterials. Her research was going well, and she was making progress on developing new methods of forming nanoparticles for the reduction of nitrogen oxides, air pollutants that are produced when fossil fuels are burned.

Unfortunately, while her career flourished, her country began to fall apart. Venezuela plunged into an economic crisis. By 2018, hyperinflation would reach 63,000% annually.

"The situation in the country was so difficult that we had to stand in lines from dawn to dusk just to get food," she says. "We were assigned a specific day each week. Mine was Tuesday." One day, Briceño waited in line in the sun from 3:00 a.m. to 4:00 p.m. and then went home empty handed. "All the food was gone," she says. Briceño knew she had to leave Venezuela when her entire monthly salary was barely enough to cover the rent for a small room.

"I felt so frustrated," she says. "I had a PhD, a permanent position at IVIC, and I couldn't believe that I had worked so hard for nothing."

Briceño learned about an opportunity to work at a new institution in Ecuador. Yachay Tech University had been founded in 2014 to provide access to education in science and technology to people from communities throughout Ecuador. In 2017, Briceño immigrated and started work there.

At first, adjusting to the difference in research culture between Ecuador and Venezuela was hard. At Yachay Tech, Briceño encountered students from rural areas who were the first in their families to attend university. The idea of doing scientific research in a laboratory was a new experience for them because they hadn't had exposure to these resources before.

Briceño saw this as an opportunity. "Our job is to teach students with love," she says. "When I began as an undergraduate student, I didn't know much either."

Briceño also had to overcome a lack of essential glassware and equipment like chromatographs and spectrophotometers. Her lab contained only tables and chairs.

But that didn't stop her. For instance, to teach her students about acids and bases, Briceño used red cabbage juice as a pH indicator. The anthocyanin molecule in cabbage changes color depending on a solution's acidity, providing a low-cost alternative to a pH meter. Instead of beakers and flasks, she used recycled baby food jars. To obtain natural carbon fibers, she turned to banana tree trunks (*Biomass Conv. Bioref.* 2023, DOI: 10.1007/s13399-023-03747-3), and she's considering making drug delivery microparticles out of Ecuadorian diatoms, a type of algal cell encased in a mineralized shell.

Resourcefulness is one of Briceño's best assets. She wants her students to learn to "do research using renewable resources" and to know they can give "added value to waste that has the potential to become new materials with the appropriate treatment," she says.

One of the tasks Yachay Tech's administrators gave Briceño when she was hired was to build up the institution's research and teaching capabilities. The deal was simple: Yachay Tech provided the funding, while Briceño and her colleagues contributed their expertise to acquire the essential technical equipment.

"My dream is to return to my country and rescue the laboratories where I was trained."

Slowly and steadily, the nanotechnology laboratory of Yachay Tech grew. Thanks to the advice of Briceño and other new hires, the department ordered equipment for Raman analysis, X-ray diffraction, and chemical vapor deposition, among other techniques. Briceño's work did not go unnoticed among her colleagues. "Sarah is extremely proactive," says Gema González, dean of the School of Physical Sciences and Nanotechnology at Yachay Tech.

With a brand-new laboratory, Briceño was determined to contribute her knowledge to the benefit of the community that had welcomed her. In September 2020, during the early stages of the COVID-19 pandemic, Ecuador was one of South America's worst-hit countries, with a death toll of 211 per 100,000 people, according to the *Economist* in 2022. The country's response was slowed by the lack of capacity for testing and monitoring and a long turnaround time to get results from polymerase chain reaction (PCR) tests.

One technology for speeding up PCR test processing involves adopting a preliminary RNA extraction from test samples using functionalized magnetic nanoparticles. While this technique makes it possible to process 10,000 tests per day, compared with 3,500 without the technology, the nanoparticles were unaffordable for Ecuador. So Briceño and her colleagues at Yachay Tech developed a low-cost method for synthesizing the necessary nanoparticles (*Sci. Rep.* 2020, DOI: 10.1038/s41598-020-75798-9).

"We produced a liter of magnetic nanoparticles that facilitated thousands of tests," Briceño says. It was a tremendously rewarding experience. Briceño and her colleagues estimated that, in just 2 days, they could make enough nanoparticles for about 50,000 accelerated COVID-19 tests.

Briceño is a role model for her students at Yachay Tech. Amauta Quilumbango, an undergraduate in the School of Physical Sciences and Nanotechnology, says the experiences that he has had with Briceño are etched in his memory.

Briceño guided him as he prepared for his thesis presentation. "She taught me that in order to talk about my research, I need to tell a story," he says. That instruction helped him change his focus on science and approach his dissertation defense in a more confident way. Inspired by Briceño's mentorship, Quilumbango aspires to earn a PhD in nanotechnology.

Ultimately, Briceño hopes to return to Venezuela. "My dream is to return to my country and rescue the laboratories where I was trained. I want to educate the people and make their laboratories what they have always been meant to be," she says. Fueled by this dream, she wants to apply everything she's learned in her career to advance her country.

CREDIT: KAREN TORO

▶ FOOD SCIENCE

Mónica Cala

Graduate student Kieran Tarazona Carrillo talks with this metabolomics researcher about cofounding a state-of-the-art research facility in Colombia and promoting Latin American research

At the University of the Andes in Colombia, Mónica Cala analyzes metabolites formed during coffee and cocoa production. She works to refine food processing approaches and uses her data to improve the quality of Colombia's specialty products. She also helped found and now leads MetCore, the country's first core research facility devoted to metabolomics, the study of small molecules produced by cells and tissues, expanding the breadth of research possible in Latin America. Kieran Tarazona Carrillo spoke with Cala about her research and the network she created to provide aspiring Latin American researchers an opportunity to conduct metabolomics research close to home.

This interview was edited for length and clarity.

Kieran Tarazona Carrillo: I first learned about your work at the Metabolomics 2022 conference and was thrilled to see another Colombian researcher working in the field! What made you want to pursue metabolomics?

Mónica Cala: I did my bachelor's and master's degrees in analytical chemistry, but when I started my PhD, I switched to biomedical analysis. I wanted to use analytical chemistry to investigate metabolic alterations in diseases and explore potential therapeutic or diagnostic alternatives. My PhD research focused on the metabolic alterations in breast cancer in Colombian populations.

A year and a half after starting my PhD, I attended the first Latin American Metabolic Profiling Society (LAMPS) meeting, where I met Coral Barbas, the director of the Centre of Metabolomics and Bioanalysis. Her research group was made up of analytical chemists who used mass spectrometry to study metabolomics, so I asked her if I could intern at the center.

This internship was crucial; it provided comprehensive training in all essential aspects of metabolomics and started my love for the field.

KTC: That sounds very similar to my journey! I studied biochemistry and analytical chemistry as an undergraduate and then came to the University of Alberta and fell in love with metabolomics.

At Metabolomics 2022, I learned that your research focuses on Colombian coffee and cacao crops. Can you tell me more about that work and why you chose to look at these crops?

MC: Because Colombia isn't very big and has a lot of mountains. We can't produce as much food as some other countries, like Brazil. So there's a significant focus on improving the quality of specialty products, like coffee and fine-flavor cocoa, to increase their value. Metabolomics enables us to correlate the metabolic changes occurring during the production of these products with different sensory and flavor profiles and select the process that enhances product quality.

For example, with both cocoa and coffee, we're trying to create tools that farmers can use to better control the first fermentation step by using starter cultures, so that they can produce beans with unique sensory

VITALS

MÓNICA CALA

▸ **HOMETOWN:** Socorro, Colombia

▸ **EDUCATION:** BS, chemistry, University of the Andes in Colombia, 2008; MSc, chemistry, Industrial University of Santander, 2012; PhD, chemistry, University of the Andes in Colombia, 2017

▸ **CURRENT POSITION:** Head of Metabolomics Core Facility, University of the Andes in Colombia

▸ **FAVORITE MOLECULE:** Neurotransmitters, especially serotonin and dopamine

▸ **WHAT REMINDS ME OF HOME:** A cup of specialty coffee

▸ **FAVORITE MUSIC:** Tropipop (also known as Colombian pop and Trop-pop)

▸ **I AM:** Latina

CREDIT: COURTESY OF ANA MARIA LEÓN

profiles and flavors. We're also working with Colcafé, a company in Colombia that produces ready-to-drink coffee beverages, such as cold brews, to improve the long-term stability of their existing products and figure out how they can create new goods for consumers using different food processing technologies.

KTC: It's amazing that all this work is being done as a part of MetCore. What made you want to create a facility like MetCore in the first place?

MC: After I finished my PhD, I initially considered doing a postdoc abroad. But I also felt conflicted that I wouldn't be continuing metabolomics research in Colombia. At that time, limited metabolomics research was being conducted in the country, and the few studies that were underway often were carried out by international collaborators. I knew that metabolomics research could be conducted locally, which is why I wanted to make it possible.

I shared these feelings with Silvia Restrepo, who was the vice president of research [at the University of the Andes in Colombia] at that time, and told her I wanted to establish a lab facility that allowed me to continue working in metabolomics here. Silvia thought that was an amazing idea and encouraged me to propose the project to the university, which I did with her support. Once the project was approved, I had 6 months to establish the business and financial plans, design the lab, and another 6 months to build the lab and set up the equipment.

KTC: Wow! That sounds stressful! But I bet it's extremely rewarding to see all your hard work pay off.

MC: Yes! It sounds corny, but establishing this facility was a dream for me. As a PhD student, I thought it would be impossible because of the lack of funding for research and limited access to cutting-edge technologies across various disciplines here in Colombia. I'm really grateful the university decided to invest in the facility.

This year marks MetCore's fifth anniversary, and reflecting on our achievements fills me with immense pride. Last year, for instance, MetCore collaborated in 34 research projects with institutions in Bogotá and other regions in Colombia and provided training for 32 Colombian students. We built a thriving, cutting-edge research environment, and while it comes with many responsibilities, the process has been incredibly fulfilling.

KTC: Earlier, you mentioned that you were first introduced to metabolomics through the connections you made at the LAMPS meeting, and I know you're one of the founding members of LAMPS. Why did you feel it was important to create the society, and how do you think it has helped other Latin American researchers?

MC: In Latin America, we encounter significant challenges in conducting research, particularly in fields like metabolomics. While this field is well established internationally, it is still developing in our region due to limited access to advanced technology and specialized knowledge. It is vital to establish networks that enable students and researchers to access technology, optimize research resources, and receive training. This was crucial for me, which is why I am deeply passionate about supporting the LAMPS network.

LAMPS develops, improves, and supports the training of new metabolomic researchers, ensuring open and accessible scientific research in our region. We're also finding ways to retain talent. For example, we've established internships at MetCore that allow students to conduct metabolomics research without having to travel abroad.

Our other focus is to encourage researchers from other parts of the world to come here and spend time working in our labs, which we're doing in collaboration with the Metabolomics Society, who have been major supporters. Looking forward, we plan to build collaborative projects addressing common issues in Latin America, like tropical diseases and food challenges, and exploring biomarkers for diagnosing diseases across different populations.

KTC: I'm in my final year of my PhD. I'm considering the possibility of continuing my career in Latin America. What advice do you have for young Latine or Hispanic students, like myself?

MC: The future of science lies in interdisciplinary approaches, so dare to explore beyond traditional boundaries. Step outside your comfort zone. Be bold, be curious, and let your unique perspective guide you to create high-value solutions and significant changes in your region—and potentially the world.

And don't forget to contribute to your region, whether you're based here or wherever you work. Each of us can play a role in advancing science in Latin America.

VITALS

KIERAN TARAZONA CARRILLO

- **HOMETOWN:** Bogotá, Colombia
- **EDUCATION:** BSc, biochemistry, University of Waterloo, 2019
- **CURRENT POSITION:** PhD candidate, analytical chemistry, David Wishart's laboratory, University of Alberta
- **MENTOR, AND WHY:** Stacey Lavery, supervisor of my undergrad analytical chemistry lab. She creates a welcoming environment, celebrates people's successes, and supports them through challenges. She has shown me that hard work, dedication, and perseverance lead to success.
- **BEST PROFESSIONAL ADVICE I'VE RECEIVED:** Never take negative criticism from someone you wouldn't ask for advice.
- **FAVORITE MOLECULE, AND WHY:** I love heme! It has a cool ring structure, and hemes have so many roles in the body.
- **I AM:** Colombian, nonbinary

CREDIT: COURTESY OF KIERAN TARAZONA CARRILLO

Kieran Tarazona Carrillo's current work focuses on standardization of fecal sample preparation for metabolomics studies with a focus on metabolite stability and applications to other biological samples. They love going to Elk Island National Park in Alberta with their friends to watch bison.

▶ BIOMATERIALS

Karina Carneiro

Graduate student Dagwin Wachholz Júnior talks with this chemist about regenerative medicine and representation for Latin American researchers

Karina Carneiro's story is a testament to creativity and representation. Like something out of a science fiction novel, Carneiro's lab at the University of Toronto is designing biomaterials out of DNA that could prompt wounds to heal themselves. Dagwin Wachholz Júnior interviewed Carneiro about her passion for chemistry and regenerative medicine, her unique position working among dentists, and her advice for young Latin American researchers.

This interview was edited for length and clarity.

Dagwin Wachholz Júnior: You are originally from Brazil, but now you work at the University of Toronto. What brought you to Canada, and how did that move shape your career?

Karina Carneiro: I was born in Brazil, but when I was 16, I participated in an exchange student program in the US. At the time, I thought I would return to Brazil to continue my education. But while I was abroad, I developed a passion for studying and for chemistry.

I started considering the possibility of pursuing my undergraduate degree in North America and applied to a lot of different universities in the US and Canada. I eventually got accepted at Mount Saint Vincent University in Halifax, where I started working in a lab during the summers. That's really when I started getting involved in research.

When I finished undergrad, I could have gone back to Brazil, but I decided to stay in Canada and chose to do my PhD at McGill University because I wanted to work with Hanadi Sleiman. For me, it was an incredible opportunity to learn how to use chemistry to modify biological molecules, such as DNA, which felt almost like science fiction.

DWJ: So you're a chemist, but now you are working at the faculty of dentistry. How did that happen?

KC: It does seem odd that I ended up in dentistry! But after my PhD, I wanted to change fields to work on something that was more biologically applicable and relevant to a different area—but that still let me use all of these skills I learned on my PhD.

I began searching for postdoc positions and ended up getting an offer from the University of California, San Francisco, in the faculty of dentistry. The professor I worked with was looking at how proteins influenced tooth enamel growth in vitro. My research was to look at the self-assembly of this protein and draw predictions as to whether this could happen in vivo as well.

After my postdoc, one of the jobs I applied to was my current position at the University of Toronto. They were looking for a scientist to join their research facility in their faculty of dentistry.

DWJ: That sounds like a position that was made for you, a chemist who already had experience working with dentists. Did you always want to be a professor?

KC: Well, at that point in my postdoc, I wasn't sure if I wanted to be an independent primary investigator. One of my mentors asked me why I didn't want to go into academia. I told her, "I don't think I fit the

VITALS

KARINA CARNEIRO

- **HOMETOWN:** Belo Horizonte, Brazil
- **EDUCATION:** BSc, chemistry, Mount Saint Vincent University and Dalhousie University, 2006; PhD, chemistry, McGill University, 2013
- **CURRENT POSITION:** Associate professor of dentistry and biomedical engineering, University of Toronto
- **WHAT REMINDS ME OF HOME:** Pão de queijo and brigadeiro
- **FIRST JOB:** Bookstore clerk
- **I AM:** Latina, Japanese

CREDIT: JEFF COMBER/UNIVERSITY OF TORONTO FACULTY OF DENTISTRY

VITALS

DAGWIN WACHHOLZ JÚNIOR

▸ **HOMETOWN:** Pomerode, Brazil

▸ **EDUCATION:** BSc, chemistry, Federal University of Santa Catarina, 2019; MSc, analytical chemistry, State University of Campinas, 2021

▸ **CURRENT POSITION:** PhD candidate, analytical chemistry, Lauro Kubota's laboratory, State University of Campinas

▸ **FAVORITE MOLECULE, AND WHY:** DNA. I really appreciate its elegant structure and its capacity to store huge amounts of information in a remarkably compact form.

▸ **FAVORITE SONG:** "Reconvexo" by Caetano Veloso. It is a meaningful song that represents the Brazilian cultural identity and celebrates the power of Brazil worldwide.

▸ **I AM:** Latino, German Brazilian

Dagwin Wachholz Júnior's current work focuses on the development of CRISPR-based biosensing devices for point-of-care diagnostics.

CREDIT: COURTESY OF DAGWIN WACHHOLZ JÚNIOR

mold. I don't think I would do a good job becoming a professor."

She said, "It's not for you to decide if you fit the mold. If you love researching and being a professor, make the mold fit you." I honestly never realized until that point that I was the one holding myself back.

DWJ: That's great advice! We need to stop excluding ourselves from a position and from opportunities just because we think we don't fit it. What are you working on now?

KC: Currently, I'm working on mineralized tissue regeneration and designing biomaterials that will give little signals to our body to [prompt it to] repair itself.

We are specifically designing DNA sequences that can hybridize with one another, almost like holding hands, to form an injectable soft gel. These hydrogels are made out of synthetic DNA, not carrying any genetic information, and are intended to be stable in a calcium media.

What we have seen so far is that when the hydrogel is injected in rats, the DNA gets degraded, releasing calcium and phosphate ions. We hypothesize that these ions could act as signaling molecules, potentially helping cells to differentiate or to rebuild damaged tissue.

DWJ: I am working with DNA in my PhD as well. More specifically, with CRISPR-based systems for diagnostics purposes. But considering the primary application of CRISPR on gene editing, do you think you could use it to design these DNA sequences?

KC: That's a tough question. It's truly inspiring to witness the advancements in the CRISPR field and the pace at which the science and its applications in humans are progressing. It's an exciting era to be involved in DNA research.

However, while I would love to be super confident and say yes, I think we know how research goes. Our work in rats looks promising, but using DNA hydrogels in humans still has a long way to go.

DWJ: Do you see other potential applications for DNA hydrogels beyond tissue regeneration?

KC: Since it is a biodegradable and biocompatible gel, it could also be used as a carrier for cell and drug delivery. The initial fear was if these structures are toxic, but so far it doesn't look like there is anything that could be dangerous. I think there's a lot of potential.

DWJ: That sounds amazing. It's really an honor for us Brazilians to have researchers like you working on such important research. How do you think we could increase this representation and open up opportunities for other Latin American researchers?

KC: What I'm doing is getting myself involved in different programs that support international students and women in science with backgrounds similar to mine.

There are also some things that I do specifically for my lab. When I'm recruiting, I prioritize curiosity and interest in a field over work experience, knowing there are barriers that can limit experience. I also try to minimize my bias by considering all aspects of a candidate instead of just focusing on their [grade point average] or publications.

And further, as a [Latina in science], it's crucial to speak up when something feels wrong, especially if you have a seat at the table where your voice matters.

DWJ: Related to the last question, what advice would you give to young researchers, like me, who are just starting out in their own careers?

KC: The most important thing is to put ourselves out there. There's such strength in the research that's being done in Latin America. I want people to recognize the hard work, energy, and creativity that goes into research there as well—all the hard work and sense of collaboration—with people just working together and trying to push things forward.

I also wish I'd actively sought out mentors. Every major step in my career has happened because of my mentors, even if I didn't seek them out specifically. But I wish I had asked for more help. That might have made things faster or caused me to make fewer mistakes.

DWJ: That makes sense. There can be a lot of shame around asking researchers we respect for help. But, as you said, the guidance and experience these people can share with us is important.

KC: Yeah, and it's important to network with others as well. I wish I had started networking earlier on in my career. I always thought I could succeed by keeping my head down and working hard. But nobody can do it alone.

DWJ: Any other advice you'd like to share?

KC: Don't try to fit the mold! We have to own who we are.

DWJ: That seems like the theme of our conversation!

KC: That's right! We make the mold!

▶ FOSSIL FUELS

Aline M. Castro

This chemist writes children's books when she's not capturing carbon

VITALS

▸ **HOMETOWN:** Rio de Janeiro

▸ **EDUCATION:** BS, chemical engineering, 2004, MSc, chemical and biochemical process technologies, 2006, and DSc, chemical engineering, 2010, Federal University of Rio de Janeiro

▸ **CURRENT POSITION:** Consultant, Leopoldo Américo Miguez de Mello Research, Development and Innovation Center, Petrobras

▸ **PROJECTS:** In 2022, I founded a publishing house named Ciência, Leitura e Afeto, which is dedicated to publishing science communication books, all dedicated to children's education.

▸ **HOBBIES:** Sewing, painting, and repurposing waste materials, like using waste bottles as gardening pots. I love storytelling for children, and I customize my lab coats to be very colorful and fun for them

▸ **I AM:** Latina

YESSENIA FUNES, special to C&EN

Aline M. Castro pulls out a pair of yellow cardboard glasses that she made. They look like the frames people wear on New Year's Eve, where numbers adorn a person's face—except these don't flaunt digits. Small red, white, and black pom-pons form a chemical structure.

"This is the sucrose molecule," the chemical engineer says from the other side of a computer screen, on a video call. She points to each of the two lenses: "There is glucose and fructose."

Castro spent her early career researching how to use sucrose, specifically cane sugar, to replace dirtier energy sources like fossil fuels. Brazil, where she lives and works, is the world's largest producer of sugar and unsurprisingly is the second-largest producer of ethanol, a fuel that can be derived from the sweet molecule.

She likes to wear these glasses when she talks about sustainability to elementary-age students. She makes such materials with her daughter on weekends. Some weeks, they craft a quick pair of glasses or customize an ocean blue tiara featuring an octopus and clown fish. Other projects take several weekends—like the lab coats the mom and daughter paint with scientific illustrations of green plant cells or red blood cells.

Castro is a researcher who is also an educator, writer, and mother. She's authored seven picture books about environmental science to help communicate the topic to young children—a passion inspired by her daughter. But her day job is with Petrobras, a Brazilian oil company. Since 2007, she's pioneered innovations in renewable fuels, plastics recycling, and carbon capture technologies as a senior researcher and consultant with the state-owned company.

But she didn't join the company to perpetuate the use of fossil fuels during the age of record-breaking heat waves and wildfires. "To work with petroleum was never my intention," she says. She believes energy companies like Petrobras can help fix the mess they've made through their investments in renewable energies and alternative feedstocks such as biogas.

Much of her time currently goes toward developing new approaches in carbon capture and utilization. Some scientists find carbon capture technology controversial, in part because of its popularity among fossil fuel companies, while others deem it necessary for lowering global greenhouse gas emissions. Castro is investigating basic solvents that can separate carbon dioxide from methane or flue gas and transform it efficiently into new products such as carbonates and carbamates.

For example, carbonic anhydrase enzymes help accelerate the reaction between CO_2 and water to create bicarbonate, a versatile chemical commodity, out of the greenhouse gas. If Castro can identify which particular process conditions are best, carbon capture facilities may require smaller reactors, less steel, less water, and overall less energy in the future.

> **"We need to speed up the implementation of this low-carbon technology on a very large scale."**

There are "a lot of advantages," Castro says. "We need to speed up the implementation of this low-carbon technology on a very large scale."

The enzymes that capture CO_2 in an industrial setting are the same ones that move CO_2 through our bodies, Castro says. "It was always fascinating to see this parallel between the biology of real life and chemistry and how we can mimic these natural reactions," she says.

It was this fascination and love for the natural world that drew her to science in the first place.

"I was aware of environmental concerns of the planet, so I wanted to do something that could contribute to the planet being a better place to live," she says.

Castro grew up near the favelas of Rio de Janeiro, dense neighborhoods where many households have incomes below Brazil's poverty line and lack basic sanitation services. "The urban landscape was degraded," she says. When she'd walk the streets with her mom, she would see plastic waste and tires scattered about. She and her mom would escape on the weekends to parks and botanical gardens when her mother was free, but Castro would be alone most days while her mom was working. It wasn't until her 10th birthday that she found a respite from her loneliness—in science.

Her dad gifted her a microscope that she could use to discover details invisible to the naked eye. She would capture ants and explore them at different zoom levels. She'd assess plant samples and dust. Sometimes, she'd mix colors and pigments just to see what would happen.

Today she realizes how important this free-form exploration was for her creativity, she says. In her childhood, Castro didn't have access to new toys, so she got into crafting, creating wardrobes for her dolls out of shoeboxes. What looked like child's play was actually helping her build the imagination she regularly flexes in the lab. "I had to train my brain to build things and to imagine how they were going to be by gluing them in this position and that and mixing materials. As scientists, we are inventors."

Her mother helped Castro become the first in her family to go to university. Castro attended the Federal University of Rio de Janeiro (UFRJ) from her undergraduate through her doctoral studies, where she excelled.

Denise Maria Guimarães Freire, a professor at UFRJ, describes her then student as "dedicated, attentive, and with a unique scientific curiosity." Castro possesses the rare combination of scientific rigor, writing ability, and creativity, she says.

Nei Pereira Jr., a professor emeritus at UFRJ who also taught Castro, says she is one of the top students he ever had among the nearly 150 he supervised over his career. The pair worked together for Castro's master's dissertation to design "an enzymatic cocktail," as he put it, that would help break down the cell walls of sugar cane waste in an industrial setting. These early pursuits have helped inform much of her work communicating with children—and helped inspire those adorable sucrose glasses. Pereira admires his former student's commitment to reaching young people.

"Aline recognized the importance of bringing knowledge to this foundational level of education and has been doing so in an accessible and engaging way," he says. "Her example should inspire other researchers to awaken children's interest in complex subjects."

Castro has loved writing since she was a child, but she didn't plan to become an author. When her daughter turned 4, she started reading books to her but couldn't find many that talked about sustainability. So she figured she would write one. Her first book was published in 2021. She donated every single copy to nonprofits working with children from lower socioeconomic groups in Brazil.

Through her books, Castro shares fantastical tales where children can travel the ocean in a submarine to clear it of plastic. She dares her readers to dream as she did when she was their age. She shows them the ways science can change the world. After all, that's why she became a scientist in the first place.

CREDIT: MARÍA MAGDALENA ARRÉLLAGA

▶ DIVERSITY

Luis A. Colón

Graduate student Deysi Gómez Cholula talks with this analytical chemist and award-winning mentor about promoting diversity in the chemical sciences

Luis A. Colón is reshaping the scientific field by offering summer research opportunities and mentorship at the University at Buffalo (UB), where his analytical chemistry laboratory is based. For the past 30 years, undergraduates from the University of Puerto Rico in Cayey (UPR-Cayey), where Colón earned his undergraduate degree, have come to UB to conduct research. Many of those students return to UB for their graduate studies under Colón's wing. The program has started to be replicated at other universities. In 2015, in recognition of the program and his mentorship at large, he received the Presidential Award for Excellence in Science, Mathematics, and Engineering Mentoring from President Barack Obama, and this year he won the American Association for the Advancement of Science Lifetime Mentor Award. Deysi Gómez Cholula spoke with Colón about the significance of curiosity, leaving home for a career in science, and perseverance in research.

This interview was edited for length and clarity and was partially translated from Spanish.

Deysi Gómez Cholula: I'm going to talk to you about your mentorship in a second, but first, tell me about your research. What initially inspired you to pursue a career in analytical chemistry? And what does your laboratory group do now?

Luis A. Colón: When I was little, I was very curious. I was very interested in how things worked, what the composition of matter was. And I have always been intrigued by measuring things.

Then, before I went to graduate school, I went to work for a pharmaceutical company. I had a very great appreciation for how important chemical analysis was, particularly for drug discovery and quality control. So when I went to graduate school, I focused on developing technology and methods for chemical analysis, specifically using separation techniques.

I decided to continue in that area, trying to overcome problems of existing technology.

DGC: In my research on photocatalysts for hydrogen production, I am exploring new characterization techniques; innovating is daily work. What future advancements do you see in chemical separation techniques and technologies?

LAC: Sustainability is very important. Here we are contributing by developing new methodologies based on supercritical fluid chromatography. This is a separation technique that basically will decrease the use of organic solvents, which can be toxic, as waste in chemical analysis.

Current efforts in my research laboratory are centered on the synthesis and properties of these materials that are hybrid silicates that can be used for separation. One application is, for example, the isolation of solutes that are found at concentrations too low for chemical analysis, such as environmental pollutants, like PFAS [per- and polyfluoroalkyl substances], or trace compounds in biofluids.

DGC: How do you find the time to balance

VITALS

LUIS A. COLÓN

▸ **HOMETOWN:** Cidra, Puerto Rico

▸ **EDUCATION:** BSc, chemistry, University of Puerto Rico in Cayey, 1981; PhD, analytical chemistry, University of Massachusetts Lowell, 1991

▸ **CURRENT POSITION:** State University of New York Distinguished Professor and A. Conger Goodyear Chair Professor of Chemistry, University at Buffalo

▸ **BEST PROFESSIONAL ADVICE I'VE RECEIVED:** Embrace the things you are passionate about with all your energy, but be alert to recognizing what is too much, and learn to say no!

▸ **FAVORITE MOLECULE:** Caffeine and sucrose. My father used to cultivate coffee and sugarcane. When I was very young, I recall asking him what made the cane taste so sweet, as I saw him sometimes putting a piece inside of his cup of coffee!

▸ **I AM:** Latino and Hispano

CREDIT: DOUGLASS LEVERE/UNIVERSITY AT BUFFALO

VITALS

DEYSI GÓMEZ CHOLULA

▸ **HOMETOWN:** San Vicente Piñas, Mexico

▸ **EDUCATION:** BSc, chemical engineering, National Autonomous University of Mexico, 2014; MSc, chemical sciences, Autonomous Metropolitan University, 2021

▸ **CURRENT POSITION:** PhD candidate, chemical science, Francisco Javier Tzompantzi Morales's ecocatalysis laboratory, Autonomous Metropolitan University

▸ **FAVORITE ELEMENT:** Hydrogen. It is found throughout the universe, and I am currently working on producing this element from water splitting via photocatalysis.

▸ **NICKNAMES:** My mom calls me Deysita or Margarita; my dad, Nachita; my sister Roxana calls me Perochita or hermanita; my sister Sendi calls me Dey; my brother Wilbert calls me Nana; and my brother Arturo calls me Mi Negrita.

▸ **I AM:** An Indigenous Oaxaqueña woman—my paternal grandfather belonged to the Amuzgos, or Tzjon Non.

CREDIT: TRAVIS SHANE DOMANSKI

Deysi Gómez Cholula's current work focuses on the synthesis of photocatalysts for hydrogen production. Additionally, Gómez Cholula is passionate about photography, is an enthusiast of physical training, and enjoys hiking in the mountains, forests, and parks.

your research with your mentorship work?

LAC: I think that mentoring and research go hand in hand. I see that it's all for the advancement of science.

When I do my mentoring, it's intentional, meaning I intend to mentor the person as well as advance the research. It's not that I have to exert extra effort that drives me away from research.

DGC: Well, it sounds like a lot of effort. You've been leading a program to bring UPR-Cayey students to UB for almost 30 years. What inspired you to start the program?

LAC: A few things. First, I went to the UPR-Cayey as a student, and I knew the needs that they had [there] because I did not have certain opportunities and resources to prepare to go to a research graduate program. That's perhaps why I didn't go to graduate school right away.

Also, I saw the need to increase diversity in the chemical sciences, particularly bringing Hispanics to chemistry. When I first came here, I was the very first Hispanic person to be hired as a faculty member in the department of chemistry. There was not a single PhD or master's student graduating from chemistry that was a Hispanic person.

All of those things somehow melded together and inspired me to reach out and establish a relationship with UPR-Cayey and try to provide experiences for undergraduate students.

DGC: How has the program grown and evolved since its inception in the 1990s?

LAC: In the mid-'90s or so, I got my first student from Puerto Rico. That student had a good experience, and she went back and spread the word. Later on, other faculty showed interest because we started to get graduate students from UPR-Cayey applying here and coming to the program.

Today, we have had, I don't know, over 100 students that have benefited over the years. Many of them have gone to graduate school. Over 3,000 Hispanic students have completed master's and PhD degrees at UB since I've been here, in the past 25 years or so.

Also very important is that other individuals, including some who have participated in this program, are replicating it at other institutions.

DGC: Do you have advice that you like to give young scientists who are considering moving far from their homes for a research opportunity?

LAC: Be curious, and be hungry for knowledge! Frustration in one experiment can lead to discoveries—don't get discouraged.

Also, for people from Latin America who go to the US to work, the language barrier is one of the top things on their mind. They think that they might not be able to perform because of that. But I think that's changing, and people are more tolerant now, finding different ways to ask questions or communicate.

DGC: I'm finishing up my PhD, and I'm always thinking about, if I do a postdoc, whether I should do it in Spain or in another place where they speak Spanish. So I see what an opportunity you're giving students, ensuring that their first interactions are with someone who knows more than just English.

LAC: Establishing a relationship between students and the university or program in a familiar language was a big help. Students noticed that I spoke the language, and they asked questions that they would've been scared to ask otherwise because they were able to ask them in Spanish and get answers in Spanish. That motivated them and others around them; eventually, they became more comfortable with the language.

If you're interested in doing a postdoc, first look for the research area that you like, where you think you can learn what you want to do. Then worry about the language and all that. You need to be encouraged to get past the thought of, "I'm not going to be able to speak English."

DGC: That's good to hear because my friends and I doubt ourselves too much. The only thing we see is the language.

LAC: What gives me confidence is that we know a lot more than we think we do. Don't get discouraged; there are opportunities out there.

DGC: Thanks so much! What gives you the most satisfaction in your work as a mentor and educator, and can you share a success story of your students that is especially meaningful to you?

LAC: In general, I think every student that walks in my lab is a success story. I think they learn and they get an experience that in one way or another will shape their career and their life. Many of them have gone on to graduate school. Many of them have discovered that graduate school is not for them, which is also important.

DGC: As you reflect on your contributions to both science and education, what legacy do you hope to leave behind?

LAC: The students that have come through my lab, that's the biggest legacy. My desire is, similar to how they were influenced positively here, they also continue influencing others.

It's like a spiderweb. It starts at a point, then expands, influencing a few, and those few influence others. And we can see how we create a better world for advancement of science and education.

▶ CHEMICAL COMMUNICATION

Rogelio A. Hernández-López

This cellular engineer reprograms biological systems to fight cancer

VITALS

- **HOMETOWN:** Oaxaca, Mexico
- **EDUCATION:** BS, chemistry, National Autonomous University of Mexico, 2007; MA, chemistry, 2011, and PhD, chemical physics, 2015, Harvard University
- **CURRENT POSITION:** Assistant professor of bioengineering and genetics, Stanford University
- **NICKNAME:** Rollo, by my swimming team friends
- **FAVORITE MUSIC:** Timba, Latin jazz
- **HOBBIES:** Salsa dancing, swimming, enjoying live music
- **I AM:** Oaxaqueño, Mexican

ALEJANDRA MANJARREZ, special to C&EN

Growing up in the city of Oaxaca in southern Mexico, Rogelio A. Hernández-López was engaged in intense training for swimming competitions. He recalls that around the ages of 13–15, his daily routine was a relentless cycle of school, eating meals in the car, a 3 h swimming workout, homework, dinner, and sleep. In a sense, he says, his perseverance and discipline were transmitted from sports to science.

And it looks like that devotion to his passions has paid off. Hernández-López sometimes thinks of his group at Stanford University as a team of high-performance athletes, where everyone is constantly training and focused on what they are passionate about. His lab is trying to understand the complex biochemical language that cells use to communicate, knowledge that could be leveraged to genetically program cells to fight disease.

His interest in chemistry emerged from another form of competition: in high school, he quickly rose through local chemistry and math contests, and he ultimately competed at the International Chemistry Olympiad in Athens, Greece. This experience was transformative, he says. It inspired him to pursue a chemistry degree at the National Autonomous University of Mexico.

During his undergraduate studies, Hernández-López's drive didn't let up. In addition to his required classes, he enrolled in mathematics, physics, and graduate chemistry courses, and he participated in short research projects exploring various areas of chemistry. In 2008, he graduated as the top student in his class.

Inspired by friends who were studying in the US, and because he was curious about doing research in a country with more resources than Mexico, he decided to pursue a doctorate at Harvard University. He admits he had some concerns as he made the move to Boston, including having "to speak English all the time"—a language he had not yet fully mastered.

"He's pretty fearless about doing new things," says Andres Leschziner, a structural biologist at the University of California San Diego who was Hernández-López's PhD adviser at Harvard. "I think everyone wanted to recruit him." Leschziner was happy when he learned that Hernández-López decided to join his lab.

> **"I no longer wanted to study isolated proteins. . . . I wanted to do things more on a cellular scale."**

Specifically, Leschziner admired Hernández-López's curiosity to learn new methods and apply them to the problem at hand. At Harvard, one of Hernández-López's goals was to advance the understanding of how dyneins, molecular motors that transport cellular cargoes, move along intracellular highways (*Science* 2012, DOI: 10.1126/science.1224151). Besides analyzing cryogenic electron microscopy data, he brought his computational skills into Leschziner's lab and built a molecular model of the interactions involved.

"Rogelio's expertise in molecular dynamics was key," Leschziner says. His sophisticated modeling approach provided a more detailed understanding for how the dynein's foot binds to and detaches from microtubules, which

CREDIT: MARIA XIMENA NATERA CRUZ

form the track along which dyneins walk, Leschziner explains.

Even with that success, Hernández-López wanted to press beyond what his program demanded. In the middle of his PhD research in biophysics, he took a summer course in physiology at the Marine Biological Laboratory, an experience that guided him toward his lab's current research questions. "I no longer wanted to study isolated proteins" or just look at interactions between two proteins, he says. "I wanted to do things more on a cellular scale."

During a postdoctoral fellowship in Wendell Lim's lab at the University of California, San Francisco, Hernández-López focused on engineering human T cells to modulate how they can tell cancer cells apart from other cells in the body (*Science* 2021, DOI: 10.1126/science.abc1855). Questions on how cells communicate and interact continue to grip him as he steers the course of his Stanford lab.

By cutting and pasting DNA into T cells' genomes, his lab aims to reprogram them to fight cancer. Most of the current approaches revolve around the T cells' ability to kill cells that pose a threat, Hernández-López says, "but we are thinking a lot about how we can make these modified cells talk to other types of cells, maybe to enhance other functions." For example, his team is interested in programming T cells to improve how they infiltrate a tumor or to extend their lifespan.

Outside the lab, Hernández-López is as tireless about his passions as he was as a kid. He still swims, and he has also become an avid salsa dancer. More formally, though, he has taken it upon himself to empower new generations of scientists.

About a decade ago, he plunged into yet another field where chemists rarely tread: he enrolled in a Harvard course on education, innovation, and social entrepreneurship. There he learned how to better manage a budding nonprofit he'd cofounded, Clubes de Ciencia México, which organizes intensive face-to-face and online science, technology, engineering, and mathematics (STEM) activities for high school and college students in Mexico.

The course inspired a new perspective at Clubes de Ciencia. Hernández-López started to structure the project like an educational start-up, in which the team in charge needed to secure financial resources, recruit talent, and convince society and potential allies of the project's possible impact.

Fast-forward, and the program has crossed borders. Following its success in Mexico, Clubes de Ciencia has been implemented in other Latin American countries under the guidance of Hernández-López and other members of the Mexican team. Throughout this expansion, these mentors "were extremely supportive," says Bruna Paulsen, a Brazilian stem cell biologist and cofounder of Clubes de Ciência Brasil. Today more than 19,000 students from nine countries have participated in programs under the umbrella organization Science Clubs International.

Hernández-López never anticipated the program's profound impact. He recently met a Stanford student from Peru who applied to the university because of Science Clubs. He adds that he has heard of many other similar stories of inspired young scientists.

Paulsen, who is currently at the biotech company Gameto in New York City, says that Hernández-López's success, charisma, and humility make him a role model. "In Latin America, everybody can name a soccer player, but it's very hard to name scientists," she says. Science Clubs International aims to change that by showing students they can become scientists too.

Hernández-López does this job very well, Paulsen says. By showing his achievements while remaining approachable, he proves to students that "it's possible to get where they dream, because someone else was able to."

▶ MATERIALS

Juan Paulo Hinestroza

This materials scientist matches nanotechnology with fashion design

VITALS

▸ **HOMETOWN:** Bucaramanga, Colombia

▸ **EDUCATION:** BSc, chemical engineering, Industrial University of Santander, 1995; PhD, chemical and biomolecular engineering, Tulane University, 2002

▸ **CURRENT POSITION:** Rebecca Q. Morgan '60 Professor of Fiber Science and Apparel Design, Cornell University

▸ **PROFESSIONAL ADVICE:** Be strong and chase the positive of every situation.

▸ **IMPACTFUL BOOK:** *One Hundred Years of Solitude*. Every time I read it, I get a new interpretation of our Latin identity.

▸ **FUN PROJECT:** I am learning Mandarin, and it is a lot of fun. I follow a Chinese chef on social media, and I love cooking Cantonese cuisine according to his recipes and learning Mandarin at the same time.

▸ **I AM:** Latino

MALENA BEATRIZ STARIOLO, special to C&EN

Chemist Juan Paulo Hinestroza finds research inspiration in the superhero cartoons he watched growing up in Colombia. In the 1970s, Lycra hadn't been invented, yet the creators of the Justice League were able to dream up a stretchy, form-fitting uniform that enabled the Flash to run at high speeds.

Today, Hinestroza leads the Textiles Nanotechnology Laboratory at Cornell University and dreams of bringing some superhero flair to the clothing industry. Working in his laboratory with chemists, engineers, and designers, he combines nanotechnology with fashion design to create fabrics with unique characteristics, like the ability to change color and filter toxic gases.

While growing up in Bucaramanga, a mountainous town in Colombia, Hinestroza loved to read books about other countries, and he dreamed of traveling the world. "I started to notice that three letters always appeared in the writers' names: PhD," he recalls. During his undergraduate studies in Colombia, he did an internship at the Colombian branch of Dow Chemical, where he worked as a project manager and process control engineer. This work gave him his first push into a research career. "I was always asking why, so my supervisor told me that I should pursue my PhD to find the answers."

> **"We as instructors have to innovate and adapt so we can inspire new generations of scientists."**

He discovered a passion for teaching during graduate school at Tulane University and became a three-time winner of the Omega Chi Epsilon Outstanding Teaching Assistant Award. "I saw that I enjoyed the interaction with students and that I had a knack for explaining complex things like applied mathematics," he says.

When he graduated, Hinestroza declined job offers from various companies and sought out a role as a professor. He found an opportunity at the Wilson College of Textiles of North Carolina State University. Until then, Hinestroza had no experience with fabrics, but he took the opportunity and ran with it like his childhood hero the Flash would have.

A few years later, he moved his group to Cornell University and focused on adding high-tech capabilities to one of the most common textile materials: cotton. His lab investigates how cotton and other natural fibers interact with nanoparticles so the team can create textiles that change color or capture pollutants.

The pollution-capturing textiles are based on metal-organic frameworks (MOFs), networks of metal clusters coordinated with organic ligands. They form cage-like structures capable of trapping other molecules, such as gases, but bringing MOFs into textiles is challenging. They tend to bond to one another rather than to the textiles—which stumped Hinestroza's team.

In 2010, the researchers had a breakthrough when two of Hinestroza's students created a structure made up of alternating layers of cellulose polymers and MOFs. With funding from the US Department of Defense, the team developed a cotton-MOF textile that can adsorb chemical warfare agents and industrial pollutants, making it potentially useful for military applications. The researchers then used this new fabric to create a mask and a hood.

This work requires a nimble and flexible mind: Hinestroza says the group doesn't always know what properties will emerge in the fabrics. "It's

Juan Paulo Hinestroza's lab includes dresses made by former fashion design students in addition to the usual benchtop necessities.

like a soccer game; you never know what's going to happen until the end," he says. Hinestroza is passionate about the sport, and he compares a successful research group to a high-performance soccer team. The union of different skills makes the team and the lab stronger.

He attributes these values to his Latin American roots, which he thinks were essential in developing his creative, resilient, and receptive spirit. "Growing up in a culture with Indigenous, Afro, Latin American, and European influences has taught me to understand others and be open to different influences," he says.

These characteristics are essential for working in such a dynamic field. "In fiber and textile science, we get to combine the technical aspects of chemistry and materials with design and culture," says Ellan Spero, a historian of science and technology at the Massachusetts Institute of Technology who first met Hinestroza in 2006. Hinestroza's combination of curiosity and the desire to apply what he learns to his research is striking, she says. "He is always integrating experiences from different cultures, inspiring students to combine technical knowledge with design challenges," she says.

This approach is present in the way Hinestroza leads his research group. For example, in 2012, Hinestroza unveiled a bodysuit capable of releasing insecticides for malaria control, a project he worked on with Frederick Ochanda, a then postdoctoral scholar from Kenya, and Matilda Ceesay, who was then a student from the Gambia majoring in apparel design. Also, Hinestroza says he loves experimenting with natural fibers from various parts of the world, such as Brazilian sisal, which leads him to keep collaborations in the country. "I love going to Manaus because the Amazon is where the greatest diversity of plants is found. I have learned that nature is much smarter than us."

His enthusiasm fuels his group's ingenuity. "He always seeks ways to encourage a passion for the laboratory and challenges us to find solutions to adversities without losing optimism," says Luiz Gustavo Ribeiro, who conducted part of his doctoral research under Hinestroza's supervision.

Hinestroza is worried by the lack of Latine representation in the chemical sciences. Because of that, he actively recruits Latine students and provides short visit opportunities for university professors from Latin America. "If we want to motivate more kids to study chemistry, we need to have more role models," Hinestroza says. Since 2000, he has been a member of the Society of Hispanic Professional Engineers, where he participates in workshops for the professional development of Latine students interested in academic careers.

"I have discovered that students have changed their learning habits, and we as instructors have to innovate and adapt so we can inspire new generations of scientists," he says. Lately, Hinestroza has been exploring generative artificial intelligence as a teaching tool, asking students to use it in their projects to encourage them to experiment with different approaches. Meanwhile, in the laboratory, he is investigating ways to synthesize MOFs from recycled polyester clothing as an innovative and ecofriendly way to manage textile waste.

CREDIT: LAUREN PETRACCA PHOTOGRAPHY

▶ PHYSICAL CHEMISTRY

Eusebio Juaristi

This physical organic chemist has spent a career thinking about molecules in 3D

VITALS

▸ **HOMETOWN:** Querétaro, Mexico

▸ **EDUCATION:** BS, chemistry, Monterrey Institute of Technology and Higher Education, 1972; PhD, organic chemistry, University of North Carolina at Chapel Hill, 1977

▸ **CURRENT POSITION:** Professor of chemistry, Center for Research and Advanced Studies of the National Polytechnic Institute (Cinvestav) Mexico City

▸ **BEST PROFESSIONAL ADVICE I'VE RECEIVED:** The harder I work, the luckier I get.

▸ **FAVORITE SONGS:** "Let It Be" and "Non, Je Ne Regrette Rien"

▸ **I AM:** Mexican

LAURA VARGAS-PARADA, special to C&EN

Eusebio Juaristi stands up in the middle of our conversation and returns with a bag full of colorful plastic sticks. By fitting together the sticks with little joints, he constructs 3D molecular models that illustrate some of his work—work that most chemists have heard of even if they wouldn't recognize Juaristi's name.

Juaristi, a distinguished professor emeritus at the Center for Research and Advanced Studies of the National Polytechnic Institute (Cinvestav) Mexico City, is one of the most cited chemists in Latin America and has received almost every national award Mexico can give. "He is a rock star," says Rodrigo Patiño, a researcher at Cinvestav Mérida in Yucatán, Mexico. Patiño has known the veteran researcher since 1995, when Patiño began research for his PhD in the laboratory next door to Juaristi's.

Some colleagues consider Juaristi one of the leading experts on the anomeric effect. A basic tenet in conformational analysis dictates that substituents in six-membered rings prefer to position themselves equatorially, or in the same plane as the ring. The anomeric effect refers to cases where substituents instead position themselves axially, jutting out from the plane of the ring.

Using the molecular models, he shows how his research team discovered that an organic heterocyclic molecule adopted a conformation that seemed impossible. Its bulky substituent was hovering above the ring rather than alongside it. "We had evidence for an unprecedented, strong anomeric interaction," he explains (*J. Org. Chem.* 1982, DOI: 10.1021/jo00146a048).

But like other fundamental principles governing molecular physics, "the anomeric effect, for example, is not a topic that attracts much of the spotlight," he says.

As he uses the molecular model kit to tell the story of discovery, he begins to reminisce about how the kit has a story of its own. When he was an undergraduate in 1970, he attended a short course on stereochemistry, where he met Ernest L. Eliel, one of the creators of conformational analysis. "He noticed how intrigued I was by his Fieser molecular models, and he gave them to me as a gift. Fifty-four years later, I still use them," Juaristi says, referring to the plastic sticks dispersed on the table. In 1972, he went to the University of North Carolina at Chapel Hill to pursue his PhD under the supervision of Eliel.

"I also concluded that my potential contribution as a teacher and as a researcher would have a much greater impact in Mexico."

In 1979, after finishing a postdoc at the diagnostic division of Syntex in Palo Alto, California, he received an invitation to join the chemistry department at Cinvestav Mexico City. "By then I had decided I wanted to have my own research group," he says. "I also concluded that my potential contribution as a teacher and as a researcher would have a much greater impact in Mexico."

C. Dale Poulter, former editor in chief of the *Journal of Organic Chemistry*, considers Juaristi's work in conformational analysis, enantioselective synthesis of β-amino acids, and asymmetric organocatalysis outstanding. But Poulter particularly credits Juaristi's role in the development of the field of physical organic chemistry on the continent, as Juaristi was a trailblazer in establishing a rigorous program for training students in Mexico in the late 1970s. "The impact of his work has spread throughout Latin America as his students have moved on to other countries

CREDIT: ALEJANDRA RAJAL RAMIREZ

to establish their own programs," he says.

In recent years, Juaristi has been one of the most determined promoters of green chemistry in Mexico. He aims to develop products and processes that reduce the release of environmentally harmful waste. He is particularly interested in using high-speed ball milling to develop solvent-free conditions for catalytic processes. "We are pioneers in applying mechanochemistry in peptide synthesis, as well as asymmetric organocatalysis through mechanochemical activation."

Despite Patiño's admiration for Juaristi, the veteran researcher is mostly unknown to chemists outside Mexico. Juaristi's colleagues say one explanation could be that fundamental science like his doesn't get enough press. But Guillermo Delgado Lamas, a former president of the Chemical Society of Mexico, also points to the strong skepticism toward research that comes from anywhere other than the famous research centers in Europe or the US.

Juaristi agrees there tends to be a bias, especially against young scientists in Latin America. "When you write a paper, some colleagues prefer to cite the work done in institutions in the US, Europe, or Japan," he says.

While working in Mexico over the past 45 years, Juaristi has noted many changes, some good, some bad. Overall, he commends the advancements he's finding across Latin America. "The number of students, chemistry departments, graduate programs in chemistry—not only in Mexico but in other countries like Brazil, Argentina, and Colombia—is something to be proud of," he says.

But scientists face new challenges with governments skeptical of the importance of education and research. Consequent cuts of scholarships and grants have recently happened in Brazil, Mexico, and Argentina. "The last 6 years have been very difficult because the current government in Mexico does not support science," Juaristi says.

Juaristi, like many of his colleagues, has lost his grant from the Mexican science council. The president-elect, Claudia Sheinbaum, has promised to revert the neglect, although Juaristi is skeptical that the "available financial resources will be sufficient to honor this promise."

Despite the troubles, Juaristi sees a bright future for his laboratory. He recalls a comment from Nobel laureate Herbert Brown that made an impression on him. Brown had visited Mexico in the 1990s, and after his lecture Brown said his best chemistry efforts came after winning the prize, well into his 60s. The comment now makes complete sense for Juaristi: "There is no reason to stop. I am starting new, exciting projects; I have many ideas; I am just 73 years old."

▶ PROCESS CHEMISTRY

Carlos A. Martinez

This process chemist used nature's catalysts to make Paxlovid a reality

VITALS

- **HOMETOWN:** Cali, Colombia
- **EDUCATION:** BS, chemistry, University of Valle, 1994; PhD, chemistry, University of Florida, 2000
- **CURRENT POSITION:** Director of the Biocatalysis Center of Excellence, Pfizer
- **HOBBIES:** Running, playing the piano, and gardening
- **FAVORITE SONG:** "Somewhere over the Rainbow" by Israel "IZ" Kamakawiwo'ole. And I enjoy classical piano music, can listen to Chopin and Beethoven for hours.
- **RECENT PROJECT:** Built a pond at my house
- **I AM:** Latino

BEC ROLDAN, special to C&EN

In 2020, Carlos A. Martinez and his team at Pfizer were racing to massively scale up production of nirmatrelvir, a key component of the COVID-19 antiviral Paxlovid. While it can take years for a drug candidate to make it to patients, Pfizer brought nirmatrelvir to market in only 17 months (*ACS Cent. Sci.* 2023, DOI: 10.1021/acscentsci.3c00145).

Martinez, director of Pfizer's Biocatalysis Center of Excellence, played a key role in making the starting material for a main fragment of nirmatrelvir using enzymes. "As a company, we all felt that the development of the vaccine and antiviral were the most important things at the time," Martinez says.

He says the biggest challenge was not the scientific aspects of the process but the need to work quickly across internal and external bureaucracy. The team had to work seamlessly to meet grueling timelines, monitor technology transfers to commercial suppliers, and ensure uniformity across manufacturers and vendors.

As part of the larger efforts at Pfizer to bring Paxlovid to market, his team repurposed and adapted an enzymatic route to make an intermediate previously used in the synthesis of boceprevir, a hepatitis C treatment that was withdrawn from the market in 2015 (*J. Am. Chem. Soc.* 2012, DOI: 10.1021/ja3010495). This fragment had been made previously, but his team couldn't find enough documents detailing the drug's production. "We almost had to reinvent the process," Martinez says. Drawing on public domain knowledge and using an enzyme produced by Codexis, he and his group were able to double the productivity compared with that of the previous process route.

Martinez is used to solving tough problems. He's led the biocatalysis efforts at Pfizer for more than 20 years. He was awarded the 2024 American Chemical Society Award in Industrial Chemistry for his "outstanding contributions to chemical research in the industrial context."

> **"There's a lot to be discovered and a lot of value to be brought to the chemical research ecosystem in the US and beyond from students from Latin America."**

Martinez's journey, defined by creatively using enzymatic reactions on the metric ton scale to produce lifesaving drugs, began in a library in his hometown of Cali, Colombia, in the 1980s. He loved reading about the chemical elements. "I always thought there was something wonderful about the periodic table," Martinez says. A biochemistry class during his fourth year of undergraduate studies at the University of Valle solidified his desire to do chemistry research that could make an impact on human health.

After completing his undergraduate studies, Martinez served as a summer visiting student in the lab of Jon Stewart at the University of Florida. "That's how I met the field of biocatalysis for the first time," Martinez says. "I worked really hard as a summer intern and eventually received an invitation to join Stewart's group. It ended up being a very good move for me."

Stewart says Martinez joined his lab as it was

CREDIT: LUIS MANUEL DIAZ

just starting up, and Martinez's time there was part of "the foundation of everything that came after" in the lab. Martinez then served as a postdoctoral fellow in Frances Arnold's lab at the California Institute of Technology, where he was a key contributor in the lab's early efforts at generating new enzymes by recombining similar sequences from different organisms. "I came away with an understanding that the development of a process could involve the development of the catalyst," Martinez says, instead of just trying to make a commercially available enzyme fit a synthetic target.

Martinez started his professional career in the first biocatalysis group at Pfizer in 2001, excited about the potential to apply the technique in industrial processes. He knew scaling up would be key. "Unless we were able to impact projects at large scale, biocatalysis was never going to be integrated into the workflows of how we do business," he says.

The group's first success story came when it successfully developed an enzymatic manufacturing process for pregabalin, the active ingredient in the nerve-pain medication Lyrica. The group's technique used a commercially available lipase enzyme (*Org. Process Res. Dev.* 2008, DOI: 10.1021/op7002248).

"It was the first time we were able to identify an enzyme and a process that could be scaled up," says Daniel Yazbeck, a founding member of the Pfizer biocatalysis group who now serves as CEO of the private investment fund Yazbeck & Co. The new process improved yields and efficiency and reduced waste streams compared with the first-generation route.

"This set the stage for future success stories," Martinez says. "It sent a message that this biocatalysis technology was scalable," giving the team much-needed credibility.

Yazbeck says the first few years of starting up Pfizer's biocatalysis group were exciting and intense. "Biocatalysis was a relatively new field, and we were spearheading Pfizer's efforts," he says. Through it all, Martinez was methodical, steady, and consistent. "Carlos was always driven to do the science and make it work," Yazbeck says. "Consistent and steady wins the game."

When he's not diligently racking up accolades or helping bring lifesaving medications to reality, Martinez tries to encourage students from his home country to recognize their own talent. "I'm very proud of my upbringing in Colombia," he says. "The education I received was top tier and quite rigorous."

Martinez gives talks at Colombian universities and maintains an informal network of Colombian scientists. He hopes his encouragement will build confidence in students to pursue graduate studies in places like the US. "There's a lot to be discovered and a lot of value to be brought to the chemical research ecosystem in the US and beyond from students from Latin America."

▶ PHARMACEUTICAL CHEMICALS

Edna Matta-Camacho

This regulatory chemist fights against educational disparities in rural Colombia

VITALS

▸ **HOMETOWN:** Ibagué, Colombia

▸ **EDUCATION:** BSc, chemistry, National University of Colombia, 2004; MSc, biochemistry and molecular biology, National Autonomous University of Mexico, 2006; PhD, biochemistry–chemical biology, McGill University, 2012

▸ **CURRENT POSITION:** Senior assessment officer, Health Canada; cofounder and executive director, Fundación STEM sin Fronteras

▸ **IMPACTFUL BOOK:** *Hidden Figures*, by Margot Lee Shetterly. It tells the true story of Black women mathematicians who worked at NASA and overcame gender and racial barriers to make crucial contributions to space exploration.

▸ **A LIFE MOTTO:** There is no straight or perfect path to achieve your goals. Believe in yourself, overcome any obstacles, seize every opportunity that allows you to move forward, and help others whenever you can.

▸ **I AM:** Latina

MATÍAS A. LOEWY, special to C&EN

Edna Matta-Camacho remembers being a very inquisitive girl who used to open radios or hair dryers with a screwdriver to find out how they worked. Occasionally, she would break things in the process, to the disappointment of her mother. "But at the same time, she supported my curiosity," Matta-Camacho says.

Today, she's just as curious. But instead of tinkering with household objects, Matta-Camacho is now a senior assessment officer at the Pharmaceutical Drugs Directorate of Health Canada, where she ensures that new drugs have fulfilled preclinical and clinical requirements of safety and efficacy to meet regulatory standards. She also created a foundation that aims to stimulate the scientific curiosity of girls and young women in rural Colombia, just like her mother did for her.

Matta-Camacho was first introduced to chemistry at the age of 14. "It was like love at first sight," she recalls. She was captivated by the idea that everything in nature, including stones, glass, and table salt, could be defined in terms of chemical compounds and crystalline states.

> "Educational institutions [in rural areas] had very precarious conditions."

Matta-Camacho went on to study chemistry at the National University of Colombia, in Bogotá, around 200 km from her hometown, Ibagué. She felt as if she'd entered her own molecular heaven. She especially enjoyed the classes that let her uncover the identity of a compound by analyzing its physical and chemical characteristics. "I liked putting all the pieces together to form the puzzle," she says.

As she approached graduation, she knew she wanted to continue her education and get her PhD, but she hadn't considered the possibility of doing so abroad. Her sister, who was doing a PhD program in parasitology in Brazil, encouraged her to look into those types of opportunities.

After exploring different options, Matta-Camacho chose to do a 6-month project at the National Autonomous University of Mexico (UNAM) that looked at the production of antibodies that help regulate thyroid hormones in the blood. She wasn't particularly familiar with biochemistry at the time, but she was attracted to the field because of a hormone deficiency she was diagnosed with at 16. Matta-Camacho didn't know it at the time, but this project was the beginning of a journey into protein research that would last more than a decade.

Once Matta-Camacho got her BSc in Colombia, she went back to UNAM to pursue an MSc, then moved northward to McGill University for her PhD work, in which she studied the mechanisms that degrade dysfunctional and misfolded proteins. She says she grew enamored by the "profound connection" between chemistry and medical research—how understanding protein chemistry was fundamental to discovering new therapies.

But as a postdoctoral researcher at McGill, and later at the Scripps Research Institute, she realized that she wasn't interested in doing all the administrative tasks that a principal investigator is expected to do, such as writing grants and managing budgets. So she decided to transition from academia to industry and joined the Canadian pharmaceutical firm Paraza Pharma. At Paraza, Matta-Camacho designed and tested modifications in small molecules to make them fit better within the active sites of proteins.

CREDIT: JESS DEEKS

But she says she grew a bit restless in industry. "I was partly motivated by the desire to see immediate applications of my work." So in 2019, Matta-Camacho left industry and became a regulatory chemist at Health Canada, working as a member of a multidisciplinary team that certifies that any drug released to market has followed all the laboratory, clinical, and manufacturing approval steps.

"The dynamic and evolving nature of the regulatory field also keeps me continually learning and engaged," she says. Over the years, she has evaluated dozens of drugs, such as new oral contraceptives, antihypertensives, and antitumor drugs potentially taken by millions of Canadians. Her work ensures that clinical trial data prove that the drug is effective and minimizes side effects.

"It's a great responsibility," she says. Working as a scientist in the government often involves applying research and evidence to public policy, putting her team on the forefront of decisions that address many societal and medical challenges. For instance, making sure that treatments in obstetrics and gynecology work properly "tackles significant issues, such as birth control access and fertility options," she says. "Ensuring the safety and efficacy of these products is crucial for improving patient outcomes and addressing these widespread health concerns."

Apart from her scientific work, Matta-Camacho also cofounded the Fundación STEM sin Fronteras (STEM without Borders Foundation), which aims for young minds in rural Colombia to "have equitable access to quality STEM education and opportunities," Matta-Camacho says. She created the foundation in 2018, after her brother and sister-in-law, both educators in the rural and peri-urban areas of Tolima, Colombia, raised concerns about educational disparities in this part of the country.

"Like many other regions in the country, these rural areas were severely impacted by the [decades-long] armed conflict. And educational institutions there had very precarious conditions," Matta-Camacho says. Early exposure to science, technology, engineering, and mathematics (STEM) fields would become key to empowering children to realize their full potential, she believed.

Now the foundation provides educators in these regions with seminars and workshops aimed at building capacity in STEM topics. "We were a gathering of scared and inexpert female teachers. And [Matta-Camacho and the foundation] gave us moral and motivational support to generate science in rural areas without computers or TV and where parents don't consider education to be a priority" because they expect children to work with the parents, says Anyi Zabala Hernández, who teaches 45 children in La Begonia, a small community in Tolima.

The Fundación STEM sin Fronteras also creates activities to spark students' interest in STEM, encouraging girls and young women in the region to pursue education. "Edna is a very intelligent and empathic person, an excellent scientist. And although she lives abroad, she thinks all the time how to ensure that [Colombian] children have the same opportunities that life gave her," says Liliana Rondón Salazar, a biologist who met Matta-Camacho in Mexico and now leads some programs at the foundation.

Matta-Camacho believes that a measure of success is the capacity to give back to society. In that regard, she considers herself quite successful, and she's proud that her foundation can help support students who share the same curiosity she had as a child.

▶ ANALYTICAL CHEMISTRY

Maria Fernanda Mora

CREDIT: THE LIGHT COMMITTEE

Graduate student **Alejandra Rodríguez Abaunza** talks with this analytical chemist about Mora's work at NASA and how her personal experiences have shaped her career

Maria Fernanda Mora is an Argentinian chemist working at the NASA Jet Propulsion Laboratory (JPL). She is developing miniaturized techniques to look for signs of extraterrestrial life on space missions. Alejandra Rodríguez Abaunza spoke with Mora about the quirks of working at NASA and about what it means to be a Latina in science.

This interview was edited for length and clarity.

Alejandra Rodríguez Abaunza: How is NASA different from other labs you've worked in?

Maria Fernanda Mora: The best part is that JPL is more interdisciplinary than academic life. I did my undergrad and PhD in chemistry labs, and we would have weekly seminars for the students. Even if it was in a different field of chemistry, you still understood most of the stuff they were talking about.

But when I came here, I didn't understand the things that they were talking about in the seminars. It was a learning experience, and it took me out of my comfort zone.

ARA: I can relate to that. I'm doing my PhD in applied earth sciences, but my bachelor's is in biology. It's interesting, but sometimes I feel lost.

MFM: It's overwhelming. But you must accept that there are many things that you don't know. Sometimes you have the feeling that you don't belong in the room, right? That was very real for me. But at some point, you understand that you have unique things to bring to the table. This is the value of having a team.

ARA: Definitely. Tell me about your current research at JPL. How does your work help find signatures of life on other planets?

MFM: We develop instruments that allow us to identify molecules that could indicate the presence of life.

In our lab, we focus on analyzing liquids using capillary electrophoresis. We use fluorescence detection for amino acids, which are very well-accepted biosignatures, and mass spectrometry to identify other molecules that we find on Earth.

We also use a conductivity detector to see the inorganic composition of our samples, which is related to a place's habitability. This is a relatively new technology for NASA exploration because liquid analysis hasn't been done on space missions.

ARA: Our research has some points in common. I also use spectrometry when I'm determining geochemistry signatures that help us to reconstruct the climate of the past.

MFM: Yeah, that's also connected to the search for life. A lot of the instruments that

VITALS

MARIA FERNANDA MORA

▸ **HOMETOWN:** Saldán, Argentina

▸ **EDUCATION:** BS, chemistry, National University of Cordoba, 2002; PhD, analytical chemistry, University of Texas at San Antonio, 2009

▸ **CURRENT POSITION:** Scientist, NASA Jet Propulsion Laboratory, California Institute of Technology

▸ **BEST PROFESSIONAL ADVICE I'VE RECEIVED:** "Shamelessly promote yourself." In my culture, it's sometimes seen as being arrogant, but I have learned that it is very important to advocate for yourself.

▸ **WHAT REMINDS ME OF HOME:** "Food, especially when I cook for people in the US. I learned to cook from my mom, my dad, and my grandma. This is how we show love in our family, through food."

▸ **I AM:** Latina

we have sent to Mars basically do spectrometry and try to understand what happened to the planet's surface and whether or not you can have organics underneath. It's important to do all of that before you send the chemistry instrument that is actually going to take a sample and do a chemical analysis.

ARA: What do you think is the unique challenge of designing your chemical experiments? In my work, we often have to adapt to unexpected conditions in the field.

MFM: It's planning for things that could go wrong and how to mitigate them. When we were designing the instrument, one of the main things that I struggled with was to make it small. In the lab, I have all the time in the world, and I can take many steps to get a precise measurement, but on flight, I have limited resources. For an analytical chemist, that's hard to accept because "I need to measure it three times!" You must change your mindset. You still want to do valuable science, but you must work with what you have.

Another challenge is that you must adapt to something that you don't expect. We don't know the composition of the samples that will be analyzed. We have some ideas depending on where we're going, but there could be something in your sample that could affect your measurement. That's challenging, but it's fun to work on those problems.

ARA: Such a big challenge! What has been your favorite project or mission to work on?

MFM: When I first came to JPL, we developed an instrument called Chemical Laptop to analyze solid samples on Mars. Now we are interested in Europa and Enceladus, which have oceans covered by ice.

Another interesting place is Titan, the only moon with organic lakes on its surface. Instead of water, those lakes are made of methane. So the theory is that if life is evolving on Titan, it would probably be different from life on Earth. These are super interesting places, and I would like to send my instrument to all of them.

ARA: What sparked your interest in science while growing up in Argentina?

MFM: My dad gave me a science book called *How Things Work*. I loved that book, and I remember it like it was yesterday. I think that's how it started, although I was naturally very curious.

ARA: When I was a child also, my parents gave me an encyclopedia called *El Mundo de los Niños*. I remember trying to learn the names of the animals from different parts of the world, like a biologist.

MFM: I remember being so immersed in the story of the book the *Journey to the Center of the Earth*. It's funny because it's about exploration, and now I work on space exploration. Maybe everything started with a science fiction book.

ARA: Funny how that happens! You moved from Argentina to pursue your PhD at the University of Texas at San Antonio. What was your experience moving to the US in the 2000s like?

MFM: I think the hardest part is leaving your family and friends. You know how it is, moving to a different country with a different language and culture.

At the beginning, I idealized my country, thinking everything was perfect in Argentina. Later, you start having a more realistic view of your country, because nothing is perfect.

At the same time, getting the chance to live in another country is extremely valuable because you grow as a person. You meet people from all over the world. But, my English wasn't great when I came to the US; I was very shy about speaking. If I could go back in time, I wish I wasn't so embarrassed by my English.

ARA: Indeed. For me, the language barrier was the biggest challenge during the first year. How else do you think being a Latina scientist influences your career?

MFM: I only started thinking about it later in my career. When I came to JPL, I noticed that most of the time, I was the only woman and the only Latina in the room. I became more aware that I'm a minority. Now I'm more interested in helping to increase the diversity in our field.

I talked to students in Argentina, and recently I participated as a speaker during the workshop "Latinas Shaping the Future of STEM+" for high school students at the annual Latina History Day Conference in Los Angeles. But I feel more the effect of being a woman than of being Latina.

Probably you have been through many situations in which people interrupt you, don't trust you, or even take your ideas and make them sound like theirs, just because you're a woman. I've been through situations like that all my career. That's also something that I am very interested in changing. In our group at JPL, we have conversations about the biases that we have. The bias against women, as some people don't realize, is very real and still happens.

ARA: What advice would you give to young Latin American scientists who are just starting their careers?

MFM: Don't be afraid of taking opportunities that maybe you didn't plan for or expect. Be open minded, look at all the opportunities out there, and don't be afraid to do something that maybe you're not so comfortable with. It might be the right place for you.

VITALS

ALEJANDRA RODRÍGUEZ ABAUNZA

- **HOMETOWN:** Moniquira, Colombia
- **EDUCATION:** BSc, biology, Pedagogical and Technological University of Colombia, 2016; MSc, marine biology and limnology, National Autonomous University of Mexico, 2021
- **CURRENT POSITION:** PhD student, earth and environmental sciences, Broxton Bird's laboratory, Indiana University Indianapolis
- **BEST PROFESSIONAL ADVICE I'VE RECEIVED:** "In academia, always be curious, and be brave," from my undergraduate adviser, Javier Luque.
- **FAVORITE ELEMENT, AND WHY:** Carbon. Radiocarbon dating is my favorite and most reliable type of "dating."
- **I AM:** Boyacense

CREDIT: KATIE DAWSON/IUPUI SCHOOL OF SCIENCE

Alejandra Rodríguez Abaunza's current work focuses on reconstructing the climate of the past using geochemistry in lake sediments. When she is not in the lab separating microscopic charcoal by hand, she enjoys spending time in the garden, picking strawberries.

▶ POLYMERS

Monica Olvera de la Cruz

This chemist brings chemical simulations into the real world

VITALS

▸ **HOMETOWN:** Acapulco, Mexico

▸ **EDUCATION:** BA, physics, National Autonomous University of Mexico, 1981; PhD, physics, University of Cambridge, 1985

▸ **CURRENT POSITION:** Lawyer Taylor Professor of Materials Science and Engineering, Northwestern University

▸ **BEST PROFESSIONAL ADVICE:** Find your own research problems because there is no satisfaction working on a problem others have formulated. It will probably be solved before you solve it, and if not solved, then it means it is too hard.

▸ **FAVORITE MUSIC:** Classical, tropical, and disco. I have too many favorite songs depending on my mood, the environment.

▸ **NICKNAME:** Mino. Sergio, my brother, gave it to me.

▸ **I AM:** Latina

MALENA BEATRIZ STARIOLO, special to C&EN

Few people would be overjoyed at the prospect of working in a computational facility at night. But in 1982, Monica Olvera de la Cruz was doing it with a smile on her face.

Back then, she was a PhD student at the University of Cambridge researching how polymer chains mix and move at the molecular level. But the research required extensive work in algorithm construction and simulations, which was a tall order for Cambridge's single computer available to students. Olvera de la Cruz would have to wait in a queue of dozens of young scientists for days to use the equipment for a few hours.

Her fortunes changed after a visit to the UK Medical Research Council's state-of-the-art computational facilities. "I asked my friend if I could run my simulations on their equipment at night," Olvera de la Cruz recalls. The answer was yes.

These polymer simulations led to a partnership with the council to try to understand what happens to DNA, a polymer, during gel electrophoresis. "I think that was the most important thing I did, to look for a problem that had significance. It was no longer just a simulation game," she says.

"That was the most important thing I did, to look for a problem that had significance. It was no longer just a simulation game."

That unexpected collaboration changed the course of her doctorate, and it was a sign of where her research would end up. Today, Olvera de la Cruz directs her own lab and several research centers at Northwestern University that are known for their work combining chemistry, materials science, biology, physics, and engineering.

She's especially well known for bridging theoretical and experimental teams with her multidisciplinary approach and bright spirit. "She loves her science and really has a deep commitment to it. It's an infectious enthusiasm," says Charles Sing, who worked with Olvera de la Cruz during his postdoctoral fellowship at Northwestern University.

Despite her longtime home in academia, Olvera de la Cruz's origins are far from universities. She grew up in Acapulco, a coastal city in Mexico that, at the time, had very few science labs. "The higher the level of education, the greater the lack of laboratories," she says. She remembers that as she was growing up, she had no opportunity to meet any researcher and had no scientist as a role model, which initially led her to consider a career in philosophy or mathematics.

Despite that, her curiosity about the nature that surrounded her flourished. From a young age, she was curious about the sea, the movement of the stars, and the mysteries of electricity. It all translated into an aptitude for science in school. She recalls her first physics class: "The teacher gave us all the equations, and I told him I didn't need them. I could derive them."

With the support of her family and the desire to understand the forces of nature, she pursued a physics degree at the National Autonomous University of Mexico. Later, encouraged by her adviser, Alfonso Mondragón Ballesteros, she pursued her PhD at Cambridge.

Over the course of her career, Olvera de la Cruz and her group of students have been the theoretical minds providing explanations that experimentalists need to accelerate their real-world discoveries. Her PhD work on DNA in the 1980s led to better ways to sequence genes. More recently, her group helped identify vulnerabilities in the spike protein of SARS-CoV-2 and helped develop soft materials for aquatic robots (*ACS Nano* 2020, DOI: 10.1021/acsnano.0c04798; *Sci. Robot.* 2020, DOI: 10.1126/scirobotics.abb9822).

For the robots, a group at Northwestern used simulations created by Olvera de la Cruz's group to design soft materials with the ability to react and adapt to the environment at a molecular level—for example, by being responsive to magnetic fields and light. Those properties were key to the robots' walking and steering.

To do this kind of simulation, the group members need to deal with many variables, such as how an electric field is distorted by ions, and they need to know which variable will be relevant for what they want to do. "It's a bit like a game, trying to figure out what is going on in our systems," says Martin Girard, a former student of Olvera de la Cruz. "Working with Olvera de la Cruz is fun, and there was always a good atmosphere in the group, which made the work enjoyable."

And despite the often behind-the-scenes roles assumed by theoreticians, "you can see the echoes of Monica's work and the ideas she pioneered going throughout the literature over the past few decades," says Sing, who is now a professor at the University of Illinois Urbana-Champaign. One of her greatest influences is in the field of electrolytes. In

CREDIT: EDDIE QUINONES

1995, she discovered that the interactions between polyelectrolytes and counterions, both charged components, can lead to the formation of a solid from a solution. This discovery contributed to the understanding of the behavior of charged molecules.

"When I was a graduate student, my PhD adviser mentioned that if I wanted to understand electrolytes, all I needed to do was read Olvera de la Cruz's papers," Sing says. "Often when I go to do something in this area, I look back and find that Monica did it very well decades ago."

With a constant smile and joy in sharing her knowledge, Olvera de la Cruz can engage anyone in the fields she studies. Today the professor is pleased to see that academia, especially in the fields of chemistry and physics, has a more significant Hispanic presence, and she hopes this will allow new generations to feel more included in the scientific community.

▶ POLLUTION

Pablo Pastén

This environmental chemist tracks the chemical legacy of Chile's mines

VITALS

- **HOMETOWN:** Calama, Chile
- **EDUCATION:** Civil engineer, hydraulic engineering, and MSc, civil engineering, Pontifical Catholic University of Chile, 1995; PhD, environmental engineering, Northwestern University, 2002
- **CURRENT POSITION:** Principal researcher of the Healthy Watersheds project, Center for Sustainable Urban Development
- **FAVORITE MOLECULE:** H_2O. Water is life.
- **FAVORITE MUSIC:** Symphonic metal
- **RECENT PROJECT:** A stained-glass lamp with Charles Rennie Mackintosh designs
- **I AM:** Latino

ROBERTO GONZÁLEZ, special to C&EN

As a child, Pablo Pastén used to accompany his father to rivers in Chile's Atacama Desert. His father worked for the General Directorate of Water and would wade into the waterways to measure their flow. Pastén waited for him on the riverbank.

"I would spend hours observing and asking myself questions about the rivers here in Chile," Pastén says. "It was a very special moment." Having grown up in Calama, a municipality deeply linked to the copper industry, he became especially interested in the waterways that flowed through mining environments.

These childhood expeditions with his father marked the start of Pastén's journey to become a lead researcher of the Center for Sustainable Urban Development (CEDEUS) in Chile, where he uses geochemistry to address societal challenges and influence public policy. One of the main issues that Pastén is working on through CEDEUS is the environmental impact of mining, an industry that accounts for over 11% of the country's gross domestic product, according to Statista. Tailings, or waste created after the ore is processed, often contain toxic elements, including heavy metals and other chemicals that can leach into water and soil.

"It's interesting how the need to work with the community and for the community suddenly changes our lives."

According to Pastén, one of CEDEUS's most consequential projects began when he and his team visited Copiapó, another city in the Atacama region. They were organizing a seminar when they learned that the community was concerned about some nearby tailings. Pastén remembers being struck by a photo from a journalistic investigation that showed a playground slide right next to a pile of mining waste.

The article that accompanied the photo told the story of Viñita Azul, an urban development in Copiapó that was built next to abandoned tailing ponds dating back to 1990. Construction continued despite warnings from Chile's National Geology and Mining Service about the potential for hazardous contaminants.

Pastén wondered what would happen to his daughters if they were to play on that slide. He knew he had to do something about the situation.

He and his team analyzed samples of road dust from Copiapó with a portable X-ray fluorescence spectrometer, which could identify metals and measure their concentrations in the area. Their findings were alarming: levels of copper, lead, and zinc exceeded international guidelines for residential soil.

They published their findings in 2022, which helped revive the discussion of a soil framework law for Chile that had been inactive for years (*Appl. Geochem.*, DOI: 10.1016/j.apgeochem.2022.105230). The impact of this work also led Pastén to write a book about public policies for sustainable urban development and discuss his pollution research with Chilean legislators.

Looking back on his time as a graduate student at Northwestern University, where he used a synchrotron to study the minerals formed by aquatic bacteria, he never thought that this introduction to the field of chemistry would lead

CREDIT: TAMARA MERINO

him to inform policy on soil management in his country. In fact, he didn't even want to be a chemist. He originally trained as a civil engineer at the Pontifical Catholic University of Chile (UC) to follow in his father's footsteps and preserve the health of Chile's rivers.

Jean-François Gaillard, an environmental chemist at Northwestern University, remembers that when Pastén joined his laboratory, he was reticent about chemistry and wanted to focus on computational modeling instead.

"A lot of engineering students want to get out of chemistry because it's too complicated. It has a bad reputation," Gaillard says. But he managed to spark Pastén's interest. Although Pastén was not a chemist by training, Gaillard thought he had gained the title after the hours they spent together in the lab doing research for Pastén's PhD.

Pastén then returned to UC and became a lead researcher at CEDEUS. He also began teaching chemistry to students in the Department of Hydraulic and Environmental Engineering.

Alejandra Soledad Vega Contreras, who took one of Pastén's courses as an undergraduate, remembers him as a strict and demanding professor. "But he is so motivated when he teaches that I think he is one of the reasons I actually got my PhD in environmental engineering," she says. She now works as a researcher at CEDEUS.

Pastén also taught his students how to use chemistry to address problems afflicting the people of Chile. Sara Ester Acevedo Godoy, who worked in Pastén's lab as an undergraduate, says he has a knack for scientific outreach. In January, for example, Pastén participated in a roundtable with a senator from the National Congress of Chile to discuss ways to link science to public policy. Now, Acevedo is trying to do the same as one of the chemists working on CEDEUS's Healthy Watersheds project, which aims to study the natural and human stressors on Chile's urban water sources in an effort to protect them.

Beyond noting Pastén's contributions to science, Acevedo describes him as "the axis of many stories" because of the many lives he has affected. She and Vega highlight how Pastén actively promotes gender equality in engineering research, a field they both describe as currently dominated by men. Although women make up only 30% of enrollments in UC's School of Engineering in 2020, Vega says Pastén supervises roughly equal numbers of men and women.

"Pablo is a total siete. In Chile, when we say someone is a seven, it means he is the best," Acevedo says.

Robert Nerenberg, an environmental engineer at the University of Notre Dame who met Pastén when they were PhD students at Northwestern, recalls the key role that he and Pastén played in an agreement between Notre Dame and UC that allows students to enroll at both universities and earn a dual degree. This university collaboration gives UC students access to lab equipment not available in Chile, like the synchrotron Pastén used as a grad student.

Pastén believes in the power of the legacy that teachers can leave their students. For him, part of his legacy is teaching applied chemistry in Chile and getting more engineers like him into the lab. "It's been a long road since the synchrotron," Pastén says. "It's interesting how the need to work with the community and for the community suddenly changes our lives."

▶ OUTREACH

Melissa Ramirez

Graduate student Ramón Gudiño García talks with this computational and synthetic organic chemist about how being a first-generation university student has influenced her career

CREDIT: COURTESY OF MELISSA RAMIREZ

Melissa Ramirez uses a cutting-edge approach that combines computations and experiments to develop catalytic reactions. As she wraps up a postdoctoral position at the California Institute of Technology, she's gearing up to start her own lab at the University of Minnesota Twin Cities using this approach to perfect computational models to study chemical reactions. Ramón Gudiño García talked with Ramirez about what it's like to move into the role of a professor as well as the importance of hands-on mentorship.

This interview was edited for length and clarity.

Ramón Gudiño García: Congratulations on your new position! I read on your website that you are a computational and synthetic organic chemist. What does that mean?

Melissa Ramirez: Currently, chemists usually first develop or optimize a reaction in the laboratory and subsequently perform computational modeling to analyze the reaction. But as a synthetic and computational chemist, I use computations and experiments in tandem to develop a variety of chemical transformations.

With the guidance of computations, I can better understand reaction mechanisms and molecular structures. Without computations, that information would be challenging to obtain or unattainable.

RGG: What will your lab at the University of Minnesota investigate?

MR: My group is going to focus on developing new reactions in asymmetric catalysis, main-group catalysis, and transition-metal chemistry. I am looking for ways to apply computations to solving challenges in synthesis.

Bigger picture, I see my group developing computational models for reactivity to predict a reaction product prior to reaction setup. As an example, it would be incredibly helpful for chemists to know whether we can functionalize one particular site of a molecule versus the other before testing the reaction out in the lab.

What really will set my group apart is the training that students will have in both experiments and computations. When I went from undergrad to graduate school, I wanted to both do computations and run experiments, and that was really challenging in terms of time management and being an effective science communicator to two different audiences.

RGG: Are you excited to be a mentor to your new students?

MR: Very excited! I am most excited to learn about my students' backgrounds and science journeys, to learn about the kinds of questions that they ask.

Another thing I'm excited about doing in my independent career is learning more

VITALS

MELISSA RAMIREZ

▸ **HOMETOWN:** Pasadena, California

▸ **EDUCATION:** BA, chemistry, University of Pennsylvania, 2016; PhD, organic chemistry, University of California, Los Angeles, 2021

▸ **CURRENT POSITION:** Postdoc, California Institute of Technology; incoming assistant professor, University of Minnesota Twin Cities

▸ **IMPACTFUL BOOK:** Stacey Abrams's book *Minority Leader: How to Lead from the Outside and Make Real Change* motivated me to pursue a career in academia. Through this book, I gave myself permission to dream big and to write my story.

▸ **HOBBIES:** I love to take high-intensity interval (HIIT) training classes and Peloton (I have the bike and rower at home!).

▸ **I AM:** Latina, Chicana

VITALS

RAMÓN GUDIÑO GARCÍA

▸ **HOMETOWN:** Mexico City

▸ **EDUCATION:** BSc, pharmaceutical and biological chemistry, National Autonomous University of Mexico, 2021

▸ **CURRENT POSITION:** PhD candidate, chemistry, Matthew R. Pratt's laboratory, University of Southern California

▸ **BEST PROFESSIONAL ADVICE I'VE RECEIVED:** My mentor Giuliano Cutolo would always tell me to write down any small change in conditions of a reaction or experiment in a given day. That might explain any unexpected results in the future.

▸ **WHAT REMINDS ME OF HOME:** All the Mexican food in LA and hearing people speak Spanish pretty much everywhere in LA.

▸ **I AM:** Latino and Mexican

CREDIT: JESÚS EMILIANO VÁZQUEZ GARCÍA

Ramón Gudiño García is developing the next generation of metabolic chemical reporters to selectively study glycosylation and the participating enzymes in the cell. He also enjoys learning new languages, swimming, and dancing salsa.

about how to help international students enter US-based PhD programs and perhaps having a partnership with UAMI [the Autonomous Metropolitan University of Mexico, Iztapalapa] and UNAM [the National Autonomous University of Mexico] to bring chemistry students to Minnesota.

RGG: Also, I see that you have done a lot of outreach and mentorship activities at Caltech, right? What were those like?

MR: Two of the most exciting outreach activities that I participated in at Caltech were, first, returning to my old high school in Pasadena, Marshall Fundamental School, to introduce students to organic chemistry. I organized graduate students and postdocs to visit my high school, where we introduced students to the field, careers in organic chemistry, and what the path from high school to graduate school looks like. We also synthesized nylon with students.

I was able to directly give back to students whose shoes I was once in. Marshall Fundamental serves students from so many racial and ethnic backgrounds. And from a standpoint of socioeconomic status, nearly 75% of them qualified for free or reduced-price lunch last school year.

The second activity was mentoring undergraduate summer research students at Caltech via the Wave program. This program aims to foster diversity by increasing the participation of students historically excluded from science and engineering PhD programs. I served as a mentor to six students in the summer of 2023 and recently mentored a group of five this summer.

RGG: As a Latina in science, how do you think your identity has shaped the way you do research and mentoring?

MR: My identity as a Latina has led me to see my colleagues and mentees beyond the science. The personal qualities that I bring to science—resilience, grit, persistence, and empathy—are shaped by how I was raised as a Latina and by the communities I am a part of.

My identity has also shaped my resourcefulness and optimistic perspective. For example, in a reaction, I may not generate the product I initially wanted but instead formed something unanticipated yet valuable.

RGG: Yes, that resonates with me. I feel like sometimes you have to make the most out of something.

MR: At an early age, I didn't have the immediate resources; I had to find a way. I had to ask questions, and I had to take advantage of [whatever was available]. I was at a public school where the education was not at a high level, so I had to take advantage of whatever college prep programs I could find.

I think, where there's a will, there's a way, but tenemos que querer. Tenemos que echarle ganas. You have to couple desire with hard work.

RGG: I know you're a first-generation university student; so am I. Every one of us has their own story about how we decided to pursue a career in science. What was yours?

MR: My parents were both born in Tijuana, Mexico, and only went up to the second grade. I became interested in science in high school because I participated in the California State Summer School for Mathematics and Science (COSMOS). There, I became really fascinated with how some fish in the ocean light up and how chemistry can be used to explain it.

Then I participated in the Caltech Summer Research Connection (SRC) program the summer after 11th grade. At Caltech, I had two mentors, Ramón Rodríguez, who was a high school teacher in Glendale, and Ann Anderson, a middle school teacher in Pasadena at the time. Both of them helped me study the water quality of the Arroyo Seco, which is a local stream here. That's when I knew I wanted to do research during college.

RGG: When I was in high school, I fell in love with chemistry as well, and I think that my parents played an important role in my going to college. Did something similar happen in your case?

MR: My parents were always working, but they always encouraged my curiosity. They wanted me to do better than they had in terms of obtaining an education.

They didn't want me to do what they did, even though both did jobs that are important. These jobs just don't provide good financial stability, I would say. My dad was a cook and a dishwasher at a restaurant local to Caltech called Burger Continental for many years. Then he worked at the dining hall at Jet Propulsion Laboratory (JPL), and then also at the dining hall here at Caltech. My mom was a caregiver to [older adults] for many years.

At a young age I had that sense of "I need to do better, and I want more for myself." I think that it is actually part of the mindset as the daughter of two immigrants.

RGG: I have one last question. Is there any piece of advice that you would like to share with other young scientists out there?

MR: Stay true to yourself. Only you can decide what you're capable of. I'm the kind of person who has sticky notes in the kitchen, and I have a sticky note right now that says, "Embrace change, aim high."

TRAILBLAZERS

▶ FOOD SCIENCE

Martín Salinas

Graduate student Natalia Gorojovsky talks with this chemical engineer about leading the way with a molecular farming biotech from Latin America

CREDIT: COURTESY OF MARTÍN SALINAS

Martín Salinas is driving the development of food science, business, and regulation all at once. He's a cofounder and the chief technology officer of Moolec Science, a spinout from Bioceres Group. Salinas and Moolec are leading the way in industrial molecular farming, a technology that can produce animal proteins in plants, and the young company is helping develop the budding sector's regulatory landscape. Natalia Gorojovsky spoke with Salinas about his motivations for and challenges with founding a biotech company in Latin America.

This interview was edited for length and clarity.

Natalia Gorojovsky: First, about Moolec: How do you pronounce it?

Martín Salinas: Moo-lec. It comes from *molec*ular farming. And the *moo* is to mimic the sound of a cow, because we're transforming plants so they intrinsically produce animal proteins, like those from pigs. If you look, our soybeans are slightly pink.

NG: I get it! So what is molecular farming?

MS: Molecular farming is using plants as bioreactors. You genetically transform a plant to produce a molecule of interest, whether that's an enzyme or a protein. You use the plant as the host and the producer. It's the plant-based approach to [microbial] fermentation. Whatever you put into the genome of the plant makes a product, which you recover and commercialize.

The upside of molecular farming is the use of the sun as the main source of energy and the use of carbon dioxide as the main source of carbon: photosynthesis is a highly efficient method to produce molecules. So just by intuition, you can see how efficient it is to make products using molecular farming. In fermentation, you need a fermenter with engines; you need to add culture media and air just to keep the microorganism growing.

NG: How would you use this technology to improve human food?

MS: People think that today's plant-based food is healthy. But it needs to have so many ingredients and ultraprocessing, just for the sake of tasting like the real food. It is not that healthy at the end of the day.

Let's say you are a company producing plant-based burgers. You need both the texturized vegetable protein (TVP) and all of the ingredients to mimic the taste of meat. Our idea is for that company to replace the TVP and many of those ingredients with just one product. That's our unique approach.

Our technology is in the grain. The traditional crushing industry just switches one grain for ours. The final product will be boosted by our technology.

NG: How did you end up founding a company in this space?

MS: Back in 2011, the Latin American big [agricultural technology] holding Bioceres had its very first molecular farming project: to produce chymosin, an enzyme used in the cheese industry, in safflower seeds. They needed an engineer to scale up the products. And since I am a chemical engineer, have

VITALS

MARTÍN SALINAS

▸ **HOMETOWN:** San Pedro de Jujuy, Argentina

▸ **EDUCATION:** BS, chemical engineering, 2005, and PhD, biological science, 2010, National University of Tucumán

▸ **CURRENT POSITION:** Chief of technology and cofounder, Moolec Science

▸ **COMPANIES FOUNDED:** Moolec Science and Phoenxt

▸ **BEST PROFESSIONAL ADVICE I'VE RECEIVED:** Be empathetic, and always remember people's names.

▸ **MEMORABLE MENTOR:** Nora Perotti, my PhD adviser, who taught me to merge chemical engineering principles with biology

▸ **FAVORITE BAND:** Nick Cave and the Bad Seeds

▸ **I AM:** Argentino

VITALS

NATALIA GOROJOVSKY

▸ **HOMETOWN:** Buenos Aires, Argentina

▸ **EDUCATION:** Biochemistry degree specializing in biotechnology, University of Buenos Aires, 2012

▸ **CURRENT POSITION:** PhD candidate, protein engineering, Patricio Craig's laboratory, and university lecturer in genomics, biotechnology, and bioinformatics, Faculty of Exact and Natural Sciences, University of Buenos Aires

▸ **FAVORITE MOLECULE:** Polymerase. The copy-and-paste tech of life. Thanks to her errors, diversity exists.

▸ **WHAT REMINDS ME OF HOME:** The smell of yerba mate mixed with orange peels

▸ **RECENT FUN PROJECT:** Diary of my daughter's fantastic questions

▸ **I AM:** Argentinian

CREDIT: COURTESY OF NATALIA GOROJOVSKY

Natalia Gorojovsky's work centers on developing artificial cellulosomes. She focuses on having a growth mindset and is the proud mom of Mila.

a PhD in biology, and had a background in biotech processing, the project was an ideal fit for me.

We got the very first approval to commercialize chymosin worldwide. It was a breakthrough for the industry. Basically, we also created, alongside regulators, the right rationale for approving this kind of product.

We started to think about what was next for our molecular farming platform. One of my first ideas was to see if we could produce growth factors for the cultured meat industry because cultured meat needs growth factors that come from bovine serum. It's not ideal for a non-animal-based company to use an animal-sourced raw material to develop their product. I wanted to fix that and see if we can produce plant-based growth factors through molecular farming.

Discussing that, Gastón [Paladini, cofounder and CEO of Moolec,] proposed to directly make meat proteins in plants instead. Between him and Henk Hoogenkamp, who is our food-tech guy and cofounder, we created this corporate start-up, like a spinout. That's how Moolec was born.

NG: I wanted to ask you about something related to my research: my PhD is about developing multienzymatic complexes for efficient cellulose degradation. I've cloned and expressed multiple cellulases. I found it challenging to select which enzymes to include in my systems. How did Moolec deal with choosing which proteins to express?

MS: It's a key question. For deciding on the proteins, our approach was to find the low-hanging fruit—proteins that would be as functional as possible regardless of having the right fold or being denatured during production.

We did a lot. We spent almost a year selecting the right proteins, looking for a robust functionality and also which ones gave the right traits in terms of flavor, color, and sensorial experience.

NG: What specific proteins did you end up selecting to put into plants?

MS: Porcine myoglobin is one. It gives color and improves the overall functionality of the soybean proteins, including nutrition profile. We've achieved high levels of expression—more than 20% total soluble protein.

So we started with something simple. Now that it's patented and behaving correctly, we want to be more ambitious in what we express.

NG: What other challenges have you encountered while creating Moolec?

MS: Oh, wow! So many challenges. Markets over the last 2–3 years have not been very receptive to new technology like ours. So we had some challenges presenting the company, getting the funding. But we did it. We made Moolec a publicly traded company.

Now we need to balance out what our clients expect with what our shareholders do. Another challenge is the public perception and regulatory pathway of genetically transformed products for human consumption.

NG: Sounds tough.

MS: It is. But we had another breakthrough: we got the very first molecular farming protein with this kind of green light from the [US Department of Agriculture in April].

We've been pioneering molecular farming. I remember when Bioceres was the only company working in the field. Now it's kind of a hot space. Many new companies are trying to produce proteins in plants, with very ambitious scope, including dairy proteins, which are way more complex. We're happy to see how the space is growing heavily.

NG: Do you think Latin America is a good place to start a company focusing on genetic modifications? Do we have more acceptance of genetically modified organisms (GMOs)?

MS: I'd agree with that. I would say Europe may be the most restrictive place for GMOs. The Americas in general, including the US, are way more receptive. The huge upside with Latin America is how efficient we are producing crops, mainly Argentina and Brazil.

NG: I see that you also cofounded a start-up, Phoenxt, that recycles textiles. How do you think that being from Argentina influenced you to become an entrepreneur?

MS: We Latin Americans are used to dealing with hard conditions in the sense of challenging contexts. But that gives us that creativity to push forward projects that may seem hard or impossible to achieve.

Whenever someone gives us a hard task, we will try to figure that out with out-of-the-box reasoning. So I think that's an upside, being an entrepreneur from Latin America.

NG: It's funny that you're trying to make vegetables more like meat, especially given Argentina's tradition of asados. Is there a vegan philosophy behind it?

MS: Actually, our value proposal is not to compete directly with meat—rather, [we're] trying to improve that ecological footprint a bit further.

We are at this stage of the world where environmental challenges are huge. Past generations can say they didn't know that what they were doing would impact the environment. But thinking about my motivations, I have a 7-year-old boy. I can't say to my son, "I didn't know."

His generation will face huge issues in terms of the environment. I would like to look at him and say, "I tried to do my best."

▶ DRUG DEVELOPMENT

Anabella Villalobos

This leader in pharma has redefined how we treat neurological diseases

VITALS

- **HOMETOWN:** Panama City
- **EDUCATION:** BS, chemistry, University of Panama; PhD, medicinal chemistry, University of Kansas, 1987
- **CURRENT POSITION:** Head of biotherapeutics and medicinal sciences, Biogen
- **PROFESSIONAL ADVICE:** Be open to and seek feedback. It will make you a better person.
- **FAVORITE ELEMENT:** Carbon. We need carbon to make medicines for patients.
- **FAVORITE MUSIC:** Salsa. I am a big fan of Rubén Blades, a Panamanian salsa singer.
- **I AM:** Latina

BEC ROLDAN, special to C&EN

When Anabella Villalobos left her hometown of Panama City in 1981 to pursue a master's degree in the US, she was filled with excitement for what she thought would be a short time abroad. "I never really planned on staying," she recalls. "I always had in the back of my mind that I'd be back."

But that initial journey away from the sunny coasts where Villalobos loved spending time growing up turned into a decades-long climb to the top of the US pharmaceutical industry. Villalobos, who now serves as the head of biotherapeutics and medicinal sciences at Biogen, has developed first-in-class treatments for neurological disorders like Alzheimer's disease and made a name for herself getting new therapeutics into the clinic.

She first fell in love with the molecular world during a high school organic chemistry class. "I actually still have my notebook from my senior year," which she keeps close by even now. She went on to study chemistry at the University of Panama, which was then the only institution in the country granting chemistry degrees.

While preparing for graduate school, she received a Fulbright-Hays fellowship, which decreased financial barriers to the master's program. And the bilingual education she received while a student in Panama reduced the language barriers she faced at a US-based institution. "Panama is a country that has a lot of influence from the US," she says. But even so, she laughs when she thinks back to perfecting her conversational English. "My fellow graduate students would speak a hundred miles a minute."

Villalobos stayed at the University of Kansas after her master's degree to complete a PhD in medicinal chemistry. She then served as a National Institutes of Health postdoctoral fellow at Yale University. Although originally interested in oncology, Villalobos landed her first pharmaceutical job in Pfizer's neuroscience group in 1989. She soon developed a passion for neurological diseases, specifically Alzheimer's disease.

Back then, scientists knew little about the underlying causes of the condition. Alzheimer's "is a difficult disease that requires a lot of patience," she says. "It's more difficult to see if you're making an impact on the brain" than on other organs that you can more easily take a biopsy of.

> **Alzheimer's "is a difficult disease that requires a lot of patience."**

One of her first projects at Pfizer involved the design and development of icopezil, a drug to treat the cognitive symptoms of dementia caused by Alzheimer's. Icopezil advanced to Phase 2 clinical trials and was in a similar mechanistic class as the first group of drugs that the US Food and Drug Administration later approved to treat cognition in Alzheimer's, such as donepezil and rivastigmine. "It was one of the most rewarding experiences that I've had," she says. "It was my first entry into the clinical space, and it taught me about the development path to advance a medicine to patients," including scientific, regulatory, and clinical aspects of developing a drug.

But donepezil and other early treatments for Alzheimer's did not slow the disease's progression, so Villalobos set her sights on developing a disease-modifying treatment—a drug that would target the central cause of the disease. She kept that goal in mind as she rose through the ranks at Pfizer, eventually becoming the company's

CREDIT: JODI HILTON

head of medicinal synthesis technologies.

To find neuroscience drug candidates that would advance further in the clinic, Villalobos helped create a central nervous system multiparameter optimization (CNS MPO) tool (*ACS Chem. Neurosci.* 2010, DOI: 10.1021/cn100008c). Whereas previous design approaches judged a molecule's properties against individual rules to determine drug potential, the CNS MPO scored six key properties for CNS drugs and created a composite score, widening the field of potential CNS drugs by including molecules that may buck certain rules but can still, for example, pass from the bloodstream into the brain. This tool has become a "standard in the field," says Michael Ehlers, who previously worked with Villalobos as the chief scientific officer for neuroscience at Pfizer.

Ehlers and Villalobos collaborated to push for more successful clinical results for the neuroscience team. "We utilized a much more experimental approach to early clinical development, and Anabella was an essential partner during that process," Ehlers says. The two worked well together, developing a robust portfolio of drug candidates with "exciting clinical data," Ehlers says.

After Ehlers moved to Biogen in 2016 to lead the company's research and development efforts, he recruited Villalobos to help integrate Biogen's medicinal chemistry research with its therapeutic modalities. "It was a bigger role for me," Villalobos says. "I had an opportunity to learn more about biologics and gene therapy," going beyond just the small molecules she focused on while at Pfizer.

Biogen has had recent successes in treatments that modify Alzheimer's disease, most recently with the FDA's approval of a monoclonal antibody, lecanemab, developed in partnership with Eisai. It's the first fully approved Alzheimer's drug that treats the disease, not just the symptoms, by reducing the number of amyloid-β plaques in the brain. Scientists consider these clumps of protein fragments to be a root cause of Alzheimer's.

"It's very encouraging for someone like me who's been in the field for a long time," Villalobos says. "To see the first set of approvals for disease modification is very rewarding, and I believe there will be more."

Besides Villalobos's record of scientific success, Ehlers emphasizes that her leadership and mentorship skills are what make her special. "She's a magnet for talent," he says.

Villalobos says building the next generation of scientific leaders is a core responsibility of her work. She identifies people's strengths and gets them started in areas she knows they'll be good at. "They gain their confidence from there," she says. "Then they take off."

"She brings out the best in people," says Gayathri Ramaswamy, who Villalobos has mentored since they met at Pfizer over a decade ago. "It's very rare to meet someone like Anabella—a strong, smart scientist and leader who has a great deal of empathy and emotional intelligence," Ramaswamy says.

She remembers Villalobos encouraging her to voice her opinions in meetings when there are far louder voices in the room. "I encourage women to raise their hand, be ready to tell their story, and ask for what they want," Villalobos says.

Between science and mentoring, Villalobos still finds time to make a trip to Panama each year with her family and visit the beaches of her childhood. More often, though, she finds these comforts along the coast near her Connecticut home, and every once in a while, she thumbs through her high school chemistry notebook even though the pencil notes have faded.

▶ COMPUTATIONAL CHEMISTRY

Joel Yuen-Zhou

This theoretical chemist traps photons and harnesses them to control chemical reactions

VITALS

- **HOMETOWN:** Mexico City
- **EDUCATION:** BSc, chemistry and mathematics, Massachusetts Institute of Technology, 2007; PhD, chemical physics, Harvard University, 2012
- **CURRENT POSITION:** Associate professor, University of California San Diego
- **PROFESSIONAL ADVICE:** Avoid being too busy; otherwise, great ideas won't come to you.
- **WHAT REMINDS ME OF HOME:** I miss Mexican pan dulce.
- **MEMORABLE BOOKS:** *On Earth We're Briefly Gorgeous*, by Ocean Vuong; *Imperio*, by Héctor Zagal
- **I AM:** Asian-Latino, gay

KRYSTAL VASQUEZ, C&EN STAFF

Joel Yuen-Zhou spends his time solving scientific puzzles and developing entirely new ways of driving chemical reactions using quantum effects. The University of California San Diego theoretical chemist says he found his career through a series of happy accidents in childhood.

As a child, however, Yuen-Zhou assumed he'd end up working in a job that he didn't enjoy. His parents, who immigrated from China to Mexico, never graduated from high school. Unaware of the breadth of career opportunities available to their son, they encouraged him to pursue one of the few professions they knew about, such as architecture or dentistry, he says. None of these career options interested Yuen-Zhou in the slightest.

Yuen-Zhou's bleak view of his future changed when he was 14 and competed in a math contest. He liked it so much that he immediately signed himself up for a chemistry competition, the first of many he would partake in.

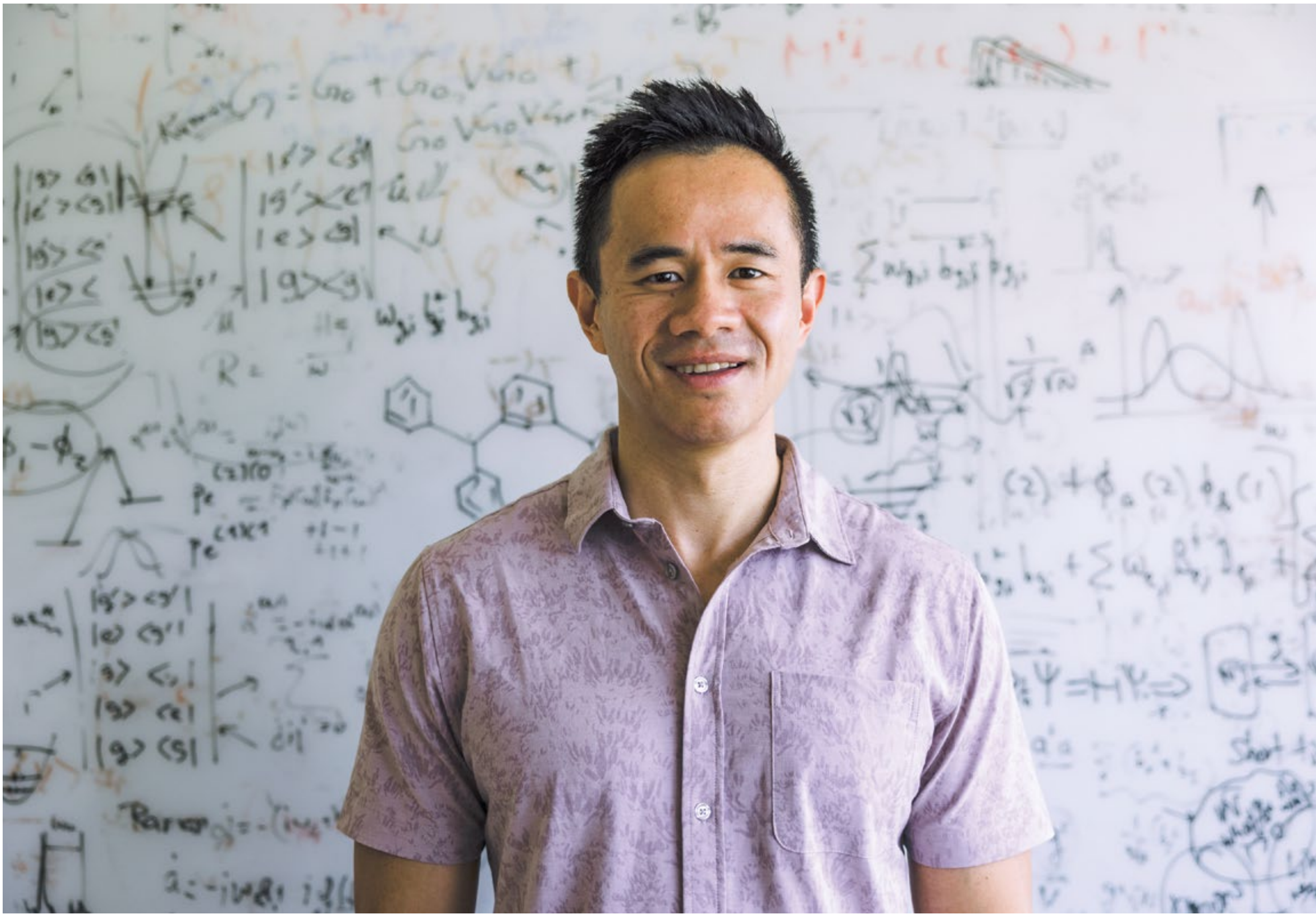
> **"Science is a space that allows for coexistence of people of diverse backgrounds, interests, and beliefs."**

At the chemistry olympiad, he met mentors who saw his potential and encouraged his love for and curiosity about science. He also decided to make a career out of entertaining himself with fun molecular problems. "I feel very fortunate that that's something that I am able to do nowadays," Yuen-Zhou says.

Yuen-Zhou is investigating a new class of chemistry fueled by light. He uses theoretical calculations to model the behavior and interactions of molecules inside an optical cavity, a minuscule area created by mirrors spaced only a few hundred nanometers apart. It traps photons by forcing them to ricochet back and forth. When his team places molecules in the cavity, they absorb the bouncing photons, generating what Yuen-Zhou calls "a continuous exchange of energy between light and matter." Under the right experimental conditions, quantum effects emerge; light and matter become indistinguishable from each other and create a hybrid state called a polariton.

The molecules that make up polaritons interact with ricocheting photons over and over again. That action creates a dynamic different from what chemists observe in traditional photoexcited molecules. In polaritons, "you create new energy states that differ drastically from what you would get outside the cavity," Yuen-Zhou says. Over the past few decades, researchers have taken advantage of these states to modify the conductivity, reactivity, and other properties of compounds.

Yuen-Zhou and his group have been expanding the space of possibilities for polariton research, says Raphael F. Ribeiro, a theoretical chemist at Emory University who did a postdoc in Yuen-Zhou's lab. In 2019, the two scientists published a theoretical study suggesting that optical cavities can mediate reactions between



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two molecules that never physically touch. For example, when glyoxylic acid and *cis*-nitrous acid are placed in adjacent optical cavities that share a central mirror, the photons act like a wire, connecting the two systems and, subsequently, promoting the isomerization of nitrous acid (*Chem* 2019, DOI: 10.1016/j.chempr.2019.02.009).

Since then, Yuen-Zhou says, other collaborators have demonstrated this concept experimentally, showing that two molecules can "start talking to each other" in a reaction that is made possible only by polaritons. He adds that in the future, this new type of reaction vessel could aid synthetic chemists by significantly improving reaction rates or allowing researchers to break bonds that they wouldn't otherwise be able to.

But because of the cutting-edge nature of some of the experiments used to probe polaritons and their potential chemical applications, chemists wonder, "Is this right? Is this real?" says Keith A. Nelson, a chemist at the Massachusetts Institute of Technology and a longtime collaborator of Yuen-Zhou's. By developing the mathematics and computer algorithms that researchers can use to understand and model their observations, "Joel has really played a pretty leading role in helping get to the core of what is going on."

Ribeiro says he was initially drawn to Yuen-Zhou's group because of the interesting research his lab was producing. He believes that Yuen-Zhou is "pushing the frontiers of chemistry."

But Yuen-Zhou contributes much more to the chemistry community than trailblazing research. Ribeiro says Yuen-Zhou is conscious of biases in academia against people from marginalized racial and ethnic groups, LGBTQ+ communities, and other groups and takes action to address them. For example, when Yuen-Zhou organizes conferences, he always scans the list of invited people to make sure it's a balanced, diverse group. And when Ribeiro was in his lab, Yuen-Zhou would regularly discuss strategies for combating bias in group meetings and personal conversations.

Yuen-Zhou's passion for inclusivity was driven by his own experiences growing up Asian Latino in Mexico. "There are not many Chinese people in Latin America," he says. As a result, "I experienced a lot of racism and bullying in school."

The chemistry olympiads frequently acted as a refuge from this reality. "I witnessed early on that science is a space that allows for coexistence of people of diverse backgrounds, interests, and beliefs," he says. At UC San Diego, Yuen-Zhou appreciates the opportunity to mentor a wide range of students and trainees, including many Asian and Latin American researchers. He hopes he can inspire them to pursue chemistry, the same way his mentors did for him.

"Those people were so generous with their time and with their efforts, and they really made a huge impact in my life," he says. To pay it forward, he says, he wants to use his platform to inspire and empower the next generation of scientists.

Historic Trailblazers

These groundbreaking scientists discovered new elements and helped develop the birth control pill

Oswaldo Luiz Alves

Oswaldo Luiz Alves was among the first Brazilian scientists to develop, research, and teach nanotechnology. He worked at the Laboratory of Synthesis of Nanostructures and Interaction with Biosystems, and he founded the Solid State Chemistry Laboratory at the University of Campinas, where he was a professor of chemistry.

Alves was born in São Paulo and was drawn to chemistry during after-school science camps in his adolescence. With a state fellowship, Alves took technical industrial chemistry courses and then finished his bachelor's in industrial chemistry in 1973 at the public University of Campinas. At the same time that he began his doctorate at the university, he was hired there as a professor. But when he did his postgraduate studies in France, he "got contaminated," as he called it, with solid-state chemistry. He then took this knowledge back to Brazil to found a solid-state chemistry laboratory. There he researched 2D materials for electronics like glasses doped with quantum dots, and he filed patents, including one related to drug delivery using silica nanoparticles.

After more than 40 years of teaching, he died suddenly in July 2021. He taught more than 50 master's and doctoral students, who carry on his legacy.—ATTABEY RODRÍGUEZ BENÍTEZ, special to C&EN

CREDIT: ANTONINHO PERRI (ALVES); WIKIMEDIA COMMONS (DEL RIO)

Andrés Manuel del Río

In 1801, Spanish-born chemist Andrés Manuel del Río discovered the only element to be unearthed in Mexico. But it took 30 years before he was credited for finding vanadium, a silvery transition metal and number 23 on the periodic table.

Del Río was working as a professor of mineralogy at the School of Mines in Mexico City when he found the metal in a piece of lead ore from Zimapán, Mexico. He named it "erythronium," from the ancient Greek word *erythros*, meaning red. He was inspired by the red color formed by its salts.

He later sent the sample to Paris, where chemist Hippolyte-Victor Collet-Descotils mistakenly concluded that it was chromium and not a new metal, as del Río had claimed.

In 1830, chemist Nils Gabriel Sefström rediscovered the element in iron ore from Sweden. He named it "vanadium" after Vanadis, the Norse goddess of love and beauty. Soon after, German chemist Friedrich Wöhler analyzed del Río's erythronium and confirmed it contained vanadium. But del Río never received proper credit for his discovery while he lived.

Vanadium's resistance to heat and corrosion led to its use in WWI artillery and the Ford Model T engine. Today, vanadium is used in alloys that build tools, engines, and machinery.

Del Río lived in Philadelphia for a time after Spanish settlers were expelled from Mexico after the war of independence, but he returned to the country in 1834. He is the author of *Elementos de Orictognosía*, the first textbook on mineralogy published in the Americas. Each year, the Mexican Chemical Society bestows an award in his name to chemists who have made extraordinary contributions to science.—SHANTAL RILEY, special to C&EN

Rebeca Gerschman

Argentinian biochemist Rebeca Gerschman was the first scientist to propose that free radicals can cause oxygen toxicity and cell death (*Science* 1954, DOI: 10.1126/science.119.3097.623). The connection between free radicals and aging, first proposed by Gerschman in 1954, is still being explored by scientists.

Gerschman earned her PhD at the University of Buenos Aires in 1937. During her graduate studies, she developed a method, later known as the Gerschman-Marenzi method, to study potassium in the blood. She did postdoctoral work at the University of Rochester, where she continued studying potassium. But her mentor was also interested in respiration, and she followed that interest, beginning to study oxidative stress.

This was when Gerschman started to study the effects of gases, like oxygen, in animals, inspired by an observation that the skin of fighter pilots was aging at faster rates than nonpilot folks. Fighter pilots are exposed to about the same radiation as a tanning bed. At increasing altitudes, oxygen concentrations can go from the usual 21% up to 100%. Gerschman surmised that a lot of oxygen and radiation could generate radicals that lead to faster skin aging in the pilots.

In the 1980s, she was nominated for a Nobel Prize for her contribution to the study of free radicals, but she died before she could receive the award.—ATTABEY RODRÍGUEZ BENÍTEZ, special to C&EN

Luis F. Leloir

Pursuing science during a tumultuous time in Argentina's history, when the government was hostile to academic work, Luis F. Leloir made foundational discoveries about glucose metabolism. Leloir was born in 1906 in Paris to an Argentinian mother and first came to the country as a toddler. He would go on to become the first Latin American to win the Nobel Prize in Chemistry.

Leloir started his scientific career in 1932 as a medical doctor. Unhappy with the tools available to doctors at the time, Leloir left clinical medicine after 2 years and began working in the medical research labs at the University of Buenos Aires (UBA). He spent a year at the University of Cambridge building expertise in biochemical research and in 1937 returned to UBA, where he continued research in the university's physiology department and eventually started teaching students.

Leloir's research was interrupted in 1943 when Argentina's military overthrew the constitutional government. Thousands of academics were fired under military rule, including Leloir's longtime mentor, Bernardo Houssay. Houssay, a future Nobelist himself, was dismissed after signing an anti-Nazi letter of protest. Leloir once again went abroad, continuing his research in the US and England.

He returned to Buenos Aires in 1947 and became the founding director of the privately funded Campomar Foundation Institute for Biochemical Research (now called the Leloir Institute Foundation). Several independent research institutes had been popping up in Buenos Aires, often run inside converted houses and staffed by academics who had been fired from public institutions.

Here, Leloir probed the enzymatic pathway that converts the sugar galactose to glucose in cells. His group identified a major player: the nucleotide uridine diphosphate, which connects to sugar molecules and allows them to be digested by enzymes and used as energy.

Throughout the 1950s, Leloir and his colleagues studied how nucleotide sugars affect energy storage and the breakdown of complex polysaccharides. The team discovered that glucose could be stored in the long sugar chains attached to the protein glycogen only after glucose formed the intermediate uridine diphosphate glucose. This discovery and others about nucleotide sugars' role in metabolism earned Leloir the Nobel Prize in Chemistry in 1970.

Leloir died in 1987, still an active researcher. In 2001, the Campomar Institute was renamed in his honor.—MANNY MORONE

César Milstein

César Milstein was an Argentinian Nobel laureate who studied enzymology and immunology. Milstein, born in 1927, is best remembered for his research in antibody production.

In his early career, Milstein made significant contributions to the understanding of enzyme kinetics and reaction mechanisms. In 1961, he accepted a position as a division head at the National Institute of Microbiology in Buenos Aires to continue this work.

In 1963, Milstein resigned from his post because of what he described as "political persecution of liberal intellectuals and scientists." He moved to Cambridge, England, to join the lab of protein chemist Frederick Sanger, an early mentor and longtime collaborator, who suggested that Milstein shift his research focus to immunology.

Milstein became interested in the diversity of antibodies, which are proteins that immune cells use to target and eliminate disease-causing agents. But the difficulty of making antibodies in the lab created a major obstacle to designing experiments that might reveal the underlying mechanisms in immune biochemistry.

While investigating the relationship between antibody diversity and production, Milstein and collaborator Georges J. F. Köhler developed a technique to fuse two cell lines: one cancerous and another that produces a specific antibody. The result was a hybrid cell line that grows easily in lab cultures and churns out monoclonal antibodies in large quantities (*Nature* 1975, DOI: 10.1038/256495a0). Milstein and Köhler each got one-third of the 1984 Nobel Prize in Physiology or Medicine for this discovery.

The newfound accessibility of these proteins revolutionized the study of immunology and human medicine, and Milstein spent much of his later career developing new applications for monoclonal antibodies in the lab. He died in 2002.—ARIANA REMMEL, special to C&EN

CREDIT: CORBIN O'GRADY STUDIO/SCIENCE SOURCE (MILSTEIN); WIKIMEDIA COMMONS (MIRAMONTES)

Luis Miramontes

Luis Miramontes coinvented a compound used in birth control pills. Born in Tepic, Mexico, Miramontes earned a BS in chemical engineering in 1954 from the National Autonomous University of Mexico (UNAM).

Miramontes started his career as a researcher in organic chemistry at the Institute of Chemistry at UNAM. He joined the pharmaceutical company Syntex in Mexico City, where he worked on the synthesis of various compounds related to steroids.

On Oct. 15, 1951, Miramontes, then 26, synthesized norethisterone, which would become the active compound base of the first synthetic oral contraceptive pill. He received the patent on the compound with Carl Djerassi and George Rosenkranz.

Miramontes continued as a researcher in organic chemistry and taught in several prestigious Mexican universities. Among his awards, he received the Andrés Manuel del Río prize, the top chemistry prize in Mexico. In 2005, the Mexican Academy of Sciences nominated Miramontes's work on the oral contraceptive pill as the most important Mexican contribution to world science. He died in 2004.—RACHEL PETKEWICH, special to C&EN

Mario Molina

As a boy growing up in Mexico City, Mario Molina played with a chemistry set. As an adult, he shared the 1995 Nobel Prize in Chemistry for work on understanding the formation and decomposition of ozone in the stratosphere.

His research helped pave the way to a landmark treaty to protect stratospheric ozone, the 1987 Montreal Protocol on Substances That Deplete the Ozone Layer.

In 1974, Molina was a postdoctoral researcher under F. Sherwood Rowland at the University of California, Irvine, when the two published a groundbreaking paper in *Nature* (DOI: 10.1038/249810a0). They hypothesized that chlorofluorocarbons (CFCs), synthetic gases then widely used as refrigerants and aerosol propellants, could deplete stratospheric ozone, which absorbs most of the sun's ultraviolet light and makes life on Earth possible.

Chemical manufacturers and aerosol producers scoffed at the idea. But other scientists confirmed and built on Molina and Rowland's work.

Molina shared the Nobel Prize with Rowland and Dutch atmospheric chemist Paul J. Crutzen. Molina received the US Presidential Medal of Freedom in 2013.

Molina was active in environmental policy, urging world leaders to address climate change and working to establish policies to improve air quality in the world's megacities.

He earned a doctorate in physical chemistry at the University of California, Berkeley, and worked at the Jet Propulsion Laboratory at the California Institute of Technology. Molina was a professor at the Massachusetts Institute of Technology and the University of California San Diego. He founded the Mario Molina Center for Strategic Studies on Energy and the Environment in Mexico City.

Molina died in 2020 at age 77.—CHERYL HOGUE, special to C&EN

Sarah Stewart

Children today routinely receive vaccines against human papillomavirus, which can cause cervical cancer and other diseases. This lifesaving treatment is thanks in part to the work of Sarah Stewart, who was among the first to demonstrate a link between viruses and cancer.

Stewart was born in 1905 in Tecalitlán, Mexico, and moved to the US early in her childhood. She pursued both master's and doctoral degrees in microbiology, which led to her interest in viruses and human disease.

At the time, there was already evidence that some viruses might be associated with tumor growth. But most researchers in the mid-20th century didn't think the link was worth investigating. When Stewart submitted her first application to look for cancer-causing viruses in 1944, the US National Institutes of Health denied her funding request, stating that the project lacked merit and that her background in microbiology made her unqualified to study human medicine.

But Stewart was relentless. She took a teaching position at Georgetown University, where she taught microbiology at the School of Medicine. At the time, only men were allowed to enroll in the medical school, but Stewart's faculty position allowed her to audit classes alongside the male students. When the school finally allowed women to matriculate, Stewart became the first woman to earn a medical degree from Georgetown, in 1949.

With doctoral and medical degrees in hand, Stewart joined the lab of Bernice Eddy in 1951 at the NIH, and the pair began many years of careful experimentation, searching for cancer-causing viruses. Finally, in 1958, Stewart and Eddy became the first scientists to establish a definitive link between tumor formation and a newly described virus that they called SE (for Stewart Eddy) polyomavirus (*Proc. Soc. Exp. Biol. Med.* 1958, DOI: 10.3181/00379727-98-24205). Stewart and Eddy's discoveries place them squarely among the founders in the field of viral oncology.

Stewart was nominated for a Nobel Prize twice, and her achievements were recognized in other ways during her lifetime. In 1965, President Lyndon B. Johnson presented her with the Federal Women's Award for her contributions to cancer research. Stewart continued her research in viral oncology for the rest of her career until she died of cancer in 1976.—ARIANA REMMEL, special to C&EN

CREDIT: WIKIMEDIA COMMONS (BOTH)

Evangelina Villegas

Mexican biochemist Evangelina Villegas is best remembered for her contributions to cereal and nutritional science, especially for her work with maize. She lived from 1924 to 2017 and spent most of her life in Mexico City, where she was born.

Villegas's interest in maize as a culturally and economically important crop in her home country and her affinity for science led her to earn a PhD in cereal chemistry and breeding from North Dakota State University.

In 1967, she joined the International Maize and Wheat Improvement Center in Mexico, where she worked to combat global malnutrition. She was soon joined by collaborator Surinder Vasal, and together they set their sights on maize, a staple crop that feeds millions of people around the world.

Despite the crop's caloric importance, most varieties of maize are low in protein, especially the essential amino acids lysine and tryptophan. Without the benefit of a varied diet, people who subsist predominantly on maize, common in parts of Africa, Asia, and South America, are at higher risk of malnourishment and associated illnesses. The protein deficiency of these diets is especially dangerous for infants, who are often weaned with maize. Villegas and Vasal hoped to combine biochemical and plant breeding techniques to engineer a protein-rich maize with a palatable flavor and texture that could fill the nutritional needs of maize-dependent communities.

After more than a decade of work, the pair developed a variety called quality protein maize (QPM). QPM not only has a higher overall protein content than conventional maize but also contains nearly double the amount of lysine and tryptophan.

QPM was soon grown in Ghana and other parts of Africa, where it was shown to improve the health of young children who had malnutrition. Its use has since expanded to countries in South America and Southeast Asia. Villegas and Vasal shared the 2000 World Food Prize for their contributions to global nutrition, and Villegas was the first woman to earn the award. In the same year, Villegas was presented with the Woman of the Year award by the Mexican Women's Association. She went on to work as a consultant to help share the research and applications of QPM around the world.—ARIANA REMMEL, special to C&EN

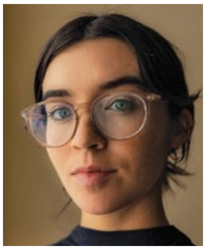
CREDIT: ASSOCIATED PRESS

Contributors

The creative minds behind this year's issue

María Magdalena Arréllaga

María Magdalena Arréllaga is an independent Paraguayan American photographer and visual storyteller based in Brazil. Arréllaga works on assignments and projects related to social, gender, political, and environmental issues in Latin America. Her personal work is centered on stories and projects that delve into responses to social and environmental issues of our time through a humanistic lens. When she is not working, she is likely climbing in the mountains.

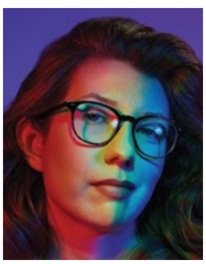


Yunuen Bonaparte

Yunuen Bonaparte is a New York City–based independent photo editor with a passion for visual storytelling. She currently edits photos for the online platforms Palabra and Narratively. Her photojournalism has appeared in esteemed publications including the *Washington Post*, the Hechinger Report, *Al Día News*, *El Universal*, and *Americas Quarterly*, among others. Originally from Mexico, Bonaparte brings her unique perspective as an immigrant to her work, enhancing each story she helps to tell.

Jess Deeks

Jess Deeks is an Ottawa, Ontario–based photographer specializing in portraits for commercial and editorial clients. Her work has been featured in the *New York Times*, the *Washington Post*, and the *Wall Street Journal*, among others. She loves collaborating on projects related to science, technology, engineering, and mathematics (STEM) fields, the arts, and the human condition. In her spare time, she likes to skateboard, hang out with ducks, and listen to podcasts like *We Can Do Hard Things* and *On Being*.



Luis Manuel Diaz

Luis Manuel Diaz is a Mexican-born visual artist working with photography. Drawing from personal and communal history, his practice examines the postmigration home, citizenship, and labor. Diaz is currently based in New Haven, Connecticut, where he's a candidate for an MFA in photography at the Yale School of Art.

Elisa Ferrari

Elisa Ferrari is an Argentine American visual storyteller based in Los Angeles. She is a National Geographic Explorer and a graduate of the University of California, Berkeley, and the University of Texas at Austin, where she studied liberal arts and ethnomusicology. Ferrari is an alumna of the Eddie Adams Workshop XXVII and a member of Authority Collective, Diversify Photo, and Women Photograph.

Luisa Forain

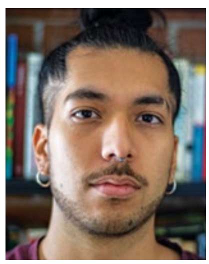
Luisa Forain is a Brazilian freelance translator and biologist based in Rio de Janeiro. She has a background in native Atlantic Forest seedling production and reforestation. She currently works primarily on translating scientific articles and science journalism. She also volunteers as a humanitarian linguist with Translators Without Borders for various NGOs in the areas of crisis relief, health, and education. Her true bliss is to be surrounded by animals and nature.

Yessenia Funes

Yessenia Funes is a queer Latina independent environmental journalist based in New York City. She's currently editor at large for *Atmos*, an independent climate magazine. Her writing has appeared in *Vox*, the *Guardian*, *Scientific American*, *Vogue*, *Yale Climate Connections*, and more.

Fernando Gomollón Bel

Fernando Gomollón Bel is a Spanish chemist and science communicator. He is cofounder of Agata Communications, a company that specializes in science communication and dissemination. He works as a freelance writer for several publications and scientific societies, including *Chemistry World* and the International Union of Pure and Applied Chemistry (IUPAC).



Roberto González

Roberto González is a freelance science journalist based in Mexico City. He focuses on writing about Latin America and the Caribbean and the intersection of science, health,

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Jodi Hilton

Jodi Hilton is a freelance photographer based in Cambridge, Massachusetts, whose

work has appeared in numerous publications, notably the *New York Times*, *Der Spiegel*, *Le Monde*, and *National Geographic*. She holds a master's degree in journalism from the University of Missouri. Her personal and volunteer work is focused on migration and marginalized racial and ethnic communities.

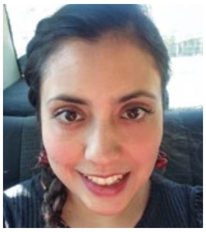
Matías A. Loewy

Matías A. Loewy is a freelance science journalist and former chemistry teacher

based in Buenos Aires. He has covered science and health topics for around 30 years. He was previously editor for science and medicine in the Argentine weekly newsmagazine *Noticias* and senior editor of *Newsweek Argentina*. He is an external editor for the science news organization National Agency for Scientific and Technological Promotion Argentina—Leloir Institute and contributor to the dissemination unit of the Institute for Clinical Effectiveness and Health Policy. His work has been featured in Medscape, CNN Interactive, Reuters Health, Knowable Magazine, *La Nación*, Infobae, and *Forbes Argentina*, among other outlets. In 2017, he received a Konex Award as one of the five most outstanding Argentine science journalists of the decade. He is the author of *Inmortalidad*, a book about research into longevity and "eternal life." Unfortunately, he doesn't think that he will be able to achieve the latter.

Alejandra Manjarrez

Alejandra Manjarrez is a freelance science journalist based (mostly) in Mexico City. Her



work has appeared in *Drug Discovery News*, *Science*, *Scientific American*, and the *Atlantic*, among others.

Tamara Merino

Tamara Merino, based in Chile, is a documentary photographer and visual

storyteller who focuses on subterranean communities, identity, human rights, the environment, and climate change. Merino's work has been featured in numerous publications globally, including *National Geographic*, the *New York Times*, and *Time* magazine. Merino was honored as one of the National Geographic Society's 2020 Emerging Explorers and received the Magnum Foundation's 2020 Inge Morath Award. Her photographs have been exhibited worldwide.

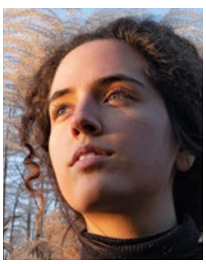
Manny I. Fox Morone

Manny I. Fox Morone is a senior editor at C&EN and has been for a while. He co-

led the 2024 Trailblazers project and normally develops and edits freelance reporters' stories about the molecular world. Morone was born in Argentina, grew up in Illinois, and currently is withering away in Washington, DC. He likes pickling vegetables.

Ximena Natera

Ximena Natera is a photojournalist who was born and raised in Mexico City and is currently based in Oakland, California.



Themes of resilience and collective memory guide her work. She graduated from the International Center of Photography and the School of Journalism Carlos Septién García, and she has been a fellow of the García Márquez Foundation and the International Women's Media Foundation.

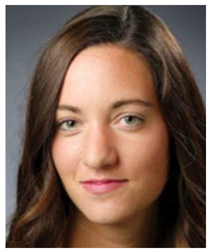
Carlos Osorio

Carlos Osorio is an award-winning Salvadoran Canadian photographer who

spent over 13 years with the *Toronto Star*. As part of a team at Reuters, he was a finalist for the 2022 Pulitzer Prize in feature photography for work covering the climate crisis. He has reported on the drug trade and the opioid crisis across North America, children trying to escape violence in El Salvador, and refugees and other marginalized communities in Toronto.

Lauren Petracca

Lauren Petracca is a freelance photojournalist based in Rochester, New



York, who works with editorial and nonprofit clients. She uses photography to examine the fragile relationship between people and the environment and how climate change and environmental practices affect culture, daily life, and mental health. Her work has been featured in the *New York Times*, CNN, Associated Press coverage, the *Washington Post*, the *Wall Street Journal*, and *Mother Jones*. Some of the nonprofits she has partnered with include Earthjustice, the Southern Environmental Law Center, AARP, and Songwriting With: Soldiers.

Eddie Quinones

Eddie Quinones is a freelance photographer based in Chicago and northwest Indiana.

He has a BA in international studies from the Ohio State University and later studied photojournalism at the University of Missouri School of Journalism. When he's not wandering

CREDIT: ZARA TZANEV (HILTON); COURTESY OF MATÍAS A. LOEWY (LOEWY); COURTESY OF ALEJANDRA MANJARREZ (MANJARREZ); COURTESY OF TAMARA MERINO (MERINO); COURTESY OF MANNY MORONE (MORONE); VIOLETTE FRANCHI (NATERA); COURTESY OF CARLOS OSORIO (OSORIO); COURTESY OF LAUREN PETRACCA (PETRACCA); COURTESY OF EDDIE QUINONES (QUINONES) around with his camera, you can find him listening to podcasts or AM talk radio and/or drinking strong, black coffee.

Alejandra Rajal

Alejandra Rajal is a Mexican freelance documentary photographer. She is a member of Women Photograph and Diversify Photo. Her work focuses on trying to understand how humans connect with the world we live in and the complexities surrounding belief systems in stories of climate change, drugs, gender, religion, and violence. Rajal has been awarded fellowships from the International Women's Media Foundation, National Geographic Society, and Fujifilm, and she collaborates regularly with media outlets across the Americas and Europe.

Bec Roldan

Bec Roldan is a multimedia science journalist with an interest in all things chemistry who has written for outlets including *Science* and NPR.org. They have a PhD in chemistry from the University of Michigan.

Malena Beatriz Stariolo

Malena Beatriz Stariolo is a São Paulo–based science journalist and a 2023 EurekAlert! fellow. She reports for *Jornal da Unesp* on research carried out at São Paulo State University, writing about physics, paleontology, chemistry, and artificial intelligence. Her main topics of interest are environmental subjects and climate change, with a focus on the social aspect. In her previous role as scientific communication coordinator at the International Centre for Theoretical Physics South American Institute for Fundamental Research (ICTP-SAIFR), she developed podcasts, videos, and multimedia projects exploring the world of physics.

Sara Stathas

Sara Stathas is a commercial and editorial photographer based in Milwaukee, Wisconsin. She has spent over 20 years creating portraits to accompany human interest stories for a range of clients, including the *New York Times*, *Rolling Stone*, and *Time* magazine, as well as advertising work for brands such as US Bank and ZipRecruiter.

Karen Toro

Karen Toro is a freelance documentary photographer and visual journalist. Her work explores themes of human rights, social justice, environmental issues, education, and gender. Toro is a regular contributor for Reuters, Bloomberg, and *El País*. She has also worked with Amnesty International, United Nations Women, the Office of the United Nations High Commissioner for Refugees, Amazon Watch, and Amazon Frontlines, among others. Her work has been exhibited in countries such as Argentina, Uruguay, the UK, Chile, and Ecuador.

César A. Urbina Blanco

César A. Urbina Blanco is a Venezuelan chemist and consultant who works for Prophecy Labs, a company at the intersection of artificial intelligence, information technologies, and green chemistry. He's also a great advocate for science communication as well as diversity and equity in science, technology, engineering, and mathematics (STEM) professions.

Laura Vargas-Parada

Laura Vargas-Parada is a freelance science writer based in Mexico City. A graduate of the London School of Hygiene and Tropical Medicine and the National Autonomous University of Mexico, she mainly writes on biomedicine but also covers the environment, technology, and other science topics. Her work has been published in *Nature*, *El Economista* (Mexico), and *La Crónica de Hoy*.

Krystal Vasquez

Krystal Vasquez is an associate editor and science policy reporter at C&EN. Vasquez co-led this year's Trailblazers project. She also covers a variety of news topics ranging from environmental policy to diversity, equity, inclusion, and accessibility in science.

Andrés Velásquez-Güechá

Andrés Velásquez-Güechá is a freelance journalist based in Bogotá, Colombia. Using short stories and nontraditional video interviews, Velásquez-Güechá merges science, literature, and media to create novel communication articles and videos. His interviews can be found at the YouTube channel of the Colombian Professional Council of Chemistry. In his spare time, he likes to read, write, and play tennis.

Myriam Vidal Valero

Myriam Vidal Valero is a freelance reporter and is based in Mexico City and New York City. Vidal writes about general science, health care, and the environment. Her work has appeared in *Nature*, *Inside Climate News*, *Slate*, the *New York Times*, and *Cancer World*, among others.

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COMMENT

Advancing a common language of chemistry for all

HAYLEY BROWN, CHAIR, ACS COMMITTEE ON NOMENCLATURE, TERMINOLOGY, AND SYMBOLS

The common language of chemistry is a marvel. Practitioners of chemistry—from students and teachers to professional researchers, legal experts, and translators—have agreed on standardized terms and representations for chemical concepts—a degree of unity that makes our modern world workable.

CREDIT: DOW

The American Chemical Society Committee on Nomenclature, Terminology, and Symbols (NTS) works to support and enable this common language for chemistry, drawing on a diverse body of members to deliver on multiple collaborations across the society and beyond to honor and advance this agreement. We educate, facilitate, and advocate for the use of chemical representations that contribute to a universal understanding of chemistry.

NTS strives to serve all chemists, and it's a delight to partner with individuals and groups inside and outside ACS to develop resources in support of practitioners everywhere. For example, the Braille Authority of North America (BANA), jointly supported by ACS NTS and the ACS Committee on Chemists with Disabilities, approved a recent update to the Nemeth Code for braille. The update to the code—available on the BANA website in PDF and BRF (Braille-ready format) formats—resolved and removed outdated symbols and usage cases while significantly expanding the scope of the chemical representations available, including extensions to address stereochemical and polymeric representation, and many other forms of chemical description beyond general chemistry. The update also introduced a tactile graphics section for Braille transcribers and users. Additional parallel efforts in support of American Sign Language are continuing into 2025 as NTS works to standardize the signs for the elements of the periodic table. We hope to have these standards available for public review by early 2025.

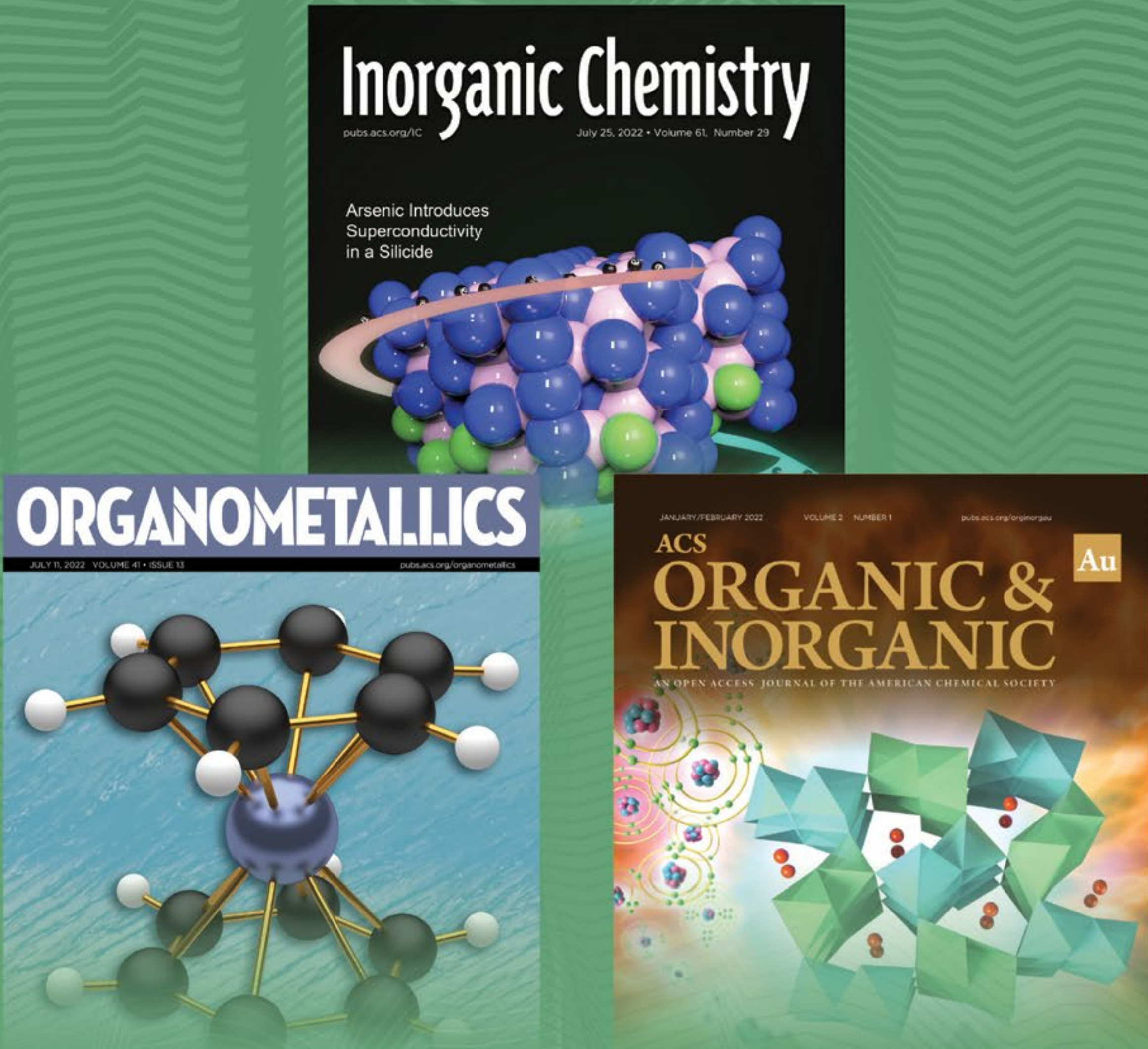
NTS is also working to expand the impact of the committee's work through additional partnerships. In support of this effort, we're initiating a committee-sponsored ChemLuminary award. Local sections, divisions, and other committees are eligible to nominate themselves for this award, which recognizes an outstanding event that promotes the mission of the NTS Committee to educate, facilitate, and advocate for the effective use of representations in chemistry for all.

As the field of chemistry progresses, the relevant nomenclature, terminology, and symbols to describe new findings and new understanding must match that progress

As the field of chemistry progresses, the relevant nomenclature, terminology, and symbols to describe new findings and new understanding must match that progress. ACS NTS has, for several years, supported the broader International Union of Pure and Applied Chemistry (IUPAC) through the public comment process for proposed new guidelines. In 2023–24, the committee has provided feedback in new areas, including the IUPAC Definition of Materials Chemistry and the Glossary of Terms for Mass and Volume in Analytical Chemistry. Driving agreement on new definitions, supporting the standardization of terminology, and enabling more robust and safer chemical labeling goes to the heart of the committee's mission.

As we look to an exciting future of advances in chemical research and technology, the shared language we use as chemists becomes increasingly important. Our strength as a discipline relies heavily on our ability to converse with each other, to teach each other, and fundamentally to understand each other. For those who want to engage more in supporting the human drive toward a universal understanding of chemistry through enabling a common language for chemistry, I encourage you to reach out and participate with ACS NTS.

Views expressed are those of the author and not necessarily those of C&EN or ACS.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▶ CAS and Westlake University collaborate on 'Trailblazing the Future with Emerging Biomaterials' report

This June, CAS, a division of the American Chemical Society, together with Westlake University, released the research report "Trailblazing the Future with Emerging Biomaterials."

The report was developed as a service to the global scientific information community. Its intent is to provide data-informed analysis for those who may be interested in biomedical materials, including business leaders, investors, and policymakers.

With the recent growth in published science, the volume and complexity of scientific information is escalating. This report addresses that complexity in the area of biomaterials. The foundational data in the report leverage the CAS Content Collection, which covers more than 50,000 scientific journals in over 50 languages, 279 million substances, and key invention details from applications published by 109 global patent authorities. Using advanced data tools and big data analytics, the report uncovers emerging trends and comprehensive landscape views of biomaterials research. This approach provides the latest discoveries, advancements, and topics of interest to the scientific community, while also offering data support for scientific research in the areas of chemistry, biology, and materials science.

The report is available at cas.org/resources/cas-insights/materials/cas-and-westlake-university-publication-biomaterials-full-length.—SARA COTTLE

▶ Sanford awarded 2024 Janssen Prize for achievements in organic synthesis

Melanie S. Sanford, professor of chemistry at the University of Michigan and ACS member, received the 2024 Janssen Prize for Creativity in Organic Synthesis. The prize has honored chemists in academia from around the world, including Nobel laureates, for their outstanding contributions to the field of organic synthesis since 1986. Sanford is the first woman to receive the award. Johnson & Johnson (J&J) presented the prize to Sanford at the Belgian Organic Synthesis Symposium in Liège.

"Continuing to develop novel synthetic methods is crucial to enable us to synthesize our drugs more efficiently and also to enable us to access the complex molecules often required to drug today's biological targets," Richard Tillyer, global head of discovery, product development, and supply at J&J Innovative Medicine, writes in an email to C&EN. "The Janssen Prize for Creativity in Organic Synthesis celebrates the bold, innovative, and creative thinking in this field, which will drive future advances in drug discovery and development."

Sanford was selected for her contributions to the development of both mild and inexpensive fluorination processes and new transition metal–catalyzed carbon-hydrogen functionalization methods. Her research, which focuses on developing new synthetic methods for creating carbon-fluorine bonds more efficiently and selectively, has profound applications in drug development, agrochemicals, and positron emission tomography imaging. The addition of fluorine to a molecule often alters its properties and interactions with enzymes and target molecules in ways favorable for pharmaceutical and agrochemical applications, thus making her work invaluable for biologists and medicinal chemists working in these industries.—SARA COTTLE

ACS hosts GCI Pharmaceutical Roundtable spring meeting

The spring meeting of the American Chemical Society Green Chemistry Institute (GCI) Pharmaceutical Roundtable was held April 9–11 at ACS headquarters in Washington, DC. The roundtable gathers for three in-person meetings each year to advance its mission of enabling innovation through the integration of green chemistry and green engineering in the pharmaceutical industry supply chain and allied industries, such as agriculture and animal health. The 2024 spring meeting brought together industry representatives from more than 45 companies in person and virtually and was the roundtable's first time convening for an annual meeting at ACS headquarters.

Albert G. Horvath, ACS CEO, welcomed and thanked members for their contributions to the ACS mission and highlighted the importance of international collaborations throughout the industry. The meeting included discussions led by the roundtable management team on new research funding opportunities, emergent federal-level chemical regulations, potential collaboration with academia and nongovernmental organizations, and the promotion of the roundtable's many green chemistry tools and metrics. With the roundtable's 20th anniversary approaching next year, the group aims to strengthen its partnerships while continuing to make progress toward more sustainable manufacturing of bioactive molecules.—CECILIA SMITH, ACS staff

▶ Chemistry Olympiad seeks coaches for 2025 USNCO Coaching program

The US National Chemistry Olympiad (USNCO) is seeking coaches to help prepare high school students for the 2025 USNCO local and national examinations. Up to 40 coaches will be recruited. Coaches can be current or retired high school teachers, chemistry professors, or industry professionals with teaching experience. They will receive monetary compensation for their time. Coaching sessions will take place on Zoom, and coaches will work in pairs to support approximately 10 high school students at a time. Four sessions of 2 h each will take place every other Friday in January and February 2025, leading up to the local section exam in March 2025.

Applications are available at www.acs.org/education/students/highschool/olympiad/prepare-for-exams/coaching-program.html. The deadline to apply is Oct. 30.
—MARGARET THATCHER, ACS staff

MEETINGS

Register for the 2024 Southeastern Regional Meeting

SARA COTTLE, C&EN STAFF

The American Chemical Society's Georgia Section will host the 75th Southeastern Regional Meeting (SERMACS) Oct. 23–26 at the Atlanta Convention Center at AmericasMart in Atlanta. Details about the meeting can be found on the meeting website at sermacs2024.org.

Technical program. The meeting will feature 50 technical symposia, including 105 half-day sessions of oral presentations and 862 poster presentations, with 351 poster presentations at the undergraduate research symposium. The technical program will include presentations by three distinguished plenary speakers: M. G. Finn, James A. Carlos Family Chair for Pediatric Technology at the Georgia Institute of Technology, delivering "Click Chemistry: Bringing the Power of Chemical Synthesis to Everyone"; Cary Supalo of Educational Testing Service delivering "Seeing Beyond the Visual: Ways to Unlock the Potential of the Blind in Chemistry"; and Dennis Liotta, Samuel Candler Dobbs Professor of Chemistry at Emory University, delivering "Making New Drugs the Hard Way."

A symposium recognizing recent Charles H. Herty Medalists, who will speak on their accomplishments in research and contributions to the chemistry community, will be part of the Thursday programming. Descriptions of other topical symposiums can be found on the SERMACS website.

Additionally, the Southeastern Magnetic Resonance Conference (SEMRC) will take place alongside SERMACS this year, as it did in 2023. SEMRC includes 6 half-day sessions over 3 days during SERMACS.

Workshops. Workshops to help define your career in chemistry include "Finding Yourself: Identifying a Career that Matches Your Strengths and Values," "Acing the Interview: Setting Yourself Up for Success in an Interview," and "Networking: How to Get Started." Other offerings include "K–12 Teachers Workshop," "Implementing Active Learning in General Chemistry Courses," "Digital Alchemy: The Fusion of Chemistry and Computing," and a workshop focusing on chemistry at Merck & Co. And "Chemical Patents Workshop: Intellectual Property (IP) for Chemists" will help with commercializing your technology.

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Undergraduate programming. For those considering their postgraduate life, the meeting will offer a graduate fair on Saturday morning as well as the workshops on career preparation mentioned previously.

Human periodic table. Participating high school students will form a human periodic table. Students will pick out an element and prepare a report on that element for credit. Then, as part of SERMACS, the students will form a periodic table—holding a placard of their element and taking the appropriate place for that element in Centennial Olympic Park. A drone will take overhead photos of the gathering.

Meeting exposition. The meeting exposition will offer a great opportunity to learn about the latest products on the market as well as to interact with potential employers and colleagues. Applications for exhibitors are available on the meeting website.

Awards. Several awards will be presented at the meeting. These include the E. Ann Nalley Regional Award for Volunteer Service to ACS, the Stanley C. Israel Award for Advancing Diversity in the Chemical Sciences, the ACS Division of Chemical Education Southeastern Regional Award for Excellence in High School Teaching, the SERMACS Industrial Innovation Award, and the Partners for Progress and Prosperity Award. The awards dinner will take place on Thursday evening in the Penthouse Theater.

Social events. Among the highlights of SERMACS 2024 will be a brewery tour and tasting followed by dinner at Max Lager's Wood-Fired Grill and Brewery on Wednesday evening, the awards dinner at the Penthouse Theater of AmericasMart on Thursday evening, and a sponsored tour and dinner at the National Center for Civil and Human Rights on Friday evening. Planned luncheons will be sponsored by the Women Chemists Committee, the Senior Chemists Committee, and the Younger Chemists Committee. Additionally, Atlanta provides opportunities to enjoy networking and interacting with colleagues from across the chemistry spectrum: discoveratlanta.com/things-to-do/main.

Lodging and registration. Early-bird registration for the meeting ends at 11:59 p.m. (EDT) on Sept. 23, and you can register at the on-site rate through the end of the meeting. The meeting hotel is the Westin Peachtree Plaza Hotel in downtown Atlanta, which connects through an enclosed walkway to the meeting venue. Travel and hotel discounts are available at sermacs2024.org/travel-information. ■

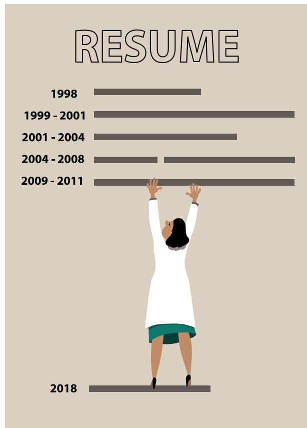
Taking a break from traditional employment

Everyone needs a break on occasion—sometimes even a substantial break. The good news is that between economic changes and COVID-19, gaps in employment history are not as surprising as they used to be, and many people are open about their reasons. But as recently as 2019, research found that while a gap of 1–2 years did not greatly affect interview callback rates, those rates decreased significantly with longer gaps—to 3–5% from 10–11% with the former. So, if you are thinking about exiting a job or the job market for a while, how can you minimize its impact on your professional future?

Before the break. As when mapping out a once-in-a-lifetime trip, you need to plan your break carefully. Include ways that you will remain connected to your professional network—or even grow it in some cases—by attending professional society meetings or visiting mentors, keeping your knowledge and skills current, and attending workshops or classes. And don't forget a game plan for your transition back into work. If you're taking an intentional break, research your current company's policies on extended leaves to see if it can hold your job, or a similar job, while you're gone.

Returning to work. If the time between jobs is lengthy, you will want to address it early in the application process, such as in a cover letter. You want to convey that the reason for the break has been resolved and that you're now fully committed to your career. Details are not necessary, but providing an explanation can go a long way toward mitigating a potential employer's concern. Give a reason, mention a resolution of that reason, then focus on the future: "I took a break from [employment] for [amount of time] to [action]. I am now ready and excited to get back into [type of work] and am even better at [specific ability] because of this experience."

Honesty is always the best policy. If you did volunteer work, consulting, or took courses, list that on your résumé as evidence of continued commitment to your profession during that time.



Employers point of view. Potential employers care about reliability and relevance. They want to know that you're ready to work again and that your skills and knowledge are current. If the gap was long, consider taking classes or attending webinars to prepare for your return and ensure that you're up to date.

Have you changed? The experience of taking a break will sometimes change you in unexpected ways, and you might find you're not interested in the same position. If you want to move into a different job or field, look into part-time, volunteer, or consulting work to gain exposure to and experience in the new field and to prevent the employment gap from growing. The transferable skills you acquire will be useful even if you decide to stay in the same kind of work.

Manage expectations. You may need to work at a slightly lower level than you were previously until you prove yourself again. This is especially true at large firms or if a gap occurs early in your career.

Having a noncontinuous work history is no longer the red flag it was, and with careful presentation, it can be a nonissue.

Get involved in the discussion. ACS Career Tips is published monthly in C&EN. Send your comments and ideas for topics for future columns to careernavigator@acs.org.—Brought to you by ACS Careers

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Newscripts

Curating quirky science since 1943

2024 Ig Nobel Prizes

Scientists who studied inebriated worms, a dead trout's swimming acumen, and pigeons as potential missile pilots were among those who garnered awards at the 34th Ig Nobel Prize ceremony. The humorous honors, which are given for "achievements that first make people LAUGH, and then THINK," were presented during an event at the Massachusetts Institute of Technology on Sept. 12. The satirical magazine *Annals of Improbable Research* produced the event in collaboration with MIT Press. The publication's editor, Marc Abrahams, a legend in laughter, served as master of ceremonies.

Researchers led by Roman Hossein Khonsari of Paris Cité University took home the Anatomy Prize for the paper "Genetic Determinism and Hemispheric Influence in Hair Whorl Formation," in which they attempted to determine whether the hemisphere one was born in has any impact on the direction—clockwise or counterclockwise—of one's hair whorls (*J. Stomatol. Oral Maxillofac. Surg.* 2023, DOI: 10.1016/j.jormas.2023.101664).

Based on work reported in 1939, Fordyce Ely and William E. Petersen posthumously won the Biology Prize for, as the Ig Nobel citation puts it, "exploding a paper bag next to a cat that's standing on the back of a cow, to explore how and when cows spew their milk" (*J. Anim. Sci.*, DOI: 10.1093/ansci/1939.1.80).

The University of Bonn's Felipe Yamashita and independent researcher Jacob White claimed the Botany Prize "for finding evidence that some real plants imitate the shapes of neighboring artificial plastic plants" (*Plant Signaling Behav.* 2021, DOI: 10.1080/15592324.2021.1977530).

Posthumous propulsion: Even dead trout are good swimmers.

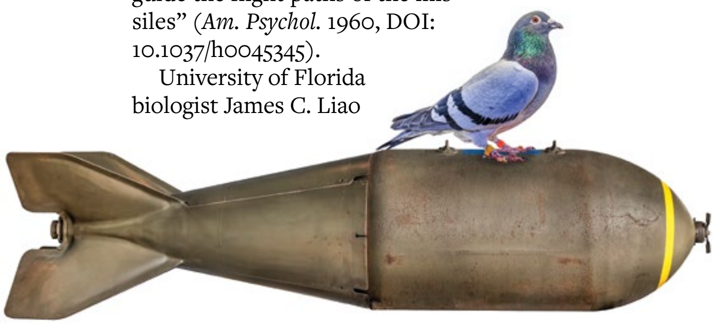
The coveted Chemistry Prize went to Tess Heeremans, Antoine Deblais, Daniel Bonn, and Sander Woutersen for "using chromatography to separate drunk and sober worms." The University of Amsterdam researchers used living *Tubifex tubifex* worms as a model system for polymers in a chromatography experiment. They separated sluggish worms that had been exposed to an ethanol solution from more active sober worms (*Sci. Adv.* 2022, DOI: 10.1126/sciadv.abj7918).

The Demography Prize went to Saul Justin Newman of the University of Oxford "for detective work to discover that many of the people famous for having the longest lives lived in places that had lousy birth-and-death recordkeeping" (BioRxiv 2024, DOI: 10.1101/704080).

Surprise spray: Participants were told they were getting a painkilling nasal spray, but some of them got capsaicin instead.

University Medical Center Hamburg-Eppendorf researchers led by Lieven A. Schenk nabbed the Medicine Prize for an experiment that involved a nasal spray containing the peppery compound capsaicin. Their work showed "that fake medicine that causes painful side-effects can be more effective than fake medicine that does not cause painful side-effects" (*Brain* 2024, DOI: 10.1093/brain/awae132).

Famed psychologist B. F. Skinner was posthumously—and somewhat sarcastically—awarded the Peace Prize "for experiments to see the feasibility of housing live pigeons inside missiles to guide the flight paths of the missiles" (*Am. Psychol.* 1960, DOI: 10.1037/h0045345).



Pigeons for peace: Missiles equipped with pigeon guides were not a success.

University of Florida biologist James C. Liao won the Physics Prize "for demonstrating and explaining the swimming abilities of a dead trout." The Ig Nobel committee cited several of Liao's papers, but perhaps his 2022 *Current Biology* article put it best: "In a remarkable example of passive thrust production, the natural flexibility of a trout corpse causes it to frequently surge upstream," he writes (DOI: 10.1016/j.cub.2022.04.073).

The Physiology Prize went to a team led by Takanori Takebe, a doctor and scientist at the Cincinnati Children's Hospital Medical Center, who discovered, according to the Ig Nobel citation, "that many mammals are capable of breathing through their anus" (*Med* 2021, DOI: 10.1016/j.medj.2021.04.004). Regular readers of Newscripts will be familiar with this work on rear-end respiration.

And for their landmark study "Fair Coins Tend to Land on the Same Side They Started: Evidence from 350,757 Flips," the University of Amsterdam's František Bartoš and 49 colleagues garnered the Probability Prize (arXiv 2023, DOI: 10.48550/arXiv.2310.04153).

A recording of the Ig Nobel ceremony will be available at youtube.com/improbableresearch. National Public Radio's *Science Friday* will air an edited recording of it Nov. 29, the day after US Thanksgiving.

Bethany Halford wrote this week's column. Please send comments and suggestions to newscripts@acs.org.

CREDIT: SHUTTERSTOCK (TROUT, NASAL SPRAY); SHUTTERSTOCK/C&EN (MISSILE)