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Life Scientists Cut Down on Plastic Waste

Across the US, laboratories are finding creative ways to minimize the amount of plastic they throw away.

Katarina Zimmer
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Worldwide, at least 300 million metric tons of plastic are produced each year, and researchers in California recently estimated that more than 90 percent of it is never recycled. Although plastic products are inherently designed to be long-lasting and stable, around half of the world's annually produced plastics are intended to be used only once, leading to huge amounts of unwanted, slow-degrading material.

ABOVE: Researchers can easily get through hundreds of disposable pipette tips and microcentrifuge tubes a day.
ISTOCK, JVISENTIN

As evidenced by the notorious larger-than-Texas raft of garbage floating in the Pacific Ocean, and reports of seabirds and whales dying after ingesting copious amounts of plastic in their habitats, the pollution caused by humans mindlessly discarding these materials has already taken a serious toll on the environment. And scient have yet to map out the longer-term effects of tiny particles of plastic waste, or microplastics, that pollute terrestrial and aquatic environments and now pervade the human food supply—with unknown effects on hun health.

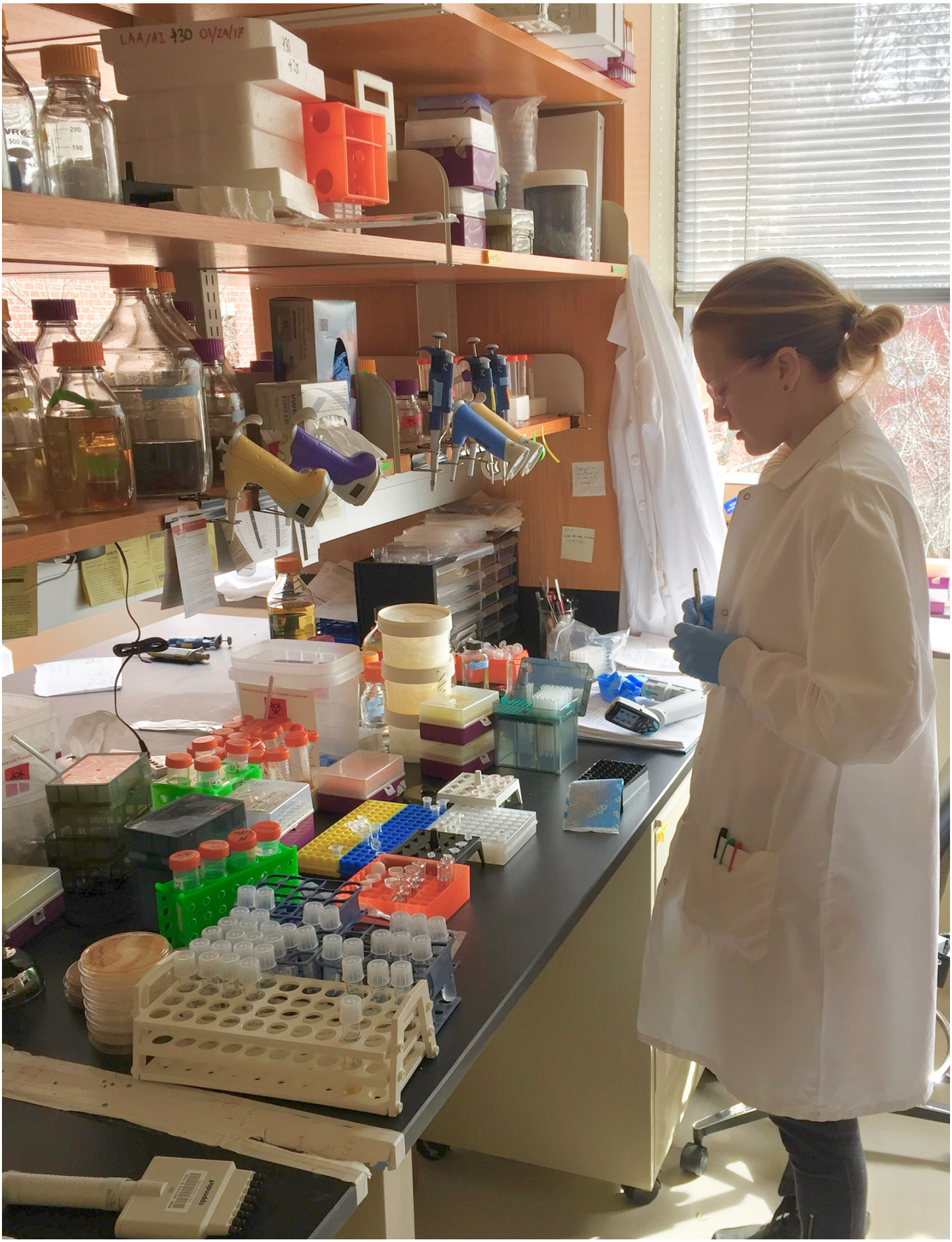
Life science researchers are far from innocent when it comes to contributing to this waste. According to one 2 estimate, the world's biosciences labs could have generated as much as 5.5 million metric tons of the stuff in 2 —nearly 2 percent of the total mound—despite the fact that researchers represent a tiny fraction of the world population.

The reason has to do with life scientists' dependence on single-use plastics, says Lisa Anderson, a biological researcher at Amyris labs in Emeryville, California, which develops sustainable alternatives to petroleum-base products and rare materials, including fuels, solvents, cosmetics, and fragrances. "Plastic is so integrated into what's done in the [bio] lab," she says. When she transitioned from chemistry-based undergraduate research t doctoral research on microalgae in 2009, Anderson was surprised by the amount of plastic waste she started generating, she adds.

Disposable microcentrifuge tubes, pipette tips and their boxes, plastic labels, and Petri dishes have become indispensable in biological research. Then there's packaging for lab materials and plastic bottles for containin growth media and reagents, for instance. Throwing away these plastics after a single use helps maintain a steri setup: A new pipette tip is required with each fluid transfer to avoid contaminating a new sample with the previously pipetted one. The same goes for PCR and sample tubes. And everything that can be conveniently disposed of saves time and labor.

But as plastic pollution becomes ever more pervasive, researchers are spurring a movement toward reducing plastic waste in the lab. Efforts range from individual scientists making tweaks to their own protocols, to universities setting up recycling programs to save plastics from going to a landfill, to innovative solutions offe

by the companies that manufacture labware. Although the scale of many of these changes is small for now, su efforts are helping life science cut down on plastic waste, one experiment at a time.



Single-use plastics have become seemingly indispensable in biological research. Here, researcher Lisa Anderson stands at her workstation MIT, surrounded by plastic consumables.
JOHN OLIVER

Reducing waste in the lab

Stanford University research specialist Nidhi Sharma currently manages the lab of plant biologist Dominique Bergmann, who studies the mechanisms of stomata development in *Arabidopsis*. A few years into her postdoc, which she carried out in another Stanford lab from 2012 to 2016, Sharma became "very aware of how much tı I was generating." At the time, she was genotyping a large number of mutant plants using PCR, some days goi through around 400 plastic PCR tubes.

Sharma decided to try to be less wasteful wherever she could, growing three or four plants inside one disposal plastic pot, instead of using a separate one for each plant, and reusing plastic labels by washing them in ethanc She began to grow her cell cultures in small plastic PCR tubes rather than larger tubes. "That kind of cut down the waste a lot for me," Sharma says, noting that, though small, the changes added up. In her work as a teachin assistant, Sharma now encourages students to take a similar approach, and documented her own efforts in the online magazine *Bitesize Bio* in 2016.

Some institutions are trying to build on researchers' desire to reduce plastic waste by setting up sharing programs for reagents and consumables, says Nicole Kelesoglu, a former research technician and current edit of the sustainable lab practices blog Labconscious, which is operated by reagent supplier New England Biolab For instance, the University of Michigan has a program through which researchers can donate extra chemicals equipment, and other materials to other researchers at the university who may find a use for them.

Other labs are opting for reusable glassware over single-use plastics, including glass volumetric pipettes, glass bottles for containing media, or glass Petri dishes. "It just takes some changes to having them cleaned [and sterilized] properly," Kelesoglu says.

Finding ways to recycle

Even when plastics have outlived their usefulness in the lab, researchers and institutions are finding ways to ke them out of the trash heap. Currently, after being thrown away, most lab plastics go to a landfill, or, if they're contaminated with anything potentially dangerous, into biohazardous waste streams, where they are typically incinerated, explains Allison Paradise, executive director of My Green Lab, a California-based nonprofit that promotes lab sustainability.

Paradise recalls being shocked by how much laboratory plastic ware is wasted while completing a summer internship at a pharmaceutical lab during high school. She remembers diligently collecting her pipette tips afi an experiment, and asking her PI where the recycling bin was. "She was just looking at me like I [was] crazy," Paradise says.

Yet many lab plastics can, in principle, be recycled—an option that some institutions are now exploring. Anne Krieghoff, manager of the sustainability program at the University of California, Irvine, was able to work out a recycling program in 2013 by coordinating with the university's waste transfer station. Before then, plastics we going from UC Irvine labs straight into landfills. Now, many of the institution's lab plastics, including polypropylene pipette tip boxes and even pipette tips, are recycled, provided they were only used for harmles reagents and water. Recycling represents a major economic bonus for the university, Krieghoff explains, as in Irvine region, landfill waste costs more to take away, whereas the institution receives money from their waste hauler for recycling.

Even when traditional recycling services for certain plastics aren't available, lab managers and university administrators often find bespoke solutions. For example, many biology labs go through copious amounts of Styrofoam, which researchers use to transport reagents and biological materials that need to be maintained at

controlled temperatures. To find a sustainable avenue for this material at Irvine, Krieghoff initially cut a deal w surfboard manufacturing company Marko, which compressed it to form the buoyant cores of surfboards. However, the university's labs collected so much Styrofoam through the program that Krieghoff later had to switch to a larger, Styrofoam-manufacturing company to accept the material, she says.

Establishing such deals is easier in some states than in others. "If you go to places in Texas and Alabama and Oklahoma, or even Missouri, they [often] don't even have basic recycling for their homes, let alone the lab," Paradise says.

Nevertheless, Nick Ciancio, a neuroscience undergraduate at the University of Alabama at Birmingham (UAB) was able to find one recycling company in Albertville last year that was willing to accept polypropylene and Styrofoam. About 70 of the university's 2,000 science labs now recycle their waste through this scheme.

However, UAB made the decision to exempt pipette tips from the program over concerns that researchers mi accidentally throw tips contaminated with hazardous waste into the recycling bin, posing a health risk to work at the recycling facility. This was a precautionary decision, Ciancio explains. "If anything is improperly dispos of, it would be a pipette tip. The first time someone outside of the institution is contaminated with biohazardo material will be the last time we recycle lab material."

Although the Environmental Protection Agency provides rudimentary guidelines on hazardous waste disposa it's up to institutions to take the initiative to go further. And because they are responsible for any eventual contamination of their waste, Paradise explains, many prefer to err on the side of caution.

Anne Krieghoff (right), manager of the sustainability program at the University of California, Irvine, has initiated a Styrofoam recycling program to reduce plastic lab waste.
ANNE KRIEGHOFF

Getting industry involved

Recognizing that an increasing number of scientists want to make their labs more sustainable, manufacturers rushing to offer their own solutions, from labware made with alternative materials to recycling programs for equipment purchased from them—with varying degrees of success.

For Mickey Blake, CEO of Mt. Baker Bio, which develops sustainable lab products, the obvious solution was to make single-use lab products out of biodegradable materials. But when she created a line of biodegradable pipette tips six years ago, she realized that the traditional waste management system wasn't set up to accommodate such products, which require specialized landfill conditions for proper biodegradation. "Not be able to complete that life cycle" from creation to degradation, Blake says, "created a whole new problem" of finding a suitable place to send the material. Mt. Baker Bio doesn't manufacture biodegradable pipette tips anymore, but is working on other solutions to solve the issue of plastic lab waste, Blake says.

Lack of access to industrial composting facilities was also an issue that Labcon, a California-based manufactur specializing in environmentally friendly labware, encountered when it developed a biodegradable, corn-deriv plastic to make certain packaging components for pipette tips. In the end, "we felt that there was a higher likelihood of our products being recycled than composted," writes Venus Happ, director of engineering at Labcon, in an email to *The Scientist*. In 2013 the company switched to using a recyclable, sugarcane-based polyethylene material for these parts instead. Labcon's pipette tips and centrifuge tubes are manufactured usi polypropylene, which can also be recycled.

Meanwhile, Virginia-based Grenova Solutions, which focuses on developing sustainable lab consumables, offe programs to sterilize contaminated plastic pipette tips for their customers. Yet other companies offer take-bac programs for their labware, such as pipette tip boxes and solvent containers, or specialized programs to recycl lab gloves, which are made of nitrile or latex and can contribute significantly to lab waste—up to 23 percent according to one audit carried out at the University of Washington in Seattle.

Texas-based manufacturing company Kimberly-Clark will take back its own gloves and recycle them for institutions willing to pay the shipping costs, while New Jersey-based TerraCycle, which specializes in difficult recycle materials, charges for its recycling service, but processes "any type of glove," says Amyris biologist Anderson. She spearheaded a glove recycling program when she was a postdoc in a synthetic biology lab at M "Those gloves [at MIT] would have gone to landfill. There was no other stream for them," she adds.

Lisa Anderson (second from right), now a researcher at Amyris, spearheaded a glove-recycling program when she was a postdoc at MIT.
NICOLE KELESOGLU

Effecting systemic change

Ideally, individual, institutional, and commercial efforts to reduce plastic waste in labs will be part of a wider improvement in scientific sustainability, says Paradise. In 2014, her nonprofit, My Green Lab, developed a lab certification scheme to set a standard for best sustainable practices, encompassing everything from reducing energy and water consumption to recycling equipment and limiting the use of highly toxic chemicals. Hundr of laboratories in the US and Canada have completed the certification.

My Green Lab also works with environmental health and safety divisions of institutions to determine what wa really has to be classed as hazardous and helps individual labs obtain logistical support from their institutions set up recycling programs, Paradise says.

Most scientists that come to My Green Lab do so because "they want to reduce their [environmental] impact," Paradise explains. But "eventually, we hope to get our certification tied into [National Institutes of Health] funding. . . . Labs that are using resources responsibly should be given extra points on their grant applications.

In the last few years, several other initiatives promoting sustainability in the lab have emerged. S-Lab in the U focuses on energy efficiency, for instance, and EGNATON, a Germany-based organization, certifies laboratory equipment and provides guidelines on sustainable laboratory building design. The Freezer Challenge encoura labs to clean out their freezers to save on space, and tune the thermostat so that they're not wasting energy on keeping samples colder than they need to be.

To help these movements take hold in the long term, however, labs still need better support from the procurement and sustainability divisions of their institutions, Paradise says. For individual scientists, Sharma

adds, sustainability isn't necessarily a priority. "It's still about publishing, doing, and getting the data. That's th[e] [major] focus in the lab."

However, "we're in an age where people are more aware of the harm we're doing by using plastics," she acknowledges. "I'm sure people are thinking about it and trying to do [the] best they can."

Keywords:

Biodegradable, biodegradation, careers, ecology & environment, lab management, ocean pollution, plastics, pollution, recycling, sustainability, techniques, waste