TechNews

GOING GREENER

Small changes in lab practices and purchasing can lead to big gains in environmental sustainability. Sarah Webb looks at the steps labs can take to boost productivity, benefit people, and protect the planet.

Credit: A. Doyle

As a graduate student, Gaia Bistulfi was concerned about waste in the molecular biology laboratory. “Where is all this plastic going?” she remembers asking herself. When she raised her concerns with several principal investigators during training, some were more receptive than others. Their biggest concern was experimental contamination, she says, and they didn’t always see a need to make a change. But when she started her own laboratory at D’Youville College in Buffalo, New York, Bistulfi was determined to reduce plastic and other waste and recycle as much as possible.

At the time, D’Youville College didn’t have a sustainability office, so she did much of her research on the internet, using tips from websites such as Labconscious.com—an online community sponsored by New England BioLabs that allows scientists to exchange ideas on reducing the environmental footprint of research. In 2013, she published a correspondence in the journal *Nature* highlighting how this attention to reducing plastic waste actually saved her laboratory 40% in operating costs. “I could squeeze a lot more out of my budget,” she says.

Researchers are increasingly concerned about the sustainability of their labs—ensuring that they make the best use of supplies, equipment, energy, water, and space. And a growing number of universities are incorporating laboratories into their sustainability initiatives.

“At any large university in the United States, the bulk of their environmental footprint is laboratories,” says Allen Doyle, Sustainability Manager at the University of California, Davis. Therefore, he adds, any small change in laboratory practices that a scientist makes is equivalent to three or four times the impact of changes made in offices or classrooms.

Improving sustainability doesn’t have to be expensive or time-consuming, experts say, and it can come with benefits that researchers don’t always expect. In fact according to the Kathy Ramirez-Aguilar, Program Manager of CU Green Labs at the University of Colorado in Boulder, green initiatives often improve the safety and overall work environment for researchers as well as the quality of the science.

Plastic, packaging and chemicals—Oh, my!

When many researchers think about sustainability, they first think about problems they can see: foam shipping containers, mountains of used gloves, piles of plastic pipettes, and toxic chemical waste. These streams of incoming supplies and outgoing waste highlight the two primary ways that scientists can improve sustainability

“There’s changing what you buy, which is one way of addressing this, but there’s also just changing how you are in the lab,” says Allison Paradise, Executive Director of My Green Lab, a California-based non-profit organization focused on improving research sustainability. In both of those areas, scientists can take concrete steps, she adds.

For some researchers, cutting down on consumables requires overcoming entrenched laboratory practices and patterns. The availability of disposable single-use plastics and concerns about contamination have led some researchers to err on the side of caution and higher consumption. But all of that waste adds up. In a December 2015 commentary in *Nature*, it was estimated that research laboratories worldwide produced 5.5 million metric tons of plastic waste in 2014.

It’s easy for researchers to use a lot of plastic simply because they haven’t asked themselves whether it’s nec-

essary, says Paradise. Plastic can also leach into an experiment, she warns, a downside of the material that researchers rarely discuss.

Bistulfi has tried to make sure her lab uses plastics mindfully. Her team studies the role of nuclear receptor protein isoforms in cancer cells. In some situations, single-use disposable pipettes are essential, she says. But for other experiments, her lab uses glass pipettes, which she notes work just as well when they're properly cleaned and autoclaved. Although her laboratory is primarily staffed with undergraduate students working with sensitive RNA, they haven't had a problem with contamination. As she trains her students, Bistulfi emphasizes thoughtful use of supplies and being conscious of what can be reused or recycled.

Five years ago, David Lydall of Newcastle University in the United Kingdom was looking for a way to save money on the expensive square Petri dishes that his yeast genetics lab used with their robots. The single-use polystyrene plates were presenting a significant cost to his lab and making his team cost-conscious about planning experiments. Lydall figured there must be a way to make reusable plates, so he consulted with an engineer and worked with a local plastics manufacturer. Together, they found a way to produce a few thousand square polycarbonate plates at a time for the same price he was paying for polystyrene. He estimates that his laboratory uses their reusable plates at least 50 times before they break or are discarded.

"Our motivation initially was financial, but then I started looking at the green issues as well," Lydall says. Though polycarbonate is more chemically costly to start with, the plates are a greener option overall, according to an audit of the environmental costs. The downside is washing up, Lydall says, but it involves the same products as washing glassware. Even though the square polystyrene plates have dropped in price recently, he says, "I don't think we would ever switch back now."

Going greener doesn't necessarily mean going to the lengths that Lydall did. Labcon in Petaluma, California, is

Examples of plastic consumables present in labs around the globe.
Credit: A. Doyle.

Allen Doyle, the Sustainability Manager at University of California, Davis, says that small changes in the lab can have a big impact on sustainability. Credit: A. Doyle.

one company that specializes in sustainable labware such as pipette tips, centrifuge tubes, and freezer storage racks. Resources are available to help with greener substitutions for common chemicals such as ethidium bromide or acetone (see "Online resources for a greener laboratory" below). But resist the temptation to buy chemicals in bulk, Paradise says. When scanning catalogs for sustainable options, beware of greenwashing, experts say. Just because a catalog labels a product as "green" doesn't mean it's a sustainable choice.

Some companies that produce and sell reagents and supplies are helping with reuse and recycling efforts. Sigma-Aldrich and New England BioLabs allow researchers to send back polystyrene shipping containers. Glove recycling is still relatively difficult, but a few campuses have tried pilot programs. Kimberly-Clark has started a program, RightCycle, for recycling nitrile gloves and other items.

Simple ways to save energy

Even though waste and recycling are visible sustainability issues, the biggest green gains in laboratories can come from more careful energy usage. Individual investigators don't typically see these bills, but energy costs are big ticket items for university campuses, companies, and research institutions. Fume hoods and ultra-low temperature (UL) freezers guzzle power: each one on average consumes energy at the same rate as an entire single-family home.

Small behavioral changes can make a significant dent in the carbon footprint and expense of this equipment. Closing the sashes on variable flow fume hoods when not in use can significantly reduce their power consumption. Harvard University's Green Labs Program has sponsored a Shut the Sash Competition since 2005, where labs that meet their customized airflow reduction goals each month receive rewards such as pizza parties and wine and cheese celebrations. As of 2010, fume hood exhaust had dropped by 30%. The difference in power consumption from the 178 hoods in the 20 labs participating has saved more than \$200,000 each year, according to a 2015 internal review.

David Lydall's laboratory uses these polycarbonate Petri dishes at least 50 times. On the left, the dishes are autoclaved and stored for use, and on the right, they're being washed for reuse. Credit: D. Lydall

Greener imaging with mercury-free microscopy

For microscopy, researchers now have a greener option than mercury-based light sources. Mercury-arc and mercury-halide lamps have typical lifespans of no more than 2000 hours. Switching to LEDs eliminates the use of toxic mercury and increases bulb life at least 10-fold. Ditching mercury also saves energy and researchers' time, says Ben Abrams, facility manager of the University of California, Santa Cruz Life Sciences Microscopy Center. Mercury lamps require both long warm-up times and mandatory cool-down periods if they've just been turned off. LEDs, by comparison, can be used almost immediately, making it easy and economical to turn the lamps off when the instruments are not in use. LEDs also produce little heat, which reduces the demands on an instrument's heating and cooling systems.

Abrams first learned about mercury-free microscopy at a conference in 2014, where he met Allison Paradise, Executive Director of My Green Lab, and Regan Baird, then Director of Sustainability at Lumencor, Inc. As Abrams started to think about how he could convert his facility's 11 microscopes over to LEDs, he looked for campus funding. He soon discovered a student-run organization, The Carbon Fund, to which he applied for funding to support green innovations. He received a \$13,000 grant and combined that with support from faculty to purchase units to convert 3 of the highest-use microscopes at his facility over to using LEDs.

"All around, it's a nice way to go," Abrams says. The LED light source is generally brighter than mercury, according to Abrams, particularly at the far-red end of the visible spectrum. One of their live-cell microscopes now uses LEDs, and during time-lapse imaging, the camera triggers the light source so that it turns on only during image acquisition. Similar experiments with a mercury light source require leaving the bulb on throughout the entire experiment, which typically ranges from a few hours to several days.--SW

Careful management of UL freezers can also lower a lab's carbon footprint. By cataloging samples and regularly defrosting freezers, scientists can make a significant dent in their energy usage. Throwing out samples when no longer needed also conserves freezer space and reduces the number of freezers needed in the first place. Researchers could also shift the temperature on these freezers up by 10°C, to -70°C rather than -80°C to save energy.

Yet another way to reduce your carbon footprint is to turn off lab instruments when they are not in use. For instruments that need to warm up or equilibrate their temperature, Paradise recommends setting up inexpensive wall timers to make sure that instruments are ready for use at the beginning of each day.

Look for ways to conserve water, particularly deionized water, which is often produced inefficiently, Paradise says. CU Boulder cut tap water use in a microscopy facility by moving away from tap water cooling and placing the instruments on the building's chilled water system, which operates on a closed loop. That shift both saved energy and kept the instruments at a more consistent temperature, Ramirez-Aguilar says.

Easier instrument sharing

Finding ways to share instruments can also address sustainability concerns while enhancing research quality, collaboration, and productivity. Shared facilities cut down on total laboratory space and instruments needed. The arrangement offers other benefits for researchers at all levels: Dedicated facility staff handle equipment setup, maintenance, and training, a combination that saves precious research hours and resources, Ramirez-Aguilar says.

In addition to shared facilities, a few campuses are looking at ways for researchers to share access to equipment housed in their own laboratories. Research needs can change quickly, says Ramirez-Aguilar, and a piece of equipment that's useful for one research laboratory today might sit unused next year. The University of California, Santa Barbara (UCSB) has an extensive website cataloging a range of scientific instruments available in departments around the campus.

Though some researchers might be skeptical about sharing their valuable equipment, principal investigators retain full control over the access to their instruments, says Amorette Getty of UCSB, who was involved in the site's launch. Website users are only told the building

Allison Paradise is the Executive Director of My Green Lab, a California-based non-profit organization focused on improving research sustainability. Credit: W. Huber.

where an instrument is housed and must contact a member of the laboratory about its use. The website also helps researchers find other scientists who might be able to help troubleshoot problems with their own instruments, Getty adds. When a UCSB biologist discovered that a fiberoptic cable was broken on a microscope, the website helped her find a compatible instrument in the engineering department. The engineers loaned her a compatible cable, allowing her to continue her experiments without waiting for a replacement.

Because Getty and her colleagues developed their website code as part of a multi-institution National Science Foundation (NSF) grant, they are eager to share it with other scientists, Getty emphasizes. CU Boulder is currently discussing using the code to found a similar website on their campus.

The power of teamwork

Teamwork and collaboration are often a critical factors in making new sustainability strategies work. Many campus sustainability initiatives have started with individuals or groups of researchers who see problems and then team up to figure out solutions. Ramirez-Aguilar started working on sustainability is-

Online resources for a greener laboratory

1. My Green Lab offers resources and consulting for universities and companies interested in improving sustainability: www.mygreenlab.org/
2. A report discussing the energy efficiency of lab equipment: www.etcc-ca.com/reports/market-assessment-energy-efficiency-opportunities-laboratories?dl=1459868428
3. MIT's green alternatives wizard for chemicals: <http://ehs.mit.edu/greenchem/>
4. University of California, Davis' Allen Doyle manages a Green Labs Planning Google group, which is open to anyone wanting to learn more about lab sustainability: <https://groups.google.com/forum/#!forum/green-labs-planning>
5. LabRats at University of California, Santa Barbara was one of the earliest campus groups devoted to lab sustainability: www.sustainability.ucsb.edu/labrats/
6. A sustainability website sponsored by New England BioLabs: Labconscious.com

sues while she was a senior biochemistry post-doctoral fellow and then later moved into her staff position.

If your campus has a sustainability office, those staff members can help with research into green options and with organizing campus and community resources around initiatives such as recycling. Paradise's organization, My Green Labs, contracts with universities and companies to help them with green initiatives.

CU Boulder's Green Labs Program has even found a way to match the waste stream from one laboratory with the chemical needs of another. When a laboratory at the Institute of Arctic and Alpine Studies realized that they had ethanol in cooling packs that gradually became useless to them as water condensed, Ramirez-Aguilar's team realized that the ethanol was still relatively clean and that another lab might be able to use it. The Biochemistry Cell Culture facility has diluted this stash of ethanol to 70% and routinely uses it in its laboratory, saving \$1700 per year. "A culture is beginning to develop around what can be reused," Theresa Nahreini, the cell culture facility manager

Whether you're a graduate student or a principal investigator, whether you work in an established lab or one just getting off the ground, any laboratory can take steps that can pay dividends for your science and for the planet. A good strategy even when you're super busy is: "Do one thing and make it stick," Doyle says. "If each person does a different thing, then you have a whole portfolio of green actions."

Written by Sarah Webb, Ph.D.

BioTechniques 60:224-228 (May 2016)
doi: 10.2144/000114413

FROM THE INVENTORS OF THE

1978 • **the BEADBEATER**

1993 • **the Mini BEADBEATER**

2015 • **the SONIBEAST**

CELL & TISSUE DISRUPTOR

The NEW SONIBEAST

- 10X FASTER CELL LYSIS
- SMALL SAMPLE SIZE
- SIMPLE OPERATION
- LARGE CAPACITY

BIOSPEC PRODUCTS
WWW.BIOSPEC.COM

SCAN FOR DETAILS