THE UNSUSTAINABLE LAB

Research laboratories have a huge impact on the environment in terms of resource requirements, energy use and waste production. With the public eye increasingly turning toward sustainability, this feature looks at ongoing efforts to make laboratories more “green”.

For reprint orders, please contact: reprints@futuremedicine.com

While we'd all like to think we're doing our bit towards a more sustainable and healthy planet, whether that be recycling properly, putting on an extra sweater instead of turning the heat up, or carpooling, have you ever considered your contributions to sustainability while at work?

The bill for an unsustainable scientific laboratory can be upwards of US\$1 million [1]. In the era of unsettling political landscapes, where you never know just what's around the corner in terms of scientific funding, every penny counts.

It may be fake news to some, but climate change is a very real issue impacted by our levels of greenhouse gas emissions. Although scientific research is generally contributing to the progression of humanity in some form, sadly it could be seen that some of the avoidable energy consumption and waste production of that research may be contributing to the hindering of humanity in another way.

Single-use plastic is also very high on the agenda nowadays, with global efforts afoot to rid the oceans of plastic waste. A 2015 report from the University of Exeter (UoE, UK) determined that 5.5 million tons [2] of plastic waste is being generated globally in the course of scientific research, with 1.8% of total global plastic production attributed to bio-scientific research. These statistics may seem shocking, with the researchers that conducted the report even expressing their surprise:

“When we started doing the calculations for this exercise, using data provided by the UoE Sustainability Office, I expected the contribution of research to the global plastic problem to be almost

negligible – but we were surprised at how high the estimate is,” commented Erin Reardon (UoE) [3].

“At a time when governments are imposing charges for single-use plastic bags and bottles, we think the scientific research community could be working towards reducing its dependency on plastic, and could be doing so without sacrificing scientific standards.”

In order to maximize research budgets, often single-use plastic equipment is the only way to go. Labs tend to be filled with these items, including microcentrifuge tubes, pipette tips, plastic labels and petri dishes – not to mention the plastic packaging that these items often come packed in. Using these items not only saves precious funding resources, but also saves time by ensuring sterility and avoiding laborious decontamination procedures.

The probability that all plastics can be eliminated across labs is slim, but a reduction is definitely possible. So, just what can be done to reduce the impact of scientific research on the environment, at the same time as addressing the concerns of funding, ease and contamination?

“The probability that all plastics can be eliminated across labs is slim, but a reduction is definitely possible.”

PLASTIC-EATING PROTEINS

There are clearly many obstacles preventing the immediate and definitive extermination of plastics in the lab. But, what if there were a way for plastic use to continue with no real environmental impact?

Thanks to researchers at the University of Portsmouth (UK), there may be an answer that allows the essential use of single-use plastics to continue. By pure fluke in early 2018, researchers discovered a form of plastic-eating protein [4].

The enzyme is capable of digesting polyethylene terephthalate ►

► (PET), a plastic that is said to be highly recyclable but when discarded can last for hundreds of years before degrading. The team inadvertently created the mutant enzyme when conducting X-ray experiments on bacteria found in a Japanese recycling center.

Originally, the bacteria in the recycling center had evolved to

the coming years we will see an industrially viable process to turn PET and potentially other (plastic) substrates back to their original building blocks, so that they can be sustainably recycled.”

Despite this incredible discovery, it cannot be relied upon to handle all single-use plastic waste and efforts should still be focused on

reducing plastic usage. These efforts at an individual level are well meaning, but it will take a movement within the scientific community on an international scale to bring about the change needed to make a significant impact.

THE PLASTIC-FREE UNIVERSITY

After the publication of the UoE report in late 2015, many scientists called for more to be done to reduce single-use plastics in the lab. Many universities are announcing their commitments to reducing single-use plastic across the board and look to more sustainable campuses. One such university that has recently announced its own commitment is the University of Leeds (UoL, UK). Their 2023 commitment pledges to phase out single-use plastics across catering and offices by 2020, with the aim to be single-use plastic free by 2023.

Their goal is to improve sustainability across the board, understand their plastic footprint and come up with solutions that are more sustainable. “We have come across things that have opened our eyes to the challenge ahead of us,” commented Thom Cooper, a sustainability program officer at UoL.

Individual departments have already begun demonstrating good practice by making changes, including purchasing reusable test tube racks instead of single-use ones, and moving to biodegradable latex gloves instead of plastic ones.

While there are success stories, there are also challenges ahead, as Cooper pointed out. “A colleague in healthcare discovered ten glass petri dishes cost the same price as approximately 600 single-use plastic ones.

That’s not a very sustainable alternative for us.”

On top of this, collaboration with outside organizations is also needed. “When training students, it is important that the faculty of medicine and health recreate the environment of a hospital. While the NHS continues to use single-use plastic items, it’s important

Figure 1. An electron microscope image of the enzyme degrading PET plastic. Credit: Dennis Schroeder. Reproduced from [5].

digest plastic, utilizing a naturally occurring enzyme named PETase. The scientists then created a new powerful version of the protein while probing its molecular structure with x-rays.

“Serendipity often plays a significant role in fundamental scientific research, and our discovery here is no exception,” explained lead scientist John McGeehan (University of Portsmouth). “Although the improvement is modest, this unanticipated discovery suggests there is room to further improve these enzymes, moving us closer to a recycling solution for the ever-growing mountain of discarded plastics.” [5]

“The technology exists and it’s well within the possibility that in

“...the University of Leeds (UoL, UK). Their 2023 commitment pledges to phase out single-use plastics across catering and offices by 2020, with the aim to be single-use plastic free by 2023.”

that our students use those items and not alternatives,” Cooper added.

Cooper now hopes that other institutions will follow their lead. “It is our hope and our intention that it inspires others to follow our lead and join the campaign.”

“The current wave of public awareness of plastics is what’s really prompted us to make a stand for this and demonstrate some leadership across our sector,” concluded Cooper. “We’re a world-leading university with lots of expertise in plastics and polymers. Where we do find stumbling blocks, we hope that we can inspire research around the potential solutions for those as well.”

UoL is historically known for being one of those at the forefront of scientific research and modern innovations. The institution was actually the first university to introduce the modern fume hood design with rising sashes back in 1923 [6].

SHUT THE SASH

Fume hoods are one of the most energy intensive pieces of equipment in a science laboratory, and surprisingly huge energy savings can be made simply by shutting the sash. This is why the Harvard Chemistry and Chemical Biology Department (MA, USA) started the ‘Shut the Sash’ competition in 2005 [7].

The ‘Shut the Sash’ competition aims to combat the high energy consumption of variable air volume fume hoods, as well as promote awareness, by turning energy savings into rewards, with pizza parties and wine and cheese nights being awarded to those at the top of their energy-saving game.

The program has grown from a pilot involving five labs to the inclusion of 19 labs and over 350 researchers. Its success can be measured in energy savings; Harvard claims that the competition saves more energy than any other behavioral program they run. It has led to a 30% reduction in fume hood exhaust levels when compared with the pre-competition values; this translates to energy savings of over US\$200,000 and 300 metric tons less of greenhouse gases being emitted into the atmosphere.

MY GREEN LAB

Labs consume as much as five-times more energy per square foot than typical offices [8]. ‘Green lab’ programs that set out to reduce this energy usage can often be institution-specific. Allison Paradise, CEO and founder of My Green Lab (CA, USA) saw an opportunity to unite scientists across the USA into one recognizable initiative.

My Green Lab is a non-profit organization who has established a program leading to a Green Lab certification. The first step is an assessment that quantifies lab practices in 14 different categories. After this, an action plan is made for improvements; once the lab has implemented these, they are then re-assessed, resulting in a Green Lab certificate if they pass. The idea is that individuals will develop new behaviors as a result of the program.

“The assessment always leads to interesting conversations,” commented Erika Daley, program manager at My Green Lab. “The assessment allows you to focus on so much that’s positive and

Figure 2. The Shut the Sash magnet design, which organizations outside Harvard can also use to create their own magnets and stickers. Reproduced from [7].

constructive; for example: best practices such as optimizing usage of equipment and cold storage, creating or updating inventories, solvent and reagent selection, and thinking about the positive actions you’re already taking that contribute to sustainable lab work and gathering ideas for what you want to change.” [9]

Thus far, more than 200 labs in the USA have been awarded the certification and 10,000 scientists have been reached this year alone. The labs must be re-assessed every 2 years, encouraging them to keep up with the sustainable changes.

While it may seem a scientific revolution is necessary to truly bring about change, don’t give up all hope – even small changes

can make a world of difference when carried out by a collective of individuals.

In terms of plastics, utilize a good recycling system. If the plastics are not contaminated with biohazard or radioactive substances, it may be possible

to decontaminate them and recycle. Can the plastic be swapped out for glass equipment, or washed, autoclaved and re-used?

Simply communicating with colleagues about these problems can make a huge difference in terms of awareness, and even turning the lights out when no one is in the lab and shutting the sash of other’s fume hoods can be stepping stones on your path to eco-warrior status.

Written by Abigail Sawyer

doi: 10.2144/btn-2018-0185

REFERENCES

1. www.theguardian.com/higher-education-network/blog/2013/may/01/university-science-laboratories-efficiency-funding
2. Urbina MA, Watts AJR, Reardon EE. Labs should cut plastic waste too. *Nature* 528, 479 (2015).
3. www.exeter.ac.uk/news/featurednews/title_488903_en.html
4. Austin HP, Allen MD, Donohoe BS. Characterization and engineering of a plastic-degrading aromatic polyesterase. *Proc. Natl Acad. Sci. USA* 115, 19 (2018).
5. <http://uopnews.port.ac.uk/2018/04/16/engineering-a-plastic-eating-enzyme/>
6. www.labmanager.com/lab-product/2011/12/evolution-of-fume-hoods
7. <https://green.harvard.edu/programs/green-labs/shut-sash-program>
8. www.mygreenlab.org/about.html
9. www.laboratoryequipment.com/article/2018/11/your-lab-can-be-greener-too