A Guide to Reducing Single-Use Plastic

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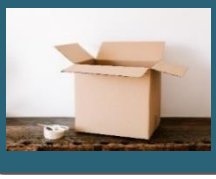

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The plastic problem

In 2018, worldwide plastic production reached an estimated total of **359 million tonnes**[1] – of which **46%** was classified as **single-use**[2]. Without improvements in global disposal, an **estimated 12 billion tonnes** of plastic are expected to rest in landfills and the surrounding landscapes **by 2050**[3] – a level of pollution permeating all parts of the ecosystem.

Laboratory waste is expected to reach around **5.5 million tonnes per year by 2050**[4]. Whilst Oxford University is fully committed to recycling and energy-from-waste (incineration) disposal streams – **none of the University's waste reaches landfill** – there are many more opportunities to reduce laboratory plastic waste.

This guide provides advice on how individuals and the wider lab community may conduct sustainable, conscientious research work.

Get involved - improve sustainability and efficiency in your lab

LEAF – The Laboratory Efficiency Assessment Framework

LEAF is a national scheme enabling laboratory certification at bronze, silver or gold level for implementation of key environmental criteria.

LEAF participants can estimate the carbon and financial savings their actions have achieved.

Find out more: https://sustainability.admin.ox.ac.uk/lab-schemes

Contact the Team: sustainability@admin.ox.ac.uk

Individual Best Practice

Scientists often generate a significant amount of plastic waste, which quickly builds up to several hundred kilograms over the year. Optimising experimental design and considering personal consumption of laboratory consumables goes a long way towards reducing overall plastic waste. A good starting point are the **5 Rs**: **R**efuse, **R**educe, **R**euse, **R**epurpose and **R**ecycle.

This section provides examples of how individual choices can make a difference. The following sections cover packaging and procurement, glassware alternatives and decontamination and disposal, and include examples of individual actions as well as lab-wide initiatives.

Experimental design

A proactive approach will enable you to adopt sustainable and efficient lab practices

Actions	Rationale & examples
Review your **experimental requirements**, including sample size, quantities and size of consumables.	Avoid excess consumables and wasted space: ▪ Swap Falcon tubes for Eppendorfs ▪ Multiple experiments on the same PCR plate
Use communal stock and **share resources** where possible.	Reduces packaging waste and deliveries, avoids expiry issues and encourages collaboration.
Reflect on what waste is likely to be generated, potential disposal streams and any opportunities for the **5Rs**.	Early considerations will reduce end-of-life impacts considerably.

Experimental execution

Exercise good laboratory practice to prevent avoidable errors

Actions	Rationale & examples
Reflect on your **glove use:** ▪ Are gloves needed at all? ▪ Are they protecting the sample or the researcher? ▪ Which types of gloves are appropriate? ▪ How many gloves should be used through the experiment?	Gloves are difficult to recycle, so using them in the intended and appropriate way is the safest and most sustainable option. ▪ Disposable gloves **shall not be reused** where they have been worn as PPE to protect the researcher from hazardous substances/ biological materials. ▪ For certain activities, non-disposable gloves may be safer than nitrile gloves.
Manage your **resources** and avoid generating unrecyclable waste.	▪ Cut **plastic labels** in half, use biodegradable tape, or directly label with removable ink ▪ **Save unused consumables** or kit elements for future experiments, or offer them to others
Choose the **most efficient type of pipette tips**, considering: ▪ Order for pipetting different reagents ▪ Ultra-low retention (prevents contaminant retention, making reuse possible) ▪ Filter or not ▪ Sterility requirements	Reduces chance of pipetting errors and the number of pipette tips. Avoids unnecessary use of filter tips. ▪ **Generate master mixes** for multi-pipetting experiments ▪ Pipette **larger volumes** first ▪ Ultra-low retention increases opportunities for reuse and recycling

Reuse & repurposing

If sterile conditions are not required, reusing items helps reduce plastic waste.

Actions	Rationale & examples
If sterile conditions are not necessary: ▪ **Reuse** pipette **tips and stripettes** ▪ Wash and **reuse plastic reservoirs**	Applications: ▪ Transferring media or PBS ▪ Pipetting water

Repurposing ideas
Polystyrene: ▪ **Reuse polystyrene boxes** as ice boxes or for **cold storage and transport** ▪ Other polystyrene materials are useful for **storing glass safely**
Reuse plastic packaging & zip-lock bags for: ▪ efficient **sample storage** ▪ **sending off sequencing samples** or **discarding gels** (DNA/protein)
Pipette tip boxes: ▪ Reuse for **storage of samples** in fridges/freezers/on the bench ▪ See inspirational **upcycling ideas** from Starlab
Pipette racks: ▪ Can hold **PCR tube strips** during experiments and for transport around the lab
Use **empty media bottles** to collect non-hazardous pipette tip waste.

Packaging & Procurement

Packaging often contains low-cost **virgin plastic** in composite form (ie mixed materials). **Consumer choices drive the market**, and encouraging manufacturers and distributors to engage with sustainable products and processes is ecologically empowering.

Actions	Rationale & examples
Individual choices ▪ Only purchase what you need when you need it ▪ Look for **flexible kit ordering** – order specific elements rather than whole kits ▪ Consider ordering **refills** instead of whole new products if possible – eg pipette tip refill racks, not whole tip boxes ▪ Consider product alternatives that are designed for transport/storage at **ambient temperatures**	▪ Appropriate purchasing avoids accumulation of unwanted consumables and reduces waste due to product expiry ▪ Ambient temperature products reduce the need for ice packs, polystyrene boxes and dry ice
Bulk ordering ▪ Consider **ordering as a group** or department	▪ Reduces deliveries and packaging waste

Actions	Rationale & examples
▪ Choose **bulk-packed items** if sterility is not needed ▪ If individual wrapping is required, ask for single-material wrapping (ie polystyrene only)	▪ Increases recycling opportunities ▪ Bulk buying media materials or **making media in the lab** increases control over media composition and available quantities
Choose your suppliers ▪ Aim to purchase goods from **ISO 14001**[5] accredited companies ▪ Look for manufacturers that offer **take-back schemes, green products** and utilise **minimal, ideally recycled and recyclable**, **packaging** ▪ Ask your suppliers about the environmental impacts of their processes and products	▪ Green quality assurance ensures that product life cycles are evaluated and maintained sustainably, and disposal is considered ▪ Check our website for details about takeback schemes, greener products and packaging solutions ▪ Let us know about any sustainability issues via the preferred suppliers feedback form ▪ Look for the new **ACT symbol**[6] for lab products (*see Appendix*)

Take-back Schemes

Some suppliers **collect used elements of non-hazardous products or packaging**, and reuse or recycle these back into useful items – typically commonplace or household goods such as benches or bins. These are the most common takeback schemes:

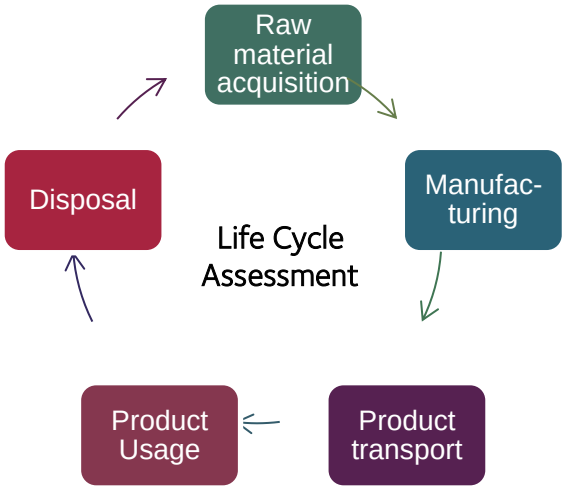
- **Tip box returns** - some suppliers collect competitors' box waste as well as their own!
- **Packaging return** - specific plastic bottles and flasks, such as **Winchester and Mauser bottles**. Many suppliers will also take back their **packaging materials** (cardboard, inner pulp)
- **Glove recycling** - often require purchase from the specific manufacturer or an input cost, and sufficient volume to make take-back worthwhile.
  Kimtech Nitrile Glove Recycling Programme - non-hazardous KCP Kimtech gloves are ground into plastic pellets and used to make new products.

Alternatives to plastics: Glassware

Glassware replacements seem an obvious choice to reduce plastic usage – but the reality is not so simple. While glassware is significantly more reusable than plastic, it also costs more resources to make, transport and clean. **Life cycle assessments** can help to make an informed decision.

When to use glass?

Considering glassware is advisable where a **centralised cleaning facility is available**, and where this is **safe** – ie where it does not pose any sharps risks. The impacts of repetitive cleaning and sterilisation of glassware should be taken into account.



Departmental provision of glassware is highly cost-effective for laboratories, but breakage risks mean that glass pipettes, for example, are not appropriate for work with hazardous materials.

Suggestions for replacing plastics
▪ Replace Falcons with Bijou bottles for storage of solutions ▪ Replace plastic reservoirs with metal or glass alternatives ▪ Replace plastic Petri dishes with glass alternatives[7] ▪ Reduce use of pre-cast gels in plastic casing by using glass plates or homemade gels Consider the choice of material regarding your experiment – plastic leachables can invalidate experimental results (eg oleamide leaching and enzymatic interaction), and therefore glassware may be a requirement[9]. Alternatively, opt for laboratory-grade plastic without additives such as plasticisers[10].

It works! A recent switch form plastic bottles to glass for filtering tissue culture media at two Harvard laboratories has reduced bottle waste generation by 2600 bottles, equating to a $9500 saving in the first 7 months[8].

Decontamination & Disposal

Recycling is only appropriate for non-hazardous and decontaminated waste streams. Clear labelling and understanding of different laboratory waste can increase recycling opportunities and improve environmental awareness. Talk to your safety officer (DSO/DivSO) if further guidance is needed on whether items are safe to recycle.

A uniform departmental laboratory bin system makes it more likely that items go into the right waste stream, improves laboratory safety and enables recycling – **communication is key**!

Initiatives	Rationale & examples
Improve segregation of different waste streams: **Clearly label and colour-code the different bins** for non-hazardous, chemical, sharps, biological and glass waste.	Clear understanding of disposal systems means less non-hazardous waste will go into hazardous streams, generating more recycling opportunities, and also reduces costs and impacts.
Trial additional lab recycling initiatives.	Get in contact with sustainability@admin.ox.ac.uk for opportunities to trial new recycling initiatives.
Consider a **decontamination station**[11] – using high-grade disinfectant as an autoclave alternative for non-hazardous items.	This saves energy and money compared to autoclaving.
Improve recyclability of lab items: ▪ Place Virkon-filled stripette column bins in tissue culture labs. ▪ Stripette wrappings can be disposed of separately. ▪ Stripettes can be decontaminated, the filter element removed using tweezers if non-hazardous.	

Final remarks

Single-use plastics are essentials in the laboratory, and the aim is not to eradicate them, but to use the resources required in a sustainable, reflective way.

The way forward is to maintain an **ethos of sustainability** – choosing the products we buy with care, reducing how much of them we use, reusing and repurposing them where possible, recycling whatever remains and above all reflecting on our processes and how we could improve them.

Encouraging sustainable laboratory best practice not only makes for a more consistent, driven scientific future, but will also, in the long term, lead to a better life for society and less damage to the environment – **each of us makes a difference!**

Find out more and get involved: sustainability.admin.ox.ac.uk/labs

Authors

Emma Lalande
Interdisciplinary Biosciences DTP student
Summer Intern in the Environmental Sustainability Team

Stefanie Reiss
Sustainability Projects Manager – Laboratory Optimisation
E: stefanie.reiss@admin.ox.ac.uk

Environmental Sustainability team
E: sustainability@admin.ox.ac.uk
W: sustainability.admin.ox.ac.uk

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2. UNEP . United Nations Environment Programme; 2020. Baseline Report on Plastic Waste
3. Geyer, R., Jambeck, J. R., & Law, K. L. (2017). Production, use, and fate of all plastics ever made. *Science advances*, *3*(7), e1700782. https://doi.org/10.1126/sciadv.1700782

4. Urbina, M., Watts, A., & Reardon, E. (2015). Labs should cut plastic waste too. *Nature*, *528*(7583), 479-479. https://doi.org/10.1038/528479c
5. ISO 14001 policy – https://www.iso.org/standard/60857.html
6. The ACT Label Programme, MyGreenLab – https://act.mygreenlab.org/about.html
7. https://www.sustainability.upenn.edu/get-involved/green-fund/reusable-petri-dish-pilot-0
8. https://green.harvard.edu/news/plastic-glassware-conversions-hscrb-saves-money-reduces-waste
9. Plastic labware contaminant risk – https://www.chemistryworld.com/news/plastic-labware-contaminant-risk/3003205.article?adredir=1
10. Radley's article on lab plastic reduction – https://www.radleys.com/blog/how-to-use-plastic-more-sustainably-in-the-lab/
11. 'Decontamination station' plastic recycling initiative, University of York – https://thebiologist.rsb.org.uk/biologist/158-biologist/features/2072-how-to-reduce-your-lab-s-plastic-waste

Complementary guidance documents

- Edinburgh University Sustainable Lab Consumables Guide – https://www.ed.ac.uk/files/atoms/files/sustainable_lab_consumables_guide.pdf
- Edinburgh University Reducing single-use laboratory plastics guidance – https://www.ed.ac.uk/files/atoms/files/lab_plastic_guidance_list_oct_2019_-_for_website.pdf

Quick links –greener products and initiatives

Suggested products

- https://www.eco-craft.co.uk/packaging/adhesives-and-tapes/tapes.html
- https://www.peacewiththewild.co.uk/product/biodegradable-paper-tape/
- https://www.thermofisher.com/order/catalog/product/300-4000#/300-4000
- https://ecatalog.corning.com/life-sciences/b2c/UK/en/Liquid-Handling/Pipets/Serological-Pipets/Stripette%E2%84%A2-Serological-Pipets/p/4100
- https://www.scientificlabs.co.uk/search/DEFAULT/1/ultra%20low%20retention%20tips
- https://www.appletonwoods.co.uk/product/pipette-tips-low-retention-graduated-appleton/
- https://www.appletonwoods.co.uk/product/echolution-cellculture-dna-kit/

Take-back schemes available for Oxford

- Chemical Packaging Scheme, Thermo Fisher Scientific https://static.fishersci.eu/content/dam/fishersci/en_EU/environment/13590%20Customer%20Packaging%20Returns%20Info%20Update%20v3.pdf
- Appleton Woods take-back schemes (tip boxes, tips, mixed glove collections) https://www.appletonwoods.co.uk/environmental-policy/
- KIMTECH™ Nitrile Glove Recycling Programme https://www.terracycle.com/en-GB/brigades/gloves
- New England BioLabs Shipping Box Recycling Programme https://www.neb.uk.com/news/the-neb-shipping-box-recycling-programme

Further resources of interest

- http://www3.weforum.org/docs/WEF_The_New_Plastics_Economy.pdf
- https://ourworldindata.org/plastic-pollution
- https://www.theguardian.com/environment/2019/nov/10/research-labs-plastic-waste
- https://cen.acs.org/environment/sustainability/laboratories-move-away-single-use/97/i43

- http://magazine.eacr.org/a-few-key-ways-to-reduce-plastic-waste-in-the-lab/
- https://www.radleys.com/wp-content/uploads/2019/03/E7-Help-Save-our-planet-with-top-tips-for-a-sustainable-lab.jpg
- https://bitesizebio.com/25950/reducing-lab-waste-one-experiment-at-a-time/
- https://www.labconscious.com/green-lab-tips/2019/7/11/how-to-switch-to-glass-petri-dishes
- https://www.selectenviro.co.uk/waste-processing.php
- https://www.thermofisher.com/content/dam/LifeTech/global/About-us/Thermo%20Fisher%20Paper%20Cooler%20Tech%20Note%20F.pdf
- https://www.thermofisher.com/uk/en/home/about-us/product-stewardship/sustainable-packaging.html
- https://www.the-scientist.com/news-opinion/ucl-to-phase-out-single-use-plastics--including-pipette-tips-66637
- https://www.rsc.org/globalassets/22-new-perspectives/sustainability/progressive-plastics/c19_tl_sustainability_cs3_whitepaper_a4_web_final.pdf
  https://www.imperial.ac.uk/media/imperial-college/faculty-of-natural-sciences/centre-for-environmental-policy/public/Veolia-Plastic-Whitepaper.pdf

Appendix

ISO 14001

The International Organization for Standardization is a non-governmental organisation focused on generating and upholding expert-led global standards, from an angle of sustainability.

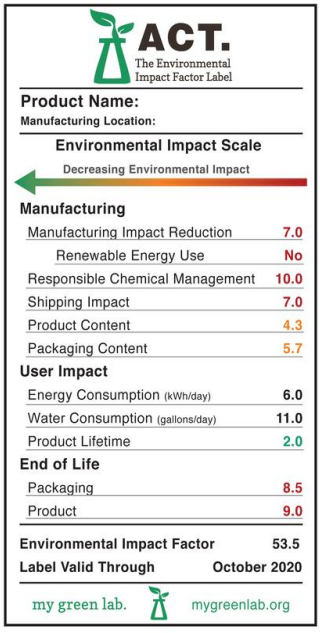
The ISO 14001 standard defines an environmental management system to enable enhancement of an organisation's environmental performance – including guidance on procurement, storage, distribution, transport and manufacture.

Accredited organisations therefore demonstrate fulfilled compliance of environmental standards, achievement of their environmental goals and sustained environmental awareness and practice.

ACT label

The ACT label program, created by non-profit **My Green Lab**, generates an environmental impact score for participating products in characterising the product's environmental **Accountability**, **Consistency** and **Transparency**.
The environmental impact score accounts for **manufacturing practices, energy consumption, water use and disposal** – all aiming to inform consumer choices as to environmental sustainability.

Eppendorf, MilliporeSigma and Thermo Fisher Scientific are some notable ACT label participants.



Estates Services

ENVIRONMENTAL SUSTAINABILITY

E: sustainability@admin.ox.ac.uk
W: sustainability.admin.ox.ac.uk

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