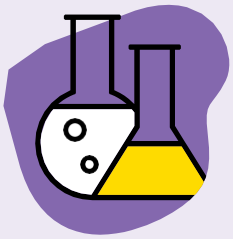

*Laboratory Efficiency Assessment Framework (**LEAF**) guides*

Green chemistry

Carefully analysing experimental processes and using green chemistry is essential if laboratory users want to develop cleaner, safer, and more efficient reactions.
The concepts of green chemistry are captured in the **12 principles of green chemistry**.

12 principles of green chemistry.

1. Aim to **minimise waste** at every step. Make prevention of waste a top priority.
2. Consider atom economy when choosing synthetic steps. In high atom economy processes, the stoichiometry of the reaction ensures that few "atoms" are wasted – at the extreme, all atoms from the reagents appear in the products.
3. Consider **using less hazardous chemical reagents** to minimise impact on human health and environment. Consult the ChemAlert database or the supplier to find chemical safety data sheets (SDS).
4. Try to **predict the environmental fate** of your molecules and consider designing molecules to minimise the potential harm. For example, polyfluorinated alkanes are persistent pollutants.
5. Aim to **reduce solvent quantities** where possible, and to use the safest possible solvents. For example, if it is safe to do so, you might be able to substitute DMF or NMP with Cyrene for reactions, or dichloromethane with tert-butyl methyl ether for chromatography.
6. Aim to **use low-energy processes**; where possible, it is better to minimise the energy used to create a chemical product by carrying out reactions at room temperature and pressure.
7. Consider using chemicals which are, or can be, derived from **bio-renewable feedstocks**. Even if you do not use bio-renewable chemicals yourself, if your work is scaled up then this design consideration provides a valuable opportunity for those who use your work.
8. Where possible, **avoid isolating derivatives** if not necessary. For example, can you telescope several synthetic steps, avoiding environmentally costly purification steps? Can you use more regioselective reactions which might reduce the need for protecting groups?
9. Explore opportunities to **use catalytic reactions**, which might remove the need for stoichiometric reagents and so reduce waste.
10. Consider designing **biodegradable materials**. For example, you might be able to introduce biologically cleavable groups into a polymer synthesis.
11. **Monitor your reactions carefully**, to identify when and if pollutants are generated, and to act to prevent release to the environment.
12. **Always have safety as your foremost consideration**. Design your processes to avoid hazards from the outset, and carefully risk assess all experiments.

For more information on green chemistry options, please visit the following website:

- **DOZN Quantitative Green Chemistry Evaluator**
- **ACS Solvent Selection Tool**
- **OSHA - Transitioning to Safer Chemicals**

This resource has been developed based on a guide created by UNSW Science Sustainability Working Group Environmental **Sustainability, Estate Management**