# Manipulating membranes and measuring microplastics

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I will give a general introduction to my group's research into controlling the self-assembly of lipids, and our more recent ventures into quantifying environmental microplastics. I will focus on two recent studies:

## Lipidic drug delivery systems are responsive to the human microbiome

While therapeutic agent testing typically occurs in sterile environments, we examined how lipidic nanomaterials interact with bacterial species common to drug delivery sites like the gastrointestinal tract and skin. Small angle X-ray scattering revealed that exposure to live Staphylococcus aureus transforms monoolein cubic and inverse hexagonal phases into inverse hexagonal and inverse micellar cubic phases through enzymatic hydrolysis and cell membrane lipid transfer, significantly reducing drug release rates. These strain-specific structural changes demonstrate for the first time how the human microbiome can alter the properties of lipidic nanomaterials, with implications varying across patients and body regions, particularly affecting monoglyceride-based formulations.

<https://doi.org/10.1016/j.jcis.2024.07.216>

## Machine learning outperforms humans in microplastic characterization and reveals human labelling errors in FTIR data

A dense feed-forward neural network (DNN) was developed for classifying microplastic particles using FTIR spectroscopic data, achieving superior performance over both complex models and human analysts across 16 microplastic categories. Through analysis and visualization of the DNN's outputs, we demonstrate that the model makes informed, generalizable decisions that avoid replicating systematic human errors found in public microplastic datasets. The complete codebase, trained model, and results are publicly available, enabling high-throughput analysis of FTIR data with reliability matching or exceeding traditional low-throughput methods.

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