Complex Coacervates as Extraction Solvents

**What and Why?**
Solvent extractions are an important technique in amongst others research, food- and pharmaceutical industry. Various tools such as organic solvents, ionic liquids, deep eutectic solvents, and aqueous two-phase systems can be used to extract various compounds.

We propose adding complex coacervates to this list. Complex coacervates are liquid-like aqueous complexes formed by oppositely charged polyions, but very little is known about the factors that influence partitioning behaviour of compounds in complex coacervates.

**Materials & Methods**
Polyion solutions of poly(ethylenimide) and poly(acrylic acid) were prepared at pH 7 before being mixed with lactic acid, n-butanol, or lipase enzymes solutions. We evaluated the partitioning of these compounds as a function of NaCl concentration, complex composition as defined via the fraction of polyion negative charges $F^-$ ($F^- = \frac{n_-}{n_++n_-}$), and temperature, amongst others. Compound concentrations were determined via gas- and ion chromatography.

Lactic Acid partitioning
We investigated the partitioning of lactic acid between the complex coacervate and the aqueous phase.

Lipase partitioning
We investigated the partitioning of PPL lipase between the complex coacervate and the aqueous phase.

Butanol partitioning
We investigated the partitioning of butanol between the complex coacervate and the aqueous phase.

Based on this strong temperature dependency, we evaluated the possibility of extracting butanol at higher temperatures, and then replacing the supernatant with new water to back-extract the butanol.

We were able to back-extract approximately 21.1% of butanol from the PEI/PAA complex back into an aqueous solution.

**Conclusion**
We show the effect of several factors on the partitioning of compounds between a PEI/PAA complex coacervates phase and an aqueous supernatant phase. In addition we extracted and back-extracted butanol as a proof of concept with a working capacity of 21%. Despite large differences in partition coefficients, the underlying mechanisms that determine partitioning in complex coacervates are poorly understood and require more research.