Lipid Production in Single Oleaginous Yeast Cells Using *In Vivo* Label-Free Imaging

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Project Goal: To develop a system for *in vivo* label-free imaging followed by single-cell RNA-Seq for understanding the lipid production mechanisms in oleaginous yeast, and to associate genes and transcriptional factors with the lipid accumulation processes at single-cell resolution.

Hydrocarbons have great potential to be used as next generation biofuels due to their relatively high energy density and compatibility with current infrastructure of fuel usage. Lipids produced by oleaginous yeast are of particular interest, as they can accumulate at high levels in the form of triacylglycerols (TAGs). The lipid accumulation is finely controlled based on nitrogen availability, while the lipid composition may vary with the carbon sources such as glucose and xylose. We explore lipid production in oleaginous yeast under different nitrogen and sugar conditions, and focus on the critical conditions under which the yeast changes their lipid accumulation behavior dramatically. Hyperspectral Stimulated Raman Scattering (hsSRS) microscopy is used to image the lipid content *in vivo* without chemical labeling of any molecules. A microfluidic platform is also developed for high-throughput imaging and subsequent isolation of single cells for whole-transcriptome analysis. With these techniques for correlating growth conditions to lipid accumulation and transcriptomic profiles of single cells, we aim to elucidate the regulatory network of lipid accumulation and optimize the biofuel production from oleaginous yeast.

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