MICROALGAE IN MICRODROPLETS: DEVELOPING PLATFORMS FOR NOVEL TOOLS IN BIOTECHNOLOGY

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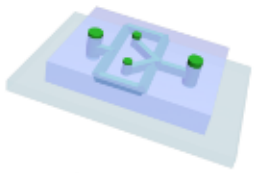
Microfluidics allows manipulation of small volumes of fluids through channels with dimensions of tens to hundreds of micrometres. Microdroplet technology is a form of microfluidics in which small (10-200 µm diameter) monodisperse aqueous droplets are generated, manipulated and analysed in various ways.[1] This multidisciplinary field provides an exciting new platform for single-cell studies of both eukaryotic microalgae and cyanobacteria, with considerable potential for enhancing algal biotechnology. Growth of several species of microalgae has been studied in detail using microdroplets, and new experimental platforms have been established that allow individual cells to be screened and sorted according to chlorophyll fluorescence, lipid content or ethanol production.[2,3] Here we provide an overview of the studies that the Microdroplets Group has done in the recent years regarding this matter, for example the study algal behaviour at the single-cell level, or the on-chip identification of transformed algal cells.

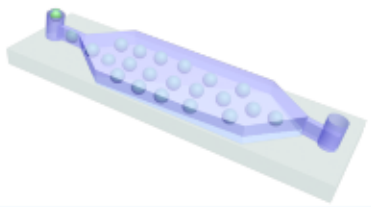
GROWING MICROALGAE AND CYANOS IN MICRODROPLETS

A MICRODROPLET PLATFORM

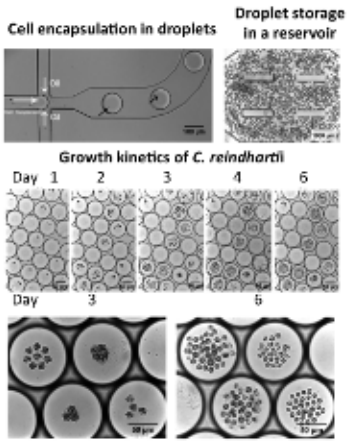
- Microdroplet generator for cell encapsulation



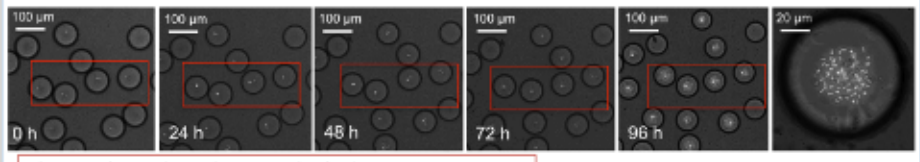
- Microdroplet reservoir for cell incubation



Microalgae: C. reindhartii



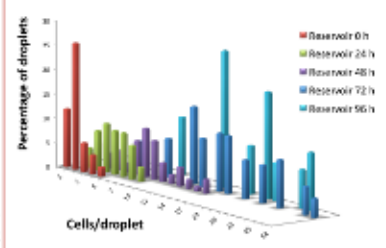
Cyanobacteria: Synechocystis PCC 6803



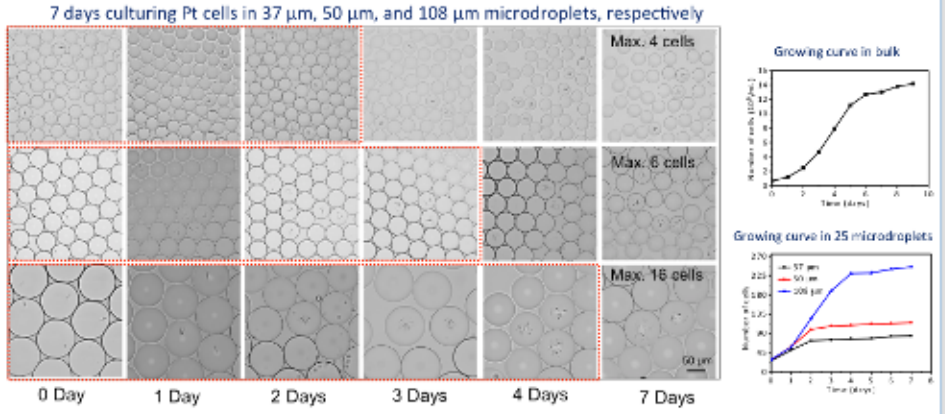
Why microalgae and cyanobacteria in droplets?

- Isolated environment – Avoiding contamination.
- Lower sample requirement.
- Single-cell encapsulation

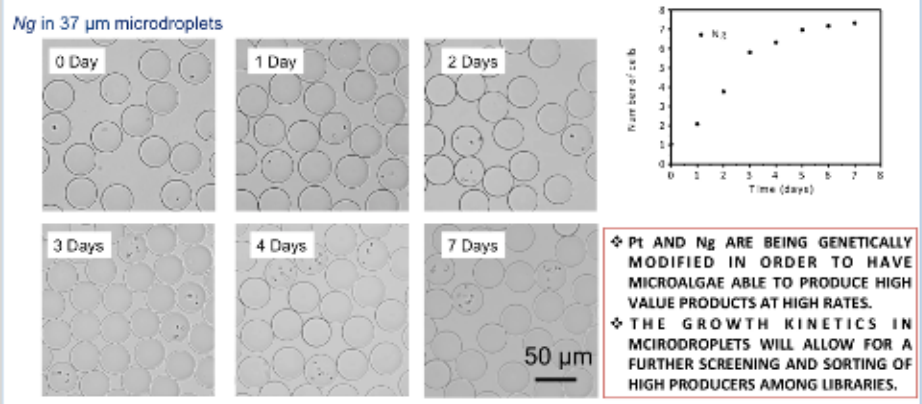
DESPITE THE CYANOBACTERIA ARE SMALLER SPECIES WHEN COMPARED TO MICROALAGE, THE AUTO-FLUORESCENCE CAN BE USED TO CREATE GROWTH PROFILES ACCURATELY, ALLOWING FOR A BETTER UNDERSTANDING OF THESE ORGANISMS AT A MOLECULAR LEVEL.



Microalgae: Phaeodactylum tricornutum (Pt)



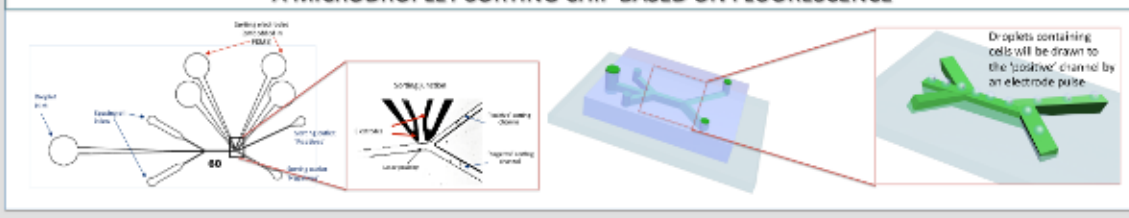
Microalgae: Nannochloropsis gaditana (Ng)



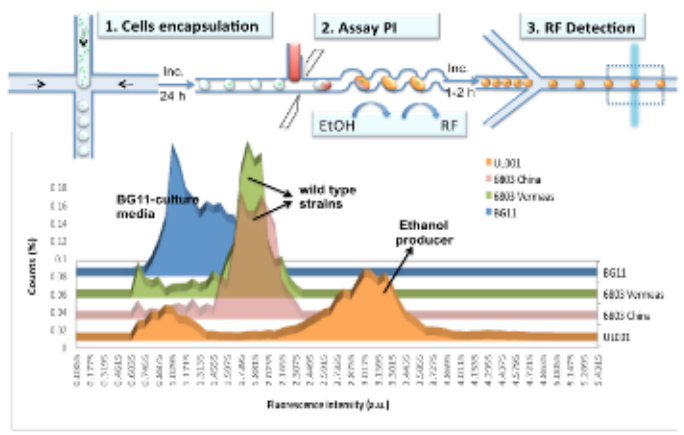
- Pt AND Ng ARE BEING GENETICALLY MODIFIED IN ORDER TO HAVE MICROALGAE ABLE TO PRODUCE HIGH VALUE PRODUCTS AT HIGH RATES.
- THE GROWTH KINETICS IN MCIRODROPLETS WILL ALLOW FOR A FURTHER SCREENING AND SORTING OF HIGH PRODUCERS AMONG LIBRARIES.

SCREENING AND SORTING MICROALGAE AND CYANOS IN DROPLETS

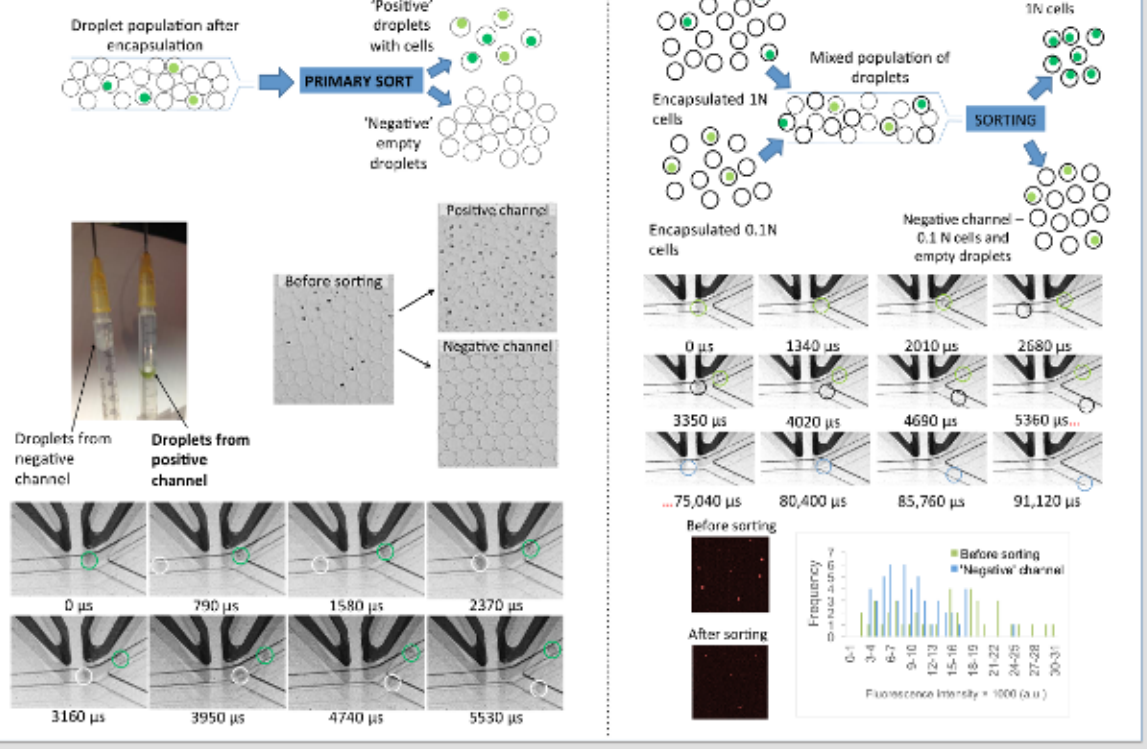
A MICRODROPLET SORTING CHIP BASED ON FLUORESCENCE



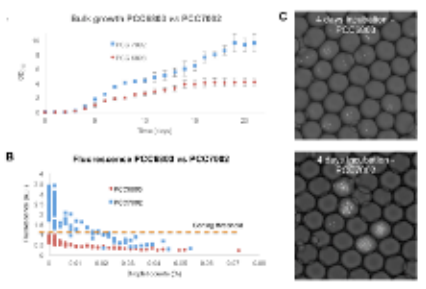
Cyano: Ethanol productivity screening in droplets



Microalgae: Label-free sorting based on native chlorophyl expression



Cyano: Selecting species based on biomass growing



THE CHLOROPHYLL-BASED SCREENING PLATFORM DEVELOPED HAS BEEN USED TO SCREEN CYANOS WITH DIFFERENT GROWTH RATES (PCC6803 *VS* PCC7002) SHOWING THE POTENTIAL OF THE TECHNIQUE TO SCREEN AND SORT HIGH BIOMASS PRODUCERS.

References:

[1]Theberge, A. B. *et al.* Angew. Chem., Int. Ed. **2010**, 49, 5846–5868.
[2]Pan, J. *et al. Integrative Biology* **2011**, *3*, 1043-1051.
[3]Abalde-Cela, S. *et al., Journal of The Royal Society Interface* **2015**, *12*.
http://www-microdroplets.ch.com.ac.uk
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