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Energy and Climate

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Microfluidic Platforms for Biofuels Research

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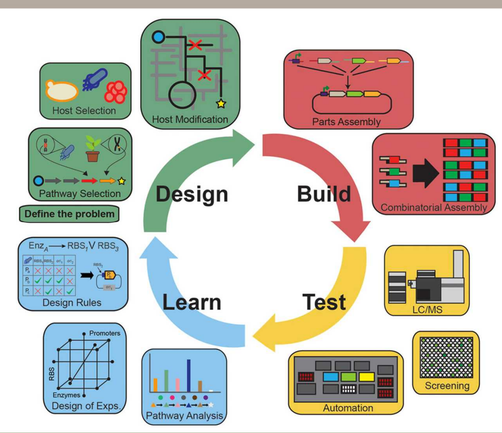
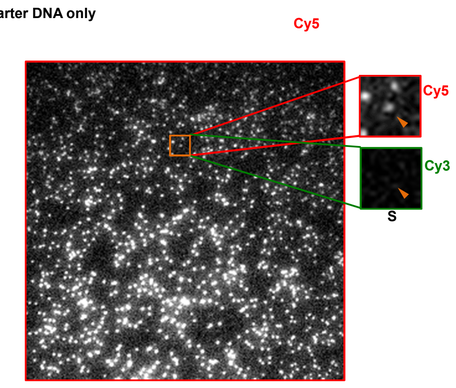
The complexity of biology requires the strategy for improvement of biofuel generation to address multiple challenges simultaneously. Automated experiments allow researchers to increase the scale and scope of questions that can be answered while reducing manpower and finances required. Towards this goal, we are developing systems for DNA synthesis, assembly, cell transformation, protein expression and enzymatic assay. Full-scale integration of these functions allows the scale and scope of enzymatic biofuel production to overcome current limitations by replacing manual experimentation with automation. Our technology exploits microfluidics ability to consume small volumes (pl to μl) and mass spectrometry's ability to detect a wide variety of compounds. These capabilities are enabling to synthetic biologists, who often require optimization of pathways consisting of many genes and given the large number of alternatives available for each element, can require a large number of unique assays. Our integrated solutions aim to enable JBEI to remain a bioenergy powerhouse in the future.



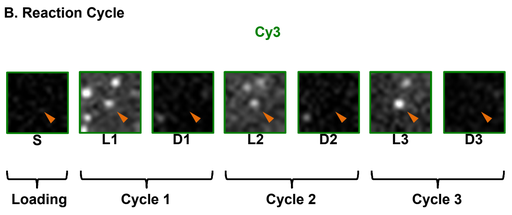
Microfluidic system for Single-Molecule DNA Synthesis

Rapid and inexpensive synthesis of plasmid-sized DNA would dramatically accelerate synthetic biology research. Developing an integrated system for rapid DNA synthesis by iterative construction of single DNA molecules in a microfluidic device would enable this.

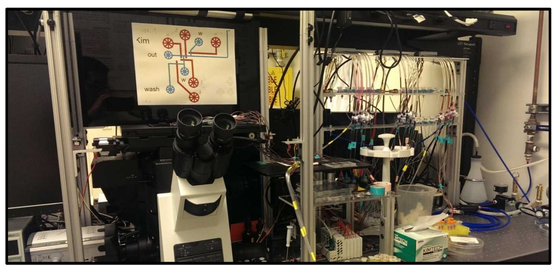
A. Starter DNA only



B. Reaction Cycle



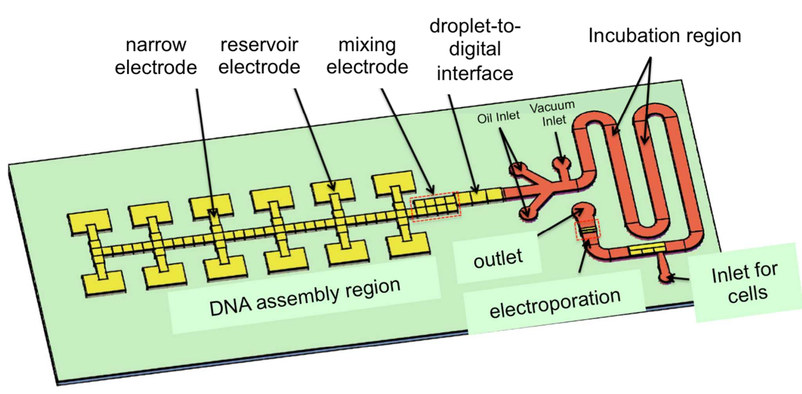
C. Single-molecule DNA synthesis setup

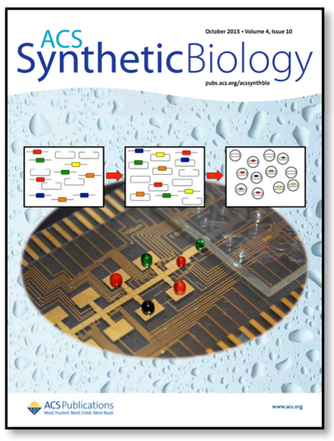


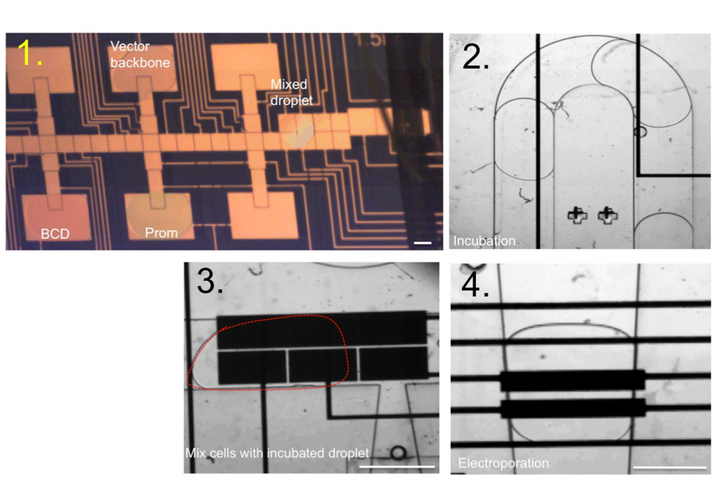
D. Schematics of the setup

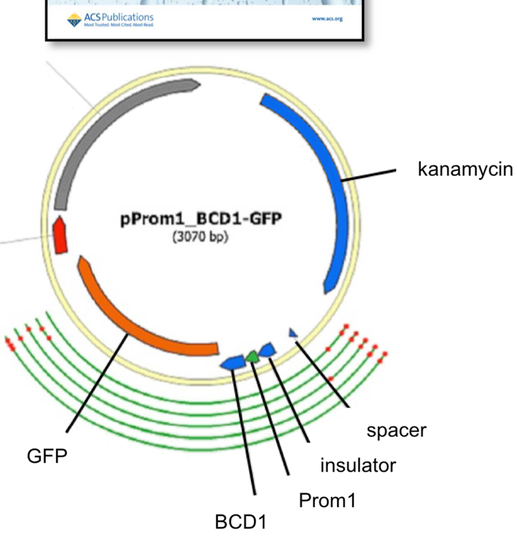
Automating DNA Assembly With Integrated Transformation

To expedite the biological design cycle, we are developing enabling technologies for rapid biological engineering (e.g. an automated platform for constructing designs and verifying the constructs in a host organism).



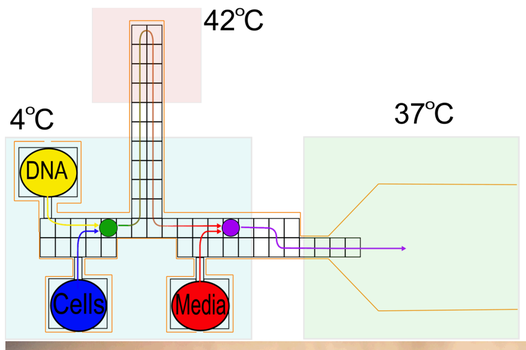


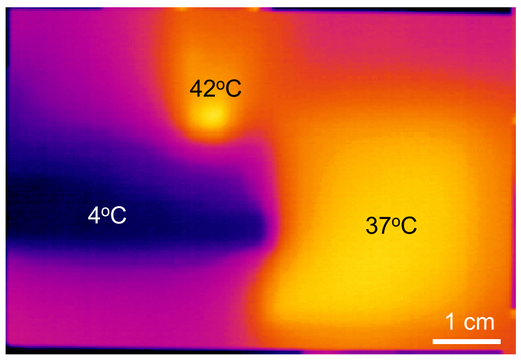


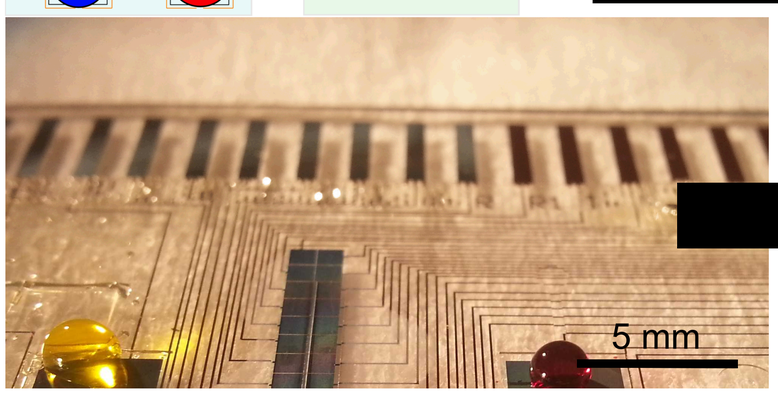


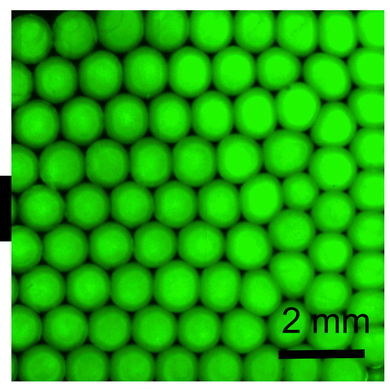
Transformation, Culture and Expression

Transformation of exogenous DNA into bacterial cells is a powerful technique for genetics studies. A highly integrated device based on digital microfluidics and strategically positioned peltiers allow all transformation procedures to be carried out on a single device.









Biomanufacturing Pathway Optimization

We are developing an integrated droplet microfluidics and mass spectrometry platform to streamline the optimization of *in vitro* biomanufacturing pathways. A microfluidic module directly generates a combinatorial library of biomanufacturing conditions each confined in a sub microliter droplet. After an incubation phase, the droplets are directly analyzed with a mass spectrometry to assess the biomanufacturing pathway products.

Exceptional service in the national interest

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