A key challenge in metabolic engineering is to improve productivity and yield. Potential applications range from the production of valuable compounds such as therapeutic molecules and biofuels to the degradation of toxic wastes. The spatial co-localization of consecutive enzymes in a pathway can result in efficient translocation of substrates between enzymes, an effect known as enzyme "channeling".

Here we report the design, modeling and construction of a bacterial micro-organelle based system for the targeted co-localization of selected enzymes. Our "Encapsulator" represents a fundamentally new class of parts which, in nature consist of metabolic enzymes encased within a multi-protein shell reminiscent of a viral capsid.

Our iGEM project aims to better understand how nature implements metabolic channeling by studying the micro-compartment gene Encapsulin originally discovered in Thermotoga maritima. We adopted a multidisciplinary approach combining bioinformatics searches and computer simulations with synthetic biology techniques.

Over the course of four months:
1) The Encapsulin gene was constructed into the standardized BioBrick (BBa_K192000) format and expressed in E.coli.
2) The Encapsulator system was designed to demonstrate in vivo assembly of the expressed micro-compartment by targeting a fluorescent marker (eCFP) into the compartment.
3) The Encapsulator system was modeled in Matlab SimBiology to predict system behavior in response to varying levels of inducers.
4) A short list of enzymes was identified as candidates for metabolic channeling.
5) An alternative micro-compartment platform was identified and explored using various bioinformatics tools.

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