Indian Institute of Science
Centre for BioSystems Science and Engineering

Seminar

at 4 PM on 12 February 2018 (Monday)
MRDG seminar hall, 1st Floor Biological Sciences Building

iFLOAT: a multifaceted approach to cluster bioengineered gas vesicles in vitro

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Abstract

Biology: Gas vesicles (GVs) are hollow protein nanostructures synthesized by phototrophic haloarchaea and cyanobacteria to regulate their flotation in aquatic habitats. Bioengineered GVs have been genetically modified for diverse purposes including ultrasonic molecular imaging, gauging cellular turgor pressures, and vaccine delivery — harnessing unique acoustic, mechanical, and surface properties of GVs — but none of their current applications exploits their most fundamental characteristic: buoyancy. Our modelling indicates that clusters of GVs float several orders of magnitude better than individual GVs, as buoyancy scales with volume while Stokes' drag scales with effective radius. Our project iFLOAT aims to improve the flotation of gas vesicles by clustering them using three distinct methods — charge-based flocculation, biotin-streptavidin interaction, and SpyCatcher-SpyTag heterodimerization — and simultaneously develop robust, reproducible flotation assays. Potential future applications of buoyant clusters of bioengineered gas vesicles include bioremediation of oil spills and flotation-based separation and purification of specific targets from mixtures.

Hardware: GCODe is an Arduino-based cell culture management system that can automatically sample fluid from a test tube/flask, quantitatively add reagents, and measure optical density. Designed, manufactured and tested entirely in-house by our hardware team, GCODe ships with a software interface that allows it to measure OD at preset intervals, plot real-time graphs, and send relevant update notifications. GCODe comes in two models, both compatible with existing shaker-incubator systems — GCODe Mini & GCODe Pro. GCODe Mini is a sleek, compact, single-wavelength colorimeter that continuously monitors the OD of a test tube culture, while GCODe Pro (pending beta testing) offers researchers more advanced features. By seamlessly integrating fluidics, optics, and electronics systems, a whole host of experiments — from optimizing IPTG induction to evaluating the MIC of an antibiotic — can be automated using GCODe Pro! Extensive documentation and open-source code make GCODe an incredibly versatile tool for any researcher, while its low cost ($80 for Mini, $250 for Pro) and detailed assembly instructions make it accessible to even the novice: our freshmen have assembled GCODe Mini from scratch using only instructions on our Wiki! By using engineering principles to automate routine tasks and allow researchers to focus on experimental design instead of execution, GCODe embodies the essence of synthetic biology and takes the field one step further into the future.

The Team

We are a multidisciplinary team of fourteen undergraduates who participated in the iGEM Competition in synthetic biology last year under the guidance of Prof. Dipshikha Chakravortty. Members worked in either the wet lab or hardware teams and were responsible for every step of the process including brainstorming, literature review, experimental design, mathematical modelling, lab work and result analysis. We won India's first Gold Medal at this event (awarded by fulfilling certain criteria; ~1/3 of the participating teams won a Gold Medal) and were nominated for the Best Hardware special prize.

http://2017.igem.org/Team:IISc-Bangalore