Development of *Bacillus Subtilis* as a Platform for Research and Education in Low Resources Settings

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Introduction

Synthetic biology is the application of engineering philosophies to traditional biological research. It focuses on building standardized, modular, and reproducible genetic/cellular tools to solve translational problems across several fields, including healthcare, agriculture, and commodities.

Advancements in synthetic biology mirror the progress that was made in electrical engineering and computer science, which revolutionized the world as we know it. This field is characterized by off the shelf components like the Arduino that are affordable and easily programmable.

Synthetic biology has that same potential. This project aims to build an analog of the Arduino for synthetic biology. However, current tools for synthetic biology research require significant infrastructure.

The Problem

The workhorse of synthetic biology is currently *Escherichia coli:*
Pros:
- Well studied
- Strong genetic toolkit
- Well adapted for laboratory settings

Cons:
- Requires treatment to take up DNA
- Produces endotoxins
- Requires -80C shipping and storage

These cons make it difficult to use *E. coli* in low resource settings like classrooms, as they often don't have the money, infrastructure, or laboratories necessary.

Our Solution

We propose to use *Bacillus subtilis* instead of *E. coli* due to the following:
- Well studied
- Strong genetic toolkit
- Well adapted for laboratory settings
- Naturally takes up DNA
- Grows at room temperature (RT)
- Published method of low-resources transformation for simple engineering
- Generates spores for simple shipping

Potential issues include:
- Safety concerns (still BSL-1)
- Potentially less efficient to transform
- Potentially long growing times at RT

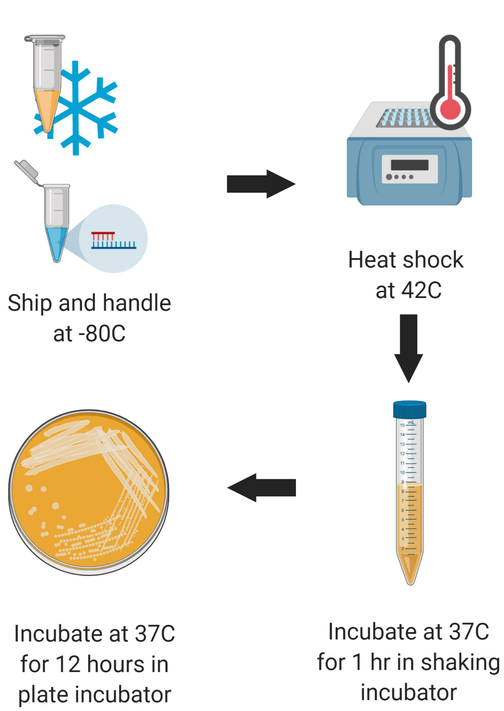

Figure 1: *A comparison of transformation protocols for E. coli (left) and our proposed protocol for B. subtilis (right). Note infrastructure differences.*

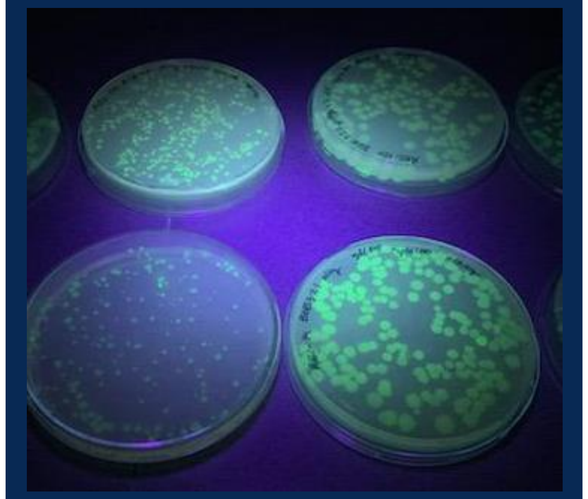

Figure 2: *Transformations of Bacillus subtilis with GFP*

Conclusions

We successfully transformed *B. subtilis* using the super-competent method published by Mijakovic et al. (2015) with green fluorescent protein. We saw high transformation efficiency and fast growth using traditional laboratory infrastructure.

We will next use the solid-solid method published by Hauser et al. (1994), then adapt the strain to grow quickly at RT using adaptive laboratory evolution.

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