

Your Name

Direct Supervisor: Supervisor Name

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Building Biological Circuits with automated systems and design

Project Overview

This UROP project will focus on using and perfecting automated lab techniques to create novel biological circuits. Ultimately, this technology should enable the user to simply input the desired DNA sequence into a computer interface and have dozens to hundreds of individual wells with that sequence created without any human interaction.

Synthetic biology is a tool that allows us to solve problems by modifying current biological structures found in nature to create new systems to solve modern problems. The principle concept of abstraction dictates that engineers are able to work with an already established set of standard devices, instead of having to create from the ground up. This system provides room for the field to grow rapidly and immensely.

The International Genetically Engineered Machines (iGEM) competition asks undergraduates to create novel systems through a standard list of interchangeable parts. I and at least seven other MIT undergraduates, will be participating in the competition this summer. Six faculty members will advise the team: Dr. Bathe, Dr. Kuldell, Dr. Maheshri, Dr. Niles, Dr. Prather, and Dr. Weiss; along with graduate student mentors. I will be working specifically with Dr. Kuldell. 180 other teams will participate and present their projects at the iGEM Jamboree in the fall. The iGEM competition helps to build a sense of community in synthetic biology.

The other major component of this project is the automation with the liquid handling robot. Eventually, we hope to program the robot such that the entire protocol can be done without human input other than setting the initial parameters. The end goal is to have one click DNA constructions from the robot. This eliminates the tedious process for the researcher as well as minimizes error. The robot is more effective at repeating the same task than a human will be.

My UROP will take place in the Synthetic Biology Center of NE47, Room 215. I will be using equipment, such as FACS, Tecan Liquid handler, incubators and the microbiology workspace.

Personal Role & Responsibilities

My role in this project will be learning the implementation of various methods for creating and testing synthetic circuits, including basic BioBrick assembly as well as the more advanced Golden Gate method. I will be learning the necessary steps to make the process fully automated.

During the spring term, we will have weekly meetings to learn the basics of biological design and collaborate on a plan for our summer project. Although the project has not been decided yet, I proposed a project for the summer iGEM team.

The ultimate goal of my project is to have a system which exists in the bloodstream, taking input in the form of blood sugar concentration and outputting a specific amount of insulin. If perfected, this could be a way to treat diabetic patients in the future. Obviously, this is a very complicated system to create in the short time frame of the summer iGEM team. However, it may be possible to create one or two elements from the system.

A small section of the system is the part that measures glucose levels and tells the circuit to proceed when they reach a high enough level. This builds on research currently being done in the Weiss lab with the Multi University Research Initiative (MURI). Currently, they are building a circuit that puts cells into a binary state, either on or off. This “on” state could be tied to a certain threshold of blood glucose and cause a report.

Goals

By participating in this UROP:

- 1) I hope to improve my lab skills and experience in creating biological circuits, working with DNA and enzymes, doing common lab techniques such as PCR, transformations, minipreps, and DNA sequencing, and automation.

- 2) I intend to be better prepared for the summer iGEM competition, which I hope to compete in with MIT, by establishing and learning techniques during the semester which can apply in the summer. For example, this automation will dramatically increase the amount of testing we can do in a set amount of time.

Personal Statement

This UROP is particularly interesting to me because it provides insight into the methods of creating biological circuits in addition to working with cutting edge techniques that will very likely be a standard in an industry which has room to grow exponentially. It will also serve to provide a solid foundation for Biological Engineering UROPs in the future.