FINAL REPORT

IPRO 302: Synthetic Biology: Engineering Novel Organisms

Table of Contents

I. Introduction

1.1 Goals and Objectives

The objective of this IPRO is to create a novel organism. In this project, we will attempt to insert "glowing" genes into a bacteria cell so that it will blink. While at this point, we may not be able to get the bacteria to blink; we are aiming to at least try. However, in the event we are unsuccessful this time around, we have started ideas as to a plan will be made to aid in the next IPRO group be successful.

1.2 Team Organization

The objectives of the project will be carried out within a team structure divided into a three main groups. Membership in each group is set by team members interests and talent, and by the needs of the objectives of the project. Membership may be overlapping and several individuals are members of each group.

Faculty Advisor: Nickolas Menhart

Group	Last Name	First Name	Titles	Major
Cloning	Bui	Phuong		Chemical Engineering
Cloning	Gaddini	Anthony	Cloning Leader	Molecular Biochemistry & Biophysics
Cloning	Vu	Anthony		Molecular Biochemistry & Biophysics
Cloning/ Documentation	Young	Elizabeth	Scribe	Molecular Biochemistry & Biophysics
Modeling	Anderson	James	Team Leader	Electrical & Computer Engineering
Modeling	Ceisel	Ahren		Biomedical Engineering
Modeling/Cloning	Lau	Sheryl	IPRO Contact Point	Electrical & Computer Engineering
Modeling/Web Design	Fessel	Jason	IPRO Reportables	Electrical & Computer Engineering
Modeling/Web Design	Nguyen	Khiem	Web Leader	Electrical & Computer Engineering

1.3 Team Descriptions

Cloning

The goal of this group is to do the primary research, design, and lab work which will achieve the stated objectives.

Modeling

The goal of the modeling group is to design comprehensive and specific modeling software to simulate the proposed behavior of the target organisms through mathematical models.

Web Design and Documentation

The team will document and disseminate the results of this work. The dissemination will occur through the team website.

II. Tasks

2.1 Summary of tasks performed to date

These are a list of current and completed tasks that have been done thus far. It also lists which group it was assigned to.

Task	Assigned to	Completion Date
Understand how to do all the lab procedures.	Cloning	21 Sept. 2004
Assemble all the necessary gene pieces on cloneman so that they can be ordered.	Cloning	20 Oct. 2004
Order gene pieces.	Cloning	
Formulating the objectives/goals for the semester	Team	4 Sept. 2004
Writing up meeting minutes	Scribe	2 Dec 2004
Website construction/updates	Web design	1 Dec 2004
Make modules and set up computer programs.	Modeling	11 Nov 2004
Drafting and submission of IPRO Project Plan	Team Leader	10 Sept. 2004
Drafting and submission of IPRO Midterm Report	Scribe/team leader	22 Oct. 2004

2.2 Things to accomplish this semester

The following table is a sketch of the general tasks that need to be accomplished in order to ensure success of the IPRO.

Task	Assigned to	Progress
Create a project plan	Joint effort	Completed
Website	Web design	Completed
Midterm report	Scribe	Completed
Lab work	Cloning	Ongoing, detailed status in section 3.2
Complete modules	Modeling	Completed
Get program working	Modeling	Completed
Plans for next IPRO	Joint effort	Completed
Presentation	Joint effort	Completed

III. Progress Reports

3.1 Statement of the Objective

The overall aim of this project is to expand upon work done by various research groups in the field of engineering novel organisms. We will be expanding on the class project model developed by other schools such as the Massachusetts Institute of Technology (Science Magazine, 9 Jan 2004, volume 303), and modify them to fit within IIT's IPRO program which will allow us to move from a strictly biological approach, to include input form other disciplines. Specifically, we will try to duplicate the work read the article "A letter From Nature", which created a form of *Escherichia coli* that blinked in a predictable oscillation, and to conduct a parallel or elaborated experiment.

However, since the beginning of our IPRO project, we have decided that it may not be possible to accomplish such a feat in the allotted time. We have therefore prepared a plan for future sessions of this IPRO, with the hope that they will complete what we have begun.

3.2 Team Reports

Cloning Group

Initially, the team had chosen to replicate the seminal work, and is attempting to get the e. coli cells to blink. A design plan was constructed, incorporating fifteen genetic elements. Revisions to the design have led to the inclusion of three additional components. To complete the target organism, each gene piece needs to be isolated, cloned into the bacteria and finally "glued" together in the lab. As of the end of this semester, the eighteen components have been isolated and amplified to the concentrations necessary for ligation. This leaves the work of actually combining the elements and cloning them into the bacteria for the next semester.

Modeling Group

The modeling group has focused on realizing a system of coupled differential equations to model the oscillations of the blinking e. coli. These equations were found in the published article, "A synthetic oscillatory network of transcriptional regulators" (Nature, 20 Jan 2000, volume 403). Using a set of functions native to MATLAB, the modeling team has prepared two MATLAB modules to realize the deterministic and stochastic models for the oscillatory system.

Web Design and Documentation

Our website has been completed, and is a highly successful repository for our

procedures, plans, and results. The location was obtained through IIT OTS and can be found at http://www.iit.edu/~ipro302f04. The intro page is implemented using flash, with a non-flash alternative available. All team working, reference and presentation documents are currently maintained within this site.

3.3 Term 1 specific targets

This project is very ambitious, and will continue beyond this specific IPRO term. As such, achievable accomplishment milestones that contribute toward the overall project milestones have been developed.

Cloning

- ✓ production of a project plan detailing exact cloning strategy
- ✓ procurement of all genetic elements in physical form under control of the team
- ✓ PCR cloning into shuttle vectors in *E coli*, with all modifications necessary to prepare them for final assembly

Modeling

- ✓ assessment and selection of an appropriate computational environment
- ✓ implementation of the basic DE set to simulate the immediate 3-component target system
- ✓ implementation of a GUI to facilitate use of the simulation by non-technical personnel.
- o implementation of analytical modules to interpret the results of the simulations:
  - ✓ Fourier analysis,
  - autocorrelation analysis
  - parameter searches
- ✓ implementation of the stochastic model
- development of a user-friendly method of modifying the basic equations to reflect different topologies and genetic circuitry.

Webdoc

- ✓ recording of team activities and structure
- ✓ preparation of IPRO deliverable documents
- ✓ assembly and interpretation of relevant literature
- ✓ Documentation of all procedures and products. Products are to include all genetic elements produced, and MATLAB modules.

IV. Conclusion

The progress made on this project has been exemplary. Each of the major semester goals has been accomplished, and the project is in an excellent position to move forward to complete our long-term goals. In addition, the way the project has moved forward in this inaugural term shows that these goals are attainable, and, barring any unforeseen complications, should result in our design being fully realized in the next semester of work.