iGEM Presentation

Ann Bui and UQ-Australia iGEM Team

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1 Introduction

The University of Queensland (UQ) is participating in the international Genetically Engineered Machines Competition (iGEM). iGEM is the premiere undergraduate synthetic biology competition and is run annually by Massachusetts Institute of Technology (MIT). The UQ team consists of an interdisciplinary mix of six undergraduates from Biomedical Sciences, Biotechnology and Physics. As part of the competition, the UQ team wishes to present high school students with

- an introduction to a new area of science
- an activity to practice thinking like a synthetic biologist
- an opportunity to start research during undergraduate university studies
- an understanding of the changing culture of science.

Further details regarding the UQ iGEM Team specifically can be found on the competition wiki. If you would like further details, please feel welcome to contact Ann at a.bui@uq.edu.au.

Below is a script written for a presentation suited for high school students with some familiarity with genetic engineering. This script can go with a slide show or just illustrations on a whiteboard. The intended accompanying activity consists of the students participating in small group discussion developing an idea for a synthetic biology research project.

2 What is synthetic biology?

Well, we have genetic information in the form of DNA, a sequence of As, Ts, Cs ad Gs. We can read it, photocopy it, and cut and paste it. However, the issue comes when we want to engineer something with this form of genetic information. Most biological approaches are slow, expensive, complex and hard to replicate in a standardised fashion. So, this is where we have the engineering approach.

Essentially, if you were to put biology and engineering together in a meat grinder, you would get synthetic biology. So, really, synthetic biology is an exciting emerging field that puts an engineering perspective onto biology.

We wish to treat a sequence of As, Ts, Cs and Gs as any other sequence of information, like how we normally have 1s an 0s. However, instead of running a sequence of 1s and 0s through a computer, we can run a sequence if As, Ts, Cs and Gs through a cell. The benefit to this is that the cells can replicate themselves, producing more copies of our information. So, we want a system of standardised genetic sequences where we know what will happen to be able to use this form of biological computing.

Let's think about this. A builder builds a house with bricks. It doesn't matter exactly which specific brick it is, it's just a brick. I should be able to swap bricks between two houses and it should not make too much of a difference. We want this in biology. Much like how we use bricks to build a house, we can have 'BioBricks' to make a biological system. We can have a library of standardised functional biological parts, let's call them BioBricks. These BioBricks have biological functions but act as bricks, which we can move around and join in different combinations to create new functionality and the ability to react in different ways.

3 Why study synthetic biology?

So, as we can guess, synthetic biology is the convergence of many disciplines including biotechnology, engineering, biomedical sciences, bacteriology and environmental science. Many of the most amazing scientific discoveries are made when analysed from the perspective of multiple fields of study, and synthetic biology is not different.

Through synthetic biology, we have the potential to further and test our understanding of systems biology and the interaction of genes and molecules within the cell. Most importantly, and really, synthetic biology is just another tool for us to use to tackle problems. We shall go through a few potential problems to tackle with synthetic biology a little later, but you can probably imagine that synthetic biology holds a lot of potential to transform current scientific thinking.

4 What is iGEM?

Now, our work in synthetic biology, as pure as motives go, is for the international Genetically Engineered Machines Competition, iGEM. iGEM is run by Massachusetts Institute of Technology over their Summer. The competition is for undergraduate students, from all disciplines, with the task to create a genetically engineered machine. This year, more than one hundred and fifty teams are competing, from around the world, of which, there are two teams from Australia, Macquarie University being the other one.

We will compete with about fifty other teams in the Asia region jamboree in Hong Kong in October, with the finalists from there presenting in Boston in November. The prizes are grouped in gold, silver and bronze. To be awarded gold, we need a complete project detailing a working system and our approaches to issues such as safety, ethics and legality.

We operate under the guidance of academics from varying fields such as biology, education and technology, but in the end, we, the students, do everything from designing and running the experiments, under supervision of course, raising finances and organising outreach activities such as this.

5 What is the purpose of iGEM?

So iGEM does sound like a lot of fun and games, but there is a serious purpose (laugh/ smile). The goal of iGEM is to promote the education of not only the new field of synthetic biology, but also the education of science around the world. We've probably noticed, but to have standardised biology with these BioBricks, we're going to need a library full of these different BioBricks (like how we have more than one type of brick to build a house). So, everything that is made by iGEM teams is to be submitted to the Registry of Standard Parts. This is an open-source library of BioBricks whose purpose is to be a collection of resources for anyone to use.

6 What is UQ doing for iGEM?

So for the UQ entry, we are trying to replicate the biological clock in a bacterial system. In humans, this 'clock' is what regulates a number of very important processes, including your sleep/ wake cycle. Jet lag results from this cycle by the different amount of exposure to light you get while travelling.

Using this principle of a twenty-four hour clock, which consistently fluctuates to regulate our bodily processes, we are trying to construct a network of genes that will oscillate in a similar fashion.

If we are successful, we will be able to put different genes into our system so that we can make the bacterial system perform a particular process at regular intervals. A simple example of this would be to make them flash periodically.

In the end, this technology could have applications such as regular release of drugs into the bloodstream so that patients who are incapable of administering the drugs themselves are not at risk. Essentially, this could be useful for regulating anything in a periodic fashion such as delivery of human hormones or drugs to the body.

7 Introduction to activity

Now, we have mentioned that there are over 150 teams in this year's iGEM competition. The competition has been running since 2004, so there's been a fair few projects over the past few years.

Instead of us just telling you some the winning projects, you're going to tell us what they were. We are going to present a problem to you. These problems have been addressed by past teams with prize-winning projects. Your task is to come up with a solution to their problem by utilising synthetic biology.

8 Further reading

There are resources available for introducing synthetic biology. Drew Endy, one of the founders of the Registry of Standard Parts, has a review in Nature: Foundations for engineering biology, discussing synthetic biology. This also come in comic form of Adventures of Synthetic Biology.

For a more simple approach, James Hutson from Science communication firm Bridge8: Synthetic Engineering: Putting the engineering back in genetic engineering