Engineering New Biological Systems

A potential revolution in biotechnology is gathering pace. By applying principles used in engineering to knowledge drawn from biology, it is now possible to make new biological systems with custom-designed functions. The possibilities of this technology are almost endless –improved healthcare, clean energy sources, new supermaterials and many more. This is 'Synthetic Biology'.

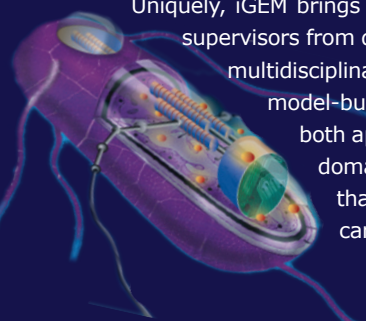
The University of Cambridge is both the birthplace of molecular biology and the home of one of the best schools of technology in the world, and collaboration between the physical and life sciences has never been stronger. There are very few better places to study this new subject.

An International Competition for Biological Engineering

The International Genetically Engineered Machine (iGEM) competition was created by researchers at the world-renowned Massachusetts Institute of Technology (MIT) in Boston. Teams of students are given a collection of standard biological components, 'BioBricks' – their challenge:

To design and build a simple biological system from BioBricks, and to operate it in living cells.

Founded in 2005, this year the competition encompasses nearly sixty teams from six continents. As well as competing against each other, iGEM encourages the sharing of experience and knowledge within and between institutes. The grand finale is the Jamboree in November, a unique opportunity for students and supervisors to meet their peers from around the world and present their results.



Uniquely, iGEM brings together talented students and supervisors from different departments in a single multidisciplinary team. Through the design-model-build-test process the students both apply their existing skills to a new domain and gain experience in fields that will be vital for their future careers.

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Department of Genetics
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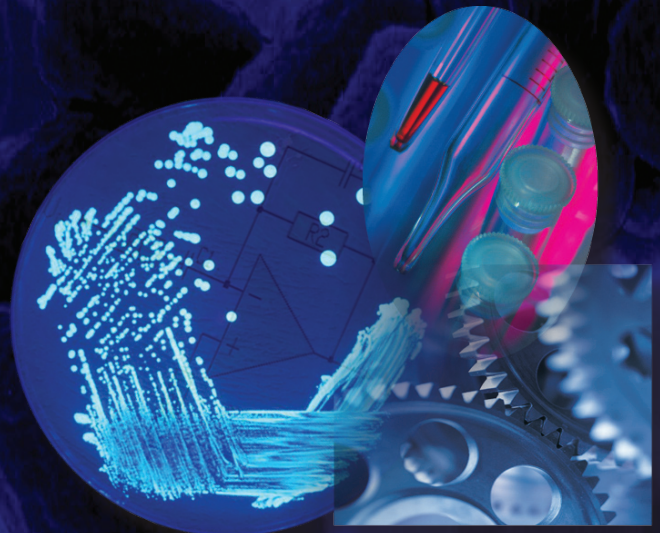
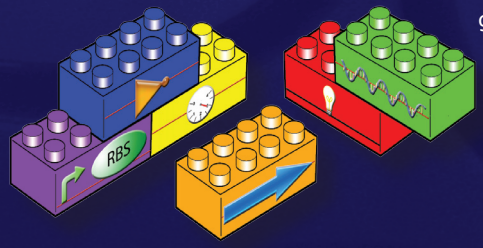
iGEM 2007
international Genetically Engineered Machine competition

UNIVERSITY OF CAMBRIDGE



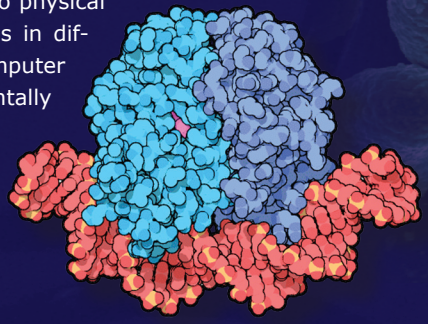
Building Blocks for Biology

BioBricks are interconnectable DNA components for assembling biological systems inside living cells. The bricks are designed to be compatible, composable and independent; in this way, a new breed of biological engineers can build custom biological circuits from standardised parts with known properties. From a technological perspective, the module-based approach offered by BioBricks facilitates the creation of new devices by abstracting away the low-level complexity of nature and providing a common framework for interconnecting functional units, allowing designers to combine existing genetic elements in new combinations and for new purposes.



Cambridge Team 2007

This summer, eleven undergraduate students (four engineers, six biologists and a physicist) aided by faculty members are working together to expand the frontiers of synthetic biology. Having started out as not only newcomers to the field but also complete strangers to each other, we have organised ourselves into a team and are sharing our skills - the knowledge of molecular biology is diffusing from life scientists to physical scientists, while capabilities in differential equations and computer programming are incrementally propagating in the opposite direction.

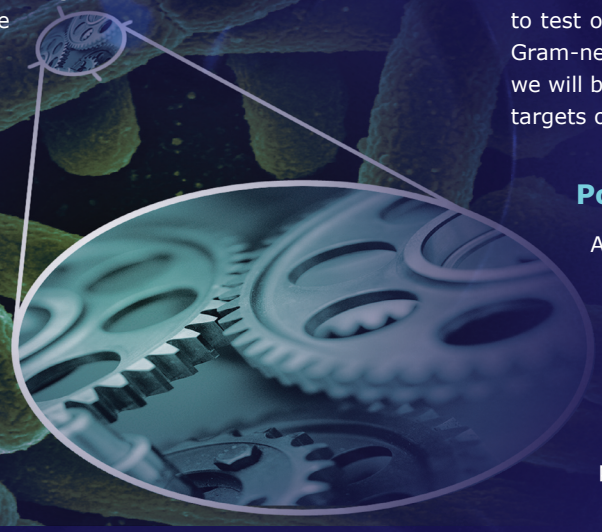


The Engineers' Perspective

For engineers, the best way to learn about biology is to pursue our natural inclination to design and build with it. The project focuses on biological details and mechanisms, providing us with not only a wealth of information relevant to future careers in biosciences but also hands-on experience of biological lab techniques. Our ability to solve problems and engage with mathematical and modelling challenges – no matter what discipline they originate from – will ensure we can contribute equally to the team.

The Biologists' View

As biology students we spend a great deal of time studying micro-organisms, but by taking part in this project we gain a whole new viewpoint, completely different to that of conventional biosciences research. By re-interpreting and sharing the knowledge we have learnt in terms of hierarchies of functional modules, we are learning a new way to create biological devices rapidly and efficiently, with very obvious commercial applications.



Projects this year:

Gram-positive Synthetic Biology chassis

Bacteria are divided into two main classes, Gram-positive and Gram-negative, with important functional differences. Most synthetic biology so far has involved Gram-negative bacteria, which are more widely used in molecular biology research; however, the biotechnology industry relies on Gram-positive bacteria to produce everything from life-saving drugs to enzymes for washing powder. We are trying to convert a common Gram-positive bacterium - *Bacillus subtilis* - into a "chassis" with a basic kit of parts, into which genetic engineers can add sophisticated synthetic biology-derived control circuitry.

Peptide signalling

In the world of cells, just like in the human world, communication is key. We have found a natural communication system based on short peptide molecules, which is well enough researched and understood that we can adapt for our own uses. Since it comes from a Gram-positive species, we will use the *Bacillus subtilis* chassis we are building to test out the system before adapting it for the standard Gram-negative synthetic biology chassis. Once working, we will be able to use it to program bacteria to home in on targets or even solve mazes!

PoPS amplifier

Almost all electronic circuits involve a component that amplifies electrical signals, to make them more detectable or to increase the output power. We aim to do the same for the standard synthetic biology signal, PoPS: to build and test reliable amplifiers with a known multiplication factor that will not interfere with any other part of the system.