



December 2015 Report

The Synthetic Biology Strategic Research Initiative provides a hub for anyone interested in Synthetic Biology at the University of Cambridge, including researchers, commercial partners and external collaborators.

Synthetic Biology is an emerging field which applies engineering principles to the design and modification of living systems. The University of Cambridge has been an important and early contributor in this area. The Synthetic Biology Strategic Research Initiative was established in 2013 with the support of the Schools of Biological Sciences, Physical Sciences and Technology to bring together related activities by researchers across the University.

Academic leadership of the SRI is provided by the Steering Committee, supported by the SRI Coordinator who works with researchers and external partners to implement SRI activities. The major aims of the SRI are to:

1. Provide a hub of interdisciplinary exchange for all those interested in Synthetic Biology at the University of Cambridge, from researchers and students to industrial partners and policy makers.
2. Promote interdisciplinary collaborations across the University through regular events and twice-yearly seed funding competitions.
3. Facilitate funding applications in the field of Synthetic Biology
4. Initiate academic-industrial partnerships across the SRI Research Themes.
5. Explore open technologies for innovation, widening participation in novel IP practices and business models for tools related to Synthetic Biology.
6. Explore the wider social context of GM technologies at the local and global level, particularly responsible innovation for sustainability and conservation.

1. Our Achievements 2013-15

In our application for SRI support, we identified three main areas for development in Cambridge: interdisciplinary exchange, open technologies and responsible innovation.

Interdisciplinary exchange: Cambridge needed a hub for exchange and collaboration between the physical sciences, life sciences and engineering to underpin advances in Synthetic Biology. We have used SRI support to set up the following:

(i) The Cambridge Synthetic Biology Meetup site¹ provides a hub for engagement with consistent community growth since the start of the initiative. Over 100 of 320 are now active on the site in any given month. The SRI has organised over 50 events including:

(ii) Cafe Synthetique at the Panton Arms which attracts 20-30 people from the University and local technology companies for monthly informal talks on synthetic biology.

(iii) Science Makers at Cambridge Makespace which has been running since April 2015 and attracts 20-40 attendees for monthly talks, demos and build sessions for open science hardware. These have included low-tech microfluidics and low-cost electrophysiology devices with speakers from across Schools, plus local scientific instrument manufacturers and design agencies.

(iv) Open Technology Week in July 2015 was the first of an annual series of events, which attracted local media attention², including:

- Open Technologies for Science Make-a-thon - 25 participants, around 15 from University and 10 from local STEM companies.
- Open Technology Workshop and mini maker faire at Engineering Department - 50 participants with speakers from CERN, ARUP, TRenD in Africa and across schools.
- OpenPlant Fund competition with pitches for interdisciplinary project funding.
- SynBioBeta Activate! - 90 participants with around 60% academics/students and 40% from local STEM companies and enterprise-related organisations.
- OpenPlant Forum - 70 participants including 10 from industry and non-profit organisations.

(v) Synthetic Biology Seminars are more formal networking opportunities. The inaugural event in November 2015 attracted 70 students, academics and representatives from seven local biotechnology and technology companies. These will run termly and are designed to engage with wider groups such as the regenerative medicine and stem cell communities. We will partner with other SRIs and groups such as CSaP and CSER to invite high-profile international speakers.

(vi) The SRI has successfully fostered interdisciplinary exchange at the student level through support of the OpenLabTools undergraduate projects in Engineering and the 2014 and 2015 Cambridge-JIC iGEM teams featuring students from across natural sciences and engineering. Both teams won gold medals at the iGEM Giant Jamboree and have since recruited others to form a Synthetic Biology Student Society at the University. The society's activities are being directly supported through the SynBio Fund and in-kind by the Coordinator and members of the Steering Committee. The SRI has also supported a new association for PhD postgraduate workers called EUSynBios which has grown from Cambridge to around 300 members across 15 EU countries with a prestigious Advisory Board, strong links with the US SynBERC association and plans to organise international networking activities in 2016.

(vii) The SynBio Fund has facilitated interdisciplinary engagement within the University. Eighteen grants have been awarded to postdocs and PhD students for the pursuit of innovative, interdisciplinary and open source projects related to synthetic biology. Nine projects were funded in March 2015 featuring a total of 24 team members from 12 departments (Plant Sciences, Physics, Pathology, CRUK, PDN, Computer Lab,



¹ <http://www.meetup.com/Cambridge-Synthetic-Biology-Meetup/>

² <http://www.cambridge-news.co.uk/Open-Technology-Week-looks-potential-open-source/story-27493191-detail/story.html>

Materials, Sainsbury Lab, Engineering, Regenerative Medicine, Biochemistry and Pharmacology). Two outstanding examples from the first round of funding are:

- Richard Bowman (Physics) has produced low-cost high-performance 3D-printed fluorescence microscope designs that were tested at Cancer Research UK, and formed the bases for both the OpenScope Cambridge-JIC iGEM project and WaterScope, an iTeam spin-out focused on water contamination in developing countries. The microscope has already been used as a teaching aid by a student-led group in India and Cambridge-based technology education group HackLab.
- Bernardo Pollack and Anton Kan (Plant Sciences) sequenced the genomes of 19 novel bioluminescent bacterial species, assembled and isolated the Lux operons, and are evolving ever bright reporter genes by gene shuffling and evolution. This provides a new synthetic biology reporter toolkit for *E. coli*, and they have been successful in gaining a second round of SRI funding to extend the project and make bright bioluminescent reporters suitable for use in plants. They are collaborating with the eLuminate Festival and a fashion designer at the Royal College of Art to design an art exhibit around biological light.

The second round was even more diverse than the first, with 45 team members in total across the nine projects, representing all schools except Arts and Humanities. Two of the nine awards went to teams whose formation can be traced back directly to SRI activities and five involved industrial collaborators.

(viii) The University of Cambridge was awarded the £12M BBSRC-EPSRC OpenPlant Synthetic Biology Research Centre in partnership with the John Innes Centre and The Sainsbury Laboratory, Norwich. The OpenPlant initiative started in September 2014, runs for 5 years, and includes direct funding for PDRAs with 13 PIs in Cambridge working in a wide range of microbial and plant systems. In addition, it has provided renovation for a central laboratory including robotics and analytical equipment. OpenPlant has provided additional resources for DNA synthesis, additional mini-funding programmes and facilitated development of novel legal tools for open sharing of materials. The award of this major grant has elevated the international profile of the University in this new field.

Scope for further large-scale funding applications awaits the publication of the UK Synthetic Biology Roadmap refresh document, due for publication in early 2016. A draft version is circulating for comment and on publication the SRI plan to run briefing sessions and targeted meetings to ensure that the University is in a good position to respond to subsequent related funding calls.

(ix) Transfer of information and community activities from the meetup group to the synbio.cam.ac.uk Falcon website is underway. We are recruiting additional clerical and design support to ensure this process is completed during the first quarter of 2016 and that the web resources can be expanded as the major portal for Synthetic Biology activities across the University.

Open technologies for innovation: We aimed to promote the adoption of more open practices for sharing of the new tools required for Synthetic Biology. Shared technologies offer the prospect of new business models for promoting translational research, and facilitate exchange of cutting-edge tools in Cambridge and technology transfer to scientists in less well-developed countries.

(x) Open practices require enabling legal frameworks and standards and members of the SRI and OpenPlant have been instrumental in drawing together research community members to draft these. The SynBio SRI sponsored the assembly of a common syntax for construction and distribution of eukaryote DNA parts which was published in *New Phytologist* and featured many Cambridge researchers among its 60 authors. The syntax forms the foundation of the new iGEM Plant Track led from Cambridge, Norwich and Valencia.

(xi) To facilitate exchange and technology transfer, the SynBio SRI along with OpenPlant has been working with Linda Kahl of the Biobricks Foundation to draft an OpenMTA: a permissive materials transfer agreement enabling redistribution and commercial use of biological materials as an alternative to the standard UBTMA. The aim of this is to reduce transactional costs and maximise freedom to operate. The draft has been developed with input from Cambridge Enterprise and the Research Office and is ready for use in the transfer of DNA parts from Cambridge in early 2016. This could be internationally significant and has already generated interest e.g. from collaborators in Chile.

(xii) To complement these activities and provide better evidence for freedom to operate, the SRI submitted a proposal for SynbiCITE proof of concept funding for synthetic biology patent data mining with Red Katipo Ltd, ContentMine and the Faculty of Law and discussions are ongoing. The SRI was involved in a successful Wellcome ISSF bid for a workshop in collaboration with CSaP, the Centre for Law in Medicine and Life Sciences and the Public Policy SRI on Responsible and Open Innovation: Large Bioresources and IP.

(xiii) The SRI Coordinator and Lalitha Sundaram from the Arsenic Biosensor Project were invited to present on open biotechnology at the Centre for Global Equality, which signalled the start of a conversation with them around the potential impact of such projects in international development. The SRI Coordinator is co-organising an international workshop at CERN on open science hardware including the research community, NGOs, civil society groups and companies. The SRI Chairs have made approaches to a major supplier about room temperature enzyme shipping to facilitate wet lab synthetic biology work in low resource settings in addition to equipment. OpenPlant supported the TRenD in Africa project to deliver plant synthetic biology training as part of their bioinformatics course in Kenya and to develop a synthetic biology lab in Abuja, Nigeria which we hope can benefit from the combined open technology outputs of the SRI and OpenPlant.

Responsible innovation for sustainability and conservation: Social acceptance remains a major potential limitation for the adoption of GM technologies, and our proposal aimed to fund work on the wider implications of the technology at local and global scales. We aimed to sponsor interdisciplinary projects in this area, and promote discussion.

(xiv) The SRI Coordinator has been co-organising termly lunch meetings with CSaP, Cambridge Centre for the Study of Existential Risk (CSER) and the Office of External Affairs as a node of the Virtual Institute for Responsible Research (VIRI) based at Arizona State University (ASU). These meetings and interactions within the group have directly led to a collaboration with Nicola Buckley (Office of External Affairs) to run a workshop on responsible research and innovation in synthetic biology for PhD students and postdocs during 2016 and a jointly organised meeting between CSER and Lalitha Sundaram (Pathology) on responsible innovation and regulation of technologies such as synthetic biology. We are also collaborating with CSaP to run a workshop around synthetic biology in 2016 led by David Willetts to engage policymakers and other audiences that the SRI has not yet focused on.

(xv) The recently convened termly seminars will provide a forum to promote discussion on topics of responsible innovation and public perception. We plan to cover issues such as gene editing in humans and gene drive systems for engineering mosquito populations and continue to partner with CSER, CSaP and the Public Policy SRI to explore the wider implications of the technology.

2. Context

Cambridge is developing an internationally recognised lead in the area of plant synthetic biology, with standardisation of DNA parts and assembly, and the adoption of open practices. Cambridge is now a major proponent of the need for open tools to promote innovation in biology, with benefits for commercial enterprise, international development and reputational benefits for the institution. Further, there are clear prospects for applications in biomedicine and the environment.

Three new opportunities for Synthetic Biology in Cambridge have presented themselves recently.

(i) As a result of the wide range of open technology events that we've been running, we have developed strong relationships with engineering companies around Cambridge. In particular, Cambridge Consultants is a large engineering company with international interests. They have deep expertise in conventional engineering, from silicon chip design and fabrication, RF technology, mechatronics, plastics and soft materials to exotic printing technologies and diagnostics. They are investing in an expansion into Synthetic Biology, and there is much potential for interactions with the University. For example the company has already offered £10,000 to sponsor the iGEM2016 team.

(ii) IdeaSpace have obtained £2M support to renovate the 13-bay extension of the old MRC Laboratory of Molecular Biology building. We have been offered space for an open laboratory for Synthetic Biology. We are consulting with the founders and managers of other open laboratories in order to build a suitable business

model for management and running a BioMakespace. This is an exciting prospect, which would complement more conventional research activities, and provide a work space for undergraduates, community outreach and entrepreneurial activities with IdeaSpace.

(iii) There are likely to be substantial funding opportunities if the draft “Biodesign for the Bioeconomy” report is implemented. This has the heaviest potential impact on the University. This will be implemented in the near future, and it is crucial that the University be positioned well to take advantage of any opportunities. The competitive funding calls from the first roadmap demonstrated how important institutional organisation and contributions are to these bids.

3. Plans for 2016 and SRI Reapplication

Our major priorities for 2016 are: (i) Consolidate the output of the SRI-funded efforts with a revised web portal. (ii) Explore better interactions between the University and Cambridge Consultants (and similar companies) through research collaboration, student activities like iGEM and development of low cost commodity electronics for bioinstrumentation. (iii) Explore models for establishing and running an independent BioMakespace, which could be a landmark development for promoting outreach and innovation in the University - similar to the Institute for Making at UCL. (iv) Continue to investigate Departmental and School interest in the establishment of a Centre for Synthetic Biology in the University. (v) Organise workshops on publication of the “Biodesign for the Bioeconomy” report, and help to coordinate University and industry responses to calls that might arise from it.

The Synthetic Biology SRI would like to be considered for renewal of our SRI.

We would like to maintain the three types of events, the monthly Cafe Synthetique and Science Maker meetings, and the more expensive termly seminars with invited speakers and catering. Jenny Molloy’s role as coordinator has been invaluable. Based on our experience so far, we would like to appoint a part time administrative assistant to help cover the logistics of event management, travel and accommodation for invited speakers and website data entry. This would allow time for the Coordinator to more effectively work on high level tasks, such as sponsorship, research coordination, communication and management across the growing Synthetic Biology community. We have also allocated £5K pa to maintain graphic design and branding for the website. Unfortunately we can’t afford to maintain the SRI mini-fund, but will look to OpenPlant funds to partly supplement this loss.