



Synthetic Biology Leadership Council – Meeting 17
Wednesday 12 July 2017
BEIS Conference Centre, 1 Victoria Street, London SW1H 0ET

Attendees

Lionel Clarke, Synthetic Biology Leadership Council co-chair
Lord David Prior, House of Lords and Synthetic Biology Leadership Council co-chair

Dr Yvonne Armitage, Knowledge Transfer Network
Jo Bray, Department for Business, Energy & Industrial Strategy
Dr Amanda Collis, Research Councils UK
Prof Tim Dafforn, Department for Business, Energy & Industrial Strategy and University of Birmingham
Tim Fell, Synthace and BIA Engineering Biology Advisory Committee chair
Prof Petra Oyston, Dstl
Prof Dale Sanders, John Innes Centre
Prof Joyce Tait, Innogen Institute, University of Edinburgh
Dr Amy Tayler, Synthetic Biology Special Interest Group at the Knowledge Transfer Network

Apologies

Prof Janet Bainbridge, Department for International Trade
Dr Louise Ball, Defra
Dr Richard Hebdon, Innovate UK
Dr Jackie Hinton, Department for Business, Energy & Industrial Strategy
Alastair Kent, Genetic Alliance UK
Dr David Tew, GSK
Mark Turner, Department for Business, Energy & Industrial Strategy
Prof Richard Kitney, Imperial College London

1 Welcome & Introduction

Lionel Clarke welcomed everyone to the meeting, and extended a special welcome to Prof Petra Oyston (Dstl), who attended the SBLC for the first time.

Lionel proposed that the SBLC should start to consider the 'next wave' for UK synthetic biology: what the SBLC imagines that the UK synthetic biology community will achieve over the next 5 - 10 years. This relates not only to the UK Industrial Strategy, but also the wider perspective beyond just UK translation.

The bioeconomy is currently being explored as the basis for both a sector deal and the Industrial Strategy Challenge Fund (ISCF). The most relevant ISCF bid is a joint circular economy/bioscience & biotechnology/sustainable aviation fuel initiative for consideration under wave three. It would be useful for the SBLC to provide a few bullet

points suggesting what the synthetic biology component of such an initiative might include.

Action 17-1: Yvonne Armitage and Petra Oyston to consider involving Dstl and a defence angle as the relevant ISCF bid is developed under wave 3.

2 Internal Business

Amy Tayler summarised the actions arising from SBLC16 (see appendix 1). Actions 16-1, 16-2, 16-4, 16-6, 16-7, 16-8, 16-9, 16-10, and 16-11 were noted as complete. Updates on 16-3, 16-5 and 16-12 required updates from Richard Kitney, who was unfortunately unable to attend the meeting at short notice. The SBLC approved the minutes of SBLC16, subject to some amendments suggested by Joyce Tait.

Action 17-2: Joyce Tait to amend the minutes of SBLC 16, and Amy Tayler to upload the amended minutes to the SBLC website.

3 Governance sub-group

Joyce Tait gave a summary of the last meeting of the SBLC Governance Sub-Group (GSG), where the members discussed embryogenesis and organogenesis related to gene editing. New developments are challenging the 14-day rule on the use of embryos. In theory, embryonic cells could be used to grow organs *in vitro*, which could have therapeutic uses. However, this is understandably controversial and there is scope for ethical concerns and misunderstandings of the current state of the art. The aspects of the debate relating to DNA manipulation are clearly of interest to the SBLC and GSG, hence the SBLC recommended that Joyce Tait and Dale Sanders continue to engage with the Royal Society group on genetic technologies.

Action 17-3: Dale Sanders & Joyce Tait to continue to engage with the Royal Society's group on gene editing and to include synthetic biology in the relevant parts of the discussion.

The GSG meeting also considered the Convention on Biological Diversity (CBD). The speed of development of gene edited crops is causing a lot of interest in the CBD open-ended online forum. Many GSG members are taking part, although it can be time consuming. The discussion that will start on 17 July 2017 on adapting the regulatory process is of most relevance to the SBLC. The GSG will make a contribution to both Defra and the CBD directly.

Action 17-4: Joyce Tait to work with the SBLC Governance sub-group and SBLC to draft an early contribution to the CBD open-ended online forum discussion regarding the regulatory process, which opens on 17 July 2017.

The GSG went on to discuss the Nagoya Protocol (NP), and whether digital sequence information (DSI) should be included in the CBD and therefore controlled under the NP. It was the opinion of the SBLC that the CBD is not fit for purpose and the inclusion of DSI under NP would be disastrous. Provider countries aren't necessarily opposed to synthetic biology and will likely want access to technology rather than money. The

SBLC noted that the US isn't a signatory to the CBD, and the NP could deter potential US collaborators from working with partners in the UK. Members of the GSG are working on a submission to the CBD, and others were encouraged to do the same. It was noted that Defra is planning a workshop on the subject in August 2017.

Action 17-5: Joyce Tait to submit, on behalf of the SBLC, a submission to Defra and the CBD regarding the proposed inclusion of digital sequence information on genetic resources under the Nagoya protocol.

The SBLC acknowledged the likely difficulty in ever reaching a collective value system for global synthetic biology. The recent reconstitution of a previously extinct horsepox virus was suggested as a topic for consideration by the GSG.

Action 17-6: Joyce Tait to make the SBLC Governance sub-group aware of the recent reconstitution of horsepox virus from synthesised DNA.

At their last meeting, the GSG was also visited by a representative of the Wellcome Trust to discuss gene editing. There is the possibility of joint initiatives between the GSG & the Wellcome Trust, and the SBLC agreed to their continued involvement in the GSG.

Action: 17-7: Joyce Tait & Dale Sanders (on behalf of the SBLC Governance Sub-Group) to contact the Wellcome Trust and the Royal Society about public engagement activities to offer support and advice, and to express an interest in seeing the outcomes.

Joyce went on to summarise her recent work with BSI on proportional and adaptive governance for innovative technologies (PAGIT), in which synthetic biology and gene editing are amongst the case studies. European Commission and Research Council activities in this area have focused on responsible research rather than responsible innovation, and companies may be concerned that it is onerous and open-ended. PAGIT aims to make it more manageable for companies. Joyce published an article on the subject in the first edition of the IET Engineering Biology journal. A report has been delivered to BSI and discussions are ongoing. This was put forward as part of the SBLC fulfilling the recommendations in section 4 of the UK synthetic biology strategic plan 2016.

Action 17-8: All SBLC members to read Joyce Tait's report for BSI (papers 5 & 6) and to send comments ASAP.

Action: 17-9: Petra Oyston and Joyce Tait to connect the relevant HSE representatives involved in separate discussions.

There has been a lot of discussion within the GSG on whether it should be promoting the engagement aspects of RRI. The SBLC noted that public engagement on synthetic biology pre-dates the roadmap (2012) and strategic plan (2016) and that lots of initiatives are ongoing and coordination might not be necessary. The BSI report

provides a set of guidelines which could be shared with organisations considering larger, coordinated public engagement exercises on topics pertinent to synthetic biology (eg: Royal Society, Wellcome Trust and BBSRC).

Action 17-10: Lionel Clarke to ask the directors of the synthetic biology research centres what we are collectively learning on responsible research & innovation (RRI), and to request they each send a one-page note to the SBLC Governance-Sub-Group.

4 Science & Technology sub-group

In the absence of Richard, Lionel introduced a recent subject considered by the Science & Technology Sub-Group (S&T SG): the sustainability of the UK Synthetic Biology Research Centers (SBRCs). When the initial call for SBRCs was issued, the Research Councils were very clear that the funding was only for five years, after which they would have to find alternative ways of sustaining themselves. The SBLC noted that some of SynbiCITE's activities are beginning to be rolled out across the SBRCs. The ISCF may be the most appropriate vehicle for the next step, with additional grant funding and training budgets from BBSRC and EPSRC's existing mechanisms. However, the requirement for matched funding and an industrial lead could inhibit the development of potentially disruptive technologies.

The S&T SG also discussed the need to accelerate IP capture and to build investor confidence, noting the role that iGEM could play. The SBLC noted that VC funds in the US are much more sophisticated than those in the UK: they raise billion dollar funds and charge significant management fees, which fund teams to support early stage companies. The SBLC is only aware of one group trying to do the same in Europe, albeit on a much smaller scale. When you look at the global private investment in synthetic biology companies, at present very little of it comes to the UK. David Willetts continues to try to raise funds to support the eight great technologies (including synthetic biology). The SBLC considered whether SynbiCITE, an accelerator fund, or Government might be able to provide some of this back-office support.

Action 17-11: Tim Dafforn, the SBLC Science & Technology sub-group, Research Councils & Innovate UK to consider what additional "back-office" support could be offered to synthetic biology start-ups and spin-outs.

The S&T SG noted that there is a Government push for 20% of undergraduates to receive entrepreneurial training by 2020. Salaries in start-up companies are initially low, hence entrepreneurship is often unappealing in graduate surveys. The SBLC recognises the role iGEM could play in this for synthetic biology.

The SBLC discussed the role synthetic biology plays in the wider bioeconomy, and acknowledged that synthetic biology is only part of the story: a suite of technologies including robotics and artificial intelligence are required to disrupt what is otherwise incremental molecular biology, and such combinations of innovative technologies need to be facilitated by the Industrial Strategy and the associated skills agenda. Amanda Collis noted that automation could be funded through ALERT capital

infrastructure calls, and BBSRC recently issued a highlight to encourage responsive mode proposals to apply machine learning to the study of biological systems.

5 Skills

The SBLC reviewed the skills recommendations from the UK Synthetic Biology Strategic Plan 2016 to determine their continued relevance and required actions:

3.1 The UK Research Councils should work with HEIs and others to develop further programmes that embed student training in multi-disciplinary, challenge-led environments.

The SBLC thought this could be delivered by iGEM.

3.2 A joint SBLC-learned society-educationalist working group should be established to rapidly develop a synthetic biology teaching framework and commission resources to enhance synthetic biology teaching throughout the education system.

The SBLC considered this to be an ongoing discussion that is broader than just translation of synthetic biology. Tim Dafforn offered to pick up this topic later in the year.

Action: 17-12: Tim Dafforn to plan bi-lateral meetings with the relevant learned societies (Royal Society of Biology, Royal Society of Chemistry etc.) to explore interest in engaging with the SBLC through either the Science & Technology Sub-Group or an Education Sub-Group.

3.3 A synthetic biology education fund should be established to enable the further development and adoption of successful synthetic biology scientific and business skills programmes (e.g. iGEM, Lean Launchpad, Biotechnology YES, RRI training) by the wider community.

The SBLC again noted that programmes such as these build entrepreneurial skills in synthetic biology students and early-career researchers. The cost of iGEM can limit participation (although raising funds is an important skill for future entrepreneurs), and the SBLC noted that costs could be reduced if the jamboree was held in the UK.

3.4 Relevant scientific societies & academies and academic centres of excellence should form a working group to consider developing a Skills School provision for synthetic biology students and postdocs.

3.5 Relevant scientific societies & academies and academic centres of excellence should develop a unique continued professional development programme to encourage cross-discipline career development and the movement of people between academia and industry to facilitate maximum knowledge exchange.

The SBLC noted that there are opportunities to influence other organisations that run skills schools and other training courses in similar areas.

3.6 Relevant Trade Associations should support the development of Apprenticeships, including Degree Apprenticeships within synthetic biology to encourage vocational technical training in synthetic biology in support of synthetic biology using industries.

The SBLC recognises the complicated nature of the landscape with regard to developing apprenticeships, and noted that it really needs to be driven by companies, preferably large corporations. The Edinburgh Genome Foundry has seen great success from taking on two apprentices, and Dstl brings a range of activity under the umbrella of an apprenticeship. Cogent would be the right organisation to advise on opportunities within the Science Industry Partnership (SIP).

Amanda Collis raised the Professional Internships for PhD Students (PIPS), in which the student identifies a suitable placement. The SBLC also noted the 1,000 additional PhD studentships announced through the first wave of the Industrial Strategy.

Action 17-13: Richard Kitney, Dale Sanders & the SBLC Science & Technology Sub-Group to discuss skills and progress against the relevant recommendations in the strategic plan.

6 International partnerships

The SBLC reviewed international partnership recommendations from the UK Synthetic Biology Strategic Plan 2016 to determine their continued relevance and required actions:

5.1 Synthetic biology institutions should coordinate joint activities and projects to share best practice, benefit from the latest technological developments and build a coherent UK offer to showcase their world leading and truly cross-disciplinary capability.

This is being delivered through activities including but not limited to the SBLC S&T SG and the academic-led Synthetic Biology UK conference series. The SBLC recognised the efforts of the SBRCs to share exhibition space at conferences to present a coordinated offering.

5.2 KTN's synthetic biology group should be expanded through further cross-disciplinary connections and engage with those companies and organisations that operate in target market applications.

The SynBio SIG has been migrated to the KTN website, but we must still determine how SynBio SIG membership can be measured. The SynBio SIG events planned for this year have focussed on different target market applications: bioprocessing (26 April 2017) and chemistry & industrial biotechnology (20-21 September 2017). A future event exploring synthetic biology for agri-tech applications is being scoped.

5.3 KTN will make public resources for synthetic biology more visible and accessible by providing tools and mechanisms to allow business and stakeholders to engage with UK assets more proactively.

A UK Synthetic Biology Landscape Tool will shortly be launched on the SynBio SIG website. It has been designed to help those new to the field navigate the synthetic biology innovation landscape to develop new collaborations. In addition to signposting users to companies, research centres, facilities, networks and societies, it also highlights funding opportunities, training courses, strategy documents, governance bodies and even standards/metrology projects. The data can also be accessed from a market sector perspective.

5.4 The membership and terms of reference of the SBLC should be periodically reviewed to reflect the changing needs of UK synthetic biology.

To be discussed under item 7.

5.5 The SBLC should continue its strategic alignment with other leadership councils and organisations to enhance coordination, efficiency and generate opportunities for innovation, particularly addressing end-users and other 'Great Technologies'.

Lionel is leading this through his work with the bioeconomy programming board, which brings together the SBLC, the Industrial Biotechnology Leadership Forum (IBLF), the Chemistry Growth Partnership (CGP), the Medicines Manufacturing Industry Partnership (MMIP), and the Agri-Food Tech Leadership Council (AFTLC).

5.6 The SBLC should continue to review, refine and act upon IP-related recommendations developed from on-going workshops and discussions.

The S&T SG have discussed the role TTOs, and Tim Fell has previously provided Lord Prior with a brief on the subject. SynbiCITE is planning an IP masterclass for TTOs at universities working in the field of synthetic biology. KTN is also planning some workshops for TTOs in the broader topic of industrial biotechnology, although they will not have a strong IP focus, they will instead address more practical issues.

5.7 SBLC representative organisations should continue to participate in mutually beneficial engagement with key international delegations to develop (i) effective technology partnerships, (ii) policy alignments, and (iii) priorities for collaboration based on mutual needs and capabilities, generating value both in the UK and globally.

This is ongoing. Some examples include a visit from a Japanese delegation and a recent UK-US workshop on synthetic biology for materials in defence. The workshop, held in Manchester and co-organised by Dstl (UK) and the Office of Naval Research - Global (US), identified hurdles to exploitation and suggested areas of investment that could

stimulate a transformational step change. US funders are onboard with an integrated line of work. The SBLC noted that this is an excellent example of another country, in this case the US, looking to the UK for leadership and coordination, and the UK will benefit from US investments in this area. A summary of the workshop will be presented at Synthetic Biology UK in November 2017.

Action 17-14: Petra Oyston & Amy Tayler to circulate amongst the SBLC the report on the joint Dstl/Office of Naval Research (Global)/University of Manchester event on biomaterials. If endorsed, Amy Tayler to publish on the SBLC website.

5.8 The HEI/industry/start-up interface in synthetic biology should be reviewed to determine if any barriers could be removed. In addition, UKTI should continue to promote UK synthetic biology assets as attractive opportunities for inward investment.

This is ongoing. Janet Bainbridge is still working with DIT (formerly UKTI) on the subject of synthetic biology.

Action 17-15: Yvonne Armitage & Amy Tayler to provide an update against those recommendations in the strategic plan assigned to KTN.

Action: 17-16: Amy Tayler to explore opportunities to post items on the new SBLC website (eg: links to related activities, highlights, case studies etc.).

7 SBLC membership and connections to UKRI

A paper with a long-list of potential new industry members had been shared with the SBLC prior to the meeting. Two additional new members had been invited prior to this meeting, although they have not yet made their decisions. After a detailed discussion the SBLC suggested that a further four individuals be invited to join the SBLC.

Action 17-17: Amy Tayler and Lionel Clarke to invite four new industry members to join the SBLC, and to seek decisions from the two already invited.

A further additional member was suggested for the S&T SG.

Action 17-18: Amy Tayler and Richard Kitney to invite one new member to join the S&T SG.

Staff in BEIS will consider who of Jo Bray, Mark Turner and Paul Henderson should attend each meeting as and when the agenda and their availability are known.

The SBLC discussed how best to engage the Research Councils as we transition into UKRI. Given the increased emphasis on manufacturing and engineering (not just bio-engineering), it may be appropriate to involve EPSRC directly in addition to BBSRC

and Innovate UK. It was suggested that the cross-council synthetic biology working group consider how they interact with the SBLC.

Action 17-19: Amanda Collis and the Research Council Synthetic Biology Working Group to consider how the relevant Research Councils (especially BBSRC & EPSRC) and Innovate UK can interact with the SBLC.

8 Reports on recent and future conferences

The SBLC noted the importance of showcasing the UK on the international stage. The investor breakfast associated with SynBioBeta London 2017 was noted as a highlight. Amy and Petra are on the programme committee for the upcoming IET/SynbiCITE Engineering Biology 2017 conference in December.

9 AOB

Lionel summarised his ongoing work to develop a UK biosecurity protocol. He's met with various security agencies to consider how the approach taken in the US could be adapted for the UK. The Metropolitan Police have confirmed that they will identify an individual to be responsible on a national level. If necessary, we can provide them with the necessary connections to advise them on the technology. An email channel and telephone number will be available for reporting.

The SBLC considered possible topics for the next open meeting of the SBLC.

Action 17-20: Amy Taylor to consult all SBLC members on the format of the next open meeting of the SBLC.

10 Preparations for discussion with Lord Prior

The SBLC agreed the actions arising from the meeting thus far (appendix 2) and decided that the following topics should be brought into the discussion with Lord Prior:

- Industrial Strategy,
- Synthetic biology in the life sciences industrial strategy and associated sector deal,
- Attracting iGEM to the UK (noting the overwhelming support from the SBLC and the upcoming deadline of 22 October 2017),
- How the CBD and NP could threaten UK businesses,
- International partnerships, and
- What Lord Prior needs from the SBLC.

6 Discussion with Lord Prior

Lionel welcomed Lord Prior and Jo Bray to the meeting.

The SBLC opportunities for synthetic biology to grow the UK bioeconomy. Tim Fell suggested that synthetic biology is the cornerstone that will enable us to engineer biology. Until recently, biology has been artisanal, but synthetic biology techniques mean we are on the cusp of truly engineering biology. Synthetic biology cannot be

considered in isolation: it is dependent on multifactorial experimental design, automation and artificial intelligence. We need to invest in skills (such as maths and computer programming) and better experimental design (such as software and agile development) to enable the biological engineering that will allow us to use biology for manufacturing. At present, the cross-disciplined nature of synthetic biology is both a strength and a flaw. In the case of using synthetic biology for novel materials, companies might be interested in the resulting materials, but they are put off by the biology.

Government propositions for specific market sectors (such as life sciences or the automotive industry) are very clear (for example, apprenticeships). Having a clear proposition for synthetic biology might not only help with Government investment, but also early-stage VC investment, too. The SBLC considered what a proposition might look like for the enabling technology of synthetic biology. The SBLC noted that the current life science sector deal covers only a very small portion of what could be life sciences, and that synthetic biology underpins a broad range of disciplines and sectors, including the overall bioeconomy and circular economy. Synthetic biology also has the potential to improve productivity within the pharmaceutical industry. To date we have invested in the research, but now we need to translate it, and time is of the essence. Lord Prior suggested the SBLC engage with Sir Mark Walport and UKRI as well as Innovate UK. Lord Prior invited Tim Fell to attend a meeting with Sir Mark Walport to discuss some of these issues in more detail.

Lord Prior asked what makes Boston and San Francisco so successful for start-ups, while New York and London are lagging behind. The SBLC suspect it is related to the more speculative capital that is available in Boston and San Francisco. The SBLC suggested that in order to stimulate more new companies, we could consider providing back-office expertise for spin-outs and start-ups (such as assistance with marketing, sales channels etc.). It was suggested that this could be incorporated into the next phase of SynbiCITE. Since the UK has a lagging investment community, Government support will make a real difference. A Catalyst fund (with funding for both academia and industry from the Research Councils and Innovate UK respectively) could be incorporated with private investor funding, which is effectively de-risked by the public funding. The SBLC also noted that the Rainbow Seed Fund (operated by Midven) can only invest £10m with a maximum of £500k in any given company, which is often restrictive.

The SBLC gave some examples of where public funding is already helping the translation of synthetic biology. For example, BBSRC and the John Innes Centre (JIC) have co-invested in scaling-up synthetic biology technology to produce vaccines in as little as 30 days.

The SBLC summarised the Bio-Start competition for Lord Prior, which culminated in an event the evening before the SBLC. It showcased an array of emerging synthetic biology companies.

The SBLC summarised some recent examples of international coordination. For example, there is alignment between the UK and US on the subject of defense. A joint workshop was held to explore synthetic biology for materials in defence applications. The US participants have already taken the outputs of that meeting to the Pentagon, hence their upcoming investments will likely complement our needs as well as theirs. The UK has also hosted a Japanese delegation. The UK's multi-disciplined community, is clearly attractive to other countries, and we need to maintain the UK's USP.

Lord Prior and the SBLC went on to discuss iGEM. If we could attract iGEM to come to the UK, it would put the UK at the centre of the biggest global synthetic biology initiative and the associated community. It's a unique opportunity that could spread into other disciplines in due course.

The SBLC went on to discuss how the regulatory environment is a major influencer of where companies are based. We have an opportunity to adapt policies and regulations to incentivise potentially disruptive technology companies to anchor in the UK. The SBLC raised their concern about how the CBD and NP could threaten innovation, and asked Lord Prior for some senior advocacy regarding the economic consequences of these policies.

Action 17-21: Lionel Clarke to provide a one-page iGEM vision to Lord Prior.

Action 17-22: Dale Sanders to invite Lord Prior to visit John Innes Centre.

Lionel thanked Lord Prior and the SBLC members for their participation before closing the meeting.

Summary of actions arising from SBLC16

Action 16-1: Urgent, Tim Fell to write a brief summary of the issues relating to university ownership and valuing of IP, which can be sent to Lord Prior via Jackie Hinton.

Action 16-2: Urgent, Joyce Tait and Alastair Kent to provide a brief summary on (i) a proportionate and adaptive regulatory system for innovative technologies, and (ii) the ability of the NHS to adopt emerging technologies, which can be sent to Lord Prior via Jackie Hinton.

Action 16-3: Richard Kitney to issue a formal invitation for Lord Prior to visit SynbiCITE.

Action 16-4: Lord Prior to connect Lionel Clarke to Sir John Bell.

Action 16-5: Richard Kitney and the Science & Technology sub-group to collate data on whether IP is core to spin-outs.

Action 16-6: SBLC secretariat to upload Governance sub-group minutes to the website.

Action 16-7: Lionel Clarke to submit the UK Synthetic Biology Strategic Plan 2016 as the SBLC response to the Industrial Strategy Green Paper (deadline 17 April 2017).

Action 16-8: Richard Kitney to liaise with the Science & Technology sub-group to coordinate responses to the Industrial Strategy Green Paper consultation (deadline 17 April 2017).

Action 16-9: Lionel Clarke, Richard Kitney and Amy Tayler to seek an update from the iGEM Foundation during SynBioBeta London 2017.

Action 16-10: SBLC secretariat to upload the approved minutes of SBLC15 to the website.

Action 16-11: SBLC secretariat to include (i) SBLC membership and (ii) SBLC interactions with UKRI on the agenda for SBLC 17.

Action 16-12: SBLC secretariat and Richard Kitney to get approval to circulate the slides from this meeting.

Summary of actions arising from SBLC17

Action 17-1: Yvonne Armitage and Petra Oyston to consider involving Dstl and a defence angle as the relevant ISCF bid is developed under wave 3.

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