



**Synthetic Biology Leadership Council – Meeting 18, Open Meeting 5  
Wednesday 08 November 2017**

**Royal Academy of Engineering, Prince Phillip House, 3 Carlton Terrace, London  
SW1Y 5DG.**

**SBLC members**

Prof Lionel Clarke, Synthetic Biology Leadership Council (SBLC) co-chair:  
Lord Henley, House of Lords Parliamentary Under Secretary of State at Department  
for Business, Energy & Industrial Strategy and SBLC co-chair  
Dr Yvonne Armitage, Knowledge Transfer Network  
Prof Janet Bainbridge, Department for International Trade  
Dr Rowan McKibbin, Research Councils UK  
Prof Tim Dafforn, University of Birmingham  
Dr Tim Fell, Synthace and BIA Engineering Biology Advisory Committee chair  
Paul Henderson, Department for Business, Energy & Industrial Strategy (TBC)  
Alastair Kent, Genetic Alliance UK  
Prof Richard Kitney, Imperial College London  
Prof Joyce Tait, Innogen Institute, University of Edinburgh  
Dr Amy Tayler, Synthetic Biology Special Interest Group at the Knowledge Transfer  
Network

**Invited speakers**

Dr Steve Chambers, SynbiCITE  
Nick Giles, Metropolitan Police

**Registered Observers**

Richard Anderson, Sciad Communications Ltd  
Laura Bellingan, Royal Society of Biology  
Anja Berndt, BBSRC  
Alan Burbidge, University of Nottingham  
Taj Chapman, British Standards Institution (BSI)  
John Collins, SynbiCITE at Imperial College London  
Pete Cunningham, Chemquip Ltd.,  
James Hallinan, Cambridge Consultants  
Jiahao Huang, Nuclera Nucleics Ltd.  
Ranjeet Mahla, UCL  
Jamie Parkin, BBSRC  
Vitor Pinheiro, UCL  
Paul Rutten, Oxford University  
Kathleen Sedgley, University of Bristol  
Oliver Sexton, Midven  
Jason Vincent, Syngenta  
Bethan Wolfenden, Bento Lab

## **Apologies from SBLC members**

Dr Louise Ball, Defra  
Prof Petra Oyston, Dstl  
Prof Dale Sanders, John Innes Centre  
Dr David Tew, GSK

## **1 Welcome & Introductions**

Lionel Clarke welcomed everyone to the meeting, explaining that the SBLC is committed to holding one open meeting per year and anyone can register to attend and participate. The SBLC members briefly introduced themselves and the apologies were noted. Lionel explained that Lord Hanley, who has recently been appointed as the new House of Lords Parliamentary Under Secretary of State at the Department for Business, Energy & Industrial Strategy, has agreed to co-chair the SBLC and noted he will attend the meeting for the first time between 14:15 and 15:00. The coordination of UK stakeholders via the SBLC and its subgroups, and the associated senior ministerial support, are quite unique: no other country has such a structure, and it's been critical in gaining a comprehensive overview of the whole ecosystem. The SBLC members expressed their thanks for Lord Prior's support and they look forward to working with Lord Henley in the future.

## **2 Internal Business**

The SBLC was reminded to refer to the register of interests, as necessary.

The SBLC briefly summarised progress against the actions arising from the last meeting:

**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.*

This bid is still under development, and Yvonne and Petra will continue to consider the inclusion of defence, as appropriate.

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

Complete.

**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.*

Joyce and Dale have continued to engage individually and will coordinate their participation as appropriate.

**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.*

Complete.

**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.*

Complete.

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

Complete.

**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.*

This activity is ongoing and will be covered under item 4.

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

Complete.

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

Complete.

**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.*

Lionel explained that this has been discussed at the science & technology sub-group, although written summaries have not been requested, hence this will be carried forward.

**Action 18-1: 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 (carried forward from action 17-10).**

**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.*

Tim Dafforn explained that this ongoing and should be carried forward. Rowan McKibbin confirmed that this has been discussed at the Cross-Council Synthetic Biology Working Group, and noted that the Research Councils are limited in how much support they can provide in this area. It may be more suitable for consideration by Innovate UK once the current activities on the industrial strategy and transition to UKRI are in hand.

**Action 18-2: 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 (carried forward from action 17-11).**

**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.*

Tim Dafforn explained this is ongoing and will be revisited in one of the breakout sessions in item 8. One-to-one discussions have already been instigated with Royal Society of Chemistry, Royal Society of Biology and Biochemical Society, although they will be brought together again.

**Action 18-3: Tim Dafforn to continue discussions with the relevant learned societies regarding skills and education.**

**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.*

Complete and to be revisited under item 3.

**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.*

The report has not yet been published, but as and when it is released and endorsed it can be made available through the SBLC website (hence action carried forward).

**Action 18-4: Petra Oyston & SBLC Secretariat to circulate amongst the SBLC the report on the joint Dstl/Office of Naval Research (Global)/University of Manchester event on biomaterials. If endorsed, SBLC Secretariat to publish on the SBLC website (carried forward from action 17-14).**

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

Complete (expanded description provided in the minutes of the last meeting).

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

Amy Tayler explained that the SBLC website has been migrated onto the KTN-uk.org website and articles can be uploaded by request.

**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.*

Amy Tayler explained that some of the invitations have been made, resulting in discussions between Lionel, Amy and the invitees. Decisions regarding their participation have not yet been made, hence further enquiries must be made and the final invitations extended.

**Action 18-5: SBLC Secretariat and Lionel Clarke to continue the recruitment of additional industry members, as agreed at the last meeting.**

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

To be carried forward.

**Action 18-6: SBLC Secretariat and Richard Kitney to invite one new member to join the S&T SG (carried forward from action 17-18).**

*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 best interact with the SBLC.*

Rowan explained that the Cross-Council Synthetic Biology Working Group, which includes the five councils that currently have an active interest in synthetic biology, meet regularly (usually preceding the meetings of the SBLC) and they solicit comments on SBLC papers from the other members. Rowan (or Amanda Collis) attend the SBLC to represent the collective Research Councils, a process which has been agreed with the relevant parties. However, Rowan noted that there has been a personnel change within EPSRC, and given the relevance of EPSRC to synthetic biology, Rowan will instigate further discussion about the position of synthetic biology within EPSRC and their interaction with the SBLC via the Cross-Council Synthetic Biology Working Group.

**Action 18-7: Rowan McKibbin to enquire with EPSRC about the position of synthetic biology within EPSRC and their interaction with the SBLC via the Cross-Council Synthetic Biology Working Group.**

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

Complete.

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

Complete.

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

Given that Lord Prior no longer co-chairs the SBLC, this action was considered redundant. Potential interaction with Lord Henley will be discussed under item 8.

The SBLC approved the minutes of the last meeting.

**Action 18-8: SBLC secretariat to upload the approved minutes of SBLC17 to the SBLC website.**

Lionel invited Paul Henderson to report on the ongoing work of the bioeconomy programming board, which brings together the industry chairs of 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 (ATLC). They are currently working on a UK bioeconomy strategy, which will link to the Industrial Strategy Challenge Fund (ISCF) and the clean growth strategy. The team is also working with the devolved administrations in Scotland and Wales to make sure it aligns with their strategies, too. It is expected that the UK bioeconomy strategy will be published shortly, although a date has not yet been set. In tandem, a bioeconomy proposal is being developed for the third wave of ISCF, and a sector deal for the bioeconomy is in the pipeline.

The SBLC discussed the status of ongoing efforts to relocate iGEM headquarters to the UK. Although it was hoped that a decision could be made over the summer to secure the jamboree in the UK for 2018, that has not been achieved. The earliest the jamboree could be held in the UK is now 2019, hence the team has more time to establish a business case for support. UKRI and DIT are involved in the consideration, which will be picked up after the 2017 jamboree. The SBLC intends to make it clear to Lord Henley their overwhelming support for iGEM.

### **3 Science & Technology sub-group**

Richard Kitney introduced the session with the caveat that his presentation was non-exhaustive but gave some highlights from recent activities of the major synthetic biology research centres (SBRCs). Richard was careful to include some background on synthetic biology given the diversity of the registered observers.

Richard explained that synthetic biology is a platform technology, and that the UK community has started with a foundation that is now being translated into industry. The UK Roadmap for synthetic biology stimulated significant investment into the SBRCs and the innovation & knowledge centre (IKC) for synthetic biology, SynbiCITE. A total of more than £300m of public funds have been invested in synthetic biology, and in 2016 the SBLC published 'Biodesign for the Bioeconomy' to outline a route to industrial impact. Synthetic biology will help us meet many of the industrial strategy challenge areas, including: clean & flexible energy; robotics & artificial intelligence; healthcare & medicines; and manufacturing & materials of the future. Synthetic biology also offers great potential for growth in biosciences, biotechnology and the life sciences (as mentioned in the life sciences industrial strategy).

Richard highlighted the work of BrisSynBio (University of Bristol), OpenPlant (John Innes Centre and University of Cambridge), the Edinburgh Centre for Synthetic & Systems Biology (SynthSys, University of Edinburgh), the UK Centre for Mammalian Synthetic Biology (University of Edinburgh), the Flowers Consortium, multiple activities at Imperial College London (CSynBI, the London DNA Foundry, SynbiCITE and frontiers engineering), SynBioChem (University of Manchester), Nottingham SBRC (University of Nottingham) and the Warwick Integrative Synthetic Biology (WISB) Centre (University of Warwick). Together, these centres and others give the UK a strong base and a broad spectrum of approaches to keep feeding the innovation pipeline (the second recommendation in the strategic plan).

Richard gave some additional detail on SynbiCITE, which supports all five recommendations in the strategic plan. It has three parts: a science, research &

engineering hub; facilities; and business support & outreach. SynbiCITE brings together more than 20 UK universities to work on training, networking and funding, as well as a large group of industrial partners to collectively accelerate innovation, which can be considered the product of invention and commercialisation.

Richard briefly introduced the DNA foundries in Edinburgh, Liverpool, Norwich and London, noting that the efforts at the MRC LMB in Cambridge are outside the remit of the science & technology sub-group. Richard clarified that the foundries don't produce synthetic DNA, instead they design and assemble DNA.

To highlight progress against the third recommendation in the strategic plan, building an expert workforce, Colette Matthewman and Ann Osbourn from OpenPlant have produced a report on the collective training and international activities of the SBRCs. Of particular note are two new MSc courses in Edinburgh: synthetic & systems biology, and synthetic biology & biotechnology.

A number of members of the science & technology sub-group consider iGEM to be extremely important and influential and support the ongoing discussions regarding relocating iGEM to the UK.

Richard briefly highlighted some of the business education & training programmes available: 4-day MBA, Lean Launchpad, Bio-start, and SynBio LEAP.

Stephen Chambers introduced the SynBio start-up survey he published earlier this year, which covers the period between 2000 and 2016. Over this 16-year period, 146 synthetic biology start-ups have established in the UK, 8% of which have been acquired and 16% of which are now inactive, leaving 111 active companies. These can be split into those that are based on technology coming out of a university ('tech-transfer', 79) and those that are not ('non-tech-transfer', 67). Tech-transfer companies tend to raise more money than non-tech-transfer companies, but the number of non-tech-transfer companies emerging is growing. Non-tech-transfer companies still need an ecosystem around them. The majority of the companies provide tools and services, and they tend to cluster around the SBRCs. In total, 171 private investments have been made totaling £564m. In recent years, the number of deals has decreased, but the average individual value has increased. Steve noted that public funding, such as that from Innovate UK and the Research Councils, is really important, but we are also seeing a significant private return on that public investment. Steve concluded that the UK synthetic biology ecosystem is approaching the critical mass we need to maximise the benefits of the technology.

Lionel invited questions from the SBLC members and the observers, one of whom asked whether there is a parallel with the US. Steve suggested the ecosystem is still significantly behind that in Cambridge, Massachusetts. A question was raised regarding the potential for synthetic biology to deliver \$60Bn by 2020. Steve suggested that the development of CAR-T and Crispr-Cas9 would help achieve this potential. Another observer noted that the scale of seed investment is growing in the US, and questioned whether the UK could provide support on a similar level. Steve

noted that and Innovate UK is restricted to supporting companies and that public funding can only go so far. However, private investors are beginning to step up in the UK, although not yet at the level of the US

#### **4 Governance Sub-Group**

Joyce Tait summarised the recent discussions of the governance sub-group. Investment in synthetic biology provides us with an enormous opportunity, and we should endeavor to get the maximum benefit from that investment. However, without fit for purpose regulatory systems in place, the market will underperform. We could get more benefit with adaptive and agile regulatory systems. In the UK and Europe, our regulatory systems are still based on those designed for chemical products of the 20<sup>th</sup> century, and we need to make them work better for bio-products of the 21<sup>st</sup> century. The fourth recommendation in 'Biodesign for the Bioeconomy' is to establish a supportive business environment for synthetic biology businesses. BIS and BEIS have funded a project at the Innogen Institute on a proportionate and adaptive regulatory system. We need to consider what support is needed for both small companies and multinationals adopting synthetic biology approaches, and Brexit may provide the UK with an opportunity to do something different. However, the UK must be mindful that we need the European market, and ideally Europe needs to consider their position, too.

The last meeting of the governance sub-group featured two guest presenters.

Fiona Fox from the Science Media Centre (SMC) explained that they can support topics that are likely to be newsworthy and the subject of debate. The aim of the SMC is to provide the best possible scientific evidence on which the media can write their stories. In doing so, they sometimes stop problematic issues from arising. The SBLC could support the SMC by providing people and stories, and by alerting the SMC to upcoming newsworthy stories. As and when items arise with the media, the lead time is usually less than 24 hours, hence it's better to be prepared in advance. The sub-group discussed whether an adaptable and proportionate regulatory framework could be misconstrued by the media as a way of industry trying to make life easier for themselves. The SMC has not met with regulators in the past, but they would be willing to do so if some pre-emptive activity was required.

Lalitha Sundaram from the University of Cambridge reported on the development of the arsenic biosensor, which is an interesting example of regulatory failure and shows how difficult it is to be an early-adopter in the life sciences. The EU commission have struggled to find a way forward because it straddles two regulatory categories. With limitations on time and money, it's possible that the project will be abandoned in its current form and a cell-free technology will be developed instead, which will side-step the current regulatory hurdles. However, questions remain about cell-free technology, too. Are there any hazards from cell-free DNA? Should cell-free technology be regulated? In the absence of specific regulation at this early-stage, standards and guidelines might be a better approach than risk choosing the wrong regulatory framework. Lalitha plans to arrange a meeting to consider how cell-free technologies might be governed in the future.



Andrew Cottam (a member of the governance sub-group) from HSE also presented at the last meeting. Louise Ball from Defra gave an update on the Convention on Biological Diversity (CBD). Over the summer there were four opportunities via the open-ended online forum to comment on different aspects of regulation on synthetic biology. Joyce and Tim Fell have been the main contributors on behalf of the governance sub-group and the SBLC. An area of significant concern is the Access and Benefit Sharing (ABS) agreements required under the Nagoya Protocol. ABS raises a lot of logistical questions. In theory, it applies at the point that any genetic material is used and before any basic research is performed. It might be better delayed until it is known that there are benefits to be shared.

The governance sub-group is trying to find ways in which these technologies can be enabled. There is concern that the regulators and policy makers in Government lack sufficient breadth and depth of understanding in synthetic biology and gene editing technology, and how it will contribute to the bioeconomy. The right regulation will aid these technologies coming to market, but no regulation or the wrong regulation will hinder it. Synthetic biology isn't relevant to just one Government department, but many including HSE, FSA, MMD, MHRA, and Defra. A novel, standards approach is a unique opportunity to make it easier in an integrated way. The SBLC could consider writing a report for Lord Henley to take to treasury to give it a higher profile.

**Action 18-9: All SBLC members to approve the minutes of the last governance sub-group meeting and SBLC secretariat to upload to the website.**

### **5 UK Biosecurity Protocol**

Lionel gave a brief presentation on his ongoing work with staff in the security services to set up a biosecurity protocol for the UK. Nick Giles from the Metropolitan Police was able to provide additional detail.

The aim is to build trust that UK synthetic biology R&D is done in a considered and safe manner. By embedding a protocol in day-to-day activity, we have the opportunity to address concerns before they escalate to major issues, safeguarding both society and science. This is the first public awareness session regarding the protocol, which will be piloted at the universities of Warwick, Bristol, Manchester and Imperial College London before being adapted and adopted more widely. Ultimately, care is required from everyone in the community to operate safely under the principles of responsible research & innovation (RRI), to intervene to prevent miss-directed or ill-judged applications, and to reduce the likelihood of damaging outcomes.

In brief, if concerns cannot be addressed locally, any potential suspicious activity can be directed to a dedicated email address ([Biological.Reporting@met.police.uk](mailto:Biological.Reporting@met.police.uk)) and telephone number (0207 230 9066). All reports will be triaged, calling on expertise in Dstl, the SBLC and beyond, as appropriate. If necessary, reports will be investigated fully, although past experience of reporting in the chemicals field suggests this will be a relatively rare occurrence. However, this is much more pre-emptive than it was with

chemicals, and it may take some time to establish the approximate thresholds of what and isn't suspicious.

Once the pilot is underway, efforts will be required to raise awareness to the protocol. The SBLC website, SynBio SIG and learned societies will be called on for assistance.

## **6 Preparation for discussion with Lord Henley**

Lionel summarised his pre-meeting with Lord Henley, and the SBLC agreed to try to raise the following points and key messages in their discussion with Lord Henley:

- Synthetic biology is a ubiquitous platform technology with a lot to offer in a variety of sectors. It is analogous to the internet, the success of which relied upon the right regulation and protocols as well as standards and engineering;
- The UK community is coordinated and works as a whole, with hotspots around the SBRCs in the regions (which echoes the theme of place in the industrial strategy);
- Investment in training and skills will not only provide the workforce as jobs are created, but will also attract businesses to the UK. However, many people being trained in UK institutions are not UK nationals, and we must maintain support for foreign nationals if we are to maintain our excellent research base;
- Brexit provides us with an opportunity to address concerns with current regulations;
- Return on investment (as demonstrated in Steve's presentation);
- Synthetic biology features heavily in the bioeconomy strategy, future ISCF proposals, and a bioeconomy sector deal. Industry is keen to work with Government on a sector deal;
- iGEM; and
- UK biosecurity protocol to safeguard society and science.

## **7 Discussion with Lord Henley**

Lionel welcomed Lord Henley to the meeting, noting the value of senior ministerial engagement. Lord Henley thanked Lionel for his enthusiastic briefing and his continued efforts to grow synthetic biology in the UK. Lord Henley knows that Lord Prior, his predecessor, was very supportive of synthetic biology, and he hopes to do the same. Lord Henley is very willing to accept invitations to visit stakeholders, not just in London but across the UK. The SBLC members briefly introduced themselves.

Lionel started by linking the review of the scientific community (which has received public funding of around £300m) with some of the insights from Steve's survey of UK synthetic biology start-ups. From a low base, we now have about 150 start-ups, which have together attracted approximately £600m in private investment. This return on investment will grow in the future. Lionel noted that the nature of these start-ups is changing, with a growing number of non-tech-transfer companies (based on people) as well as tech-transfer companies (based on technology), which emphasises the roles that people and skills play in this burgeoning community.

Tim Fell described synthetic biology as a ubiquitous platform akin to the internet and the associated business activity, which we don't describe as the internet industry *per se*. Similarly, in time we won't refer to the synthetic biology industry, but it will

underpin activity across nearly all the industrial strategy sectors. At present, we are using synthetic biology tools and technologies to move biology from an artisanal discipline to an engineering discipline. Biology has the potential to be the ultimate distributed manufacturing system. However, it's disruptive, so at this relatively early-stage we can't expect big pull from large, multinational corporations. Instead, the real innovation is coming from start-ups, people walking out of universities and starting companies. Our ecosystem is starting to take shape and get traction, driven by people, skills, and the business environment, but the regulatory environment must also be fit for purpose for an emerging, disruptive technology. People and businesses must feel welcome to base themselves in the UK to build the biological equivalent of the internet. Companies are growing, and we want them to grow in the UK.

Tim used Synthace as an example. Synthace started as a company using biological processes to make chemicals. They bought in automation, and developed the necessary software to allow a multi-factorial approach and to increase the productivity by four orders of magnitude. They soon realised that the value of the software far outweighs the value of any chemical they could make. The founder of Synthace relocated from the US to the UK on account of the excellent research base and the regulatory environment, knowing that private finance would be harder to come by in the UK than the US. However, Synthace is the exception rather than the rule, and the UK still needs to be more attractive to businesses.

Joyce explained that the UK's current chemical regulations aren't suitable for biology, and that we need to adapt the regulatory systems for the needs of emerging technologies. BSI and BEIS have funded a project to look at how regulatory systems can be more adaptive. The project is a foundation that could be developed and used to attract business and inward investment to the UK. Regulations cross multiple Government departments and organisations: HSE, Department of Health, MHRA, Defra, BSI etc. The industrial strategy could give us the opportunity to establish an institute that enables cross-sector comparisons and identifies what changes will make the most difference. For example, in the context of new antimicrobials in the US, one change in the FDA guidelines means the cost of trials has been cut by 50%. Standards could be key in adapting the regulatory system.

The SBLC is aware of the potential impact of changing the UK regulatory environment on international markets. However, in general the UK is better connected to the US on synthetic biology rather than continental Europe.

The SBLC discussed the important role that skills development has in increasing productivity and attracting inward investment in the UK. The excellence of the UK research base relies heavily on non-UK nationals: approximately 30% of academics are non-UK nationals, and many non-UK students come to the UK to train. However, if our immigration policy isn't fit for purpose, they will leave and we will have trained our competitors. The policy needs to accommodate not just the students and academics but their families, too, especially if we want future leaders build their careers in the UK. However, Brexit also means the EU is no more attractive than the rest of the world for recruitment of non-UK staff.

In addition to company support, the appropriate downstream infrastructure needs to facilitate the application of new developments using the UK as a test bed for synthetic biology. In the case of novel drug development, the UK needs to be an attractive place to conduct clinical development, and the NHS needs to implement new technologies in clinical practice. The NHS provides a very attractive procurement opportunity, if new technologies can be implemented. Lord Henley offered to pick this up with Lord O'Shaughnessy (Parliamentary Under Secretary of State at the Department of Health).

The SBLC noted that inward investment takes a long time and Government often works on shorter timescales. We are starting to see private sector payback from previous public-sector funding, but we must continue to provide support, too.

The SBLC briefed Lord Henley on the proposed relocation of iGEM Headquarters to the UK. iGEM stimulates an enormous variety of synthetic biology science, and having it based in the UK is a huge opportunity. Lionel offered to provide a briefing paper.

**Action 18-10: Lionel Clarke to provide Lord Henley with a briefing note on iGEM.**

Lionel thanked Lord Henley for his participation.

**Action 18-11: SBLC members to update any previous briefing papers so they can be included in Lord Henley's briefing ahead of the next SBLC meeting.**

#### **8 Breakout sessions:**

The SBLC members and registered delegates agreed to the following four breakout sessions, which were discussed for 40 minutes before a summary was provided:

##### **(i) Maintaining funding for fundamental bioscience (facilitated by Rowan McKibbin)**

There is a recognition that we need to maintain funding to feed the innovation pipeline. To aim for continuity of funding, grant-holders shouldn't wait for funding to end before looking for the next source of income. Successful funding bids under UKRI will likely need to adopt an interdisciplinary approach. It is unlikely that funding will be ring-fenced for synthetic biology, but as an enabling technology there should be many available opportunities. Fundamental bioscience is still important to the Research Councils, but other funding sources should be considered, too: charities, philanthropists, overseas funding agencies, the private sector and beyond.

##### **(ii) Business opportunities for the UK: investment & trade (facilitated by Janet Bainbridge)**

This group developed a wish-list:

- gap funding or fiscal advantages to support TRLs 4-5;
- de-risking strategies for potential investors and/or training for investors on synthetic biology business models and/or collating details on investors that are open to synthetic biology business models;
- open-access demonstration facilities;

- a repository of case-studies;
- a single synthetic biology portal with all up-to-date information in one place;
- a list of the UK's USPs for synthetic biology companies and investors;
- and business-to-business mentoring for small start-ups.

**(iii) Towards a synthetic biology teaching framework (facilitated by Tim Dafforn)**

Integrating synthetic biology in teaching curricula, including primary education, will provide a better talent feed. Biosciences has traditionally been a discovery science, but synthetic biology could be promoted as a building science to make it more exciting and engaging for young scientists. Synthetic biology brings together a lot of disciplines, making it a sound basis for project work. Early exposure to emerging technologies will likely make it less intimidating when it is applied. Tim Dafforn will continue this discussion with the Learned Societies.

**(iv) Ideas for the future development of synthetic biology in the UK: What businesses need to seize the opportunity, flagship projects, etc. (facilitated by Tim Fell)**

This group discussed some flagship projects and key activities that are needed to support synthetic biology beyond 2018:

- a careers portal: there are a lot of initiatives to support skills and training (BiotechYES, iGEM, SynBio LEAP etc.). A repository with these schemes, plus some information on potential career opportunities, would be very useful;
- "mind the gap" funding for pre-companies: early-stage ideas often struggle to get as far as securing Innovate UK funding. Some pre-company funding and mentoring could make a significant difference. Bringing iGEM to the UK might help in this regard;
- standards: the language of standards will affect protocols and metrology. We need a flagship owner to take it forward.

**8 Closing remarks and Close**

Lionel thanked everyone for their participation, noting that this is Amy Tayler's last meeting and thanking her for her support, before formally closing the meeting.

**Actions arising from SBLC 18**

**Action 18-1:** 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 (carried forward from action 17-10).

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**Action 18-3:** Tim Dafforn to continue discussions with the relevant learned societies regarding skills and education.

**Action 18-4:** Petra Oyston & SBLC secretariat to circulate amongst the SBLC the report on the joint Dstl/Office of Naval Research (Global)/University of Manchester event on biomaterials. If endorsed, SBLC secretariat to publish on the SBLC website (carried forward from action 17-14).

**Action 18-5:** SBLC secretariat and Lionel Clarke to continue the recruitment of additional industry members, as agreed at the last meeting.

**Action 18-6:** SBLC secretariat and Richard Kitney to invite one new member to join the S&T SG (carried forward from action 17-18).

**Action 18-7:** Rowan McKibbin to enquire with EPSRC about the position of synthetic biology within EPSRC and their interaction with the SBLC via the Cross-Council Synthetic Biology Working Group.

**Action 18-8:** SBLC secretariat to upload the approved minutes of SBLC17 to the SBLC website.

**Action 18-9:** All SBLC members to approve the minutes of the last governance sub-group meeting and SBLC secretariat to upload to the website.

**Action 18-10:** Lionel Clarke to provide Lord Henley with a briefing note on iGEM.

**Action 18-11:** SBLC members to update any previous briefing papers so they can be included in Lord Henley’s briefing ahead of the next SBLC meeting.