Written evidence from Dr Rodrigo Ledesma-Amaro (ENB0026)

Respondent:

Dr Rodrigo Ledesma-Amaro leads a research group at the interface of synthetic biology and metabolic engineering at Imperial. His research lab is based in the Department of Bioengineering and the Centre for Synthetic Biology and Innovation.

Dr Ledesma-Amaro also directs the new UKRI-funded Microbial Food Hub, a £14m investment in a major new area of engineering biology applications.

This submission focuses on the area of 'food applications' of engineering biology, Dr Ledesma-Amaro's research specialism.

Question responses:

1. What are the UK's key strengths in the area of engineering biology?

1.1 In general, UK is very strong in fundamental synthetic biology but is not as well developed in translational or applied engineering biology.

1.2 Some of the first centres for synthetic biology in Europe were created in the UK, and this is also true for educational programmes. Many of those programmes have been based at Imperial, which currently constitutes one of, if not *the*, largest synthetic biology communities in the world.

1.3 The UK is also really advanced in 'biofoundries' infrastructure where there has been more investment than in any other European country. However, this comparative advantage is currently being hampered because many foundries lack use and applications by internal and external users, something that could be improved by strategic government leadership and directed policy action.

2. What are the key applications for engineering biology?

2.1 The UK has been stronger in pharmaceutical applications of engineering biology but has been historically weaker in other industries such as chemicals, food, materials, and fuels, among others.

2.2 There is now a great opportunity for the UK to become an international leaders in the 'food applications' space, especially in

using engineering biology to make healthier and more sustainable food, which will also serve to increase UK food security.

2.3 This is because 'food applications' is a new field that is just emerging (sometimes called 'alternative proteins') and some large international investments have just landed here such as the Microbial Food Hub funded by UKRI (£14m) led by Imperial and directed by myself.

2.4 Additional investments from UKRI in the space include Growing Kent and Medway (£15m), CARMA (£15m) and the ongoing process to make an Innovation and Knowledge Centre on alternative proteins (£18m). This together with the high calibre food research universities in the country has the potential to drive collaborations and innovation with the engineering biology community.

2.5 In the novel food space, which includes microbial food, cultivated meat and plant-based food, the microbial food space is one of the strongest in the UK, which has a great international recognition in microbiology research worldwide. The UK is also one of the countries that consumes more microbial food already (thanks to Quorn mainly) and therefore public accepts microbial food products.

2.6 The UK needs additional investment in both the engineering biology food space and biomanufacturing since a great limitation in the implementation of the technologies developed is the lack of infrastructure for scale up.

2.7 It is also worth highlighting that the alternative protein/food research space is really emerging now and it is very limited both in the UK and abroad, especially when compared with other application areas. This means that it will require significant funding but has the potential for the UK to become a genuine international leader, especially in the academic sector – which will then translate to the commercial sector.

3. How can Government policy support the development of engineering biology?

3.1 Investment in applications of engineering biology with academic grants targeting applied research (e.g. current BBSRC grants don't necessarily encourage applied research). Our current research funding system is designed to place a higher value on scientific innovation (a prerequisite for high quality publications) than on a project's applied potential, which is more likely to lead to successful commercialisation/spinout.

3.2 The UK has a great advantage in the food space compared to EU countries now because of post-Brexit regulatory independence. Government should use this advantage to encourage the rapid creation of new, pro-innovation and enabling regulations around novel foods in particular.

3.3 I would recommend learning the lessons from highly successful international regulatory models, for example Singapore or the US, rather than EU, to become the European leader in the food space. With the right regulatory and commercial environment, companies will choose UK as an entry point to the EU market.

3.4 Policies around food labelling could also help the development of novel foods by, for example, showing to the public how these foods are more sustainable.

3.5 For the private sector and emerging startups, the UK has good programmes for public funding via Innovate UK but they are limited to established startups since they need to contribute with their own funds (20-30%) which make these programmes less accessible to earlier-phase startups.

3.6 The government should consider open pre-seed and seed funds for academic spin out to facilitate the initial steps in company creation. I see many startups going abroad at very early stages because of this.

4. How can the UK maximise the economic potential of developments in engineering biology?

4.1 The government should promote academic research that is more applied and ensure that there is adequate funding for research with high application value in addition to existing funds for innovative foundational scientific research.

4.2 We can do more to facilitate the attraction of international talent. PhDs and postdocs in particular contribute major value to original research in the UK and to our vibrant startup culture.

4.3 In food, promoting collaboration at different scales of the food system, from feedstock, cellular engineering, biomanufacturing, downstream and purification, scale up, formulation, analysis of nutrition and food properties, analysis of sustainability, etc. This is a system-wide approach that requires central co-ordination and strategic leadership.

4.4 Supporting TTO (Technology Transfer Office) functions in universities. These functions are vital for supporting knowledge

exchange and university-led innovations into commercial propositions. Ensuring there is long-term support for universities to engage in technology transfer activities is an important policy lever that can be mobilised quickly.

4.5 Building accessible infrastructure for scale up, as a complement to the UK's existing (and effective) support for spinouts/startups.

4.6 Government can, with the correct scientific advice, play a constructive role in identifying applications with high potential for commercialisation and prioritising those, e.g. identifying top molecules to be biomanufactured so academics can work on them.

4.7 Promoting collaborations between industry and academia via cofunded programs, through which government can further incentivise industry to work with academics.

4.8 Support early stage innovation and startups – our current success in building innovative startups across emerging technologies should not lead to complacency and international competition is high.

4.9 Another positive step for government leadership would be to support production plants to be developed in the UK. There are many examples of UK companies that go abroad when they reach the moment to build their production factories (e.g. Enough in the Netherlands).

5. What are the risks posed to society by engineering biology?

5.1 In the food space, novel foods made with engineering biology will need to be assessed for allergenicity and safety, as is already the case in current food regulations.

6. How should engineering biology be regulated?

6.1 The current regulations are sometimes too strict, and this can impede innovation. For example, in the food space, we are often limited by existing novel food regulation, GMO regulations, etc. These need to be streamlined and updated to take account of scientific-technical progress and the horizon of opportunity for the UK in novel foods.

6.2 GMO regulation should be revised to help drive innovation. Current regulations can be simplified and streamlined without risk to public safety, as has been demonstrated by the use of GMO products in the last few decades.

6.3 Facilitate a 'cultivated meat' approvals process that is quick, agile and empowers commercial innovation in the sector. We can learn

from the countries leading commercialisation in this area, such as Singapore.

6.4 Simplify microbial food approvals, in line with similar regulatory changes listed above. Especially, with the safe and wide use of Quorn in the UK, we could facilitate the development of novel microbial-biomass based food based on what FSA has learned through their interactions with Quorn over the years and other companies could benefit from it.

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7. What are the possible barriers and limitations to good and effective use of engineering biology?

7.1 There is a lack of specific funding streams for engineering biology – now mixed in generic BBSRC and EPSRC calls. The status of engineering biology as a national priority should be reflected in specific funding streams to drive research and innovation on this topic.

7.2 Engineering biology usually deals with the creation of improved, engineered cells which widely expands natural biodiversity – however, most of this new biodiversity is not conserved. Cell/culture collections should be created specialised in engineered microbial cells.

7.3 More engineering biology PhD programmes should be created, there are very few in the UK compared to other priority areas such as AI and quantum. An initiative on a similar scale is necessary if engineering biology is to maintain parity with developments in the other critical technologies identified in the Science and Technology Framework.

7.4 Lack of international talent especially in PhD level because of the few opportunities post-Brexit. This is not a challenge unique to engineering biology in the sector and not one that the Committee and Parliament are unaware of. National leadership on this remains a priority for UK higher education as a whole, as well as for every priority technological and scientific area.

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