Written evidence from Professor Roisin Owens (ENB0009)

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

If defined in its broadest sense, engineering biology is very strong in the UK. My expertise is in bioelectronics, 3D tissue models and organs on chip. Particularly in the organ on chip area, where cells are housed under conditions which attempt to mimic physiological parameters such as blood flow, the UK has a growth industry. The organ on chip network based at QMUL highlighted ~30 industrial partners, many of them SMEs working in this area. The Organ-on-a-Chip Technologies Network (organonachip.org.uk). NC3Rs recently launched a Crackit challenge called Sensochip – seeking to integrate devices and sensing with Organ on chip or in vitro models. The very strong biotechnology sector in the UK has expressed a need for better, more in vivo like (and human) in vitro models for drug screening. This requires biomaterials, cell engineering, electrical monitoring, fluidics and more, integrated into systems that would be impossible without engineering expertise.

I am currently working with the Royce Institute in Manchester to do a roadmap of bioelectronics: specifically, materials for healthcare. Other examples of such activities can be found here: Roadmapping & Landscaping - Henry Royce Institute Bioelectronic devices also have utility for monitoring in vitro models, or as implantables for stimulating function (e.g. Vagus nerve) or recording (e.g. Electrocorticography arrays for monitoring brain function during surgery). Other bioelectronics experts in the UK are working on bioelectricity, possibly as a route to control cell growth and stimulation. Biophotovoltaics is yet another area, seeking to harvest energy from biological systems using materials and devices. These are just some examples however.

The roadmap will seek to gather information from UK academics, industry and clinicians and benchmark against international progress.

2. What are the key applications for engineering biology?

The fundamental issue is to define exactly what is meant by engineering biology. UKRI defines it thus: '*Engineering biology is the application of rigorous engineering principles to the design and fabrication of biological components and systems, from modifications of natural systems to new forms of artificial biology. It encompasses the entire innovation* *ecosystem, from breakthrough synthetic biology research to translation and application.'*

However, engineering biology has somehow become synonymous with synthetic biology, rather narrowly defined as genetic engineering of biological organisms. For me, and others in my field, engineering biology is much broader and more about applying engineering in its broadest sense, to biological systems.

My particular area of expertise is bioelectronics – where we apply electrical engineering principles to record and stimulate biological systems. I work in the department of chemical engineering and biotechnology, and use chemical engineering principles to develop 3D tissue models that can be electrically recorded. I also work with Materials Scientists to develop new biomaterials (bioderived or synthetic) as scaffolds or hydrogels to host 3D tissue models.

Tissue engineering is a term used to describe research usually focused on regenerative biology – developing a piece of tissue in a lab that could be implanted into a body to recover lost function. An example could be growing a new organ or replacing a heart valve. Sometimes these materials are synthetic, but increasingly, they are bioderived, or even hybrid, where they may be seeded with cells before implantation to avoid rejection by the body. The same tissue engineered constructs can also be used in the lab to study disease. I'm co-PI on a new Wellcome funded discovery platform grant on tissue scale biology led by the Cambridge Stem Cell Institute. The combination of engineering (mechanical, electrical, chemical) with stem cells to develop new in vitro models is very exciting. Many engineers also work with clinicians to develop devices for implantation which may benefit from in vitro testing or incorporation of cells as above.

The UK lags behind the US in tissue engineering, probably because US Universities benefitted from significant funding from the Whitaker foundation, which established biomedical engineering departments in many top US Universities. Often, initially, as offshoots of Chemical Engineering departments. The department of Chemical Engineering and Biotechnology at Cambridge is somewhat unique, since it was a fusion of Chemical Engineering dept. and the Institute of Biotechnology and thus straddles the divide between biology and engineering. A new degree (since 2023) in Chemical Engineering *and* Biotechnology will train a new generation of students conversant in basic biological principles as well as engineering fundamentals.

The UK has also focused the engineering biology conversation on biological sciences. To be truly successful, cross disciplinary institutes and hires should be made allowing research to flow and flourish in both directions. I’m a biochemist who worked first in an electrical engineering dept. and now in chemical engineering and biotechnology. More scientists should cross the divide to avoid silos. I’m deputy head of the School of Technology at Cambridge which includes Chemical Engineering and Biotechnology, Engineering, Computer Science and Technology, all of which have a part to play in contributing research to engineering biology.

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

The funding councils need to broaden the vision for engineering biology and recognise the strengths of UK research and innovation. The current narrow focus is confusing and blocking progress. Funding for engineers doing biology or vice versa, sits at the edge of EPSRC and BBSRC. Recent discussions with both agencies has revealed that some proposals that do both engineering and biology are not reviewed by either agency. Without funding, these projects will never flourish. A recent meeting with the Wellcome Trust highlighted interest in Tools and Technology but the Trust may not have the infrastructure to properly evaluate pioneering work in engineering which could serve biological or medical sciences.

The UK needs to train more students in engineering biology – without biomedical engineering departments we lag behind many other countries, particularly the US.

07 May 2024