Bioinnovation: from research to commercialisation

Searching for long-term, sustainable success? Then look beyond the science.

By **Richard Hammond**

Great ideas to solve big problems

The idea of manipulating biology to solve problems and make profit is not new. Plants and animals have been selectively bred for thousands of years, and medicines developed from the natural world.

The discovery of DNA accelerated this process, because if you understand the code, you understand how to reprogramme and how to control rather than the messier trial and error that characterised the previous millennia.

In the last ten years, however, two things have changed: much improved tools, techniques and methods to manipulate biology, and wider recognition of the externalities in developing and commercialising new technologies – particularly the environmental costs.

These improvements in technology are exemplified in the appearance of "synthetic biology". This takes biological research and brings it together using engineering principles to solve problems across many sectors, including human health, agriculture, the environment and industrial chemicals.

The UK is at the forefront of this new discipline and there has been significant governmental support through the synthetic biology roadmap and *Biodesign for the Bioeconomy* UK synthetic biology strategic plan.

Synthetic biology takes the ideas of abstraction and rational design-build-test to develop new solutions. This "biodesign" opens up the possibility of developing entirely new bio-based products and therapies.

CRISPR-Cas is a powerful method for precise editing of genes from bacteria to human cells, providing a fundamental biodesign tool. CELLO, a design and simulation software tool, assists people to design genetic logic circuits and simulates the expected performance of the circuit. It builds on the core ideas of abstraction and prediction used to design electronic circuits in silicon, ideas that drove the computer revolution as it separated the design and execution tasks allowing specialisation.

Antha was developed here in the UK as a software tool to define workflows and manage data in the lab. It allows the complex automation and execution of experimental programmes beyond what a human can. Combining tools such as CRISPR-Cas, CELLO and Antha is driving new biotechnology.

Climate change and a focus on the environment has also led to increasing regulation of activities. Consumers are now more aware of the environmental impact of delivering everyday products and services and are looking for alternatives. The popularity of "Green New Deal" policies in the last two years further illustrates the appetite for new thinking. Even the current Covid-19 pandemic is being viewed as the precursor to a bigger global struggle against climate change.

However, commercial success in

biotechnology remains difficult. There are plenty of problems and lots of new technologies. The challenge is finding a route from idea to market through a complex landscape of needs and concerns. The Cambridge Consultants' Bioinnovation Team collaborates with companies worldwide to identify these routes and navigate them effectively.

Bioinnovation and sustainability

Bioinnovation looks beyond the technology to the intersection of tools (biotechnology), rules (governance models) and interests (economic models). It recognises the complexity of delivery and focuses on how to create sustainable value and embraces the reality that there will always be a risk versus reward debate around technological advances – particularly where biotechnology in concerned – and this debate must be had.

Earlier this year an editorial in *Nature* brought economists and scientists together in an effort to align scientific and economic research and unite them into a broader framework. Similarly, in September 2018 the World Economic Forum published an interesting dialogue focused on food systems where they define this model of tools, rules and governance for bioinnovation.

The UK is at the forefront of synthetic biology

Innovation is required in biotech, governance, and economic models to enable commercial success. Biotechnology gives techniques and methods to develop and supply products and services in a long-term sustainable way, but this alone is not enough. The challenges are very different across sectors from therapeutics to agri-tech to industrial biotech.

Cell therapies are now available where genetically modified cells are infused into patients to treat cancer. This can be highly effective, giving relapsed or refractory patients a cure, and this potential sucess outweighs concerns about using genetically modified materials – but the cost and access to treatments are an increasing issue as benefits are demonstrated.

Conversely, in agriculture genetic modification gives new ways to increase food production and manage the effects of climate change, yet there is strong debate about the willingness to grow and eat modified crops and animals.

Industrial biotech is all about scale and cost. The debate here is typically between interests and technology: is there a green premium society that is prepared to pay for biotech approaches to manufacturing that reduce the environmental impact?

Routes forward

There are three tangible actions we can take to drive towards more rapid commercialisation.

We need to break the vertical integration model: today delivery of biotech is highly vertically integrated – one company takes on everything from research to volume manufacture. This forces organisations to be generalists. Other industries commercialise and thrive through specialisation: companies become expert in one part of the process. Ford assembles and markets cars, other companies supply parts and services aligned to their specific expertise. Synthetic biology is building the toolset to do this in biotechnology, and further support is needed in developing necessary governance models and frameworks such as technical standards to allow seamless integration between different organisations.

We must have innovation through start-ups, meaning funding and incubation. The increasing emphasis on start-ups and entrepreneurs for early-stage development is taking on the vertical integration model. The challenge here is scale. Significant innovation takes a lot of effort and the funding needed at an early stage can be large. However, the UK does not have the mindset to invest large at an early stage, especially compared to US. We need to develop investment and economic models to encourage that necessary investment early on, to deliver a step-change innovation.

There needs to be an informed dialogue regarding risk and reward. A key part of the governance model is the risk-reward balance and how the numerous stakeholders engage and understand both the benefits and issues of new biotechnology. We need to build on existing frameworks and approaches to establish mechanisms for good engagement and evaluating acceptability given the changing attitudes towards the status quo.