

## Science &amp; Society

Industrial Biotechnology:  
To What Extent Is  
Responsible Innovation  
on the Agenda?Achim Rosemann<sup>1,\*</sup> and  
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**The UK Industrial Biotechnology (IB) Strategy presents a consistent plan to develop the IB sector but fails to endorse an innovation process that allows for input from multiple publics. This could be disadvantageous for the bioeconomy: there are notable cases where negligence to address societal dimensions has caused innovation failure.**

Hopes, Hype, and Responsible  
Innovation

Industrial biotechnology is portrayed as providing game-changing solutions for some of the world's greatest challenges. From climate change, to global health problems, alternative energy sources, and sustainable forms of production: IB promises a remedy – and new forms of economic profit. However, hype for new technologies tells a partial story. Despite the potential to shape more sustainable futures, advanced techniques in biological engineering and synthetic biology are not without risks and can have unintended disruptive effects. Like most transformative technologies, IB will have consequences – intended or otherwise – on the economy, industrial systems, and consumers [1]. In this article, we look at ways in which 'responsible research and innovation' (RRI) and an attention to the societal, ethical, and environmental implications of IB are discussed in current UK discourse, specifically the *National Industrial Biotechnology Strategy to 2030* [2] (Box 1).

We ask: In what ways, and to what extent, does the report address the societal, ethical, and environmental implications of industrial biotech innovations? And does it engage with ideas of RRI and associated practices of stakeholder engagement and systematic anticipation of downstream consequences? (Box 2). Although the National IB Strategy has set out a comprehensive plan to develop the IB sector, it lacks a consistent commitment to RRI and does not provide a plan for integrating relevant principles into actual research, innovation, and commercialisation practices. This raises concerns. The strategy promotes a top-down, 'deficit model' of communication to inform citizens and to make IB innovation more transparent, but it fails to endorse an open and inclusive innovation process that allows for input from societal stakeholders and the multiple publics that constitute society. We suggest that this would be disadvantageous for an emerging biobased economy: there are notable cases where failure to address societal dimensions has resulted in innovation failure and/or reputational damage. While the focus of our analysis is the UK, we believe the issues raised are relevant to IB innovation at a more general level.

## RRI: Catchphrase or Cornerstone?

A key feature of the UK National IB Strategy is that RRI is mentioned, albeit minimally. The Strategy does not define the term or provide ideas on how to operationalise the concept. The location

of the term is at the end of the document, in a sentence that states: 'Public commitment by academia and industry to the principles of RRI in conjunction with development of public awareness of IB will help to foster positive social attitudes [...] and drive the market pull for responsibly developed IB products.' (p. 52) [2].

While the Strategy repeatedly mentions the expected future societal and environmental benefits of IB innovation, it does not refer to societal concerns, such as dual use applications or potential adverse effects of biomanufacturing on the environment. While protagonists may understandably wish to downplay such concerns, or indeed view them as irrelevant, the core principles of RRI are an acknowledgement that no technology is 'risk free' and that engagement with civil society is necessary so that 'a social license to operate' is maintained. The selective emphasis on the benefits of IB, the neglect of potential adverse effects, and the absence of a convincing commitment to RRI principles, present a missed opportunity to demonstrate openness and transparency in communication and in intent.

RRI Is not Just 'Public  
Communication'

The shaping of public awareness on IB is a key concern of the National Strategy, primarily in ways that intend to alleviate concern and help foster positive social attitudes. To achieve these goals the

## Box 1. A National Vision for IB

In 2018, the UK Industrial Biotechnology Leadership Forum (IBLF) published *Growing the UK Industrial Biotechnology Base: A National Industrial Biotechnology Strategy to 2030*, a report that advances an ambitious vision and roadmap for the UK IB sector from 2018 to 2030 [2]. Copromoted by the UK Bioindustry Association (BIA), the report sets two ambitious goals: to develop a national strategy that establishes the UK as a world leader in IB, and to enable the sector to become a mainstream part of UK industry. In order to achieve these goals, the document proposes a programme that involves a variety of elements that range from the development of a supportive policy and regulatory environment, improved access to funding and finance, the promotion of trade and commercialisation, to unified communication and public outreach. From this, the report develops a plan of action that seeks to cultivate a political, regulatory, infrastructural, and public environment that supports the IB sector consistently and that aids realisation of the technological and economic potential of IB. The document proposes a three-phase implementation plan and close collaborations with UK funding bodies, government departments, and industry organisations.

**Box 2. RRI**

RRI is an action-oriented policy concept that aims to connect research and innovation with the values, needs, and expectations of society. It seeks to anticipate the environmental, societal, and economic consequences of new inventions and technology applications, and encourages broad, early-stage public engagement and continuous collaboration between societal actors during the whole of the research and innovation process [7,8]. In the past few years, RRI has been promoted by funding bodies in the EU and the UK. RRI ideas have also played a role in the governance of controversial technology fields such as synthetic biology, nanotechnology, and artificial intelligence. In the UK, for example, RRI was a central element in the 2012 Synthetic Biology Roadmap and the funding of several Synthetic Biology Research Centres. It is also promoted by recently funded Doctoral Training Centres of the Engineering and Physical Sciences Research Council, and applied across a plethora of technologies [9]. These examples show that in various areas of the UK innovation landscape, RRI is meaningfully happening. Considering this, it is surprising that the National Industrial Biotechnology Strategy lacks a clear commitment to RRI and fails to provide a plan for integrating RRI into practice.

strategy proposes a plan for ‘targeting the masses’. This plan involves techniques such as: public advertisements, working with ‘celebrity IB champions’, ‘developing brand and communication channels (for example: YouTube channel, video of pitches for investors, case studies, etcetera)’ (p. 44) [2]. The report summarises the goals and strategies under the umbrella term ‘communication’. Communication is defined in the report in several ways. These include: speaking with ‘one IB community voice’ that can disseminate ‘consistent clear messages’; and making sure that ‘society is well-informed and supportive of responsible research and innovation in IB’ (p. 7) [2].

This last statement is of interest: it presupposes that RRI is a given and is automatically present in the processes and/or products of IB innovation. However, this is an illusion. Most innovations, in particular those that make use of controversial technologies or procedures such as the genetic modification of microbes, or the generation of new microorganisms ‘from scratch’, will create new types of dilemmas, potential risks, and public concerns. Additionally, these challenges may well have to be addressed on a case-by-case basis.

To address controversies and to reduce public concerns requires the consistent and long-term involvement of society; not just in the form of a one-sided, top-down

transmission of information from the IB community to wider society and the public, but in a multidirectional process of learning [3]. Societies need to decide collectively to what extent they want to embrace the opportunities of IB, and to what level they will mitigate potential adverse effects relative to the benefits of IB innovation.

The National IB Strategy seems unprepared for this purpose in our view. While its aim is to assure that by 2030 ‘wider society is well-informed and supportive of RRI in IB’ (p. 44) [2], it reduces communication to a one-way feed that is based on the long-defunct deficit model: a scientifically illiterate public needs to be informed, indeed taught, and its attitudes and perceptions need to be changed (<https://www.scidev.net/global/communication/feature/public-understanding-of-science-lessons-from-the.html>).

**More Sustainable Futures Do not Lessen the Need for RRI**

As in most strategy documents, the National IB Strategy invests in space to introduce possible future benefits of IB innovations. While there is justified hope that many of the services, products and manufacturing processes that the IB sector is developing have the potential to make production cleaner, and consumption and waste management more sustainable, this does not make RRI a redundant goal. To start with, all IB products

will not necessarily make the world a cleaner or a better place. Many will facilitate production of the same kind of fast-moving consumer goods that fill the shelves of supermarkets today. More importantly, to produce new products and manufacturing processes that are ‘more sustainable’ does not mean that they are necessarily safe or without unintended adverse effects for human societies and the environment [4,5].

The National IB Strategy sketches over these challenges. What is conveyed instead is an entirely rosy picture, in which many of the world’s current problems will be solved. Unquestioning support for IB, from this perspective, becomes a moral imperative. Any attempt to slow down or restrict IB innovation becomes an ‘immoral act’, because it increases human suffering or environmental degradation. This ignores a thoroughgoing evaluation of potential future risks and unintended consequences of innovations. It also neglects a more holistic reflection on how new innovations will be distributed across societies and how advances in the IB sector will impact existing economic, agricultural, and environmental systems and the lives and behaviour of citizens and consumers.

**Concerns on Being ‘Left Behind’ Should not Override a Commitment to RRI**

Underneath its optimistic rhetoric of the widespread potential of IB, the report expresses a clear concern. The UK, we are told, is in danger of ‘falling behind other countries’, and at the same time ‘cannot afford to be left behind’. This trope is commonplace across many technical sectors seeking to remain visible to funding and policy agendas. Nevertheless, a tough economic landscape, the unpredictable consequences of Brexit, alongside a pound that since 2016 has steadily weakened, increases the pressure on industry and innovation sectors in the UK to

succeed, perhaps more than in the past. We maintain, however, that the aim to achieve economic sustainability for the UK, or any country, should not override a commitment to responsible innovation. Hasty or aggressive innovation practices that ignore public concerns or societal consequences can backfire, and indeed create more harm long-term than short-term benefits can justify.

### Concluding Remarks

The UK National IB Strategy to 2030 lacks a consistent commitment to RRI that is backed up by plans to operationalise RRI into research, innovation, and commercialisation practices. To invest in more sustainable products or production, as we have pointed out, does not preclude the need for RRI. If IB gains a more prominent role, the sector will be subjected to increasing public debate and scrutiny [6]. Failure to embed RRI ideas into innovation processes and to embrace a meaningful dialogue with local and global publics and stakeholders, could be disadvantageous

for any emerging biobased economy. As the controversies and critical public responses to the use of genetically engineered algal oil by companies such as Solazyme and Ecover illustrate (<https://www.rathenau.nl/en/publication/algae-oil-trial>), failure to adequately engage with societal dimensions can result in innovation failure and/or reputational damage. Considering these challenges, the development of IB requires a multidirectional process of learning, and an honest, systematic assessment of the mid-to-long term effects of IB innovation. Reliance on claims of improved sustainability alone is not enough.

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