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## **Genomic technologies in the bioeconomy: Introduction**

This section of the Handbook brings together a set of chapters that provide an overview of social science scholarship about “the bioeconomy”, especially as it pertains to health and human genetics. As pointed out by Paul Martin in his chapter, “[t]he notion of the bioeconomy only emerged in the 2000s and was largely absent from public and policy discourse before then, but has since become one of the most important justifications for public investment in genomics” (Martin, this volume). In 2012 both the United States (US) and the European Commission (EC) published key documents setting out their strategy for promoting the bioeconomy (European Commission, 2012; The White House, 2012). The definition of the bioeconomy in the US *National Bioeconomy Blueprint* is representative of how the bioeconomy is portrayed in policy documents produced by governmental institutions:

“...the bioeconomy [is] economic activity powered by research and innovation in the biosciences [...]. The bioeconomy emerged as an Administration priority because of its tremendous potential for growth and job creation as well as the many other societal benefits it offers. A more robust bioeconomy can enable Americans to live longer and healthier lives, develop new sources of bioenergy, address key environmental challenges, transform manufacturing processes, and increase the productivity and scope of the agricultural sector while generating new industries and occupational opportunities.” (The White House, 2012)

Scientific institutions involved in biosciences, notably those involved in genetics, have also embraced the concept. As just one example, the Chairs of the UK’s three bioscience Leadership Councils produced this definition:

“All economic activity derived from bio-based products and processes which contributes to sustainable and resource-efficient solutions to the challenges we face in food, chemicals, materials, energy production, health and environmental protection” (BBSRC, n.d.).

Thus, governmental and bioscientific institutions have defined the bioeconomy in terms of its *materiality* as economic activity derived from biological research and innovation, and the products and processes that are expected to arise from that research/innovation. They have also expressed immense optimism about the prospects for the bioeconomy for solving a wide spectrum of environmental and health problems; although, ultimately, for governmental institutions, “it is about growth and jobs” (European Commission, 2012). Portrayals of the bioeconomy by its advocates are very positive, in several senses of the word. They are clearly “hopeful and confident, and think of the good aspects of a situation rather than the bad ones” (Anon, n.d.). In addition, the bioeconomy is portrayed as positive in the sense that it is “real” and this reality is built upon tangible “actual or specific qualities” (Anon, n.d.), namely the value that can be extracted from biological materials. In contrast, social science scholarship does not take the positive nature of the bioeconomy for granted. It is more critical about the potential outcomes, both about whether the optimistic hopes will be realized in the foreseeable future, and whether these hoped-for futures should be seen as positive and unreservedly welcomed, especially for/by the least powerful, such as patients and women. Social science scholars also stress the intangible attributes of the bioeconomy. They do not focus only on the biological basis of the bioeconomy. Instead, they show the ways in which the bioeconomy depends on, and generates, new or particular political, economical and social realities. In 2006, in one of the first policy documents about the bioeconomy, the Organisation for Economic Cooperation and Development (OECD) did seem to recognize that the bioeconomy was not just about particular kinds of economic activities, but also about the transformation of our world: “the bioeconomy can be thought of as a world where biotechnology contributes to a significant share of economic output” (OECD, 2006, p. 22). The chapters in this section review how social scientists have described and analysed these transformations. Although the authors express scepticism about both the reality and the universally positive impact of the bioeconomy, they all seek to

move beyond sweeping celebrations or castigations of the hoped-for futures portrayed by the advocates of this new world in order to analyse the underlying transformations co-produced alongside the political-economical project of the bioeconomy.

As the chapters in this section demonstrate, the bioeconomy is not simply “powered by” biological research and innovation: the bioeconomy *transforms* the organisation and conduct research and innovation that it purportedly depends on. In particular, it involves an increased permeability between public and private spheres. Thus, for Chiappetta and Birch “the bioeconomy is more than an analytical or descriptive category; it is also a political-economic project embedded in particular capitalist logics” (Chiappetta and Birch, this volume). They stress that “these policies and visions represent more than the conceptualisation of the potential benefits of biology itself; they are also implicated in policy attempts to shape the direction of biological R&I as a capitalist enterprise”. Their chapter, like others in this section, builds upon important prior work by social scientists on “biocapital”, that has stressed the intimate links between biotechnologies and market, notably by Marxist-inspired scholars Sunder Rajan and Catherine Walby (Sunder Rajan, 2006; Waldby & Mitchell, 2006); and feminist scholars Sarah Franklin and Margaret Lock (Franklin & Lock, 2003). In 2008 Stefan Helmreich published a comprehensive review of what he termed “species of biocapital,” sketching out a “variety of terms have been forwarded to name how ‘life’ in the age of genomics, stem cell research, and reproductive technology has become enmeshed in market dynamics” (Helmreich, 2008, p. 463). A decade on, the chapters in this section of the Handbook illustrates how science studies scholars have continued to “generate their own accounting of the bioeconomy” (Helmreich, 2008, p. 463).

The chapters in this section also build upon prior scholarship on sociology of expectations by Nik Brown, Paul Martin and others, focusing on the role of (generally unfulfilled) hope (Borup, Brown, Konrad, & Van Lente, 2006; Brown & Michael, 2003; Martin, Brown, & Kraft, 2008). Paul Martin’s chapter starts from the observation that although the field of genomics has attracted massive public and private investment over the last 20 years, progress in translating this into widely used clinical applications has been slow. Martin therefore asks: “how has it been possible to sustain high levels of public and private support and investment for genomics over a long period in the face of limited tangible benefits for healthcare?” and “how has support for the idea of the bioeconomy gathered momentum in the context of this slow progress in realizing the benefits of genomics?” These questions also permeate through the other chapters and endure as a key interest in social science analyses of the bioeconomy. Martin’s chapter shows how this high level of hope has been maintained around a perpetually reconstructed *future potential* of genomics. It analyses the performative function of this “genomic hope” in winning support for a particular imagined future and shows how genomic hope, the application of technology in healthcare and the creation of the bioeconomy have been and continued to be *co-produced*.

Martyn Pickersgill’s chapter describes an “imagined biological” based on a range of assumptions and understandings of articulations of genes, brains and bodies that configure. His chapter analyses how assumptions about the plasticity of this imagined biological influence policy rhetoric and policy interventions - especially for “the early years” (the first three years of a child’s life); and on the creation of capital associated with the plasticity of this imagined biological. He shows how bodies are understood to shift and change, and how understandings of the imagined biological also shift over time. When the biological is understood as mutable, interventions on the biological are promoted as a source of societal and economic value: producing citizens who are healthier and better adapted to what is expected of them in a capitalist society, and who are not a burden on “the tax payer.” Thus, like “genomic hope”, discourse around the “era of the brain” and epigenetics presents the (imagined) biological as promissory matter.

Edward Nik-Khah’s chapter focuses on the way in which economic ideas are used to justify particular forms of organization of science and medicine. He argues that the most distinctive - but often overlooked - feature of neoliberalism concerns *knowledge*. Unlike classical liberals, neoliberals do not argue that markets should be praised for their presumed superiority in allocating goods or enhancing productivity, but for their capacity to generate knowledge: their “*epistemic virtues*.” He demonstrates how a phalanx of academic departments and think tanks around the Chicago School of Economics has set about promoting their particular neoliberal view of pharmaceutical science and regulation. A key feature of this vision is that science must endorse the epistemic superiority of the marketplace. This leads them,

for example, to argue that post-market surveillance should replace large scale randomized clinical trials for new pharmaceuticals: real-world data and the Internet of Things is promoted as a far more effective means of producing evidence than Randomised Clinical Trials and publications in academic journals. These neoliberals envision partial “incomplete” approvals of new drugs, that would allow the medical marketplace to generate knowledge. They recognize that this may conflict with the pursuit of patient health but rather provocatively argue that “the problem is not that we have too many thalidomides, but too few” (Nik-Khah, this volume).

Lamoreaux identifies “gendered bioeconomies” as an important “species of capital.” Her chapter reviews the literature from feminist science studies scholars, who have stressed the importance of analysing the interlinkages between gender (and ethnicity) and biotechnology. Thus, “[n]ot only are biotechnologies intertwined with markets, but they are also entangled with gendered and racialized bodies and biological substances” thus “[r]eproductive biovalue is incalculable without consideration of gender (Lamoreaux, this volume). Feminist ethnographic researchers have revealed systematic asymmetries between women and men, as well as their associated germ cells. For example, Lamoreaux draws on Almening’s (2011) work that shows the differential values attributed to egg and sperm, where men who “donate” sperm are understood as employees performing work, whereas women who donate eggs are viewed as altruistic gift givers. Lamoreaux points out that the commodification of germ cells and reproduction does not just produce babies, but also gendered understandings of the body, of reproductive expectations, and new gendered pharmaceutical, medical, scientific and labour markets. Lamoreaux also emphasises the intersectional dimension of feminist analyses of the bioeconomy. While many social studies scholars (e.g. Chiappetta and Birch, in this volume) emphasise the importance of focusing on “the political-economic” rather than only the biological or material, analyses by feminist scholars tend to reject this dichotomy altogether. They analyse the circulation and valuation of material and immaterial phenomenon in tandem, and thus stretch understandings of both reproduction and the economy.

The concept of the bioeconomy, as promoted by its advocates, is based on a notion of “latent value” that can be extracted from biological material and processes. The chapters in this section illustrate how different conceptions and implications of this notion of latent (bio)value can be identified in the social science literature on the bioeconomy. Chiappetta and Birch argue that for some science studies scholars, notably Waldby, latent value (in the form of biotechnological products) is *inherent* in living matter (e.g. tissues, cell lines) “as surplus or waste.” Here the notion of “latent value” is quite close to that used by advocates of the bioeconomy from governmental and scientific institutions whereby latent value is “incumbent in biological products and processes” (OECD, 2006, p. 1). Chiappetta and Birch stress that, from their perspective, latent value is not inherent in biological material and processes; rather, it is conferred by the networks working on these objects. For Martin, and other work that focuses on the promissory or speculative nature of the bioeconomy, value is latent in the sense that it is perpetually positioned in a hoped-for future. As discussed by Chiappetta and Birch in their chapter, Sunder Rajan is interested in what he terms an “inversion” of production and value apparent in the bioeconomy: “he is interested in how promise, hope, and other future claims come to constitute present value as a result of the expectation that modern biotechnology will lead to commercial products” (Chiappetta and Birch, this volume). This can be seen as another form of “latency”. In Pickersgill’s chapter, another form of “latent value” emerges, where the creation of capital emerges from the plasticity of the “imagined biological.”

The last chapter in the section, by Uli Felt, is about the concept of “Responsible Research and Innovation” (RRI). RRI has emerged in the last 5 years or so as the latest in a series of attempts by scientific institutions to address what they perceive as problematic links between “science” and “society”. Previous attempts, under the banner of Ethical and Legal Issues (ELSI or ELSA), were criticised by some science studies scholars because they only allowed a narrow set of questions to be raised, often pre-formatted by the physical/natural scientist; and ultimately appeared more focused on smoothing out social concerns rather than addressing them. The ELSI/ELSA model was also associated with a division of moral labour: “scientific” researchers are seen to be responsible for the creation of knowledge and technology, while ELSA/ELSI researchers, who come from the social sciences and humanities, care for and reflect upon the social and ethical implications of the knowledge and

technology created. When RRI first emerged around 2012, it was presented by some authors as a response to these critiques and there was some hope among some science studies scholars (myself included) that RRI might provide the means to move away from the “science and society” ELSI/ELSA model into a more open, more participative and more reflexive model that would recognise the intricate interlinkages of “science in society.” Just a few year later, these hopes appear to be dashed. Arie Rip (2016), for example, has suggested that RRI can be seen as the emperor’s new clothes. Felt shows how RRI could perhaps have become a means to help disentangle - and challenge - the links between sociotechnology and capitalism generated by/in the bioeconomy that the other chapters in this section explore. However, this would have meant enabling RRI programmes to ask uncomfortable questions, for example around the taken-for-granted optimism about “scientific progress” and its necessarily positive contribution to healthy and sustainable livelihoods. Many RRI programmes have attempted to overcome ELSI/ELSA’s moral division of labour” by enforcing collaboration between researchers and other scholars from the social sciences, humanities, and the arts, but this has usually still (like ELSI/ELSA programmes that came before) been as part of co-funded programmes led by the natural/physical scientists. Together with colleagues involved in RRI programmes in the field of synthetic biology in the UK, I have found that such collaborations seriously limited the kinds of roles that can be played by science studies scholars could play (Balmer et al., 2015, 2016).

Felt also explains how RRI emerged at a time when innovation came to be seen as the key driving force for societal development. As Felt says, during this period “[t]he importance of a steady flow of innovations to assure international competitiveness has become the core mantra in European discourse”. The chapters by Martin and Nik-Khah also reveal how the discourse around the bioeconomy is associated with a shift in language from “research and development” to “innovation,” which was in part a response to the unfulfilled hopes about the delivery of biotechnology products onto the market. In the pharmaceutical sector, the so-called “productivity crisis” (a decreasing number of novel drugs at the same time as rising R&D costs) has been used as justification for a new innovation model based on public-private partnerships (Nik-Khah, this volume). The slow progress in the rate of adoption of genomics in the clinic is used to justify major organisational change and investment “not only on the grounds of improved patient care, but also in promoting innovation and entrepreneurship within the bioeconomy” (Martin, this volume). In this context, it is difficult for RRI initiatives to ask questions that challenge the very need for this continuous flow of innovations, and the overall organisational changes associated with this push for scientific entrepreneurship. As I have argued elsewhere, social scientists working within RRI programme may wish to bring to the fore “uncomfortable knowledge” that their collaborators from the natural sciences actually need to ignore in order to function (Marris, Jefferson, & Lentzos, 2014). As a result, RRI programmes, like ELSI/ELSA programmes before them, tend to address only narrowly defined concerns about the “responsible” nature of specific innovations or fields of technoscience (essentially “do no harm”). As Felt suggests, it seems that, rather than opening up discussions about the (capitalist) politics entangled in the bioeconomy, RRI is destined to serve neoliberal ideas through depoliticizing debates. Therefore, despite so much social science scholarship on the ways in which the bioeconomy is necessarily entangled and co-produced with social, political and economic realities, the notion of the bioeconomy promoted by policy actors remains positive in yet another sense: it is portrayed as ostensibly “free of ethical, political, or value judgments” (Anon, n.d.).

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