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Forum on Synthetic Biology

Synthetic biology is a rapidly emerging field in the life sciences that radically departs from traditional biology. The traditional approach to biological research has been to isolate a small number of biological components in order to understand their structure and function. This reductionist approach assumed that single biochemical events resulted in single effects, in a simple cause-and-effect relationship. In reality, most genes, proteins and other components carry out their functions within a complex network of interactions, with positive and negative feedback loops that regulate their operation. A single component, such as a gene, thus rarely controls a specific biological function or disease. Indeed, any given component may influence many different functions.[1]

The simple cause-and-effect framework of the reductionist approach places severe restrictions on our ability to understand, manipulate and design increasingly complex systems, and a new approach to biology has emerged called systems biology. Acknowledging that biological systems are multi-scale and multi-level, this approach tightly couples state-of-the-art biological measurements with sophisticated mathematical and computational modelling to facilitate our understanding of how networks of interactions between the components of a biological system give rise to its observed properties.

Over the last decade, advances in molecular biology technologies have allowed scientists to manipulate, or re-engineer, DNA coding regions in many different organisms from bacteria, to plants, to animals. This has led to a revolution in molecular and cell biology—driven, primarily, by the genome project. Animal models of human disease can now be created, cell-based systems can be manipulated to address fundamental biological problems, and organisms can be altered in various beneficial ways. However, all of these approaches are primarily based on hypothesis-driven questions, where researchers aim to address specific questions with often single and specific experimental solutions. By contrast synthetic biology aims to establish a rational framework for DNA manipulation, based on the application of engineering design principles. In short, synthetic biology 'strives to make the engineering of biology easier and more predictable' (Royal Academy of Engineering, 2009: 13).

There are a number of different activities that fall within the term synthetic biology. The creation of minimal genomes, as discussed by Craig Venter in the panel discussion 'Beyond the genome: The Challenge of Synthetic Biology', which we published in *BioSocieties* 3(1), is one approach. The standardization of parts, devices and systems, described by Drew Endy in our roundtable on synthetic biology published in *BioSocieties* 3(3), is another. In this issue of *BioSocieties* we publish a pair of lectures delineating two additional approaches: the metabolic engineering approach advanced by Jay Keasling and the development of chassis described by Pam Silver. Alongside these lectures we publish an article by Evelyn Fox Keller in which she explores what synthetic biology has to do with biology, and an article by Filippa Lentzos in which she outlines the events and discussions that have taken place

1 See Pearson, 'What is a gene?', for a helpful and accessible account of how our thinking about genes has changed over the last century.

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in the United Kingdom over the last few months about the social context of synthetic biology.

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