THE FOUNDATION FOR SCIENCE AND TECHNOLOGY

DINNER/DISCUSSION SUMMARY

Synthetic Biology – a threat or an opportunity?

Held at The Royal Society on 18th November, 2009

The Foundation is grateful for the support for this meeting from the Biotechnology and Biological Sciences Research Council, the Home Office, Imperial College London and The Kohn Foundation.

Chair: **The Earl of Selborne KBE FRS**
Chairman, The Foundation for Science and Technology

Speakers: **Professor Richard Kitney OBE FREng**
Professor of Biomedical Systems Engineering, Department of Bioengineering, and Senior Dean and Director of the Graduate School of Engineering and Physical Science, Imperial College London
Professor Pamela A. Silver
Department of Systems Biology, Harvard Medical School
Professor Nikolas Rose
Director, BIOS Research Centre for the study of Bioscience, Biomedicine, Biotechnology and Society, London School of Economics and Politics

PROFESSOR RICHARD KITNEY said that the emergence of Synthetic Biology was a field with immense potential for wealth creation - comparable to the impact of synthetic chemistry in the 19th Century - had resulted from a number of factors both within biology (the discovery in 1953 of the double helix and the completion in 2001 of the initial sequencing of the human genome) and outside it, such as the speed and vast storage space of modern computers and the internet. Researchers had been able to understand living organisms in much more detail both at the level of individual molecules, cells and as complex systems of cells.

A key feature of Synthetic Biology had been the application of engineering principles to biological system design and development (i.e modularity, characterisation and standardisation). This had made it possible for researchers to obtain to order synthetic DNA (from principally German and US companies) and to make use of a central registry of standard parts so that systems could be designed and built using standard devices and parts. The availability of such basic materials had provided an invaluable platform from which research into the possible applications of Synthetic Biology technology could proceed at a much faster pace. Areas which could be particularly susceptible to Synthetic Biology included vaccines, biofuels, agro-science and new drugs. Those working in Synthetic Biology were well aware of the major impact which it could have outside the realms of science and technology and in the realms of ethics and society. They had therefore seen it as vital to involve social scientists closely in their work both to maximise the beneficial outcomes of that work and to minimise the disruptions to that work from ill-informed fears about the consequences of that work. The close collaboration between LSE and Imperial was evidence of this. If the UK was to take full advantage of this new source of wealth creation which would be emerging over the next 30 to 50 years (and not miss out in the way it had with the IT revolution in the 20th Century) action would be needed now to develop the necessary educational base, research base and industrial base.

PROFESSOR PAMELA SILVER saw Synthetic Biology as having a number of important advantages over engineering although drawing upon the principles of engineering; it was modular in construction, it was highly sensitive and it was capable of easy duplication. Moreover it had been shown that cells had the capacity both to count and remember. The core element was the availability of cheap and quick DNA synthesis, just as the availability of cheap chips had enabled the IT revolution to occur. Her vision was that researchers would be able to design products incorporating clever Synthetic Biology devices without needing to know just what those devices contained. Design would become easier and more predictable and the real challenges would become not the DNA component but the ways in which such components could be harnessed to a variety of different applications.

Professor Silver described in some detail research into ways of engineering micro-organisms for the production of energy and harnessing the mechanisms of photosynthesis as a source of materials which would have advantages (economic and environmental) over those at present only available in nature. But she also emphasised that scientists needed to be aware of the impact of Synthetic Biology in the social and political contexts. The lessons of the unintended consequences of some biofuel projects needed to be learned. The geopolitical consequences of replacing oil with fuel produced by Synthetic Biology could be immense.

PROFESSOR NIKOLAS ROSE underlined the importance of social science as a key factor in enabling the full potential of Synthetic Biology to be realised. History had shown that the scientists and engineers developing a new technology needed to have regard to its social and political context and to be aware of the unintended consequences. Research had shown that the public was not generally as distrustful of scientists as the media might frequently suggest but that there were four important areas of concern to which scientists needed to have regard. The public was concerned about "biosafety" – the risks of accidental release of laboratory created organisms and the subsequent absorption of them by other organisms. He believed that the systems of regulation now in place provided adequate protection against such risks but he was aware that public opinion did not generally share that judgement.

A second area of concern was "biosecurity" – the risks of deliberate use of Synthetic Biology organisms in aggressive actions. The ability to buy synthetic DNA cheaply and to misuse it could be worrying to many people. He believed that such concerns were probably exaggerated and needed to be debated openly between scientists and the public. The public needed to understand better both the magnitude and extent of the potential advantages available from advances in Synthetic

Biology technology and the true nature of the potential risks and how those risks could best be minimised.

A third area of concern was in the field of intellectual property rights and a fear that commercial interests might lead to a lack of freedom to exploit the benefits flowing from the advances in knowledge achieved by Synthetic Biology research. Provided that patenting could be focussed "downstream" these concerns could be overcome.

The fourth area of concern was that "humans had no right to create the organisms that evolution had forgotten" and that it was both morally wrong and potentially dangerous for humans to seek to go beyond the limits which nature set for itself. He believed that a combination of informed dialogue and stable regulatory systems could do much to reduce such concerns. In his opinion nature was not our ally and it was right for humans to use science to help them deal with nature.

His key message was that social science had a crucial role to play in ensuring the success of natural science and in identifying the possible unintended consequences of new technologies so that timely action could be taken to reduce them.

In the subsequent discussion there was general support for the notion that social science had a vital role to play in ensuring the success of natural science. There was also general support for the need for scientists to engage in open and candid debate with the public about the advantages that Synthetic Biology could bring and the risks which might be involved. The history of the motor car was a good example of the readiness of the public to accept the benefits of new technology despite the attendant disadvantages, such as road deaths. Recent experience over GM had shown all too clearly the consequences of a failure on the part of scientists to engage in sufficient activity to inform the public properly about the reality of the risks and the potential of the benefits. It was however important for scientists to resist the avid appetite of the public (and perhaps Governments and other sources of funding) to expect unrealistically early returns from research endeavour.

Some speakers commented on the need to ensure that Non-Governmental Organisations (NGOs) properly understood the benefits of new technologies such as Synthetic Biology; the GM experience had shown the influence which NGOs could have on public opinion. Scientists needed to be alert to the risks of losing their licence to practise. It was also suggested that there could be advantage in the scientific community making greater use of professional public relations teams to manage the way in which its messages were conveyed to the public and to politicians.

Some speakers voiced concerns about the potential dangers of misuse of new knowledge emerging from Synthetic Biology research but it was also pointed out that some of the worst threats from bioterrorism already existed (e.g. anthrax) and the fears had proved to be unwarranted. Moreover, it would be foolish for society to forego the benefits flowing from advances in technology just because of the potential dangers; it would be better to find ways of deterring bad people from doing bad things than to stop the creation of good things because bad people might misuse them. One speaker urged that attention should be given to the inequalities that could arise from the mismatch between winners and losers as a result of technological advance.

There was some discussion about what action was needed to ensure that the UK became a big player in any future Synthetic Biology revolution. It was pointed out that commercial opportunities were already there for UK companies to start to exploit. German and US companies were already active. But the discussion was short on specifics and there was no comment about the steps which might need to be taken to ensure that the educational base in this country was appropriate to enable the UK to play a prominent part in an endeavour requiring inputs from a variety of separate disciplines.

The key messages to emerge from the evening were that Synthetic Biology was here to stay with immense potential for both good and ill. It was important that the potential for ill should not be allowed to stand in the way of realising the potential for good. The close collaboration between natural science and social science was to be welcomed; it provided a means for identifying the unintended consequences for social systems of scientific advance and for helping Governments to take appropriate steps to provide regulatory frameworks able to contain the ills and give scope for maximum benefits. Natural science needed the contribution of social science both to retain its licence to practice and to ensure public acceptance of its ability to confer net benefits on society. Scientists needed to engage in full and frank dialogue with the public both to learn and to educate.

Sir John Caines KCB

The speaker presentations can be found on the Foundation website at www.foundation.org.uk .

Useful web links:

Biotechnology and Biological Sciences Research Council
www.bbsrc.ac.uk

Economic and Social Research Council
www.esrc.ac.uk

The Foundation for Science and Technology
www.foundation.org.uk

Harvard University – Silver Lab
http://silver.med.harvard.edu

Home Office
www.homeoffice.gov.uk

Imperial College London
www.imperial.ac.uk

Imperial College London, Department of Bioengineering
http://www3.imperial.ac.uk/bioengineering

London School of Economics and Politics – Professor Rose
www2.lse.ac.uk/sociology/whoswho/academic/rose.aspx

Nuffield Council on Bioethics
www.nuffieldbioethics.org

Research Councils UK
www.rcuk.ac.uk

The Royal Academy of Engineering
www.raeng.org.uk/news/publications/reports/Synthetic_biology.pdf

The Royal Society
www.royalsociety.org

Select Committee on Science and Technology Inquiry into bioengineering
www.parliament.uk/parliamentary_committees/science_technology/s_t_bioengineering_inquiry.cfm