BIOCHEMICAL SOCIETY

Royal Society of Biology

SYNTHETIC LIFE:

How far could it go?
How far should it go?

WELCOME

Synthetic biology is a revolutionary technology that could have a huge impact on humans and our environment. The potential impact of this area of science is astonishing; from bacteria that could generate energy, to creating food without the need for large organisms.

Synthetic biology is dividing opinion. Today's speakers Professor Paul Freemont, Dr Louise Horsfall, Professor Robert Edwards, Dr Susan Molyneux-Hodgson and Chair Dr Adam Rutherford will discuss and debate this exciting topic and its possible applications.

This event has been organised by the Biochemical Society and the Royal Society of Biology, as part of Biology Week 2015.

We hope you enjoy the lively talks and thought-provoking debate.

#BiologyWeek

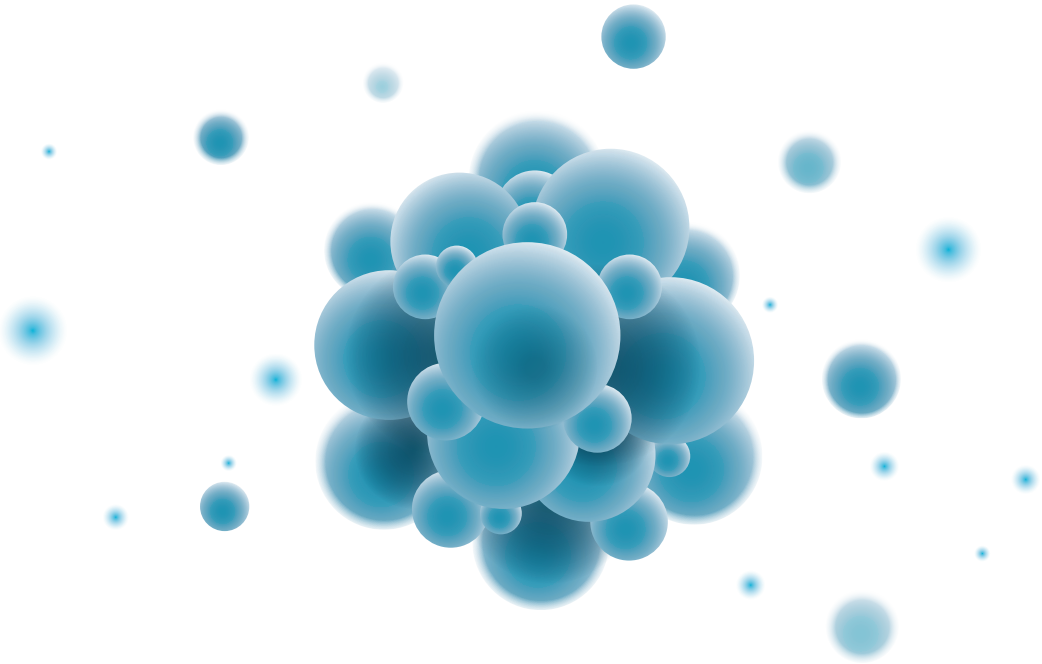
WHAT IS SYNTHETIC BIOLOGY?

Synthetic biology is so new there isn't one singular definition for it. It is based on the idea that engineering approaches can be used to study biological systems, manipulate them and to produce new ones that do not exist in nature.

All living things contain DNA (deoxyribonucleic acid), and it is found in every cell in our bodies. It is a unique code, made up of a sequence of chemicals. This sequence, called our genetic code or genome, determines how an organism is made; the same way the letters in the alphabet form words or sentences.

Humans have been manipulating the genetic code for thousands of years, by selectively breeding plants and animals with desired characteristics. As we have learned how to read and manipulate the genetic code, we have started to take genetic information from one organism and transfer it to another. This process we call genetic engineering, and it has enabled researchers to develop different varieties of plants and animals.

One of the most recent advances in genetic engineering is synthetic biology, which combines engineering and biology to design and develop novel organisms not found in nature.



HOW DOES SYNTHETIC BIOLOGY WORK?

Synthetic biology is essentially made up of two processes; organisms are either designed from scratch, or the nonessential DNA is removed from an organism.

Organisms are designed from scratch

BioBricks are pre-made sequences of DNA with specific functions, and are freely available for researchers to order. They can be combined to build more complex sequences, which can then be incorporated into living cells to construct a new genome. This process uses engineering approaches such as the standardisation of parts, to create new biological systems.

The nonessential DNA is removed from an organism

Specific sequences are removed from an organism, new ones are synthesised in the laboratory and are then transplanted back into the organism. Using this process, the J. Craig Venter Institute have successfully created the first self-replicating synthetic bacterial cell.

The use of either approach is generally associated with a team's research interests and research traditions. Each approach will allow scientists to gain a greater understanding of life.

Uses of synthetic biology

The potential uses of synthetic biology are far reaching, and the impact of these uses could be profound. Today's speakers will highlight some of the applications available to us, such as waste management, medicine and crops as well as the ethical discussions taking place around synthetic biology, such as who will decide on how it should be used, and what roles can society play in the technological developments.

ABOUT THE SPEAKERS

Dr Adam Rutherford (Chair) is a geneticist, science writer and broadcaster. He presents BBC Radio 4's Inside Science, and his book, Creation (2013), discussed the origin of life, genetic engineering and synthetic biology.

Professor Robert Edwards is Head of the School of Agriculture, Food & Development at Newcastle University and was formerly the Chief Scientist at the Food and Environment Research Agency. His research interests are focussed on the biotransformation of synthetic compounds and natural products in plants and the manipulation of these pathways for applications in crop protection and food chemistry, using approaches that include synthetic biology.

In the course of this century we will have to produce more food than we have in the last 10,000 years, when we are facing unprecedented climate change and the depletion of global resources needed for agriculture. In advanced economies, when we do produce more food, obesity increases, as does malnourishment. Can we solve these massive challenges in the next few decades without drawing on new technologies like synthetic biology to help us produce safe and nutritious food? - Edwards, R (2015).

Professor Paul Freemont is Co-director of the Synthetic Biology Hub at Imperial College London including the Centre for Synthetic Biology and Innovation and National UK Innovation and Knowledge Centre for Synthetic Biology. The Hub aims to develop foundational technologies to enable synthetic biology research in application areas like biosensors, biosynthesis, bioprocessing and metabolic and genome engineering and enable the translation of new synthetic biology technologies into industry.

Synthetic biology has a powerful vision for merging engineering design practice into the construction of biology systems and cells at the genetic level. It has led some commentators to predict a "Biotechnological Revolution" that will be transformative for the 21st century, but with such transformative potential comes significant societal and cultural concerns.

I am interested in applying synthetic biology to infectious diseases in terms of cheap, easy to use point -of-care diagnostics as well as developing novel antibiotics and new therapeutic approaches, but I do see challenges in the emerging field of human genome engineering. I am, however, optimistic that by developing the technology in an open, transparent and socially responsible way, the benefits of synthetic biology will become apparent and acceptable - Freemont, P (2015).

Dr Louise Horsfall is a Lecturer in Biotechnology at the University of Edinburgh. She is interested in multidisciplinary challenges involving Biotechnology, Synthetic Biology, Novel Enzymes and Protein Engineering. She is currently the elected co-chair of the Bioengineering and Bioprocessing Section of the European Federation of Biotechnology and a member of the EPSRC's Early Career Forum in Manufacturing Research.

I believe that synthetic biology has the potential to transform the way in which we view the waste we produce. We all know that the world has a limited amount of resources and that we need to move to a circular, more sustainable economy where we use the resources we have more wisely. If we can use waste as a feedstock then we can complete that cycle, and I believe that synthetic biology provides us with the tools to do that. As most waste is man-made we cannot rely on natural systems to do this for us, but we can be inspired by nature to design and engineer these systems for ourselves. In some cases solutions closely resemble simple garden composting and could be available very soon, but for other problems such as metals, where scarcity and supply security have become worldwide issues, any solution is years away - Horsfall, L (2015).

Dr Susan Molyneux-Hodgson is Director of Research, in the Department of Sociological Studies. Susan co-founded and is currently Director of the SATIS (Science and Technology in Society) research group. Her research is focused on three substantive areas: the sociology of scientific communities; science and society relations, and; interdisciplinary collaboration.

Synthetic biology has, so far, proven to be an intriguing development for those social scientists interested in analysing the worlds of science and innovation. From the early days of its appearance on the UK scene, a number of us have been entangled in the field's progression in various ways. Investigations into the challenges that the still-emergent field might pose to society and explorations of public views on the topic, were conducted relatively early on. We can raise the question of why that has been the case when other technologies do not necessarily experience these forms of deliberation. Is there something specific about synthetic biology that raises issues of democracy, politics and our place in the world?

The opportunity to discuss the two questions framing our debate this evening is most welcome. Based on my experience, responses to the first question – how far can it go? - could range from 'nowhere' to 'a very long way'. My initial response to the second question – how far should it go? - is another question: through what processes do we want to decide? - Molyneux-Hodgson, S (2015)

ABOUT THE ORGANISERS

The Biochemical Society promotes the future of molecular biosciences; facilitating the sharing of expertise, supporting the advancement of biochemistry and molecular biology, and raising awareness of their importance in addressing societal grand challenges. We achieve our mission though our publications and journals, scientific meetings, educational activities, policy work, awards and grants to scientists and students. The Biochemical Society is the largest discipline-based learned society in the biosciences with 7000 members.

The Royal Society of Biology is a single unified voice for biology: advising Government and influencing policy; advancing education and professional development; supporting our members, and engaging and encouraging public interest in the life sciences. The Society represents a diverse membership of individuals, learned societies and other organisations.

Biology Week is an annual celebration of the life sciences organised by the Royal Society of Biology. This year it takes place from 10th-18th October and includes over 100 events and activities all over the UK and beyond for everyone from children to professional scientists. The events will give people of all ages the chance to learn more about biology.

FURTHER READING

Synthetic Biology Project
http://www.synbioproject.org/

Information about researching and studying synthetic biology
http://syntheticbiology.org/

Synthetic biology engineering research centre
http://www.synberc.org/

Applications of synthetic biology
https://www.thermofisher.com/uk/en/home/life-science/synthetic-biology/synthetic-biology-applications.html

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[2] Cameron (DE), Bashor CJ and Collins JJ (2014) A brief history of synthetic biology. Nature Reviews Microbiology, Perspectives. http://collinslab.mit.edu/files/nrm_cameron.pdf
[3] Russ ZN (2008) Synthetic biology: enormous possibility, exaggerated perils. Journal of Biological Engineering. http://www.jbioleng.org/content/2/1/7#B2
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[5] Synthetic Biology (2015) BioBricks. http://syntheticbiology.org/BioBricks.html
[6] Stilgoe, J (2014) Don't shut the door on the synthetic biology debate. http://www.theguardian.com/science/political-science/2014/may/08/dont-shut-the-door-on-the-synthetic-biology-debate

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