Synthetic Biology: responding to the social and ethical challenges

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New report

- *Synthetic Biology: Social and Ethical Challenges*
  - Review commissioned by BBSRC of the main social and ethical issues raised by synthetic biology
  - Published yesterday and available at www.bbsrc.ac.uk
- Thanks to:
  - Members of BBSRC working group on synthetic biology exploring issues of concern to the public
  - Andy Balmer – graduate student who did most of the background research and drafting

Key questions

- What are the main social and ethical questions raised by synthetic biology?
- Who should be involved in dealing with these issues?
- What measures should be adopted?
- Are there any lessons that can be usefully learnt from the experience of other emerging technologies?

Placing synthetic biology in context

- No internationally agreed definition – key idea of applying engineering principles to modify living systems and create new ones
- Field in the making – different traditions in the US, UK and EU

Something old, something new

- Idea of biological engineering has a long history – central to the development of molecular biology
  - Loeb
  - Müller
  - Early work in molecular biology supported by Rockefeller Foundation
- What exactly is new – speed and low cost of DNA synthesis

Syn*bioethics:* the rise of concerns about synthetic biology

- Wide range of concerns expressed in scientific community and by civil society groups (e.g. ETC)
- ELSI streams in scientific meetings and calls for codes of ethical conduct, social science research, etc.
- Engagement with social and ethical issues in new funding streams
  - e.g. BBSRC networks

Areas of concern

- Uncontrolled environmental release
- Biological weapons
- IP – creation of monopolies
- Trade and global justice
- Creating artificial life

Environmental release (1)

- *Key scientific developments*
  - Venter – creation of first synthetic virus from scratch: bacteriophage Phi X174 (2003)
  - Minimal genome project – first synthetic bacterial genome (2008)
- Possible applications in biofuels, bioremedication, novel photosynthetic organisms

Environmental release (2)

- *Social and ethical issues raised*
  - Uncontrolled release of novel bacterial GMOs
  - Fears that engineered ‘components’ would have a selective advantage and could not be contained
- Parallels with fears about GM crops and nanotechnology

Environmental release (3)

- *Scientific and policy response*
  - Emphasis on success of established laboratory containment regimes and limited environmental impact of GM crops
  - New forms of biological containment
  - Improved oversight of SB and enforcement of biosafety governance

Biological weapons (1)

- *Key scientific developments*
  - Production of known, modified or new microorganisms designed to be hostile to humans
  - Synthesis of polio virus
  - Sequencing and construction of pandemic Spanish flu virus

Biological weapons (2)

- *Social and ethical issues raised*:
  - Lack of oversight of manufacturing of synthetic oligos. Journalist ordering parts of smallpox virus
  - Ease of access to knowledge and technology
    - Terrorist groups
    - Rise of ‘biohacking’ and ‘garage biology’
  - Lack of control over state use of SB

Biological weapons (3)

- *Scientific and policy response*
  - Proposals for self-governance
    - Tighten up control of Select Agents to cover SB
    - Better oversight of commercial DNA synthesis
    - Ethical standards and codes of conduct
  - External groups calling for statutory regulation and oversight

IP - creation of monopolies (1)

- *Key scientific developments*
  - Development of microorganisms for biofuel production
    - Creation of broad technology platforms
    - Venter - hopes to produce a synthetic form of *Clostridium* by amalgamating the genomes of two separate species, *Clostridium cellulolyticum* and *Clostridium acetobutylicum*

IP - creation of monopolies (2)

- *Social and ethical issues raised*
  - Broad patents may create monopolies and stifle innovation
    - Venter has filed patent applications for making synthetic genomes (UPSTO no. 20070264688) and putting them into cells (20070269862)
  - Overly narrow patents may lead to hundreds of patents covering a single part – complex licensing

IP - creation of monopolies (3)

- *Scientific and policy response*
  - BioBricks Foundation – 'synthetic biology commons'
  - Open Source model – allowing ready access to standard parts (700 by 2007)
  - Innovative forms of IP protection to enable public access

Trade and Global Justice (1)

- *Key scientific developments*
  - Use of SB to enable production of anti-malarial drug artemisinin in *E.Coli*
  - Artemisinin based combination therapy (ACT) holds significant promise to overcome drug resistant strains

Trade and Global Justice (2)

- *Social and ethical issues raised*
  - Case of artemisinin overhyped
  - Creation of monopoly by Novartis
  - Shift of production from developing to developed countries – dependency?

Creating Artificial Life (1)

- *Key scientific developments*
  - Search for ‘artificial life’
  - Attempts to produce life-like cells, minimal genomes, chassis and ‘chells’

Creating Artificial Life (2)

- *Social and ethical issues raised*
  - Fears of scientists ‘playing God’
  - SB destabilises traditional and lay notions of ‘life’ as an easily defined concept
  - Blurs the boundaries between the animate/ inanimate, natural/ synthetic

Creating Artificial Life (3)

- *Scientific and policy response*
  - Social science and philosophical work of definitions of life
  - Chell programme – 'Turing Test' for life imitation

Lessons from history of recombinant DNA

- Many similar issues raised by early development of rDNA in 1970s and '80s
- Yet few of these concerns materialised –why?
- Key role of:
  - Leadership from scientific community in addressing risks and ethical issues
  - Pre-emptive policy initiatives
  - Tight regulation – relaxed over time
  - Open public debate

Leading the debate

- Importance of setting the agenda for discussion
  - Science and technology must not get too far ahead of public opinion
  - Need for clear social benefits
- Demonstrate responsibility of funders, research community and industry
- Building consensus

Engaging the public

- Why engage the public?
  - Search for legitimacy, democratic principle, better technology? Not just tokenism
- When is the right time?
  - Not too early (nano) … or too late (GM crops)
- Who to involve?
  - Importance of talking to critics
- How to engage?
  - Multiple experiments in dialogue

Governing synthetic biology

- Finding right balance between self-governance and statutory regulation
- Governance at multiple levels – international, regional, national, local
- Range of different mechanisms –
  - International treaties, national laws, professional guidelines, education and awareness raising
- Key areas – GMOs, bioweapons

The management of expectations

- The dynamics of expectation in S&T
  - High expectations key to mobilising resources, support etc.
  - Role of ‘the future’ in shaping the present
- Translating basic research into working technologies that are widely used and socially acceptable is a slow process
- Need for realism, responsibility and reflection