SYNTHETIC BIOLOGY AND THE RESPONSIBLE CONDUCT OF RESEARCH

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In this paper, we suggest that synthetic biology poses no special issues for the Responsible Conduct for Research or for Institutional Biosafety Committees (IBCs). Moreover, researchers working in the area, as well as regulatory agencies, have been proactive in ensuring that research into synthetic biologicals are appropriately governed and potential risks mitigated. Regulatory frameworks for the responsible conduct for research, such as The Australian Code for the Responsible Conduct of Research,[1] provide such a governance framework. Institutional Biosafety Committees also provide an appropriate mechanism for mitigating risk.

I INTRODUCTION

Synthetic biology can be defined as the design and construction of new biological organisms not found in nature.[2] It has the potential to provide solutions to 'some of the challenges that the world faces in the fields of environmental protection (detecting and removing contaminants), health (diagnostics, vaccines and drugs) and energy and industry (biofuels)'.[3] However, the development of synthetic biology poses risks. Groups such as Friends of the Earth, International Center for Technology Assessment, and the Action Group on Erosion, Technology and Concentration ('ETC Group') argue inter alia that synthetic biology research must 'be accompanied by precautionary mechanisms to safeguard the health of workers and local communities, to preserve the biodiversity of the planet, to ensure public participation, [and] to provide for democratically decided social goals.'[4] Thus, there is agreement internationally that synthetic biology research should be regulated for the conduct of research, the products evolved and practical outcomes of the research.[5]

So, while there is recognition of the enormous potential benefits of synthetic biology research and caution about the potential risks, we maintain that synthetic biology poses no exceptional risks. In other words, risks can be managed and mitigated by current regulatory frameworks, legislation and by a public ethics approach to the research such as

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1 National Health and Medical Research Council, *Australian Code for the Responsible Conduct of Research* (2007) < https://www.nhmrc.gov.au/_files_nhmrc/publications/attachments/r39.pdf >.

2 Markus Schmidt et al, 'A Priority Paper for the Societal and Ethical Aspects of Synthetic Biology' (2009) 3 *Systems and Synthetic Biology* 3; Sune Holm and Russel Powell, 'Organism, Machine, Artefact: The Conceptual and Normative Challenges of Synthetic Biology' (2013) 44 *Studies in History and Philosophy of Biological and Biomedical Sciences* 627; Ainsley Newson, 'Current Ethical Issues in Synthetic Biology: where should we go from here?' (2011) 18 *Accountability in Research* 181.

3 International Risk Governance Council, *Policy Brief: Guidelines for the Appropriate Risk Governance of Synthetic Biology* (2010) <http://www.irgc.org/IMG/pdf/irgc_SB_final_07jan_web.pdf>.

4 Eric Hoffman, Jaydee Hanson and Jim Thomas, *The Principles for the Oversight of Synthetic Biology*, Friends of the Earth (13 March 2012) Friends of the Earth <http://www.foe.org/news/archives/2012-03-global-coalition-calls-oversight-synthetic-biology>.

5 International Risk Governance Council, above n 3.

recommended by the Nuffield Council of Bioethics.[6] Our view is consistent with the findings of the Gene Technology Ethics and Community Consultative Committee (GTECCC), the committee that provides advice to the Office of the Gene Technology Regulator (OGTR). The GTECCC met in early 2013 to consider inter alia whether synthetic biology raised new ethical or technical issues. It stated that synthetic biology did not raise new ethical or technical issues and thus should be regulated under the *Gene Technology Act 2000* (Cth). It also noted the importance of the social and ethical responsibility of scientists.[7]

II RESEARCH INTEGRITY

Many countries have developed guidelines and codes to ensure the responsible conduct of research, otherwise known as research integrity. International guidelines have also been developed, including the 2010 Singapore Statement on research integrity, which was the first attempt to encourage and standardise policies, guidelines and codes of conduct by researchers, research institutions, funders of research and research publishers.[8] The 2013 Montreal Statement extended the scope to include cross-boundary research collaborations.[9]

The Australian Code for the Responsible Conduct of Research ('the Code') is the pre-eminent framework and guide for Australian research institutions and researchers governing responsible research practice. The Code 'promotes integrity in research... and explains what is expected of researchers by the community.'[10] A strong research culture is noted to demonstrate honesty and integrity; respect for human research participants, animals and the environment; good stewardship of public resources used to conduct research; appropriate acknowledgement of the role of others in research; and responsible communication of research results.[11]

The Code is divided into two parts: Part A, which outlines general principles of, and required policies for, responsible research; and Part B, which addresses breaches of the Code, research misconduct and provides a framework for resolving allegations. The Code requires research institutions to develop policies on the general principles of responsible research, which include the promotion of the responsible conduct of research, and the establishment of good governance and management practices. A good governance framework is one 'through which research is assessed for quality, safety, privacy, risk management, financial management and ethical acceptability.'[12] The general principles also include the requirement for the institution to monitor research carried out under its auspices.

The research governance framework set out in the Code mandates that research institutions adopt policies to ensure researchers and research students are appropriately trained and that they understand their responsibilities under the Code. They are also required to develop policies on authorship management of research data and primary materials; publication and dissemination of research findings; peer review; collaborative research across institutions;

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6 Nuffield Council on Bioethics, *Emerging Biotechnologies: Technology, Choice and the Public Good* (2012) <http://nuffieldbioethics.org/wp-content/uploads/2014/07/Emerging_biotechnologies_full_report_web_0.pdf>.

7 Office of the Gene Technology Regulator, 'Gene Technology Ethics and Community Consultative Committee Communique May 2013' (May 2013) <http://www.ogtr.gov.au/internet/ogtr/publishing.nsf/Content/gteccc-comm-May2013-htm/$FILE/gteccc-comm-May2013.pdf>.

8 Singapore Statement on Research Integrity, *Singapore Statement on Research Integrity* (22 September 2010) <http://www.singaporestatement.org/statement.html>.

9 Research Integrity, *Montreal Statement on Research Integrity in Cross-Boundary Research Collaborations* (8 May 2013) <http://www.researchintegrity.org/Statements/Montreal%20Statement%20English.pdf>.

10 National Health and Medical Research Council, above n 1.

11 Ibid 1.3.

12 Ibid.

and the management of conflicts of interest. Importantly, and consistent with the recommendations of the GTECCC, the Code recognises that research integrity is a joint concern of both institutions and researchers.

III BIOSAFETY AND SECURITY

Health and safety has been advocated for all workplaces and, resultantly, there is a duty to manage risks relating to health and safety.[13] The five key components of efficient management of work health and safety risks are governance; prevention; response; hazard management (biological, physical, chemical, ergonomic and psychological); and recovery.

A biohazard is any biological (plant, animal or microbial) source of potential harm. Biosafety refers to the protection of public health and environment from accidental exposure to a biological risk, usually of microbial origin. Biosecurity refers to prevention of the misuse of biohazardous material through loss, theft, diversion or, as revealed by some recent events, intentional release of toxins or pathogens.

The advent of genetic engineering opened up the potential for biological agents being used for a variety of uses. At the same time, it also brought in its wake an increased awareness of the potential hazards of manipulation of genetic material. Even way back at the first International Conference on Recombinant DNA Molecules, it was noted that recombinant DNA technology is not free from risks.[14] It is important to note that genes can be transferred vertically (from parents to progeny) as well as horizontally (between two individual organisms). Horizontal gene transfer ('HGT') is of particular importance in the context of microorganisms, where gene transfer can occur passively (via transformation) or actively (via transduction or conjugation). Transduction and conjugation, being active processes, are easy to monitor and hence easy to prevent. The same cannot be said of transformation. The free DNA capable of transformation can persist in the environment for long periods (months) and therefore it is not easy to monitor or control.

Luckily, the effectiveness of the common genetically modified organisms ('GMOs') has been poor, in terms of HGT as well as outcompeting native species.[15] However, Synthetic biology could change this, due to the creation of novel gene sequences not usually found in nature. Hence caution is warranted, for example, through measures such as the use of more fastidious hosts and non-transmissible vectors for the synthetic genes. Such measures have been embedded in the existing regulations.[16]

Biosafety and Biosecurity aspects for laboratories are adequately addressed by guidelines broadly based on recommendations of organisations such as the World Health Organisation,[17] and the Bioethics Commission.[18] These recommendations are based on risk assessments and include the following perspectives: code of practice (access, personal protection, procedures, laboratory work areas, and biosafety management); laboratory and facility design; laboratory equipment; health and medical surveillance; training; and waste handling.

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13 *Work Health and Safety Act 2011* (Cth).

14 Paul Berg et al, 'Summary Statement of the Asilomar Conference on Recombinant DNA molecules' (1975) 72 *Proceedings of the National Academy of Sciences USA* 1981.

15 Markus Schmidt, 'Xenobiology: A New Form of Life as the Ultimate Biosafety Tool' (2010) 32 *BioEssays* 322.

16 Office of the Gene Technology Regulator, above n 7.

17 World Health Organization, *Strengthening health security by implementing the International Health Regulations* (2005) <http://www.who.int/ihr/publications/biosafety/en/>.

18 Presidential Commission for the Study of Bioethical Issues, *New Directions: The Ethics of Synthetic Biology and Emerging Technologies* (2010) <http://bioethics.gov/synthetic-biology-report>.

IV RESEARCH INTEGRITY AND BIOSAFETY CHALLENGES

As described above, there are many ethical issues raised by developments in the field of synthetic biology. These include having insufficient knowledge about the potential risks inherent in the new technology; environmental concerns over the accidental or malicious release of genetically modified organisms; the creation of monopolies; exploitation of resources; and philosophical issues relating to the creation of life. Detailed discussion of these matters is beyond the scope of this paper. However, there is an inevitable tension between regulation and innovation, especially as this pertains to synthetic biology technologies as a research integrity issue. Scientific freedom is vital for innovation, defined as increased speed, efficiency, performance and cost-effectiveness in product development.[19] Yet the developments and discoveries made by innovative synthetic biology research must be balanced with security concerns. For Erickson et al, this means that regulators 'should support innovation and commercial development of new products while protecting the public from potential harms.'[20] Erickson et al suggest that this requires inculcating scientists to create a culture of safety.

The Nuffield Council on Bioethics cogently argues that emerging technologies such as synthetic biology should be governed by a public ethics approach. Essentially, consideration of the social good must be included in policy decisions via public engagement. When framing research policy through societal challenges, a public ethics approach should be taken to avoid overemphasis on technological rather than social solutions to problems with substantive social dimensions.[21] There is often tension between academic freedom to publish research and calls for censoring scientific details that could help terrorists develop biological warfare weaponry. This has led to the dilemma of dual use research of concern (DURC).[22]

The categories of research identified as DURC by the Fink report are those that render a vaccine ineffective; confer resistance to antimicrobial agents; enhance the virulence of a pathogen; increase transmissibility of a pathogen; alter a pathogen's host range; enable evasion of diagnostic tools; or enable weaponisation of a biological agent.[23] A direct result of this report was the establishment of the National Science Advisory Board for Biosecurity (NSABB) as a part of the National Institutes of Health (NIH). It has also prompted national authorities to draw up a specific list of biological agents (microbes and toxins), which attract strict oversight.[24]

It is not easy to accurately predict what future developments will bring in the area of synthetic biology. For example, we would be faced with new challenges and dilemmas if orthogonal life (biological entities with unconventional biochemical building blocks and metabolic pathways) or xeno nucleic acids (nucleic acids that do not use conventional base pairs present in DNA or RNA) become a reality through synthetic biology.[25]

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19 Brent Erickson, Rina Singh and Paul Winters, 'Synthetic Biology: Regulating Industry Uses of New Biotechnologies' (2011) 333 *Science* 1255.

20 Ibid 1256.

21 Nuffield Council on Bioethics, above n 6.

22 Bracha Rager-Zisman, 'Ethical and Regulatory Challenges Posed by Synthetic Biology' (2012) 55 *Perspectives in Biology and Medicine* 590.

23 Committee on Science, Technology and Law, *Science and Security in a post–9/11 World: A Report based on Regional Discussions between the Science and Security Communities* (National Academies Press, 1st ed, 2007).

24 Australian Government Department of Health, *Security Sensitive Biological Agents* (30 March 2015) <http://www.health.gov.au/ssba>.

25 Schmidt, above n 15.

V CONCLUSION

Authorities agree that while there is no justification for additional agencies or oversight bodies focused on synthetic biology

> because of the difficulty of risk analysis in the face of uncertainty—particularly for low-probability, potentially high-impact events in an emerging field—ongoing assessments will be needed as the field progresses. Regulatory processes should be evaluated and updated, as needed, to ensure that regulators have adequate information.[26]

Public education and democratic deliberations between scientists, policy makers and community groups are essential to guide future policy and regulations with respect to emerging technologies, including synthetic biology.

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[26] Presidential Commission for the Study of Bioethical Issues, above n 17.