CONVENTION ON BIOLOGICAL DIVERSITY (CBD) NOTIFICATION 2015-013

Submission of Information on Synthetic Biology

Submission by Australia

NOTE: **All information provided in this response has been drawn from Australian Government agency inputs only. No consultation with State and Territory governments was possible for this notification due to the deadline for the response.**

Notification 2015-013: Submission on Synthetic Biology

Australia is responding to the invitation to Parties to the Convention on Biological Diversity (the Convention) other Governments, relevant organisations and indigenous peoples and local communities to submit information relevant to the Ad Hoc Technical Expert Group (AHTEG) on Synthetic Biology as referenced in decision XII/24. Australia thanks the Secretariat for the opportunity to provide input on this issue.

It is Australia's view that:

- synthetic biology, and any organism that is produced by this means, would be covered by definitions in the Cartagena Protocol on Biosafety, as well as, Australia's gene technology legislation.
- current risk identification and assessment methodology as outlined in the Cartagena Protocol and Australia's Risk Analysis Framework is equally applicable and adequate to assess risks from synthetic biology.

Introductory remarks

Australia acknowledges that the term 'synthetic biology' is being used more widely in science to differentiate between the conceptual approaches used by synthetic biologists versus that of the more traditional biotechnologists. There are also arguments which suggest that synthetic biology is qualitatively different from modern biotechnology. However, given the large overlap in techniques and applications, Australia questions whether this is the case.

Australia reiterates its view, as submitted at SBSTTA 18 and COP12, that synthetic biology does not meet the criteria of a new and emerging issue, but is willing to engage in discussions anchored in sound science to explore whether there are synthetic biology applications capable of posing inherently different risks to biological diversity that fall outside of the Cartagena Protocol.

Australia also reiterates that it is important to distinguish between synthetic biology techniques undertaken in containment and environmental release of organisms derived from synthetic biology. Most applications of synthetic biology in the near future are confined to laboratory research or contained manufacturing. While it is difficult to predict how soon products of synthetic biology may be ready for wider environmental release, it is unlikely commercial applications of synthetic biology (especially organisms) would be proposed in the near future that would not be categorised and regulated as gene technology and genetically modified organisms (GMOs) in Australian and other national legislation or modern biotechnology and living modified organisms (LMOs) in the Cartagena Protocol on Biosafety[1].

a- Information that is relevant to the work of the AHTEG, including views on:

Relationship between synthetic biology and biological diversity

i- How to address the relationship between synthetic biology and biological diversity;

The majority of current synthetic biology applications in development are for contained use (research or manufacturing) and are therefore somewhat removed from a direct impact on the environment and biological diversity. From a process point of view, large scale manufacturing using a synthetic organism would be similar if not the same as other more traditional manufacturing processes using wild type (or modified) organisms (e.g. large scale fermentation), including the sourcing of input materials and treatment of process wastes. Therefore, it is important to identify causal pathways by which the use of synthetic organisms might impact on biological diversity, and whether any of those causal pathways are inherently different from those identified for wild type or LMOs and their products.

[1] For simplicity, the acronym 'LMO' used from this point forward is taken to also encompass 'GMO's, as defined under Australian national legislation.

Similarities & Differences

ii- The similarities and differences between living modified organisms (as defined in the Cartagena Protocol) and organisms, components and products of synthetic biology techniques;

In Australia's view, the term 'synthetic biology' has increasingly been used to describe a subset of biological research in which the tools of gene technology are used to apply engineering principles to the fundamental components of biology. That is, using the knowledge and tools of biotechnology to reduce biology to its most basic functional units (genes, proteins and pathways) then modify and reassemble them to produce a novel organism capable of efficiently producing the required outcome. This can be carried out *in vitro,* using modern biotechnology, or *in silico*, with the designed genome being chemically synthesised and used to create the organism (also a modern biotechnology technique). The term synthetic biology is being used to separate this, ground up, additive approach (synthesis), from the more traditional deletion or transfer approach (modification). Some synthetic biology applications may also involve the use of artificial amino acids or nucleic acids (xenobiology), though these are still at a very early stage of development and are a long way from commercialisation or release.

The broad and interdisciplinary nature of approaches described as 'synthetic biology' makes similarities and differences between synthetic biology products and living modified organisms problematic to describe categorically. As with much other contemporary scientific research there is a continuum of work being undertaken with synthetic biology representing an evolution of biotechnology towards the application of multidisciplinary engineering / systems approaches in which scientists and engineers think of DNA and proteins as parts, devices, and systems. These components can then be used and combined in new ways to achieve different outcomes.

However, in all cases the end result is a modified organism with intentional changes to its biology. The outcome of these changes can be predicted and the potential for risks or benefits from these organisms can be assessed through already established risk assessment processes used for LMOs.

The Cartagena Protocol defines 'modern biotechnology', which is part of the definition of an LMO, as follows:

"Modern biotechnology" means the application of:

> *a. In vitro nucleic acid techniques, including recombinant deoxyribonucleic acid (DNA) and direct injection of nucleic acid into cells or organelles, or*
>
> *b. Fusion of cells beyond the taxonomic family,*
>
> *that overcome natural physiological reproductive or recombination barriers and that are not techniques used in traditional breeding and selection.*

The use of 'including' in part (a) of the definition indicates that the list of techniques which follows is a selection of examples of *in vitro* nucleic acid techniques, rather than a definitive list. Therefore, it is arguable that synthetic biology, in each of its various manifestations, can be described as part of modern biotechnology.

Current biotechnology applications labelled as synthetic biology, such as the production of food ingredients (e.g. vanilla flavouring) or cosmetics (e.g. rose fragrance), involve the modification of existing organisms through the addition of genes coding for entire biosynthetic pathways and/or the modification of existing genes and gene pathways to allow the production of new molecules. If such organisms are described as products of synthetic biology due to the addition of one or more biosynthetic pathways, they are very similar to some LMO plants that are considered products of modern biotechnology and, therefore, currently regulated. In these cases a parent organism and/or donor organisms can be identified and their known characteristics used in the assessment of the properties of the new 'synthetic' organism. Science-based risk assessment of these organisms is possible within the existing regulatory frameworks.

For extensively modified organisms, the scale of changes may impact on the usefulness of the parent organism as a comparator. Further information may also be required for the assessment of organisms using novel nucleic acids (xenobiology), including their ability to persist outside of laboratory conditions and their capacity to transfer genetic material to other organisms. However, the production, commercialisation and release of the potential products of xenobiology are a long way off. This expected development time and process should allow for better understanding of any scientific and regulatory gaps, including where these products might diverge from those encompassed by current regulatory instruments, including the Cartagena Protocol.

Current best practice & Adequacy of existing regulation

iii- Adequacy of existing national, regional and/or international instruments to regulate the organisms, components or products derived from synthetic biology techniques;

vi- Best practices on risk assessment and monitoring regimes currently used by Parties to the Convention and other Governments, including transboundary movement, to inform those who do not have national risk assessment or monitoring regimes, or are in the process of reviewing their current risk assessment or monitoring regimes;

Australia reiterates its previous submission to CBD Notification 2014-090, that current synthetic biology applications for research and commercial purposes involve the modification of existing organisms in ways that would be captured by regulatory schemes which cover LMOs. End products which are not themselves LMOs may be captured by other existing product regulators, such as those responsible for regulating therapeutic goods, agricultural chemicals or industrial chemicals.

In Australia, organisms created via synthetic biology would be regulated under the *Gene Technology Act 2000* (the GT Act) and applications for release into the environment would be subject to a science-based, case by case assessment. The GT Act and corresponding state legislation are administered by the Gene Technology Regulator, supported by the Office of the Gene Technology Regulator (the Office). The GT Act includes definitions of 'gene technology' and 'genetically modified organism'. Based on these definitions, known and proposed synthetic biology applications would be regulated in Australia under the GT Act. Australia maintains a watching brief on synthetic biology. The Australian gene technology regulatory scheme undergoes periodic review to ensure that it keeps pace with technology developments and scientific knowledge regarding risks. In this context, the Gene Technology Technical Advisory Committee (Technical Committee) provides scientific and technical advice to the Regulator on biosafety and gene technology.

Certain products arising from synthetic biology may also be regulated by other Australian agencies if they meet relevant definitions in the associated legislation such as, for therapeutic goods (the Therapeutic Goods Administration - TGA), veterinary and agricultural products (Australian Pesticides and Veterinary Medicines Authority - APVMA), industrial chemicals (National Industrial Chemicals Notification and Assessment Scheme - NICNAS), and foods or food packaging (Food Standards Australia New Zealand - FSANZ). The Gene Technology Regulator also has the ability to impose licence conditions relating to GM products, this could occur where end products are not regulated by other agencies, and a risk requiring management has been identified.

Other international best practice, such as good laboratory practices (GLP) and good manufacturing practices (GMP), would guide both research and commercial scale synthetic biology applications.

In Australia, research involving synthetic biology is subject to the same general requirements as all other research, including avoiding harm to human health or the environment. Access to funding under the Australian Research Council requires adherence to the *Australian Code of Conduct for Responsible Research* developed by the National Health & Medical Research Council, the Australian Research Council and Universities Australia https://www.nhmrc.gov.au/guidelines-publications/r39.

Import of organisms not native to Australia, and biological products would require authorisation from the Department of Agriculture under the *Quarantine Act 1908* http://www.agriculture.gov.au/import. Import of GMOs requires additional authorisation under the GT Act.

Definition

iv- An operational definition of synthetic biology, comprising inclusion and exclusion criteria;

Australia notes that there is no agreed definition of synthetic biology, internationally or scientifically. Synthetic biology is a very broad, umbrella term encompassing and/or applied to a wide, and varied, range of techniques and potential applications and end products. Many techniques described as synthetic biology may equally be described as techniques of modern biotechnology, gene technology or genetic engineering, in particular those applications that are closest to commercial scale application. We reiterate that, given the current debate over organisms currently classified as LMOs and those that would be described as the products of synthetic biology, existing tools and approaches for environmental risk identification and assessment are equally applicable to organisms and products derived from synthetic biology techniques. Australia recognises work being undertaken by other national and international bodies (for example, the European Commission) to develop a working definition of synthetic biology and recommends that any Convention work in this area should be in collaboration with these fora to avoid any contradictions in the definition developed.

Because of the breadth of techniques and applications which may be included in the term, agreement of a sensible definition for synthetic biology may be problematic and/or elusive. Time may be better spent in identifying/cataloguing applications referred to as synthetic biology that do not fall within the existing broad definition of "modern biotechnology" and LMOs contained within the Cartagena Protocol. These applications can then be assessed to determine whether they might pose inherently different risks to biological diversity that need to be managed.

However, should the parties to the Convention decide to move forward in developing a definition, care should be taken that the effort/time taken to develop the definition does not exceed the value of such a definition. Focus should be on developing a definition that is useful for determining which, if any, aspects of synthetic biology fall outside of current regulation and result in actual risks to biological diversity.

Risks and Benefits

v- Potential benefits and risks of organisms, components and products arising from synthetic biology techniques to the conservation and sustainable use of biodiversity and related human health and socioeconomic impacts relevant to the mandate of the Convention and its Protocols;

Given the overlap between modern biotechnology and synthetic biology, the risks and benefits arising from synthetic biology are expected to be similar to those arising from other novel organisms and their products.

Additionally, synthetic biology based work carried out entirely within containment (research, development and manufacturing) would have little or no direct contact with the environment and its biodiversity. Risk identification would need to demonstrate a clear and viable linkage between the contained work and any potential adverse environmental impact. It would also need to demonstrate that any risks identified as arising from synthetic biology are inherently different from those posed by similar uses of wild type or LMOs in order to require different management/regulation.

Australia supports a case by case, science-based risk-assessment of synthetic biology applications to identify actual risks to biodiversity and related human health. Management of identified risks (if any) should be consistent with relevant international obligations and current regulatory frameworks for LMOs.

One of the greatest potential benefits of synthetic biology would be the capacity to engineer microorganisms to be able to produce any naturally occurring molecule (e.g. flavours, scents, dyes or pharmaceuticals) and thereby eliminating the need to cultivate large monocultures of the original source plants or animals. This would also reduce the amount waste produced during extraction and purification

from the original organisms. Additionally, the ability to produce novel molecules could benefit human health by producing designer pharmaceuticals. Synthetic organisms would also be able to produce desired products all year round and would not be impacted by growing seasons, weather extremes or the need to cultivate crops in both hemispheres. This could reduce the area of land required for commercial cultivation, aiding in the conservation and sustainable use of biodiversity.

A potential benefit of xenobiology is the requirement for a substance which is not found in nature. Organisms with artificial amino acids (and which do not encode a pathway enabling them to produce the artificial amino acid) would be reliant on the supply of that amino acid and would not be able to survive in environments where the amino acid is not present. Organisms with artificial nucleic acids would not be able to exchange DNA with wild type organisms, as the recipient organism would not have the ability to replicate or translate the novel sequences. This would prevent any engineered or novel genes from 'escaping' into the natural pool of biodiversity, and again may be self-limiting, if an artificial substance is required for the production of the new nucleotides. Therefore, there would be minimal potential for harm arising from an intentional or accidental release of these organisms.

Current effectiveness?

vii -The degree to which the existing arrangements constitute a comprehensive framework in order to address impacts of organisms, components and products resulting from synthetic biology relevant to the objectives of the Convention on Biological Diversity and its Protocols, in particular threats of significant reduction or loss of biological diversity;

Currently, Australia is not aware of any synthetic organisms or novel products of synthetic biology ready for release into the environment. Nor is Australia aware of any evidence that current synthetic biology applications would result in inherently different risks to biological diversity that might be posed by wild type organisms or LMOs.

Contained work is covered by codes of responsible conduct which allow for research and developmental work to be carried out safely and sensibly. National and international biosafety and biosecurity legislation and/or codes of conduct provide for organisms to be contained in a manner which minimises exposure of people and the environment to potentially dangerous microorganisms.

b- Information on measures undertaken in accordance with paragraph 3 of the decision, including the identification of needs for guidance; and

Currently, all work with synthetic organisms in Australia would require authorisation under the GT Act. Contained work, including large-scale manufacture, must be carried out in facilities certified by the Regulator as being suitable for the work to be carried out. The certification of facilities covers both structural and behavioural aspects of containment.

Regulation of genetically modified organisms under the GT Act is underpinned by case by case, scientific risk assessment. For all proposed environmental releases of genetically modified organisms (including synthetic organisms), the Regulator must prepare a comprehensive risk assessment and risk management plan and consult with relevant State and Territory Government(s), The Australian Minister for the Environment, the Technical Committee, other regulatory agencies, Local Government and the public. Licences impose conditions to manage any risks to human health and the environment. Non-compliance with the GT Act or licence conditions carries significant penalties. Products of synthetic biology which do not meet the criteria to be GMOs are regulated by other product regulators, as identified in the answer to (iii) above.

To date, Australia has not received any applications for the intentional release of a synthetic organism into the environment. Work involving the large scale production or manufacture of synthetic organisms is also not being conducted in Australia at present.

c- Further information on the components, organisms and products resulting from synthetic biology techniques that may have impacts on the conservation and sustainable use of biological diversity and associated social, economic and cultural considerations.

Australia is not aware of any additional information to add at this stage.