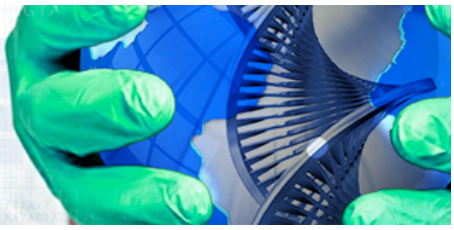
FACT SHEET

23rd March 2015

Synthetic biology



What is synthetic biology?

The field is evolving so rapidly that even scientists working in it don't agree on a definition, but in essence synthetic biology (synbio) is an extreme version of genetic engineering. Instead of swapping genes from one species to another (as in genetic engineering), synthetic biology creates entirely new forms of life – Synthetically Modified Organisms (SMOs) - or reprograms organisms to do things that would not naturally occur. Synbio uses a variety of techniques, including 'printing' synthetic DNA and inserting it into bacteria, yeasts and algae.

How is synthetic biology being used?

Scientists are excited by the potential of synbio to engineer microbes to cheaply produce drugs, biofuels and other useful substances. Synthetic biology is about to enter the market via new ingredients for food, cosmetics and household products. These new ingredients include synbio versions of vanilla, stevia and saffron flavourings. They are produced using synthetically modified organisms, including synbio yeast and algae, raised in vats and fed on sugar.

Synthetic biology ingredients for food and cosmetics

On the market:

- Vanilla flavouring
- Grapefruit flavouring
- Orange flavouring
- Resveratrol
- Patchouli
- Squalane (Neossance)
- Vetiver oil (vetivone, Epivone)

In the pipeline:

- Stevia
- Saffron
- Cocoa butter
- Milk and egg substitutes
- Agarwood

What are the dangers of synbio?

Synthetic biologists often use terms such as BioBricksTM - implying that DNA is just like Lego and easily engineered.[1] However, scientists still don't understand the role of all the genes of even the simplest organisms.[2] Scientists have also found that the insertion of a simple gene sequence can result in unpredictable effects[3] and they often can't predict which DNA sequences will be harmful.[4] Scientists are only just beginning to investigate the potential risks that SMOs pose to human health and the environment.[5] The capacity of some synbio labs to generate a few billion modified genomes a day[6] means that these unknown risks are rapidly proliferating.

Biohacking

There are a growing number of independent 'biohackers' conducting synbio experiments in community labs and kitchens.[7] Concerns have been raised that these individuals have neither the knowledge nor the tools to properly dispose of wastes or prevent release into the environment.[8]

Bioweapons

Scientists have rated the synthesis of viruses using synbio as "relatively easy" at present. For example, an infectious poliovirus was produced in a US lab in 2002 using DNA provided by a commercial supplier. The United Nations' Subsidiary Body on Technical and Technological Advice (SBTTA) therefore warns that synbio may be "expanding the pool of actors able to acquire agents for biological warfare."[9] The US military is a major funder of synbio[10] and scholars have warned of the potential for a synbio arms race.

Environmental risks

Some of the organisms that synthetic biologists are engineering are widespread - including yeast and the stomach bacteria *E. coli*. Scientists have raised concerns that SMOs may be invasive if accidentally released and have harmful effects on human health and the environment. The United Nations' Subsidiary Body on Technical and Technological Advice observes that "once released into the environment these organisms cannot be retrieved and could potentially represent a catastrophic risk."[11]

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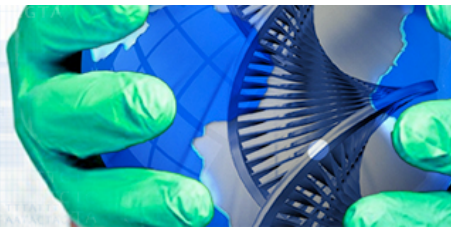

Health concerns

The US Presidential Commission for the Study of Bioethical Issues identified synbio laboratory workers as potentially at risk because of accidental exposure.[12] These could include exposure to novel pathogens and organisms with modified properties - such as the stomach bacteria *E. Coli* engineered to produce industrial compounds. The European Group on Ethics in Science and New Technologies observed it is "hard to predict" the "long -term health-related risks associated with the ecological effects" of synbio.[13]

Impacts on the developing world

Currently commercialised SMOs (synbio yeast and algae) require sugar as a feedstock. Expanding sugarcane plantations to meet feedstock demand from a growing synbio industry could exacerbate the current destruction of critical ecosystems in the developing world. Commodities currently produced by small farmers may be displaced in favour of synbio products, and the land they are grown on converted into large-scale sugar plantations.

The UN's SBTTA warns that synbio may lead to "the further consolidation of international trade by a few rich States and trans-national corporations."[14] The US Government is one of the largest investors in synbio research and corporations investing in synbio research include BP, Dow, ExxonMobil, Merck and PepsiCo.[15]

Safety mechanisms

Whilst many synthetic biologists acknowledge the possibility of invasiveness and unintended effects, they often suggest built in 'kill switches' or engineering organisms so that they are unable to survive outside the lab as possible solutions to this problem. However scientists have argued that these approaches are prone to failure because a number of microbes always spontaneously mutate and deactivate the relevant gene. Likewise, synthetic material can be transferred to other microbe species. Even if such measures were workable, their enforcement would require global regulatory intervention.

Is synbio regulated?

Products derived from synbio are beginning to enter the global marketplace without regulatory frameworks in place to assess the unique risks they pose to human health and the environment. In Australia, there are no specific regulations regarding SMOs.

What needs to happen?

Friends of the Earth is calling for a moratorium on the environmental and commercial release of SMOs until a binding international legal framework can be developed to regulate the risks posed by synbio.

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