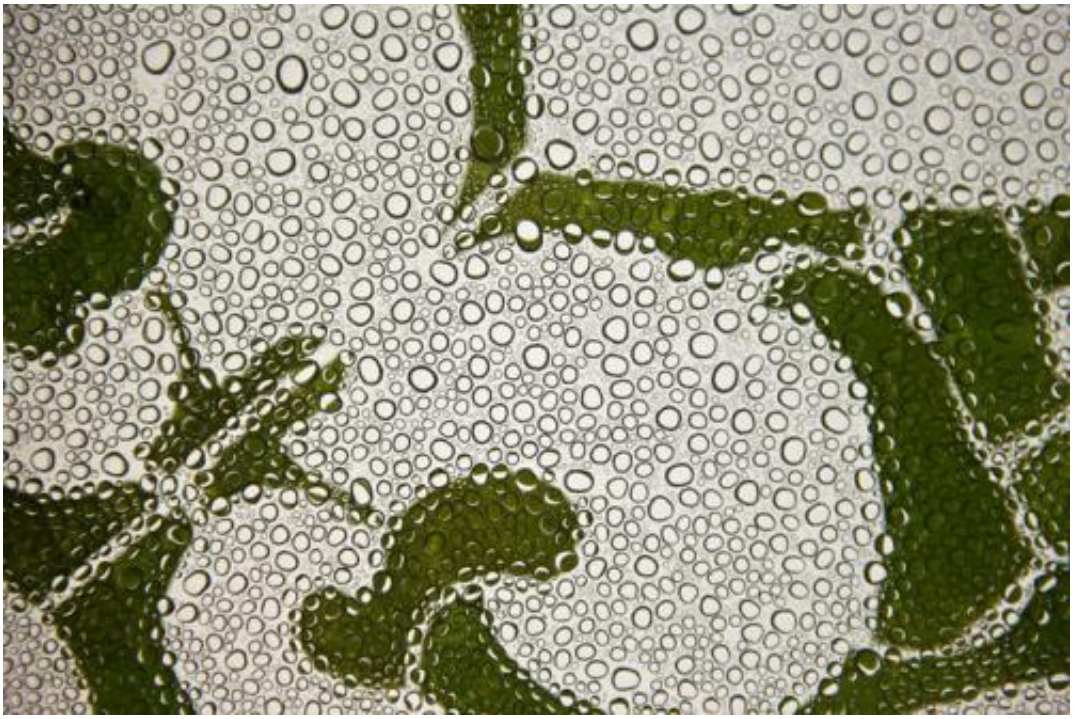
If synthetic biologists think like scientists, they may miss their eureka moment

April 28 2014, by Alistair Elfick



Advances in gene programming herald exciting possibliities. Credit: Z33 Arts Centre, CC BY-SA

Synthetic biology is an emerging discipline, but paradoxically it is not particularly new. Since the mid-1970s we have been developing ways of instructing pieces of biology to perform useful tasks in an ever more efficient and sustainable way.

Much of this has found its expression in industrial biotechnology, manufacturing things like drugs, enzymes and proteins. It has applications in everything from biofuels to pollution sensors, from smart plastics to cutting-edge medicines.

You could conceive of synthetic biology as writing little DNA programs that instruct cell behaviour, like a little genetic app. Previously all we could do was to take a gene from one organism and give it into another. Now we can rewrite the gene and even write entirely new genes which do not exist in nature.

We borrow the cell's machinery, its metabolism, and run the app. It will do whatever the app tells it to do. It becomes like your chassis, or your operating system.

First base

In first-generation biotech, the instructions were very simple, such as, "make drug". We have become good at that. To take an example, the rennet used to curdle milk in cheese-making was historically extracted from stomach of a newborn calf.

Now most of it is manufactured by genetically modified yeast. That's all that is meant when cheese is said to be "suitable for vegetarians".

Contemporary first-generation biotech has become very good at instructions like, "make lots of drug" or "make lots of enzyme". But we are close to the point where we will be able to write whatever gene circuit we want. This will allow us to start with a blank sheet of paper.

We expect to be able to move to writing more complicated statements that are conditional or logical, such as: "If you sense chemical X, start making product, and if you sense chemical Y, start cell division, or else

do nothing."

That opens up a whole range of things that you can do through biotech in manufacturing useful molecules, biofuels, bioplastics, medical biodevices and so forth. You can start to think about reprogramming cells to perform complex tasks in the body.

One that is hypothesised is to reprogramme bacteria that could be introduced into the body. When they encounter cancerous cells, they would start to make an anti-cancer drug.

The known unknowns

As well as these known possibilities, I am optimistic that there are also a set of unknown possibilities. They will be our equivalent to the mobile phone. Nobody imagined when the original cell phones came out that we would use them for sending emails or taking pictures or checking your bank account.

Synthetic biology is often presented as being simply a technology that offers a way for industrial biotech to achieve sustainable drop-in replacements for existing products such as liquid fuels, plastics and so on.

This is modelled on 20th-century engineering paradigms of making, based on the processes of design, build, test and then manufacture. That's been a very successful approach but my work has led me to believe that this may not be optimal for designing with life.

Potentially we might be missing something by apeing what has gone before rather than coming up with a new approach that has been attuned to sympathetically harness the properties of the biological realm.

There's an acute concern that the door is starting to close on synthetic biology. There is a sense in which the optimism that tells us we will be surprised at some point seems to be fading. Will synthetic biology become a disruptive technology that promises to disrupt nothing?

The Synthetic Aesthetics project

In an attempt to put a foot in that door, a group of colleagues and I embarked on a project to collaborate with a group of designers to see what our two disciplines could learn from one another.

The notion was, what can we learn about how to design life better by involving people that are designers or artists? We had six different reciprocal placements pairing 12 people over a total of a month, which included two weeks in the science lab and two weeks in the design or art studio.

The projects that resulted included combining the logic of plant biology with architecture; designing bacteria to digest computer circuit boards; designing a cup that can flavour the water put inside it; making cheese from bacteria collected from human body parts such as feet, noses and armpits; and re-interpreting synthetic biology from the perspective of geological time.

The reflections of the participants are being published in a book today called Synthetic Aesthetics – Investigating Synthetic Biology's Designs on Nature.

As the closing paragraph of our books asserts: "we hope to help prevent synthetic biology simply following unimaginative and entrenched paths". Synthetic biology can be a route to sustainable biomanufacture, but to constrain it by the immediacy of our known ambitions risks robbing ourselves of something much more wonderful.