What is SYNTHETIC BIOLOGY?

Engineering Life and Livelihood
WHAT IS SYNTHETIC BIOLOGY?
(Engineering Life and Livelihood)

SO HERE’S A THOUGHT EXPERIMENT.
WHAT IF LIVING THINGS WERE ACTUALLY MACHINES?

THE SORT OF MACHINES THAT YOU COULD TAKE APART, REPROGRAM, AND REWIRE...

...TO DO SOMETHING ENTIRELY NEW?

IF SO, PLANTS COULD JUST BE REWIRED TO GLOW LIKE LIGHT BULBS...

...OR YEAST TINKERED WITH TO PRODUCE VANILLA.

THE BIOTECHNOLOGY INDUSTRY HAS ACTUALLY SPENT YEARS TRYING TO THINK ABOUT LIFE THIS WAY.

AND THAT IS THE IMPETUS TO A RAPIDLY EXPLODING NEW INDUSTRY CALLED SYNTHETIC BIOLOGY.
DON’T GET IT WRONG: LIVING THINGS ARE NOT MACHINES. A BACTERIA OR A YEAST IS A COMPLEX EVOLVING ORGANISM.

IT’S AS DIFFERENT FROM A MACHINE AS A SKYSCRAPER IS FROM A CLOUD.

BUT THE FIELD OF SYNTHETIC BIOLOGY TRIES TO BRING ORDERLY ENGINEERING PRINCIPLES TO THE MESSY STUFF OF LIFE; IT TRIES TO RECHARACTERISE LIVING ORGANISMS AS ENGINEERABLE.

HERE’S HOW: FOR A START, ANY LIVING ORGANISM HAS A BODY OR A CELL...

... BUT THE BIOLOGICAL ENGINEERS LIKE TO IMAGINE THAT AS A ‘CHASSIS’.

IT ALSO HAS A SORT OF ‘INSTRUCTIONS’ IN THE DNA OF THE CELL. THEY LOOK SOMETHING LIKE A ‘CODE’.

DNA ‘CODE’ IS MADE UP OF FOUR CHEMICAL LETTERS G,T,C AND A.

ROUGHLY SPEAKING, IT’S THE ORDER OF THOSE LETTERS, LIKE THE ORDER OF COMPUTER CODE IN SOFTWARE, THAT HELPS DETERMINE HOW A CELL GROWS AND WHAT GOES ON INSIDE IT. WHETHER IT PRODUCES INK OR VANILLA OR A PROTEIN THAT GLOWS GREEN.
Now imagine - so the thinking goes - if you could just 'reprogram' that 'code' so that the 'chassis' cell does something commercially profitable with these so-called 'biological machines'.

The cell can be 're-programmed' to act as though it were a tiny biological 'factory' that would pump out whatever chemical you desire.

And scaling that up, you could make millions of those 'programmed cell factories' (because they are self-replicating) and then hold them in a big industrial vat.

Well, that would be a new way to make the stuff our consumer societies rely on: the plastics, fragrances, food ingredients, and fuels.

That is the incredible vision behind synthetic biology (or syn bio). It's the applied re-engineering of lifeforms to make stuff.

Synthetic biology is in fact already a multi-billion dollar industry.

There are products already in the market place.

There's around a hundred synbio companies who have deals with the largest chemical, food, energy and cosmetics companies on the planet.

Many of them are household names.
According to SynBio companies, their products are already in soft drinks, soaps, face creams and washing detergents. They are unregulated, unlabelled and under the radar of public awareness.

Technically, synthetic biology is an extension of genetic engineering: 'Extreme genetic engineering,' if you like.

The difference being that the field of manipulating life has come quite a long way since corporations first started splicing and dicing genes back in the early 1970s.

Back then, it used to work this way: genetic engineers would search out sections of DNA code in nature...

... cut the DNA out of existing organisms, and then insert it into a new host organism in a 'cut-and-paste' process.

Today, synthetic biologists use a DNA printer. It's called a DNA synthesiser. It builds artificial DNA from scratch and so you can now arrange the DNA code any way you want.

Buy

You don't need to find DNA in nature anymore. You just buy it from the Internet.
It’s even possible to synthetically print out from scratch all of the DNA of a living organism. Craig Venter did his in 2011. He created a microbe, nicknamed Synthia, whose full set of DNA had been printed out by machine. He called it “the first self-replicating species on the planet whose parent is a computer.”

Most synthetic biology companies are coming up with artificial DNA codes that force microbes to make industrially useful compounds.

Saffron is usually picked from crocus flowers in Iran, but Evolva can now brew their synthetic saffron in a large vat of engineered yeast – much the same way beer or wine is made.

Evolva, a Swiss-American synbio company, has re-engineered yeast to make the compounds found in the spice saffron.

Another synbio yeast produces vanillin – that’s vanilla flavour, but without a vanilla plant being needed.

“Natural”

Because the ingredients are made in a kind of ‘brewing’ process, the companies believe they can label them as ‘natural.’ That pits the truly natural compounds directly against the new synbio inventions.

This prospect of lab-grown food and consumer ingredients is exciting to the 22 billion dollar flavour and fragrance industry.

Every hectare of natural saffron growing in Iran provides jobs for up to 270 people per day, and replacing that with syn bio saffron now threatens those jobs.

But, especially with those ‘natural’ claims, it’s reason enough for tropical farmers to become alarmed.
AN ESTIMATED 200,000 PEOPLE GROW, TEND AND CURE VANILLA BEANS IN MADAGASCAR, UGANDA, MEXICO, AND ELSEWHERE.

THOSE FARMERS ALREADY HAVE PRECARIOUS LIVELIHOODS BECAUSE OF CHEMICALLY SYNTHETIC VANILLA. BUT NOW SYNBio VANILLIN FURTHER UNDERMINES THEM.

IT ALSO THREATENS THE ECOSYSTEMS THEY LIVE IN, BECAUSE VANILLA FARMING IS CLOSELY TIED TO RAINFOREST PROTECTION. THE NATURAL VINES REQUIRE INTACT FORESTS TO THRIVE.

OF COURSE, THE SYNTHETIC BIOLOGY INDUSTRY CAN'T DO AWAY WITH FARMERS ALTOGETHER. VATS OF ENGINEERED YEAST OR ALGAE REQUIRE VAST QUANTITIES OF SUGAR SOURCED FROM CORN OR SUGARCANE PLANTATIONS.

BUT IF THE PRICE OF NATURAL VANILLA CRASHES BECAUSE OF SYNBio VANILLA, FARMERS MAY INSTEAD RESORT TO HACKING AWAY THE FOREST TO PLANT RICE TO SURVIVE.

THIS IS WHY SO FAR, ALL THE LARGEST SYNBio COMPANIES HAVE SET UP MANUFACTURING PLANTS IN BRAZIL.

CANE SUGAR FROM BRAZIL MAY BE SWEET TO EAT, BUT IT HAS A VERY BITTER SIDE TOO. IT'S WATER-HUNGRY, CHEMICAL-LADEN, AND IS OFTEN HARVESTED BY WORKERS IN SLAVE CONDITIONS.

IN THE FUTURE, SYN Bio COMPANIES HOPE TO ALSO FEED THEIR MICROBES ON WOOD CHIPS AND SAWDUST AND EVEN NATURAL GAS, AND SO THE EXTREME GENETIC ENGINEERING FOLKS ARE NOW BUDDYING UP WITH THE EXTREME ENERGY INDUSTRY OF FRACKING.

THE EXPANSION OF SUGAR CANE IS DRIVING DESTRUCTION OF BRAZIL'S ECOCLOGICALLY PRECIOUS CERRADO REGION AND IT'S DISPLACING OTHER AGRICULTURE DEEPER INTO THE AMAZON.
AND THEN THERE’S THE HOT BUTTON QUESTION OF SAFETY. GENETIC ENGINEERING HAS ALREADY FACED 40 YEARS OF GLOBAL CONTROVERSY BECAUSE OF THE UNPREDICTABLE SIDE EFFECTS OF MUCKING AROUND WITH GENETIC CODE. EXTREME GENETIC ENGINEERING ONLY INTENSIFIES THOSE UNCERTAINTIES. HOW A SYNTHETIC BIOLOGY ORGANISM WILL GROW, ADAPT, BEHAVE AND CHANGE IS AT BEST SPECULATION.

SOME UNPLEASANT SCENARIOS ARE EASIER TO IMAGINE THAN OTHERS.

WHAT IF AN ALGAE ENGINEERED TO PRODUCE GASOLINE (WHICH HAS BEEN DONE) ESCAPES AND IT STARTS TO REPRODUCE IN RIVERS, STREAMS AND OCEANS?

IN THIS CASE, THE ESCAPED ORGANISM MAY BECOME A SELF-GENERATING OIL SLICK.

IN APRIL 2013, A GROUP OF ‘BIO-HACKERS’ FROM CALIFORNIA USED THE WEBSITE KICKSTARTER TO RAISE ALMOST HALF A MILLION DOLLARS TO COMMERCIALISE A SYNTHETIC BIOLOGY PLANT THAT GLOWS IN THE DARK.

GOVERNMENTS DON’T YET KNOW HOW TO ASSESS SYNTHETICALLY MODIFIED ORGANISMS FOR SAFETY AND SO MOST ARE SUPPOSEDLY BEING KEPT CONTAINED, BUT NOW A NEW WAVE OF SYNTH BIO ORGANISMS ARE BEING DEVELOPED THAT ARE INTENDED FOR ENVIRONMENTAL RELEASE.
For forty dollars a pop, the ‘Glowing Plant Project’ promised to send hundreds of thousands of bioengineered seeds to over 6,000 random individuals across North America.

That’s a large unregulated release of synthetically modified organisms!

Crazily, the US government declared it didn’t have the means to regulate these extreme organisms.

So despite vocal opposition, the glowing plant company will soon start mailing out its unregulated, unmonitored Synbio plants.

As the industry of synthetic biology races ahead, regulators are very much lagging behind. Delegates to the 193 countries of the UN convention on biological diversity are belatedly beginning to grapple with oversight of synthetic biology.

Already, an international fight is brewing between a handful of rich countries who back the Synbio industry and those tropical nations whose farmers, fields and forests stand to lose from the new bioeconomy that synthetic biology is about to unleash.
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For more information on Synthetic Biology
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