



An increasing number of people - many with no formal biological training - are genetically engineering common microbes in community labs and kitchens, posing potentially serious risks to the environment and human health and raising serious ethical questions. These individuals regard the living world as suitable for hacking, like the entirely artificial digital world. They also believe that voluntary codes of conduct are sufficient to regulate their activities, despite the fact that digital subcultures create harmful viruses for entertainment! And our regulator - the Office of the Gene Technology Regulator (OGTR) - has so far failed to address the risks posed by these techniques or even decide if they will be regulated.

What is biohacking?

Biohacking generally means genetically modifying a bacteria, yeast, plant or animal to change its function or physical characteristics. The term is often used interchangeably with DIYBio (Do-It-Yourself Biology). Some people also use the term to describe forms of 'human enhancement'.

Biohacking is occurring in homes and informal, uncontained community labs around the world and biohackers are also offering biohacking kits for sale online so that anyone can genetically engineer yeast and bacteria using the new GM technique CRISPR "even if you have had zero experience with Biotechnology" ¹

What are the risks?

Human health risks

The genetic engineering of commonly occurring microbes such as yeast and the stomach bacteria *E. coli* by people with no lab training in a kitchen whilst drinking beer² poses obvious health and safety concerns. There is a very real risk that these new genetically modified (GM) organisms could invade our bodies and our environment with unknown consequences.

Even commercial biotechnology labs can have sloppy occupational health and safety standards and some workers have suffered serious health impacts from exposure to unknown pathogens.³ The casualties include an Agriculture Department scientist who spent a month in a coma after being infected by the *E. coli* bacteria her colleagues were experimenting with. Even labs that theoretically have the strictest biosafety procedures have suffered potentially dangerous breaches such as the escape of anthrax from US Defense Department labs last year.⁴

One key problem with new GM techniques such as CRISPR is their potential to produce unexpected mutations in experimental organisms. This can result in the production of unexpected toxins. Hence,

government agencies overseas have argued that any products derived from them must be assessed for safety.⁵ This makes it even more disturbing that in the US some biohackers are trying to make food products such as vegan cheese with no regulation.⁶

Environmental risks

Biohacking also poses potentially serious environmental risks. These are well illustrated by the case of a strain of the soil bacteria *Klebsiella planticola* (SDF20) that was genetically engineered to convert dead plant matter into alcohol.⁷ The US Environmental Protection Agency was envisioning that farmers could use these bacteria to convert plant material into a sludge, which could be poured off into the soil and reused. The agency was weeks away from approving the environmental release of the bacteria when independent scientists tested its effects when added to soil containing wheat plants. They found it caused significant increases in the numbers of bacteria and fungal feeding nematodes - coinciding with death of the plants.⁸ Had the bacteria been released into the environment, the global consequences could have been catastrophic.

Accidental or simply reckless release into the environment from DIY labs could occur through disposal into sinks, toilets, rubbish or stormwater.



Our regulator is asleep at the wheel

The OGTR has said that unauthorised genetic engineering is illegal under the Gene Technology Act. However, the agency has yet to determine whether it considers new GM techniques such as CRISPR to be gene technology under its Act, although its sister agency, Food Standards Australia New Zealand considers similar new techniques not to be GM.⁹ The OGTR states that “to date, the OGTR has not received or assessed any applications for intentional release of organisms modified using site-directed nucleases (e.g. CRISPR, zinc finger nucleases, TALENs).” This is despite the fact that DIY CRISPR kits are available online. Techniques such as CRISPR are quite clearly GM and pose potentially serious risks to the environment and human health. The OGTR needs to step up and ban the use of these techniques outside contained and certified laboratory facilities.

CRISPR has been labelled a weapon of mass destruction (WMD) by US officials

Earlier this year the US Director of National Intelligence, James Clapper added gene editing techniques such as CRISPR to a list of threats posed by “weapons of mass destruction and proliferation” in the annual worldwide threat assessment report of the U.S. intelligence community. “Given the broad distribution, low cost, and accelerated pace of development of this dual-use technology, its deliberate or unintentional misuse might lead to far-reaching economic and national security implications,” the report concluded.¹⁰

Can the biohackers regulate themselves?

Until recently most biohacking has taken place in community labs. In an attempt to deal with the ethical and safety issues posed by biohacking the DIY-biology community developed some basic codes of conduct in mid-2011.¹¹ However, last year synthetic biologist Josiah Zayner, crowdfunded more than \$62,000 for the production and distribution of DIY CRISPR kits. These kits are now available online and allow individuals with no lab training to genetically engineer common microbes with no expert supervision. Even more disturbingly, Zayner’s crowdfunding video does not even seem to comply with the DIYbio code of conduct - showing Petri dishes containing samples stored next to food in a refrigerator.¹²

Good science or bad engineering?

The biohacking community has referred to biohacking as “citizen science” and “democratising science” - but in reality it is neither. Science is a serious quest for knowledge - whereas biohacking is an attempt to ‘hack’ organisms to do what you want them to. That’s not good science - it’s bad engineering.

This mantra also serves the powerful corporate interests that want techniques such as CRISPR deregulated. As Colleen Cordes notes “the DIY buzz that synbio is exciting, fun, and empowers each person to tinker with life suggests that everyone has the right to play the game pretty much the way they want. That serves powerful corporate and academic interests because it means no one has much right to participate in decisions about common, enforceable rules. Won’t that make just about anything that the synbio industry and patent-heavy universities want to commercialize acceptable too? That neatly negates the whole possibility of democratically decided limits or prohibitions on designing or using these unprecedented technologies. In short, it nixes democracy.”¹³

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¹ DIY CRISPR Kits, <https://www.indiegogo.com/projects/diy-crispr-kits-learn-modern-science-by-doing/>; DIY Bacterial CRISPR Kit, <http://www.the-odin.com/diy-bacterial-crispr-kit/>

² Grush, L. (2015) SXSW 2015: I Reprogrammed A Lifeform In Someone's Kitchen While Drinking A Beer, *Australian Popular Science*, <http://www.popsci.com.au/make/hacks/sxsw-2015-i-reprogrammed-a-lifeform-in-someones-kitchen-while-drinking-a-beer-401653>

³ Pollack, A. & Wilson, D. (2010) Safety Rules Can't Keep Up With Biotech Industry, *New York Times*, MAY 27, 2010,

http://www.nytimes.com/2010/05/28/business/28hazard.html?src=busln&_r=0;

⁴ Sandronsky, S. (2012) Biotech Worker's Illness Raises Worries About the Growing, Largely Unregulated, Industry, <http://tinyurl.com/h4zrx36>

⁵ ABC News (2015) New Safety Review Ordered at Pentagon's Anthrax Labs, Thursday, September 03, 2015 <http://abc7news.com/news/new-safety-review-ordered-at-pentagons-anthrax-labs/968958/>

⁶ Eckerstorfer, M., Miklau, M. & Gaugitsch, H. (2014) *New plant breeding techniques: risks associated with their application*, Austrian Environment Agency.

⁷ Wohlsen, M. (2015) Cow Milk Without the Cow Is Coming to Change Food Forever, *Wired*, http://www.wired.com/2015/04/diy-biotech-vegan-cheese/?mbid=synd_state

⁸ Krebs, A.V. (2001) Commentary: Searching for a fair resolution concerning controversial story on possible effects of *Klebsiella p* on the environment, *The Agribusiness Examiner*, 119, June 11, 2001

⁹ Holmes, M.T., E.R. Ingham, J.D. Doyle & C.W. Hendricks (1999) Effects of *Klebsiella planticola* SDF20 on soil biota and wheat growth in sandy soil. *Applied Soil Ecology* 11: 67-78.

¹⁰ Commonwealth of Australia (2016) Official Committee Hansard, Senate Community Affairs Legislation Committee, Estimates, 16/3/16.

¹¹ Regalado, A. (2016) Top U.S. Intelligence Official Calls Gene Editing a WMD Threat, *MIT Technology Review*, February 9, 2016, <http://tinyurl.com/h76cq6b>

¹² <https://diybio.org/codes/>

¹³ Kuiken, T. (2016) Governance: Learn from DIY biologists, *Nature*, 531:167-168, Cordes, C. (2015) DIY Bio-Engineering: Disrupting Democracy, <http://www.biopoliticaltimes.org/article.php?id=8555>