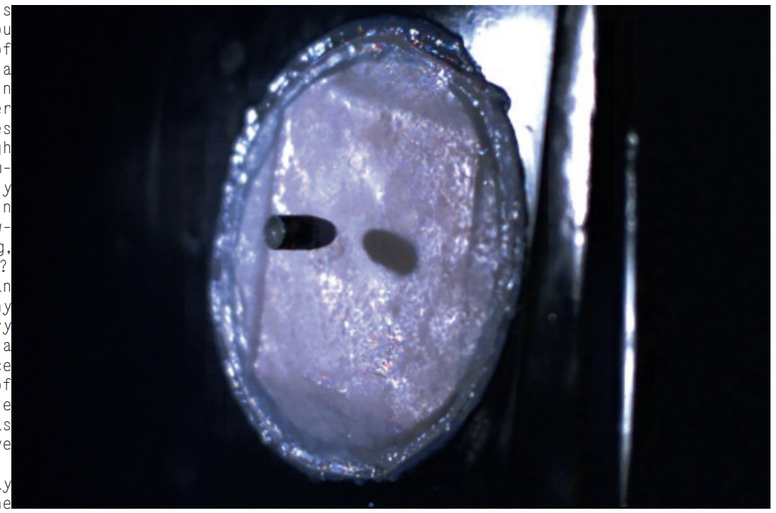
Bio Shock

From test-tube-grown leather jackets to bulletproof skin, bioart is science fiction made real. Stephen Fortune surveys the science/art crossover of the future

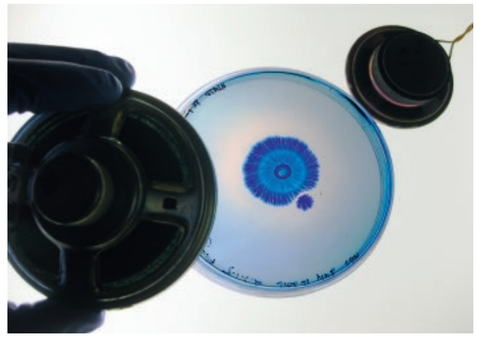
In Jalila Essaïdi's *2.6g 329m/s*, you witness a skein of human flesh stop a speeding bullet in its tracks. The sheer force sends ripples coursing through the gelatinous dream-catcher, the unlikely act captured in mesmerising slow-motion. Jaw-dropping, yes, but is it art? That tired adage can be levelled at many forms of contemporary art but holds a particular resonance for the field of bioart, which, notable exceptions aside, has been in the public eye for barely 20 years.



Bioart today is indebted to the trails blazed by artist/scientists Oron Catts and Ionat Zurr, who founded the Tissue Culture & Art Project in 1996. From a lab-cum-studio alongside the Perth Institute of Contemporary Art, for 17 years they have created projects that ignite imaginations: a leather jacket grown in a test tube, for instance, or a frog's-leg steak served up fresh from the petri dish - ideas that translated the lab technique of tissue culturing into artworks that opened a public window into the world of biotech.

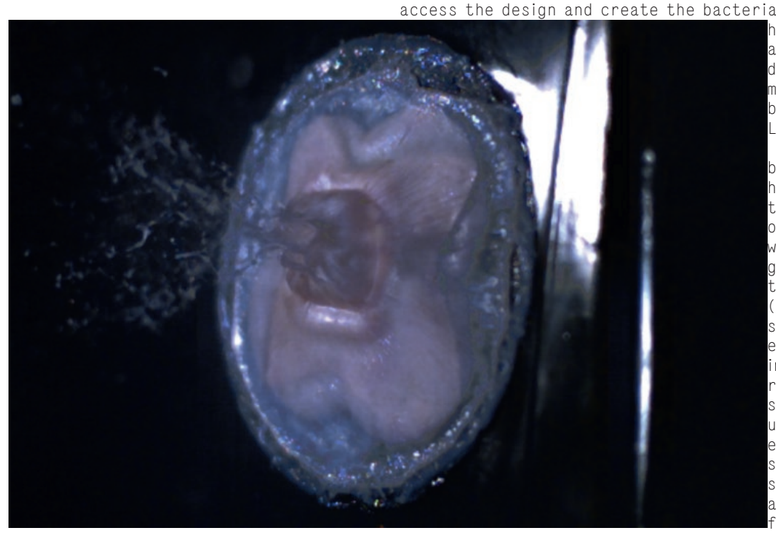
Four years later, the pair established SymbioticA at the University of Western Australia, a research lab aimed at fuelling international collaborations between artists and the university's science labs. A canon of bioart began to emerge, and techniques which had previously been exclusive stalwarts of science labs began trickling down to curious artists. Catts and Zurr continue to make provocative "semi-living" artworks and hold international workshops with other artists keen to learn the ropes of biomedia.

2.6g 329m/s was made possible by tissue-culturing techniques - Essaïdi created her bullet-stopping skin by genetically engineering human-skin cells to express a protein usually found in spider silk, which, when woven, possesses a strength that surpasses steel. Today, genetic technologies are sufficiently advanced that the spider's genome can be sequenced, the sequence of DNA that creates the strong silk protein isolated and that same sequence of DNA instructions transplanted into



other living creatures to "manufacture" the silk in bulk. The most infamous case of this was Nexia Biotechnologies' BioSteel fibre, created from the milk of transgenics goats. "I wanted to inspire a sense of awe for this huge machine that we call nature," says Essaïdi, "and the mechanics by which it produced all these ingenious constructs that have been fine-tuned and enhanced over millions of years."

In 2013, bioart is hot on the heels of the most exciting biotechnological advances. Genetically modified organisms are manufactured by synthetic-biology research labs in the hope of optimising photosynthesis, coaxing diesel from ponds of genetically engineered algae or devising new cures for ailments by reprogramming bacteria into medicinal nanomachines. Synthetic biology is a scientific discipline that treats organisms as living machines awaiting genetic reprogramming. Cohen Van Balen, the design partnership of Tuur Van Balen and Revital Cohen, produces work influenced by such scientific advances. For his *Pigeon d'Or*, for example, Van Balen devised a way to make urban pigeons shit soap by reprogramming their gut bacteria. "*Pigeon d'Or* developed from approaching the city as an organism," Tuur says, "with the bacteria as the material we use to rewrite urban metabolic pathways." The bacteria that perform the faecal alchemy are not present in any living pigeons, but the shit-to-soap gene is available on the BioBrick Registry of Standard Biological Parts. "Anyone can access the design and create the bacteria using the BioBrick," he says. (BioBricks are DNA sequences designed to be used in modular fashion, like building a genome from Lego bricks).



As synthetic biology becomes the high technology of our time, a dedicated core of biohackers are working out how to do genetic engineering the do-it-with-others (DIWO) way. Amateur scientists and enthusiasts gather in hacklabs and reverse engineer the scientific techniques used in genetic engineering. These so-called "DIYbio" spaces have spread across the globe, from Manchester to Slovenia to Indonesia. Nurit Bar-Shai, co-founder of New York community biolab Genspace, sheds some light on what made DIYbio spaces possible: "During the years after the dotcom bust, major advances in technology and biotech made it cheaper to tinker with science and work with biology. Then the recession of 2008 brought a wave of social changes and scarcity of resources around the world. Many labs and biotech startups were bankrupted. Most of Genspace's equipment was donated to us by a lab that closed down after the recession."

On the global stage, biohacking platform Hackteria has led the way in demystifying bioart and providing people with easy practical ways to engage with it. Formed in 2009, Hackteria has become the de-facto resource for all budding biohackers. The interplay between biohacking and bioart is particularly fluid among Hackteria-affiliated practitioners. "Hackteria is not, generally speaking, about finished products or finished works," says Hackteria co-founder Marc Dusseiller. "The bioart just happens, but is not the primary goal."

The Hackteria flavour of bioart and biotech education is particularly visible in Indonesia, where sister organisation Lifepatch complements the bioart residencies hosted by media-art lab the House of Natural Fiber (HONF), helping underfunded school students with such ingenious hacks as converting a webcam into a functioning microscope. At HONF in 2010, Julian Abraham and others initiated a project aimed

at creating a safe form of fermentation based on tropical fruit, after the Indonesian government raised prohibitively high duties on alcohol. After leaving HONF, Abraham continued the theme, creating sound-based bioart pieces under the name Kapitän Biopunk. He provided workshops in homebrewing alcohol to accompany his *Fermentation Madness*, a sound-art piece that converts the processes of fermentation into an interactive soundscape.

This focus on fermentation broadens the definition of bioart to include cultural practices of biomanipulation. Abraham mischievously suggests that "it gives you direct feedback: you can taste the product of your artistic experiment." Bioart theorist George Gessert points to the artificial selection inherent to decorative plant species as an early instance of bioart practice. Ornamental plant breeding could perhaps be better labelled "bioartisanal".

Appreciating this cultural ancestry is a reminder that bioartists need not be obsessively preoccupied with the latest biotechnological advances. Looked at from one angle, the processes underpinning genetically modifying organisms are simply souped-up husbandry and artificial selection. But there are insidious elements that differentiate genetically modified products from "pure" bioartisanal activities. Intellectual-property problems blight GM foods, seeds and plants. We can expect the patent disputes played out between Apple and Samsung to be restaged ad nauseum between biotechnological corporations in coming years, albeit with far weightier consequences. Such conflict is fertile territory for bioart provocateurs, as illustrated by art duo BCL's *Common Flowers – Flower Commons* project. "We felt that the discussion regarding genetically modified crops and plants was not getting the attention it should in Japan," says Shiho Fukuhara, one-half of BCL with Georg Tremmel. Together they used DIYbio techniques to clone the first commercially available genetically modified flower, the Japanese Suntory corporation's blue-petalled Moondust. They later released their cloned flowers into the wild with an accompanying "how to clone" guide on their website, pitting the forces of nature against the intellectual-property imperatives of Suntory.

Bioart, bioartisanal practices and DIYbio share one prerequisite: patience. Nurit Bar-Shai considers this a strength: "Since it is a very elaborate practice, which requires dedication and patience, most of the work that comes out is thoughtful and significant!" That is certainly true of the remarkable work of Calgary-based poet Christian Bök. His *Xenotext* project, ongoing for the past 11 years, explores how to write poetry in the language of DNA by encoding poetic stanzas into the genome of a bacteria: a poem written within a living organism, which then writes its own poem in response. The work is close to completion, as Bök works on the final hurdle of encoding it into an extremophile bacterium - one capable of surviving extreme temperature. Bök encoded a 14-line stanza into a gene, using a cipher that maps the Roman alphabet to the GATC alphabet of DNA. The bacterium's cellular machinery reads this DNA sequence and, in response, generates a protein, whose sequence of amino acids creates an accompanying 14-line poem, the opening couplet of which reads: "*The faery is rosy / Of glow*". When the poetic protein is completely produced in the cell it emits a fluorescent light, underscoring the call-and-response poetry between DNA and protein, and referencing lines of verse enciphered in amino acids.

One man's poetry can be another's graffiti, and scrawling graffiti into genomes is not just the domain of artists. Craig Venter, a giant of the genetic biotechnologies field, famously stored watermark messages in mycoplasma laboratorium, the first organism whose entire genetic code was artificially composed. Venter and his colleagues programmed a genome using software, and uploaded the genetic software (the DNA) to a genetically vacant cell, whereupon "synthetic life" booted up into existence. The messages nestled away in the code included "what I cannot build, I cannot understand", a misappropriation of physician Richard Feynman's famous "what I cannot create, I do not understand". (Venter has since corrected the genetic code to reflect the original phrasing.) Electron micrograph photography of mycoplasma laboratorium was recently exhibited at Observatory in Brooklyn as part of *CUT/PASTE/GROW*, a collaboration between curator William Myers and Genspace. Also featured were BCL's open-sourced Moondust carnations and Hackteria co-founder Andy Gracie's selectively bred spacefaring fruit flies.

The exhibition encapsulated the crosstalk between scientists, biohacking communities and artists encompassed by today's bioart. Such collaborations could become the norm. Fukuhara thinks that "getting access to a fully functioning lab can be quite a barrier, and 'amateur biohacking' can help surmount this barrier." Essaidi believes that "for an artist to truly reflect she needs to engage with the actual materials. These days the knowledge and tools are becoming more accessible. DIYbio labs offer a different approach to the professional environment and a lot of pioneering work in this field will be done in community-run biohacking spaces." The diversity of approaches means that the definition of bioart remains fluid. Gracie feels that "bioart now includes artists who use biological material as maybe one element of a wider piece of work, not using the manipulation or reappropriation of that material as the sole focus." Works like Revital Cohen's "The Immortal" go a step further - in this piece all biological matter is deliberately abstracted. A series of life-support machines connect to each other, circulating air and liquids in an attempt to mimic a biological structure. It's a reflection on the dominant mechanistic view of life enshrined in today's bioscience, with synthetic biology the most explicit exponent.

But where is the art amid all this commentary? "Art has always been particularly good at confronting complex multiple narratives," Gracie says. "Society lags behind the modernised perception of nature which is in place in the life sciences. Bioarts and biohacking can induce a paradigm shift of how nature is perceived by the public."

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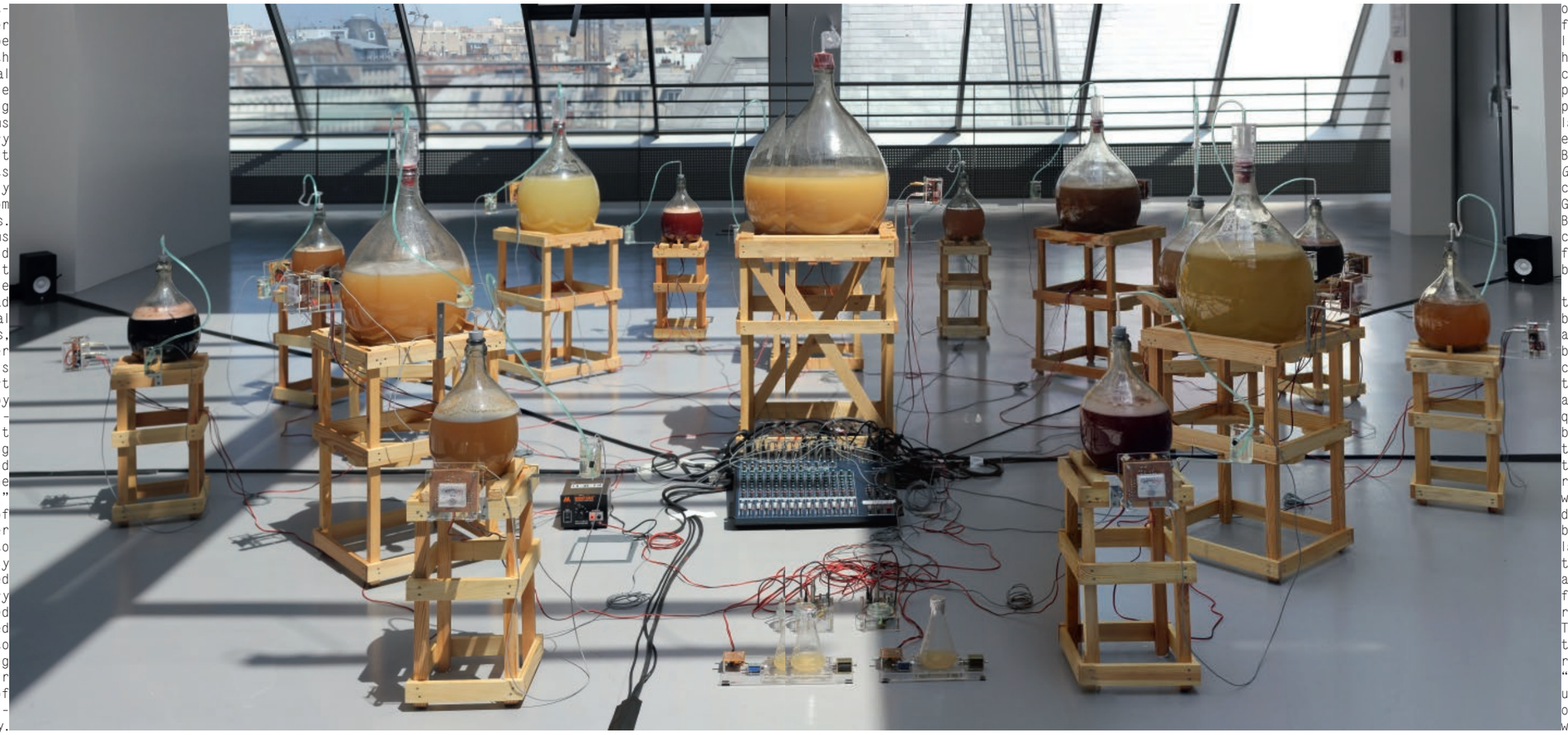

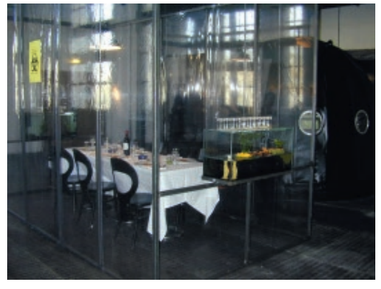

Previous spread, clockwise from top: VICTIMLESS LEATHER, 2004, ORON CATTS & IONAT ZURR; 2.6G 329M/S, JALILA ESSAIDI; THE IMMORTAL, COHEN VAN BALE; SOUND TO SHAPE, NURIT BAR-SHAI; 2.6G 329M/S. This spread, clockwise from top: BACTERIAL MOSAICS, DANIËL GRUSHKIN; KAPITAN BIOPUNK: FERMENTATION MADNESS, 2011, JULIAN ABRAHAM; GENETIC HEIRLOOM: INTERVENTIONIST HEALER, 2010, COHEN VAN BALEN; DISEMBODIED CUISINE, 2003, ORON CATTS & IONAT ZURR