

# Biotech in the basement

Do it yourself 'biohackers' want to break down institutional barriers and bring science to the people. But good intentions are up against the hard realities of doing science. Joe Alper reports, with additional reporting by Laura DeFrancesco.

In September, a New York City-based group of biohackers held a DNA extraction party as part of the city's ConfluxCity day—an annual street fair for the investigation of urban life or psychogeography, in the parlance of festival organizers. Several people went home with a test tube of their own DNA, a modest success, which is emblematic of how things are going for the garage biotech movement. Whereas eight cities now have active do-it-yourself bio (DIYbio) groups and over a thousand individuals have joined various Listserves for biohackers, the number of actual participants in the movement, if you can call it that, is quite small. One might even argue that as some of the most vocal proponents—some might call them publicity hounds—are not scientists but artists and social commentators, garage biotech might actually be something more akin to performance art or guerrilla theater.

But this is not to say that the movement lacks seriousness of purpose. Inspired by the International Genetically Engineered Machine (iGEM) project at Massachusetts Institute of Technology (MIT) in Cambridge, amateur scientists have attempted some fairly sophisticated projects in home laboratories, and a handful of small companies and projects have emerged to serve the population.

## The next HP?

Biohackers like to point out the parallels between the biotech and information technology (IT) industries. Both have a common birthplace in the San Francisco Bay area and derived their early funding from many of the same venture capitalists. But whereas the entrepreneur-driven IT industry was born out of the work of hobbyists working in their garages—think Hewlett and Packard, Jobs and Wozniak—the biotech industry was and still is a product of well-funded, professional researchers working in big, well-equipped labs.

Not that there aren't biotech hobbyists trying to follow in the footsteps of their IT counterparts. In fact, put 'do-it-yourself biotech' into Google and you'll be rewarded with dozens of newspaper and magazines article

heralding the rise of a garage biotech movement. There's a Garage Biotech blog (<http://blog.openwetware.org/freegenes/category/garage-biotech/>), bulletin board (<http://www.biopunk.org/>) and online community (<http://www.diybio.org/>) for biotech do-it-yourselfers.

Several garage (or, in one case, bedroom) biotech stories have attracted the media spotlight. Using a PCR machine that was purchased on eBay for a mere \$59, Kay Aull, a former researcher at the now defunct Cambridge, Mass.-based Codon Devices, genotyped herself to see if she carried the gene for hemochromatosis, which afflicts her father. Computer programmer Meredith Patterson, after creating glow-in-the-dark yogurt in her San Francisco apartment, is working on a biosensor for melamine, the toxic contaminant of the Chinese infant formula that sickened 300,000 infants in 2008.

DIYbio hosts several ongoing projects on its website, among them an openware hardware management package, called SKDB, and SmartLab, which aims to build inexpensive hardware for lab settings. SmartLab is working on such things as data logging instruments and video streaming for recording lab activities and capturing "did-I-just-pipette-that-into-the-wrong-tube?" moments. And since being excluded from iGEM's annual competition, which now requires university sponsorship in order to compete, DIYbio may start its own, according to DIYbio Boston founder MacKenzie Cowell (Box 1).

## Making hardware

At least two equipment suppliers have popped up in recent years as an outgrowth of the biohacker movement. Pearl Biotech, a small instrument supply company with origins in

a Sacramento, California garage, markets to the do-it-yourself crowd with a gel box for under \$200, complete with power supply and transilluminator. The company, which grew out of the 'Open Gel Box' project, has also set up a site for tracking the cost of DNA synthesis, called the "1 cent per base pair" project (<http://www.1centbp.com/>) that provides information on DNA synthesis companies providing the most competitive rates.

Ginko Bioworks, located in a former ship container near Boston's harbor, is a bona fide start-up that is developing a set of tools for the uninitiated. It is now marketing a cloning kit through New England Biolabs in Ipswich, Mass., which is tailor-made to facilitate interaction among end users; the kit has a set of linkers taken from the Biobrick registry of standardized parts, which makes kit-generated components compatible with any other. Started by a group of five MIT students and faculty, the company bootstrapped itself into existence and created a fully functional laboratory with some seed money and used

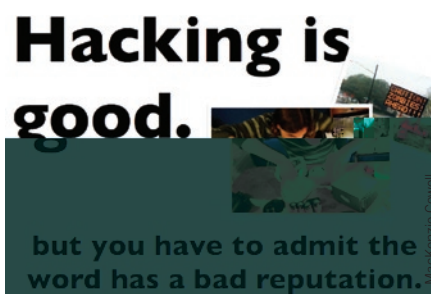
equipment. They now support themselves through (an undisclosed amount of) kit revenue and a contract with the Scottish life science consultancy ITI Life Sciences in Dundee, worth £1.25 million (\$2.09 million).

Reshma Setty, one of Ginko's founders, feels accomplished, having gotten off the ground without going to venture cap-

italists for money. "There's a presumption that you need \$5–\$10 million of VC funding. We deliberately started differently," she says. She thinks that there's room for a tier of companies in this area that can provide services and tools with much smaller amounts of funding than traditional VC-funded models.

## Thinking big

At least one project supported by the do-it-yourself bio movement is moving out of the confines of the home laboratory into the global biosphere. The BioWeatherMap Project hopes to send people around the globe out into their environments to sample the resident microorganisms, which will then be used to create a global microbiome. With low-cost cotton swabs and costs of analysis so far donated by like-minded scientists, the project got off the ground in June at the X,Y,Z



Redefining hacking. The term hacking in popular usage refers to computer criminals, but to DIYbio enthusiasts, hacking is taking things apart and putting them back together in a good way.

**Box 1 Enthusiasts versus professionals?**

How garage biotech differs from biotech practiced in institutions is subject to debate among university scientists. To Stanford University's Drew Endy, this is an "artificial divide." The notion that separating science from the university is a means of promoting exploration may overstate the reality as well as raise expectations of what can be accomplished. He sees a large amount of excitement over the technology. "The technology is cooler than PCs," says Endy. And without venues, either within universities or without, to service that excitement, a vacuum is created, he says, which inevitably gets filled.

However, missing in the world of amateur biotechers is oversight, which Endy sees as less of a problem than some of his colleagues. "All the three-letter agencies are abreast of what's going on and are trying to figure out the right strategy to prevent an accident or deliberate [harmful] act. We live in a world where there are attacks," Endy says. But Jim Thomas, of the nonprofit action group on Erosion, Technology and Concentration, based in Ottawa, Ontario, Canada, feels that those undertaking biological engineering research should be doing so in the contained conditions of authorized laboratories. According to Thomas, the biosafety of synthetic organisms has yet to be assessed in a

serious way. "As far as we know, regulators are not considering this or else [are] assuming they can be assessed as if they were transgenic species," he says.

Safety concerns are among the reasons that iGEM has decided to restrict the competitive part of the festivities to university-based students. "How biosafety is handled depends on having recognized controls in place. This could be recapitulated at the local level and surrogates provided for what resides in institutions, but the reality is that it's not in place," says Endy, one of iGEM's founding faculty when he was at MIT. DIYbio's Cowell understands the concern but disagrees with the solution. "A better outcome might have been for iGEM to help interested amateurs team up with local iGEM teams, or to work in the same lab but on a separate team. Instead, iGEM wants the amateur community to figure it out on its own, and then—maybe—they'll let us in."

Jim Collins, Professor of Biomedical Engineering at Boston University, thinks the movement is generally a bad idea. He finds that it's not appropriately regulated, and [doing synthetic biology] is sufficiently challenging that he doubts that anything of value will come of it. "At best, they will make a mess; at worst, they will get sick or make someone sick," he worries.

and U Workshop in Los Angeles, curated by the League of Imaginary Scientists. Funding for this remains an issue, however. Jason Bobe, Directory of Community at the Personal Genomes Project (which aims to attract public volunteers willing to have their genome sequenced in return for open disclosure), says that they are looking to corporations and foundations to help underwrite a national BioWeatherMap day to coincide with the week of DNA 2010, an annual event held in April to commemorate the completion of the human genome sequence. As part of the festivities, the BioWeatherMap project hopes to put swab kits into the hands of every

high school biology teacher across the nation and to inspire a new generation of students to get excited about biology, genomics and ecology, according to Bobe.

But a few one-off projects, largely inactive websites and some press coverage in places such as *Wired*, *Le Monde* and even the staid *Economist* does not a movement make. And in fact, some of the more legitimate practitioners of grassroots biotech cringe when asked about their so-called movement. "The hype was funny, and it's far from over," says Tito Jankowski, a San Francisco Bay area do-it-yourselfer, who is a biomedical engineer by training.

Another biotech hobbyist notes that while there may be over 1,000 people on an enthusiast's mailing list, only a dozen or so people actually are doing experiments in makeshift labs. This relates to the issue of how many 'amateur' biologists can afford a thermocycler, centrifuge or -80 °C freezer, let alone procure the supplies needed for an at-home biotech lab. Indeed, calls to several companies that supply reagents to mainstream molecular biology laboratories failed to find one willing to deal with individuals. "This is a joke, right?" sums up the tone of the response.

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