As a child in the early 1990s, I stumbled across a news article: researchers were turning bananas into polio vaccines. The banana plant would be engineered to express polio antigens, so whoever ate the fruit would become immune. It was meant for developing countries; bananas are cheap.

The concept made sense to me. I had watched my brother strip down and rebuild a car; I saw no reason you couldn't do the same to a banana. You couldn't hit a molecule with a wrench, but there had to be a way, and then you could change things however you liked. I was fascinated.

Nearly two decades later, I have learned the truth: GMOs are hard. My research is driven by the goal of making them easier. In particular, I am interested in computational methods for revealing effective design principles in biology - systems biology for synthetic biology. Ultimately I hope to lead a research group in this area, either in academia or industry.

My record also demonstrates a personal commitment to Broader Impacts. In a controversial field, education is key to public acceptance. I seek out opportunities to teach, and have found creative ways to engage audiences outside the classroom. Good outcomes are also key; I have made significant efforts to promote social responsibility within the field. As a graduate student, I will continue these activities, finding innovative ways to reach diverse audiences.

PUBLIC OUTREACH – I am best known for my work with DIYbio. This amateur science group was founded in 2008; that summer, they inspired an Internet contest for bio-hackers, and the rhetoric around it (both pro and con) was so far overblown that I decided to enter with a realistic project. With two months, a $500 budget, and a tiny closet for a lab, what could I do?

After some sleuthing, the chemicals and equipment proved to be available. The problem was DNA constructs. There was pUC19 and lambda phage, both as positive controls for a kit, and a few low-copy plasmid backbones. That was it. Given these constraints, I thought back to a senior project on digital counters. I realized that you could rewire the canonical "genetic switch" of lambda phage to form a pulse generator circuit, a key component in digital logic.

By the deadline, I had one plasmid built and ready. I had pale blue *E. coli* with that plasmid in them, just as I had expected. A second plasmid was in parts, due to a balky PCR primer; there was just enough money left to order a new one. And I had a functional lab in my closet.

The response startled me a bit. There was an outpouring of interest, mostly from biology novices. I needed a different project for this audience, something simple and interesting - no circuit theory allowed. Instead, I chose genetic testing. I adapted an allele-specific PCR protocol for home use, and later worked with sequencing as a more general technique.

This work was picked up by the media, with front-page articles in the *Wall Street Journal* and *Boston Globe*, editorials in *EMBO* and *Nature Medicine*, documentaries, and numerous interviews for TV, radio and print. Technology conferences began inviting me to speak. I used the attention to give a reasonable perspective on my work and the overall state of synthetic biology.

Behind the scenes, I have also worked hard to promote responsibility and safety within the DIYbio movement. I have publicized best practices for lab safety, met with law enforcement and security agencies, and helped set up communal lab spaces in Boston and elsewhere. I also answer technical questions on the online forum. These questions come partly from enthusiastic early adopters of DIYbio, but also from other budget-challenged groups, such as high school teachers and scientists from developing countries.

However, the greatest payoff was in showing total laypeople that biotech isn't magic. When a genetic disease was diagnosed in my family, I helped talk my relatives through the testing process. For most of them, "reading DNA" was a scary black box. Once you open the box, though, it's simple chemistry - you could run the test in a closet. DIYbio shows this in a way that sticks.

TEACHING – I like the challenge of explaining things in a way that others can grasp. For example, in high school, I saw that my classmates in AP Biology were confused by a lab in population genetics. I wrote an interactive simulator which showed the principles more clearly. This little freeware program was distributed at a national conference and used in a number of classrooms.

In college, I was a TA for two classes, first-year biology and a project course in synthetic biology. I was also a junior coach twice at Biology Olympiad camp, an intense two-week crash course for the twenty high school finalists. With another alum, I organized the lab sessions, taught evening lectures, and wrote much of the team selection exams - we slept less than the students did.

After college, I was a programming TA for a course in computational linguistics; this was a Saturday enrichment course for local high school students. I returned to Biology Olympiad camp as a lecturer. With DIYbio-Boston, I also helped organize a series of increasingly ambitious public workshops for the Cambridge Science Festival. Last year's involved sequencing parts of the human genome. One participant was a Boston University professor; we adapted the workshop for his lab course, reaching over 150 undergraduates, most of them non-science majors.

SOCIAL RESPONSIBILITY – Science does not happen in a vacuum. To inform myself on the broader issues, I have taken significant coursework on the interactions between society and technology; this is a specialty at MIT, where I minored in Anthropology.

The training has already proven useful. For example, I have been involved with the NSF's Synthetic Biology ERC since its founding; this ERC has a heavy BI component, funding anthropologists and economists along with the scientists. These groups work very differently, and were at first intensely unsure of what to do with the others. As the youngest person in the room, I found myself serving as a translator, gently reframing the points of far more senior people so they could hear each other. Over time, I also became the voice of the non-institutional lay audience. Members of NSF site visit teams have cited my influence as a positive in their BI ratings.

DIVERSITY – As a geek and a woman, I regularly find myself alone in a room full of men. Just as regularly, I find that my presence allows other women to feel welcome. I am happy to be a role model, especially for younger women; I volunteer with K-12 science events partly so the students will have a woman as their judge or coach. These events have included the Biology Olympiad, the DOE's Science Bowls, science fairs, quiz team meets, and others from the local to national level.

I am also an enthusiastic mentor to students from other backgrounds. In high school, I was on several international-level science teams; these took me abroad, where I lived and worked with students from across the globe. I helped a number of these students apply to schools in the USA. In college, I lived in a French-speaking dorm and took summer courses in Chinese. These language and cultural skills allowed me to live in Shanghai for a summer, where I worked on a pilot program for high school students doing research at the city's university. As the life sciences tutor, I supervised eighteen students as they worked in labs for the first time and prepared technical papers and presentations in English. These experiences show that I can be a good colleague and mentor to just about anyone, and that I will actively work to do so throughout my career.

INVITED PRESENTATIONS

- Aull KH. 2010. Is life hackable? *Asilomar Microcomputer Workshop*, Pacific Grove, CA.
- Cowell M, Aull KH, Morrison J. 2009. DIY Synthetic Biology: From Design to Construction with New Model Organisms. *CodeCon 2009*, San Francisco, CA. Repeated at 2009 *Maker Revolution (Cyberarts Boston)*, Cambridge, MA, and 2009 *XORcon*, Cambridge, MA.
- Aull KH. 2009. Homebrew Genetic Testing. *CodeCon 2009*, San Francisco, CA.
- Aull KH. 2008. The State of DIYbio. *DIYbio Meetup*, Cambridge, MA. Updated and repeated at 2009 *SynBERC Retreat*, Berkeley, CA, and 2009 *DIYbio Meetup*, San Francisco, CA.