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BIOLOGICS OF RESISTANCE: THE OPEN INSULIN PROJECT AND THE PROMISE OF ANTIBIOCAPITAL

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Abstract

BIOLOGICS OF RESISTANCE: THE OPEN INSULIN PROJECT AND THE PROMISE OF ANTIBIOCAPITAL

Andrew I. Murray

This dissertation attempts to understand the emergence and development of the Open Insulin Project, a community laboratory-based project to create an open-source protocol for affordable bioengineered insulin. It seeks to situate this effort within broader trends in the capitalization of the biosciences and biomedicine and to explore its potential and struggles as a resistance effort working against these prevailing trends. It draws on roughly three years of ethnographic study, including participant-observation within the Project and interviews with key members and associates. It argues that the Open Insulin Project is the product of a contradiction within biocapital and that it represents a new phenomenon: antibiocapital. It further explores the ways in which appropriating bioengineering constrains a would-be antibiocapitalist Project and compels such an effort to conform to the sociopolitical order of biocapital. Situating the Project within a broader trend of amateur bio, it argues that the emergence of amateur bio social movements creates the potential for reimagining rights and governance in the contemporary biosciences, though this potential may be limited by the presence and influence of powerful interests. Finally, it argues that this Project and efforts like it

provide unique opportunities for collaboration between the social, natural, and engineering sciences that could overcome some of the limitations of past efforts, including those under the banner of Ethical, Legal, and Social Implications/Aspects (ELSI/A) research and "post-ELSI" efforts in synthetic biology. Such collaborations challenge the approaches of both social scientists and projects like Open Insulin.

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I must first and foremost thank the members of the Open Insulin Project from whom I have learned so much, and I hope that we continue to learn together. Second, I would like to thank my dissertation committee for their support and feedback. I would especially like to thank my dissertation chair and adviser Jenny Reardon, who helped provide focus, rein in some of my bad habits, and make me a better writer and researcher. I would also like to thank the many fellow graduate students who provided camaraderie, commiseration, and community that vastly improved my time in graduate school. Last, but certainly not least, I would like to thank my supportive family members who have been not merely tolerant, but proud of my academic pursuits. Special gratitude goes to my partner Colleen, who moved across the country and back with me and our animal companions and who was more gracious and understanding in the face of research trips, late nights writing, and precarious stacks of books than I could have dared to hope.

Introduction: Biologics of Resistance

Figure 1. The banner that hangs prominently inside Counter Culture Labs.

Most of the key members of Open Insulin were huddled around one of the large folding tables at Counter Culture Labs.[1] A sheet of plywood leaned vertically against a set of shelves on the side of the table opposite the lab benches. We had gathered for a strategy session to help chart the course of the Project. We all received post-it notes and markers. The first part of this exercise was called "divergence" and focused on brainstorming. On these post-it notes, we wrote goals, objectives, and action topics for the Project. These ideas about the future of the Project proliferated. The organizers tried to organize these into categories: *End Users, Lower Cost, New Paradigm, Production/Distribution, Humanitarian Advocacy, Prototype, Org Network*.

[1] Murray, fieldnotes, January 13, 2019.

At least broadly speaking, the organization's large-scale goals were relatively clear: Open Insulin was ultimately focused on making insulin more accessible. But members didn't always agree about the best way to make this happen, or what other steps they might need to take to get there.

Ultimately, the group decided that the best way to proceed was by developing a timeline.[2] To build the timeline, most agreed that the group's "scientific milestones" would make the best benchmarks. Once this decision was made, things started humming along as members started indicating the benchmarks they needed to hit, the most imminent of which members seemed to agree was producing pure insulin for the first time, which could happen as soon as the following month. After that, it was a matter or purifying and scaling up to small batch production. After that… things got a bit more complicated. Would the group seek FDA approval? "We'll see," Anthony,[3] the Project's co-founder, said. Open Insulin's approach was a bit of a gray area when it came to FDA oversight. Should the group share the protocol? Ideally, yes, but this depended on legal advice and strategy.

As one of the last strategy session activities, to try to match personnel to the goals that the group had identified, we were tasked taking to the post-its once again, this time writing our own strengths and potential

[2] Murray, fieldnotes, January 20, 2019.
[3] Where present, Project members' names are real and used with permission. This is for two reasons: First, in a globally unique project like Open Insulin, it would be nearly impossible to veil identities without losing the important specificity of the Project and its aims. Second, nearly all members of the Open Insulin Project readily agreed to having their real names present in disseminated research results, with many expressing unsolicited preference for this approach. See Chapter 4 for more details on research methods.

contributions.[4] I had been a participant-observer with the Project for more than a year and a half, but my role was something I was still trying to figure out myself, and it wasn't clear to me how I could contribute to the timeline as it was organized around technical benchmarks. It seemed to me that I was working on some other timeline, spending several years with the Open Insulin Project to grasp how they fit into economies of biotechnology and medicine, how they conceptualized and aimed to solve a social problem that I also thought was important and was also struggling to grasp. I wrote what I could think of: "Social theory / Broader contextualization / Connections with STS communities," and I hoped that the other members of Open Insulin would eventually find the results of what I learned from them interesting, perhaps even useful.

Coming to Counter Culture Labs

The Open Insulin Project is based out of Counter Culture Labs, a community laboratory in the Temescal neighborhood of North Oakland, California. I first visited Counter Culture Labs on a Saturday in late Spring 2017, for a newcomer lab tour and orientation. These tours were open to the public and advertised via Meetup, a website widely used by hobbyists for advertising and recruiting for local gatherings and events. I had developed an interest in "DIY" biology and bioengineering, and I had heard of a few

[4] Murray, fieldnotes, February 10, 2019.

different related projects at the lab: Fermentation Station, which offered relatively freeform classes on making kombucha, vinegar, wine, and all kinds of extracts and syrups; Real Vegan Cheese, which was working on genetically engineering microbes to produce milk proteins to produce a cheese substitute as close as possible to the real thing; and the Open Insulin Project, which was working on developing a way to make affordable insulin. After my introduction to the lab space, I was encouraged to stop by any project meetings I was interested in. Each group met regularly, either weekly or bi-weekly, with all meetings were open to the public and posted on Meetup. Wednesday nights were especially busy, with Open Insulin and Fermentation Station meetings taking place at the same time, followed by the general meetings for Counter Culture Labs, and then a "Biohacker Social" event with beer and pizza.

CCL itself was housed in a larger activist organization called the Omni Commons, which occupied what was once a sanitation workers' union building. The lab space was in the back of the building's first floor. As you walked through the entrance way and the narrow hallway to find it, you were first greeted by the low hum of several -80˚c freezers and then by the recognizable trappings of a biology lab: neutral gray benches and stools, a large ventilated biosafety cabinet, racks of hazardous waste disposal bins, shelves of flasks and pipettes, and the occasional centrifuge, shaker, or chromatography machine—plus some more unusual features, like the milk

crates filled with repurposed jars of mysterious substances, or the plastic storage bin simply but puzzlingly labeled “EBOLA SUITS”(see Figures 2-7)— . Overhead, there hung a large banner that read, “CITIZENS FOR SCIENCE / SCIENCE FOR CITIZENS” (see Figure 1).

On one side, there was a set of long foldable tables and chairs and a single computer monitor with a mounted webcam. The meetings for Open Insulin and other CCL projects happened around these tables. Though based primarily at CCL, Open Insulin also collaborated closely with some folks at their “sister lab,” Santa Clara’s BioCurious, which was about 45 minutes away in the rare instances when Bay-Area traffic wasn’t a factor. Eventually, the Project also branched out to Baltimore’s BUGSS (Baltimore Underground Science Space) community lab, as well. Often, volunteers, members, and interested parties from much farther afield would participate in meetings via video conference.

Figure 2. Some of the lab benches at CCL. The biosafety cabinet is visible at back left.

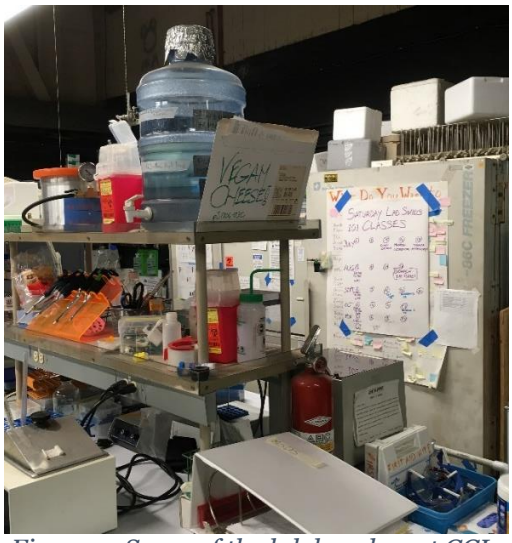

Figure 3. Some of the lab benches at CCL, with a sign for the Real Vegan Cheese Project and the lab's humming freezers along the wall.

Figure 4. Some lab equipment, with one machine simply marked "PCR."

Figure 5. Some lab equipment, including an assortment of glassware and a microwave ("NO FOOD").

Figure 6. Some of the assorted crated of jars from the Fermentation Station Project.

Figure 7. Some of CCL's storage shelves, including a container marked "EBOLA SUITS."

Upon expressing an interest in conducting my ethnographic fieldwork at the lab, the then-president of the organization told me that CCL was "open" for the purposes of observation and photography. While someone had propped the door before my first visit, in my following visits, I noticed that the entrance to the Omni Commons remained locked. Eventually, I also noticed a small doorbell that I could ring, which someone would usually answer by popping open the door, though the bell could be a bit difficult to hear from the lab over the hum of the equipment. Eventually, I gained key card access to the building, but my first few encounters with difficulty entering the building

prefigured how complicated the extent and meaning of *openness* would come to seem.

Following my orientation, I chose a Wednesday for my next visit to the lab, and so first ended up at the table for an Open Insulin Project. Working as an ethnographer, I regularly attended Open Insulin's twice-weekly meetings, both participating in discussions and collecting detailed fieldnotes, and conducted interviews with members and affiliates of the Project and CCL. I quickly became a member of the team, both an observer and participant, roles I continued to play through the time of this writing more than three years later.

Insulin in the Era of Biocapital and Biomedicalization

The issue of insulin access and affordability became especially significant in the United States, where the high cost of insulin had led to deaths from rationing personal supplies due to lack of access or as a cost-control measure (Sable-Smith 2018; Popken 2019). Those dying were not only the uninsured, but in several cases, people who had health insurance but faced high payments nonetheless. The flurry of news stories that reported on this unfortunate trend tended to place significant blame with the three pharmaceutical companies responsible for the vast majority of insulin both in the United States and globally: Sanofi, Eli Lilly, and Novo Nordisk. Together, these companies accounted for 99% of global insulin by value, 96% by volume

(Cefalu et al. 2018). Following these reports, insulin became a prominent and bipartisan issue in American politics (Caffrey 2019). Though especially visible in the United States, the number of insulin-dependent diabetics—both Type-1 and Type-2—was on the rise globally (Garg et al. 2018), presaging a major global insulin shortage on the horizon (Basu et al. 2019).

Much of the outrage further focused on the fact that insulin's unaffordability seemed especially irrational because the drug was nearly a century old (Bliss 2007 [1982]; Hirsch 2016). At the time, insulin was a miracle drug, replacing difficult and minimally effective therapies for those with Type-1 diabetes, who could typically expect to live for only a few years. Recognizing its importance, its discoverers had famously sold their patent to the University of Toronto for $1 apiece to make insulin as available as possible to as many people; as one discoverer said, "every effort must be made to reduce the cost of insulin" (quoted in Bliss 2007:142). Their partnership with Eli Lilly did give the company a temporary monopoly on production in the United States, but this, too was intended to get the medicine to as many people as possible as quickly as possible (Bliss 2007). For a long time, insulin was widely available to those who needed it in the United States (Hirsch 2016).

The insulin developed in 1921 was animal-derived—most of the discoverers' experiments were with dogs—and this insulin remained the therapeutic standard for many years thereafter, with most diabetics taking

bovine or porcine insulin derived from cattle and pigs, respectively. In the late 1970s, however, a fledgling biotechnology company called Genentech successfully recreated native human insulin for the first time by genetically modifying *E. coli* (Genentech 1978; Fraser 2016). This synthetic human insulin became the first biologic pharmaceutical to obtain FDA approval, and Eli Lilly began marketing it under the name Humulin in 1982. In many ways, synthetic human insulin paved the way for the entire biotechnology industry.

The rise of biotechnology heralded by Genentech's successful development and introduction of synthetic human insulin ushered in the era many science and technology studies (STS) scholars have identified as the era of biocapital (Sunder Rajan 2006; Helmreich 2008). These scholars typically trace this era to the dawn of the 1980s when key technological and policy changes enabled new forms of intellectual property protections over biological products and closer relationships between the academic biosciences and industry. Kaushik Sunder Rajan argues that the economic and the epistemic have "imploded" and that as a result, "capitalism" has become insufficient as an explanatory structure for the rapid changes in biotechnologies, the life sciences, and markets—hence the need for the amalgamated concept *biocapital* (2006: 279-280). In the era of biocapital, life, property, and profit are more closely intertwined than ever before. A key area of the transformations wrought by the rapid growth of biological technoscience has been in healthcare and medicine, where they have ushered in a new era of

biomedicalization (Clarke et al. 2010). For insulin, some of the most important changes in the biocapital and biomedical era have been the privatization and commodification of pharmaceutical research, resulting in intensifying stratification of access to medicines and as a result, health outcomes.

Following its FDA approval, native human insulin remained the standard for some time, it was largely displaced by the introduction of insulin analogs in the 1990s (Cefalu et al. 2018). These drugs made modifications to the insulin molecule that changed the way it behaved in the body. For patients, so-called long-acting and short-acting insulins provided quality-of-life improvements over native human insulin, though some debate persisted about the extent of these benefits and whether there are also significant clinical benefits (Brixner and McAdam-Marx 2008; Sanlioglu et al. 2013; Grunberger 2014; Fullerton et al. 2016; Lipska et al. 2018). Nonetheless, these insulin analogs became the new first resort and standard of treatment for insulin-dependent diabetics (Bashoff 2019; HCCI 2019).

Despite only slightly higher production costs, analogs were also more expensive, and as newer drugs, they were covered by newer intellectual property protections (HCCI 2019). On top of this, companies often extended these protections through process modifications and other "evergreening" techniques, meaning that protections on drugs that should have expired at the twenty-year mark—for insulin analogs, this meant beginning in the mid-

2010s—remained effective (Collier 2013; Greene and Riggs 2015). The costs of insulin analogs rose steadily during this decade, and the costs for native human insulin, while lower, rose as well (Cefalu et al. 2018; HCCI 2019; See Figures 8-9). While pharmaceutical markets like insulin's were notoriously complex and opaque (Cefalu et al. 2018; see Figure 10), the actions of the pharmaceutical companies that continued to dominate global insulin supply—particularly their actions relating to intellectual property—became the focus of efforts like Open Insulin to crack the insulin affordability problem and resist the ongoing capitalization of the first biologic pharmaceutical.

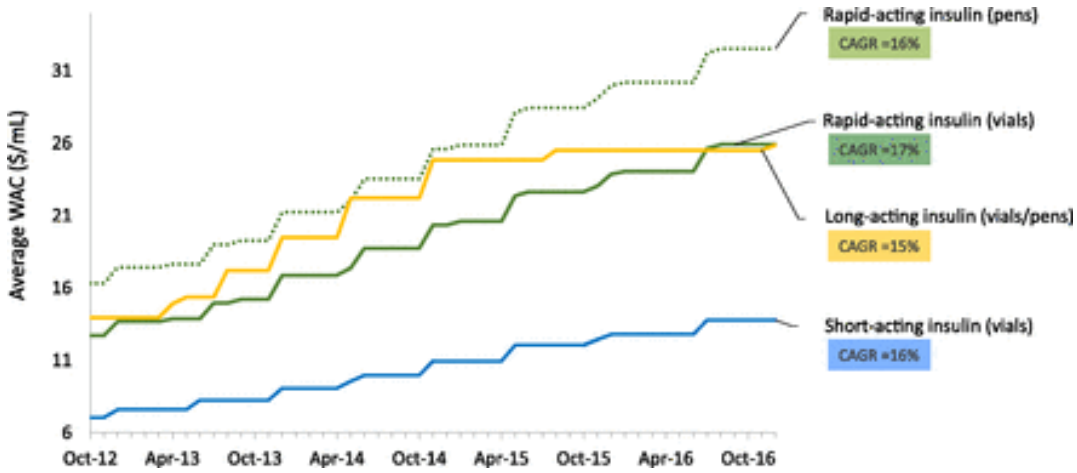

Figure 8. Average Wholesale Acquisition Cost (WAC) for several insulin analogs between October 2012 and October 2016 (Cefalu et al. 2018).

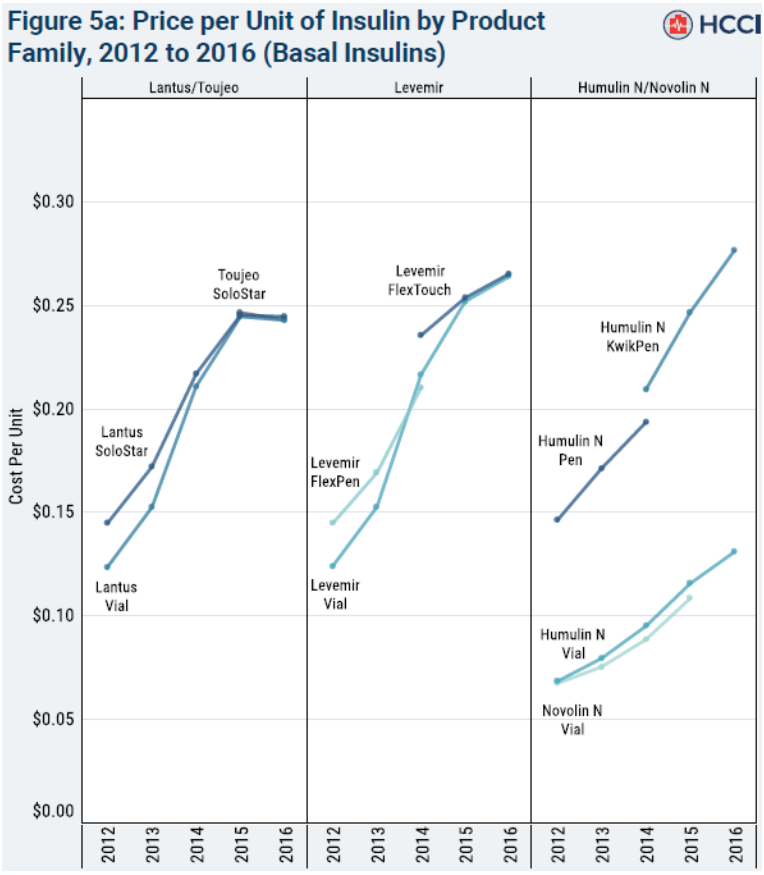

Figure 9. The prices per unit of various types of basal insulin analogs and native human insulin from 2012-2016 (HCCI 2019).

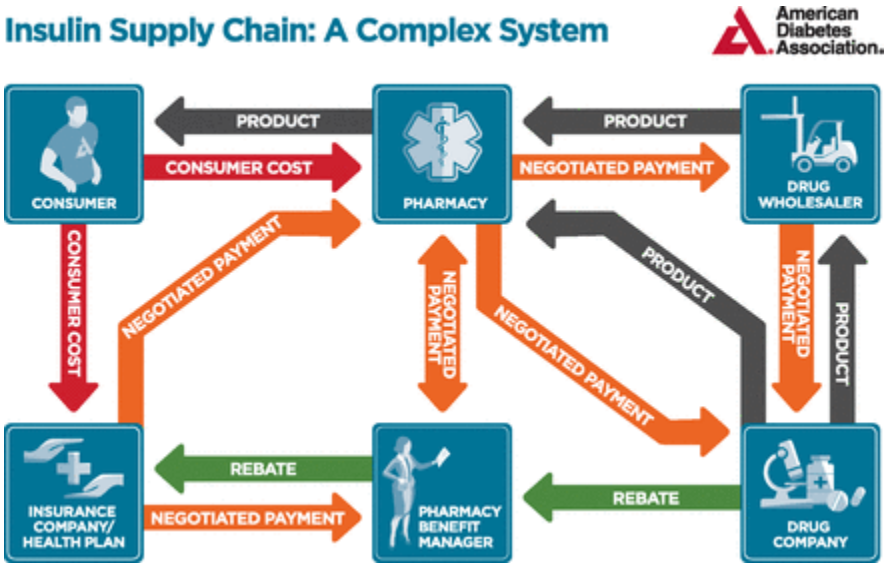

Figure 10. A representation of the various costs and payments in the insulin supply chain (Cefalu et al. 2018).

The Open Insulin Project

Figure 11. The primary Open Insulin Project logo.

When I first began attending Open Insulin meetings, there was a small group of about 5-7 core volunteer members, nearly all of whom remained with the Project for the duration of my fieldwork, though many others would join and leave during that time. In response to this complex landscape, the Open Insulin Project adopted what at first seemed like a relatively simple and straightforward strategy: make affordable insulin themselves. As the first biologic pharmaceutical, the story of insulin's rising cost heralded a grim future for access to newer biologics. As an essential medicine with fatal consequences for those lacking access, insulin was also a dramatic example of the stratification of 21st-century biomedicine. Insulin was thus a perfect candidate for such a project; it should have been both relatively simple to make and relatively easy to build a coalition around.

After Genentech first produced insulin in *E. coli,* microbe-produced insulin became the industry standard. This accomplishment and the dawn of

the biocapital era were nearly 40 years in the past, and as a result of the growth of biotechnology, the tools of genetic engineering were becoming increasingly accessible. It became feasible to build a community laboratory in the Bay Area and to try to genetically engineer an insulin-producing microbe strain. The Project aimed to adopt open-source principles to get around the intellectual property protections on insulin analogs that they understood as a key factor in keeping insulin's cost high. They believed that by developing a simple, small-scale insulin production protocol and making that protocol available to anyone who did not intend to profit from it, they could undermine the "oligopoly" held by the "big three" global insulin producers—or simply, "Big Pharma." Members likened this approach to building a network of nonprofit insulin microbreweries, each capable of supplying enough insulin for several thousand people with diabetes (see Figure 12). [5]

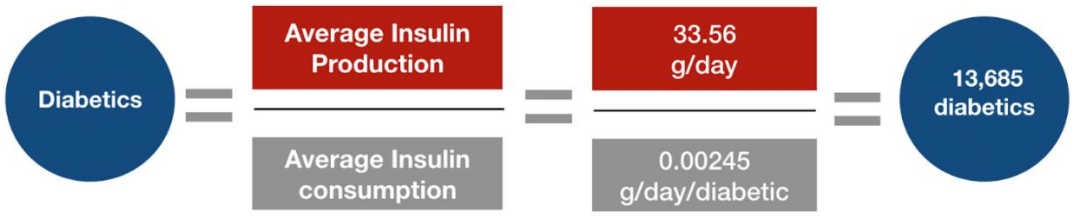

Figure 12. Graphic demonstrating the Open Insulin Project's estimation of the number of diabetics who could be served by a single setup of their proposed small-scale production system.

[5] Murray, interview, December 10, 2017.

Open Insulin Project members routinely identified and described their effort as "anticapitalist."[6] In a classically Marxian sense, these members were seizing the means of insulin's production: microbes, flasks, pipettes, freezers, chromatography machines, reagents—means that were increasingly accessible to them in the shadow of the Bay Area's biotech industry. But as Marx himself pointed out in *The German Ideology,* seizure—"taking"—means little when what is taken depends on specific conditions of production and exchange ([1845-6] 1978: 196). Further, if, as Sunder Rajan (2006) argues, biological epistemology and economy have "imploded," how could Open Insulin members hope to separate the two and turn biocapitalism's tools on biocapital itself? The Open Insulin Project raised important questions about the possibilities of resistance and alternative formations in the biocapital era, including whether it might be possible to build an antibiocapitalist effort. Such an effort, as Open Insulin members imagined the Project, would disentangle biotechnology from economic incentives. Even if only in the case of one drug at a small scale, such an effort could prove to be a powerful proof of concept for a different way of organizing technologized biomedicine.

While Open Insulin's goals seemed relatively straightforward on their face, the conditions of production and exchange of biological and biomedical materials were subject to extensive constraints and oversight. Even if the Open Insulin Project obtained the technical means to make insulin in their

[6] E.g., Murray, interviews, January 14, 2018; October 10, 2018; May 12, 2019; November 16, 2019.

Oakland laboratory, they would have to contend with complicated legal and regulatory questions and navigate numerous gray areas and uncertainties. It proved difficult to take up the technical tools of biocapital without coming up against their accompanying sociopolitical systems. While the Project's technical aims made it unique as a form of resistance, it proved difficult to avoid these systems by engineering their way around them. While Open Insulin members identified their Project as a means of anticapitalist politics, their heavy emphasis on their engineering work at times threatened to overshadow the Project's other necessary dimensions.

Open Insulin was not alone in their unconventional adaptation of bioengineering. The Project was part of a larger trend of amateur bio: people taking up biology and bioengineering in community labs, garages, dorm rooms, and other unusual and improvised spaces. These practices went by many names, with distinctions and overlaps between them: DIY-bio, biohacking, and community bio to name the most significant few. [7] However practitioners identified, they, like Open Insulin, were interested in bringing biological tools to more people. While many Open Insulin members participated in amateur bio groups and events, not all amateur bio enthusiasts

[7] Throughout the dissertation, I use the terms *amateur bio* and *amateur bio network* to collectively refer to this group of enthusiasts and their practices. When I use other labels (DIYbio, biohacking, or community bio), I refer to these specific subsets of the broader group and to those who embraced and gathered under the banners of specific labels. The *amateur* in *amateur bio* is intended as the opposite of *professional* rather than *skilled* or *trained*. *Bio* is intended to simultaneously capture *biology, bioengineering, and biotechnology.* This terminology, while imperfect especially in its risk of portraying those in this network as untrained or unskilled, was my way of establishing some analytical and discursive distance from active and existing terms and labels (see Chapter 3, Conclusion).

shared Open Insulin's antibiocapitalist ethos. As amateur bio grew and evolved, Open Insulin members again encountered the signature entanglements of biocapitalism as academia and industry came to play a major role in the emergent consolidation of a community bio movement.

I remained a participant-observer of the Open Insulin Project through these developments and challenges. The other Project members had welcomed me as a member since that first Wednesday I showed up at the table. They were not only open—as they liked to point out their name implied—to me joining the group as not just an observer, but a fellow member; it would have been difficult to study the group in any other way.[8] I was readily welcomed into the group and treated much the same as any other participant; when other social scientists also began studying Open Insulin during my fieldwork, they were treated similarly. The participatory culture of Open Insulin led me to reevaluate the relationships between the social and natural sciences. Through my involvement and alongside Open Insulin's other members, including these other social scientists, I considered whether projects like Open Insulin might not only hold hope for redressing the stratified effects of biocapitalism and biomedicalization, but also for forging new collaborative relationships between social scientists, natural scientists and engineers. Such collaborations would challenge the methods, institutions, and practices of the social and natural sciences alike.

[8] Murray, fieldnotes, April 24, 2019.

Especially when it comes to questions of biocapitalism, science and technology studies scholars have had a complicated relationship with hope and promise. As I experienced in my work with the Open Insulin Project, they can be sources of obfuscation, tools deployed to realize short-term goals. When used this way, hope and promise can generate value regardless of whether or not it is ever realized, and for this reason, they have become prominent components of biocapitalist economies (Thompson 2005; Sunder Rajan 2006; Fortun 2008). As a result, social scientists have often developed an aversion to hope and a fondness for naysaying (Fortun 2005). Mike Fortun, however, argues that building better science studies entails "learning to live with, and cultivate, the excesses of promising" (2005:171).

The Open Insulin Project reappropriates not only the physical tools of biocapitalism, but also the hope and promise it has cultivated in the biosciences. Learning to maintain a reasonable suspicion of the obfuscatory tendencies of hype and overpromising while also recognizing in promise the emergence of new worlds is also key to understanding the appeal and potential of biologics of resistance. Beyond merely developing a protocol, building new types of science and working toward new kinds of worlds were Open Insulin's project. As Yann, the Project's lead scientist explained, "Open Insulin is only a step to say, 'maybe we can have a different kind of society.'"[9]

[9] Murray, interview, July 18, 2018.

Chapter outline

In Chapter 1, I describe the conditions that make the Open Insulin Project possible. I characterize the Open Insulin Project as the result of three developments closely linked to biocapital: the volatility and excess of the biotechnology industry; the emergence of synthetic biology at the intersection of biology, engineering, and informatics; and the empowerment of scientized patient-consumers of biomedicine. Because Open Insulin was both enabled by biocapital and a project of resistance to biocapital—what I call an antibiocapitalist biologic of resistance—I describe it, following Marx, as the product of a contradiction of biocapital. This analysis provides some modest hope for resistance within regimes of biocapital, in contrast to much of the theorization of biocapital in science and technology studies (e.g. Franklin 2003; Sunder Rajan 2006; Cooper 2011; see Helmreich 2008). These theories have described biology as "overdetermined" by (Sunder Rajan 2006) or "annexed within" (Cooper 2011) capital, providing little room for efforts like Open Insulin's that turn biocapital's signature tools against biocapitalism itself.

Chapter 2 serves as a sort of counterpoint to Chapter 1's story of hope and possibility, describing the pressures that the Open Insulin Project faced as an antibiocapitalist bioengineering effort. Applying a co-productionist framework (see Jasanoff 2004) to analyze the legal and regulatory challenges that Open Insulin encountered, the chapter further fleshes out theories of

biocapital. It argues that biocapital is partially inoculated against technical resistance efforts because its social order obscures its political content. As Open Insulin entered biocapital's technical domain, its members found themselves in need of expert advice to navigate the threats and uncertainties of biocapital's sociopolitical order. The expert advice that they received, while typically "objective" in appearance, had the effect of suggesting that the Open Insulin Project take on features of the very biocapitalist institutions to which it aimed to provide an alternative. One member called this transformation, "becoming the thing you're wanting to fight."[10] One especially significant effect was the members' doubling down on their engineering efforts. They understandably interpreted this as playing to their strengths, but I argue that this strategic choice further deferred important sociopolitical questions.

Chapter 3 examines the Open Insulin Project within the broader context of the amateur bio network. As a participant-observer with the Open Insulin Project, one of the better-known and best-liked amateur bio projects, I had a uniquely situated perspective on the growth and development of amateur bio. As the tools to undertake bioengineering became more accessible, growing numbers of amateur enthusiasts worked to build a community and an identity, and to articulate their practices and values. Different factions and labels emerged. As amateur bio, especially those

[10] Open Insulin OIS WG meeting notes, January 14, 2019.

identified as “biohackers,” became a magnet for controversy, these questions of identity and values became even more pressing.

Drawing on my experiences attending three amateur bio events, the chapter analyzes these processes of community definition through a theoretical lens that combines bioconstitutionalism (Jasanoff 2011) with branding (Banet-Weiser 2012). As amateur bio enthusiasts defined their communities, they utilized the language of citizenship, freedom, and rights. While biohackers continued to focus on individual rights to biotechnology and bodily autonomy, a new label—“community bio”—emerged more focused on inclusion and collective responsibility. However, these efforts focused on inclusion also tended to limit the forms of dissent and political engagement available to participants. Whereas biohacking was fractured yet provocative, community bio was inclusive and relentlessly agreeable. Analyzing community bio as an example of “branded bioconstitutionalism” demonstrates how community bio reinforced some of the political limitations of both brand cultures and bioconstitutionalism to build a large movement that was full of latent tensions and conflicts but provided little room for addressing them—at least until these tensions surfaced as new scandals near the heart of community bio.

In the final chapter, Chapter 4, I take up the question of methods. The chapter specifically addresses what it means to work as a social scientists and participant-observer within an amateur bio project like

Open Insulin. It asks these questions in conversation with collaborative methods in STS, particularly methods that have focused on moving beyond the framework of Ethical, Legal, and Social Implications (ELSI) research. Some scholars have identified synthetic biology as a promising field for crafting collaborative post-ELSI research methods (e.g., Rabinow and Bennett 2012; Calvert 2013; Balmer et al. 2015), and I suggest that amateur bio, as a related field, provides some similar opportunities, but also some unique ones. As a member of Open Insulin, I helped institute a social science-oriented working group as part of the Project. In this working group alongside Open Insulin's other members, we addressed questions related to hacking sociology: studying a project focused on material tinkering and in the process, reflecting on both the project and the institutions and methods of the social sciences that apprehend it. Rethinking these roles especially required assessing the place of critical social science approaches in spaces like Open Insulin that are both fundamentally critical and relentlessly hopeful.

Chapter 1

Opening Insulin: Contradiction and the Prospect of Antibiocapital

Figure 13. One of the Open Insulin Project's logos, described by one team member as "our militant logo" and by another as "retro communist."

> "We believe healthcare is a human right, and no one should be deprived of access to life-saving medicine. Access to insulin should be non-partisan, should prioritize people before profit, and not be dependent on the charity of corporate manufacturers. The Open Insulin project is a transparent effort to make widely available, effective, and safe technology to reduce the burden of Type I diabetes. We hope to localize and democratize insulin production and distribution to save lives."
>
> - The Open Insulin team, "DRAFT Open Insulin Manifesto & Memo of Understanding"

> "The whole system is not designed for the improvement of humankind; it's designed for profit. And it will cause problems."
>
> - Yann, lead scientist, Open Insulin Project

I had been with the Open Insulin Project for roughly half a year when the group decided that it was important to craft a document that explicitly laid out their core aims and values. They made this decision after the Project's co-

founder Anthony—also Open Insulin's de-facto leader, in practice if not necessarily in title—was contacted by a potential collaborator from India. In the weeks and months prior, the Project had acquired several international collaborators who shared an interest in providing low-cost insulin to those in need, though their individual contexts—Australia, Belgium, Cameroon, Senegal—differed greatly from one another. Especially given the media coverage of Open Insulin, which had been featured in several online publications, an inquisitive message from a kindred spirit in another country was nothing new for Anthony and the other Project members.

Still, there was something different about this most recent collaborator, different enough that it prompted the Open Insulin team to begin work on a document that would come to serve as a touchstone for members talking about the values and purpose of their efforts. This prospective collaborator was a onetime affiliate of Biocon, Asia's largest pharmaceutical company.[1] Though not one of the "big three" global producers of insulin (Eli Lilly, Sanofi Aventis, and Novo Nordisk), Biocon was a significant biosimilar synthetic insulin producer. In fact, this same company was the first to develop synthetic human insulin using the yeast *Pichia pastoris,* the same model organism around which the Open Insulin Project had focused its efforts following earlier frustrations with the bacterium *E. coli.* Biocon also held recent patents related to producing Open Insulin's target insulin analog, glargine—also

[1] Murray, fieldnotes, April 29, 2018

called “long-acting” insulin—in *Pichia*.[2] Open Insulin Project members would have to become familiar with these patents in order to develop their own, non-infringing protocol.

Over a year after the communication, Biocon and its Dutch partner Mylan would become the first companies to bring a biosimilar glargine to market when they launched Semglee© in Australia during the fall of 2019 (Biocon 2019). Around the same time, they announced their intention to reduce the cost of insulin in low- and middle-income countries to just 10 U.S. cents per day, significantly less than the U.S. retail average of around 5 dollars per day. In this announcement, they cited insulin’s credited discoverers, Frederick Banting and Charles Best, who famously sold their own reluctantly acquired patent for one dollar to the University of Toronto (Pramanik 2019). The discoverers explained their rationale in language deeply resonant with the Open Insulin Project’s own aims, if less than premonitory: “When the details of the method of preparation are published anyone would be free to prepare the extract, but no one could secure a profitable monopoly” (Banting et al., quoted in Bliss 2007:133).

Despite these apparent compatibilities, even a connection to Biocon was enough of a concern to trigger Open Insulin to begin developing their manifesto. Both the impetus—a proposition from someone with pharmaceutical company connections—and the desire to create such a

[2] Murray, fieldnotes, November 19, 2017

document reflected most Open Insulin members' belief that the project was fundamentally anticapitalist.[3] A connection with a major pharmaceutical company with a vested stake in insulin's profitability was cause for suspicion. For me, a sociologist, the manifesto as a genre already invoked Marx and Engels' 1848 outline of the process ending capitalism by transferring the means of production into common ownership. Alongside Anthony and the other project members' invocations of Marxism, anarcho-syndicalism, and economist Elinor Ostrom's work on the commons, these comparisons became unavoidable. The Open Insulin Manifesto outlined a commitment to decentralized insulin production and a commitment to keeping its corresponding intellectual property in the commons. In it, the team laid out its core tenets: "We believe that ownership and control of the means of production and distribution of medicine should be spread as widely as possible, and aligned as closely as possible with the needs of those who use medicine."

The draft version of the manifesto draws on these ideas and more. It draws especially heavily on precedents in open-source software, for example by invoking the Peer Production License—"an explicitly anti-capitalist version" of the Creative Commons non-commercial variant license.[4] It includes "Don't be an asshole," the so-called "asshole rule" developed from

[3] E.g., Murray, interviews, January 14, 2018; October 10, 2018; May 12, 2019; November 16, 2019.
[4] The latter, also called "copyfarleft" to distinguish it from the latter's "copyleft," was itself described and justified in another manifesto: "The Telekommunist Manifesto" (Kleiner 2010).

the suggestions of Stanford business and management science professor Robert I. Sutton and common in Silicon Valley tech startup circles. It expresses commitments to open and decolonized science and espouses the belief that healthcare is a human right. It draws directly from a kindred effort, Open Source Pharma (OSP) to paint a picture of a project that frees pharmaceutical research and development from the encumbrances of intellectual property and financing, instead crowd-sourcing mass brainpower to innovate, to find another way to make and distribute insulin.

The content of the draft reflects the training of those who wrote and compiled it: at that time Open Insulin members included computer scientists-turned-biohackers, life sciences PhDs, and community organizers and advocates, plus me, a sociologist.[5] In the time after the draft, many members came and went, and the Project grew and diversified. The draft manifesto ends with a list of "valued partners" who could help the project realize its mission, some of whom were been among the newer participants: people who could advance the project's technical knowledge, regulatory professionals, potential government and academic partners, other biohacker spaces, independent researchers, and intellectual property advisors.

Though most Project members would refer to this document as simply "the manifesto," the team was initially caught between their needs for a

[5] For details on my status as a participant-observer and member of the Open Insulin Project, see Chapter 4.

manifesto—a political treatise outlining their purpose and aims—and for a memorandum of understanding, or MOU—a quasi-legal document explicitly establishing the terms of collaboration. Some members also joked about establishing expectations using an "unbreakable vow" or a "blood oath."[6]At my own joking suggestion, the document was for a time informally referred to as the "Manifesto of Understanding." As of this writing, it was one document separated into two sections: one for the Manifesto and the other for the MOU. While the group agreed that an MOU would have been necessary for any collaboration with the Biocon affiliate, it never quite took shape; predictably, neither did a partnership. The Manifesto, while significantly more fleshed out, also remained unfinished.

Its incompleteness notwithstanding, the Manifesto became a common point of reference for members during later meetings that focused on embarking upon other collaborations; coming to shared understanding of the group's aims, milestones, and strategies; and further demarcating the shape and aims of Open Insulin in organizational bylaws.[7] It remains a work in progress, but many of the members still hold it up as an example of a shared ethos and purpose. Drawing from the many wells of inspiration it does, it also serves as a testament to the convergence that makes the Open Insulin Project possible and compelling.

[6] Murray, fieldnotes, November 5, 2018.
[7] E.g., Murray, fieldnotes, April 14, 2019

Introduction

In one of the earliest uses of the portmanteau *biocapital,* Sarah Franklin (2003) described the emergence of "ethical biocapital." Thinking in the context of reproductive technologies and the fraught terrain of stem cell research, Franklin described ethical biocapital as a commodity form, a type of innovation, and a market strategy in which "concerns about public opinion are literally being built into biological life forms" (2003:98). Since Franklin's writing, theorizations of biocapital—succinctly defined as the shift toward the commodification and marketization of the life sciences since about 1980 (see Sunder Rajan 2006)—have proliferated in the social sciences (see Helmreich 2008). Theorists of biocapital call attention to the ways in which life itself is increasingly subject to the demands of profit-seeking enterprise.

Franklin's early contribution was to identify how the complex ethics and values surrounding the stuff of life are also subject to commodification. Widespread objections to certain ways of handling biological materials—for example, human embryos or seed crops (see Schurman and Kelso 2003)—had constituted cultural obstacles to biological commodification. The response, Franklin suggested, was to anticipate and incorporate ethics into the biotechnological materials themselves, such as by engineering ways around the use of embryonic stem cells. In this and other theorizations, the transition to biocapital appears as progressive, inevitable, and overdetermined (Sunder

Rajan 2006), capable of leveraging increasingly sophisticated biological control to transform would-be obstacles into new opportunities for accumulation. These obstacles could be ethical or cultural, as in Franklin's example, or they could arise from the nature of biomaterials themselves (see Boyd, Prudham, and Schurman 2001). While biology was not inherently suited to commodification, an increasingly sophisticated array of engineering techniques capitalized on biology by reshaping biomatter itself.

In one sense, Open Insulin fell in line with Franklin's characterization of ethical biocapital: the Project's members built ethics into bioengineering. In another important sense, however, Open Insulin was different. Rather than ethical concerns about playing god, Open Insulin members objected to capitalism itself, and especially to biocapitalism,[8] positioning themselves as a movement of resistance to the commodification of a life-saving medication. They objected to what they described as an "oligopoly," a "cartel," or simply, "Big Pharma."[9] Their approach was not to anticipate and insulate themselves against consumer backlash. Rather, their bioengineering efforts were backlash made manifest as the materialized objections of an empowered biotechnological citizenry. Open Insulin was less "ethical biocapital" than

[8] This is my reading of Open Insulin Project members' politics, as they did not engage the social science literature on biocapital themselves. Most members of Open Insulin did, however, identify the Project as more broadly anticapitalist. E.g., Murray, interviews, January 14, 2018; October 10, 2018; May 12, 2019; November 16, 2019.
[9] E.g., Murray, fieldnotes, October 26, 2018; June 2, 2019; January 18, 2019.

antibiocapital—an opposition to the capitalization of health and medicine—or *bioanticapital*—the biotechnologization of anticapital.

This chapter tells the story, from the vantage of a participant-observer, of the conditions and possibility for the emergence of such a project. This account tends toward the hope and optimism that Open Insulin members, associates, and supporters held for their project and for the future of biotechnology and medicine. It does so in the service of understanding what a project like Open Insulin represents, why it emerged when and where it did, and whether the stage might be set for the emergence of similar efforts. The next few chapters will put this optimism to the test and examine what happened when the Open Insulin Project moved from concept to concrete practice. This trajectory roughly mirrors both the history of Open Insulin as it grew and developed and the course of a new member's induction into the Project, like the one I went through as I first learned about the Open Insulin Project and began to regularly attend and participate in its meetings.

Crucially, biocapitalism itself created the conditions of possibility for Open Insulin. These conditions were characterized by several different developments at the intersections of biology and capital, especially as they converged in areas of biotechnological concentration like the San Francisco Bay Area. These convergent developments included: the development of a biotechnological industry characterized by hope and promise, speculative investment, volatility, and a focus on intellectual property (Thompson 2005;

Sunder Rajan 2006; Fortun 2008; Birch 2017); the emergence of synthetic biology at the nexus of biology, engineering, and informatics (Roosth 2017); and the selective empowerment of patient-consumers within the stratified patchwork systems of 21st-century biomedicine (Clarke et al. 2010; Rose 2007). These developments interacted with one another, and they were evident in the story of the Project as well as in the stories of the individual volunteers that it comprised.

Because Open Insulin was the product of the same conditions that produced the very expensive and inaccessible medicines it opposed, I characterize the Project as the product of an internal contradiction of biocapitalism. Marx identified the most fundamental contradiction of capitalism as its tendency to generate crises of overproduction: periods in which depressed wages and increased production capacities become incompatible, failing to generate a consumer base capable of sustaining profitability (1990 [1894]; Marx and Engels 2002 [1848]). In short, capitalism renders labor ever more productive while simultaneously deepening the exploitation of those who perform it. According to Marx, the effects of crises of overproduction, though usually managed by expansion in search of new markets, eventually threaten capitalism itself as they grow in severity and expose the contradiction at the heart of capital accumulation. Scholars working in the Marxian tradition have identified many more contradictions of capital, including the cultural (Bell 1972), the ecological (O'Connor 1988;

Foster 2000), the financial, and the geographical (Harvey 1982), complicating the relationship between capitalism's forces, relations, and conditions of production. Notably, David Harvey (2014) argues not only that capital is rife with contradictions, but that these contradictions are central to the reproduction of capital. These contradictions rarely resolve but are instead reconfigured and moved around as capital reinvents itself.

The state of affairs that produced the Open Insulin Project revealed a contradiction in biocapital: insulin was produced in new, more user-friendly, and more profitable forms, while at the same time, the cost to patients continued to increase steadily, resulting in approximately half of those who needed insulin lacking reliable access (Gotham, Barber, and Hill 2018; Biniek and Johnson 2019). Amid growing upset about the unaffordability of healthcare, insulin, a nearly hundred-year-old essential medicine, served as a powerful synecdoche. In the United States, this upset drove support for socialized medicine, calls for accountability from public representatives, and demonstrations against the pharmaceutical companies that many members of the concerned public—as well as members of Open Insulin—held accountable (Sable-Smith 2018; WBUR 2019; Caffrey 2019; Rowland 2019). Among some biotechnologically inclined residents of the Bay Area with access to the region's excess biotechnological resources, it drove efforts to put these means of production to work and actually make medicine. These efforts addressed

the insulin affordability crisis by challenging the entanglement of biology and capital.

Biology, Capital, Medicine

As a self-identified radical, anticapitalist project, Open Insulin serves as a counterexample to the ways in which biology is increasingly "enterprised-up" (Strathern 1992) and converted into forms of capital. As an empirical case, it helps demonstrate that biology and its values are neither fully subsumed by capital, nor are developments in the biosciences readily explained by economic developments independent of the biosciences. Rather, Open Insulin both emerges as a response to the entanglement of the biological, the medical, and the commercial and is uniquely empowered by the features of this entanglement.

Scholars of science and technology studies studying diverse areas of biology—including molecular biology and genomics, plant and animal breeding, assisted reproduction technologies, tissue engineering, regenerative medicine, and pharmaceuticals—have identified a shift since roughly 1980 toward the mutual entanglement of biology and capital. Sunder Rajan (2006) explains this transition as the dawn of the biocapital era. For Sunder Rajan the transition is neither total nor complete, but rather piecemeal and tendential: "the relationship between 'capitalism' (itself not a unitary category) and… biocapital is one where the latter is, simultaneously, a

continuation of, an evolution of, a subset of, and form distinct from, the former. Further, biocapital itself takes shape in incongruent fashion across the multiple sites of its global emergence" (2006:10).

Sunder Rajan (2006) ethnographically explores this emergence in the contexts of American and Indian pharmaceutical development. He leaves us with the sense that biotechnology does indeed represent a new phase of capitalism. This phase varies across contexts, including the contexts Sunder Rajan explicates, but he nonetheless identifies trends. Many of these trends stem from changes in the American life sciences that have subsequently become models for emerging life sciences industries like India's. In the American context, policy changes at the dawn of the 1980s—most notably, the Supreme Court Case *Diamond v. Chakrabarty* and the Bayh-Dole Act—subjected biological life and matter to intellectual property protections and rendered the boundary between academic and industrial life sciences progressively porous. As a result, the life sciences have increasingly adopted a speculative, future-oriented grammar, focused on hope, hype, and salvation.

Biocapital does not merely describe the influence of capital on the biosciences and biotechnology; it also describes the ways in which contemporary capital is increasingly biological and biopolitical (Sunder Rajan 2006). In other words, our ways of thinking about value are also increasingly informed by our ways of thinking about life. While in some ways Sunder Rajan takes pains to illustrate the symmetry of this mutual transformation of

biology and capital, he does argue that "the life sciences are *overdetermined* by the capitalist political economic structures in which they emerge" (2006:6). He makes the case that political-economic formations, while they may not determine the course of the life sciences in any straightforward sense, nonetheless "disproportionately set the stage" (2006:6) for their developments.

Other scholars who have explored dimensions of the phenomenon that Sunder Rajan calls biocapital have identified similar features. Stefan Helmreich (2008) taxonomized the work in this area when he catalogued the "species of biocapital." The theories in this vein call attention to how biology, biotechnology, and biomedicine increasingly subject life itself at the molecular level to the speculation and financialization; collectivized risk and individualized risk management; flexibility and de-standardization; and commercialization in pursuit of added surplus value (e.g., Waldby 2000; Fortun 2008; Thompson 2005; Rose 2007; Franklin 2007; Dumit 2007). Melinda Cooper argues that these processes have brought biology, and specifically biotechnology, into line with the advance of neoliberal capitalism: "the biotech revolution… is the result of a whole series of legislative and regulatory measures designed to relocate economic production at the genetic, microbial, and cellular level, so that life becomes, literally, annexed within capitalist processes of accumulation" (2011:19).

By arguing both that biology has been capitalized and that capital has been biologized—even if, as Sunder Rajan (2006) argues, the former overdetermines the latter in the last instance—theorists of biocapital emphasize biology's unique features. Those who apply a "Marxist-feminist" lens (Helmreich 2008), place special emphasis on biological materiality, specifically biomatter's generative and reproductive capacities. Reproduction—as opposed to production—has historically been taken for granted within capitalist economies, but the development of new forms of control over these capacities (see Franklin 2007; Landecker 2007) has helped to generate surplus value from them. The separation between production and reproduction breaks down under biocapitalism, and "life itself" becomes the objective (Rose 2007; Cooper and Waldby 2014). And a powerful objective it is; in medicine, a focus on the pursuit and optimization of health has enabled the growth of massive technoscientific industries of surveillance and intervention (Clarke et al. 2010). In these industries, patients become active consumers of technoscientific information and products, empowered agents in their ongoing pursuits of the horizon of healthfulness. The power of "life itself" and the economies of hope that they inspire further speak to the unique cultural power of the biosciences, which profoundly shape what it means to live and die in the 21st century.

In contrast to these suggestions of biology's distinctiveness, Kean Birch (Birch and Tyfield 2013; Birch 2017a, 2017b) notably criticizes the concept of

biocapital and, even more widely, the tendency in science and technology studies to append "bio-" onto existing theoretical concepts. Birch and Tyfield characterize this tendency as a "fetishization of everything 'bio'" (2013:299). Birch's most significant concerns with the proliferation of bio-concepts stem from the biological overshadowing and overwhelming the concepts to which it becomes attached (2017b). Birch and Tyfield fear that in the process, a tendency to attribute too much power to biological matter and technoscience displaces sophisticated analytical work, sacrificing attention to how economic and financial processes of modern capitalism are changing independently (2013). A key example of the latter is the shift Birch observes toward assetization and rent-seeking in the life sciences, as opposed to the Marx-influenced analyses of the commodity form that tend to dominate the STS biocapital literature. For Birch, the end result is analyses that are unable to grasp the complex, evolving relationships between biology, economies, knowledges, and societies (2017b). Against these tendencies, Birch argues for the need to examine the practices, political-economic actors, and knowledges involved in the creation and management of value in bio-economies.[10]

The Open Insulin Project could not exist if not for the developments characterized in the biocapital literature, developments it relies on for knowledge, resources, and intelligibility. While my analysis of the Open Insulin Project draws heavily on the existing biocapital literature, I aim to

[10] Birch and Tyfield (2013) do refer to the *bioeconomy,* acknowledging that in so doing, they fall into the same "bio-everything" trap.

avoid Sunder Rajan's, Cooper's, and Marx's (over)deterministic interpretations and to find, through the example of Open Insulin, more room for alternative formations. Employing ethnography and empiricism as advocated by both Sunder Rajan and Birch, I strive to stay grounded among the actors and practices that produce the value of the Open Insulin Project, looking at how they craft and characterize their approach. This approach emerges specifically from the bioengineering and biomedical landscapes of the Bay Area, enabled by a persistent desire for increasing control over biomatter and from strong ethical objections to the capitalization of health and medicine in particular. My study of Open Insulin suggests that if the entanglement of biology, biotechnology, and capital is indeed an overdetermination of the life sciences by capitalist political economy (Sunder Rajan 2006) or their annexation within capitalist forms of accumulation (Cooper 2011), it is incomplete, contestable, and perhaps, extricable.

Making Open Insulin

The Open Insulin Project is a volunteer team comprising—among others—self-proclaimed "biohackers" and "mad scientists"; community activists; computer hardware and software engineers; students, retirees, PhDs, and professionals; and the gainfully, self-, un-, and under-employed. These folks took different paths to get involved with the project, but there are some clear running themes among its founders and most consistent members.

These themes reflect the conditions that make the Project possible, providing the materials, the labor, and the will that Open Insulin needs to operate; they also carry within them some of the tensions that made Open Insulin challenging. Members were generally well educated, often in computer and information sciences, indicative of the way biology is increasingly tied not only to engineering, but to computer engineering specifically. This has allowed open-source and hacker activists to identify biotechnological interventions. Several of the Project's volunteer members were between jobs or splitting their time between Open Insulin and other commitments in the Bay Area's tech-oriented economy. These members felt qualified and compelled to intervene in healthcare economies by becoming producers of biomedicine, and they did so as a vehicle for their moral objections to the capitalization of healthcare.

These individual stories of involvement—"community bios"—are woven into the history of the Project itself, from its foundation to approximately four years into its existence. This "community bio" illustrates how Open Insulin was conceived, how its home, Counter Culture Labs, was built in the shadow of Bay Area's biotech industry. It also illustrates how the Project drew on synthetic biology and its particular fusion of biology and engineering. Finally, it demonstrates how Open Insulin engaged the existing biomedical system using a calculated strategy of circumvention based largely on precedents in software. While this strategy provided an empowering sort of roadmap for the

Project, it also implicitly accepted many of the features of biocapitalist order (see Chapter 2). Overall, the collective story of the Project further demonstrates how biocapital underwrote Open Insulin's antibiocapitalism. This "community bio" shows how Open Insulin developed from its inception and the factors that enabled its progress while also gesturing toward some of the difficulties and hurdles it encountered along the way.

Community Bios

I learned about the Open Insulin Project through an interest in the amateur side of bioengineering and synthetic biology. Like many others, I appreciated and sympathized with the Project's aim to address the high cost and inaccessibility of insulin. I walked through the propped-open door of Counter Culture Labs for the first time during the summer of 2017, and I became a regular participant and observer. Over the course of my work in the project, I saw many members come and go, with a relative few staying and becoming regular contributors. As time went on, the Project grew gradually, with more people showing up for the first time and more of those first-timers coming back. There was a core group of Project members that were present for the majority of my fieldwork, and the stories of how they came to be involved and why help tell the story of the conditions that make it possible to sustain the Project.

Open Insulin's co-founder Anthony had, of course, been there since the beginning. He came to the Bay Area as a computer scientist with a limited background in biology and a recent type-1 diabetes diagnosis.[11] In the wake of Occupy Oakland, he got involved with founding a computer hackerspace, similar to an existing space across the bay in San Francisco. A few years after that, as Anthony recalls, some of the same people developed an interest in founding a biohackerspace. Anthony had participated in some demonstrations of an insulin pump hack that posed dangers to their users by allowing access to the pump's software and the ability to manipulate their insulin dispersal. Driven by a response from the pump's manufacturer that he perceived as both inadequate and condescending and a more general frustration with lack of progress in insulin availability in the five or so years since his diagnosis, Anthony took up the cause of diabetes care as the Bay Area's biohackerspaces took shape.

The group of hackers that developed an interest in founding a biology-focused counterpart to their existing hackerspace were anchored by Patrik, a bioinformatician with a background in electrical engineering.[12] Though his day job was in bioinformatics, Patrik kept a sharp divide between this work, which he would eventually shift to doing only half-time and his exploits as a mad scientist by night, as he was often fond of saying. Patrik had worked as a postdoc for George Church, who is both one of the most significant figures in

[11] Murray, interview, December 10, 2017.
[12] Murray, interview, April 3, 2019.

the history of the Human Genome Project (HGP) and considered one of the founders—if not *the* founder—of the nascent field of synthetic biology (Roosth 2017).[13][14] Patrik had always had an interest in the intersection of computation and biology. As he put it, he began working on computational problems by drawing on biology but eventually "hopped the fence" and began working on biological problems drawing on computation. His role in Counter Culture Labs was an outgrowth of his desire to familiarize himself more with the wetlab side of things.[15]

Along with Patrik, Maria was the Open Insulin affiliate most involved with the broader community of biohackers and community labs. She got involved with BioCurious—alongside CCL, one of the Bay Area's two community labs—during its early days and filled many roles in her time there: Executive Director, Treasurer, Director of Community Engagement, and President.[16] She held an MBA, and before her involvement with BioCurious, she worked at Apple before moving to a major bench-to-bedside medical nonprofit. She had been involved with hacking clubs since the early nineties, but she attributes her work with this nonprofit with sparking her interest in biotech. As it happened, she was laid off just as BioCurious was opening its doors. She was one of its first volunteers, and as she says, has "not stopped showing up since." In addition to her many hats at BioCurious, Maria was

[13] Murray, interview, May 16, 2018.
[14] Murray, fieldnotes, October 2018.
[15] Murray, interview, April 3, 2019.
[16] Murray, interview, April 27, 2018.

involved with a wide range of projects; this includes a few that have activity at both BioCurious and CCL, among which is the Open Insulin Project. She hosted a satellite Open Insulin meeting at BioCurious and connected with CCL via video conference. She was such a consistent presence, even if not in person, that members of other organizations in the Omni Commons recognized her as "the voice" when they eventually met her in person. For Maria, whose husband is a Silicon Valley tech executive, her tireless volunteer work as a member of BioCurious and an advocate for the larger network of community labs became her primary occupation.

Throughout most of my fieldwork with the Open Insulin Project, its lead scientist was Yann, a protein biochemist from France. Yann came to the U.S. with his wife, herself a postdoc biologist. He was a recent PhD, temporarily without a work permit, trained for academia but with deep misgivings about the state of the academic job market and the desirability of a life moving between different postdoctoral positions. He luckily stumbled across a flier for the Open Insulin Project and started attending meetings.[17] He replaced another PhD-holding scientist who had been heading up the lab work, which was mostly out of Anthony's hands by that point. This previous "lab authority" fell into the same kind of employment trap that Yann was wary of himself:

> "He found a job… it's not even a job. This is where America is really sad. So you find a gig, you call it a gig. It's fascinating that before people were saying, if you have a diploma, you are

[17] Murray, interview, January 14, 2018.

> protected from the gig economy. No, it's not even a protection. You do your PhD and you will have this company calling saying, 'oh yeah, we have a short-term contract for you.' I find it really bad. But he found a gig, so he has no time in here."[18]

Without employment and deeply sympathetic with Open Insulin's anticapitalist cause, he became one of the Project's most steadfast members and could be found running experiments in the lab most days.

Thornton had recently received his PhD in molecular and cell biology from nearby Berkeley, where he had been heavily involved with the graduate student union.[19] He had become disenchanted with academic science, coming to view it as a game among the powerful. After completing his degree, he was searching for a project that could combine his interest in research science with a political project along the lines of his union work. He came across the Open Insulin Project through an internet search and began attending meetings. He brought his union organizing skillset to the Project. Despite Open Insulin's work being, as he described it, "pretty similar to my wheelhouse," Thornton mainly worked on the organizational and strategic dimensions of the Project, helping to facilitate meetings and establish connections.

Michael came to Counter Culture Labs from what he described as "high tech."[20] He had worked for many different Silicon Valley companies, including a handful of startups and higher profile companies like Adobe, Sun, and

[18] Murray, interview, January 14, 2018.
[19] Murray, interview, August 8, 2018.
[20] Murray, interview, March 3, 2019.

Apple. His background was in design, and he often emphasized his former work in what he called a "world of creativity and innovation."[21] Coming from such an environment, he drew excitement from the development of genomics and of CRISPR-Cas9 and gene drives in particular. He took these as indicators that biotechnology was on the cusp of a transformation akin to the information technology boom that birthed Silicon Valley, calling this the "appropriate time in history for the convergence of high tech and biotech."[22] He had perceived a shift late in his career away from Silicon Valley's more beneficent early days and toward more selfish motivations. In retirement, he was looking around for a project that could help steer an impending biotechnological revolution in a humanitarian direction. He discovered both BioCurious and later, the more conveniently located Counter Culture Labs via booths at Maker Faire, an annual do-it-yourself festival. The Open Insulin Project stood out to him as the kind of humanitarian effort he was looking for, an opportunity to act against what he described as "corpocracy" or "corporate oligarchy" and in the interest of care rather than profit. He dabbled in lab work before moving into a role as treasurer of both CCL and the Project.

Ramy was elected as Counter Culture Labs' president not long after I began my participant observation. She started attending mycology-focused meetings at Counter Culture Labs, before she happened to meet Anthony far afield in Brussels. Both had travelled for an unconference at the invitation of a

[21] Murray, interview, March 3, 2019.
[22] Murray, fieldnotes, June 27, 2018.

Belgian associate who had visited CCL. Ramy, whose training is in public and environmental health, immediately saw the appeal of the Open Insulin Project, and it became her primary focus at CCL. She later ran for lab president at Anthony's urging. Ramy took a special interest in the inclusivity of the space, noting that she wanted to make it more welcoming to outsiders. She did no wetlab work as a member of the project, but as more involved with organization and outreach.

These brief biographical sketches show some of the paths that people took to find their way to the Open Insulin Project and in so doing, illustrate the convergent conditions that make a project like Open Insulin possible. Many of these people came from backgrounds in information technology and computer sciences. Some, like Anthony and Maria, were involved with conventional hacking (if hacking can ever be called conventional) before finding their way into biology and biomedicine. Others, like Patrik, Yann, and Thornton, were trained at the intersection of biology and information sciences, in biotechnology or bioinformatics. Some, like Michael, had no prior experience with biology but anticipated a biotechnological boom and wanted to get in on the ground floor. The emergence of synthetic biology and the broad approach to biology as an engineering and informatic discipline meant that a range of skillsets that were widespread in the greater San Francisco Bay Area were relevant to the Project's aims.

Many of Open Insulin's members found themselves able to contribute significant amounts of time to the Project because of their employment status. The shift toward a "gig economy," which Yann described as he discussed some of the turnover at the Open Insulin Project, is well documented (e.g., Friedman 2014, Manyika et al. 2016) and closely linked to the greater San Francisco Bay Area's tech-focused entrepreneurial ecosystem. As a result, many highly skilled but unemployed or underemployed volunteers find their way to the Open Insulin Project. There, they hope to keep busy, to put their skillsets to good use, or to develop or maintain skills relevant to finding new employment in the biotechnology industry. Some have experienced enough success in their careers that they are able to devote their time to a pet project like Open Insulin without needing to worry about finding stable employment.

In short, they Bay Area had a surplus of what I call "ambient expertise": a range of highly skilled workers who were accustomed to temporarily lending their labor to a range of projects, who regularly found themselves with flexible time, and who sought to both apply and augment their skills and knowledge in these periods of flexibility. This expertise was not exclusively technical; project members like Anthony, Thornton, and Ramy also had experience with community and labor organization, the legacy of which runs strongly through Oakland and Berkeley (see Wolman 1975; Balderston 2012). These skillsets were important to the organizational and advocacy work that helped grow and sustain the project.

The Open Insulin Project was also enabled by the empowerment of patients and consumers in contemporary biomedicine. Clarke et al.'s (2008) theorization of the process of biomedicalization includes—in addition to the increasing co-constitution of biomedicine and capital—an increase in scientific knowledgeability and responsibility among biomedical subjects: "[Biomedicalization] demands of patients, consumers, and patient groups that we become more knowledgeable and responsible—essentially more 'scientized'—vis-à-vis biomedicine" (2010:16). They refer to this, following Landzelius (2006, cited in Clarke et al. 2010), as a process of "metamorphoses of patienthood," and following Rapp (1999, cited in Clarke et al. 2010), discuss the forms of "moral pioneering" that these metamorphoses can produce.

The Open Insulin Project was one such form of moral pioneering. Insulin-using diabetes patients like Anthony felt empowered to act in the interest of their own health. Anthony was fond of introducing himself as the "token diabetic guy," and at many of the earlier meetings I attended, he was the only person with diabetes present, or at least the only one who readily volunteered that information. As time went on, others who identified their Type-1 diagnoses as an important biographical detail would also volunteer with the Project. Some had worked on other insulin-related hacking projects in the past. Significantly, though, many of those who did not have diabetes themselves simply felt indignation at the injustice they identified in the

difficulties insulin users faced. They too felt empowered and even obligated to act in the interest of insulin-users' health, forging new collective ideas about the rights and responsibilities of biological citizenship. Community laboratories gave them the fora and the tools for a new way of doing so. Beyond being patients and consumers of biomedicine, these Open Insulin members worked to become producers of biomedicine.

The objects of Open Insulin members' moral pioneering were the existing institutions of biomedicine, corporations especially. Project members were united by the belief that pharmaceutical corporations neither had the best interests of patients at heart, nor were they the best organizations to provide essential medicines to patients. For many of the core Project members and in many of the Project's day-to-day discussions, this belief manifested as an overt, sweeping anticapitalist sentiment. Even those who did not fully embrace anticapitalism, however, both identified and deeply objected to the prioritization of capital accumulation over patient wellbeing.

For example, Michael, who was perhaps the least convinced of Open Insulin's status as a fundamentally anticapitalist project, nevertheless talked about both software and medicine being "overrun by corpocracy."[23] Though he did not believe that corporations were inherently evil, he believed that among good and bad corporations, the bad had taken precedence and that

[23] Murray, interview, March 3, 2019

Open Insulin's grassroots organizing was providing an alternative that emphasized an expansive version of care over profitability:

> "We can do something… to change the way we operate on earth and do it in a way that's not just about money and profits, that's really driven by care for our environment, care for other humans, care for the other beings who live on earth…. The kind of things that we're doing in a community organization like ours I think are thoughtful, intentional ways of trying to do that in the world, thinking in that holistic way."[24]

Michael saw a shift in the nature of corporations in general, which he dated roughly back to the 2007-2008 global financial crisis, toward shareholder- and profit-focus and away from the best interests of not just consumers, but the planet and its inhabitants as a whole.

Despite being one of the more outspoken anticapitalists and Marxists among the Project members, Yann expressed a similar, modest hope for greater social conscientiousness. He suggested that the Project was a step toward this and away from a narrow focus on profit:

> "For me, and I know it's not the same for everybody, but for me [Open Insulin] is a political action I do because I don't like the way the economic system for the drugs market is organized to just be focused on how to make more profit. And for me, Open Insulin is already a step in the door to say, okay, maybe we can have a different kind of society where you are not focused only on profit, and you'll be focused also socially on what's involved to have a company."[25]

[24] Murray, interview, March 3, 2019
[25] Murray, interview, January 14, 2018.

Maria's home lab BioCurious was more firmly rooted in Silicon Valley and sustained itself largely by renting out lab space to biotech startups. Still, she called the American healthcare model "broken" and lamented that companies did not have incentives to look out for the best interests of patients.[26] She called strategies to profit off of older drugs like insulin "predatory" and gleefully remarked, "I'll be eating cake to the death of Big Pharma."[27][28]

Other members of Open Insulin were more unequivocal about whether the Project was fundamentally anti-capitalist. Thornton described the Project's attractiveness to him as a rare example of "radical science." For him, the case of insulin "epitomize[d] the problems with hypercapitalism in healthcare."[29] Ramy also attributed the source of problems with science to capitalism and described herself as "post-capitalist." She lamented the difficulty of pursuing open science projects "until capitalism gets turned over."[30] Many other members, like David, Max, and Louise, individually echoed these sentiments in interviews, pointing again to the prioritization of shareholder profits over patient health, pointing to capitalism as the cause of these misplaced priorities, and describing Open Insulin as an anticapitalist tool.[31]

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[26] Murray, interview, April 27, 2018.
[27] Murray, interview, July 12, 2018.
[28] Murray, fieldnotes, December 15, 2019.
[29] Murray, interview, August 8, 2018.
[30] Murray, interview, October 10, 2018.
[31] Murray, interviews, July 14, 2019; November 16, 2019; and May 12, 2019

Like Yann and Michael, the Project's founder Anthony saw Open Insulin as a test case and a model for different ways of organizing economies, in healthcare and beyond:

> "We're trying to address the systemic issues behind the problem.... I think that the way we're approaching things should apply to a lot of other things. Medicine in general, I think, is widely acknowledged to be in a state of crisis, in America at least. If we can show how people can make medicine for each other on a small scale organized in a way that is accountable to the people using the medicine, then that could apply to other medicines besides insulin. And I think it could apply to a lot of the other necessities and conveniences of life that get manufactured. I see this as shifting from an extractive model of economic activity where you have a small elite that owns and controls the means of production and uses that as leverage to extract wealth from the rest of people and shifting to a common-space economic model where when there is a resource that is important for people's wellbeing, all of the people who rely on it organize together to decide how that resource should be managed in an effective way. So really what we're doing is just an instance of what I think should be a shift in how all economic activity is carried out."[32]

In Anthony's analysis, Open Insulin addressed the structural causes of the problems of healthcare. These structural causes lay in the concentration of biomedical means of production in the hands of a few producers who were not accountable to patients and consumers. The solution, and what Open Insulin proposed, was to put these means of biomedical production into more hands.

Overall, there was a shared belief among the Open Insulin Project members that, if capitalism itself was not the core problem, there was certainly a problem with the way that capitalism operates in healthcare

[32] Murray, interview, May 26, 2019.

economies, resulting in the prioritization of profit over health and care both. Members broadly agreed that the combination of a focus on profit and shareholder gain with the provision of essential medicine was a threat to the safety and lives of those with diabetes. This consensus was expressed in the language of their incomplete Manifesto, which members nevertheless turned to as a point of reference for their shared values:

> "We are motivated by several prospects: First, to decentralize the production of insulin, and to make it available at low cost to all who do not have access to it in the present prevailing business, economic and societal milieu."
> "We believe that ownership and control of the means of production and distribution of medicine should be spread as widely as possible, and aligned as closely as possible with the needs of those who use medicine."
> "We will not allow private, for-profit institutions to exploit our research, and we seek to prevent them from exploiting their patients" (DRAFT Open Insulin Manifesto).

This project was, if not strictly anticapitalist, *antibiocapitalist*. The beliefs espoused by its individual members and its collective Manifesto were firmly against the current state of pharmaceutical production and widely identified contemporary capitalism—if not capitalism writ large—as the underlying cause of its problems. At the same time, their ability to act on their antibiocapitalist stance was enabled by the same complex of conditions. They took advantage of the flexibility and surplus of labor and knowledge and the empowerment of biomedical patients and consumers to channel their sentiments into a biotechnological tool, Open Insulin. The biographies and

perspectives of the different members revealed how their individual stories converged at Counter Culture Labs.

A Community Bio

The stories of the individual Project members, how they came to Open Insulin, and their philosophies regarding the Project tell part of the story of how Open Insulin became possible; the history of the Project as a collective shows how these volunteer-activists were able to build a Project and a laboratory. The same developments characteristic of biocapital that brought volunteers through Counter Culture Labs' doors enabled this. The Bay Area biotechnology economy provided excess materials and resources that allowed for the construction of a workable wetlab. Synthetic biology's approach to biology as a series of standardized parts helped produce the biological flexibility that made Open Insulin possible, providing a setting in which these biological tools circulate if not freely, then at least at a cost friendly to a community lab with limited funds. Open-source software provided a translatable framework for those interested in producing medicine themselves.

The Open Insulin Project emerged from the seed of Anthony's personal interest in lowering barriers to diabetes treatment. Such a project became feasible only when biology and biotechnology became practicable outside of these academic and commercial laboratories that have historically been their

necessary homes. As a first step, this meant building a minimally functional lab space. The Project's origins were closely linked to the construction of two linked communities and their biohackerspaces in the Bay Area: Oakland's Counter Culture Labs, which would serve as CCL's primary home, and Silicon Valley's BioCurious.

These labs were built from communities interested in applying maker, hacker, and D.I.Y. principles to biology. Those present at their foundations were interested in building spaces where people could experiment with biology without having to go through conventional institutions.[33] Some had been working on hacking projects and saw an accessible biology lab as a logical outcropping of that work, something the world needed to reestablish and protect scientific literacy and the right to scientific inquiry.[34] BioCurious got its start first. The fledgling lab launched as a Kickstarter project in 2011, raising over $35,000 from 239 backers (BioCurious 2011). Over half of this came from a series of $2500 donations that included lifetime memberships, suggesting a relatively small but also relatively well-off community of interest.

BioCurious found its home in Sunnyvale, in the heart of Silicon Valley.[35] When the lab first opened, it had difficulty attracting members.[36] At that time, the lab had found a space, but this space was still largely unpopulated by the kind of laboratory equipment that could draw in visitors.

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[33] Murray, interviews, April 3, 2019; April 27, 2018.
[34] Murray, interviews, April 27, 2018; December 10, 2017.
[35] During my fieldwork, BioCurious moved to a larger space in nearby Santa Clara.
[36] Murray, interview, April 27, 2018.

The lab addressed this by brainstorming a series of community projects that would help to attract and sustain interest over time. This included the bioprinting project which would become perhaps the longest continually running community biology Project anywhere. Another of these community projects, Glowing Plant, focused on engineering bioluminescent plants. Its members wanted to create a startup company based out of BioCurious, giving BioCurious a substantial share. This project raised nearly $500,000 in its own Kickstarter campaign and attracted a lot of attention in the process. The negative attention related to concerns over genetic modification resulted in Kickstarter entirely banning bioengineering projects from the platform (Zhang 2017). The project's fundraising success, however, attracted a growing financial interest in startup synthetic biology projects.

Eventually, a falling out led to the separation of Glowing Plant from BioCurious entirely, and it eventually fizzled because it could never insert the genes it needed to and could only produce plants with a faint glow (Zhang 2017).[37] After these events, BioCurious' leadership made the decision to keep its community projects open source. [38] However, providing laboratory space to startups became a major part of BioCurious' operations model. During my fieldwork, BioCurious was host to over a dozen different startup companies that rented out benchspace and used the lab's facilities. Taking advantage of its location in Silicon Valley and its proximity to company executives and

[37] Murray, fieldnotes, December 6, 2017.
[38]Murray, interview, April 27, 2018.

venture capitalists who would often pass through and visit BioCurious for tours, BioCurious became a model for a community laboratory. The lab became one of the largest and most sustainable biohackerspaces by supplementing its open-source Projects with speculative investment from those looking to get a piece of the synthetic biology revolution.

In the early days of BioCurious, it was drawing interested people from the surrounding region, including several from the East Bay.[39] The commute between the East Bay and Santa Clara (especially considering the Bay Area's notorious traffic) compelled this contingent to discuss founding their own organization. Members initially met in members' homes and in a rented spare room in which they set up a basic laboratory. As it happened, an individual who had made a lot of money in the early days of Silicon Valley was looking to rent out a large building, a former sanitation workers' union building, that he owned in North Oakland to organizations focused on social justice. At the same time, another organization, Sudo Room, was looking to build a more conventional, computer-focused hackerspace. The new East Bay biohacker contingent, which also shared overlapping members with Sudo Room, became part of a coalition that moved into the building on a three-year lease with the generous option to purchase the building for a fixed price at the end. With the help of a separate large donation, they managed to purchase the building, establishing the Omni Commons.

[39] Murray, interview, April 3, 2019.

The Open Insulin Project was officially born around the time Counter Culture Labs was moving this new home.[40] Open Insulin's initial funding also came from a successful crowdfunding campaign, on Experiment.com, through which it raised $16,656. This combined with the membership fees and donations that both Open Insulin and Counter Culture Labs collected to form the Project's modest budget—modest especially in comparison to the traditionally high cost of biological equipment, reagents, and other materials necessary to run the Open Insulin Project. They have managed to build a surprisingly effective biological laboratory on this shoestring budget, allowing the Open Insulin Project to proceed with its attempts to produce insulin in the lab.

The San Francisco Bay Area's tech and biotech communities helped make Open Insulin's work possible by furnishing Counter Culture Labs with materials and equipment. Perhaps the most important material resource is the nearby supply depository, Oakland's Bio-Link Depot. Bio-Link collects donations of scientific equipment and distributes them to educators and researchers, including those at both CCL and BioCurious. Many of the members of CCL and Open Insulin help out at the Depot, in exchange for increased access to their store of donations. Bio-Link allows labs replacing their equipment or, in some cases, companies going bankrupt to receive tax deductions in exchange for these donations.

[40] Murray, interview, December 10, 2017.

One of the most memorable Bio-Link episodes happened about a year into my fieldwork. The biomedical blood-test startup Theranos had gone from one of the most buzzworthy and highly-valued companies in the biotech sphere to the object of a full-blown scandal. The company had amassed billions in speculative capital and the support of several high-powered board members, including a former United States Secretary of State (Carreyrou 2018). Investigative reporting eventually revealed that Theranos had misled its investors and the public; the company was dealing in vaporware. Their revolutionary low-volume blood-testing failed to materialize. Where they deployed blood tests, their results were inaccurate and misleading, and they were conducted on machinery purchased from other companies. Theranos went defunct. Their young CEO, Elizabeth Holmes, once hailed as the next brilliant, college dropout tech visionary, was indicted on charges of fraud and barred from serving as an officer or director of another company for a decade.

In the wake of this debacle, members of CCL and Open Insulin, in their capacity as volunteers with Bio-Link Depot, went to retrieve donated materials from Theranos' labs.[41] They ran four or five trucks' worth between Bio-Link and Theranos, and I was at CCL when they returned, pushing a Theranos-labelled glassware cart loaded with boxes of nitrile gloves, pipette tips, and more (Figure 2). I helped unload the carts and run internet searches to log the value of the donations for tax purposes. Among the goods, the lab

[41] Murray, fieldnotes, July 25, 2018.

scored three incubators typically used for human cell culture that would ordinarily go for $1000 apiece. I discovered that a box of Ultra-Clean™ aluminum foil goes for $79. Lab members were thrilled as much by the event as by the materials. They dubbed it “Theranos Christmas” as they described the inside of the company’s former facilities. Along with a massive American flag, one of Holmes’ own quotes was largely and prominently displayed on the wall: “This is about being able to do good.” Anthony somewhat wistfully described Theranos as “embodying some aspect of the American spirit,” which he described as a P.T. Barnumesque hucksterism. Yann put a salvaged Theranos “BLOOD COLLECTION SYRINGES” sticker on the back of his laptop alongside those for Counter Culture Labs, the Open Insulin Project, and the biohacker conference Biohack the Planet, plus another that simply said, “if nature is unjust, change nature” (Figure 3).

Figure 14. A Theranos-acquired cart bearing their logo and a load of nitrile lab gloves.

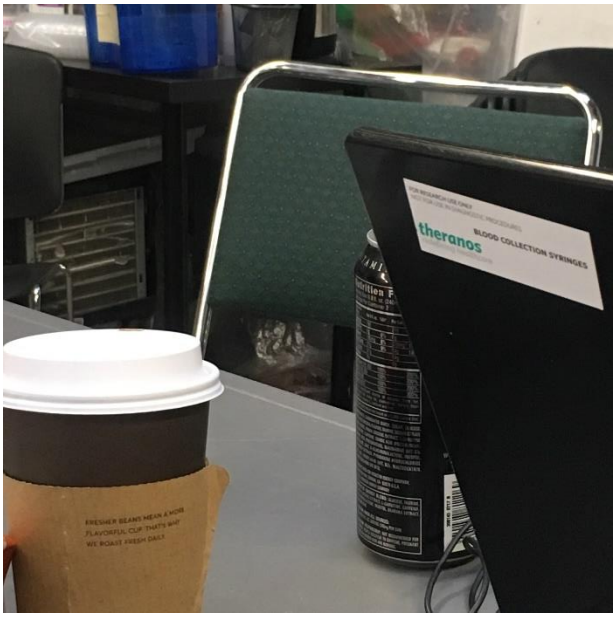

Figure 15. The Theranos sticker on the back of Yann's laptop.

There were other sources of equipment aside from Bio-Link. Within the relatively small and close-knit synthetic biology community, much of which is concentrated in the Bay Area and around Stanford University—as well as in the Boston/Cambridge area where it is anchored by Harvard and MIT—Project members were often personally acquainted and friendly with people on the more academic side of synthetic biology. Occasionally, these connections directly provided Counter Culture Labs, which was also a 501 (c)3 nonprofit organization, with donations of equipment they no longer needed. Among other pieces of machinery, this was how the lab came by its OpenTrons pipetting robot, for which they quickly set about finding a place and a purpose.[42] Lab members also sourced cheap materials from online auctions. If they needed a specific piece of equipment, they often turned to

[42] Murray, fieldnotes, October 3, 2018.

eBay, another reliable source of secondhand equipment that often also came from failed startups.[43] Apparently, to avoid liability for donating biotechnology materials, some companies would simply place them out by dumpsters.[44]

Using materials collected by these means—missions to and for Bio-Link, direct donations to the lab, and occasional purchases from auctions online and otherwise—CCL and Open Insulin members happily filled their lab with secondhand, outdated, and malfunctioning equipment, with which they made do. They learned to work with and repair less-than-perfect machinery, find older computers with compatible operating systems, hunt down old software, and repair broken equipment with parts either salvaged or purchased online. Piece by piece, they managed to build a remarkably serviceable biolab.

Yann, Thornton and Max all came to CCL from academic labs, and they each commented on their initial surprise at the quality of CCL on their first visits. None was really sure what to expect. Thornton described wondering if Open Insulin was merely an art project until he visited the lab for the first time:

> Actually, I could see immediately that they had real equipment, they had real stuff, they had the stuff that I, you know, knew is needed to actually make this thing.... And then also, I can see immediately that like, it's janky, right? I mean, these machines

[43] Murray, fieldnotes, May 9, 2018.
[44] Murray, fieldnotes, March 3, 2019.

> are soldered, and hardware together and it looks like a souped-up car."[45]

Thornton felt that the lab was "janky" and a little bit jerry-rigged, but still functional for the purposes of producing insulin. Max's impressions were similar:

> It was better than I expected. Like I was kind of expecting just, um, like things cobbled together from things you find around the house. So to see—even though it's a lot of stuff that's super outdated or not fully functional—still equipment manufactured for research, that was a surprise for me to see at first."[46]

In addition to the lab exceeding his expectations, Max personally saw its jankiness less as an encumbrance than as an added draw and a bit of a fun challenge. The need to hack was part of the appeal of working in a community lab, an interesting puzzle for someone accustomed to working in a state-of-the-art lab and ordering expensive reagents without a second thought.

Counter Culture Labs' wetlab, though limited like its funding, was equipped with the essentials. In addition to its liquid-handling robot, the lab had a biosafety cabinet, several lab-quality freezers and refrigerators, incubators, thermocyclers, spectrophotometers, gel electrophoresis devices, centrifuges, autoclaves, stir plates, hot plates, scales, and more. They also built open-source versions of a PCR machine and a gene gun, which was rigged with a paintball cartridge.[47] This was on top of an ample supply of pipettes and pipette tips, nitrile gloves, petri dishes, para-film, and

[45] Murray, interview, August 8, 2018.
[46] Murray, interview, November 16, 2019.
[47] Murray, fieldnotes, April 25, 2018.

glassware—much of which, if the logos were any indication, came from the nearby University of California, San Francisco (See Figure 4). With all of this packed into their very own building, the purchase of which was also enabled by proximity to Silicon Valley, Counter Culture Labs became a space that even those accustomed to working in better-equipped academic laboratories recognized as serviceable. The surplus, disposable wealth and materials of the Bay Area bioeconomy helped establish a wetlab in which Project members could get to work bioengineering Open Insulin.

Figure 16. Some of Counter Culture Labs' UCSF-branded glassware.

Members often called the lab work and the challenge of actually producing insulin the "core" of the Open Insulin Project.[48] While certainly challenging, the effort was enabled and consistently aided by developments in bioengineering, especially the development of synthetic biology, and by input

[48] Murray, fieldnotes, May 15, 2019.

and assistance from experts and professionals who did not directly work as members of the Project. Synthetic biology and the infrastructure that accompanied its development helped to make biological engineering more feasible in a community lab setting, as well as encouraging the open-source ethos that Open Insulin embraced. Key contributions from some outside biotechnology experts, as well as information available online, substantially shaped the trajectory of the Project's technical approach.

Biotechnology is increasingly informed and shaped by precedents in engineering, especially computer engineering, and Open Insulin was no exception. A mass movement of engineers into biology helped create the field of synthetic biology, which strives for greater precision and modularity than previous forms of bioengineering (Roosth 2017). Developments in synthetic biology have provided resources and incentives for community-based projects, most clearly exemplified by the BioBricks Foundation and its branches. These include the Free Genes Project, which collects useful gene sequences and licenses them under the BioBricks Foundation's Open Material Transfer Agreement (Open MTA)—of which Counter Culture Labs is a signatory[49]—to build a "biotechnology commons" (Bio Bricks Foundation n.d.; Free Genes n.d.). The BioBricks Foundation also receives contributions from the International Genetically Engineered Machine Foundation (iGEM), which incentivizes continued participation in the development of synthetic biology

[49] Murray, fieldnotes, February 3, 2019.

through annual competitions. In addition, the nonprofit organization Addgene stores and distributes plasmids—circular DNA segments used to transfer genes into single-celled organisms like bacteria and yeast—and the viral vectors used to implant them (n.d.).

Synthetic biology helps to make biology more engineerable, to the point where biological engineering has become doable with a more minimal laboratory setup that one could build in a garage, dorm room, or community lab like CCL or BioCurious. Open Insulin pulled from these resources and from synthetic biology's approach more broadly. Project members utilized Free Genes and Addgene to obtain the plasmids with which they worked.[50] When working with collaborators outside the Project, Open Insulin members sometimes deployed the Open MTA as a safeguard of the technology's open-source status. One Open Insulin collaborator in Australia entered his insulin expression protocol—which he called *Winsulin*—into the iGEM competition, so this approach entered and remained in the online commons.[51] Another CCL- and BioCurious-based synthetic biology project, Real Vegan Cheese, received an iGEM gold medal.

Even when members of the biotech community did not become members of Open Insulin, Project members often utilized and learned from their expertise. This expertise drew on synthetic biology's paradigmatic approach to engineering life. The Open Insulin Project began, as Anthony

[50] Murray, fieldnotes, March 14, 2018.
[51] Murray, interview, February 27, 2019.

recounted, after a one-hour presentation from someone with experience producing insulin in an academic lab setting.[52] This presentation convinced Anthony, who was already focused on diabetes- and insulin- related projects in the community lab setting, that producing insulin was a realistic aim. The Project began working with the common bacterium *E. coli,* the same model organism that Genentech used when they developed the first bioengineered insulin—also the first-ever bioengineered pharmaceutical—in the late 1970s (Fraser 2016), at the dawn of bioengineering.

The Project's days working with *E. coli* were limited. They switched from this bacterium to a type of yeast, *Pichia pastoris,* after someone reached out to them with advice and a pre-modified *Pichia* strain. This contributor, who Michael called "a *Pichia* expert,"[53] had his own effort to produce a not-for-profit strain of insulin, and he sought to help out the Project by recommending switching to *Pichia,* which had become much more developed as a an industrial protein production tool since Genentech first produced insulin in *E. coli.*[54] The development of a range of viable "microbial factories," as members frequently referred to them,[55] was a significant focus of the development of synthetic biology. As an analogy and image, it was widespread within the field (see Figures 5 and 6; Kavšček et al. 2015; *FEMS Yeast Research* 2017; Payen and Thompson 2019).

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[52] Murray, interview, December 10, 2017.
[53] Murray, fieldnotes, January 24, 2018.
[54] Murray, interview, February 23, 2018.
[55] E.g., Murray, interview, July 18, 2018.

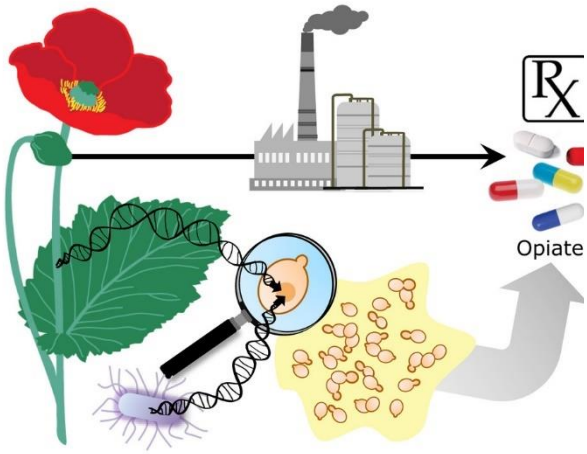

Figure 17. One representation of microbes standing in for factories, from the lab of Stanford University professor Christina Smolke (n.d.).

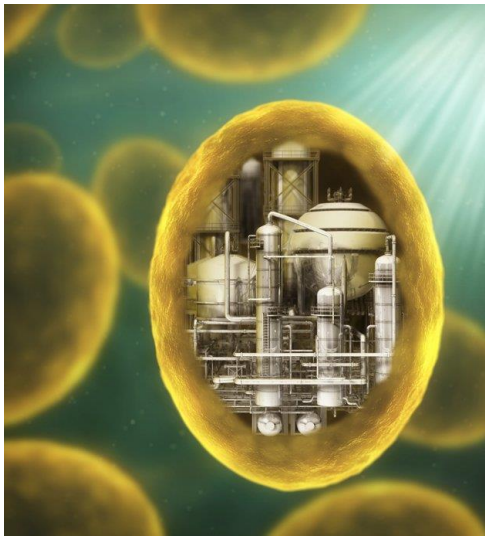

Figure 18. Another representation of a microbial "factory" (Futurism *2016).*

Pichia, as both the expert and members of the Project explained to me, provided several advantages.[56] It may be more efficient than *E. coli* or other model organisms like *Saccharomyces cerevisiae,* also commonly known as brewer's or baker's yeast. Yeasts like *Pichia* are capable or secreting recombinant proteins, facilitating extraction and purification, and they tend to mutate more slowly, reducing the risk that they would lose or alter key modifications. *Pichia* is unique in its ability to use methanol as a carbon source. Other microorganisms' aversions to methanol allowed Open Insulin Project members to use it as both a nutrient source and an anti-contaminant. In one of the few bits of lab work I did during my fieldwork, I helped Yann feed the Project's *Pichia* strains by pipetting methanol into their Erlenmeyer

[56] Reardon and Murray, interview, February 23, 2018; Murray, fieldnotes, May 7, 2018.

flasks beneath the lab's biosafety cabinet (see Figures 7 and 8). As the *Pichia* expert explained, "in terms of sterility, you don't have to worry about the culture. Methanol would kill anything else."[57]

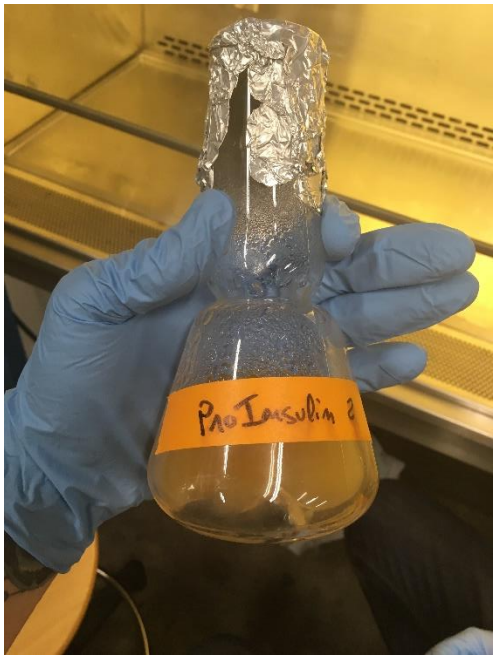

Figure 19. The author holding an Erlenmeyer flask containing Pichia *cultures modified to produce proinsulin glargine.*

Figure 20. Yann, the Project's lead scientist, demonstrating how to feed cultures of Pichia *using methanol.*

[57] Reardon and Murray, interview, February 23, 2018.

Some background on insulin is necessary to understand the Project's specific approach, which drew on synthetic biology's fusion of information technology and bioengineering to adapt precedents in open-source software movements to biomedicine. The *Pichia* strains that the Project received produced an insulin precursor called proinsulin (see Figure 9). Insulin consists of two chains of amino acids, referred to as the A- and B-chain. Human bodies produce insulin, a small, folded protein, by first creating a larger precursor molecule and then cleaving off the superfluous connecting portion, called the C-peptide (*C* for *connecting*). The Project's goal was to produce "mature," cleaved insulin that could be used as an injectable therapeutic.

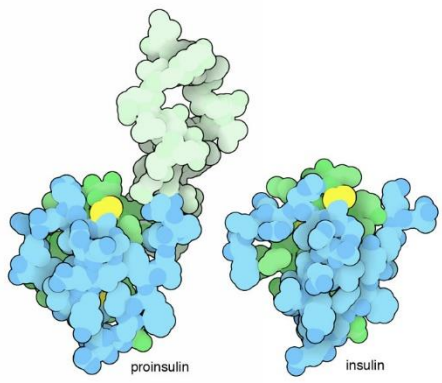

Figure 21. A comparison of the insulin precursor proinsulin, which contains the A chain, B chain, and C peptide, with mature insulin, in which the C peptide has been cleaved and removed (Goodsell 2001).

The form of insulin that Genentech initially developed as the first recombinant biologic pharmaceutical is native human insulin, the same insulin that human pancreases produce. However, newer, slightly

modified molecular forms, insulin analogs, are now more popular in the treatment of diabetes for multiple reasons, including convenience and quality of life improvements (Brixner and McAdam-Marx 2008; Fullerton et al. 2016). The actions of long- and short-acting insulin analogs more closely resemble the way the human body uses insulin, and these insulins may allow greater treatment flexibility and may be more reliable overall for the treatment of Type-1 diabetes (Bashoff 2019; Grunberger 2014). As a medicine long off-patent, relatively inexpensive native human insulin was available on the market, though patients may have been unaware of its availability, as doctors prescribed it increasingly rarely and instead increasingly prescribed analogs.[1] Though their production costs were similar (Gotham et al. 2018), these analogs were more expensive than the affordable native human insulin for a number of reasons, among which was that insulin was a biologic, large-molecule pharmaceutical.

This point was important because generic drug regulations applied to small-molecule pharmaceuticals, with precisely known and identifiable structures. Large-molecule pharmaceuticals, on the other hand, are difficult or impossible to identify definitively, making it difficult to determine whether a given drug would function exactly the same way in the body. Generic drugs could save on cost by forgoing some requirements to reach market, like full clinical trials. A similar framework for biologics,

[1] Reardon and Murray, interview, February 23, 2018.

the biosimilar designation, emerged only in 2009 (FDA 2020).[2] However, considering the complex reasons why insulin's cost has risen in recent years (Biniek and Johnson 2019) and the seemingly disappointing returns of biosimilar programs in Europe and the United States to date (Greene and Riggs 2015; Zhai, Sarpatwari, and Kesselheim 2019; c.f. Gotham et al. 2018), it remained unclear whether the development of this designation would be sufficient to reduce insulin prices. Open Insulin members certainly doubted they would.

As their intervention, the Open Insulin Project selected one of these analogs, glargine or long-acting insulin, as its target because it identified a particular need for an affordable biosimilar version. This meant modifying—or "transforming"—strains of *Pichia* with plasmids to produce a glargine precursor and an enzyme to do the cleaving. Yann believed, based on his research, that glargine production in *Pichia* was achievable and set about designing a new process that, as far as he could tell, was not covered by existing patents.[3] As part of this process, Yann designed sequences for new plasmids, deciding to produce Proinsulin and the protease to cleave it—called Kexin or KEX2—in two separate strains of *Pichia*. Yann initially felt confident in his Kexin-producing strain, perhaps unsurprisingly, as the protease was native to yeasts, naturally occurring in

[2] It is also worth noting that Open Insulin members themselves were occasionally unclear on the differences between the designations (Murray, fieldnotes, April 29, 2018).
[3] Murray, interview, January 14, 2018; fieldnotes, June 20, 2018.

S. cerevisiae. Eventually, however, after some struggles to verify proinsulin production, the Project reworked its approach.[4] As time went on, the Project diversified its approaches still further and additionally began experimenting with a protocol for lispro, rapid-acting insulin.[5]

By aiming to develop insulin production protocols that circumvented existing patents, the Open Insulin Project was turning not only the tools, but the intellectual property strategies of biocapital against the capitalization of insulin. They hoped to use their own incremental innovation to create a protocol that they could use to produce insulin without profit motives. Because Open Insulin was adopting the same premise of incremental innovation that "Big Pharma" used to maintain their intellectual property rights, Open Insulin members like Anthony anticipated that any attempts to "come down" on Open Insulin would necessarily undermine their own strategies and practices (though see Chapter 2).

Understandably given the backgrounds of several Project members, Open Insulin's approach to biosimilar insulin drew on the open-source software movement's creation of alternatives to patent-protected exclusionary software. Open Insulin's members were interested not only in continuing to bridge the gaps between computational and biological engineering, but also in importing open-source, commons-based models

[4] Murray, fieldnotes, June 23, 2019.
[5] Murray, fieldnotes, October 27, 2019; January 26, 2020.

into biotechnology. In fact, they originally considered naming the project *Open Source Insulin* and designed a logo featuring that name alongside the familiar DNA double helix (Figure 10).

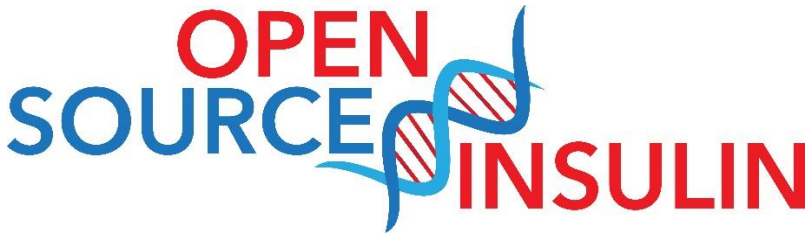

Figure 22. A logo design for one of the Project's proposed names: Open Source Insulin.

Instead of creating an operating system like Linux, which members used as a touchstone example of open-source work,[6] Open Insulin members wanted to produce a protocol for a biologic pharmaceutical that could be freely reproduced by those with the technical means to do so—means that were becoming increasingly available in the wake of a booming biotech industry. They hoped that open-source insulin would challenge Big Pharma's "big three" as open-source software had challenged onetime monopolists like Microsoft. Their hacker ethic dictated that if people could do something in a janky, piecemeal laboratory setup, it had no reason to be so costly for patients.[7] The widespread availability of computers empowered technically literate "geeks" to reorient power and knowledge in the computing field by becoming producers in the Free Software

[6] Murray, fieldnotes, April 14, 2019.
[7] Murray, interview, August 8, 2018.

movement (Kelty 2008). The widespread availability of the tools of the biotechnological and biomedical trades creates the potential for a similar reorientation among the informed, proactive subjects of contemporary biomedicine. In other words, as biology and biomedicine become more computational, some of the computer revolutions' culture and spirit of personal empowerment finds new life in biology and biomedicine.

Conclusion: Open Insulin as a Biologic of Resistance

"It all converged right here in Oakland at Counter Culture Labs."

> - Michael, Counter Culture Labs and Open Insulin Project treasurer

The Open Insulin Project was enabled by the very entanglements of biology, medicine, and capital that its members sought to resist and undermine. The Bay Area's biotechnological excess helped fund, stock, and staff community laboratories where the work could happen. Synthetic biology's fusion of computation, engineering, and biology helped provide both frameworks and services that Project members utilized in designing their protocol. It also enabled an open-source hacker ethos, instilled in those with backgrounds in computer hacking, to inform a bioengineering-focused project. Through this convergence, a new proactive form of biomedical citizenship emerged, in which Open Insulin members not only viewed access to this essential medicine as a right, but took it upon

themselves to guarantee that right by producing pharmaceuticals themselves and providing access to the information necessary for others to do the same. They worked to engineer anti-patent communitarian ethics into life itself and to realize a form of ethical biovalue other than the pursuit of capital (see Waldby 2002).

This suggests that the Open Insulin Project's version of antibiocapital is one born from a contradiction within biocapital. While capital is increasingly important to the course of the life sciences (Sunder Rajan 2006), it also produces volatility and excess (Thompson 2005; Fortun 2008; Birch 2017); increases the plasticity and generativity of biomatter (Franklin 2007; Landecker 2007; Roosth 2017); and both scientizes and moralizes biological citizenship and patienthood and stratifies access to care (Clarke et al. 2010). Together, these tendencies create the possibility for an antibiocapitalist project that turns the tools of biocapital and biomedicine against the commodification of life and health. These tendencies are also deeply related to the biomaterials through which they operate (c.f. Birch and Tyfield 2013). Biology is uniquely generative not only in its reproductive nature, but also in its cultural cachet that has allowed its construction as a vehicle of so much hope and promise and made it the object of such strong ethical and moral sentiment.

It would no doubt be hyperbolic to suggest that Open Insulin's anticapitalism indicates the stirrings of a revolution that will spell the end

of for-profit healthcare, much less capitalism writ large. But Open Insulin is symptomatic of growing focus on the stratification produced and perpetuated by for-profit healthcare, especially in the United States. In the hands of people armed with biotechnological knowhow and a belief that capitalism itself is the problem, it becomes a new type of critique, practice, and proof-of-concept all in one: a biologic of resistance.

The Open Insulin Project suggests one modest way in which biocapital is more contestable than some analyses suggest (e.g., Franklin 2003; Sunder Rajan 2006; Cooper 2011). However, its story as presented here is far from complete. Conditions of possibility are one thing; a successful resistance effort is another. The hopeful story presented here perhaps even foreshadows how the Open Insulin Project is not itself immune from the cultures of hope and hype that help make it possible and that have fueled overpromising and underdelivering efforts—Theranos too had a vision of doing good. Likewise, the dual impulses of the "Manifesto of Understanding" illustrated some of the tensions between political objections to resent systems and the need to operate according to their rules. As the following chapter illustrates, there are other ways in which the cultures and institutions of biocapital create difficulties for a project seeking to resist biocapital regimes from within.

Chapter 2

"Trickiness All Around": Open Insulin and Biocapital's Compelling Sociopolitical Order

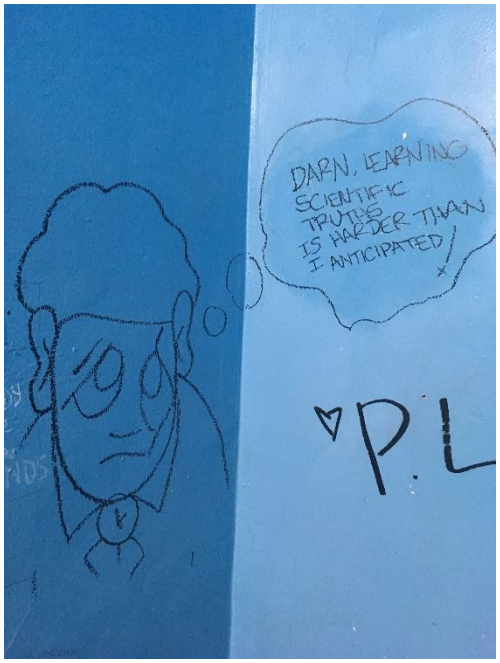

Figure 23. Some of the more dejected graffiti in the Counter Culture Labs restroom.

> "There are arguments that we're going to get into if we do what we need to do."[1]
>
> - Anthony, Open Insulin Project founder

The Open Insulin Project had been working toward developing its open-source production protocol for glargine for about four years, and I had been working with the Project for nearly two of those. In that time, I had seen and heard a few different timelines, observed some differences of

[1] Murray, fieldnotes, January 18, 2019.

opinion regarding overall strategy, and witnessed a few setbacks. The perpetually nonfunctioning high-pressure liquid chromatography machine (HPLC) especially had become both a recurring source of frustration and a bit of a running joke.[2]

Despite such setbacks, there was a growing sense of momentum. More new people had been showing up at the meetings, and more of those new people had *kept* showing up. Yann, the project's lead scientist, had received some promising results from his tests for the presence of target proteins. The project had received a few significant donations. Things were pointing toward what Thornton took to calling the "inflection point": definitively producing glargine in the lab for the first time.[3]

Around this time, I also sensed a change in the tone of the Project. With the inflection point nearing, the group's concerns widened, and new contributions threatened to shake up the way the Project had been managed to that point. Both during and after one especially tense weekly Open Insulin working meeting, Thornton sent me a string of text messages: "I think what we're doing today is a big mistake." / "Fucking arms of capitalism" / "Oof oof oof" / "Maybe this is how all organizations go." He eventually left the meeting but continued to text me, explaining:

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[2] There were dozens of references to the HPLC and its many issues in my fieldnotes, e.g., April 15, 2018; April 25, 2018; June 20, 2018; July 11, 2018; July 18, 2018; March 10, 2019. As of this writing, the Project's most recent fundraising campaign included a stretch goal of purchasing HPLC software (Open Insulin Project 2019).
[3] Murray, interview, August 8, 2018.

"It felt like Power was infecting us. / I don't really even know what I mean when I say that."[4]

The following week, Thornton and I met over a beer at a brewery near the lab to talk over what had happened and what we thought about it. He and I had developed a good rapport since he joined the project, and he was often interested in my work and my perspectives. Though the volunteer labor of Open Insulin often aligned with training, Thornton, who holds a PhD in bioengineering, immediately gravitated toward organizational questions, drawing on his student union experience. We'd talked several times about Open Insulin's organization. On this occasion, he wanted to hear more of my thoughts about the Project—as he put it, "even things you think I wouldn't want to hear." We sat together for a few hours, rehashing and discussing the recent meeting and its implications for Open Insulin.

The meeting itself was a tense and wide-ranging discussion, attended by a broad swath of its members at the time, about half of whom had been involved with the Project before I was. Others had come to Open Insulin more recently, part of the recent momentum the Project seemed to be gathering. There was a palpable tension both between newer and more established members, which was closely linked to the difference between

[4] Murray, fieldnotes, April 7, 2019; Murray, personal communication.

the flexible and largely informal way the project had been operating to that point and the demands of more formal and explicit organization.

Project members were planning to incorporate Open Insulin as an independent nonprofit organization, moving it out from under the Counter Culture Labs umbrella. This task of incorporation and developing an explicit organizational structure, like other tasks in the volunteer-based organization, tended to fall to those with relevant expertise: in this case, legal and corporate. The longtime members of the Project, most of whom had backgrounds in the biological or informational sciences, thus increasingly sought the advice of some of the newer members. This brought some significant shifts of perspective and expectations in a short period of time, and some of the longer-term members—Thornton included—seemed to feel the reins of the Project slipping away. In meetings like this one, they were left wary, often sitting silent, exchanging furtive glances, or in this case, sending surreptitious text messages. Thornton understood what had happened as an existential threat to the Project, and he again expressed his concern to me via text: "Sometimes I wonder to what extent I fall into the same patterns I'm opposed to.... Trickiness all around."[5]

The meeting started around the bylaws to establish Open Insulin as an independent nonprofit organization, moving it out from under the

[5] Murray, fieldnotes, April 7, 2019.

umbrella of the community laboratory it calls home. The bylaws that we discussed were adapted from another open-source nonprofit, the Python Software Foundation. It started out simply enough, going through the bylaws and discussing the desirability of its contents for Open Insulin. A discussion of the decision-making procedures, however, led to a sort of infinite regression problem: without decision-making procedures, how do we make decisions about decision-making procedures? To this point, Open Insulin had been making its decisions largely informally, without ever having enough dissent among its relatively few consistent members that details and procedures became a major concern. Now that the Project was growing and procedures were being written down and formalized, the concerns were suddenly imposing.

Drawing on the Python bylaws was one example of how to approach this problem of "first-step decisions," by patterning the organization after others. But even this was itself a decision, and the group was having a hard time agreeing what decisions, if any, had been made. Suddenly, this lack of clarity was pervasive. New team members tried to get a sense of how far off insulin production was. More established team members disagreed about the answer. One team member called for realism, another demanded separating fact from opinion. Even insulin itself became fuzzy, as it emerged that there is a difference between insulin as a molecule, as a drug, as a fact, as a milestone, and as a fundraising tool. For example,

establishing the presence of insulin through a laboratory test did not mean that this insulin could be injected, though it might make a compelling case for raising more money to begin working toward a purification protocol. Further, some of these insulins, as a newer member with a legal background pointed out, might be too legally risky to pursue without facing the threat of a lawsuit from a pharmaceutical company. But even this warning, yet another member pointed out, was not "*actual* legal advice"—that is, not provided by a licensed attorney operating in a professional capacity.[6]

Suddenly, the whole nature of the organization seemed in question, forcing the project's co-founder Anthony to assert, in a statement that would have seemed circular were it not for the conversation that preceded it, "Open Insulin is about making open insulin." He clarified that the project is pursuing a specific strategy for increasing insulin access: hacking it in a community laboratory. Whereas before it seemed that the main challenge facing the Open Insulin Project was the technical work of making glargine, now organizational and legal questions came to seem even more complicated and intimidating. On the other hand, protein engineering, which members often simply referred to as "the science," seemed concrete and manageable. As such, reestablishing its central role became a way to defer other challenges. Even Thornton, who had opted to

[6] Murray, fieldnotes, April 7, 2019.

leave these roles in others' hands in favor of organizational questions, expressed a similar sentiment after these events: "Maybe the strategy is to try to refocus on the science…."

Introduction

The story of the Open Insulin Project merely begins with its aspirations and conditions of possibility. Open Insulin may represent hope for antibiocapital movements that challenge the inequalities produced and reproduced by for-profit healthcare, a hope born from contradictions of biocapital (see Chapter 1). Drawing on synthetic biology's fusion of informatics, engineering, and biology and its members' hacking-inspired mentality, the Open Insulin Project selected a strategy based on precedents in the open-source and Free Software movements. Translating this strategy into a new domain, that of bioengineering and biomedicine, entailed facing unique challenges. The most significant of these challenges related to the intellectual property systems that bore on their work, the regulatory agencies that could potentially claim oversight capacity, and the unique and intensive demands of biological engineering.

Each of these types of challenges produced significant uncertainties for Project members' efforts and at times, even appeared to pose existential threats to the Project and its mission—for example, the hypothetical threat of lawsuits forced Project members to consider

restricting access to information in a way that restricted many members' interpretations of what it meant to be an open-source effort. Open Insulin members often responded to these uncertainties by "refocus[ing] on the science"—that is, by doubling down on and expanding the Project's technical and engineering components. In so doing, they ceded ground to the sociopolitical order of biocapital and in some respects, even took on characteristics of a biocapitalist endeavor themselves.

As an example of an antibiocapitalist resistance effort that pursued a practice—bioengineering—and an object—insulin—deeply entangled with biocapitalism as part of its resistance strategy, it showed how biocapital's (Sunder Rajan 2006) institutions offer some protections against attempts at extrication. The flexibility and plasticity of biomatter that stemmed from bioengineering and synthetic biology (see Landecker 2007; Roosth 2017) helped make Open Insulin possible, the institutions of biocapital showed themselves to be flexible as well—both fluid in ways that made them hard to clearly apprehend and firm when challenged and pressed upon. The regulatory and legal "gray areas" that seemed to present opportunities[7] for changing institutions proved difficult to take advantage of in practice. Even if getting one's hands on the technical means of biotechnological production had become easier, the logics and institutions that dominated the biotech landscape created complex limitations on the

[7] Murray, fieldnotes, October 31, 2018; March 13, 2019.

ways in which they could be utilized. While the exact shape and extent of these limitations were often unclear, they nonetheless compelled precautionary approaches that affected the structure and organization of the Open Insulin Project itself.

Applying theories of co-production (see Jasanoff 2004)—especially analyses that focus on the patent (Parthasarathy 2017) and regulatory systems (Jasanoff 2005) most relevant to Open Insulin's work—to a reading of the Project's development helps paint a clearer picture of biocapital's normative force. Such a reading demonstrates that resistance efforts that appropriate bioengineering, adopting the technical order of biocapital, find themselves compelled in various ways to conform to its sociopolitical order, as well: for example, narrowing members' commitments to a broad definition of *openness* in favor of a precautionary approach to intellectual property. While Open Insulin members understood that they were working against biocapital in the guise of "Big Pharma" and the aggressive commodification of an essential medicine, they typically avoided directly or systematically confronting the established political institutions of biocapital.

At the lab bench and elsewhere, as the Project expanded and the demand for materials and expertise grew, so did the need for money. The Project benefited from the surplus laboratory equipment and expert labor of Bay Area tech and biotech, but its fundraising capacity for an effort of

its scope and ambition remained limited. Further, the types of expert labor that the Project's intellectual property and regulatory domains demanded were expensive and harder to come by through volunteer channels. To raise more funds, members consistently turned their attention to crowdfunding. The novelty and sensationalism those platforms demanded encouraged hype and promise that also echoed biocapitalist efforts (Thompson 2005; Sunder Rajan 2006; Fortun 2008). Beyond crowdfunding, the desire to positively shape public impressions of the Project and to avoid liability for contentious political speech impacted and inflected the Project's communications more broadly.

Those working with a co-productionist lens (see Jasanoff 2004), have long pointed out that the separation of the social from the technical or scientific is illusory; in reality, these things are always produced together. The Open Insulin Project's strategy of foregrounding the novelty of community lab-based bioengineering and emphasizing circumvention of existing institutions risked ignoring this co-productionist reality and thereby tracking the social and political order of biocapital into their would-be antibiocapitalist effort. Following co-production's insights, to stand better odds of challenging biocapitalism, projects like Open Insulin would do well to align their technical interventions with more direct and systematic sociopolitical interventions.

Co-Production and Biocapital's Politics of the Apolitical

The STS theory of co-production asserts that technoscience and the social order are produced together; in other words, technical questions are inseparable from questions of politics, governance, and ethics (Jasanoff 2004). The theory provides beneficial insights because it counteracts the pervasive myth that science is an apolitical, purely technical domain. Particularly in the United States, one of the practical effects of this myth in the biosciences has been the privileging of technical forms of expertise to manage the potential for political controversy (Jasanoff 2005; Parthasarathy 2017). Questions of governance, put into the hands of technical experts, become technical objective matters themselves. In this way, the political work that technoscience necessitates is depoliticized, displaced by allegedly purely technical work. This displacement has affected both the U.S. patent and regulatory systems for the governance of biotechnologies and pharmaceuticals.

As bioeconomies have become more oriented around finance and assets (Birch and Tyfield 2013), patents have become a more prominent feature of the biocapital landscape. Their prominence should place increased scrutiny on the patent system and especially its effects on how products in the life sciences are produced and distributed. However, as Shobita Parthasarathy argues in *Patent Politics* (2017), the American patent system operates based on a core belief that patents are unqualified

goods: patents both foster increased innovation and facilitate the distribution of innovation's products. Parthasarathy points out that this patent system, despite its deeply political nature, has tended to emphasize technical and legal dimensions in order to operate with a veneer of neutrality and objectivity. This has been especially true in cases involving biological patents, including patents on genetically engineered organisms and human genes, which have become objects of protest and contention both in the United States and abroad. Some of these have been on economic grounds, objecting to the concentration of capital and power that patenting life forms enables. Others have raised fundamental moral and ethical objections to the entire concept of patenting life (Parthasarathy 2017; see also Schurman and Munro 2003).[8]

In the United States, the Patent and Trade Office (PTO) has managed these objections and controversies by positioning itself as an amoral arbiter, tasked only with determining what qualifies as an invention using its criteria of novelty, non-obviousness, and usefulness (Parthasarathy 2017). The European patent system, by contrast, often acknowledges the moral and socioeconomic dimensions of patents. Insofar as the U.S. system does acknowledge ethical and social issues, its core belief in the universal benefits of patents has led it to operate under the

[8] The wholesale objection to patenting life is more common in the European context, while Americans have proven more willing to accept patents on genetically engineered life (Parthasarathy 2017; Jasanoff 2005).

assumption that a strong patent regime is in the best interests of both inventors and the public.

In the early days of patented medicine in the mid-19th century, when the issue arose whether the patenting of pharmaceuticals might impede public access to medicines, the government left responsibilities in the hands of market players, opting not to ban pharmaceutical patents. In the early 20th century, in the Oldfield hearings, Representative William Oldfield and his allies in Congress faced substantial opposition from patent lawyers and manufacturers after upon suggesting a more interventionist role for government in guaranteeing the availability of technologies (Parthasarathy 2017:31). A group of expert witnesses, mostly patent lawyers, successfully argued against proposed legislation by asserting that patents were innovation and market drivers, solidifying both the core tenet of the U.S. patent system and the authority of those with "techno-legal" expertise in matters of patent governance. The PTO has upheld this legacy by attributing primary responsibility for the effects of patents to the patent holders rather than to the patent system (Parthasarathy 2017:61).

This question is once again moving to the fore in the United States, spurred partially by the high cost and lack of availability of insulin. Strategies to extend the life of patents through small changes—so-called "evergreening" (Collier 2013)—like the creation of slightly modified but

effectively similar “me-too” drugs have helped small-molecule pharmaceutical manufacturers avoid the transition to a market dominated by affordable generics (Dumit 2012). Despite their benefits, the prevalence of insulin analogs represents a similar trend to “me-too” drugs in larger-molecule biologic pharmaceuticals toward “incremental innovation” (Greene and Riggs 2015). Older drugs like animal-derived or native human insulin that would ordinarily become affordable out-of-patent alternatives for patients instead become obsolete, either removed from the market, unprescribed, or replaced by analogs at point-of-sale. Also concerning is that insulin analogs like glargine are heavily “overpatented,” covered by dozens of intellectual property protections that last long after the typical 20-year window for patent expiration closes (I-MAK 2018). For example, while the molecules themselves may fall out of patent, process improvements and dosage formulations remain eligible for protection. As an example, as of 2017, Sanofi’s Lantus—the company’s brand of insulin glargine—had received 49 patents from 74 filed applications. The resulting “patent thickets” are not unique to biotechnology (see Shapiro 2000), but their potential life-and-death effects have certainly attracted attention and spurred regulatory response.

In contrast to the patent system, the U.S. Food and Drug Administration (FDA) acknowledges its task “to strike a balance between encouraging and rewarding innovation in drug development and

facilitating robust and timely market competition" that benefits patient-consumers (FDA 2018:1). This is part of the mission of its new biosimilar designation, the designation under which Open Insulin's glargine could eventually hope to reach market. Even so, the regulatory requirements for biologic pharmaceuticals also typically relegate regulatory questions to a matter of bureaucratized technical expertise.

At the dawn of bioengineering, in the early 1980s, the U.S. Food and Drug Administration (FDA), as an existing regulatory institution, was tasked with regulating it. Its approach, the "Coordinating Framework," operated on the assumption that biotechnologies and bioengineering should be treated no differently than existing chemical or biological processes (Jasanoff 2005). As a result, the regulation of biotechnology became the domain of technical experts, rather than the public, patients, or consumers. As Sheila Jasanoff argues, "the forces of mainstream science and industry—not social activists, technology critics, or the environmental movement—were henceforth to be in the driver's seat in managing the emergent technology (2005:52). FDA—along with the National Research Council (NRC) and the United States Department of Agriculture (USDA)—maintained that biotechnology did not pose unique risks, a position underwritten by an emphasis on bioengineering's "precision, predictability, and near-perfect amenability to control" (Jasanoff 2005:54).

Though regulatory jurisdiction was granted to established institutions under the operative belief that bioengineering was just another precise production process, it has become clear that larger-molecule biologics like insulin and its analogs must be regulated differently from small-molecule drugs. This is due in large part to biomatter and bioengineering's high degrees of complexity and uncertainty that were obscured by regulation's emphasis on precision and control (Jasanoff 2005). While many drugs are small enough to identify their exact molecular structure, biologics are too large and complex for such certainty. The biosimilar designation was enacted as a rough-equivalent of generics for biologic pharmaceuticals following passage of the Patient Protection and Affordable Care Act (ACA/Obamacare) in 2009-2010 (FDA 2019), and FDA approved the first biosimilar in 2015. While traditional generics have exactly the same molecular structure as their antecedent drugs, biosimilars, by contrast, have uncertain and varying structure, demanding both more testing and the assurance of greater consistency throughout the manufacturing process (Mutti and Corsini 2019). Animal and human clinical trials are an especially costly requirement that manufacturers of conventional generics can avoid but that are usually necessitated by the complexity and variability of follow-on biologics (FDA 2019). The biosimilar designation acknowledges the molecular uncertainty of biologic pharmaceuticals while also providing an

abbreviated pathway to approval for drugs that are "highly similar" to approved biologics (FDA 2019).

FDA makes concessions to the social concerns that the United States patent system rejected on its premise: namely, the need to balance accessibility and innovation in pharmaceuticals, as well as to the need for special considerations for biologic drugs. However, by presenting a modified version of the generic pharmaceutical designation, it fails to take up pressing political matters, like the way in which "me-too" drugs have displaced much of the generics market or the fact that even countries with more established biosimilar guidelines than the United States have not seen decreases in cost nearly as significant as those of generic drugs (Greene and Riggs 2015). In large part, this is because biosimilars still require extensive testing, including costly human trials. Like the patent system, it funnels social concerns into a new technical designation but ultimately puts responsibility for these matters on market actors.

Though bioengineering and biomaterials have presented unique challenges, the PTO and FDA have continued to operate under long-held assumptions about how to encourage new drug development and increase drug access. Whether they view these goals as mutually compatible or as oppositional and requiring a balancing approach, these institutions erect "expertise barriers" (Parthasarathy 2017) that limit the scope of knowledge

that can be brought to bear on questions of how to govern intellectual property and drug production and distribution.

These limitations have historically served the interests of established industry players, reinforcing biocapital by strengthening corporate biotechnology's hold over the sphere. As a circular example that illustrates how such limitations shore up the existing system, the expertise that has become most relevant to patent disputes is familiarity with the patent system itself (Parthasarathy 2017). The privileging of expertise concentrated in biotechnological industry has had reciprocal effects, where regulatory industries have presumed expertise because of industrial connections: as an example, FDA has given faster drug approval to established institutions with more perceived status (Kim 2012). The favoring of "techno-legal" expertise concentrated in industry—and, as a corollary, industrial experience presumed expert—posed challenges for the Open Insulin Project's tech-centered, circumvention-focused approach. By positioning themselves within the technical order of biocapital, Project members found themselves expected and otherwise compelled to take on aspects of its social order, as well.

Intellectual Property Protection and its Problems

Since my earliest days with the Open Insulin Project, the patent landscape was a going concern among members. In my early days

attending meetings at Counter Culture Labs, before I even understood many of the scientific terms Project members were using, several members around the table conducted a search for papers and patents covering the sort of work they hoped to undertake on insulin glargine.[9] They conducted another, more expansive patent search as comprehensively as they could nearly a year and a half later.[10]

Patents are interesting in that they are both a form of disclosure and a form of enclosure; the recipient of a patent makes essential information about their invention public in exchange for a period of exclusive rights to that invention. Many of the problems with this model have been well established: patent thickets (Shapiro 2000), evergreening (Collier 2013), and trolling (Feldman and Price 2013-2014) and the establishment of patent politics as the privileged domain of scientific and industry experts (Parthasarathy 2017). However, the sheer complexity of the patent landscape makes it difficult to make definitive determinations about the extent to which patents contribute to drug unaffordability;[11] the conventional wisdom of the U.S. patent system that patents increase access to drugs has long competed with claims, echoed by Project members, that they limit access.

[9] Murray, fieldnotes, September 27, 2017.
[10] Murray, fieldnotes, January 23, 2019.
[11] Murray, fieldnotes, April 14, 2019.

As another result of the complex patent landscape, it could be difficult for Open Insulin members to discern exactly what was and is not under patent. This was made more difficult not only by the sheer number and specialized nature of patents, but also by the fact that the information in patents themselves was often vague and not entirely reliable.[12] As members noted, contemporary biotechnology patents revealed enough to ensure protection but not enough that the covered protocols could be faithfully reproduced based on the information in the patent alone.[13] Patents could also be very broad, covering much more than Project members felt was novel or reasonable. While patent filers utilize these forms of obfuscation to maximize the scope of their patents and minimize their disclosures, Anthony explained to me that organizations are also increasingly turning away from patents altogether and toward trade secrecy.[14] Legally obtaining protocols, even merely for reference or education purposes—that is, not licensed for reproduction—often costs money.[15] The combination of a broad, complex, not entirely dependable, and incomplete record of existing and legally protected insulin production methods made Open Insulin's work daunting, to say the least.

In addition to their own struggles with patents, Open Insulin members had to be concerned about the intellectual property forms

[12] Murray, interview, February 23, 2018.
[13] Murray, interview, May 26, 2019; Murray, fieldnotes, September 19, 2018.
[14] Murray, fieldnotes, September 26, 2019; Murray, interview, May 26, 2019.
[15] Murray, fieldnotes, October 3, 2018.

affecting the suppliers and collaborators that made their work possible. Though the OpenMTA had a growing number of signatories, including Counter Culture Labs, organizations like Addgene that provided plasmids were not committed to it (BioBricks Foundation n.d.a). The material transfer agreements (MTAs) that they used, unlike the OpenMTA, limited what they could do with biological materials. While plasmids purchased under the terms of the OpenMTA could be remodified and reused (BioBricks Foundation n.d.b), plasmids purchased under the terms of a standard MTA could be used for research purposes but not modified.[16] Some companies preferred not to deal with community biologists at all.[17] Members explained that when the Free Genes project, itself part of the BioBricks Foundation and therefore one of the primary utilizers of the OpenMTA, encountered potential legal implications for requested sequences, their by-design reaction was radio silence: rejection of the request without response or comment.[18] Members also feared that organizations like universities that could be potential collaborators for Open Insulin would demand shares of intellectual property developed using their facilities as standard practice.[19]

What emerged from this state of affairs was the fact that intellectual property infringement was simultaneously an impediment, a danger, and

[16] Murray, fieldnotes, November 29, 2018; January 30, 2019.
[17] Murray, fieldnotes, April 14, 2019.
[18] Murray, fieldnotes, April 2, 2018.
[19] Murray, fieldnotes, June 19, 2019.

fundamentally uncertain. Limited access to specific expertise pertaining to the patent system and patent law, along with the breadth of and limited information contained within existing patents, meant that Open Insulin members could only do their best to ensure that their work did not infringe on existing patents. The Open Insulin Project's aversions to patent policy were not entirely clear-cut. Members did express distaste for the patent system, expressed preferences for patent abolitionism, and discussed their objections to pay-for-delay intellectual property practices.[20] While Project members did occasionally consider more concerted efforts to intervene in the types of policy discussions that would have affected their approach to patents, they largely avoided these for two reasons. First, members decided that other organizations were more focused on and more effective at seeking policy change, while Open Insulin pursued a specific, limited strategy: "Open Insulin [was] about making open insulin."[21] Second, one volunteer pointed out that due to the sheer complexity of pharmaceutical pricing, it was difficult to effectively advocate for policy without making claims that lacked support.[22] For example, there was no landscape analysis thorough enough to counteract conventional policy wisdom and demonstrate that patents did indeed

[20] Murray, fieldnotes, July 25, 2018; January 18, 2019.
[21] Murray, fieldnotes, April 7, 2019.
[22] Murray, fieldnotes, April 14, 2019.

contribute to pricing problems. As a result, Open Insulin generally stuck by its tech-focused, circumvention-based approach.

Attorneys, when available, could provide advice regarding navigating existing patents, but securing legal advice could be difficult and came with additional constraints.[23] *Legal advice* was itself highly formalized and restricted, preventing attorneys who may have been sympathetic with the project and who had available time to volunteer from providing official legal services, even when they might have liked to.[24] Further, a large portion of patent lawyers are employed at large firms with many clients. As a result, potential attorneys often had multiple conflicts of interest with Open Insulin's work.[25] This often made it difficult for the Open Insulin Project to find lawyers who possessed the necessary expertise who were able or willing to work either pro bono or for a modest fee, and who did not have any conflicts. Expertise in the requisite areas and conflicts of interest tended to go hand-in-hand.[26] The ability to pay attorneys' rates would have made things simpler, but the Open Insulin Project did not have the budget for it. Even when the Project found pro bono lawyers, they faced difficulty establishing confidence and consistency in their working relationships. Open Insulin's legal questions were

[23] Murray, fieldnotes, February 3, 2019.
[24] Murray, fieldnotes, February 3, 2019; February 27, 2019; Mach 6, 2019; April 7, 2019.
[25] Murray, fieldnotes, March 6, 2019.
[26] Murray, fieldnotes, July 18, 2018; March 6, 2019.

complicated and labor-intensive for attorneys.[27] As Anthony once described the problem, "pro bono representation is… you get what you pay for."[28]

At times, those with legal experience cautioned Project members against reaching out to legal intellectual property legal experts and against sharing too much information about their lab work and their protocol under development.[29] Vetting procedures and non-disclosure agreements (NDAs) were both suggested as ways of helping protect the Project, as well as limiting communications with attorneys to certain Project members.[30] One way in which these practices could help was by making attorneys "comfortable," as few attorneys would want to work with the Project otherwise. Adopting more hierarchical "executive structure"—or formalizing an executive structure that these members believed already existed informally—would help make this possible, giving some members access to privileged communications.[31] This executive structure, they argued, would helpfully limit decision-making power to experts, even as Louise, a biology PhD, passionately argued that experts rarely make the best decision-makers.[32] Further suggestions included limiting all documentation of Open Insulin,[33] which would have been a significant

[27] Murray, fieldnotes, February 3, 2019.
[28] Murray, fieldnotes, October 10, 2018.
[29] Murray, fieldnotes, February 24, 2019.
[30] Murray, fieldnotes, April 14, 2019.
[31] Murray, fieldnotes, April 7, 2019.
[32] Murray, fieldnotes, April 7, 2019.
[33] Murray, fieldnotes, April 14, 2019.

change, considering that all of the Project's meetings and meeting notes were hosted online and readily accessible.

Prospects of vetting potential members, instituting NDAs, and limiting fundamentally challenged many Open Insulin members' ideas about openness and open science. Most members embraced and espoused an expansive version of openness, rather than a more limited definition based on simply releasing a protocol to which they could offer free access.[34] Many Open Insulin members resisted this more limited definition that even temporarily restricted access to information and kept the protocol-in-process more tightly under wraps.[35] The Project's most established members in particular tended to push back against this advice. Anthony said that he had turned down jobs due to a principled and categorical refusal to sign NDAs. Maria called herself a "heretic open-source person" and said simply, "I believe all the data should be freeeeeeeee."[36]

However, not following the advice could result in serious consequences, including existential threats to the Project. Open Insulin members tended to look at openness as a form of protection and strength, allowing the Project to operate without fear that their work would be

[34] Murray, fieldnotes, April 14, 2019.
[35] Murray, fieldnotes, February 3, 2019.
[36] Murray, fieldnotes, April 14, 2019.

"sniped," "swooped," or stolen and enclosed.[37] A few of the attorneys who got involved with the Project in unofficial legal capacities, however, tended to view Open Insulin's broad version of openness as a risk and a form of weakness, increasing the danger that the Project's work would provoke legal action or prevent them from receiving a defensive patent if they wanted or needed to go that route in the future.[38] Likewise, they suggested that the research that Project members did to try to ensure non-infringement, gleaning information from patents and compiling it, could have threatened the Project by placing it under suspicion of infringement.[39] Even having conversations about infringement was suspect, and all lab records—including my own field notes—could be discoverable in an infringement lawsuit.[40]

For a while, a wave of paranoia swept over the Project and its members, some of whom understandably became very concerned with the legal risks they were facing. They began to silo information, both to protect themselves and to maintain attorney-client privilege, which could be broken like a vacuum seal, after which there were only limited ways to re-secure it, called "clawback."[41] I even sought to amend my exemption from

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[37] Murray, fieldnotes, February 3, 2019. Another CCL-based project, Real Vegan Cheese, had multiple experiences with individuals attending group meetings and taking ideas from the project for start-up companies or outside efforts. The two projects shared several members, including Yann, so the concern was also very present among Open Insulin Project members. Murray, fieldnotes, April 2, 2018; October 17, 2018.
[38] Murray, fieldnotes, February 3, 2019; April 7, 2019.
[39] Murray, fieldnotes, February 3, 2019.
[40] Murray, fieldnotes, March 6, 2019.
[41] Murray, fieldnotes, April 14, 2019.

the oversight of my university's Institutional Review Board based on new concerns that I was studying a Project that was no longer "open" in the sense I originally believed. It appeared that legal liability was reshaping the Project and its goals in real time, to the point that Anthony became concerned that the money Open Insulin had raised "on the premise of open-source" would be retroactively rendered dishonest.[42] These concerns peaked during and shortly following the organizational meeting during which Thornton texted me, dismayed. While they were never again as controversial as they were during that time, the structure the Project subsequently adopted—including a legal working group with separate, closed meetings—bore their mark.

Regulatory Prospects

In addition to needing to navigate intellectual property protections, the Open Insulin Project also had to contend with regulatory and oversight bodies whose purview included biotechnological activities and pharmaceutical manufacture and distribution. This included the Center for Disease Control (CDC), which specified biosafety level (BSL) standards, and could also include the Federal Bureau of Investigation (FBI), which was tasked with assessing the potential for bioterrorism. Most importantly, it included the Food and Drug Administration (FDA), which

[42] Murray, fieldnotes, April 7, 2019.

oversaw nearly all facets of pharmaceutical production and distribution. The specter of FDA especially hung over the Project's development. At least one paper discussing the Open Insulin Project argues that the U.S. regulatory landscape, not patents, is the largest impediment to insulin affordability (Gallegos et al. 2018). Like patents, regulatory agencies provided possible opportunities for circumvention while also creating the need for professional expert advice and legal counsel and posing potential existential threats to Open Insulin as a whole.

The United States had a relatively favorable regulatory environment for community-based biotech. Many of the technical resources that CCL and Open Insulin took advantage of in their work were also available in Europe or Australia, both places where Open Insulin had international collaborators. Still, both the European scientists who worked at CCL, including Yann and Julianne, and international collaborators like Dennis in Belgium and Alex in Australia, commented on the United States' greater leeway for biotechnology and genetic engineering.[43] Due in large part to biotechnology's more controversial history outside the United States (Jasanoff 2005), pursuing biotech outside of conventional institutions tended to be much more difficult abroad. Community laboratories, where they existed, tended to be in much closer relationships with universities

[43] Murray, interviews, October 17, 2018; August 13, 2018; February 27, 2019; Murray, fieldnotes, October 17, 2018.

and governments and to serve largely as innovation hubs expected to provide economic benefits.

In the U.S., these types of biotechnology incubators also existed,[44] but some community labs—including both CCL and BioCurious—had been able to remain more independent, though they also relied, albeit less directly and to varying degrees, on established biotechnology institutions. Counter Culture Labs was a BSL-1 lab according to the CDC standards, which allowed them plenty of leeway to carry out genetic engineering in approved cell cultures, including such well-established model organisms as *S. cerevisiae, P. pastoris,* and *E. coli*. Since the early days of the community biology network, its members took an active role in engaging the FBI, once again demonstrating a version of the belief that openness and transparency was a source of strength (see Wolinsky 2016).[45] Community lab members and enthusiasts expressed the belief that doing biotechnology in small communities created a sense of responsibility that ensured safety—indeed, did a better job ensuring safety than institutional oversight (Kuiken 2016).[46] Apparently convinced by amateur biologists' self-governance procedures, the FBI allowed community biology to pursue its work largely unimpeded.

[44] Murray, interview, April 27, 2018.
[45] Murray, interview, May 16, 2018.
[46] Murray, interviews, July 11, 2018; December 9, 2018.

While the bioengineering portion of the Open Insulin Project's work was relatively unregulated, the prospects of drug production and distribution faced far more scrutiny. Open Insulin's approach to regulatory agencies like FDA was guarded. Because navigating regulations required specific, highly specialized knowledge and because Open Insulin's efforts lacked much precedent in the pharmaceutical sphere, regulatory requirements for the Project were also deeply uncertain. At times, Project members expressed confusion about the differences between biosimilars and generics, or chalked differences up to research and development or marketing.[47] Despite this lack of clarity and FDA's stated missions to protect public health and improve patient access to insulin, including by facilitating biosimilar drug development (FDA 2019), Project members expressed reluctance to reach out FDA.[48] In contrast to amateur biologists' experiences proactively establishing relationships of transparency with the FBI, some Open Insulin members expressed concern that reaching out could tip off FDA that Open Insulin's work is something that the regulatory agency needed to be concerned about.[49] In this way, Project members' guardedness with regulatory agencies resembled their concerns over the threat of infringement lawsuits and the concern that openness was a source of vulnerability rather than strength.

[47] Murray, fieldnotes, April 29, 2018.
[48] Murray, fieldnotes, June 27, 2018.
[49] Murray, fieldnotes, October 3, 2018; October 31, 2018; March 13, 2019.

Project members' general anti-institutional sentiments often extended to FDA and its role in securing power for corporate pharmaceutical interests. Despite FDA's public health-focused mission, they tended to view FDA as antagonists; Anthony simply declared, "I don't agree with the FDA on anything!"[50] Not all members' attitudes toward FDA were so pessimistic, as another member pointed out that FDA has helped protect people from dangerous counterfeit drugs.[51] This same member, however, also pointed out that in its dealings with FDA, the Open Insulin Project was punished for not being a "massive capitalist operation." The daunting prospect of having to obtain FDA approval even at one point provoked suggestions from several different members that Open Insulin partner with a pharmaceutical company with the resources and experience to navigate FDA approval, a proposition that the core members of the Project swiftly shot down.[52] When they did entertain them, Project members' impulses to reach out to FDA despite their concerns were based in their beliefs that regulatory approval has as much to do with coziness with regulators as with other criteria.[53]

Open Insulin's reluctance to engage FDA directly often meant looking for ways to pursue strategies that fall outside of FDA's typical purview. These approaches generally focused on the fact that the members

[50] Murray, fieldnotes, December 5, 2018.
[51] Murray, fieldnotes, October 31, 2018.
[52] Murray, fieldnotes, August 15, 2018.
[53] Murray, fieldnotes, February 21, 2018.

believed that FDA was both built for and concerned primarily with the mass production of pharmaceuticals, rather than with "people just doing things for themselves and not for anyone else."[54] This included modeling Open Insulin's work after other efforts that fell into legal gray areas, like patient cooperatives for medical cannabis.[55] There was also talk of using an approach akin to what in Europe was called "magisterial production," in which drugs were produced on-site in hospitals. A potential partnership with Mount Sinai Health System revolved around this approach.[56]

As is typical of the Project's lack of clarity surrounding regulation, it was never entirely clear that approaches like this would circumvent regulation; instead, they could spur FDA to develop new regulations in response. A group of experts, in a public FDA workshop on the subject of bacteriophage therapy, specifically argued that FDA needed to ask questions about the rise of individual therapies and magisterial production (FDA 2017). It remained an open question for the Project just how much they would like to "push on the FDA"[57] and how much FDA and the specter of regulation pushed on the Project.

Counter Culturing

[54] Murray, fieldnotes, October 31, 2018.
[55] Murray, fieldnotes, March 13, 2019; August 15 2018.
[56] Murray, fieldnotes, January 26, 2020.
[57] Murray, fieldnotes, April 24, 2019.

While the emergence of synthetic biology and the availability of expert knowledge and labor and professional equipment in the Bay Area have significantly lowered barriers to entry for bioengineering and in that sense made the Open Insulin Project technically feasible, the technical work continued to present challenges. Some group members suggested that the engineering portion of Open Insulin was "simple," or "easy," drawing on the fact that insulin had been produced using recombinant DNA technology since the early 1980s.[58] However, this same idea belied the technical difficulties that the Project faced trying to produce long-acting insulin glargine in their Oakland community lab and revealed that much of the ease and accessibility of bioengineering, even on a strictly technical level, remained aspirational and anticipatory. Practically, costs remained high and resources remained limited. This was especially significant for two reasons. First, Open Insulin members tended to think of and refer to the glargine protocol development as the Project's "core."[59] Second, Open Insulin members reacted to challenges by doubling down on and expanding their engineering efforts.

When I first began attending Open Insulin Project meetings, they had already made the switch from working in *E. Coli* to working with *Pichia*. *Pichia* is uniquely capable of using the sterilizing agent methanol as a carbon source, making it less susceptible to contamination than other

[58] Murray, interview, August 8, 2018; fieldnotes, August 15, 2018; January 10, 2019.
[59] Murray, fieldnotes, May 15, 2019.

microbes—in fact, its response to the stress that methanol causes is to produce a protein.[60] This means that by introducing a gene for the production of a target protein and exposing the yeast to methanol, bioengineers can both protect against contamination and take advantage of *Pichia*'s cellular machinery.

Even so, the Project members had issues with contamination and were forced to spend time, effort, and resources identifying and eliminating its cause. Repeatedly over the course of several months, Yann discovered bacterial contamination in the yeast cultures.[61] Detectable by smell or by the presence of unusual white matter in the cultures, he was at first unsure of the cause, thinking that it may have been due to a lack of care in sterilization procedures, a malfunctioning biosafety cabinet hood, careless handling, or bits of cotton ball that he was using as stoppers. I wondered how this contamination was possible, as I had believed methanol—and by extension, *Pichia*—to be desirable primarily because it precluded the possibility of contamination. I learned then that bacteria surviving in methanol was actually "not that unusual."[62] Working with biological cells, even *Pichia* cells, has a fundamental risk of contamination.[63]

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[60] Murray, fieldnotes, June 27, 2018.
[61] Murray, fieldnotes, February 21, 2018; April 18, 2018; April 25, 2018; June 6, 2018; July 18, 2018.
[62] Murray, fieldnotes, April 25, 2018.
[63] Murray, fieldnotes, January 24, 2018.

Project members raised numerous ideas about the origins of the contaminants. Some remarked on the suitability of the lab's old building for biological culturing. Michael waved his hands as he remarked, "there's all this stuff that kind of floats in the air here, and I'd hate to see what's in it."[64] Others pointed out that the hay and mushrooms that the lab's mycology group kept around were potential sources of spore-forming bacteria.[65] In response, a mycology group member defensively attributed *all* contamination to human error and a lack of strict lab procedures. Despite repeated attempts to identify the source, the contaminations continued.

Yann eventually discovered that contamination was coming from the methanol itself.[66] I learned that the methanol Yann had been using was purchased from a gas station up the street.[67] In addition to its utility as a sterilizing agent in laboratory applications, as a simple alcohol, methanol is also an effective octane booster. Yann turned to this automotive methanol as an affordable source to avoid paying the additional cost of lab-grade methanol. While not terribly expensive in itself, especially compared to some other laboratory reagents, this methanol came with a hefty shipping cost—greater than the cost of the methanol itself.[68]

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[64] Murray fieldnotes, February 21, 2018.
[65] Murray, fieldnotes, April 25, 2018.
[66] Personal communication, September 5, 2018.
[67] Murray, fieldnotes, May 7, 2018.
[68] Murray, fieldnotes, April 25, 2018.

Even after identifying the methanol as a source, occasional contaminations continued to occur long afterward.[69] The contamination is one of the signs that applying engineering principles to biomatter is not as straightforward or "easy" as members often suggested and that the barriers to entry were not yet as low as popular narratives about biohacking in garages and dorm rooms suggested (e.g., Caplan and Neuhaus 2017; Fernandez 2019). Explaining an unsuccessful expression test on another yeast-based CCL project, Patrik summarized this point rather succinctly and disputed synthetic biology's typical approach: "It's biology, it's not engineering, unfortunately… it's just doing stuff 'til it works."[70] Another CCL member put it even more succinctly: "hacking this kind of shit is really complicated."[71]

In short, synthetic biology's aspirational characterizations of life as engineerable (see Roosth 2017) do not translate especially well to multipurpose, underfunded, and somewhat messy community labs, at least not yet. Though CCL was relatively—even surprisingly—well-equipped and ideally located in one of the world's biotech hubs, it still faced many limitations. The lab's nicer equipment was limited, and members were forced to make choices about when and how to deploy it. As Yann struggled to find the cause of his repeated contamination issues, he

[69] Murray, fieldnotes, January 16, 2019.
[70] Murray, fieldnotes, May 21, 2018.
[71] Murray, fieldnotes, April 16, 2018.

debated whether it was worth using sealed, sterile, filtered Erlenmeyer flasks to help manage the problem.[72] Lab members had a general sense that laboratory equipment companies that sold to grant- or venture capital-funded institutions unnecessarily inflated their prices. Though CCL was gifted an OpenTrons pipetting robot, members discovered that the corresponding custom pipette tips along cost $500.[73] Kexin, the proinsulin-cleaving enzyme, cost $250—partly because its low demand dictated custom production.[74] Software to help fix the lab's perpetually struggling HPLC would have cost around $15,000.[75] Even just shipping plasmids, which can be dabbed onto a regular notecard and mailed, cost about $150 through more official channels.[76]

The time scales of biology produced their own challenges. On the one hand, Open Insulin's recruitment of skilled volunteers was due to a combination of location and economic landscape. On the other hand, the Project was fortunate to find scientists who could work consistently and long-term. Yann was the best example of this, and he was at the helm of Open Insulin's lab work in Oakland for about three years. Eventually, however, he had to move across the country, leaving another volunteer, Max, to take up the reins in Oakland. Thus, skilled labor was available but

[72] Murray, fieldnotes, November 29, 2017.
[73] Murray, fieldnotes, October 3, 2018.
[74] Murray, fieldnotes, August 12, 2018.
[75] Murray, fieldnotes, April 25, 2018.
[76] Murray, interview, October 17, 2018; Project members often seemed unclear on whether simply dabbing genetic information on cards and sending the through regular mail was legal or not. Murray, fieldnotes, June 13, 2018; September 24, 2019.

never guaranteed and not necessarily reliable. People who began working with Open Insulin during stints of unemployment would find a new job and immediately disappear from meetings.[77]

The consistent presence of skilled labor was also essential, because people working in the wetlab needed to come in nearly every day.[78] As Yann described it, "it's difficult to not be full-time when you are doing biology."[79] Julianne, another CCL member and biology PhD, similarly remarked, "you cannot be here for [just] an hour or two per day."[80] Some machinery, like a mass spectrophotometer, is out of reach not only because of high cost but, as Patrik explained, because of high maintenance, requiring a "designated maintainer."[81] While there was a great deal of flexible labor in the Bay Area, this flexible labor was rarely both full-time and long-term.

While the machinery that CCL had was serviceable, it was not state-of-the-art, and this could make it difficult to deal with biological variability and the requirement for high levels of purity in an injectable pharmaceutical. The procedures for transformation—genetic modification—and initial protein production were relatively straightforward, if a little "haphazard."[82] Plasmids were mixed with lightly

[77] Murray, fieldnotes, December 12, 2018; February 3, 2019.
[78] Murray, interview, October 17, 2018.
[79] Murray, interview, July 18, 2018.
[80] Murray, fieldnotes, October 17, 2018.
[81] Murray, fieldnotes, July 11, 2018.
[82] Murray, fieldnotes, May 22, 2019.

shocked microbes, with low uptake rates counteracted by linking a common antibiotic resistance-conferring gene to the protein-producing gene of interest. When these cultures were exposed to the antibiotic, the successfully modified microbes expressing the gene for antibiotic resistance—and presumably, the gene for production of the target protein as well—survived and could be proliferated (see Figure 2).[83]

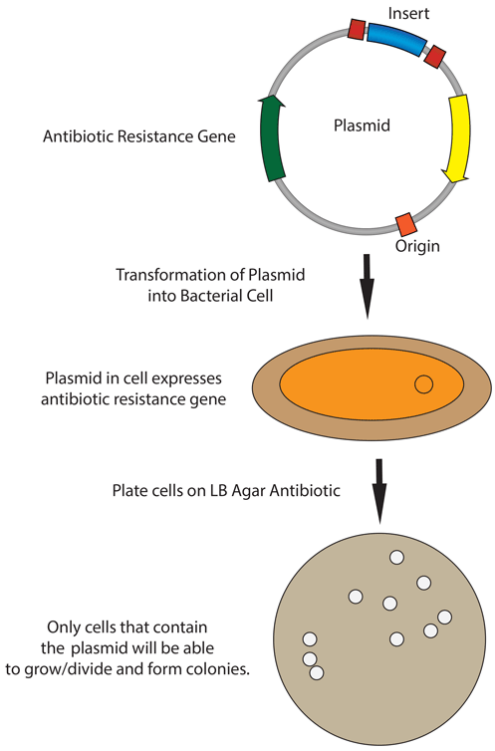

Figure 24. An example of cellular transformation from the plasmid banking nonprofit organization Addgene. This protocol genetically modifies bacteria.

Still, assuming successful production, the presence of insulin molecules often remained unclear and uncertain. It could be difficult to

[83] Murray, fieldnotes, September 5, 2018.

identify and one identified, to purify. One Open Insulin member pointed out that insulin is "*technically* a biologic, but it's a very well understood molecule."[84] As biologics go, insulin is also relatively small at the molecular level. Even so, Project members had difficulty determining whether there was insulin in a cell culture, one reason for the sense of being always on the verge of producing insulin.

I was present for multiple tests aimed at confirming insulin's presence, including one at CCL and one offsite at a local university lab. Both tests were inconclusive. The first used a chromatography machine in the lab but produced inconsistent results, possibly because a peptide present in the solution was about the same size as the insulin molecule, rendering a size-based analysis like chromatography effectively useless. [85] The next test was a bit more sophisticated, using a machine called a mass spectrophotometer.[86] Though we spent a while with the machine trying to get a result, this test was also inconclusive, due, Yann said simply, to "something wrong with the sample."[87] At one point, a contaminant in the medium was mistaken for expressed proinsulin, and this realization led to the redesign of the entire proinsulin construct.[88] Once insulin was confirmed present, purification and testing for purity would be substantial

[84] Murray, fieldnotes, January 5, 2020.
[85] Murray fieldnotes, September 5, 2018.
[86] Murray, fieldnotes, January 30, 2019.
[87] Murray, fieldnotes, March 3, 2019; March 6, 2019.
[88] Murray, fieldnotes, June 23, 2019.

efforts in and of themselves. Early in my field work, Anthony explained, "purification and keeping purification simple is a significant issue. Downstream's where the bottleneck usually is."[89] Purity testing is one of the most significant reasons why insulin at the individual or home scale is unlikely.

Once Insulin was successfully produced, identified, and purified, Open Insulin members hoped to make distributed insulin production possible at a relatively small scale. As Project members felt themselves getting closer to producing insulin for the first time, they realized that they would also need to create the technical means for others to reproduce their protocol. This required making the protocol as simple as possible. As Open Insulin members explained to me, insulin production protocols tended to be both large-scale and complex, requiring a large and intricate lab setup.[90] The production protocols that had fallen out of patent were very demanding. To fulfill its aspirations, the Open Insulin Project needed produce a significantly simpler protocol that required a minimal lab setup, more minimal than the supplies and materials that CCL had at its disposal.

While CCL was situated in an area where it could benefit from surplus equipment and materials, setting up many such laboratories would be an incredible challenge. Open Insulin's international collaborators, such as Khady Sall, a Senegalese molecular and cell biologist, did not have

[89] Murray, fieldnotes, December 6, 2017.
[90] Murray, fieldnotes, November 19, 2017.

access to the same level of equipment and was not really able to devote any effort to working on Open Insulin.[91] For this reason, the Open Insulin Project expanded its focus to include and open-source hardware effort focused on building a small-scale protein production system as inexpensively as possible. Despite advice that making Open Insulin an international effort would be incredibly difficult because of vastly different legal and regulatory requirements that would require different approaches in each new country,[92] members also pinned hopes for international collaborations on this hardware engineering project.[93]

Creating a consistent, inexpensive, small-scale protein production system would be another feat in and of itself. In fact, a Defense Advanced Research Projects Agency (DARPA)-funded MIT project received attention for developing a compact biologic-producing microbioreactor, which they described as being useful on battlefields as well as in areas with limited infrastructure (Perez-Pinera et al. 2016). Open Insulin members seized on this as a point of reference for their own aspirations and considered collaborating.[94] A Dutch pharmaceutical sciences professor also developed a small-scale system (Schellekens et al. 2017). It was not clear, however, that either of these developments would meet Open Insulin's requirements, especially its low-cost requirements. They were also both

[91] Murray, interview, November 9, 2019.
[92] Murray, fieldnotes, April 7, 2019.
[93] Murray, fieldnotes, January 20, 2019.
[94] Murray, fieldnotes, January 13, 2019.

designed to provide smaller doses of a range of medicines on demand, with the latter focused on advancing personalized medicine by providing drugs uniquely catered to patients (van der Garde 2017). Further, the news that the MIT group was going on to form a for-profit company to sell their innovation effectively put an end to Open Insulin members' impulse to collaborate (see Chapter 1).[95]

In short, as members felt that the milestone of producing insulin drew nearer, they had to think more about next steps, including how an insulin production protocol would be reproduced in other locations that do not have even as sophisticated a setup, as much access to materials, or as large a budget as Counter Culture Labs. This meant creating an entire open hardware arm of Open Insulin to create the equipment capable of running the simple protocol that the Project was still developing.[96] This greatly expanded the scope of the Project and called into question the applicability of open-source software precedents and radically decentralized approaches to technologies with equipment and infrastructure as expensive and concentrated as biomanufacturing's. Attempts to translate the approach often multiplied and complicated Open Insulin's already formidable engineering challenges.

Word Out, Money In

[95] Murray, fieldnotes, May 26, 2019.
[96] Murray, fieldnotes, October 31, 2018.

Many of the above challenges facing the Open Insulin Project—the difficulty getting reliable long-term expert labor, especially specialized advice about intellectual property and regulatory strategies; obtaining access to particularly expensive materials and demanding pieces of equipment; and the prospect of needing to conduct clinical trials—would, of course, have been eased greatly by a large influx of money. Indeed, Anthony once called fundraising simply Open Insulin's "main roadblock."[97] While Open Insulin members often prided themselves on their hacker-inspired approach of making do with resource scarcity, they also acknowledged the need for more funding and the fact that a project like this could not run on passion alone.[98] Anthony nicely summarized this ambivalence toward money: "Ahh, money. It's bad. Sometimes it's good. Most of the time it's bad."[99] Once, when tabling for Counter Culture Labs, a self-described biotech angel investor asked how much money Open Insulin would need to see the Project through to completion. This was a question I wasn't used to hearing discussed; Yann didn't have a figure quite ready, either, but he agreed with the investor's estimate of about $20 million, a figure far larger than any fundraising goals or prospects I had ever heard discussed.[100]

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[97] Murray, fieldnotes, January 30, 2019.
[98] Murray, fieldnotes, April 17, 2019.
[99] Murray, fieldnotes, January 24, 2019.
[100] Murray, fieldnotes, June 10, 2018.

A concern with fundraising was one of the biggest factors shaping Open Insulin's public communications. Indeed, one volunteer who came to Open Insulin from the Silicon Valley tech world suggested that, imitating standard industry practice, the Project should combine its marketing and communication efforts into one team, "marcomm."[101] While this particular structure never came to fruition,[102] it illustrated some of the ways in which the Project was pushed to conform to the expectations and standard practices of industry. Indeed, the language of "marketing" and bringing insulin "to market" was common, and some members regularly objected on occasions when it was invoked, both because it implied certain regulatory requirements and because they were ambivalent about the idea of, as Anthony put it, "actual commerce" altogether.[103] How could a Project fighting the marketization of pharmaceuticals have a marketing wing?

Thus, while organized fundraisers were only occasional, the prospect of raising funds informed the Project's communications more broadly, and a large fundraising push was ever on the horizon. In their pursuit of the additional funding that the Project needed, Open Insulin Project members risked engaging in the same practices of promise and hype typical of Bay Area tech and biotech cultures and biocapital more

[101] Murray, fieldnotes, April 7, 2019.
[102] This was one of the few instances where I felt compelled to vocally object to a suggestion.
[103] Murray, fieldnotes, October 25, 2017; August 15, 2018.

broadly (see Thompson 2005; Sunder Rajan 2006; Fortun 2008). The major issue with this hype is that it presented a simplified, optimistic version of the Project and its work, further testing Open Insulin members' espousal of a sweeping version of openness. A tendency toward simplification and vagueness that was both hopeful and readily communicable was further reinforced by legal concerns about discussing their production protocol in detail and the desire not to attract either "Big Pharma" or FDA's attention.

The resulting fundraising and communications strategies the Project adopted surely shaped the perception of the Project from the outside. Rather than focusing on the scope and nuances of the Open Insulin Project's necessary work and challenges, these communications tended to emphasize and centralize the technical dimensions of the Project. These aspects were legible, "sexy,"[104] and "easy," though they often took precedence over what were almost certainly the bigger challenges—and costs—facing Open Insulin. The domination of lab work-focused imagery could easily give the impression that the lab work made up the lion's share of Open Insulin's work.

One of the biggest struggles of both the nonprofit and pharmaceutical sectors is the need to raise money, and amateur bio is no different.[105] Since its inception, the most significant form of fundraising

[104] Murray, interview, April 27, 2018.
[105] Murray, interview, July 18, 2018.

that Open Insulin had utilized was crowdfunding, which also helped give rise to CCL and BioCurious. The Project raised its initial budget using the website experiment.com. In addition to the crowdfunding campaign, a large part of Open Insulin's funding consisted of isolated individual donations. In 2018 alone, these donations actually surpassed the total amount that the Project received from its initial crowdfunding push.[106] The Project also began using the online streaming service Twitch around the beginning of 2020 as a way to generate small amounts of additional funding. Open Insulin members strategized around these different fundraising possibilities and focused on crowdfunding most of all. The Project found itself without the necessary bandwidth to competitively pursue grant funding and did so only occasionally.[107]

Crowdfunding through the internet has become a way to supplement healthcare funding where public investment in healthcare is low (Bassani, Marinelli, and Visnara 2018), including among insulin-dependent diabetics in the United States. The issue is common enough that the crowdfunding platform GoFundMe's blog features a post called "How to Get Insulin When You Can't Afford It: Six Ideas," the last of which is to start a crowdfunding campaign (2020). In one of the most publicized deaths from insulin rationing, the victim had started a GoFundMe page to help pay for insulin shortly before his untimely death (O'Neil 2019). The

[106] Murray, fieldnotes, January 2, 2019.
[107] Murray, fieldnotes, July 18, 2018.

rise of the use of crowdfunding has led to the need for patients to produce "worthy illnesses" and has reinforced the austerity and disinvestment in public health that creates the need for such campaigns in the first place (Berliner and Kenworthy 2017).

Similarly, a focus on crowdfunding required the Open Insulin campaign to present itself as worthy of charity. Using hype—as Anthony put it, "important hyping"[108]—as a strategy, Project members focused especially on using the "inflection point" of producing insulin in the laboratory for the first time as the key to generating a substantial sum—usually expressed in the six-figure range—via a crowdfunding push.[109] The hype and promise were not merely reserved for making outside impressions. In my observations, members did often believe that they were on the verge of this "inflection point." On multiple occasions since at least 2017, when I first joined the Project, members stated that they were on the verge of successfully producing insulin for the first time.[110] Once, Project members uncorked a bottle of champagne to celebrate this very achievement.[111] At least once, a Project member described the technology portion of the Project as "wrapping up."[112] Thus, the technical achievement of making proinsulin glargine for the first time was to be a jumping off

[108] Murray, fieldnotes, May 9, 2018.
[109] Murray, fieldnotes, May 9, 2018; May 27, 2018.
[110] Murray, fieldnotes, November 29, 2017, October 31, 2018.
[111] Murray, fieldnotes, September 26, 2018.
[112] Murray, fieldnotes, August 8, 2018.

point: "As soon as we make insulin, then we need to make the best of that. We need to announce it and use that to raise money."[113]

The big crowdfunding push would be used to move from proof-of-concept insulin to insulin that could actually be produced and reproduced consistently, distributed, and injected into patients—a distinction between different types of insulin that was not always readily apparent in the Project's public-facing language.[114] Indeed, on one occasion, a Project member explicitly suggested using "very vague wording" to skirt this point.[115] Technically producing insulin did not mean producing a product that was pure enough to be injected, concentrated enough to be effective, or free enough of property protections to be distributed. Indeed, vagueness also seemed to be a necessary part of the strategy in order for the Project to avoid unwanted intellectual property or regulatory scrutiny.[116] Even so, Project members tended to focus on injecting Anthony—or another willing Type-1 diabetic—with the insulin they had produced as the culmination of their proof-of-concept, notwithstanding these distinctions and the fact that self-injection of biohacked treatments had already produced media

[113] Murray, fieldnotes, May 27, 2018.
[114] Murray, fieldnotes, January 2, 2019.
[115] Murray, fieldnotes, May 27, 2018.
[116] Murray, fieldnotes, March 6, 2019. In one extreme example of this, a Project member described the appropriate response to producing insulin for the first time as "a secret party."

fallout and regulatory crackdown, including from FDA, in the past (Baumgaertner 2018; Regalado 2019; Mullin 2017).[117]

Of course, the need to attract attention conflicted with the need for to avoid being, as one volunteer warned, "the tallest poppy."[118] This apparent conflict further compelled a shift in Open Insulin's communications away from specificity. In addition to worries that they would be targeted in an infringement lawsuit despite their circumvention-focused approach, Project members also became concerned about the legal implications of their speech. Some of this related to CCL's status as a 501 (c)3, which prohibited members from intervening in political campaigns or elections. However, members also became concerned about coming across as too confrontational toward "Big Pharma," suggesting that this could also turn Open Insulin into a target for a defamation lawsuit that would endanger the Project.[119]

Whereas Big Pharma had been a standard boogeyman and target during my tenure with the Project, Open Insulin's media strategy—and at times, its members in less carefully monitored communications—became less focused on anti-Big Pharma critique and more concerned with embracing positivity. The defamation test was simple: put themselves in

[117] Murray, fieldnotes, July 25, 2018; interview, August 8, 2018. Regarding this last point, Open Insulin members regarded this as fundamentally different from the negative reactions to past self-injections, which used experimental treatments. Insulin's status as a well-understood, well-established, and effective treatment for diabetes made the difference.
[118] Murray, fieldnotes, February 24, 2019.
[119] Murray, fieldnotes, March 10, 2019.

the shoes of a pharmaceutical company, and then don't publish anything they wouldn't want published. A Project whose core members identified it as fundamentally political suddenly needed to police its speech and exercise caution whenever it "veer[ed] into anything political."[120] At this point, Ramy described the Project as merely having a political "subtext."[121]

As the political content of Open Insulin's communications dwindled and they began to draw more solid lines between their internal and external communications,[122] members opted to prioritize a focus on the Project's technical dimensions. Members felt that the technical dimensions of the Project were more compelling for fundraising purposes.[123] Ramy put this bluntly, saying, "from an external com[munication]s point of view, people connect with the science shit."[124] Again, however, the need to avoid communicating too many details about the Project's technical work further compelled a lack of detail. The emphasis on work at the lab bench risked exaggerating the portion of the Project and project members that regularly worked on the technical side of bioengineering. This was the case when a photo of a first "science workshop" featuring me, a few other social scientists, and others who rarely worked in the lab learning the basics of gel electrophoresis was used in a small crowdfunding campaign (see

[120] Murray, fieldnotes, April 7, 2019.
[121] Murray, fieldnotes, March 10, 2019.
[122] Murray, fieldnotes, April 7, 2019.
[123] Murray, interview, August 20, 2018.
[124] Murray, fieldnotes, April 7, 2019.

Figure 4).[125] Through this campaign, the Project raised just over $6,000 of its target $10,000, which was enough to purchase a small used bioreactor for the Project's next phase.[126]

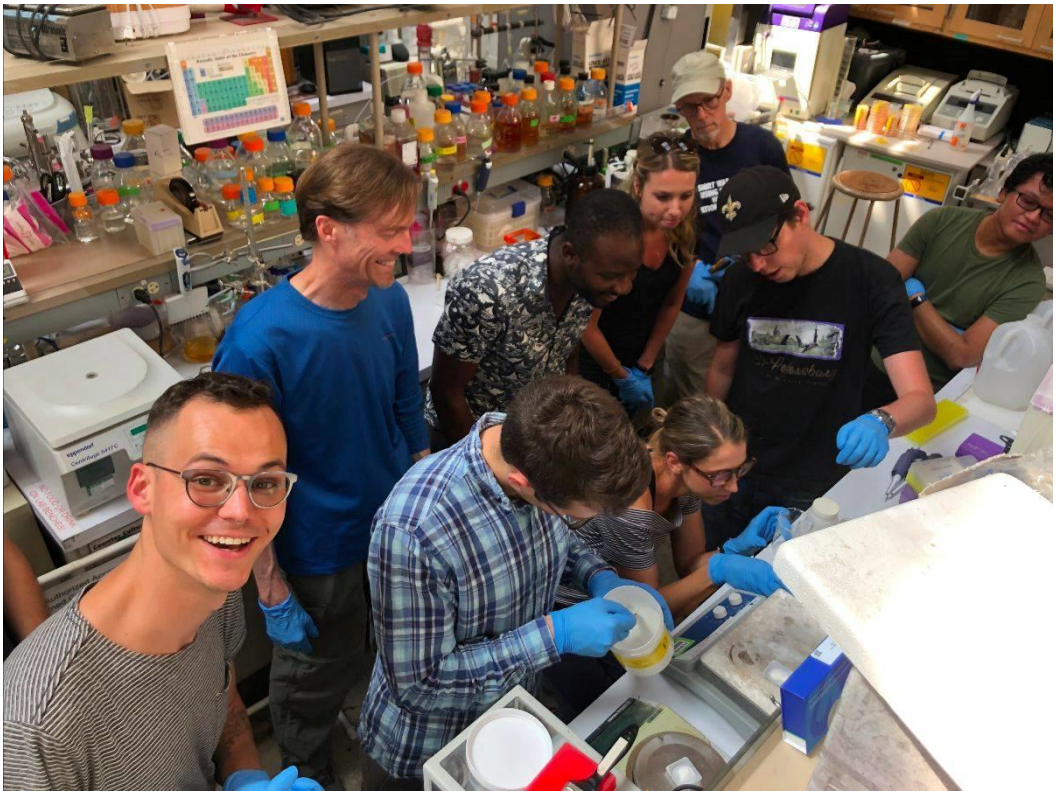

Figure 25. A photo of one of Yann's "Science Workshops," featuring mostly non-biologists (including the author, grinning far left) learning how to conduct gel electrophoresis. Image credit: Open Insulin Project.

This potentially misleading emphasis was not entirely new, and it was not limited to fundraising efforts. Especially when journalists and documentarians visited the lab to cover Open Insulin, a fairly common occurrence, CCL and Open Insulin both liked to do "labby" work for show,

[125] Murray, fieldnotes, August 4, 2019.
[126] Murray, fieldnotes, January 26, 2020.

even if, as Yann joked, this just consisted of him shaking some flasks.[127] Sometimes, they staged demonstrations or "reenactments" for journalists.[128] This preference was by no means one-sided; on one occasion, journalists who visited to do a story on Open Insulin discovered that the Project members were having a discussion around a table rather than working at the lab benches and "looking at beakers" as they expected.[129] They lost some interest as Thornton talked about power and leveraging networks. Later, they found a way to get satisfying shots by attaching Open Insulin Project stickers they had found to seemingly random pieces of laboratory equipment and shooting the meeting with this equipment in the foreground.

In these approaches to communications and fundraising, there was a narrowing of focus and a muddiness of aims. A narrowing of focus to the technical dimensions of the Project fit the narrative that Project outsiders seemed to expect. It also had the potential to become self-fulfilling, causing the Project to attract both funders and volunteers who expected lab work to be the Project's biggest focus and primary indicator of progress, without a strong understanding of how the technical dimensions of Open Insulin's Project were necessarily linked with complex legal, regulatory, and political questions. I also saw a risk of reversal: that the

[127] Murray, fieldnotes, June 13, 2018; December 5, 2018.
[128] Murray, fieldnotes, May 22, 2020.
[129] Murray, fieldnotes, November 7, 2018.

way that fundraising had influenced communications, it could begin to influence other dimensions of the Project and could become the goal of Open Insulin's work, rather than vice versa. One of insulin's forms, after all, was a fundraising tool.

Conclusion: Countering Cultures, or "Becoming the Thing"?

The Open Insulin Project was compelling because it presented a vision of technoscience done otherwise, separating the profit motive from the public good of providing life-saving medicine to those who depended on it. As an antibiocapitalist effort, it was both a product of a biocapital landscape (see Chapter 1) and subject to its pressures. Applying a co-productionist lens (see Jasanoff 2004) to the Open Insulin Project shows how biocapital's institutions offered some protection against such challenges, but also show that Project members were able to recognize these protections and that they were often linked to choices Project members made, even if they were significantly influenced in these choices.

The complexity and risk of navigating patent thickets; the prospect of being subjected to regulatory bureaucracies like FDA; and the difficulty and expense of doing the engineering work that set Open Insulin apart from other forms of activism all posed significant challenges to the Project. In the day-to-day work of the Project, these challenges were defined by high degrees of uncertainty, tense moments, and feelings of uncertainty,

frustration, and the loss of control.[130] Project members often tried to allay these by turning to expertise. Often, this was their own technical expertise, leading to a focus on the Project's work in the wetlab. Though many of those who could help Project members deal with and navigate legal and regulatory uncertainties were systematically less available than technologists and engineers, they also turned to the expertise of volunteers and sympathetic experts in law and regulation when it was available. In the process, the Open Insulin Project shifted toward favoring "techno-legal" forms of expertise (Parthasarathy 2017) and toward an embrace of hype and promissory communication that was both vague enough to be low-liability and compelling enough to get the Project the funds they needed to tackle these different challenges.

Embracing these forms of expertise and communication, Open Insulin, which was according to its members a fundamentally antibiocapitalist project and a way of "pursuing politics,"[131] came to take on some of the features of the very institutions it was created to resist. Some members put their fingers on this very possibility, which Thornton described as "fall[ing] into the same patterns I'm opposed to" and Maria described as "becoming the thing you're wanting to fight."[132] Often, this advice suggested a cautionary and non-confrontational approach. As a

[130] Murray, fieldnotes, October 31, 2018; March 13, 2019.
[131] Murray, fieldnotes, May 26, 2019.
[132] Murray, fieldnotes, April 7, 2019; Open Insulin OIS WG meeting notes, January 14, 2019.

result, Project members were compelled to capitulate and conform to the demands of the same systems they set out to oppose, to dull and veil their criticisms of these systems, and to double down on the technical work of engineering their way out of problems despite the fact that this technical work presented its own substantial challenges. This resulted in facing compromises to their core values of openness and democratic "flat organizational structure,"[133] including pressures to limit communication and silo information.

In other words, Project members' choices (1) to take up and center bioengineering, a technoscientific order with a sophisticated and well-established sociopolitical order; and (2) to try to operate within, navigate, or circumvent rather than more directly challenge this sociopolitical order, brought the sociopolitical order of biocapital into the Project itself. The fact that one of the defining features of this sociopolitical order was creating the impression of apoliticism to maintain the guise of objectivity (Jasanoff 2005; Parthasarathy 2017) gave the expert advice that some volunteers, members, and expert advisors encouraged the Project to act on the appearance and force of value-neutral imperatives. Without aligning their technoscientific critique with a sophisticated, systemic sociopolitical critique that challenged the neutrality of these suggestions and the nature of the expertise behind them, it was difficult for the Project to reconcile its

[133] Murray, fieldnotes, April 7, 2019.

values and politics with the suggestions they received. This was surely easier said than done, and the fact that the advice members received—and at times, followed—about threats to the Project derived from and helped reinforce biocapital's social order did not make the threats any less real or imposing. Even so, the Project's prevailing concern with overcoming and circumventing barriers to technical knowledge and tools—a concern that was widespread within amateur bio—often eclipsed concern for the ways that institutions systematically privileged the technical to the exclusion of other types of expertise.

Of the threats facing the Project, one volunteer provided advice that again invoked a famous biomedical technology failure familiar to Open Insulin members: "Don't be Theranos."[134] She intended this as a warning about Open Insulin's hype generation and potential overpromising, which she understood as clashing with the Project's need to keep a low profile.[135] However, Theranos was also notorious for their control of flows of information both within and outside the organization; for plans to bypass FDA oversight when introducing their doomed diagnostic devices; for an extreme, totalitarian "executive structure"; and of course, for the hope and hype they cultivated through their expressed desire to "do good" by disrupting an existing industry (Carreyrou 2018).[136] The story of Theranos

[134] Murray, fieldnotes, March 6, 2019.
[135] Murray, fieldnotes, February 3, 2019.
[136] Murray, fieldnotes, July 25, 2018. See Chapter 1.

was fascinating not because it was anomalous, but because it was a product of Silicon Valley tech culture's lionization of disruptive revolution a technological saviorism (Geiger 2018). Enabled by proximity to Silicon Valley and Bay Area tech and biotech and dependent on its denizens to provide volunteer labor, the Open Insulin Project was not immune to some of the same cultures and pressures that helped shape Theranos, even if their vision of doing good fundamentally opposed much of what Theranos stood for as an *enfant terrible* of Bay Area biocapitalism.

Coda: Departure

About six months after Thornton and I shared a beer to follow up on the previous meeting and the text messages he sent me, I received another message: "So, I'm very close to leaving Open Insulin, and I was wondering if you'd be interested in chatting?"[137] By the time we spoke on the phone, Thornton—who during his tenure had been one of Open Insulin's most consistent and dedicated members—had already left the Project. When we talked, he went through his list of the reasons why.[138] He spoke quickly, and he had clearly put some thought into what we wanted to get across to me.

He complained about a generalized superficiality on both the technical and organizational sides of Open Insulin and a lack of deep

[137] Murray, personal communication.
[138] Murray, interview, October 16, 2019.

strategizing and meaningful collaboration. On the technical side, he discussed a lack of transparency and consistency with the lab work and suggested that for all he knew, the work was "changing all the time." He objected to the way developing an open hardware system became a part of the project. He said it was "crazy" to think that bioengineering hardware was simple enough to take so lightly. He suggested that talking about almost having insulin was a poor way to frame the Project's progress because this would make people think that they would have something ready to inject into people soon. While he understood the appeal of exaggerating to raise money, which he suspected was the motive, he said simply, "it's not efficacious."

The organization was supposedly democratic, and the bylaws formalized this. However, Thornton felt that in practice, power was concentrated among certain members who tended to act independently. The "executive structure" that some relatively new members had discussed wanting to formalize—a suggestion protested by Anthony and many of the other longer-serving Project members—flashed into my mind. He suggested that this could have been a manifestation of modes of working in an organization that members had internalized without realizing it.

The sharing of knowledge and information within the organization, he said, was worse than the other labs he had worked in. Chuckling, he lamented, "we never wrote anything down!" He chalked

this up to both lack of funds, and to an unwillingness to acknowledge the high degree of uncertainty that Open Insulin was dealing with. “It’s not open,” he said, laughing again. “Open Insulin is very closed.”

Chapter 3

Open to Interpretation: Branding Bioconstitutionalism in Amateur Bio

> "Community biology is very broad, it has a lot of facets, and this is empowering."[1]
>
> - Global Community Bio Summit panelist 1
>
> "This meeting isn't owned by our community. This meeting's owned by MIT."[2]
>
> - Global Community Bio Summit panelist 2

The second-annual Global Community Bio Summit (GCBS) at the MIT Media Lab hosted a broad swath of people interested in and excited about the prospects of community bio: biohackers and grinders, bioartists, company representatives, self-described inventors and entrepreneurs, bioethicists, journalists, social scientists. According to my registration, I was there as both a sociologist studying the "community bio" phenomenon and as an affiliate of Counter Culture Labs and the Open Insulin Project. When I arrived at the Media Lab and picked up my nametag, it identified me simply as a representative of my home university, UC Santa Cruz.[3] Several other Counter Culture Labs and Open Insulin Project members were in attendance. For some of them, it was their second GCBS. In

[1] Murray, fieldnotes, October 27, 2018.
[2] Murray, fieldnotes, October 27, 2018.
[3] Murray, fieldnotes, October 26, 2018.

accordance with their large roles in the amateur bio community at large, Maria and Patrik had helped organize the event.

For the event, all the Media Lab rooms on the sixth floor had been rechristened with cellular names: Nucleus, Mitochondria, Lysosome.[4] The Summit programming consisted largely of sessions, activities, speakers, and panels that took place in the main auditorium, the Golgi Room. During a few blocks of time each day, attendees would filter out into the Nucleus for snacks, coffee, and conversation, and from there, to some themed breakout sessions in the various organelles. Topics varied widely. Some focused on wetlab work and required a fifteen-minute safety training and a signature as prerequisites for participation. Some focused on the ins and outs of running community labs or provided promotional, recruitment, and networking opportunities by highlighting specific labs and projects.

The main features took place in the Golgi, where several hundred folding chairs were arrayed in front of a stage flanked by three projector screens. Of these, two were dynamic, showing images and slides related to the conference's current proceedings. The last was static, fixed with the logos of the event's corporate sponsors, including OpenTrons, Millipore Sigma, Scientist.com, and Takeda (see Figure 1). Each of these corporate sponsors would have the opportunity, over the course of the Summit, to

[4] Murray, fieldnotes, October 26, 2018.

give short presentations to the attendees in the Golgi and to everyone watching the event's online livestream.

Figure 26. The projector screen dedicated to the corporate sponsors of the second-annual Global Community Bio Summit.

Another of these sponsors, Veritas ("The Genome Company"), was sponsoring a raffle. Event organizers distributed the entry forms, small sheets of printer paper with the Bio Summit logo in the corner and the words, "Fill out for a change to win A Veritas Genetics Whole Genome Sequencing Kit!" at the top (see Figure 2). The paper required a name and had an optional space for an email address and a checkbox to opt-in to receive genome-sequencing related emails from Veritas. As the raffle neared, attendees who had not received theirs hustled around the Golgi, looking to get their hands on an entry form. I had received one, but unsure

I wanted my genome sequenced, I folded it—still blank—and tucked it into my pocket.[5]

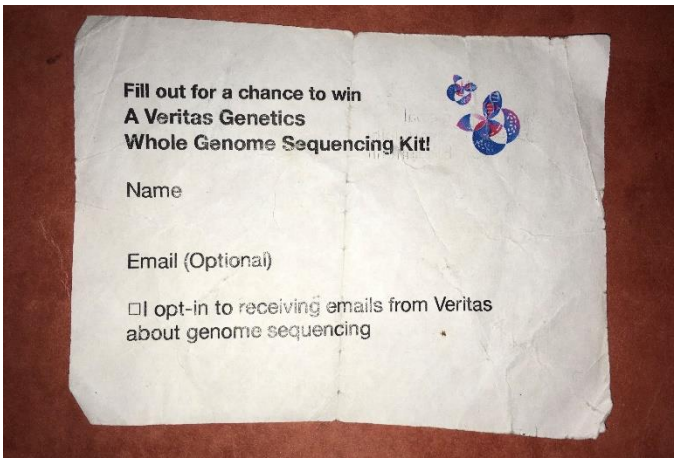

Figure 27. My folded, crumpled, and uncompleted raffle ticket from the second-annual Global Community Bio Summit.

In the panel preceding the drawing, one of the panelists was a representative from Veritas. He explained that when customers buy Veritas' sequencing kits (or, presumably, win them in a raffle), they contribute their data to a research community. Genetic data, he explained, is a powerful natural resource, like water. The goal should be to unlock this resource rather than to hoard it. To this end, Veritas produced an open-source software that they believed would democratize access to data, allowing people to manage and control their own genomes. All of this, he explained, merely required clearing a very low barrier to entry: a computer. I wondered how Open Insulin members like Anthony, Ramy,

[5] I was reminded of Jenny Reardon's similar reluctance to complete a form acknowledging her understanding that she may be a research subject. She, too, tucked the form away (see Reardon 2018).

and Yann, ever suspicious of large institutions and directing fierce scorn at pharmaceutical companies in particular, felt about being at the Media Lab, listening to corporate sponsors present about open-source and the democratization of the sciences. These were principles they also embraced, and they did so, in my experience, to the exclusion of profit-motivated corporate interests (see Chapter 1).

After the panel's talk of "infinite discovery machine[s]," biologized designer-shoe company collaborations, and innovation's ability to drive radical change, one organizer selected an audience member seated near the stage to draw the raffle's winning entry, to audience applause. As it happened, she drew her own entry. She was visibly excited as she received the full genome sequencing kit, which was packaged in a small, colorful paperboard box that immediately reminded me of the boxes used to package software—at least before purchases of most software moved to digital downloads. The organizer facilitating the drawing asked why she wanted to have her whole genome sequenced. She answered that she was from Mexico and was excited to have the opportunity, which was not as accessible in her home country. After the built-up anticipation and release of the raffle, the other attendees and I departed the Golgi to the conference's first break-out sessions, like little vesicle-bundled proteins in intracellular transport.

Introduction

The Open Insulin Project is one effort in a larger network of amateur bio-focused laboratories, projects, and enthusiasts. Within the Project, despite its relatively limited and well-defined scope, members struggled to find clarity and maintain the Project's focus, values, and identity, particularly when their Project came up against biotechnology's governing institutions (see Chapter 2). Perhaps predictably, the focus, values, and identity of the broader networks were often at least as unclear. As biology and bioengineering became increasingly accessible (see Chapter 1) and the number of people pursuing biotechnology in unconventional spaces grew, problems of defining this new collective emerged: what were these new practices, who was participating in them, and to what ends?

This chapter tells the story of that coalition-building and the crafting of a collective "we the people" of amateur bio, as well as its implications for its participants, including members of the Open Insulin Project. Drawing on literature in bioconstitutionalism and branding, I show how amateur bio's problem of the "we" was addressed using frameworks of citizenship and rights as well as through collective affirmation and inclusive branding. These efforts were especially visible during gatherings and conferences for amateur biologists. I attended three such gatherings—Biohack the Planet (BHTP) and two consecutive Global Community Bio Summits—during my fieldwork with Open Insulin.

Attending these events, shadowing members of Open Insulin and Counter Culture Labs, allowed me to see amateur bio practitioners establishing discourses of rights, identity, and values in real time in key "bioconstitutional moments" (Benjamin 2013).

The branding of amateur bio required navigating several different tensions. These included the presence of apparently conflicting interests, perhaps rendered most stark by the juxtaposition of corporate investments in the field with the presence of vehemently anti-corporate efforts like the Open Insulin Project. Beyond this, further tensions existed: between the risky activities and potential dangers of synthetic biology experiments; between self-experimenting amateur bioengineers and the specter of regulatory oversight; and between universities' supportive roles and the presence of science PhDs and the disparagement of established institutions and formal education.

Despite the large overlap between their demographics, BHTP and the GCBS showcased very different ways of navigating these tensions, reflecting their organizers' strategies and the different factions within the amateur bio network. They did so in the wake of controversies that put biohacking and do-it-yourself biology (DIYbio) under increasing public scrutiny. In the wake of these controversies, BHTP organizers—one of whom was no stranger to controversy himself—sustained their subversive approach to amateur bioengineering, building a biohacking community

oriented around techno-libertarianism and individual autonomy. On the other hand, those who steered the events of the GCBS, notably the MIT Media Lab's Community Biotechnology Initiative (CBI), embraced inclusion to bring together a broad coalition of biohackers and do-it-yourself biologists as well as amateur science educators, ecologists, bioartists, bioethicists, journalists, and social scientists, rebranding this seemingly united movement as "community bio."

Branding community bio depended on distancing the movement from past controversies, and it relied on a strategy of emphasizing common ground and largely ignoring rather than confronting the community's latent tensions. In so doing, it reinforced some of bioconstitutionalism's tendencies: generalization, the superficial impression of meaningful participation, lack of constructive conflict, and difficulty addressing the complexities of questions of openness and inclusion and sharing and ownership (Benjamin 2013; Reardon 2017). Like other branded politics, it focused on limited forms of empowerment and questions of access at the expense of questions of labor and property rights (Banet-Weiser 2012). These questions of empowerment and access were oriented around increasing access to bioengineering.

Despite the limitations of branded bioconstitutionalism as a governance framework, combining branding and bioconstitutional lenses makes it clear that biotechnological rights and citizenship are co-

constituted by institutional actors and amateur participants in the post-genomic era, and that their constitution is permeated by ambivalence. Despite the outsized role that the CBI played in branding "community bio" and the broad and safe values this branding embraced, they failed to avoid conflict and controversy altogether. When scandal shook the Media Lab, it forced a reckoning with some of community bio's latent tensions and paved the way for a more fruitful discussion of community membership, rights, and values.

Of Counter Cultures and Constitutions

Scholars of the biosciences have identified a shift from questions of ethics—like the issue of informed consent and privacy—to more fundamental questions of constitution, or what Jasanoff (2011) calls "bioconstitutionalism": "How is this world put together? Who and what gets to live and prosper in it?" (Reardon 2017:5). Scholars who have studied bioconstitutionalism have focused on how it reconfigures conversations in the biosciences around liberal political rights and values like inclusivity, participation, and openness. As a movement that rallies around these same values, analyzing amateur bio as a bioconstitutional movement is key to understanding its politics. Existing scholarship teaches that in practice, bioconstitutional efforts have tended to produce versions of inclusivity, participation, and openness that are limited and

limiting and that have both effectively excluded those marginalized by existing biotechnological regimes and reproduced those existing regimes' concentration of biocapital.

Ruha Benjamin (2013) demonstrates the former in her account of the California Institute of Regenerative Medicine (CIRM) and its Independent Citizens' Oversight Committee (ICOC). Benjamin argues that despite appearing "radically inclusive" (2013:5), the modes of inclusion that actually emerged failed to foster meaningful forms of participation and accountability. Benjamin points to conflicts of interest that limited participants' abilities to implement Proposition 71 and effectively represent the public interest in the CRM and ICOC. But even more importantly than the presence of such conflicts, Benjamin calls attention to an absence: "a *lack* of constructive conflict over the priorities and governance of science" (2013:5, emphasis in original). This lack especially failed to make science accountable to marginalized groups. In so doing, the appearance of radical inclusivity and its inability to produce meaningful representation and debate continued to limit the scope of the bioconstitutionally defined *people* who participated in scientific governance (2013).

Jenny Reardon (2017) demonstrates the latter in her account of the development of genomics. While liberal values like participation, inclusivity, and openness increasingly serve as organizing principles in the

postgenomic biosciences, Reardon points to their complexity in the cases of the Human Genome Project (HGP) and Personal Genome Project (PGP). Reardon identifies that openness, identified by seminal sociologist of science Robert K. Merton as science's norm of communism, is easier to map onto *science* than onto *technoscience,* where the lines between technology and science are blurred to the point of indistinction. This is the case in genomics and biotechnology, as the case of the HGP illustrates. While its advocates mobilized the idea of "open" science, they also depended on proprietary sequencing machines. The apparently contradictory norms of sharing and ownership rights thus constituted what Reardon calls a "formative tension" in the development of genomics (2017:30-31). Despite this complexity and tension, the norm of openness has retained its broad appeal, and advocates—including many of the Open Insulin Project members I worked with—continued to echo Merton in arguing that it inevitably improved scientific knowledge production. Reardon (2017), however, points out that this is not always the case.

The PGP resulted in another mobilization of openness, this time to justify the free circulation of genomic data and to argue against rights to data privacy (Reardon 2017). Proponents of the PGP[6] promised the decentralization of sequencing technology in a process akin to the rise of personal computing. In order to make this a reality, however, they needed

[6] These proponents notably included George Church, who has played a significant role in synthetic and amateur biology as well.

to collect the data of large numbers of people willing to forgo the right to privacy and submit their data to a commons. They succeeded in reaching groups of largely white technoscience enthusiasts, calling into question whom this genomics revolution would be for. Making the argument for openness and the relinquishment of privacy, they also drew lines between what should be shared for the public good—personal genomic data—and what need not be—intellectual property and proprietary technologies.

Hilgartner's (2017) study of the genomics community analyzes bioconstitutional technoscience in terms of knowledge-control regimes, which comprise governing frames that help actors define and interpret their worlds and actions. In Hilgartner's analysis, openness is itself a knowledge-control regime that suggests a normative allocation of resources, entitlements, and burdens. Knowledge control-regimes are typically constitutional in that their prescriptive descriptions are both stylized and generic (2017:12). Hilgartner is especially concerned with questions of control and agency and change within "lawlike" technoscientific regimes. He finds agency in the actors' capacities to contest specific fringe cases, find wiggle room in ambiguity, or deviate from constitutionally expected paths. He attributes special importance to periods of rapid change like the ongoing genomics revolution that remake allocations of power, authority, and wealth through struggle—what Benjamin calls "bioconstitutional moments" (2013:6).

These studies demonstrate that in bioconstitutionalism, relationships between appearances and espoused values and their practice is far from straightforward. Rather, they are typically complex, fraught with tension, and defined by struggle. In some cases, Benjamin suggests, they may be characterized by a lack of conflict that might meaningfully challenge established regimes. As a postgenomic movement pushing an inclusive and participatory version of open technoscience, it is worth analyzing amateur bio in similar terms. To better understand amateur bio, however, I argue that bioconstitutionalism benefits from supplementation by another participatory, cultural theoretical framework: branding.

Sarah Banet-Weiser (2012), discussing a global shift to brand cultures, argues that they are fundamentally structured by ambivalence. She articulates these claims against those who, in the tradition of Frankfurt School scholars of the "culture industry" understand mass culture as progressively eroding agency and authenticity (e.g., Horkheimer and Adorno 2002 [1947]; see also Marcuse 1964, Klein 2001). Instead, Banet-Weiser argues that authenticity has itself become a brand. Rather than indulging in misplaced nostalgia for a (likely fictitious) time when politics and consumption were separate, Banet-Weiser compels an analysis that starts from the assertion that brands are not displacing culture; "brand cultures are *cultures*" (Banet-Weiser 2012:216, emphasis in original). Further, these cultures operate largely through what Raymond

Williams describes as "structures of feeling," affective relationships that define the experience of brands.

Banet-Weiser's analysis of Dove's "Real Beauty" advertising campaign illustrates these ambivalent structure of feeling (2012). Rather than understanding this campaign either wholly cynically—as an attempt to due and manipulate consumers—or wholly naively—as a purely good-faith effort that has nothing to do with selling products—Banet-Weiser understands it as fundamentally ambivalent: capable of fostering authentic communities and discussions about gender expectations and the beauty industry. These networked publics are no less real because they are encouraged by a company that is part of that same industry. In Banet-Weiser's analysis, embracing branding culture allowed companies to enroll consumer-citizens as co-constructors and ambassadors. This is a risk that allowed brands to become ubiquitous cultural touchstones, but that also opened these brands up to culture's idiosyncrasies: flexibility, unpredictability, instability, and precarity.

Likewise, from the side of consumer agency and empowerment, brand culture is not without limitations. Banet-Weiser argues that brands' needs to appeal to large groups means that the politics branding culture embraces are often relatively "safe" and uncontroversial (2012). While these politics may at times call attention to inequities, they rarely pose meaningful challenges to their structural causes. Branded politics limit

modes of empowerment and activism, often channeling them into individualism and consumption. Brand culture also depends largely on the unpaid labor of its "consumer-citizens" to build brands and generate the data that is increasingly both the cost and product of consumption in the digital age.

In many ways, branding and bioconstitutionalism reinforce one another. Both tend to provide limited forms of citizenship and participation. Likewise, both limit the potential for constructive conflict. However, both also provide some space for agency and contestation. Understanding bioconstitutionalism itself as branded compounds these common qualities, which were key to understanding how Open Insulin members participated in and helped define the broader amateur bio network as it grew and evolved.

What's in a Name?: Branding Amateur Biology in Response to Controversy

Amateur biologists made up a loose, decentralized network of affiliates that encompassed a group of practices far broader than Open Insulin's work, ranging from "grinder" transhumanist body modification enthusiasts to bioartists to local STEM education advocates. As those in this network worked to forge collective identities, one key focus was the name that participants used to define their activities. There were several in

circulation, among which three were most common: do-it-yourself biology (or, more simply, DIY-bio), community bio, and biohacking. Considering the broad scope of practices in question, it is perhaps unsurprising that there were differing opinions and disputes about labels. BioCurious alone had a five year-long internal dispute over whether to call the lab a biohackerspace or a community lab.[7]

Each different name bore different connotations and histories, and which label(s) a person or project embraced often revealed how they found their way to amateur bio. Many, including members of Open Insulin and Counter Culture Labs, regarded the terms as largely interchangeable.[8] Open Insulin members also used these labels instrumentally, to communicate what they were doing and to gain access to collaborators and resources. Few of them had deep investment in any particular label, though many expressed preferences for one or another.[9] Over time, a shift emerged away from *biohacking* and *DIY-biology* in favor of *community bio,* though these different labels continued to coexist and, in many cases, to describe the same individuals, laboratories, and projects.[10] The shift was significant, however, because it reflected both the influence of MIT's Community Biotechnology Initiative and the response to a string of

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[7] Murray, fieldnotes, October 26, 2018.
[8] Murray, interviews, October 11, 2019; February 27, 2019; October 15, 2018; December 9, 2018; March 3, 2019.
[9] Murray, interviews, May 27, 2018; August 8, 2018; October 10, 2018; August 13, 2018; February 27, 2019; October 17, 2018; December 9, 2018.
[10] Murray, personal communication, October 28, 2018.

controversies implicating—and perhaps, tarnishing—biohacking and do-it-yourself biology.[11]

Biohacking emphasizes the similarities to computer hacking and the connections to hackerspaces and hacking clubs. The term was provocative in a way that some practitioners found appealing.[12] Others worried about the ways in which this label encouraged connotations of the lone tinkerer at work in a garage.[13] While hacking's connotations in the information sciences are mixed at best, its invocation in the world of bioengineering often provoked discussions of irresponsible activity, including the production of bioweapons.[14] This prospect was part of the reason many members of the network worked to forge an early, proactive relationship with the Federal Bureau of Investigation (see Wolinsky 2016). Still, several noteworthy developments made it difficult for aspiring amateur bioengineers to shake controversy.

In 2016, a team of Canadian researchers at the University of Alberta recreated an extinct horsepox virus using mail-order DNA (Noyce, Lederman, and Evans 2018). The $100,000 effort raised anew questions about the regulation of synthetic biology and its growing ability to create or recreate pathogens (Kupferschmidt 2017). Then, in late 2017, Josiah Zayner—Bay Area biohacker, CEO of biohacking supply and education

[11] Murray, interview, December 9, 2018.
[12] Murray, interview, April 27, 2018.
[13] Murray, fieldnotes, October 26, 2018.
[14] Murray, fieldnotes, August 31, 2018.

company The ODIN, and founder of the biohacker conference Biohack the Planet—injected himself with an experimental CRISPR-based gene therapy he designed to increase muscle growth (Lee 2017). He performed the stunt live at SynBioBeta, an annual synthetic biology conference in San Francisco. Several months later, in February 2018, another self-identified biohacker and startup CEO, Aaron Traywick, injected himself with a different experimental gene therapy at a livestreamed biohacking event in Austin, Texas (Mullin 2018). Traywick had earlier gathered a group of biohackers to form his company, Ascendance Biomedical. After the stunt, these biohackers largely abandoned the company, which in turn quickly imploded (Zhang 2018). Shortly thereafter, in another strange turn of events, Traywick was found dead in a sensory deprivation tank under mysterious circumstances (Bromwich 2018).

A story published in *The New York Times Magazine* a few months later considered these events—the horsepox synthesis, the self-injection stunts, and the growth of amateur bioengineering—in combination (Baumgaertner 2018). By linking the growth of amateur bioengineering and the controversial activities of some biohackers to the production of potential bioweapons in a university lab, the article suggested that these amateur bioengineers were a pressing concern for the post-9/11 security state, in which bioengineering became a possible source of terroristic

bioweaponry.[15] In the article, one of synthetic biology's founders and a major figure in genomics, George Church, was quoted as saying, "anyone who does synthetic biology should be under surveillance, and anyone who does it without a license should be suspect" (Baumgaertner 2018). Already by the time of Traywick's self-injection stunt, Zayner had expressed regret for his own actions and concern over its potential repercussions. (Zhang 2018). His own ominous words were used in the *NYT* article's title: "someone is going to get hurt" (Baumgaertner 2018).

The article sent ripple effects through the community. Many members of labs like CCL and BioCurious felt the need to respond to what they felt was scaremongering, sensationalistic reporting.[16] Some members viewed Church's statements as a betrayal, or supposed that the must have been misquoted or taken out of context. Patrik said simply, "that doesn't sound like George."[17] A typical response from members like Maria was that the so-called "D.I.Y." activities the article described more often happen in community labs and other social networks that could guarantee safety even better than conventional corporate or university laboratories (see Kuiken 2016).[18] While most amateur bioengineering was happening in safe

[15] It is possible that concerns over engineered bioweapons became more pressing in the wake of the COVID-19 global pandemic that began in late 2019, as this dissertation was being written. One of the many conspiracies surrounding the emergence of the novel coronavirus that caused the pandemic was that it was engineered in a laboratory in Wuhan, China.
[16] Murray, fieldnotes, May 21, 2018; May 23, 2018.
[17] Murray, fieldnotes, May 16, 2018.
[18] Murray, interview, April 27, 2018.

and supportive community lab environments, a relatively small number of self-identified biohackers gained visibility because of their wayward, irresponsible experiments.

The *NYT* article (2018) focused specifically on activities it identified as "biohacking" and "D.I.Y. gene editing," and it was one factor precipitating a shift away from those labels and their associations with rogue individualism. *Biohacking*'s subversive and techy appeal also began to be used by an even wider group of practitioners, some of whom were engaged in very different work. This included those interested in transhumanism, body modification, and life extension, as well as groups of people focused on optimizing nutrition.[19]

As biohacking became both more controversial and more fractured, some Open Insulin members, like Yann, felt mounting disagreements with other biohackers. He even mulled the concept of writing an op-ed discussing some of the rifts within the biohacker community.[20] He characteristically objected specifically to business interests and what he called simply "capitalist guys," but he also reacted strongly when Zayner published an opinion piece defending He Jiankui, the Chinese scientist who gene-edited twin embryos (Zayner 2020).[21] In the piece, Zayner both self-identifies as a biohacker and also bestows the title human on He to

[19] Murray, interviews, April 3, 2019; February 27, 2019.
[20] Murray, fieldnotes, September 5, 2018; October 15, 2018.
[21] Murray, fieldnotes, January 11, 2020, January 16, 2020

describe his freedom from regulatory oversight and his consequent position at the scientific vanguard. Yann disagreed with Zayner's portrayal of embryo gene editing as inevitable. He also specifically objected to the way Zayner leveraged their community to make this argument, saying, "I hate how he uses biohacking to back him up."[22] As biohackers like Zayner continued to emphasize individual autonomy and the inevitability of technoscientific progress, many Project members embraced community responsibility, believing that it was amateur biologists' duty to self-regulate and to consider the potential consequences of their actions.

Still, affinities with the biohacking community remained among Project members. While expressing disapproval of recent self-experimentation stunts, members of Open Insulin did not shy away from self-experimentation altogether. Patrik, telling an amateur bio-inflected version of the history of the biological and medical sciences, explained that self-experimentation had long been the path to progress.[23] He expressed some respect for the historical nobility of self-endangerment and self-sacrifice for a greater good. Similarly, Anthony had long planned to self-inject insulin produced by the Project as a demonstration of its safety and effectiveness. Drawing my own parallels between the recent biohacker self-experimentation controversies and these plans, I asked if he was worried about how this demonstration would be perceived. He and other members

[22] Murray, fieldnotes, January 11, 2020.
[23] Murray, fieldnotes, May 16, 2018.

were fiercely dismissive of these parallels, for the simple reason that insulin was not an experimental treatment but a long-established, trusted, and testable medicine.[24,25]

As biohacking was becoming a newsworthy magnet for controversy, DIYbio.org, which served as a network hub, was falling into disuse. The site's activity tapered off around 2018, though a Facebook group remained active (DIYbio.org; facebook.com/groups/diybio). In addition to the shift away from "do-it-yourself" and toward more communitarian "do-it-together" rhetoric that downplayed associations with solitary biohackers, a new group and a new umbrella term emerged that helped displace *DIYbio* especially.[26] MIT Media Lab's Community Biotechnology Initiative began to organize events using the name *community bio,* pulling together biohacking and DIYbio, plus "biomaking" and members of community laboratories, casting a wide net (Community Biotechnology Initiative 2018).

Open Insulin Project members continued to attend events that convened amateur bioengineers under different descriptors, including both *biohacking* and *community bio*. These events reflected emerging tendencies within the network: an overall increasing gravitation toward the name *community bio,* with some polarization and tenacious

[24] Murray, fieldnotes, July 25, 2018; interview, August 8, 2018.
[25] Anthony remained interested in pursuing, outside of Open Insulin, the prospect of a gene therapy-based cure for Type-1 diabetes. Murray, interview, May 26, 2019.
[26] Murray, personal communication, October 28, 2018.

preference for *biohacking;* an accompanying shift toward an inclusive and non-confrontational approach, including a strong emphasis on intra-community responsibility; and with these changes, a willingness among members to participate in ways that could further their and their projects' goals despite apparent disagreements and conflicts of interest.

Community, Biology, Movement

As a participant observer with Open Insulin, I attended three different conferences alongside other members of the Project: The Zayner-organized Biohack the Planet (BHTP) in Oakland, CA and twice, the Global Community Bio Summit (GCBS)[27] at the MIT Media Lab in Cambridge, MA. As their names suggest, the first of these events convened participants identifying as "biohackers," while the second convened a broader and more international group of "community biologists." Even so, there were significant overlaps in attendance. At both, Open Insulin Project members, plus other members of Counter Culture Labs and BioCurious, gathered with representatives of the country's other major community labs; self-identified biohackers and body modification enthusiasts; members of the synthetic biology community; bioartists; entrepreneurs; and a relatively small collection of bioethicists, journalists,

[27] The full name of this event was the Global Summit on Community Biotechnology.

and social scientists who studied and collaborated with members of these communities, myself included.

Their substantial overlap in attendance notwithstanding, the events exhibited noticeably different dynamics. Each presented a different vision of biology and bioengineering undertaken in laboratories outside conventional institutions and framed this vision in the constitutional language of citizenship, freedom, and rights. BHTP cultivated an atmosphere of gleeful subversion.[28] As might be expected from self-identified biohackers' participation in publicity stunts, the event's constitutional discourse focused especially on individuals' rights to tinker with biology and to exercise bodily autonomy. The GCBS, apparently in response to the controversies arising from these same stunts, downplayed individual bodily rights and instead emphasized common participation and inclusivity.[29] Both emphasized rights to access to biological tools and materials for those outside traditional scientific institutions.

Open Insulin members in attendance objected differently to each of these attitudes, revealing how the Project was, in significant ways, at odds with many of the currents of both biohacking and community bio. Disagreements often revolved around the consistent presence of profit motives in both the biohacking and community bio scenes. Among other biohackers, Open Insulin members' focus on community health, safety,

[28] Murray, fieldnotes, August 31-September 1, 2018
[29] Murray, fieldnotes, October 26-28, 2018.

and the prioritization of the underprivileged served as the major grounds for disagreement, concerns that were at least nominally more at home in community bio spaces.

Importantly, among other community biologists, specific points of disagreement were more difficult to identify. I argue that this was a feature of the community bio network and how the MIT Media Lab's Community Biotechnology Initiative has encouraged its growth and development. Whereas biohacking provoked controversy and backlash with its flair for dramatic stunts and provocations, community bio persistently sought to distance itself from controversy as a way to chart an inclusive and diplomatic course. This approach to establishing a new identity for an amateur movement allowed community bio to capture a wide range of participants while underplaying tensions, fragmentations, and disagreements between them. This created an uncontroversial impression favorable for public relations and maximizing participation at the expense of the capacity to address tensions and thereby profoundly challenge existing hierarchies and disparities within the biosciences.

Biohack the Planet

Counter Culture Labs hosted the third-annual Biohack the Planet event at the Omni Commons late in the summer of 2018.[30] The event's

[30] Murray, fieldnotes, August 31, 2018.

first day easily marked the most people I had seen gathered at the Omni. The ballroom, which featured a stage in front of rows of repurposed church pews and folding chairs, was near capacity, with attendees also standing along the room's edges. I noticed that many attendees seemed to know each other well, and I got the sense that biohackers were a relatively small and tight-knit group, even if its members did come from all over the country, and in a few cases, farther abroad. At the check-in desk, event volunteers distributed nametags and sold the event's t-shirt, which featured a line-drawing of a pipette framed by the words "BIOHACKING IS NOT A CRIME" (see Figure 2). At the kickoff of the first day's events, many of the participants would find lab-grade pipettes like the one depicted taped to the underside of their seats in a surprise giveaway. The message: with the necessary tools, you too can be a biohacker.

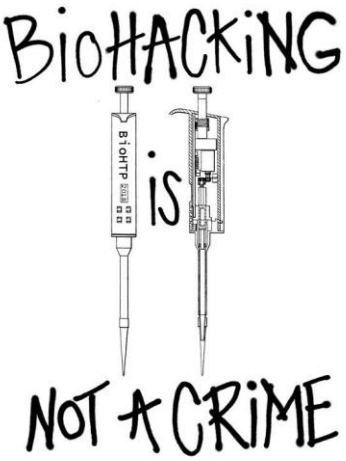

Figure 28. T-shirt design for Biohack the Planet 2018.

I came in and took my seat in a folding chair next to several other CCL members. Right away, during the mic check, a rebellious, defiant

emotional atmosphere was apparent: “Can you hear me now, you heckler? Fuck you.” [31] This was followed a few minutes later by a bit of friendly advice: “By the way, if you do drugs, you should do them now.” Early speakers were approvingly introduced as “infamous.” On stage, a few discussed their dream scenarios for biohacking: one said he’d like to make a warg, a fantasy wolf from J.R.R. Tolkien’s *The Lord of the Rings*; another said more simply and realistically, a cell, before cracking a quick joke about pneumonia. The first time a speaker mentioned bioethics, someone in the audience booed loudly.

Speakers repeatedly reaffirmed biohacking’s roots in software movements, comparing trends in bioengineering to earlier developments in information technology.[32] Echoing Zayner’s comments about the inevitable future of bioengineering, they treated the development of biotechnology as a natural law, invoking Moore’s law of computing—as I had also heard Michael do[33]—and suggested that “total control” of biotechnology was mere decades away. Several speakers compared biohacking’s current state to relatively early computer technologies, saying that being present in this moment was “like watching the semiconductor industry boot up.”[34] Another argued about the future of biohacking and synthetic biology, “right now, we’re at vacuum tubes, and we need to get to

[31] Murray, fieldnotes, August 31, 2018.
[32] Murray, fieldnotes, August 31, 2018.
[33] Murray, fieldnotes, May 29, 2019.
[34] Murray, fieldnotes, September 1, 2018.

Linux."[35] Overall, biohackers embraced synthetic biology's understanding of the world, where life is simultaneously an example of a sophisticated information system and a rudimentary information system that must be developed further.

The meeting's participants also repeatedly reemphasized biohacking's individualist and anti-regulatory inclinations. Significantly, this applied even when they emphasized building community and situated biohacking within community labs.[36] One speaker who headed up a community lab talked about both wanting to put a community lab in every neighborhood and emphasized that the major purpose of these labs was to develop personal forms of explanation and connection with the living world.[37] This same speaker legitimated the existence of community labs as resume- and experience-builders. In many cases, arguments for community revolved around ways to increase and protect participation by increasing access and reducing the likelihood that the FDA would "come down" on biohackers.[38] Others identified addressing urgent health crises like malaria and tapping into hope as ways of cultivating protective trust in biohacking, or downplaying negative associations with biohacking—as examples, speakers and audience members mentioned pathogenic

[35] Murray, fieldnotes, August 31, 2018.
[36] Murray, fieldnotes, August 31, 2018.
[37] Murray, fieldnotes, August 31, 2018.
[38] Murray, fieldnotes, September 1, 2018.

microorganisms and the "zombie apocalypse."[39] In contrast to their attitudes toward regulatory agencies, which some suggested were enemies or obstacles, speakers put faith in individual biohackers' own abilities to make decisions about rightful access to biological materials and emphasized the desirability of increasing such access, indeed, making it universal. Upon hearing this, one of CCL's members, Rolf, who was sitting beside me, told me, "I'm not sure that's such a good idea."[40]

Among the speakers were a large number of transhumanists, a community I had little experience with as a participant-observer at Counter Culture Labs. Invoking the incidents that had already helped solidify biohacking's notoriety, these participants emphasized rights to enhancement and self-experimentation. Some among these had and advocated for relatively minor modifications, like implanted RFID chips or magnets under their skin.[41] Others were a bit more extreme, like a vibrating penile implant. One speaker had run a presidential campaign on a platform of achieving immortality from a coffin-shaped campaign bus. My fellow CCL and Open Insulin members reacted to these with a mixture of incredulity, frustration, and bemusement. Yan called some presenters "dreamers" but still expressed worries over its provocations, including the

[39] Murray, fieldnotes, September 1, 2018.
[40] Murray, fieldnotes, August 31, 2018.
[41] Murray, fieldnotes, August 31-September 1, 2018.

prospect of government intervention in biohacking in the form of FBI raids. [42]

Finally, speakers also demonstrated their positions on the relationship between biohacking and business. Lamenting the lack of grant funding available to biohackers, one speaker stated the need for biohackers to self-fund or adopt startup models.[43] When asked by an audience member if community labs were spaces for developing proprietary technologies, another speaker suggested that these labs should leverage startup and intellectual property culture. From his examples, however, it was not clear who was doing the leveraging. He noted that his community lab did not take a share of IP developed there and added, "you can get free labor, too." While at least one speaker claimed that biohacking had few monetizable applications,[44] it was clear that others disagreed, with one simply asking, "how can we get more value out of DNA?"[45]

Ramy, on stage as a representative of CCL and the Open Insulin Project, staked a position in favor of open source and against community laboratories as spaces for developing proprietary technology—Rolf, seated next to me, widened his eyes and murmured approvingly, "join our religion."[46] Later, offstage, Ramy admitted that she was not sure if that

[42] Murray, fieldnotes, August 31, 2018-September 1, 2018
[43] Murray, fieldnotes, September 1, 2018.
[44] Murray, fieldnotes, August 31, 2018.
[45] Murray, fieldnotes, September 1, 2018.
[46] Murray, fieldnotes, August 31, 2018.

was the Lab's official policy, though she would have liked it to be. She was slightly worried she had unilaterally declared it so on stage. Other CCL members seemed split on the subject, with at least one newly wondering if they were not supposed to be working on proprietary technology at the lab.[47] Among CCL members, however, Open Insulin members were—unsurprisingly—overwhelmingly in favor of the idea.

In what I found to be a particularly egregious example of start-up culture presence in the biohacking community, one speaker directly charted his path from biohacking to venture capital.[48] In describing his start-up company's mission, he lamented that existing gene therapies only focused on one percent of people. What about, he asked, the other 99%? Focusing on this target market had the potential to greatly expand the range of profitable therapeutics. In contrast to Ramy's advocacy of blanket open-source policies, others' noncommittal stances or willingness to strategically embrace the presence of start-up and venture capital operations in biohacking spaces, or the depiction of biohacking as passion-fueled and generally difficult to profit off of, this speaker said simply that he wouldn't be doing what he was doing were it not for his large ownership share.

In describing the company, he provided examples not related to diagnosable illness, but the example of increasing his own height. The

[47] Murray, fieldnotes, August 31, 2018; interview, April 3, 2019.
[48] Murray, fieldnotes, September 1, 2018.

vision he presented, as Yann pointed out, was transparently eugenic.[49] Frustrated, I tried to point out as much but ended up asking a flustered and rambling—though definitely accusatory—question. Wasn't, I asked, this a form of pathologizing what should be normal human difference? The speaker responded by reasserting the same rights to individual bodily autonomy that were so prevalent throughout BHTP, clarifying that he was merely interested in self-improvement, changing "unhealthy aspects" about himself.

In this instance, I felt the need to speak up as a social scientist concerned with histories of racist and ableist sciences and their rearticulations in postgenomic biomedical technologies. But I also felt the need to speak up as a member of the Open Insulin Project, who had been hearing feedback from other members as the conference unfolded. These other members shared my concerns with some of the overly ambitious "dreaming" on display, with putting highly consequential decisions in the hands of individuals, and with emphasizing autonomy to justify new—and yet disturbingly familiar—ways of capitalizing on DNA. Maria approached me approvingly after the session had ended, congratulating me on the question.

Staying close to Open Insulin Project members and other CCL and BioCurious affiliates during the event, their disagreements with many of

[49] Murray, fieldnotes, September 1, 2018.

the conference's goings-on were often clear. At times, they made their positions clear on stage or as questions posed to other speakers.[50] Through them, I was able to gain a better understanding of the tensions that existed between those who identified as biohackers, as well as some of the similarities: an anti-institutionalism that included a distrust of government agencies, as well as an interest in growing biohacking's scope and reach (in the case of Open Insulin members, through increasing the number of community labs). They embraced biohacking and its controversial brand with a healthy measure of ambivalence, and biohacking's edgy and contrarian culture had enough of a contentious steak to provide the space to air their—and my—concerns and criticisms. Biohackers—a brash, brazen, and irreverent bunch—were far from conflict-averse.

Global Community Bio Summits 2.0 and 3.0

I attended two consecutive Global Community Bio Summits—GCBS 2.0 and 3.0, as organizers called the second- and third-annual Summits—at the MIT Media Lab in Cambridge, MA. The digs were decidedly different from the Omni Commons' repurposed North Oakland sanitation workers' union building. The Media Lab Complex, which opened in 2010, occupies a corner lot on MIT's campus. All glass, chrome, and white, it

[50] Murray, fieldnotes, August 31, 2018.

features a large open atrium stretching multiple floors linked by zigzagging staircases and transparent elevators. For the Bio Summits, I followed signs indicating that the other attendees and I (see Figure 4) should ride these elevators to the sixth and highest floor, which featured several large, open rooms and an expansive balcony overlooking the Charles River and Boston on its opposite bank.

Figure 29. The group photo of participants at Global Community Bio Summit 3.0 (author pictured back left). Source: twitter.com/globalbiosummit

Compared with my experience at BHTP, the GCBS was organized more like a conventional conference. The introductory and concluding sessions and the main panels were conducted in the sixth floor's multipurpose room, dubbed the Golgi Room for Summit 2.0 and redubbed the Mitochondria for version 3.0. In between these, I had to make decisions about how best to plan my days and prioritize among overlapping sessions. I tried to attend those most in line with my interests

in the community, especially those directly relevant to Open Insulin. To this end, I often shadowed other CCL and Open Insulin members, attending sessions they attended or in some cases, organized. Most members of the Project, even those like Ramy and Yann who had other commitments to CCL or to projects aside from Open Insulin, considered the Project their highest priority.[51] Particularly after my experience at BHTP, I wanted to see how these members I had observed extensively in their day-to-day work on the Project interfaced with community bio.

Though there was substantial overlap between both speakers and attendees at BHTP and the GCBS, the emotional atmosphere of the GCBS was noticeably different. From the outset, GCBS 2.0 speakers and presenters focused on fun, hope, and positivity.[52] One speaker giving a presentation on the law assured participants that they didn't really need to worry about the it, since it tended to be boring and threatened to make community bio no longer fun—and anyway, the law was for bad people, not community biologists, who were good people. In this way, the same anti-regulatory sentiments present at BHTP manifested as an argument in favor of fun. Another speaker emphasized the important of finding ways to remain happy and positive.[53] Many engaged in high-flying emotional

[51] Murray, interviews, October 10, 2018; January 14, 2018.
[52] Murray, fieldnotes, October 26, 2018.
[53] Murray, fieldnotes, October 28, 2018.

rhetoric about how community biology stood poised to radically change the world and shape the future.[54]

At the event, Open Insulin members also evinced an emphasis on fun. Patrik said simply of community bio, "it's a lot of work, but if it wasn't fun, then we wouldn't be doing it."[55] One of Open Insulin's international collaborators, Khady, said of producing insulin in genetically engineered tobacco plants that it would be "fun, but also useful."[56] Near the event's end, Maria—who was also one of the event's organizers—simply asked me, "are you having fun?"[57]

At GCBS 2.0, several sessions focused on developing a "Statement of Shared Purpose."[58] A community organizer and leadership trainer led these sessions, based on principles from an experienced community organizer and sociologist. At the first session, in front of the bulk of the participants, organizers shared the initial draft of the statement of purpose, which they had prepared in the months leading up to the event.

The first draft of the statement read as follows:

> Statement of Shared Purpose (1.0):
> Our shared purpose is to fundamentally transform the life sciences so that its production, sharing, learning, and communication is accessible, inclusive, and sustainable, by organizing diverse global communities of citizen scientists and activists, and establishing a worldwide network of

[54] Murray, fieldnotes, October 26-28, 2018.
[55] Murray, fieldnotes, October 26, 2018.
[56] Murray, fieldnotes, October 26, 2018.
[57] Murray, fieldnotes, October 28, 2018.
[58] Murray, fieldnotes, October 28, 2018.

> community laboratories, projects, and shared technical and community resources.

When they shared this draft, the organizers announced that the whole group of attendees would continue to work on it over the ensuing three days. There were to be three smaller sessions to revise it, with attendees encouraged to attend one of these sessions to contribute. I attended the third and final such session, at which I sat beside Ramy at one of the circular tables in the Golgi. I gathered that several people, including Ramy, had attended one or both of the first two sessions. At this last session, roughly 50-60 people out of more than 350 total attendees had gathered in the Golgi Room to participate.

When the organizers developed the first draft of the value statement, they apparently had an easy time identifying the movement's goals.[59] In contrast, they found difficulty in describing who made up the movement and what its strategies were. One of the facilitators enthusiastically remarked that the Bio Summit was different from a typical conference in that it brought together people not based on who they were, but on their shared purpose and goals. The *what* was relatively clear, but the *who* and the *how* were more elusive.

Through the first two sessions, they had already produced a second draft of the statement, and they presented it with the significant changes in bold lettering [*sic*]:

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[59] Murray, fieldnotes, October 28, 2018.

> Global Community Bio Summit Statement of Shared Purpose (2.0):
> Our shared purpose is to fundamentally **transform the life sciences** and **democratize biotechnology** to **empower global communities** by organizing **life science change-makers** and **citizen-scientists**, inclusive of **marginalized** communities, by establishing a worldwide network, building community laboratories, delivering **local education**, designing innovative projects, and sharing resources.

Building on this progress, we who gathered in the Golgi were enlisted to help produce a third draft, which would be revealed to all the attendees on the last day of the conference. As the group provided feedback on these first drafts, some tensions manifested early. Someone brought up how the focus on production brought industry to mind, quickly adding that they didn't see anything wrong with that.[60] In response, Ramy, who had also attended the second session, whispered to me in a frustrated singsong: "no one's mentioning capitalism."

To further work on our contributions, we broke out into groups, where we were encouraged to work with people we had never met before.[61] Though we knew each other well, I followed Ramy as we formed a group of eight or ten, wanting to see if her whispered aside developed into a larger conversation. The facilitators provided us with three questions as prompts: "What is the goal?" "Who is in the community?" "What can we do?"—*What? Who? How?* Everyone around the table provided answers, and a

[60] Murray, fieldnotes, October 28, 2018.
[61] Murray, fieldnotes, October 28, 2018.

few responses came up repeatedly from different participants: making science more accessible, making change and being change-makers, and sharing resources—all of which were already in version 2.0 of the statement.

Seeing that Ramy had taken on more of a facilitation role, perhaps because she had already participated in an earlier session, I tried to provoke a little discussion: perhaps it would be helpful to approach these questions in the negative, to think about who was *not* in the community or what the community *wouldn't* do.[62] The other members seemed to receive these ideas positively, but they failed to gain much traction. The group continued trying to rethink the statement's language, tossing around different terms they wanted to see included.

A few hours later, after the conclusion of the workshop and during the Summit's closing session, the organizers unveiled statement 3.0. As of this writing, it remained the most recent draft, and artwork featuring it was displayed prominently on the Bio Summit's homepage (see Figure 5):

> Global Community Bio Summit Statement of Shared Purpose (3.0):
> Our shared purpose is to **fundamentally transform the life sciences** and **democratize biotechnology** to **inspire creativity** and **improve lives** by organizing **life science change-makers** and **bioenthusiasts** to build an **inclusive global network**, cultivate an **accessible commons of knowledge** and **resources**, launch **community laboratories** and **projects**, and **enable local educators**.

[62] Murray, fieldnotes, October 28, 2018.

Figure 30. Global Community Bio Summit Statement of Shared Purpose (Version 3.0) (Biosummit.org).

I was struck by the overall vagueness of the statement's language. What was a "life science change-maker," anyway? What did the community mean by "democratization"? Members of Open Insulin, I knew, had struggled to consistently define the terms and limits of their namesake value, openness, so when it came to guiding practices, I wondered what purpose this statement might serve. In an exercise focused on purpose and values, and in a room with apparent tensions and conflicts of interest heading into the activity, very little substantive or difficult discussion took place. Participants had largely worked to increase the scope of their common purpose to make it more accommodating and to find more appealing language to express it. Because the activity was about finding common ground among those interested in community bio, a large

group with diverse backgrounds, interests, and concerns, this outcome was perhaps inevitable.

The organizers' stated goal of the exercise was "to make explicit the implicit." The statement helped constitute the Global Community Bio Summit and community bio as a cohesive movement by applying to everyone present. This manifested in the one-size-fits all language of the statement, language that could apply equally to MIT, to startup entrepreneurs, to community lab bioartists, and to anticapitalist biohackers. The activity was about articulating a purpose that everyone could agree was common, rather than debating what the purpose of community bio should be. In this context, my small provocations made no sense, and neither did Ramy's criticism of what nobody was talking about.

The second thing I noticed was how little changed between the draft that organizers provided and the version produced at the end of the Summit. Even version 3.0 was supposed to be an incomplete work in progress, but when I attended the following Summit a year later, a poster of statement 3.0 was on display, the same "unofficial documentation" caveat in the lower left corner notwithstanding (see Figure 6).[63] Among the vague terminology, the most substantive change I noted was the inclusion, in version 2.0, of "marginalized communities"—and their conspicuously renewed absence from version 3.0. Overall, the statement of shared

[63] Murray, fieldnotes, October 28, 2018; October 11, 2019. This version of the Statement of Purpose was still live on the GCBS website as of the time of this writing.

purpose created the impression of debate and participation. This impression was also, as I interpret it, its main product. Through an activity fundamentally unconducive to conflict, any kind of substantive debate was effectively eliminated.

Figure 31. Statement of Purpose Version 3.0 on display at Bio Summit 3.0.

At GCBS 2.0, as at BHTP, much of the energy focused on questions of access and ways to increase it, with the underlying assumption that increasing participation was an end in and of itself that would transform the life sciences and improve lives. The kinds of participation that I observed, however, were limited. Whereas whispered asides to me at BHTP reflected conversations and tensions that I also saw manifest and be discussed onstage, those at the GCBS, like Ramy's frustrations, stayed

mostly on the margins. I observed very little overt disagreement or controversy, though there were subtler signs. As at BHTP, these were visible both in what speakers said on stage and what audience members said in their questions.

Perhaps most noticeable was the omnivory of perspectives and beliefs, with little need to reconcile differences between them. Speakers and sessions drew on Shinto, Native American, and other "non-Western" cosmologies and traditions.[64] Some speakers deployed these traditions to talk about respect for the earth and the need to save it, while others articulated the need to escape earth and build new, backup worlds in outer space. Many continued to discuss biology as analogous to coding and computer engineering, while others acknowledged that "open source bio" was deeply complicated and that adapting agreements from software would be inadequate to the task. There were many examples of describing biology as "the ultimate technology" and of the attendees changing the future, while many of the projects on display—including Open Insulin—sought to reproduce experiments, technologies, and protocols that were "simple" or decades old or to gain access to rudimentary materials and forms of equipment. Though we were in a building near the center of MIT's campus, in a room full of college degree holders (including a concentration of PhDs surely disproportionate to that of the general

[64] Murray, fieldnotes, October 26-28, 2018.

population), people repeatedly expressed disdain for higher education and its institutions.

As at BHTP, some tensions were clearer to me because of my position as a member of Open Insulin and closeness with its other members, particularly those involving capital interests and the pharmaceutical industry. Audience members loudly applauded the idea that "some people have too much money" but even more loudly applauded the event's corporate sponsors.[65] One speaker, speaking from a regulatory perspective, declared the need to distinguish "good commercial work" from people doing commercial work "for their own interest," while another speaker said that commercial enterprises were inherently trustworthy specifically *because* they would always operate in their own best interests and those of their shareholders. On the contrary, keeping with the theme of disparaging higher education, it was tenured academics we had to watch out for, like the one running the laboratory that reconstructed a horsepox virus—and in this case, like the speaker himself.

As an example, this speaker referenced the event's corporate sponsors, all of whom, as far as he knew, were "behaving responsibly."[66] At this, someone in the audience—I suspected, and later confirmed, that it was Ramy—cleared their throat loudly as an objection. The nature of this objection was that one of the sponsors, Takeda Pharmaceuticals, had a

[65] Murray, fieldnotes, October 26-28, 2018.
[66] Murray, fieldnotes, October 27, 2018.

controversial history surrounding Actos, a drug for the treatment of Type-2 diabetes (Pollack 2015). The company, along with its partner and co-marketer, Eli Lilly, was found to have concealed the risk of the drug to cause bladder cancer in patients. With approximately 9,000 pending lawsuits and at least one substantial judgment already against their favor, Takeda agreed in 2015 to pay $2.4 billion in settlements but neglected to admit fault. Still, Takeda and the other sponsors helped fund my and others' travel, food, and lodging to make our presence at the Summit possible.[67]

The incident left Ramy frustrated. As the Summit continued, she attempted to voice her concerns but seemed to be repeatedly passed over for questions.[68] At one point between sessions in the Golgi, she approached a couple of people she had seen speak. Together, they spoke solemnly for a long while about their unaddressed concerns. However, this conversation, and perhaps others like it, remained on the margins.

Yann came to the Summit hoping for a specific conflict.[69] Another project he was involved with at CCL had gone through a crisis after a foundation head who had been sponsoring them for several months decided to withdraw his support from Counter Culture Labs where the

[67] These other sponsors also included MilliporeSigma, owned by Merck, a pharmaceutical company with a history that includes both a price-fixing settlements (Bowers 2005) and a failure to inform both patients and investors about the heart risks of a now-discontinued pain medication (Pierson 2015).
[68] Murray, fieldnotes, October 27, 2018.
[69] Murray, fieldnotes, October 26, 2018.

project began, moving his support entirely to a lab in southern California.[70] He expected Yann and Julianne, the other scientist working on the project at CCL, to send their samples to their collaborator at this lab and notified them that they would no longer be getting funding from him for the project.

Understandably upset, Yann and Julianne both believed that this head was trying to use their work to start a company, and they were concerned that their fellow community lab member and collaborator in southern California had betrayed them.[71] To make matters worse, they had been unable to get in touch with him since they received the news. He was supposed to be at the GCBS, and Yann hoped to face him there and ask for an explanation. When he didn't show, Yann wondered how he could decide whom to trust moving forward. Clearly, trusting people because they were part of "the community"—as he referred to the network of community labs and amateur bioengineers—was unreliable.[72]

A final indicator of tension was an activity that summit organizers put together to illustrate the different ethical perspectives in the community, which would carry over from GCBS 2.0 to 3.0.[73] For this activity, organizers put up large sheets of paper and assigned them topics relevant to community biology. The organizers set up the sheets as a

[70] Murray, fieldnotes, October 15, 2018; October 17, 2018; interview, October 17, 2018.
[71] Murray, fieldnotes, October 15, 2018; October 17, 2018; interview, October 17, 2018.
[72] Murray, fieldnotes, October 26, 2018.
[73] Murray, fieldnotes, October 26, 2018.

spectrum, laying out three possible ethical stances—two extremes and a center—and asking that participants write their thoughts on post-it notes and stick them where they believed they fell (see Figure 7). Well into the second day, these sheets showed few signs of activity, with only a few sporadic contributions.

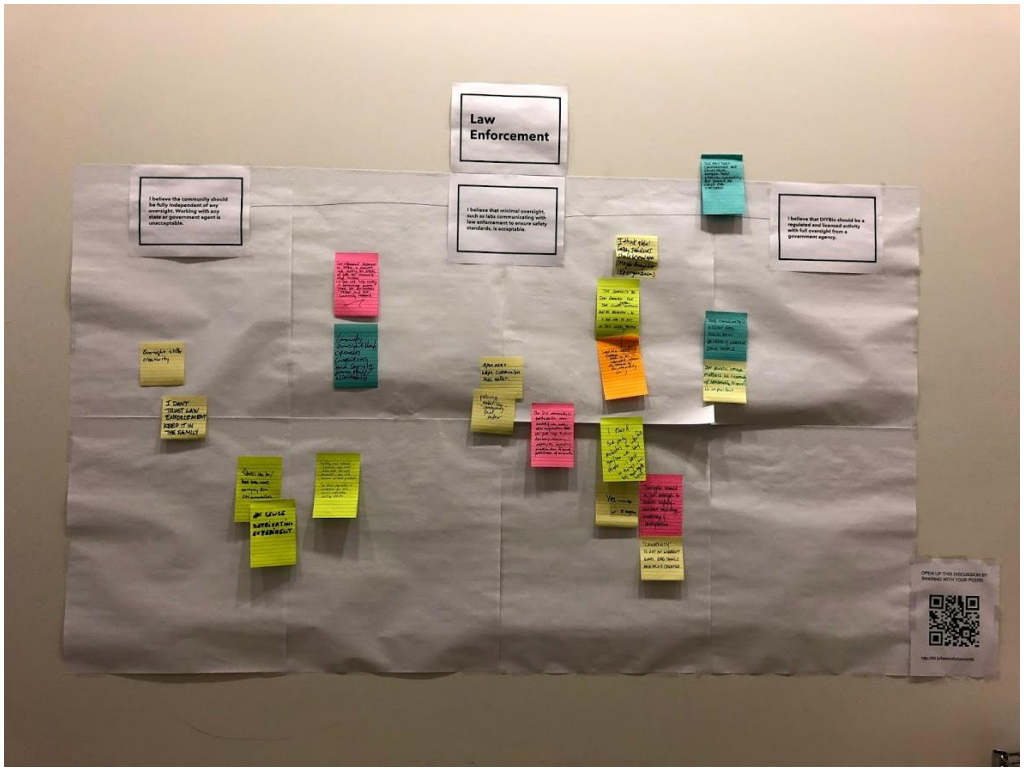

Figure 32. The "Law Enforcement" sheet of the GCBS 2.0 ethics activity at the end of the Summit (photo credit: Alex Pearlman).

Maria, who was on the Summit's organizing committee, encouraged me to post some of my thoughts to get the ball rolling.[74] I followed her suggestion, again attempting to provide provocations. Whether my contributions helped spur others to contribute their thoughts I can't be

[74] Murray, fieldnotes, October 27, 2018.

entirely sure, but by the end of the third day, there were many more post-its on the walls. Interestingly, several posters had defied the constraints of the activity, posting comments on the bare walls and off the spectra altogether (see Figure 8). These comments outside the confines of the activity as structured demonstrated that people had opinions to voice on community values that organizers failed to anticipate in planning the activity. These opinions existed, now quite literally, on the margins. As such, they had potential as an interesting starting point for a discussion about the range of values and opinions in the community. These questions were not brought to the center of attention at GCBS 2.0, but they were photographed, archived, and used as a partial foundation for an ethics activity the following year.

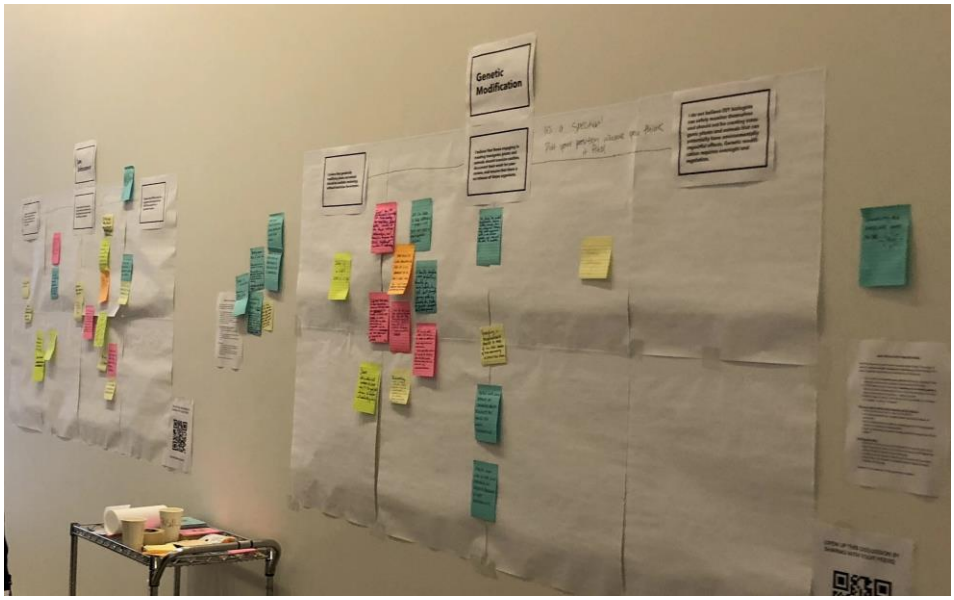

Figure 33. The "Law Enforcement" and "Genetic Modification" spectra at the end of GCBS 2.0. The post-its on the wall off to the posters' sides have no clear space on either spectrum.

There was a shadow cast over GCBS 3.0. The tensions that were murmurs before became louder. Just a month before the Summit, a scandal rocked the MIT Media Lab. The Media Lab had accepted money from and at the request of Jeffrey Epstein, a financier who had recently committed suicide in prison after his indictment on child sex-trafficking charges (Tracy and Hsu 2019). In this revelation's wake, the Media Lab's director resigned.[75] At the GCBS, I learned that several sponsors had withdrawn their support, including Takeda just a week before the event.[76] This resulted in a shortage of funding, including funding for the travel awards that had helped me and other Open Insulin members pay for our cross-country flights the previous year.

At the Summit, one of the walls that hosted the ethics activity at GCBS 2.0 was dedicated to a large banner for MilliporeSigma—one of the sponsors that did not pull their support (see Figure 9). Across the hallway at the registration tables, many nametags went unclaimed, indicating a much lower than anticipated turnout (see Figure 10). Side by side, this banner and these unclaimed nametags reflected both community bio's dependence on corporate sponsorship and funding and the principles of

[75] As of the time of this writing, this position had not been filled, though the Media Lab did initiate a search in June 2020 (Maes 2020).
[76] Murray, fieldnotes, October 11, 2019.

community members unwilling to accept sponsorship and funding from just anywhere.

Figure 34. The large Millipore Sigma banner at GCBS 3.0. The banner is in front of the same wall that hosted the GCBS 2.0 ethics activity posters pictured in Figures 7 and 8.

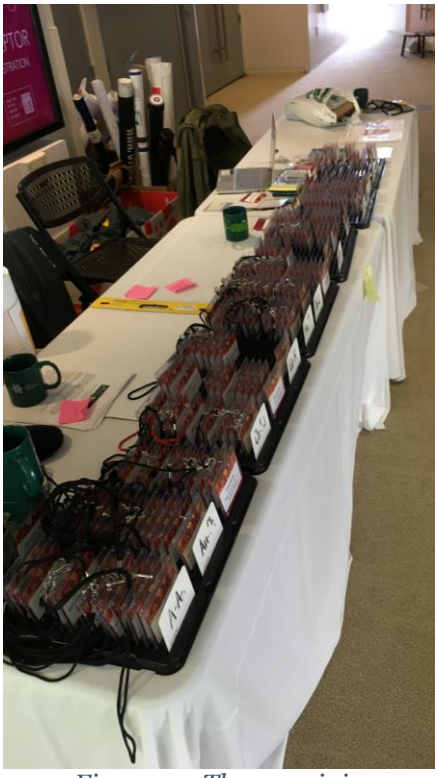

Figure 35. The remaining unclaimed nametags and lanyards at registration on the third and final day of GCBS 3.0.

The introduction to GCBS 3.0 infused the enthusiasm of the previous year with an ominous undercurrent. One early speaker emphasized the wonder and magic of the Media Lab while contrasting it with what he called human nature's dark side.[77] Statements about the Epstein incident were brief, but they lay bare many participants' conflicted

[77] Murray, fieldnotes, October 11, 2019.

partnership with the institution and its relation with community bio. These comments suggested that the answer to the question of whether participants should trust the Media Lab was not *yes* or *no,* but more complicated; that the issues the Media Lab had were systemic; and that participants had to work to identify institutional blind spots and to leverage the power of institutions for good.

Looked at cynically, the Media Lab was doing damage control. However, even if only to do effectively and come across as authentic and believable, Media Lab representatives needed to implicate themselves as part of the problem and state a desire to change the game from within. Whether or not they were successful, Anthony reacted positively to the shift in participation between GCBS 2.0 and 3.0, noting that anyone with a reputation they might endanger had steered clear after the Epstein scandal: "it feels more grassroots because it's almost like anyone who had a reputation to care about is gone."[78] In this, he compared it more favorably to Biohack the Planet.

The limitations of these comparisons, however, were apparent as organizers also unveiled a new code of conduct. Notably, this code included "a strict ban on stunts like self-injecting," along with a stern warning: "This is not empty rhetoric. We have removed participants from this event before. We will remove participants again from this event if

[78] Murray, fieldnotes, October 12, 2019.

necessary."[79] The seriousness of this warning clashed sharply with the overall positive attitude of the previous year and much of the rest of the Summit. Until this point, I was not aware that any participants had been removed. Organizers also emphasized that they would be strictly enforcing the requirement to wear our Summit lanyards and badges, particularly in the hands-on workshops. I noticed "registered attendees only" signage in the Media Lab lobby and didn't recall the language being present the year prior.

Speaking with Maria, I learned more about what was going on under the now-noticeably tense surface of the Summit. Regarding the code of conduct, she said that someone had been removed from GCBS 2.0, and that someone had already nearly been removed at 3.0.[80] I also learned that the Summit had planned a strain exchange of biomaterials. Participants were to send in their strains in advance, and the GCBS would serve as a central hub facilitating their exchange and shipping them back out. Apparently, the Media Lab grew concerned about the risks of this exchange just before the Summit—it was unclear if this was also a result of an increased sensitivity to optics and controversy—and called it off. Still, Maria said, there was an informal strain exchange happening. Multiple participants had traveled with plasmids and strains, which she emphasized was precisely what organizers were trying to avoid in the first place.

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[79] Murray, fieldnotes, October 11, 2018.
[80] Murray, fieldnotes, October 11, 2019.

One of the event's participants provided me with some more insight into the Media Lab's relationship with the community bio movement and its handling of controversy.[81] His interpretation of the relationship was decidedly two-way. Some in the community bio movement were interested in and attracted to the power and prestige of institutions. Going back to the first GCBS, people in a community that had largely been spread out or remote to that point were able to network and form interest-based groups on MIT's campus. The amateur bioengineers got access to MIT's prestige and resources. This begged the question, "what does MIT want with all these biohackers they would never accept into any of their main programs?"

The answer, he told me, lay in the Media Lab's business model. This business model was attracting donations from corporate sponsors and wealthy individuals who were, relatively speaking, scientific laypeople.[82] The Media Lab raised funds by showcasing inspiring and innovative science in what he called "science by press release." In many cases, he quipped, this science was "all just hype and TED Talks." A second, smaller Media Lab scandal that had also emerged in the weeks prior to GCBS 3.0 provided an example. Reports indicated that another Media Lab project, OpenAg, which had indeed established itself via a 2015 TED Talk, had made exaggerated and false claims to corporate sponsors, including the

[81] Murray, interview, October 11, 2019.
[82] Murray, interview, October 11, 2019.

retail giant Target (Cohen 2019). Community bio, then, was a way for the Media Lab to present itself to funders and sponsors as at the cutting edge of something, an inspiring, feel-good movement to, as MIT Media Lab members repeatedly emphasized at the GCBS, "change the world." It was, in other words, a branding decision.

This branding decision was not without risks. The Media Lab, my interlocutor explained, wasn't sure that it would be able to sell the idea of community bio.[83] The type of biohacker publicity stunts that often attracted the most attention were also magnets for controversy, something the MIT Media lab did not need or want, especially in the wake of their recent scandals. But perhaps even more fundamentally, in many cases, it was supporting a movement that conflicted with the Media Lab itself. As my interlocutor put it, again describing trying to make sense of the first GCBS, "these were people that have all the tools in the world bringing together all the people that are trying to build tools for everyone in the world."

It wasn't clear that these disparate interests would or could be reconciled, but in the meantime, community bio as a movement was being co-constituted and branded by both the MIT Media Labs and participants who were skeptical of its interests and desired to challenge its model. With the Media Lab setting many of the terms for participation, it could be

[83] Murray, interview, October 11, 2019.

harder to see the forms of skepticism and resistance. This was especially true at GCBS 2.0, but in the wake of controversy and scandal, these forms became more visible as the Media Lab's compromised position created the need to more directly address how the institution was implicated in some of the systemic issues in biocapitalized technoscience.

These newly evident tensions formed the backdrop for the follow-up to the previous year's activities: a series of three ethics workshops patterned after the previous year's statement of purpose workshops and derived from the ethical spectrum activities. Leading up to this activity, the audience displayed a difference between BHTP and the GCBS; whereas someone at BHTP had loudly booed the first mention of bioethics, here the audience cheered as the organizer, Alex Pearlman—a trained bioethicist—exclaimed, "ethics is not where you should step back. This is the place where you have to step up."[84] Pearlman confirmed this difference: "I would not have done this activity at Biohack the Planet…. I felt the audience at Bio Summit is much more willing and able to share experiences, and it's such a participatory event that I knew this was the right place for something like this."[85] Indeed, Pearlman had been brought on board at the Media Lab as a research affiliate due to a shared interest in pursuing ethics research in amateur bio.

[84] Murray, fieldnotes, October 11, 2019.
[85] Murray, interview, November 5, 2019.

In preparation for the GCBS 3.0 activity, Pearlman sourced multiple codes of ethics that could apply to community bio and reviewed the previous year's ethics spectra to try to grasp the community's ethics. Summit organizers met in the days leading up to the event to lay some of the groundwork for the activity. These participants identified four ethical subject areas based on their own experiences in community bio—"Open Access to Science and Knowledge," "Transparency," "Rights and Sovereignties," and "Education"—and tried to develop a list of "dos" and "don'ts" for each.[86] This exercise served as a sort of test run for the workshops at GCBS 3.0, which would significantly increase the scope of participants and subject areas.

Like the previous year's statement of purpose sessions, this activity aimed to discover the community's existing ethical principles and concretize them, in this case into community bio's own code of ethics. As a result, the activity risked the same shortcomings that the previous year's activities faced: too much prompting from the outset, too much encouragement to find common ground, too little productive conflict, and a resulting avoidance of the depth and nuance of key constitutional questions. As Pearlman later noted, the assertion of shared ethics and values was itself a disincentive to participate in activities to articulate them.[87] At the same time, she understood the workshops' methods as

[86] Murray, fieldnotes, October 13, 2019.
[87] Murray, fieldnotes, October 13, 2019.

innovative for bioethics, likening them to ethnography and even describing the activity as "hacking ethics."[88]

I attended multiple ethics workshops this time around, curious to see how they would play out in the changed atmosphere of GCBS 3.0. From the outset, the workshops were more contentious than those I had experienced the previous year. Branching off from the categorized ethical principles with which Pearlman and the other organizers had worked, differences emerged in priorities. The previous year, the *Who?, What?,* and *How?* of the Statement of Purpose were answered with a tendency toward breadth and accommodation, drawing on and reinforcing that event's atmosphere of relentless positivity. Especially in the noticeably tenser atmosphere of GCBS 3.0, the requirements of developing a code of ethics provided more space for dissent and disagreement. This conflict allowed participants like Yann to assert that profit-seeking was fundamentally unethical—and to receive pushback on that assertion.[89] It allowed other participants to assert the importance and indispensability of bodily autonomy and freedom from government regulation and others to assert the importance of community—as opposed to individual—autonomy and adherence to federal biosafety guidelines.

While openness and inclusivity had served as the foundations for convening a group under the banner of community bio, it became clear

[88] Murray, interview, November 5, 2019.
[89] Murray, fieldnotes, October 13, 2019.

that defining this group's ethical principles could not simply be a matter of finding common ground. This group shared a common interest in doing biology and increasing access to doing biology. At GCBS 2.0, organizers asserted that this *what* of community bio was relatively plain from the outset.[90] At that event, the more difficult *who* and *how* questions were answered broadly and tentatively. GCBS 3.0 proved that these answers would be insufficient as foundations for building a community code of ethics. Instead, the questions resurfaced.

This resurfacing was most clear during an ethics panel that Pearlman moderated between workshop sessions.[91] Here, the relationship between establishing a code of ethics and determining the bounds of the community became explicit. One participant, discussing the development of a code of ethics, noted that they were able to do it because they had a well-defined community: in this case, a human augmentation-focused group of biohackers. In contrast, community bio was much broader and had the potential to splinter. Put simply, the desire to create a community code of ethics first required a satisfactory answer to the question, "who is the community?"[92]

The ethics workshops resulted in another large collection of post-it notes, and I joined a volunteer group attempting to sort and categorize

[90] Murray, fieldnotes, October 26, 2018.
[91] Murray, fieldnotes, October 12, 2019.
[92] Murray, fieldnotes, October 12, 2019.

these following the third workshop session.[93] What was supposed to be a single short session ultimately consumed about six hours as our relatively small group—a few people came and went to and from other GCBS activities, but the group ranged from just four to eight people at any given time–worked through the themes that emerged in the ethics workshops and discussed how we might turn them into a code of ethics. As had been true with the Statement of Purpose the year prior, the results of the activity were additive. The proposed ethics had proliferated, and to complicate matters, many of these were in tension with one another. Others took a meta approach, recommending establishing and clearly communicating values as ethics in themselves.

Ultimately, we decided that the best way to proceed was to produce a list of questions.[94] These questions were available on the GCBS website alongside the Statement of Shared Purpose 3.0, as "Community Ethics Document 1.0" (GCBS 2020). The list of questions was, in effect, a way of extending this ethics workshop. The idea was to provide the opportunity for individuals, community labs, and projects to answer the questions for themselves, laying the groundwork for their own codes of ethics and for future discussions about ethics in the greater community bio sphere. It dispensed with the notion that everyone gathered at GCBS held common

[93] Murray, fieldnotes, October 13, 2019.
[94] Murray, fieldnotes October 13, 2019.

ethics and instead sought to create a better picture of the range of ethics and values among participants.

At the event's close, we who had helped to catalogue the data from the ethics workshops took the stage and shared our results.[95] We discussed the reasoning behind the list of questions that we had produced and our hope for the activity before taking turns reading the questions aloud. By chance, it fell on me to read a question whose inclusion we had weighed heavily: "How do we decide what acceptable funding sources are?" At this, most of the audience was silent, except for one person, who let out a loud, drawn-out, and disappointed, "awwwww." This time, I wasn't at all sure who it was.

Branding Bioengineering, Bioengineering Ambivalence

Understanding bioconstitutionalism as branded helps capture several important features of how the bioconstitutional developments of amateur bio played out over the course of my fieldwork. Self-identified biohackers, after becoming the subject of controversy and scrutiny, generally maintained their commitments to the rights of individuals and to provocative radicalism. Biohacking as on display at BHTP was fractured and volatile, but it also provided space for airing dissent and disagreement. On the contrary, ambiguity and agreeableness were

[95] Murray, fieldnotes, October 13, 2019.

fundamental features of community bio's participatory cultures. At GCBS, liberal democratic values served as ambiguous signifiers, the content of which could be open to interpretation and supplementation, helping to maximize the scope and number of participants. Tensions were kept in check and ambiguity and safe politics protected by "structures of feeling" (Banet-Weiser 2012, following Williams 1961) that encouraged positivity and fun, tendentially producing certain modes of participation and empowerment while discouraging others.

As is typical of branded politics (Banet-Weiser 2012), the need to attract a large number of participants—underwritten by the MIT Media Lab's corporate sponsorship-focused funding model—resulted in a movement that selectively encouraged certain forms of participation and tended toward the relatively safe and agreeable; indeed, in this case, the emphasis on biosafety and discouraging wayward biological experimentation made the politics of safety quite literal. In an apparent tradeoff for the ability to both influence and benefit from the emergence of a potentially anti-establishment bioconstitutional trend in the biosciences, established biotechnological institutions like the MIT Media Lab and its Community Biotechnology Initiative helped provide a platform for projects like Open Insulin that often broadly opposed them. This created an atmosphere of tension and ambivalence in which those with apparently contradictory aims coexisted and built a movement together.

For a time, this strategy seemed to effectively suppress dissent and conflict. At GCBS 2.0, tensions were often subtly present and mostly visible to me through my status as an Open Insulin member shadowing its other members. Despite their disagreements with many of the goings-on of GCBS 2.0, these other members continued to participate for the networking opportunities that it provided. Only at the event's margins did they initiate conversations that questioned the emergence of the community bio movement even as they contributed to it. The events leading up to and during GCBS 3.0, however, shifted the balance of power in a way that made intragroup tensions and ambivalence more evident and created the possibility for more constructive conflict between and among organizers and participants. The Media Lab's funding scandal forced organizers and Media Lab representatives to address expressly some of the systemic issues the institutionalized biosciences. The different atmosphere that resulted shook up the dynamic of community bio and allowed the Summit's ethics activity to address some of these same systemic issues—perhaps even demanded it.

This framework helps explain the mutual interest of established biotechnological institutions and antibiocapitalist activists in amateur biology movements and to reevaluate the prospects for participatory governance and sociotechnical change in the postgenomic bioconstitutional era. As both a member of the Open Insulin Project

and an ethnographer, I played a significant role in the workshops shaping community bio. This dual role allowed me to observe more easily some of the latent tensions within amateur bio. But there were also tensions between my two roles—participant and observer—in both the Project and the broader movement. The work of navigating these tensions and inhabiting this dual role is the subject of the final chapter.

Chapter 4

Hacking Sociology[1]

> "Members of the community are open to collaboration. A spirit of generosity in our interactions and the sharing of information across institutional and professional boundaries are fundamental to our community and our work. We're receptive to constructive comment and criticism from people of all backgrounds, as the experiences and skill sets of all members constitute valuable contributions to our efforts."
>
> - "Open Insulin Project Initial Resolution on Operating Procedures"

Open Insulin members anticipated that the process of developing the organization's new bylaws would take a few weeks. Instead, it was taking several months, and well into the process, it was still not clear when the bylaws would go into effect. It was also unclear, given Open Insulin's casual atmosphere and open-door policies, how strictly the organization would stick to the letter of its own law. The decision-making procedures as laid out in the tentative bylaws began to both restrict and formalize Project membership. Previously, decisions had been made by the people in the room on the basis of the principle of *do-ocracy*.

Do-ocracy, inherited from open-source software and hackerspaces, put decision-making power in the hands of participants. Volunteers who showed up to Open Insulin chose their own roles and responsibilities,

[1] I must especially thank my collaborators in the Project's "Open Insulin in Society" working group for their contributions to our discussions that have inevitably permeated my thinking in this chapter. These collaborators especially include but are not limited to the several other social scientists who made the Open Insulin Project a field site during the course of my own fieldwork.

though they often did so at the suggestions of the group's core members, who took it upon themselves to assess members' experience and interests and to find ways in which they might contribute. In this way, people with wetlab experience might be incorporated into the ongoing wetlab work at Yann's direction, or those with software experience might be tasked with figuring out how to get the software needed to get the HPLC up and running.

As a sociologist, my experience did not seem as readily legible to these existing group members, at least not in a way that could be immediately applied to the Project. My most visible skill was notetaking, which I could rarely apply to Open Insulin's day-to-day recordkeeping, as I was taking my own fieldnotes throughout meetings. These notes would have sorely disappointed members looking for a quick recap of a missed meeting. Over the course of my work with Open Insulin, I took on several different roles, in mostly ad hoc fashion. I helped prepare and proofread a few grant proposals, which were only written and submitted sporadically. As other members did, I took some turns preparing agendas and facilitating weekly meetings. I tabled for Counter Culture Labs and Open Insulin at a local North Oakland street fair. On a couple of occasions, I helped out in very minor ways with lab work, which I aspired to do out of an interest to learn more about the wetlab portions of the Project. For a while, I helped to coordinate and schedule the Project's international calls,

which had fallen off a bit when I first came to the Project. As someone pursuing interviews with Open Insulin's international collaborators, I made sense as a point person.

During my first year and a half or so with Open Insulin, this international facilitation role was the closest I came to a regular role within the Project. This, however, was not uncommon among members, many of whom moved between different roles and tasks either as the Project demanded, as project leaders—typically *de facto* or by virtue of tenure length and consistency—suggested, or as their interests changed and developed. Some established or settled into these roles and took them on more permanently. Some, like me, did not.

As an ethnographic sociologist walking the lines between participation and observation, I felt myself being pulled by multiple forces as I established my place in the Project. At least at the outset, I wanted to understand Open Insulin's motives and operations without affecting them too much, a classic ethnographic dilemma. At the same time, I had no illusions about the fact that my presence there was bound to alter the Project. I had reservations about sharing my thoughts too much with members, especially before I felt they were well informed and well formulated, but I was happy to provide my thoughts and perspective when asked or when I felt it was necessary. I was deeply sympathetic to the Project's aim of supplying insulin to those who could not afford it from

extant manufacturers, but I wanted to avoid filling a simply instrumental role in the Project that merely deployed my ancillary skills while not relating to my research and primary occupation as a sociologist. I wanted to understand how social science could play a role in the Project while positing that its incorporation would challenge both social science as I knew it and the Project as conceived.

When drafting the bylaws, Project members needed to find a way to translate Open Insulin's informal, do-ocratic approach into formalized rules. This translation was not straightforward; like the other instances of Open Insulin's loose, often tacit structure encountering the demands of established institutions (see Chapter 2), it produced disagreements and put the group's identity and resolve to the test. The membership rules that Anthony drafted and brought up for discussion included a distinction between basic members and full members of the Project. Full members of Open Insulin had voting rights and had to meet certain requirements. Chief among these was participating in one of the Project's working groups that were being formalized at the same time and were intended to reflect the way the group's work had diversified and specialized: Science, Legal, Financial, Communications, Grant Writing, and Crowdfunding.[2] Full members would be required to work either in these working groups or "on

[2] "Open Insulin Working group list," accessed May 28, 2020.

the business of the Corporation" for at least five hours each week including meetings and five hours each week excluding them.[3]

I had been working with the Project for over a year and a half by this point, and this was the first time any kind of distinction arose between types of members. In my experience, those who came to the Project for even more than one meeting were readily accepted as members. Now, with a distinction between full and basic members, I became concerned that an organization I thought was happily making space for me and my work as a Project member would render it invisible. My belief, reinforced by Open Insulin members' embrace of my presence throughout the course of my fieldwork, that my work was useful and interesting to the (other?) Project members came up against these new requirements. I was not a consistent member of any of the working groups being sketched out, and while I easily spent five hours per week on work related to Open Insulin, this work of observing, interviewing, and theorizing did not have clear or consistent deliverables.

I became concerned that my work was not legible enough within the Project as it was taking shape. I was interested in bringing social scientific theory and methods to bear on a Project that was pursuing social justice and challenging institutional science in provocative and interesting ways, and I hoped that this interest was mutual. Crossing the typical

[3] "Open Insulin Bylaws Working Notes," accessed May 28, 2020.

institutional expertise divides between lab work and the other necessary work of science was one of the Project's most interesting qualities, which was at least somewhat threatened by the new divisions into conventionally focused working groups. What was my role as a sociologist working within the Project? Was I more observer—even if a welcome observer—than participant?

Introduction

This final chapter is about methods. While perhaps a bit unorthodox to place a methods section at the end, studying with the Open Insulin Project entailed ongoing methodological discovery—as perhaps all projects do—that continued through the time of this writing. Other Open Insulin Project members were figuring out how to assemble and tinker in makeshift biological laboratories. As a social scientist in this space, I was also recruited into this experimental tinkering. As expected, I faced the typical navigations of qualitative sociological fieldwork: gaining access to the field site, building rapport, establishing my role as a participant-observer, and requesting and conducting interviews. In addition, I faced challenges related to working in an "open," experimental, participatory space in which the engineers framed and understood their work as deeply social:[4] reconciling a participatory mode of knowledge production with

[4] This was true even if they tended to overemphasize their work's technical dimensions (see Chapter 2).

Open Insulin members' expectations for participation, deciding when and how to contribute to and intervene in the course of the Project, squaring my emerging theorizations of the Project with its other members' own theorizations, and deciding when and how to share my work with other Open Insulin members. As time went on, these were challenges that I faced alongside other social scientists who conducted fieldwork with Open Insulin and Counter Culture Labs. These experiences held useful lessons for establishing the role of the social sciences and social scientists in the emerging field of amateur bio.

Outside of these community lab spaces, other social scientists working alongside synthetic biologists have also approached the emergent field as an opportunity and a forum for developing new methods of collaboration between the social and natural sciences (e.g., Calvert and Martin 2009; Rabinow and Bennett 2012; Balmer et al. 2016). Typically working closer to the core institutions of biocapital, for example in research collectives at the intersections of academia and industry, these efforts have focused on synthetic biology's status as both a novel biotechnological field with controversial potential and an unusually receptive domain to forming close working relationships between social and natural scientists and engineers. Some have cited the prospects of amateur biology as a special justification for increased capacities for addressing the social dimensions of synthetic biology (e.g., Rabinow and

Bennett 2012). If the goal of synthetic biology is to make biology more readily engineerable, the decreased learning curve and increased access to bioengineering is a predictable outcome sure to have significant—and significantly less predictable—results.

As a participant-observer with the Open Insulin Project, I attended, documented, and participated in hundreds of meetings, an average of 1-2 each week for nearly three years in total; conducted and transcribed 30 recorded semi-structured interviews, in addition to many more informal and largely unstructured interviews, with Project members and affiliates; attended biohacking and community biology-related conferences alongside other members (see Chapter 3); and spent many more hours attending, observing, and participating in daily happenings and other projects based out of Counter Culture Labs, accumulating hundreds of pages of detailed fieldnotes in the process. Over the course of this fieldwork, I developed an understanding of the unique opportunities the Open Insulin Project presented for ethnographic participant-observation, particularly as it compared with its supporting institutional counterpart, synthetic biology. Through its focus on equity, justice, and alternatives to capitalized biomedicine (see Chapter 1), the Open Insulin Project provided both unique opportunities and challenges for developing—or hacking, if you like—collaborative social science approaches. These opportunities and challenges encouraged the development of new roles for myself and the

other social scientists within the organization and often challenged both us and the other members of the Project to reevaluate our own roles and responsibilities within the group and beyond, as concerned biological citizens, knowledge producers, technologists, and hackers.

Collaborative Methods at Scientific Crossroads

The role of the social sciences in the postgenomic biosciences has been largely informed by the Ethical, Legal, and Social Implications (ELSI) Program of the Human Genome Project (HGP) (see NIH 2019). Established in 1990, ELSI enshrined the participation of social scientists in genomic research, a precedent that has extended to other forms of postgenomic technoscience. Famed geneticist James Watson first proposed ELSI during a press conference, and it became the largest publicly funded bioethics program in history, at five percent of the HGP's total budget (Jasanoff 2005). In 1997, the ELSI Working Group, which to that point had operated relatively independently of broader institutional imperatives, was dissolved, and ELSI was implemented across the National Institutes of Health (NIH) (Jasanoff 2005; NIH 2010).

NIH support for the ELSI program became a model for both similar institutions around the world and other forms of technoscience outside of biotechnology and biomedicine, including nanotechnology. The "ELSI-fication" (Williams 2006) of science helped fund groups of experts in

ethics, law, and the social sciences and place them in close working proximity with natural scientists and engineers. Scholars, however, have criticized the ELSI framework for its relegation of its titular concerns to the status of "implications"; that is, it embraces both a linear model of innovation and a familiar, artificial separation of science from society that places so-called social concerns downstream, secondary in both temporality and significance (Williams 2006; Balmer et al. 2015). Implicitly, this operates on a deterministic model that privileges the supply side of technoscientific production.

Several more specific criticisms of ELSI models stem from this positioning of chiefly negative social concerns downstream. Regarding ethics, law, and society as external to science proper resulted in the perception—or worse, the enactment—of ethics, law, and society as bureaucratized hurdles to clear on the way to scientific progress. By tending to focus on avoiding or mitigating negative implications or potential for harm, the application of ELSI further oversimplified processes of technoscientific development and dissemination (Balmer et al. 2015). ELSI-fication also produced the expectation that experts in these ELSI areas were responsible for these areas, removing the burden of self-reflection from scientists themselves, some of whom became dismissive of or even openly hostile toward ELSI. For example, ELSI in the United States often failed to be taken seriously at the highest levels of NIH and the

HGP, a relationship not helped by the perception that the five percent of funding devoted to ELSI was being funneled away from research (Jasanoff 2005). Finally, and relatedly, the presence of experts in these ELSI areas threatened to become a stand-in for public representation and by extension, for adequate ethical, legal, and social accountability and due diligence, at least as far as funders were concerned (Balmer et al. 2015).

Over the decade following ELSI's implementation in the United States, its capacities to meet its *raison d'etre,* safeguarding public interests by delivering benefits and anticipating adverse effects of genomic technoscience, diminished significantly (McCain 2002). Instead, ELSI became more subservient to private interests. Rather than helping to shape research agendas, ELSI tended to delay their technological development. In effect, the perception of ELSI as an obstacle to technoscientific progress was less a misapprehension on the part of scientists than an outcome that both stemmed from and exacerbated ELSI's lack of integration into—and thereby, transformational influence on—technoscientific research programs. While ELSI programs increased the number of social scientists receiving funding to work in close proximity with natural scientists and engineers, they often found themselves frustrated by the expectations of institutions and their would-be collaborators.

Those frustrated included those working in the emergent postgenomic field of synthetic biology. Synthetic biology emerged ambitiously, promising to develop biology into a true engineering discipline, something that conventional bioengineering was too imprecise to accomplish (see Roosth 2017). Seeing an exciting new field with transformational potential, some social scientists specifically approached collaboration with synthetic biologists as an experimental method.

Rabinow and Bennett (2012) worked experimentally for several years as leads of the Human Practices division of the Bay-Area synthetic biology organization Synberc, designing Human Practices as an explicitly "post-ELSI" approach. They understood their role as thinking more expansively about the relationship between science and society than ELSI frameworks allowed. During their years of work on the project, they were frustrated on several fronts. They found that the scientists at Synberc rarely expressed much interest in their work or in collaboration, due in part to their multiple funding sources and obligations beyond the single funded project of which Rabinow and Bennett were a part. Eventually, Rabinow was suddenly and unexpectedly removed from his position in favor of someone pursuing more legible work in the area of biosafety. While synthetic biology provided Rabinow and Bennett with promising avenues for developing collaborative methods, they found themselves stymied by both culture and institutions. In other words, the difficulties

that they faced in their post-ELSI experiment recalled the limitations of working within the ELSI model.

Others have been more optimistic about forging new working relationships between social scientists and synthetic biologists. Jane Calvert (2013a) identified synthetic biology as a promising area for this research first because of its status as a hybrid discipline at the intersection of biology and engineering. While this alone does not set the field apart from other contemporary technoscientific developments, synthetic biology's champions also demonstrated that they were "heterogeneous engineers" (Calvert 2013b, following Law and Callon 1988) that is, they were skilled at bringing together technical and social forces, consciously building communities as well as technologies. This skill evinces an understanding within synthetic biology that technoscience and society are fundamentally interconnected, an understanding that both echoes the wisdom of science and technology studies and runs counter to many of the assumptions of the ELSI model. On top of this, some prominent synthetic biologists have shown themselves to be not only interested in, but familiar with the social sciences, including science and technology studies (see Roosth 2017).[5]

[5] When Sophia Roosth first approached Drew Endy, a founder of synthetic biology and collaborator of Jane Calvert's, he invoked and praised Paul Rabinow's work: "Pulling a paperback copy of Paul Rabinow's *Making PCR* from his bookshelf, he told me that if this was the sort of book I wanted to write, then I had full access to his laboratory" (Roosth 2017:180).

For this reason, social scientists working adjacent to synthetic biology identified the field as a promising space for developing "post-ELSI" modes of social and ethical engagement. Calvert and other social scientists in the UK placed special emphasis on defining the role of social scientists in synthetic biology. Arguing that synthetic biology is a hybrid "field in the making" (Calvert and Martin 2009:201) whose practitioners espouse an atypical awareness of the ethical and social dimensions of their own work, these scholars have taken the opportunity to examine and theorize forms of engagement between the social, natural, and engineering sciences. As the embrace of the constitutionalist language of rights and citizenship provided a way to move past rigid, bureaucratized versions of ethics especially (though see Chapter 3) the intent behind "post-ELSI" is to more fundamentally integrate social concerns and those who specialize in them into processes of technoscientific research and development. Calvert and collaborators (Balmer et al. 2015) theorize a "collaborative turn" away from the ELSI-based forms of working together that they identify, by contrast and following Rabinow and Bennett (2012), as cooperative rather than collaborative.

Calvert (2013b), focuses on collaboration between social and natural scientists as a research method in its own right. Calvert identifies the way that she was "swept up" into synthetic biology after being approached by synthetic biologists who needed a social scientist to meet

funding requirements for an ELSI component. Calvert and other social scientists working with synthetic biology in the UK theorized the different capacities and relationships that they experienced in collaborations with synthetic biologists (Balmer et al. 2015). Several of these roles for social scientists maintained the limitations of the ELSI model and were largely shaped and imposed by the synthetic biologists: "public representatives," who stand in for society writ large; "foretellers" who anticipate downstream outcomes; dutiful, gossiping, trophy "wives," with all of the gendered power disparities and emotional labor burdens that the title implies; and "critics," as a naysaying, suspect presence in the perception of synthetic biologists (see Fortun 2005).

On the other hand, some of these roles suggested possibilities beyond the limitations of the ELSI model: "critics"—in the social science tradition of critique—and "tricksters" who complicate, breach, and destabilize; "reflexivity inducers" who push synthetic biologists to become more self-aware of their visions, expectations, and imaginations; "educators" who embed these critical and reflexive capacities in synthetic biology students as part of their training; "colleagues" who succeed in achieving relatively parity of status and power; or most ambitiously and aspirationally, "co-producers of knowledge" who engage in emergent interdisciplinary conceptualization (Balmer et al. 2015). These roles gesture toward the hope these social scientists have for synthetic biology

as a space for developing post-ELSI methods, and they advocate collective experimentation at the collaborative interfaces of social and natural scientists, which also require social scientists to "play the chameleon," moving between different roles lest they settle into the more prescriptive and instrumental among them.

Not all scholars have felt that ELSI is sufficiently restrictive to warrant a post-ELSI shift. East Asian ELSI practices have followed similar tendencies to those of the US and UK, placing emphasis on technoscientific advancement and favoring bureaucratized and delimited versions of ethics such as informed consent (Yoshizawa et al. 2014). However, in both Canada and Europe, institutions replaced the "implications" of ELSI with "aspects," and some scholars operating in those contexts have argued that the critique of ELSI/ELSA research as insufficiently collaborative and integrated is based on an overgeneralization of this research (Myskja, Nydal, and Myhr 2014). Myskja et al. further argue that the call for post-ELSI modes of engagement threatens the collaborative work that social scientists have accomplished under ELSI and ELSA mantles. Still, the authors seek a development and an expansion, though not anything as radical as the prefix *post-* would warrant, from "ELSA 1" to "ELSA 2," expressing sentiments similar to post-ELSI advocates by associating the later with

"new kinds of collaboration with science and technology" (Myskja et al. 2014:14).

I opt not to engage in the debate between the merits of ELSI/ELSA and post-ELSI or to advocate either for or against a move away from ELSI into a post-ELSI mode. Instead, I take both critiques and defenses of ELSI and ELSA as evidence that the opportunities and limitations that social scientists working in the ELSI vein face are highly contextual, clearly varying by national context (see Jasanoff 2005) and field, among many other factors. What is a promising avenue for increased experimentation, reflexivity, and transdisciplinary collaboration in a favorable context may find social science researchers struggling to break through elsewhere. These scholars broadly agree that these are desirable pursuits however they articulate movement in their direction.

These lessons in the importance of institutional and cultural context beg the question of what opportunities and constraints the space of community bio—and specifically a project like Open Insulin focused on remediating biomedical injustice—presents for collaborations between social scientists and natural scientists and engineers. This is especially true given that several of the scholars who identified promise in synthetic biology grew less optimistic over time (Rabinow and Bennett 2012; Calvert 2019), suggesting that the novelty an play of synthetic biology has diminished somewhat as it has become more established. Rather than

turning to synthetic biology efforts like Synberc, which operates at the nexus of academia and industry, it may be promising to turn further to the margins of academic science and engineering.

In community labs and biohackerspaces, different forms of experimentation and knowledge production emerge. Relative to synthetic biology, some scholars have identified these practices as unpredictable and urgently demanding sustained attention and risk analysis (Bennett et al. 2009). At the same time, however, others have identified their potential for more fruitful collaborative relationships than the core institutions of synthetic biology have permitted. Calvert (2013a) describes teams at iGEM as both closely akin to do-it-yourself biology and particularly exemplary of heterogeneous engineering approaches.[6] Balmer et al. (2015) argue that it was easier to play co-productive and reflexivity-inducing roles in the iGEM context. Likewise, Papadopoulos (2018), discussing the hacking movement more broadly, argues that these formations produce exemplary opportunities for building "more-than-social movements." For Papadopoulos, community labs and hacker- and makerspaces provide fora for tinkering with "alterontologies," experimenting with matter as a form of political activism, "address[ing] questions of justice by changing its everyday material conditions" (2018:10), which would be an apt description of the Open Insulin Project.

[6] This exemplariness seemingly includes the ways in which synthetic biology helps guide amateur biology as a social movement, which I analyze and critique in Chapter 3.

Papadopoulos, however, is not especially interested in the role the social sciences might play in these constellations or how collaboration in these experiments might constitute a research method in itself. Following these insights about the rise of amateur bio, social scientists interested in these methodological challenges might ask themselves what forms of experimentation, reflexivity, and transdisciplinary collaboration become possible in these spaces. Other collaborative attempts and analysis of the Open Insulin Project make it clear that it also comes up against institutional and cultural challenges (see Chapters 2 and 3). In a project like Open Insulin, which is nominally "open" but where the range of possibility and tinkering is constrained from the outset (see Chapters 2 and 3), what challenges do social scientists face in their attempts at collaboration and methodological tinkering, and what roles can they play?

What's a Social Scientist to Do?

Both Open Insulin and Counter Culture Labs, as both the physical location and umbrella organization under which the Project operates, presented unique opportunities and challenges for collaboration between social scientists and natural scientists and engineers. Consistent with amateur bioengineering's place on the margins of biotechnological industry and synthetic biology, it displayed some of the same characteristics that scholars in the social sciences have attributed to these

fields. Its kinship with industrial biotechnology entailed a start-up approach and mentality, underwritten by crowdfunding and hype. In its kinship with synthetic biology, it embodied a transdisciplinary and pro-convergence, "heterogeneous" (Calvert 2013b) spirit. Its other lineages filled out the picture still further and created other collaborative possibilities: amateur bioengineering's precedents in software informed its hacker ethic and its contrarian, anti-institutional tendencies; its connections to community organizing and specific focus on insulin's unavailability to diabetics under biocapitalist production paradigms gave the Project its emphasis on equity and social justice. Each of these suggested different possibilities.

The possibilities that Calvert and her collaborators identified in synthetic biology, possibilities that nurtured the hope for "post-ELSI" forms of collaboration, also existed in the Open Insulin Project: transdisciplinarity, as well as a familiarity with, respect for, and willingness to engage the social sciences. By its very nature, the Open Insulin Project challenged the nature of expertise. As a result, many of its members took pride in their omnivorous, transdisciplinary approach. This was true of those, like Yann, Thornton, or Max, with backgrounds in synthetic biology or related biological fields. It was also true of those like Anthony, Patrik, or Rolf who, like many of the founders of synthetic biology, found their way to bioengineering from other forms of

engineering, particularly software. It was true, too, of Ramy, who had a background in both sociology and public health, and Maria, who had worked alongside ethnographers before at Bio Curious and with another project, Real Vegan Cheese.[7]

Calvert (2013b) describes the way in which she was "swept up" into the world of synthetic biology, and I also found myself swept up into the Open Insulin Project. Even when I established my initial intent to study multiple projects at Counter Culture Labs,[8] I was almost immediately embraced as a member of Open Insulin. Members told me that social scientists had come to study and work with the Project before and that they were both accustomed to and welcoming of observation.[9]

Though I always planned to base my research around participant-observation, the observation required little active effort on my part to become participatory. Right away, members, particularly Michael, began checking in with me. In one early meeting, he asked if I was "having fun yet" and reassured me that I was not the only one still working on grasping the Project's technical details.[10] In another, unprompted, he helped explain a visual representation of a plasmid as displayed on Benchling.[11]

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[7] It was also true of many of the social scientists participating in Open Insulin who, like many science studies scholars, began their academic careers in the natural sciences.
[8] I did conduct fieldwork on multiple projects at CCL, most notably the Real Vegan Cheese Project. However, Open Insulin was both the project I began studying the earliest and eventually, my sole focus at CCL.
[9] Murray, fieldnotes, September 27, 2017; October 25, 2017.
[10] Murray, fieldnotes, September 27, 2017.
[11] Murray, fieldnotes, November 8, 2017.

Early on, I was helping unload Bio-Link Depot supplies from a vegetable oil-fueled old Mercedes: pipettes, parafilm, and a water bath. Yann, who noticed me writing in my fieldnotes notebook, expressed curiosity about what I was writing. When I told him a substantial portion were technical details to look up later, both he and Anthony offered to help explain them to me.[12] The first time I attended on a scheduled cleanup day, Patrik enthusiastically enrolled me, along with the other members, into consolidating, organizing, and cleaning the lab. By several months in, I was being photographed as an Open Insulin team member for a planned—later postponed—update to the website.[13] When Michael moved to take my picture, I asked if I should be considered a member, since I was not paying CCL membership dues. Several members reassured me as Michael snapped a headshot.

Many members of Open Insulin also cited social scientific theory or research as influences on their work with Open Insulin. For Thornton, involvement with a student union had exposed him to social science concepts related to labor movements. He continued to employ their principles in his efforts to organize with Open Insulin. He also valued the social sciences and perhaps even, in his own estimation, overvalued them. On one occasion when he and I were discussing Open Insulin, I expressed my concerns that the Project was reproducing a separation between the

[12] Murray, fieldnotes, November 19, 2017.
[13] Murray, fieldnotes, March 14, 2018.

technical and social dimensions of its work (see Chapter 2). Thornton, who had expressed his desire to return to "the science" as a back-to-foundations response responded that this was a hard point for him to wrap his head around. What's more, he worried that he tended hold things he did not quite grasp in high—perhaps even inflated—regard.[14]

Beyond expressing an interest in my fieldnotes, Yann liked to talk with me about sociology. He showed himself to be critical of scientists' depoliticization of their own work and was specifically wary of the tendency of "hard objectivity" to mute criticism, and lamented that his fellow scientists and engineers seemed unwilling to part with it.[15] On the other hand, he talked about sociology as "more difficult" and "more subject to bias, but also really interesting." In our conversations about sociology, science studies, and the history of science, I brought up Latour's *Pasteurization of France* (1988)—which I thought Yann, as a French biochemist, might find interesting—and Shapin and Schaffer's *Leviathan and the Air Pump* (1985), of which I lent him a copy (he did not read all of it, but he found the book interesting, though difficult). On at least one occasion, Yann expressed an interest in the prospect of "sociology hacking," akin to the biohacking that he was working on.[16] Perhaps informed by his experience with the copy of *Leviathan and the Air Pump,*

[14] Murray, fieldnotes, April 13, 2019.
[15] Murray, fieldnotes, August 29, 2018.
[16] Murray, fieldnotes, August 29, 2018.

he explained this as an issue of accessibility, addressing disciplinary jargon and figuring out how to effectively share concepts; when I pressed a bit, however, he also laughingly admitted of the people doing the bulk of the lab work at CCL, "we're all PhDs."

In addition to the interest and interactions spurred merely by my presence in the lab as a participant-observer, I made a point of asking during interviews what the role of the social sciences was or could be in the Open Insulin Project, in CCL, or in the biohacking and community bio spaces more broadly. The answers that I received showcased a range of familiarity with the social sciences and expectations for social scientists, though some definite tendencies emerged. By and large, these participants were supportive of social scientists' participation in the Open Insulin Project and amateur bio more broadly, though they also likely evinced these positive attitudes by their very agreement to participate in an interview. On the other hand, the few potential participants who denied interviews or did not respond to requests may have had somewhat less favorable opinions. Some participants who agreed to an interview and expressed general support for the social sciences also admitted to not knowing what social scientists might be interested in or giving little thought to the social sciences one way or another.[17] Even with these caveats and exceptions, the broad base of support among the many central

[17] Murray, interviews, May 12, 2019; November 16, 2019.

and longstanding CCL and Open Insulin members I interviewed suggested an amenability to integrating the social sciences. This amenability echoed Calvert's and others' hopes for more collaborative engagements between social scientists and natural scientists and engineers that could perhaps overcome some of the resistance and dismissive attitudes that Rabinow and Bennett (2012) experienced.

Many participants looked to the social sciences to help create a more complete descriptive picture by providing an additional source of perspective. For some, in alignment with the community's focus on openness and inclusion, this added perspective—indeed, any added perspective—was a benefit in and of itself, just one of many benefits of broadening the range of participants in Open Insulin.[18] These participants suggested that the social sciences and social scientists provided additional "ways of looking at things,"[19] like a community's culture.[20] They could connect other with resources and analyses relevant to Project work. As Anthony put it, quoting computer scientist Alan Kay, "perspective is worth 80 I.Q. points."[21] These participants discussed the addition of various perspectives as helping projects' prospects and providing "balance."[22]

[18] Murray, interview, November 9, 2019.
[19] Murray, interview, February 27, 2019.
[20] Murray, interview, March 3, 2019.
[21] Murray, interview, May 26, 2019.
[22] Murray, interview, November 5, 2018.

Many participants further looked to the social sciences for their explanatory potential. Several suggested that the social sciences and their practitioners could provide not only perspective, but context. In the spirit of C. Wright Mills' sociological imagination (1959), some suggested that social scientists could help position the Open Insulin Project and community bio within broader social and historical trends.[23] Others invoked structuralism, identifying the potential of the social sciences to reveal structures that were otherwise hidden "under the surface."[24] One suggested that one role of the social sciences was to study the social functions of the other sciences, implying the existence of unrecognized latent functions (see Merton 1968 [1957]).[25] Some anticipated that the social sciences could shed light on dynamics and motives that may not be readily apparent.[26]

While many participants noted the social sciences' interest in processes of social change, some understood them as playing a more interventionist role in these processes and embraced social sciences' interest in politics.[27] One member noted sociology's interest in challenging dominant structures.[28] Another suggested that social scientists could help provide scientists with political context, awareness, and feedback for their

[23] Murray, interview, October 10, 2018.
[24] Murray, interview, May 26, 2019.
[25] Murray, interview, November 5, 2019.
[26] Murray, interviews, July 18, 2018; August 13, 2018.
[27] Murray, interview, July 12, 2018.
[28] Murray, interview, October 10, 2018.

work.[29] In these cases and others, participants interpreted the interests of the social sciences and social scientists as compatible with their own, identifying what they felt was common ground between different stripes of science-activism—for example, a common interest in reimagining and retooling science education.[30] Some participants also saw social scientific intervention as useful at a smaller scale, within the social milieu of labs and projects themselves. Some suggested that social scientists could provide useful feedback about group dynamics or foster education by stirring productive conflicts.[31] On the other hand, another participant suggested that social scientists could help resolve unproductive ones.[32]

In general, these expectations for and speculations on the role of the social sciences in Open Insulin and like community biology efforts showed a positive interest in social scientists' abilities to contribute in unique ways. This was true among those who simply believed that including more disciplinary perspectives could only strengthen their efforts, even if they admitted to thinking or knowing little about the social sciences and their potential roles. The pervasive more-the-merrier attitude was one way in which openness—as inclusion—manifested in the Project and made it easy for me, as a social scientist, to get "swept up" into participating, even without clear reasons, roles, or expectations. It was also

[29] Murray, interview, November 5, 2018.
[30] Murray, interview, February 27, 2019.
[31] Murray, interviews, May 12, 2019; November 5, 2018.
[32] Murray, interview, February 27, 2019.

true among those who did show familiarity with the social sciences and some of their theoretical and methodological precepts, who provided some suggestions for how the social sciences might assist or find common ground with the Project. Not all participants or all suggestions, however, identified the social sciences as a source of unique perspective or capabilities.

Some participants expressed beliefs that the social sciences could perform roles more limited to documentation or communication, coming close to subsuming the social sciences as another component of a promissory, self-promotional organization. On at least one occasion, a member referred to me jokingly as a "scribe" who "[wrote] poems and songs about us."[33] While a joke, it contained truths that other participants bore out across interviews. Multiple participants identified the potential role of social scientists as summarizing or documenting.[34] Often, this documentation was linked to communication—and often in ways that bordered on or were conflated with promotion. For example, one participant expressed the belief that social scientists could help with "getting the word out that… these biohacking communities are a good thing."[35] Others also hoped that social scientists could help with public speaking and public awareness more generally.[36] In some cases,

[33] Murray, fieldnotes, December 6, 2017.
[34] Murray, interviews, November 7, 2018; May 26, 2019.
[35] Murray, interview, July 14, 2019.
[36] Murray, interviews, November 7, 2018; February 27, 2019; August 13, 2018.

participants posited that social scientists' contextualizations of Open Insulin and amateur biology would help demonstrate their uniqueness and exceptionalism.[37]

These latter attitudes especially, akin to the joke about writing the praises of Open Insulin in poems and songs, indicated that social scientists seeking to participate and collaborate within Open Insulin would be subject to the same forces that compelled hype and promotion in the Project's other communications (see Chapter 2). The presence of these forces and attitudes combined with the emerging sense that the Project would need to more carefully monitor access, participation, and communication to create an uncertain atmosphere for me and the other social scientists working with the Project. In the shift from a sweeping, generalized form of openness to one more limited by open-source precedent and self-preservationist precaution, the role of the social sciences in the Project also shifted.

When I first came to the Project, members cheerfully and casually welcomed me as a participant observer. Since the Project had grown and diversified, it had also developed concerns over its flows of data and information (see Chapter 2). These concerns certainly included information about the details of the insulin production protocol under development, which remained practically accessible to those gathered in a

[37] Murray, interview, July 12, 2018.

basic sense, even if grasping its detail required a fair bit of technical knowledge. They also included concerns over the presence of journalists seeking a story who could potentially publish information that tarnished Open Insulin's public image, either through inaccurate reporting—in one instance, a story misreported based biographic details of members, claimed that that insulin should be injected when one's blood sugar drops (the opposite is true), and claimed that Open Insulin had a more specific and defined regulatory strategy than was actually the case[38]—or through a focus on features like intragroup squabbles or the cleanliness of the laboratory space.[39]

This put me and other social scientists working with the Project into a strange position. On the one hand, several Project members had expressed favorable attitudes toward and familiarity with the social sciences. Some had also extended their beliefs in scientific integrity to the social sciences, arguing for social scientists' freedom of inquiry.[40] On the other hand, other Project members' interpretations of social science roles blurred the lines between the social sciences and journalism and suggested similar expectations of favorable coverage, with the added possibility that any other coverage would not be merely unwelcome, but could possibly

[38] Murray, fieldnotes June 11, 2019.
[39] Murray, fieldnotes, December 5, 2018; May 5, 2019.
[40] Murray, fieldnotes, June 16, 2019; August 29, 2018.

endanger the Project in terms of reputation, which affected fundraising capacity, and legal liability.

The latter interpretations were thrust to the forefront during the long (unexpectedly so, for many members) process of developing Open Insulin's bylaws. When discussing the Project's constituent working groups and their requirements for participation, another social scientist—an anthropologist of science who had developed an interest in Open Insulin as part of a larger Project on Type-1 diabetes and its management—voiced her concerns about her role in the group and her rights to publish information about the group.[41] This was not the only occasion around that time on which these questions of communication rights and openness came up during a meeting;[42] however, it did mark a turning point for the participation of social scientists in the Project. While the latitude of social scientists once seemed both straightforward and broad, it was becoming decidedly more complicated in the context of discussions weighing tightening control over the publication of information, a presumptive goal of all of the social scientists working with the Project, myself included. As the Project was becoming more formalized, it was also becoming more important to formalize and clarify the role of the social sciences within it, enabling us embedded social

[41] Murray, fieldnotes, May 5, 2019.
[42] Murray, fieldnotes, May 23, 2019.

scientists to clarify our own roles and expectations as participant-observers both for ourselves and the other members.

Social Sciences in Open Insulin, Open Insulin in Society

In the wake of emerging concerns over the role and latitude of the social scientists as well as the visibility and legibility of social scientific work within and contributions to the Open Insulin Project, I suggested starting a working group focused on social science theory and methods. I raised the prospect during the second full day of bylaws discussions. At the time, the listed working groups in the proposed bylaws were limited to only *Legal, Finance,* and *Science*.[43] In proposing this working group, I was embracing the Project's do-ocratic philosophy, finding a place for the social sciences within the Project not because members were willing to entertain the idea—though they largely were—or because it was a requirement that a social science or ELSI component be written into a grant funding proposal, but because I was at the table and willing to stake a claim for our own roles in relation to the group.

The working group, which was still active at the time of this writing, determined its focus both in collaboration with the other members of Open Insulin and through its need to address concerns shared among the social scientist participant-observers with the Project. We did encounter

[43] Murray, fieldnotes, May 5, 2019.

several challenges stemming from the constraints facing the Project and its members, as well as the need to address specific concerns that attracted little interest to those outside the worlds of the university-based social sciences. At times, the relationship between the social scientists and other members of the Project seemed tense, especially when the social sciences adopted a critical perspective. The working group strove to address these tensions and to become and remain as transparent, accessible, and collaborative as possible.

By the time this working group began, I was no longer the only social scientist working as a long-term participant observer with the Open Insulin Project. Following my proposal, I was joined in this effort by three other social scientists by training. In addition to the anthropologist of science, another sociologist had arrived about a year into my fieldwork and had largely focused her efforts on the legal dimensions of the Project. Third, a human geographer who was working with projects across multiple community labs was a relatively recent arrival at the time. Together, we set to establishing a working group in collaboration with the Project members.

In the spirit of transdisciplinarity and mutual interest, I hoped that these other social scientists and I would not be the only participants in the new working group, and I repeatedly said as much. Even so, for lack of a better name and for intelligibility's sake, we provisionally titled the group the Social Working Group and over time also referred to it as the Social

Sciences Working Group (SSWG). Eventually, in the interest of increased accessibility (though deeming Rabinow and Bennett's "human practices" [2012] too broad), we changed the group's name to Open Insulin in Society (OIS). This group became the center of work in the traditions of the social sciences as well as our discussions about the role of the social sciences in Open Insulin and amateur biology projects like it.

We intended the group to serve as a formalized space for social science-informed and -inflected work on and within the Project. The hope was that this space could both integrate social science work into the Project in some official capacity as others' roles were becoming more official through the bylaws and the division of labor accompanying the Project's growth and development and provide a designated group for contextualizing, analyzing, and theorizing the Open Insulin Project, regardless of training. It also aimed to make the social science research that was being conducted on the Project more clearly visible and accessible to its members. Perhaps predictably given the group's genesis, the initial meetings reflected more on the social sciences themselves than on the Project as a whole. These concerns included social science methods and practices for collective transparency, including the newfound methodological considerations necessary for studying and writing about a group that was in many ways broadly "open" as a matter of principle but

within which definitions and expectations of *openness* varied and were wont to change among its many, consistently revolving members.

Our goal was to address our concerns alongside the other members of Open Insulin, so upon establishing our intent to start a working group, we set a time to present and discuss the prospect with the other members as part of the ongoing bylaws development process. In the meantime, we began as a working group by discussing the ins and outs of being participating members of a group that we were also studying, leading to the identification of several unique elements and requirements of conducting collaborative social science in this community lab setting: to establish roles for ourselves with little guidance and limited precedent; to clearly and repeatedly establish ourselves as participant observers as group membership evolved, including presenting clear expectations and procedures of consent; to reconcile different social science perspectives, temporalities, and approaches—including more and less participatory methods—among our group of elective contributors and beyond; and to foster receptiveness to and interest in collaboration among the other Project members, who, while welcoming, did not play an especially active role in bringing social scientists to the table.[44] In all cases, we as a group had to contend with the limited capacities and multiple commitments of Open Insulin's volunteer membership base, social scientists included.

[44] Murray, fieldnotes, May 23, 2019; June 13, 2019.

When the time came for our one-hour meeting with the group, we decided to address four different sets of concerns at the interface of the social sciences and the Open Insulin Project.[45] First, we wanted to clarify how the social sciences and those who practice them related to the Project, clarifying that we were a diverse bunch with diverse interests, even if we were broadly interested in collaborative approaches. Second, we wanted to discuss membership: were social scientists desired members of the Project, as my early experiences and interviews had led me to believe? If so, how could and should our work be made legible within the organization? Third, we wanted to determine how our participant-observation related to the status of the Project and its meetings as "open," determining how best to inform people of participant observation in public meetings and to make sure that Project members understood what kinds of data we were producing and would likely publish. Finally and relatedly, we wanted to take up the question of whether and how our work might put the Project at risk, and, with the other group members, to discuss our responsibilities to Open Insulin as participant-observers.

During this discussion, I was pleased to learn that the membership base of Open Insulin at that time broadly supported the formation of the social working group and the ability of social scientists to study and write about the Project mostly at our own discretion.[46] I say *mostly* because the

[45] Murray, fieldnotes, June 13, 2019.
[46] Murray, fieldnotes, June 13, 2019.

group members did clarify that they hoped that the role of the social sciences in the Project would protect rather than undermine the Project's openness. In context, this was intended as an assurance of our freedom and latitude as researchers. At the same time, it sustained the kind of ambiguity around the meaning of *openness* that made it difficult to determine the extent of these in the first place.

Following the discussion and at Ramy's suggestion, we also developed a shared set of best practices that would help us to systematize and clarify the role of the social sciences in the Project, including resolving some of the ambiguity around its openness.[47] We took some steps to ensure that our research was as transparent as possible, especially in the context of Open Insulin's newly ambiguously public meetings and discussions.[48] As part of this process, we determined common ground between our different Institutional Review Board (IRB)-approved protocols, so that we could develop mutually compliant best practices. As a measure of transparency, we developed and employed a recruitment script to read at any observed Open Insulin meeting featuring new attendees—a majority of Project meetings.[49] This script informed attendees of the presence of participant-observers and identified each of them, formally established the meeting as public (thereby dispersing with any ambiguity

[47] Murray, field nots, June 13, 2019.
[48] Murray fieldnotes, July 5, 2019.
[49] Murray, fieldnotes, July 12, 2019.

on that point), and offered all attendees the ability to opt out of data collection and dissemination or to discuss their concerns with the observers. It further made it clear that identifiable information would not be collected from any participants who had not independently provided consent to individual researchers.

Second, we made decisions about how the research process and its results would exist accessibly within the Open Insulin group. This included the choice to make all potential publications about Open Insulin available to all members of the group for comment, with the caveat that the author or authors retain final say over their contents.[50] It also began the process of drafting a coauthored article about the role of the social sciences in the Project, an effort that continued to form part of the working group's efforts as of this writing.

Finally, we made information about these best practices and our individual research Projects readily available to other participants. In addition to making ourselves available for inquiries and actively encouraging the participation of those who were not social scientists by training, we also created an information packet (see Appendix). This packet contained the aforementioned script, a description of our agreed-upon best practices, and a version of all of our participant information and informed consent forms, which contained information about us, our

[50] This includes the present dissertation, which the author also scheduled to present to interested members of the Open Insulin group in August 2020.

institutions, and the topics of our studies. We kept this packet at Counter Culture Labs to make it available as an easy, low-stakes way for participants to learn more about our work should they feel uncomfortable or unsure about approaching us in person. When, during 2020's global COVID-19 pandemic, much of the Project's work moved online, we duplicated this informational packet in Open Insulin's shared drive.

As we navigated the persistent ambiguity around *openness* within the Project, OIS crafted our own collaborative version and ethos of openness. This version, bolstered by input from other Project members, reinforced research transparency as a key facet of openness, but not without limitations. The broader Project mulled limiting transparency to maintain the potential to secure defensive intellectual property and to protect itself from outside legal threats. We social scientists also limited transparency when it came to our fieldnotes. While we agreed to make potential publications available and accessible to the group, fieldnotes remained strictly in possession of individual researchers.[51] IRB protocols and the personal content of fieldnotes would have made sharing them nearly impossible, and in this way, we social scientists also engaged in a limited version of openness that restricted transparency in the interest of freedom of inquiry and the protection of participants.

[51] I can recall one occasion where I shared an edited portion of my fieldnotes from a Global Community Bio Summit session with a lab member who had missed the session in question. Personal communication, December 10, 2018.

As researchers, we also determined that we faced questions of collective risk for which our IRB protocols were not especially well equipped.[52] IRBs, like ELSI, dealt in relatively narrow and bureaucratized forms of ethics and legality that focused on individualized informed consent and harm minimization, as through the protection of personally identifying information. This formalized version of research ethics, however, did little to cover the unique challenges of working within a potentially vulnerable *group* like Open Insulin.

Within this group, as I learned through my pre-interview practice of verbal informed consent, individuals were rarely concerned with their personal identification as members of the Project. Indeed, within a group that both benefitted from and prided itself on its global distinctiveness, public profile, and openness, maintaining confidentiality through the typical ethnographic dissemination practices of using pseudonyms and otherwise veiling the identity of individuals and organizations would be very difficult without sacrificing much of the specificity that made Open Insulin both possible and interesting. On the other hand, we social science researchers became aware through our fieldwork and the Project's development that our research could put the group's work at risk. For example, we were made aware that ethnographic fieldnotes were potentially discoverable in the event of a lawsuit targeting Open Insulin

[52] Murray, fieldnotes, July 7, 2019.

and that specific information about lab protocols could prove especially damaging (see Chapter 2).[53] Further, while individuals rarely expressed concern about their personal identification, some occasionally expressed concerns about the group appearing conflicted or dysfunctional to outsiders.[54] I learned of some of these vulnerabilities well into my fieldwork and alongside other Project members. Not all members considered these risks serious,[55] but many—and perhaps especially the social scientists among us—were nevertheless compelled to reconsider our responsibilities to the group.

Ethnographers working in the vein of science and technology studies have often "studied up" among those with more power, prestige, and social capital than themselves (see Nader 1972). In community lab projects like Open Insulin, the power hierarchies are less straightforward. If, as I argue, the relative parity in terms of social capital—call it "studying sideways"—coupled with mutual respect and interest paves the way for more balanced collaborative relationships, it also introduces some of the risks and ethical challenges familiar to those who study those with less power and privilege than themselves. The production of ethnographic data becomes a potential source of liability and vulnerability, as in cases where ethnographic data has been subpoenaed (e.g. Khan 2019), ethnographers

[53] Murray, fieldnotes, March 6, 2019.
[54] Murray, fieldnotes, May 5, 2019.
[55] Murray, fieldnotes, May 12, 2019.

have been compelled to testify in court (see Lubet 2017), or the details disclosed in ethnographic publications have put both researchers and their participants under intense ethical scrutiny (Goffman 2015; see Lewis-Kraus 2016).

In Open Insulin's case, the liability was at the group level and depended largely on nebulous potential: either for public perception of the group at large and how it could affect their viability for attracting confidence and funding or for subjection to a patent infringement lawsuit, which nearly all group members believed would be baseless but nonetheless harmful to the group due to the time and resources required to demonstrate their innocence. In my experience, established institutions of research ethics like IRBs were not well equipped to deal with research in these conditions, desiring clearer designations of risk and legality than actually existed in practice. Thus, a greater share or the burden of developing best practices for research in these new—but increasingly prevalent—contexts fell on researchers themselves.

These questions specific to the institutions and practices of social research and their limitations in the context of the Open Insulin Project commanded much of the working group's attention in its early stages. As a more-or-less direct result of the need to address these issues upfront, the group initially had a difficult time attracting and retaining members who were not trained in the social sciences. The group did draw interest from

several such Project members, including several who had earlier voiced to me their interest in and support for the social sciences. Some of these members participated more often and more consistently than others, but often, as very involved members of the project, their attentions and capacities were split between many other roles and working groups.

Much of our ability to attract and sustain other members' attention revolved around the aforementioned collaborative publication, and it was difficult to discern how much of the interest was in many members' expressed desires to "get the word out" as opposed to an interest in integrating the social sciences into the Project more broadly. An initial submission for publication was written collaboratively, though I and another social scientist spearheaded the effort. Reviewer feedback on this suggestion indicated that it read too much like promotion for the Project, for which I was certainly partly at fault. I took this an indicative of a similar pressure that exists between the social scientists and the other members of the Open Insulin Project. I have pointed out the ways in which the Project and its members were pushed toward and slipped into a promotional, promissory culture of hype that reproduced some of the features of the very biocapitalist mode it sought to oppose (see especially Chapter 2). Social scientists like myself—by no means immune to cultural imperatives of branding and self-promotion—faced a similar pressure to ensure our own viability by arguing for the exceptionalism of our research.

In this, there was risk that social scientists who did desire to publish—their own disciplinary mode of "getting the word out"—would slip into the same mode and further reinforce these tendencies. On the other hand, there was a risk that a generalized suspicion of promissory rhetoric would produce an allergy to hope and promise of any kind, however justified (Fortun 2005).

Finally, relevant to my own research approach and related to these persistent promotional tendencies, it could be especially difficult to pursue critical social science in the context of a Project like Open Insulin. Social scientists working in critical theory traditions have long attempted to pull back the veil on cultural systems, revealing their underlying power structures; indeed, several Project members expressed familiarity with these histories and traditions. Science and technology studies scholars—again, with the field's historical tendency to "study up"—have often turned critical perspectives toward technoscience, insisting repeatedly that rather than being an asocial space of natural law and fact, its institutions are thoroughly social and porous amalgamations of the material and the symbolic—even if they are often constructed to conceal, deny, or downplay this reality (see Shapin and Schaffer 1985; Haraway 1988, 1989; Latour 1993).

In general, the Open Insulin Project's members embraced a critical spirit that called attention to power structures reproduced and

perpetuated by technoscience. But what happens when a social scientist's trained critical sensibilities identified similar structures and tendencies within a critical project? How welcome would these contributions be? Many Open Insulin members indicated that their concerns for medical justice went beyond the relatively narrow scope of the Project and the approach it took to creating an open-source insulin production protocol;[56] in this respect, they viewed Open Insulin as but one way of "pursuing politics."[57] Where members had such a flexible interpretation of their broader aims, a critical lens on the Project itself could be welcomed as helping to reveal some of the limits of a specific approach or making a case that it needed to pivot or expand the scope of its considerations. On the other hand, where members did not, this form of criticism could easily be perceived as undermining, reproducing a tendency of science studies to embrace suspicion and naysaying (Fortun 2005).

While Open Insulin showed clear signs of the former attitude, the faith and conviction required to operate and strive for success within a culture of hype and self-promotion strongly encouraged the latter. Even if much of this attitude was performative, symbolic interactionists have long taught that nothing is ever *merely* so (e.g., Goffman 1959). As such, there existed conflicting attitudes toward the critical social sciences' role within the Project, and these were mirrored in my own conflicting attitudes as a

[56] Murray, interview, April 3, 2019; fieldnotes, April 15, 2019.
[57] Murray, interview, May 26, 2019.

participant-observer who both strongly believed in the Project's focus on justice and observed some challenges and constraints.

Conclusion: Social Science Roles in Community Lab Projects

Amateur bio projects like Open Insulin's "do-ocratic" approaches could provide opportunities for social scientists to move beyond some of the constraints of ELSI frameworks. The Project fostered a collaborative atmosphere that was accepting of—even excited about—contributions from different fields. As a project on the margins of synthetic biology, some of the possibilities I encountered as a member of Open Insulin overlapped with the possibilities that other social scientists have identified within the field of synthetic biology (e.g., Balmer et al. 2015; Calvert 2013a, 2013b).

Some of the unique features of Open Insulin required expansion or elaboration on the roles available to social scientists in these kinds of spaces. In these community biology projects, social scientists could play—indeed, needed to play—a large part in identifying and developing their own roles, responsibilities, and contributions. In my experience, this worked best in collaboration with others, both those trained and untrained in the social sciences. Incorporating the social sciences into a Project that aimed to build a new kind of science specifically attuned to questions of longstanding interest in the social sciences—questions of power, equity, and justice—was a give-and-take exercise that forced reevaluations of the

methods, tools, and concerns of both social scientists and their technoscientifically inclined collaborators.

The roles that I played over the course of my fieldwork were not necessarily productive. In developing and occupying our roles, the other social scientists and I needed to contend with the strategic imperatives of the Project as well as the established research requirements of our respective academic institutions. Rather than a mutually fruitful collaboration, this could result in failing either to adapt the social sciences to the needs of studying and collaborating with these projects or to foreclosing collaborative roles that the social sciences could play and instead bending these roles to these projects' predefined objectives.

These following roles emerged from my participant-observation as a member of the Open Insulin Project. They supplement the roles that Balmer et al. (2015) identify for social scientists in synthetic biology:

The booster: The booster/validator/legitimator/hype-generator/proselytizer role was a perceived utility of social scientists that Open Insulin members expressed to me, a role I was critical and wary of, and a role I nonetheless found myself slipping into. Pushed by a desire to minimize the risk to the group, genuine shared care and concern for medical justice, and a pressure to argue for the value of my own research, it was easy to become boosterish about the Project, even as I identified these pressures and the ways they limited the Project's scope and

reproduced familiar biocapitalist features. There was often a fine line between enthusiasm about the Project's aims and mission and a commitment that limited the capacity for reflexivity and dissent. The challenge with this role was seeing the value in the Project and the hopes that it represents—for those bearing the burdens of the unavailability of insulin, for similar projects elsewhere and in the future, and for those hoping to build a different kind of technoscience—without losing sight of its challenges and constraints or worse, rendering them unthinkable and unspeakable.

The security risk: This role existed in tension with the booster and was in many ways its foil. The ethnographer who did not board the hype train risks being perceived as a threat to the Project through their deep familiarity with and extensive records of its workings. While I and the other group members knew that statistically and relatively speaking, the public reach of most social science works was small, we were also made aware that these works could nonetheless reveal and publicize dynamics within these projects that would alter their perception outside the group. Also, while I did not want to overstate the audience or sway of the social sciences within the broader culture, as a social scientist, especially one interested in practices of public sociology like sharing my work in the context of a community project, I also worked to expand both. Belief in the value of social science perspectives to the public

understanding of technoscientific movements like amateur bio and in the intellectual license and discretion of social scientists at times came into tension with desires to control narratives for the good of the Project.

The metacritic: The metacritic turned the tools of critical theory toward a project that was already critical. A critique of the power of biocapital and "Big Pharma" especially was central to the Open Insulin Project. At the same time, the Project was not immune from many of the structures and power dynamics that shaped and defined biocapitalism and the technoscientific model to which they hoped to provide an alternative. The metacritic could easily overlap with the security risk by drawing attention to such forces and limitations. As a member of an academic institution like a university working within an organization with widespread anti-institutionalist convictions, the metacritic could also easily come across as untrustworthy or antagonistic. One key difference was that Project members could welcome and perceive the metacritic's input as valuable *if* they embraced an expansive version of the Project and its aims, as many Open Insulin members did. The metacritic could call into question the frameworks that the Project was using and their transformative potential. Like the role of the critic that Balmer et al. (2015) identify, the metacritic could easily be understood as exclusively negative, an undermining naysayer, because the identification of any positive features or consequences of the project in question would be

readily incorporated—in this case, into the Project's already-existing critique—as intentional. Clear communication of aims and sympathies could help avoid the interpretation of the metacritic as a simple damper.

The hacker: The hacker, like the other members of the Project, was a do-ocratic tinkerer, teacher, and supplier of situated perspectives and intellectual tools. Calvert was "swept into" synthetic biology by ELSI-fied bureaucratized requirements to place social scientists within engineering projects. By contrast, I and the other social scientists working with Open Insulin came to the Project because of shared hopes and concerns and a belief in our abilities to contribute. In this, we were also "swept into" the Project as participants in the same way as others. Even though we were observers, everyone who attended Open Insulin meetings was encouraged to contribute using their own skillsets. Especially once we founded and consolidated a working group as part of the Open Insulin Project, we social scientists could contribute social science theoretical perspectives and provide our own analyses, both of which Open Insulin members assured us would be useful contributions. These contributions would, ideally, pave the way for us to play Balmer et al.'s desired collaborative roles of "reflexivity inducer" and "co-producer of knowledge" (2015).

"Hacking sociology" has a double meaning: it entails both reflecting on social science's analytical tools and doing so to better

navigate and map the social terrain of hacking spaces and projects. Hacking sociology put me into collaborative relationships both with other social scientists and with community biologists and biohackers who were themselves active theorizers of their own practices (see Kelty 2008). From these collaborative relationships emerged new understandings of the state of the contemporary biosciences and social sciences alike and where they provided opportunities for experimentally reconstructing them with different goals and priorities, spaces at the margins of biocapital from which we could work at "reclaiming and reinventing technoscience from within" (Papadopoulos 2018:206).

Conclusion: Open Bio Logics

By the summer of 2020, the COVID-19 global pandemic had cast many of the features of American biocapitalism in sharp relief and exacerbated many of its exiting inequities. Responses to the pandemic evinced a muddy and conflicted relationship with scientific and medical experts, in which many were unsure of whom to trust and scientists and government officials often contradicted one another's advice (Kaiser Health News 2020; Park 2020). As the number of cases in the United States continued to grow even as other developed nations saw declines (Nace 2020; Noack 2020), many portrayed pandemic response as a tradeoff between harm to public health and economic health (Bazelon 2020; Samuels 2020; Fottrell 2020). Put simply, they argued that widespread quarantining to minimize cases was not in the country's economic best interest, even though economic assessments continued to show that large increases in cases would do at least as much economic damage as extended economic closure (AP and Wiseman 2020; Marte 2020). At the same time, health insurance company profits soared amid large decreases in elective medical procedures.

Especially early in the pandemic, many advocated and hyped up ineffective—even harmful—miracle treatments, the most widespread of which was hydroxychloroquine, a drug normally used to treat malaria, lupus, and arthritis. Early hope for the drug resulted in shortages of the

drug for people with on-label prescriptions. By the time consensus began to show that the drug was ineffective in treating COVID-19 and could produce harmful cardiovascular side-effects and FDA revoked its emergency use authorization (Cohen and Bruer 2020), use of the drug had already become a thoroughly and bafflingly bipartisan political issue. This was further complicated by speculation that President Donald Trump's notorious promotion of hydroxychloroquine was tied to a small personal financial stake in Sanofi, which manufactured Plaquenil, name-brand hydroxychloroquine (Bump 2020). More questions of investment and access loomed around the hope for an eventual vaccine, as German officials reported that Trump had secretly floated a billion-dollar offer to secure the United States' exclusive access to a COVID-19 vaccine, an offer that was promptly and unequivocally refused (Dyer 2020).

As these battles about the value of reducing infection and mortality and the promise of forms of treatment and cure raged on, the country was also facing a renewed reckoning with systemic racism—anti-Black racism in particular—in the wake of an ongoing string of extrajudicial killings, most notably the killing of George Floyd by a Minneapolis police officer. As Black Lives Matter became the largest protest movement in American history (Buchanan, Bui, and Patel 2020), the COVID-19 pandemic was producing tragically and predictably stratified effects. Research indicated that Black and Indigenous Americans experienced the highest mortality

rates from COVID-19, several times higher than those of whites (APM Research Lab 2020). Co-morbidities meant that demographics already suffering disproportionately from medical conditions like obesity, cancer, pulmonary disease, kidney disease, and diabetes were at greater risk (CDC 2020).

During the pandemic, diabetes patients were faced not only with these co-morbidities, but with the difficulty of consistently getting insulin (Wong 2020). Those who relied on employment for health insurance often found themselves unemployed and without the means to afford the medicine. One survey found that as many as one in four insulin users in the United States had resorted to rationing insulin since the pandemic's start (dQ&A and ADA 2020).

Pervasive as it was, the pandemic also influenced work in amateur bio, including at Counter Culture Labs and BioCurious. Members of the two "sister labs" began holding regular video calls for updates on the newest information about the virus. CCL teamed up with an organization that studies urban biomes, the MetaSUB Consortium, to swab public locations in and around Oakland and sequence the swabs for traces of the SARS-CoV-2 virus. Members of CCL joined an effort called the Open COVID-19 Initiative. This effort, a large online collaboration using the online "mobilization platform" JOGL ("Just One Giant Lab"), sought to

develop “open-source and low-cost tools and methodologies that are safe and easy to use in response to the COVID-19 pandemic” (2020).

At least one “do-it-yourself” response to the pandemic was both more ambitious and more ambiguously amateur. Under the mentorship of genomics and synthetic biology pioneer George Church, a group of scientists largely connected to Harvard and MIT produced a “DIY,” “citizen science” COVID-19 nasal vaccine (Regalado 2020). The group’s leader was Preston Estep, Chief Scientific Officer of Veritas and a biotech entrepreneur and researcher with a passion for life extension research. Estep and other members and associates of this team, including Church, took the experimental vaccine themselves, without the benefit of clinical trials, believing that it was safer than risking contracting the virus. They posted their protocol online for others to copy, with significant warnings: “ Does Not Constitute or Substitute for Medical Advice,” “No Promises or Guarantees of Efficacy,” “Not Approved or Reviewed by the FDA” (RaDVaC 2020). Estep asserted that they believed themselves exempt from FDA oversight because they were self-administering the vaccine and not charging for it, occupying a regulatory gray area. Open Insulin members like Maria were unsure whether to trust this group of ostensible DIY-ers.[1] This group of professional scientists appeared to be using DIYbio as cover for freeing themselves from the constraints of their home

[1] Murray, fieldnotes, August 16, 2020.

institutions and reigniting controversy around DIYbio and wanton self-experimentation in the process.

This vaccine effort and the wider context of the pandemic further shaped public perception of amateur bio, for better and for worse, and often directly implicated Open Insulin. One article, titled "It's all fun and games until someone unleashes a pandemic," both explicitly linked the "DIY" vaccine to biohackers' previous dalliances with self-experimentation and once again warned of the dangers of DIY-bioengineered pathogens, citing conspiracy theories that the novel coronavirus was actually an engineered bioweapon (Greenbaum 2020). It raised safety concerns about a broad spectrum of amateur bio practices, including grinders and biohackers, and specifically named Open Insulin. On the other hand, another article argued that the pandemic could actually help "D.I.Y.-bio" and "open science" gain greater legitimacy (Talbot 2020). Localized insulin production efforts like Open Insulin's, for example, could help guarantee people access to drugs during global crises like the COVID-19 outbreak. And in the wake of the pandemic, more scientists were publishing and sharing experimental protocols. Restricting access to important information, like restricting access to an eventual vaccine, was increasingly frowned upon.

Open Insulin pressed on. By August, the Project was finally nearing its official incorporation as the Open Insulin Foundation. The number of

volunteers had held fairly steady since the organization first started gaining steam, around the time Open Insulin first began working on its bylaws. We had even gained a couple of new subscribers to Open Insulin in Society on the working group's channel on Mattermost—an open-source workflow platform. Due to the pandemic, nearly all of Open Insulin's and Counter Culture Labs' work had moved online. Only a few people retained access to CCL to continue work on "the science." Others worked remotely, calling into working group meetings using another open-source platform, the open-source video conferencing program Jitsi.

The Global Community Bio Summit 4.0 was just a few months away. Like many other conferences, it was going virtual in the wake of the pandemic, which had the added benefit of allowing more participants. When I put in my online application, I was surprised to find myself required not only to read through the ethics document I had helped develop the year before, but also to "abide by [its] letter and spirit." It remained a list of questions, so there was not much to "abide by" as far as I could tell. Still, I was intrigued to see the document's continued life and eager to see how it would be deployed in the future.

Biohack the Planet had moved to Las Vegas the year after I attended its last year at the Omni Commons. Las Vegas was also the site of the annual DEF CON, the premier hacker conference that many hackers-turned-amateur bio enthusiasts also attended. For 2020, DEF CON also

moved online, for an iteration the organizers called "SAFE MODE." Biohack the Planet organizers instead opted to postpone their event indefinitely. Anthony had presented Open Insulin's work at the virtual DEF CON on August 7, just two days before, in the midst of all these developments, I gave the first of my two dissertation research presentations to members of the Open Insulin Project.[2]

These research presentations were in keeping with the best practices the Open Insulin in Society group had developed, part of our own version of openness and accessibility. I also uploaded drafts of each chapter I had written to the group's shared drive, but knowing that reading 200-plus-page social science dissertations was both less accessible and less likely than I would like, I also opted to present—naturally, via Jitsi—each chapter to the group. I created a slide deck and presented the research two chapters at a time, allowing for questions and comments as I went.

I wasn't sure how the Project members would respond to the findings. I was unsure if the critical elements of the work would concern them, or if they would connect with my assessments. I worried about the slides that tried to condense the theoretical concepts I was using—biocapital, co-production, bioconstitutionalism, post-ELSI—and make them easy to grasp but seemed to end up dense and text-heavy. I worried

[2] Murray, fieldnotes, August 9, 2020.

about the time I had allotted and whether it would be enough for the members to say everything they wanted. I wondered how many members would show up at all, especially given some of the turnover that had happened since I first began working with Open Insulin.

Several of Open Insulin's longstanding members I had been working with for several years—Anthony, Yann, Louise, Maria—attended both sessions. Other members made it to one or the other, and some of the social scientist members of the Open Insulin in Society working group were also present. The apportionment of time—a half-hour for each chapter, roughly twenty minutes to present and ten minutes for questions—proved to be a bit short. Each session went fifteen minutes over the hour, when it had to end to make way for the Hardware Working Group meeting on the Open Insulin Jitsi channel.

As brief as the presentations were to capture three years of research, many of the members expressed interest in reading the dissertation to be able to engage with the concepts in more detail. Based on the presentations, I was pleased that most members thought that the work was interesting, and many provided further empirical examples that helped flesh out the arguments I had presented. Anthony supplemented the examples of legal risk and threat that I presented in Chapter 2. While "the paranoia came first," as he put it, describing the sense of pervasive and unclear risk that I describe in that chapter, he also told me that later

legal advice reinforced the pattern of suggesting that the Project conform to institutional and industry norms—though it did so for what he called "ostensibly different reasons."[3] Regarding Chapter 3, Maria said that the theme of the upcoming GCBS 4.0 would be *governance,* and that members of the community bio movement were having discussions about how to "get out from under the Media Lab." She and Patrik noted that while the Media Lab had certainly been part of gathering momentum around the *community bio* label, the need to create distance from controversial stunts had been the biggest factor.[4] *Community bio* was attractive to many because it avoided some of the potentially controversial and potentially misleading implications of other terms, like *DIY-bio* or my own chosen term, *amateur bio*.

My use of this term was perhaps the biggest point of discussion following my presentations, showing that forging the identity of the broader network with which Open Insulin associates continues to be a matter of going concern.[5] As Anthony argued, connecting the work in Chapters 3 and 4, there were ongoing questions about who was defining this community and how. Since so many were formally trained, one member wondered if *amateur* was really an apt label. Yann chimed in to say that it distinguished even professional biologists' work outside of

[3] Murray, fieldnotes, August 9, 2020.
[4] Murray, fieldnotes, August 16, 2020.
[5] Murray, fieldnotes, August 16, 2020.

professional settings, so perhaps it made sense—in any case, he would rather be called an *amateur* than a *do-it-yourself biologist*.

I hoped that the end of these discussions, which in many ways marked the end of my dissertation project, would not mark the end of this work's life within the Open Insulin Project. I planned to continue attending meetings and participating as a member of Open Insulin, though I was not certain of where my research would take me in the years to follow. Perhaps, having shared many of the thoughts I had formulated over my three years with the Project to that point, I would contribute even more than before, advocating for the perspectives that I had developed through my work. Maybe I wouldn't be the only one; in the week after I had presented the first two chapters, Louise posted on the Open Insulin in Society Mattermost channel to discuss whether to add the concept of antibiocapital to the "Who We Are" section of Open Insulin's website. I used this to initiate a discussion about biocapital theory and its relationship to Open Insulin's work, hoping to build more bridges between the theory I brought to bear on this case and what Open Insulin members already knew well.

Under American biocapitalism, the increasingly untenable logic in the pharmaceutical patent sector is that innovation and distribution, profitability and accessibility, go hand-in-hand (Parthasarathy 2017). Recognizing problems of access and perhaps recognizing their mandate to

protect the American public, FDA's regulatory approach has posited a tradeoff between the two, introducing a biosimilar designation intended to facilitate the approval of affordable "follow-on" biologics. The Open Insulin Project was a resistance effort because it asserted not only that profitability impeded access, but that accordingly, profitability must be forsaken altogether for the greater public good of increased accessibility. The Project was not the first group to make such a case, but it was perhaps the first that aimed to do so through the introduction of its own biologic that was "open"—unencumbered by intellectual property restrictions, rent-seeking, trade secrecy, or the veils of purposefully vague, unclear, or obfuscatory protocols. Enabled by biocapitalism's development and excesses and frustrated by the ways it produced persistent and elaborate barriers to access, Open Insulin members posited a biologic of resistance.

Their work revealed that such resistance would not come easy. Circumventing existing institutions was easier said than done, as existing intellectual property and regulation often went beyond the status of concerns to manifest as active risks for the Project. These risks were often unclear, compelling risk management practices that challenged the Project's structure, tactics, and values—openness included. Where the Project received support from a broader network of apparently like-minded amateur bio enthusiasts interested in reimagining rights and governance in the contemporary biosciences, the established core

institutions of the biosciences were also there. They raised questions of conflicts of interest and suggested limits to the potential for meaningful and substantive debate and change in a world where even the idea of—and hope for—community bio could be for sale.

I continued my work as a sociologist embedded within the Open Insulin Project, in collaborations-in-progress with others who shared concerns about inequitable access to a life-saving drug and the logics and complexities of the systems that produced it. In a country that was still largely closed, where medicine continued to be big business, the promise of an open future remained just that: potential, sustained in part by the hope and persistence of a group of amateur biologists with a rough-and-ready wetlab and a shared belief that a different kind of science was possible.

Appendix

Open Insulin in Society information Packet – Open Insulin: Social Science Best Practices

This document is intended for social scientists studying Open Insulin and for anyone interested in knowing more about the role of social scientists associated with the project.

Recruitment script: Read aloud at each meeting under observations where people who have not previously been read the script are present: "I am one of several social scientists who work with the Open Insulin Project. We want to make it clear that this is considered a public meeting and that we may be taking notes.* Unless you have given informed consent separately, we will not disseminate any identifying information. If you do not wish for your contributions to be included in our studies, you can approach any one of us [identify who we are] after the meeting. If you want to know more about our research or are interested in participating further, you can approach any of us after the meeting or refer to our information packet."

**Script variation* (only if researchers are audio recording or taking photographs): We want to make it clear that this is considered a public meeting and that we may be taking notes, making audio recordings, or taking photographs.

Keeping meeting notes: When the social working group meets, we will summarize our notes on our channel of the Open Insulin Mattermost page: https://chat.openinsulin.org/openinsulin/channels/wg---social-sciences

Informed consent: Informed consent is required for many studies involving human subjects, including social science research. Consent forms (or participant information forms) for each individual study can be found in the Social Science Studies Information Packet in print at Counter Culture Labs or online in the Open Insulin in Society Working Group Drive folder: https://drive.google.com/drive/u/0/folders/1Y-2klzqEEKh-NPd49NDflvugsSeE-gPT

Voluntary participation: Participating in any study requires a clear explanation of risks and rights from the researcher, and accompanying practices to mitigate these risks. We have identified two types of risk:

- **Individual risks**: This type of risk has been historically prioritized and assessed through Institutional Review Boards (IRBs), and may include risks such as discomfort, and concerns over confidentiality. However, we acknowledge that Open Insulin's uniqueness increases the risk of individual identification and confidentiality breach. More information about the individual risks identified for each individual study are outlined in each researcher's consent forms.
- **Group risks (part of larger, ongoing conversation among Open Insulin group members):** In addition to individual risks, there may be special risks present for a *group* such as Open Insulin. Practices to account for and minimize these types of risks are not well developed in institutionalized ethics (including IRBs). The risks that publication itself may pose to a group like Open Insulin or the legal discoverability of research materials are worth consideration. We social scientists strive to identify and remain aware of these risks and to continually develop ways to minimize them in our research practices.

Approachability/availability of social scientists: each social scientist studying Open Insulin will be available to answer questions and discuss their individual study. They can be contacted via email (generally available on informed consent/participant information forms) or via Mattermost.

Publications: Any social scientist studying Open Insulin will be open to sharing their writing prior to publication and be receptive to feedback. We welcome feedback and are willing to engage in dialogue regarding the results and writing. Nevertheless, we retain the freedom to submit and publish the final product as we see fit.

Contributions to Open Insulin: We are aware of the unfortunate tendency in the social sciences to engage in the one-sided practice of "helicopter" research, using research participants as subjects for study without reciprocating and giving back. As researchers, we strive to resist this tendency and to work toward improving the practices and methods of the social sciences. We believe that the results of our research will benefit not just ourselves as individual researchers, but also the communities with whom we work and with whom we share core values of justice, equity, and democracy in the sciences. Even so, we agree to also remain open to lending our skills in contributing to the project in other ways not directly related to our individual research projects.

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