

# *A Human Genome Synthesis Project: The Crazy Constructive Science of BBC America's Orphan Black*

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## **FROM READING TO WRITING**

**M**AY 10, 2016, HARVARD UNIVERSITY: over one hundred professionals involved with the field of synthetic biology, representing both industry and academia (but no journalists) walk into a room. They are there to discuss an initiative that they analogize to the Human Genome Project (HGP), the international scientific collaboration to map the sequence of nucleotides that constitute human genetic inheritance. At the turn of the millennium, the HGP culminated in a joint announcement by President Bill Clinton and Prime Minister Tony Blair—joined by Francis Collins of the US National Institutes of Health (NIH) and Craig Venter of the Celera Genomics Corporation—celebrating what Clinton called the “most wondrous map ever produced by humankind.”<sup>1</sup> The advance was heralded with promises of fantastic advances in health and human wellbeing. With rhetorical flourish, Clinton speculated, “our children’s children will know the term cancer only as a constellation of stars.”<sup>2</sup>

While the 2000 meeting celebrated the “reading” of the genetic code, participants at the 2016 meeting aimed to lay the groundwork for what has variously been called HGP<sub>2</sub>, the Human Genome Synthesis Project, and HGP-write: the chemical synthesis and joining together of the

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<sup>1</sup> “June 2000 White House Event.” National Human Genome Research Institute. (*NHGRI*). Accessed July 21, 2017. <https://www.genome.gov/10001356/June-2000-White-House-Event>.

<sup>2</sup> “June 2000 White House Event,” National Human Genome Research Institute.

3 billion base pairs that make up a human genome.<sup>3</sup> That this initiative flows from the earlier research program is evident from the continuation of the textual metaphor. Although the transition from reading to writing genomes appears as a logical continuation of the earlier project's framing, the broader issues raised by the two projects are not necessarily identical. The HGP—now retrospectively labeled “HGP-read”—inflamed debates over how the genetic code might produce new forms of identification or interact with older categories of identity. What does genomics have to say about what it means to be human, or who belongs to a particular ethnic group? Could genetic information lead to new kinds of identities and possibly new kinds of stigma? Would genomics reinforce biologically essentialist ways of thinking? In these discussions, humanists and social scientists, along with many biologists, largely took the position of guarding against genetic determinism and arguing for the importance of culture in shaping categories of identity such as gender and race.

In contrast, the issues raised by HGP-write and related efforts in synthetic biology to increase the scale and scope of biological fabrication are still becoming apparent, although they will undoubtedly be rooted in earlier chapters of genetics and biotechnology. While the HGP could ethically be framed as a response to the humanist imperative “know thyself,” synthesizing a human genome fits less easily into the framework of human self-understanding: the larger aim of synthetic biology is not to produce perfect replicas of biological objects, but to open them up for redesign.<sup>4</sup> To judge from recent cultural engagements with these technologies, including the BBC America television series *Orphan Black*, discussed in this essay, the issues at stake may be less about what our genes make us, and more about who will make things with genes. Whose values will be built into new synthetic life forms? Who will embrace the identity of *Homo faber*? Who (or what) will be creator and who will be creature in this creation story?

HGP-write sparked controversy from the moment it came into public view, over questions of access and inclusion about the circumstances under which the meeting took place. Drew Endy and Laurie Zoloth, a synthetic biologist and bioethicist who were invited but declined to attend, published a letter criticizing the lack of openness and questioning the benefits of synthesizing a human genome.<sup>5</sup> Headlines painted a picture of a secretive meeting of scientists with a questionable agenda. In response, the organizers hosted a public meeting in May of 2017, claiming that the project was never intended to be secret.<sup>6</sup> They also changed the name from HGP-write to GP-write, removing the “human” from the synthesis project (although both GP-write and HGP-write appear on the project's website (<http://engineeringbiologycenter.org>)). The main focus, according to the

<sup>3</sup> “Scientists Talk Privately About Creating a Synthetic Human Genome - The New York Times.” Accessed July 21, 2017. <https://www.nytimes.com/2016/05/14/science/synthetic-human-genome.html>.

<sup>4</sup> The historian and philosopher of biology Evelyn Fox Keller writes, “. . . it is not clear what, if anything, our expertise in synthetic biology contributes back to an understanding of traditional biology. Its object is rather to expand our known universe to include living entities not as they have evolved but as we design them” (296). “What Does Synthetic Biology Have to Do with Biology?” *BioSocieties* 4, no. 2–3 (September 2009): 291–302. <https://doi.org/10.1017/S1745855209990123>. (This claim would of course be disputed by the many synthetic biologists who have taken Richard Feynman's slogan “What I cannot create, I do not understand” as a justification for their discipline.)

<sup>5</sup> Endy, Drew, and Laurie Zoloth. “Should We Synthesize a Human Genome,” 2016. <https://dspace.mit.edu/bitstream/handle/1721.1/102449/ShouldWeGenome.pdf?sequence=1>.

<sup>6</sup> Organizers responded that they had declined to invite the media in order to comply with the policies of the journal *Science*, in which an article was forthcoming, and that they had planned to go public after the article appeared. However, Drew Endy posted on Twitter a screenshot of an invitation allegedly from the organizers in which the rationale given for excluding the press was to allow for uninhibited discussion.

current online description, is not to create “parentless” human beings, but rather to advance the technologies for genome synthesis, a foundational technology for biomedical research that has applications including creating improved cell lines for in vitro experimentation.<sup>7</sup>

The organizers seemingly had reason to tread carefully in their pursuit of genome synthesis. At the 2000 HGP announcement, Clinton and Blair reiterated the standard and accepted motivation for genomics research (improving human health), and warned of moral pitfalls. Genomics research must not be used to divisively or to discriminate; rather, the fact that all humans have 99.9% similarity should be taken as a scientific confirmation of our “common humanity.” Blair stated that the new knowledge must be used to “transform medicine” and not “abused, to make man his own creator.”<sup>8</sup> Just what this last statement would entail is not self-evident, but synthesizing a human genome suggests something that edges in that direction. Still, some scientists were reluctant to accept these symbolic boundary conditions. James Watson, co-discoverer of the structure of DNA, quipped, “If we don’t play God who will?”<sup>9</sup> The technology guru Stewart Brand, an enthusiastic backer of synthetic biology projects including “de-extinction” efforts, urges “we are as gods and we have to get good at it.” HGP-write leader George Church played on the biblical creation story by titling his popular science book about synthetic biology *Regenesis: How Synthetic Biology Will Invent Nature and Ourselves* (2012).

In a certain respect, HGP-write’s controversial nature—even including the media firestorm surrounding its rocky rollout—is a feature and not a bug. Andrew Hessel, another HGP-write leader who pitched the idea for the project as early as 2012, wrote that year that synthetic biology needed a grand project sufficiently exciting to “capture the public interest”: “The HGP was one of the few life science endeavors that have captured the public consciousness, resulting in massive media coverage that continues to this day. An effort to write a human genome would build on this foundation.”<sup>10</sup> The “human” in the project’s name is undeniably attention grabbing and headline-friendly. It accomplishes in miniature the rhetorical trick of Hessel’s article, which disavows the science fictional prospect of synthetic, or genetically engineered humans (“What I’m definitely not suggesting is growing a baby from a synthetic genome”) even as it is undeniably conjured as a future possibility (the next line reads, “Before we can fly, we need to be able to walk”). “If you put humans as the target, even though you are not going to make a human baby, it will be provocative, it will be misinterpreted, but people will engage,” says Hessel, who, out of the project’s four leaders, has been the strongest advocate of keeping the focus on “human” genome synthesis.<sup>11</sup> Perversely, controversy and confusion here become a marker of successful public engagement.

The shifting nature of the media spectacles involved in these initiatives speaks to the growing significance of private funding in many areas of scientific research, including synthetic biology. The HGP was spearheaded by the NIH and culminated in sober state theater, even as the

<sup>7</sup> Center of Excellence for Engineering Biology FAQ. Accessed 10/30/2017. <http://engineeringbiologycenter.org/faq/>

<sup>8</sup> “June 2000 White House Event,” National Human Genome Research Institute.

<sup>9</sup> Connor, Steve. “Nobel Scientist Happy to ‘Play God’ with DNA.” *The Independent*, May 16, 2000.

<http://www.independent.co.uk/news/science/nobel-scientist-happy-to-play-god-with-dna-277364.html>.

<sup>10</sup> Hessel, Andrew. “Time for Another Human Genome Project?” *Huffington Post* (blog), March 14, 2012.

[https://www.huffingtonpost.com/andrew-hessel/human-genome\\_b\\_1345842.html](https://www.huffingtonpost.com/andrew-hessel/human-genome_b_1345842.html). Accessed 10/30/2017.

<sup>11</sup> Cross, Ryan. “Money Still Missing as the Plan to Synthesize a Human Genome Takes Another Step Forward.” *Science News*, May 8, 2017. <http://www.sciencemag.org/news/2017/05/money-still-missing-plan-synthesize-human-genome-takes-another-step-forward>.

competition from Venter's private company became a major part of the story. In contrast, the HGP-write leaders (two prominent geneticists who now work in synthetic biology, a lawyer with experience in life sciences funding, and Hessel, who works for the software company Autodesk and describes himself as a "futurist") formed an independent non-profit organization to drive the effort. They hope to raise money from "public, private, philanthropic, industry and academic sources globally," and their first contributor is Autodesk, a company that makes design software and took an early interest in synthetic biology, (<http://engineeringbiologycenter.org/>).

While publically funded projects must strive for broad social acceptability, HGP-write seems to be taking cues from the technology industry in hoping that an audacious pitch will attract a smaller number of deep-pocketed donors. HGP-write leader Jeff Boeke, for instance, admits that the NIH "[hasn't] been as enthusiastic as we are" about the project.<sup>12</sup> In this mediated environment in which financial speculation and speculative fiction blur,<sup>13</sup> explorations of biotechnology in fictional media are all the more relevant. Not only do such creative investigations provide a repertoire of futures that scientists, policy makers, and other actors draw on, but they also respond recursively to the ways in which science fiction is mobilized in nominally non-fictional venues such as press releases and startup pitches. *Orphan Black* and the case of HGP-write suggest that the future of synthetic biology will be constructed through the actions of groups with varied interests and high financial stakes, and that this context must shape the way we evaluate the implications of genome synthesis technologies on identity and on equity.

### **FROM BIOLOGICAL ESSENTIALISM TO BIOLOGICAL POTENTIALITY**

While the initial rhetoric of the HGP suggested a universal conception of humanity by framing the human genome as a singular entity, research in the following decade turned to difference. On the one hand, population genetics deconstructed racial groupings into more complicated and varied groupings (pointing out, for example, the insufficiency of categories such as "African" by showing that there is more genetic diversity in Africa than in the rest of the world). Henry Louis Gates, Jr., on the PBS series *Finding Your Roots*, suggested that genetic testing would combat racism by undercutting any notion of genetic purity. Genetic ancestry tests construe ancestry as a matter of mixture and percentage, showing that even those who might previously have thought of themselves as belonging to a single racial category tend to show some degree of admixture.<sup>14</sup>

Other observers of genomics research in the twenty-first century, however, raised concerns about a return to biological determinism and genetic conceptions of race.<sup>15</sup> The language of genetic ancestry, they pointed out, provides a euphemistic way to talk about the biology of racial differences, providing the potential for racist ideologies to be reinscribed through genetics. The "new genetics" continues to rely on old racial categories both in research and in applications,

<sup>12</sup> Ibid.

<sup>13</sup> On the mediatization of science, see: Maesele, Pieter. "On Media and Science in Late Modern Societies." *Annals of the International Communication Association* 37, no. 1 (January 2013): 155–81. <https://doi.org/10.1080/23808985.2013.11679149>. On the role of speculative finance in biotechnology, see Melinda Cooper's *Life as Surplus: Biotechnology and Capitalism in the Neoliberal Era*. (University of Washington Press, 2008) and Kaushik Sunder Rajan's *Biocapital: The Constitution of Postgenomic Life*. (Duke University Press, 2006).

<sup>14</sup> Fullwiley, Duana. "The "Contemporary Synthesis": When Politically Inclusive Genomic Science Relies on Biological Notions of Race." *British Journal of Sociology* 66, no. 1. (2015), 809.

<sup>15</sup> Ibid.

as in the heart disease medication Bidil that was marketed as a drug for African-Americans.<sup>16</sup> Moreover, empirical research provides some support for the idea that genomics could reify the concept of race. Participants presented with the findings of a population genetics study were more likely to subsequently express belief in essential racial differences. After reading about “admixture” research, the concept of race became more solid and real to them.<sup>17</sup> This potential for race to be reified in genetics is significant and concerning because scientific racism in the twentieth century was connected to racial and genetic essentialism.<sup>18</sup>

At the same time, essentialism is also where 21st century genetics departs from earlier considerations of genetics and identity. Essentialism is connected to the idea of natural kinds and unchanging properties. Some argue that the new genetics is fundamentally different than the old, insofar as it is marked by opportunity and potentiality rather than determinism. Nadia Abu El-haj writes, “In contrast with scientific racism, which presumed that ‘the empirically real exhausts the ontologically possible’ postgenomic medicine generates probable outcomes. And, quite crucially, it presupposes that the ‘ontologically possible’ can be changed.”<sup>19</sup> The prospect of genome synthesis frames the genome as always already one contingent possibility among many. It is in this respect an anti-essentialist technology, opposed to any taxonomy that would frame racial categories as unchangeable natural kinds.

Moreover, accounts of how genes are connected to expressed characteristics (phenotype) have become more complex, as biologists have gained a deeper understanding of gene regulation and gene-environment interactions. As the surge of research and reporting on epigenetics over the past decade has demonstrated, the genome considered in context is a responsive, adaptable system: sensitive to external variables, even bearing the marks of environmental conditions that afflicted earlier generations. Such research has shown the “central dogma” of molecular genetics, in which causality flows from genes to RNA to proteins and never the other way, to be grossly simplified. In place of the central dogma, network models of multidirectional causality have emerged. As sociologist of science Nikolas Rose puts it, “the genetic code is no longer thought of as a deep structure that causes or determines, but rather as only one set of relays in complex, ramifying, and nonhierarchical networks, filiations, and connections.”<sup>20</sup>

*Orphan Black* reflects this more nuanced portrayal of genetic causation. It also imagines a world in which synthetic human genomes not only exist, but have been used to create human beings, most of whom have been raised unaware of their unusual origins. The clones are the result of secret experiments in human cloning and recombinant DNA technology by the US military and biotechnology corporations. While the clones are now adults, meaning that the experiments would have taken place decades ago in the world of the show, they explore many technologies that are currently under development and discussion. Moreover, although secret military experiments

<sup>16</sup> Krupar, Shiloh, and Nadine Ehlers. “Target: Biomedicine and Racialized Geo-Body-Politics.” *Occasion* 8 (August 31, 2015).

<sup>17</sup> Phelan, Jo C., Bruce G. Link, Sarah Zelner, and Lawrence H. Yang. “Direct-to-Consumer Racial Admixture Tests and Beliefs About Essential Racial Differences.” *Social Psychology Quarterly* 77, no. 3 (September 2014): 296–318. doi:10.1177/0190272514529439.

<sup>18</sup> *Ibid.*, 4.

<sup>19</sup> El-Haj, Nadia Abu. “The Genetic Reinscription of Race.” *Annual Review of Anthropology* 36, no. 1 (September 2007): 283–300. doi:10.1146/annurev.anthro.34.081804.120522. 291.

<sup>20</sup> Rose, Nikolas. *The Politics of Life Itself: Biomedicine, Power, and Subjectivity in the Twenty-First Century*. Princeton University Press, 2009. 130.

are the stock-in-trade of much similarly themed science fiction, *Orphan Black* departs from the standard science fiction trope of “carbon copy” clones by depicting the women as highly individual personalities.<sup>21</sup> All portrayed by the virtuosic Tatiana Maslany, physical similarity is the extent of the clones’ overlap. Changes in posture and physical presence, hair, makeup, and voice make each of the eleven clones exquisitely distinct. Even when one clone masquerades as another, Maslany’s physical bearing subtly betrays the deception to the attentive viewer. The show offers up no revelations of uncanny similarities in surprising domains, as is common in stories about the reunion of twins separated at birth. It is true that all the clones we meet are resourceful, stubborn, and intelligent, but then, given the life-threatening circumstances they regularly find themselves in, a clone who was none of these things would be unlikely to survive long (and in any case, the show gives no indication that these traits are primarily genetic).

*Orphan Black* also presumes no affinity between clones based on their genetic relation. We first meet the clone Helena, for example, as she is attempting to hunt down and murder the other clones. Rachel, the only clone who was raised “self-aware” with knowledge of her biotechnical origins, alternates between loyalty and betrayal. Many of the clones do come together in powerful solidarity, but the show repeatedly finds that genetics don’t make a family, one character puts it. The bonds of the “Clone Club” sisterhood can be extended to non-genetic kin, such as Sarah’s foster brother, Felix, who is affectionately nicknamed “brother-sestra” by the Ukrainian-raised clone Helena. And while Helena eventually becomes fiercely protective of all her “sestras,” bonds between the clones are never taken for granted, but are built through shared experience, as the women attempt to unravel the mysteries surrounding their origins, and protect themselves and their loved ones from threatening groups wielding the power of science, religion, and unexpected (though not historically unprecedented) combinations of the two.

Rather than revealing latent similarities, the show revels in how many different characters Maslany and the special effects team can produce, each a pleasurable demonstration of the endless permutations of personhood that can be drawn from the raw material of Maslany’s body. Even the clones’ biology demonstrates complexity rather than determinism. Prone to a respiratory ailment, the disease presents at different ages; while some clones have already died from it, others remain healthy. The emphasis on difference over similarity is also highlighted in moments of misrecognition, or more precisely, moments in which the characters fail to register relatedness, to humorous effect. In one such case, we are introduced to a clone named Krystal, a manicurist and makeup aficionado who assiduously curates all aspects of her appearance. She spoils the melodrama of a planned first encounter with another clone, retorting, “Okay, are you, like, blind? Cause this girl looks nothing like me... she’s like a seven on a good day, and I’ve been told I’m a ten” (Season Four, Episode 10). While in other cases, “naïve” clones are appropriately shocked upon encountering one or more unexpected twins, the Krystal episode demonstrates that resemblance is in the eye of the beholder, and that genetic relatedness is no guarantee of relationality in any significant sense.

## **OWNERSHIP IN THE BIOECONOMY**

Rather than focus on the role of genetic information in identity construction, *Orphan Black* consistently highlights the socioeconomic context of biotechnology, suggesting that this context implicates biotechnology in structural inequalities that divide along lines of race and gender.

<sup>21</sup> My thanks to Everett Hamner for pointing out the show’s departure from this trope.

The control of women's bodies and particularly the policing of reproduction is a major theme; the clones fight against both scientific and religious factions that want access to their bodies, whether for data-gathering purposes or to place their bodies and reproductive capacities in service of spiritual ends. The clones enlist some of the same scientific and technological tools that have been used on them without their consent to fight back and to ameliorate the harms that have been done to them; in this way, biotechnology is neither condemned nor neutral, but instead shown to be itself the contingent product of a lineage that extends to historical episodes such as the eugenics movement. The show's focus on the significance of ownership of genetic tools and components is in line with a focus on these themes in synthetic biology, where debates about intellectual property have been foregrounded. However, its connection of these themes of ownership and autonomy to the history of women's struggles for bodily autonomy is novel in discussions of synthetic biology.

*Orphan Black* astutely depicts the assemblage of social groups and institutions that make up synthetic biology, from the biohackers and transhumanists that haunt its fringe to the military, industrial, and academic power centers at its core. In doing so, it directly references contemporary developments in synthetic biology. One example of this citation can be seen in the character of Dr. Aldous Leakie, the head of the privately funded Dyad Institute. With his large bald head and media-friendly persona, Dr. Leakie bears a suspicious resemblance to Craig Venter, the scientist who was a main figure in the race to sequence the human genome (and attracted controversy for seeking patents on human genes). Venter has since gone on to found private institutes to support his new work in synthetic biology writing rather than reading genomes.

In 2011, Venter's lab announced what they called in their press release the "First Self-Replicating Synthetic Bacterial Cell."<sup>22</sup> Their claim to originality lies in the fact that they were the first to synthesize the complete genome of an organism: the bacterium *Mycoplasma mycoides*. As other scientists were quick to point out, although the genome was sequenced de novo, it was not an original design: it largely replicated the natural genome of the bacteria. However, Venter's team did incorporate some changes, among them a "watermark" to identify the bacteria. Using a coding system that translated the alphabet into nucleotides, they "signed" the genome with their names and quotations by James Joyce and Richard Feynman.

A genome with a similar synthetic signature appears on the show in a poignant scene in which the Cosima, along with her love interest and fellow scientist Delphine, obtain genetic samples from the clones. They learn that each of their genomes has been stamped with a signature, one that has been copied to every cell in Cosima's body: "Property of the Dyad Institute." This scene dramatizes the questions of ownership that are present in synthetic biology, as well as earlier chapters of genetics research in which the patenting of human genes was a flash point, while connecting the politics of patenting to differential health consequences for real bodies. For some synthetic biologists as well as self-described biohackers, openness has been raised as an ethical imperative against restrictive patenting regimes. As gene sequencing and synthesis have become cheaper, voices clamoring for the right to access both the information and the tools of biotechnology have grown louder. For biohackers inspired by developments in synthetic biology, expanding access to biotechnology is a normative good. Biohacking, in this case, refers to people

<sup>22</sup> "First Self-Replicating Synthetic Bacterial Cell." J. Craig Venter Institute, May 20, 2010. <http://www.jcvi.org/cms/press/press-releases/full-text/article/first-self-replicating-synthetic-bacterial-cell-constructed-by-j-craig-venter-institute-researcher/>.

who experiment with biology and biotechnology in their homes or in community labs or “biohackerspaces”; such groups have also been designated DIY (do-it-yourself) bio. For such groups, a hands-on relationship to biology is framed in the discourse of rights, connected to self-knowledge and bodily autonomy.<sup>23</sup>

*Orphan Black* captures the ambivalent but symbiotic relationship between professional synthetic biologists and biohackers. With its goal to make biology easy to engineer, the idea of lowering the barriers to entry into bioengineering is an integral part of synthetic biology. Influential members of the synthetic biology community have drawn on theories of distributed innovation, suggesting that a broader distribution of tools and new mechanisms for openly sharing work will speed the progress of the field and allow the collective intelligence of crowds to use biotechnology to address wicked problems like global warming and food production.<sup>24</sup> Here, the idea of unpredictability has a positive valence: synthetic biologist Drew Endy likes to quote the tech guru Bill Joy who says “most of the smart people don’t work for you” to suggest that he doesn’t want to try to control what people do with the enabling tools he is building and doesn’t want to predetermine what uses it might be put to. “Most of biotechnology hasn’t been imagined yet,” he says; his work has been directed at enabling these unimagined possibilities (<https://openwetware.org/wiki/Endy:Research>). At the same time, distributing the tools of synthetic biology has raised concerns about biosecurity, bioterrorism, and bio-error. When asked about biohacking at the SynBioBeta biotechnology conference in San Francisco in 2014, Venter said he did not think it should be encouraged because if something goes wrong in a garage or biohackerspace, it “could bring down the whole house:” in other words, it might lead to regulation that would threaten his own research empire.

A similar ambivalence is portrayed in the relationship between Doctor Leakie and the “Freaky Leakies” who experiment with Leakie’s ideas and tools in their own homes and bodies. Doctor Leakie promotes something he calls “neolution,” a kind of transhumanist ideology he explains as “self-directed evolution” and claims is “not only a choice, but a human right” (Season 1, Episode 6). In framing biotechnology in relation to one’s individual rights over the body, his rhetoric is in line with the discourse of many biohackers. On the show, “Freaky Leakies” put his idea into practice with body modification and self-experimentation. Yet even as Leakie writes books addressed to a popular audience, when he is questioned about the Freaky Leakies, he looks uncomfortable and says, “I wouldn’t call them followers.” This moment encapsulates the way in which engaging with unruly and unpredictable publics can both enhance and detract from the legitimacy of biotech firms and other institutional actors.

While biohacking tends to be framed in the language of individual rights and individual choice, both on and off-screen, Leakie’s notion of “self-directed evolution” highlights the paradoxes of this individual framing. Evolution is a process that involves populations and multiple generations: a single organism cannot evolve in the biological sense. Instead, collective patterns emerge out of many singular events. Yet a similar rhetoric of consumer choice and individual empowerment has been activated in debates about using existing reproductive technologies or newer gene-editing tools to select or modify human embryos for certain physical characteristics, in order to distinguish them from earlier interventions on populations. Transhumanists argue that using biotechnology to alter future generations would be unlike the eugenics of the 20th

<sup>23</sup> Roosth, Sophia. *Synthetic: How Life Got Made*. University of Chicago Press, 2017.

<sup>24</sup> Carlson, Robert H. *Biology Is Technology*. Harvard University Press, 2010.

century because it would be based on individual choice rather than state coercion. It would not prevent any groups from reproducing but only give people more options: a positive rather than a negative eugenics.<sup>25</sup> Biohackers may be motivated by existing inequalities to expand access to technology, but still largely draw on the color-blind and gender-neutral discourse of individual choice.<sup>26</sup> In contrast, *Orphan Black* shows how individual choices can still reinforce the disadvantage or privilege of certain groups in the context of systemic inequality. It does so by exploring how new capacities to control DNA could intersect with existing practices in the commercialized field of assisted reproductive technologies.

Brightborn is a company run by the Dyad Institute that offers boutique fertility services to wealthy would-be parents; they also surreptitiously offer gene-editing service to parents who hope to give their child a leg up on success. Brightborn's advertising materials feature a fair, blue-eyed and dimpled baby, an image in line with an industry that in actuality has yet to embrace gene editing but has long paid a premium for donor eggs from white, conventionally attractive women with high SAT scores and Ivy League credentials.<sup>27</sup> In contrast, two of the surrogate mothers portrayed on the show are black women who bear white children. Amelia, the woman who bore Sarah and Helena, is an immigrant woman of color who is offered money and help assimilating in exchange for surrogacy services. Kendra, another black surrogate mother, escapes from Brightborn's facilities with the white baby she gave birth to after it is born blind and she fears for its life. The way in which these applications of biotechnology are portrayed as developing along racialized lines is a reminder of how new technologies interact with existing inequalities. At the same time, *Orphan Black* suggests that the potential remains for disadvantaged groups to use the tools of biotechnology in order to redress these injustices.

## FEMINIST BIOHACKING

In her article "Do-it-yourself biology, garage biology, and kitchen science: A feminist analysis of bio-making narratives," Claire Jen shows how popular portrayals of biotechnology, which rely on promissory comparisons to the origin stories of the tech industry, obscure an alternate feminist genealogy for biohacking. Despite DIYbio's gender-neutral language of inclusion and aim to make the tools of biology available to all, biohacking is depicted in media accounts as a "boys club" of tinkerers analogous to the Homebrew Computer club—"a band of unshaved guys in a garage who revolutionized the world."<sup>28</sup> In contrast to the garage as the mythic birthplace of DIYbio, Jen finds a lineage of kitchen science, linked to educational efforts to support women in STEM fields, as well as a history of institutional exclusion and resilience. She connects DIYbio to a tradition of feminist appropriation of technoscience and health advocacy. Such a lineage would include the "self help clinics" of the 1970s in which groups of women performed vaginal self-examinations in the name of demystifying their bodies, while also conducting research into understudied topics such as the biological basis of female pleasure. As with DIYbio, this previous

<sup>25</sup> Suter, Sonia M. "A Brave New World of Designer Babies?" *Berkeley Technology Law Journal* 22, no. 2 (2007): 897–969.

<sup>26</sup> Giordano, Sara. "Labs of their own': Post/Feminist Tinkerings with Science. Forthcoming.

<sup>27</sup> Karsjens, Kari L. "Boutique Egg Donations: A New Form of Racism and Patriarchy." *DePaul J. Health Care L.* 5 (2002): 57.

<sup>28</sup> Jen, Clare. "Do-It-Yourself Biology, Garage Biology, and Kitchen Science: A Feminist Analysis of Bio-Making Narratives." In *Knowing New Biotechnologies: Social Aspects of Technological Convergence*, edited by Matthias Wienroth and Eugénia Rodrigues. Routledge, 2015. 130.

joining-together of science and politics operated through the distribution of tools such as the plastic speculum and associated how-to protocols.<sup>29</sup>

While few biohackers explicitly reference this lineage or identify their work as feminist, the Catalan collective “GynePunk,” associated with the DIYbio network Hackteria, is an exception. Calling themselves “cyborg witches,” they reference gynecology’s colonial history of experimentation on slaves, bringing issues of race to intersect with those of gender. Gynepunk aims to reimagine gynecological practices so that they can be performed at home. Projects include a 3-d printed speculum as well as other low cost, open source hardware for home diagnostics. Like their forebears in feminist health activism, GynePunk promotes a tactile, hands on approach to science. Their work does not shy away from bodily fluids, and aims to make women more comfortable with their bodies.

While Gynepunk is not explicitly cited in *Orphan Black*, both imagine women taking into their own hands tools that have been used to control them. In this respect, they express a compelling underdog narrative that has framed biohacking more broadly. In *Orphan Black*, biohacking is referenced when Cosima and her lab partner Scott set up an underground lab to continue work on the clone’s health issues independently of the Dyad Corporation, which had previously been sponsoring her work. The same narrative of the reappropriation of tools is present in a scene starring Helena, a clone who traces her origins to a Ukrainian orphanage and who has been badly abused by a number of different groups. Helena falls under the control of the Proletheans, a religious sect; their leader, Henrik Johanson, drugs Helen in order to extract her eggs, and fertilizes them with his own sperm. Helena escapes, but not before enacting a revenge fantasy on Henrik. We see him strapped on his back, his legs spread in stirrups as if he were about to undergo a gynecological exam. Helena fingers various test tubes and medical devices, including a speculum. She takes her time, smelling each sample with her usual physicality, and taunts him as she looks over the various samples used on the farm in the technological mediation of both animal and human reproduction (“you want cow baby?”). Finally, she picks up a massively long syringe, and we see a glimpse of his terror-struck face before the camera cuts away to his screams (Season 2, Episode 9).

The scene of Helena’s revenge relies on an underdog narrative that also fits the Gynepunk collective: the disempowered shall inherit the tools. The reappropriation of the speculum appears in both cases, as does a tactile, hands-on approach to biology. In the case of Gynepunk, participants hope that building cheap tools could improve health care for women in remote or impoverished areas, or allow any woman to “do-it-herself.” Do what herself? It is worth keeping in mind that openness and freedom of choice are compatible with political-economic arrangements that have worsened inequality; these sorts of biohacking tales can also be read as individual accommodations with precarity<sup>30</sup> and a withdrawal from collective political struggle. Despite the attraction of the underdog narrative, many would find 3d printed tools an insufficient substitute for more comprehensive medical care, although they may prove beneficial in certain circumstances.

Nevertheless, these cases demonstrate that biology has moved away from determinism and towards a new potentiality,<sup>31</sup> both at the biological and the social level. At the biological level,

<sup>29</sup> Murphy, Michelle. *Seizing the Means of Reproduction: Entanglements of Feminism, Health, and Technoscience*. Duke University Press, 2012.

<sup>30</sup> Delgado, Ana, and Blanca Callén. “Do-It-Yourself Biology and Electronic Waste Hacking: A Politics of Demonstration in Precarious Times.” *Public Understanding of Science* 26, no. 2 (2017): 179–194.

<sup>31</sup> Taussig, Karen-Sue, Klaus Hoeyer, and Stefan Helmreich. “The Anthropology of Potentiality in Biomedicine: An Introduction to Supplement 7.” *Current Anthropology* 54, no. S7 (October 2013): S3–14. doi:10.1086/671401.

there is a tension between the control of life and the exploitation of those aspects of life that make it so valuable, but also difficult to control: generativity, plasticity, potentiality, openness to the effects of chance and contingency. On the one hand, synthetic biologists want to make biology completely predictable and rational, in order to move closer to the fantasy that one could design an organism on a computer, print it out, and have it behave exactly as it is supposed to.<sup>32</sup> But on the other hand, tools such as machine learning are used to harness the effects of complex interactions between genes and other elements in the cell and environment—even when those interactions are not fully understood. Or, to take another example, techniques of directed evolution rely on random mutagenesis, taking advantage of chance and contingency, again, without necessarily knowing why a system works the way it does.

*Orphan Black*'s serial format, which introduces an expanding and unruly<sup>33</sup> crew of clones along with a variety of other groups that want to appropriate biotechnology for their own ends, is well suited to exploring the effects of distributed biotechnology. It illustrates a tension between tension between control and contingency at the social level as well the biological, as no one person or institution has a final say over how the technologies are used. The singular personality of Helena exemplifies the unpredictability of broadly distributing the tools of biotechnology: not only because her wild and uncontrollable personality is shaped by the contingencies of her experience as well as her genetics, but also because who knows what kind of “crazy science” (to use an *Orphan Black* catchphrase) she would make with these tools, and what unpredictable elements she would introduce into the collective experiment of synthetic biology. A

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<sup>32</sup> Spector, Michael. “A Life of Its Own,” September 28, 2009. <http://www.newyorker.com/magazine/2009/09/28/a-life-of-its-own>.

<sup>33</sup> Stutsman, Staci. “The Unruly Clones: Tatiana Maslany’s Melodramatic Masquerades in *Orphan Black*.” *Journal of Film and Video* 68, no. 3 (2016): 83–103.