

Children of Capital: Eugenics in the World of Private Biotechnology

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ABSTRACT: The prospect of human germline intervention—in this case, the application of the CRISPR/Cas9 system to human embryos—raises, again, the specter of eugenics, a practice that aims to improve the human germline by employing an understanding of heredity in the exertion of control over who gets born or who reproduces. Although eugenics is popularly identified as *government* control over reproduction, market forces and cultural mores have led individuals to embrace eugenics absent government mandate. In a world in which biomedicine and biotechnology are funded by large, private interests, concern about *if* eugenics will occur have elided *what form* eugenics might take.

KEY WORDS: [Q2]CRISPR, gene editing, germline editing, liberalism

I. INTRODUCTION

A powerful and efficient new biotechnology has raised the profile of eugenic questions yet again. In December of 2015, an international group of scholars, laypeople, activists, and policy makers come together in Washington, D.C., to debate the use of clustered regularly interspaced short palindromic repeats, better known as CRISPR. The genetic technology is purported to usher in a new age of genetic engineering owing to the use of the CRISPR associated protein 9, or Cas9, to target sequences of DNA for modification with very high precision. The promise of genetic engineering—a promise heralded by CRISPR, but not unique to it—is improved medicines, genetically engineering embryos to be free of heritable diseases, better crops, and new forms of fuel and energy generation.¹

As with any genetic technology, the concern was raised that interfering with the germline of humanity through using CRISPR to modify embryos would lead to eugenics, a practice that aims to improve human lives by employing an understanding of heredity in the exertion of control over who gets born or who reproduces.² Speaking at the summit, historian Daniel Kevles gave a primer on the history of eugenics. He noted that while the state-sanctioned eugenic practices, such as those committed by the Nazi party before and during World War II in an attempt to weed out “inferior” and promote “superior” genetic stock in the population, were unlikely to be precipitated by human germline modification fueled by CRISPR, consumer demand could push reproductive practices into socially unpredictable and ethically hazardous waters.³

Typical concerns about eugenics can be understood as, largely, a concern about the interference of government in human reproduction on a large scale. Following the eugenics-inspired medical atrocities committed by Nazi doctors in World War II, the issue of government-mandated alteration of the human germline became a hallmark of bioethical discussions about genetics.⁴ Eugenics, in turn, was comprised of a set of practices, first through selection (so-called negative eugenics), and later through interventions in human genetics (positive eugenics).

Decades ago, Troy Duster warned that the new genetic technologies such as prenatal diagnosis and the prospect of gene therapies amounted to a “backdoor to eugenics.”⁵

In the late twentieth century, however, scholars viewing human enhancement as a means to reduce human suffering—and, potentially, to liberate humanity from the chains of human nature itself—sought to reclaim eugenics for their own. Nicholas Agar championed “liberal eugenics” under which “Goods of genetic engineering must be allocated to an individual in a way that improves prospects associated with all possible life plans—most especially the worst-off potential life plan.”⁶ Julian Savulescu has argued in favor of “procreative beneficence,” by which individuals that have the means to improve the quality of life of their progeny have the obligation to do so,⁷ including enhancing human physical and moral capacities far beyond the limits set by evolution.

These arguments hinge on two distinctions. First, proponents of genetic enhancement claim that benefits conferred on children through genetic modification are not of a different kind to those benefits conferred on children through environmental conditions and enculturation. That is, parents that choose to have or create a child genetically predisposed towards mathematical greatness are no different, morally speaking, than those who achieve a similar predisposition through selecting a good school.

The second distinction is that the difference between treating a condition such that a person’s capacity is increased from below statistical normality to “normal” is not different, morally speaking, than a proportionate increase from “normal” to above statistical normality.* Savulescu has argued that therapy is, in fact, a mere subset of all enhancements: the set of enhancements that move an individual’s health closer to a statistical norm from some depleted state.² Other kinds of “therapies” such as vaccines are more or less a basic kind of enhancement, supplementing the body’s natural defenses against disease.⁸

The upshot of these distinctions is that the “new eugenics” of genetically modifying our offspring to live longer, work harder, and be more vital is not substantively different from typical medical interventions. Nor is it different from exercising the unconventional parental autonomy we assume individuals have when raising children, such as feeding them good food and sending them to good schools. The new eugenics is, in moral terms, the same as common intuitions are about what we want for our children; only now (or soon) we can enhance our children in a controlled, genetic fashion.

This claim has been contested a number of times.^{9–11} Here we focus specifically on enhancements proposed by contemporary proponents of genetics, and the practice of

* By statistical normality, we could be talking about mean or median scores; which of these one chooses is not strictly relevant for the point the new eugenicists wish to make.

implementing CRISPR as a tool in the life sciences. Namely, what are the impediments to a defensible use of these technologies, given current institutional and social arrangements? That is, if the enhancements promised by CRISPR were to come to pass, what values would inform its use? This is an exercise in “designing ethics” into a technology, rather than mounting an in principle objection to that technology.¹²

Our focus will be the history of American eugenics, and how this movement was in part an enthusiastically pursued public movement for genetic improvement. We choose American eugenics for three reasons. First, American eugenics involved an identifiably public, grassroots support for improving human capacities through controlling reproduction. Second, American eugenics arose in part from a set of societal concerns that parallel the concerns that drive some of the claims of contemporary proponents of human germline interventions. Third, the goal of American eugenics was to diminish the social burden of evils like alcoholism and intellectual inferiority by fostering reproductive genetic selection to enhance positive qualities in the population. This was advocated in lieu of eliminating or increasing certain racial or ethnic groups. Thus it is more similar to a eugenics that emerges from consumer demand than the Nazi eugenics programs that were in the service of genocide, though the aggregate consequences are likely to favor some groups over others.

In what follows, we canvas some of the key themes in the American eugenics movement. We then turn to CRISPR and its associated technologies, and the stated claims of key individuals within the life science who hold what we call “eugenic beliefs”—that is, do not self-identify as eugenicists, but hold beliefs that share strong parallels with the older eugenics movement. We then argue that the underlying values of the life sciences, if applied to eugenics, are problematic insofar as the contemporary life sciences is strongly predicated on negative liberty, and the maximizing of a narrow range of human health and well-being. We conclude with a series of policy recommendations that government might take to mitigate the effects of this new eugenics.

The thesis of this paper is that eugenics was rejected historically “as a combination of bad science and bad policy.”¹² We want to ask, then, if we have reason to believe that our politics are sufficiently improved to match our improved science, and make contemporary eugenics a good idea. Our answer, qualified with potential policy options, is *no*.

II. AMERICAN EUGENICS

Concerns about government eugenics in the United States are far from imaginary. As late as the 1960s, widespread sterilization of young African-American women occurred because of racist beliefs that they were destined to produce “inferior stock.”^[Q3](Dula, 1992) The Oregon State Board of Eugenics, later the Oregon State Board of Social Protection, performed compulsory sterilization on 2,600 residents up until 1981.¹³ “Top-down” eugenics in the United States is a real and recent phenomenon, but we will not say more about it other than to emphasize the hope that American authorities have moved beyond the belief, and the legal authority, to enforce these practices.

What is less discussed is how eugenics operated in the public sphere, advocated by high-profile public intellectuals, media, and professional societies. Eugenics once

occupied the place of a “civil religion” in the United States, and was practiced and *embraced* by Americans across the political and ideological spectrum.¹⁴ This is a far cry from the traditional view of the enforcement of eugenic practices, which subvert liberty and autonomy in a more direct fashion.

A paradigm of this popular eugenics is the 1914 [Q4]Race Betterment Conference in Battle Creek, Michigan. The Conference held “better babies” contests to judge “perfect” children against a set of allegedly objective quantitative measures including lung capacity and height. Far from being an anathema, the Associated Press, [Q5]United Press, and other news agencies covered the conference favorably. The better babies contest at Battle Creek was one of the first in a series of similar competitions held around the country.¹⁴

The obsession with creating the perfect child was fueled by a broad public health interest in the heredity of conditions such as alcoholism, “feeble-mindedness,” criminality, and moral turpitude. Whole families were surveyed, and the incidence and heritability of these traits mapped across multiple generations and hundreds of years. Although some researchers acknowledged the role of environmental factors in generating these antisocial traits, heredity was by and large considered the dominant mechanism for the creation of “inferior” families that presented a social and public health threat to the United States. One hope was that by identifying the perfect child, the right people could be selected to breed, and that they would generate new families with superior social traits.

Prominent intellectuals and writers of the day promoted eugenic beliefs. Inventors and scientists including Alexander Graham Bell¹⁵ and Francis Crick were avid supporters of eugenics.¹⁶ Eugenicists occupied prominent positions as political leaders (Theodore Roosevelt), jurists (Oliver Wendell Holmes, Jr.), and activists (Margaret Sanger).¹⁷ Science writers and journalists of the early twentieth century promoted eugenics as a means to prevent the collapse of society through the proliferation of criminality and feeble-mindedness in the population. One study found that over 1,600 popular articles were published between 1890 and 1924 on the merits of eugenics.¹⁴

Eugenics was thus not simply a matter of government regulation of reproduction. It was a comprehensive set of beliefs about the fitness of humans, and the kinds of measures individuals ought to take to promote that fitness. It was grounded in a particular scientific milieu that is now largely defunct. The distinguished Cold Spring Harbor Laboratory occupies the land of the former Eugenics Records Office (ERO), for many years the advocacy and research center for “scientific” eugenics. Although eugenics as understood in the heyday of the ERO has long past as a set of normative beliefs about human enhancement, connected to other beliefs about human potential, health and well-being, it can and does persist in a modified form.

III. MODERN EUGENIC BELIEFS

Proponents of contemporary genetic enhancement do not, as a rule, go by the name of eugenicists. This should come as no surprise, given popular conceptions of eugenics. Nonetheless, it is instructive to examine the statements by proponents of genetic selection and enhancement, and the parallels they share with early eugenicists. Although

“eugenics” as a system of thought is much less popular, eugenic *beliefs* about human health and well-being are still alive and well.

In terms of CRISPR, consider, for example, how the concept of ageing has been recast in pathological terms—not merely the diseases that affect a person in advanced age, but the very process of growing old. George Church, a Harvard-based geneticist, wants to cure the “disease of ageing,” and his endeavors in this area have attracted the interest of Calico, a Google-funded startup whose slogan is “we’re tackling aging, one of life’s greatest mysteries.”¹⁸ English gerontologist Aubrey De Grey shares their vision, advocating for “lifespan escape velocity,” whereby increases in lifespan match and eventually outpace the aging of a population, as a means to the end of “strategies for engineering negligible senescence.”¹⁹

The parallel between anti-aging and older eugenic beliefs about societal ills arises in the context of death and dying in twenty-first century America. Consider that noninfectious diseases now dominate disease and death in the United States. In 2013, the leading causes of death were heart disease (796,494 deaths) and cancers (585,881 deaths)—both of which were approximately fourfold the prevalence of the third leading cause of death, chronic lower respiratory diseases (149,205 deaths). These, combined, comprised 59% of the total mortality in the United States. An overwhelming number of the deaths caused by these factors occur in Americans over 55 years of age; for heart disease and chronic lower respiratory diseases, the majority occurs in Americans over 75 years of age.²⁰ In the case of cancer, it is the body’s inability to reliably replicate cells into advanced age that is viewed as the partial cause of death. Increasingly, all of these diseases are recognized to have a genetic component, adding to the incentive to pursue CRISPR-based therapies to either render a living individual less susceptible to a disease, or by modifying an embryo so that it does not harbor that propensity.

Even should individuals live a long life, moreover, the burden of disease from disabilities associated with longevity is an increasing concern in American society. The worldwide costs of caring for patients with Alzheimer’s disease was estimated to be \$604 billion in 2010, with approximately 70% of this burden concentrated in North America and Western Europe.²¹ Early detection and prevention of the onset of Alzheimer’s could substantially reduce this burden, but anti-aging scientists wish to go a step further. By preventing the onset of aging, moreover, individuals could continue to work later into their lives, which would stabilize national economies by reducing the burden incurred supporting elderly retirees.²²

Understanding eugenics and the genetic interventions posed by CRISPR would be incomplete without understanding its link to genomics. Genetic engineering requires accurate knowledge of the function of human genes, which in turn requires access to huge amounts of genomic data. Ann Wojcicki, co-founder of 23andMe, the California based personal genomics company, claimed in a recent interview that “If you are going to have children I think you have a responsibility to know if you are carrying [a carrier of a genetic marker for disease].”²³ Wojcicki claimed in the same interview that her company, ahead of major health care systems, would give people the chance to be “in charge of their own

health.” 23andMe also possesses a patent for a child “calculator” that will compute the probabilities, for certain donor combinations, that a child from donor genetic material will possess a range of traits including the risk for colorectal cancer, congenital heart defects, and green eyes.²⁴ In addition to being able to provide individuals with health data, the company’s activities produce an immense amount of genomic data that, when collected across its more than 1 million customers, represents one of the world’s largest DNA repositories for use in medical research. [Q6]{Seife:2010de}

The new genetics parallels older eugenic beliefs in a number of important ways:

1. The identification of a series of pressing social ills that are believed to have a genetic basis;
2. The collection of data for the purpose of diagnosing the genetic basis for these issues;
3. The advocating, by popular communicators and senior members of the scientific community, of interventions at the genetic level to prevent these social issues from occurring; and
4. The popularization of steps 1–3 through communication strategies.

The difference between older eugenics and contemporary eugenic belief is, in part, technical. Modern genetics presents a highly reliable basis on which to diagnose genetic conditions, and its link to computing provides the statistical tools to detect fine-grained changes in genetic makeup that inform our risk factors for many conditions. Pre-World War II eugenics boasted its own specialized technologies, such as craniometers and calipers to infer traits such as intellect and criminality. These devices have been replaced by technologies like magnetic resonance imaging (MRI) that can help diagnose gross brain abnormalities and help explain intellectual disabilities and perhaps pathological behavior.²⁵

Yet modern eugenic beliefs are grounded in an altogether different set of values, underscored by the institutional underpinnings of the life sciences. The biology of the twenty first century is incredibly powerful and *profitable*. The *2012 National Bioeconomy Blueprint*, for example, claimed that the US economy generates \$76 billion from agricultural biotechnology and \$100 billion from industrial biotechnology.²⁶ The *National Bioeconomy Blueprint* does not detail what component of healthcare revenues can be attributed to biotechnology, but as a key driver in pharmaceutical research and development is likely that similar economic benefits can be attributed to biotechnology in the space of health.

CRISPR, and the genomics that would enhance it, is a spectacular example of life sciences driven by business. A continuing legal dispute between researchers led by Jennifer Doudna of the University of California, Berkeley, and Feng Zhang of the Broad Institute, centers on the patent for CRISPR-Cas9. While the present holders of the patent, the Broad Institute, continue to provide the technology freely to the scientific community, there is no guarantee that they or Doudna, should she win rights to the patent, will do so in the future as the technology becomes more profitable.

In genomics, the company 23andMe is the center of continuing controversy for their flouting of US Food and Drug Administration (FDA) guidelines regarding the scientific

and clinical validity of their tests for various genetic diseases. The company received a cease and desist notice in late 2013, ordering them to terminate the marketing of a \$99 test kit that included promised genetic risk factors for a variety of diseases.²⁷ The company revised their relationship with the FDA in 2014, and in 2015 announced FDA-approved diagnostic tests for Bloom's syndrome. The company is also approved to market its tests in the United Kingdom, and has stated its intention to use overseas marketing to collect data that it can then use to convince regulators in the United States.²³

CRISPR, as a technology slated to revolutionize the life sciences tout court, is justified by its proponents on the power it has to reshape human genetics as a means of addressing a set of compelling social issues. Although the human germline and gene therapy interventions that provoke concerns of eugenics are a small subset of this, the culture of the life sciences ought to frame questions about what modern eugenics could look like in practice.

IV. CHILDREN OF CAPITAL

Eugenic beliefs in the modern life sciences are grounded in [Q7]two values:

1. The promotion of health. However, here health is taken to be
2. At minimum, functioning of a particular kind, namely the functioning of an able-bodied person from a developed nation, in the prime of their life.
3. The maximization of functioning beyond that minimum, where possible.
4. The promotion of liberty. Here, liberty is taken to be primarily negative liberty. Individuals are (or ought to be) free to pursue their own health goals, and the market provides interventions according to the demand for particular interventions.

There is nothing unique about these goals; this kind of eugenic belief is consonant with modern neoliberal ideals about individual preferences and the function of markets. However, in the context of eugenic beliefs, a number of issues may arise.

V. RELATIONSHIP BETWEEN USERS AND EUGENIC TECHNOLOGIES

Neoliberal ideals are frequently cited, in the context of health, as promoting technologies that service only a select group of potential users, as a function of both expedience (in bringing a technology to market) and demand (from those who can afford to pay).^{28,29} To understand why this is concerning when applied to eugenics, consider Alzheimer's disease. While the genetic basis for Alzheimer's in non-Hispanic whites is increasingly understood, the basis for the disease in different ethnic groups is understudied. Moreover, the risk for Alzheimer's is higher in some groups, such as African Americans, but without a known genetic basis for this difference.³⁰

The problem here is twofold. First, any genetic intervention targeted at Alzheimer's will, at this stage, disproportionately favor those for whom the genetic basis for the disease is best described—in this case, non-Hispanic white patients. It is likely that other interventions for pathologies considered by the contemporary life sciences could

underperform in groups outside a particular sample, or could even be harmful if off-target effects in diverse genetic groups are poorly understood. Moreover, it is established that the initial conditions of a market will determine the kinds of exchange that can occur.³¹ Until the pool of genetic technologies gains a more diverse basis, it will be disproportionately accessible to white and rich consumers, who in turn will possess a disproportionate share of the market as others enter.

Second, if the prevalence of Alzheimer's in nonwhite groups cannot be explained in genetic terms—or as thoroughly in genetic terms—then novel genetic technologies will simply be less likely to address them. This is particularly concerning if there is no demand (e.g., ability to pay) for any interventions that might help with these alternate pathways to Alzheimer's or any other condition affecting the end of life.

In more general terms, neoliberal ideals about markets and health cannot account for kinds of ill health that are not treatable in a profitable manner. This is because they privilege a very narrow kind of freedom, namely one in which all that matters is that individuals are not explicitly prevented from engaging in exchanges, and they do not account for other measures of freedom and opportunity. For example, those who may have a dire need for medical care or gene therapy, but do not have the financial opportunities to enter into the genetic market, or for whom there are too few to present a profitable consumer group, will be excluded from the market.³²

This is not a new criticism of markets and health, but in the context of eugenic beliefs in the contemporary life sciences, it presents a compelling issue in terms of how market-driven eugenics functions is increasing the gap in health and well-being between different groups in society. If the data collected and interventions designed are embedded in existing inequalities or injustices, then modern eugenic beliefs and practices are likely to amplify those inequalities and injustices.

VI. CHOICE AND RESPONSIBILITY

Where eugenics at the turn of the twentieth century did not strictly place on the “inferior” the responsibility to act, leading ultimately to government intervention, new eugenic beliefs do place this responsibility on individuals. This issue is central to decision-making about health and health care in society in liberal [Q8] states such as the United States, where the provision of subsidized care is often determined by the degree to which we view individuals as responsible for their own choices.³³ If, all of a sudden, refusing to have oneself modified to reduce a particular risk factor for a disease is considered not only something one is *free* to do, but also something one *ought* to do, we could expect that there will be reduced support for providing public assistance for these conditions.

We might also expect a liberal eugenics, even if it prohibits direct state interventions, to authorize the pursuit of eugenic practices by changing the incentives to which individuals are exposed. For example, hospitals may “nudge” prospective parents by making comprehensive prenatal genetic testing an opt-out activity (whereby the procedure is assumed to be permitted unless the parents explicitly refuse), thereby changing the epistemic burden

under which parents must make decisions about future genetic interventions. Alternatively, states may create tax incentives that reduce the tax burden of individuals who adopt a set of liberal eugenic practices. The degree to which these influence choice varies greatly, but both drive at the prospect of modern eugenic beliefs shaping norms around choice and an individual's genetic future (or the future of their children).

Yet it isn't clear that these are the kind of things we ought to allocate to individual responsibility. If one refuses to reduce one's chance of acquiring a disease X, and then gets disease X, then it was this refusal that proved to be the critical decision that led to the disease (except in rare cases of autosomal dominant genetic disorders, where all the risk is wrapped up in a single dominant genetic marker). The majority of eugenic decisions will only change relative risks, such that even if the probability of contracting a disease were lower with a genetic intervention, it would still be possible that the person could contract the disease. Or there may be competing factors that mean that a genetic marker merely overdetermines the result: while ordinarily a particular marker may determine a disease, in some cases it may not provide any extra chance when, for example, environmental factors would have caused the disease anyway.

A neoliberal health landscape, however, would conceivably place the burden of responsibility for an individual's genetic future, and their ancestor's genetic future, squarely on the individual. Under such a rationale, the motivation to provide health services to individuals suffering from disease or disability could radically shrink, as more and more health states become the province of individual responsibility. We already see this in terms of, for example, obesity.³⁴ To purport that one's entire health is in the control of the individual, and that this entails that one's health is thus one's responsibility, could at its most extreme lead to the total depletion of (in some countries, already limited) publicly funded health services.

VII. DISABILITY

A corollary to claims about choice is that a eugenics driven by a narrow vision of health and a particular conception of negative liberty privileges some health states over others. That is, in addition to making individuals responsible for changes in their genetic makeup, contemporary eugenic beliefs have the potential to create a context in which a very narrow vision of what it is to be healthy is promoted, and create stigma around any other kind of conception of health or well-being.

A reply to this is that no one, in practice, would want to turn down the chance to live longer and do more with their lives. But it isn't clear that such a claim could be sustained. Where the better babies competition sought to reduce children to a set of factors that were asserted to be objective, contemporary genomics seeks to describe potential children entirely in terms of risk factors. Yet there is potentially a range of other values to be promoted in having a child. There may be, for instance, the value in having a child who is close—if not in appearance, than in genetic lineage—to one's ancestors. There may be some phenotypes that are part of a person's culture that, much like Deaf culture³⁵

may generate a set of unique and unifying experiences worthy of respect even if those individuals are not “enhanced.”

Second, it isn’t clear why a very long life path, or a life path absent the prospect of certain risks, is in principle better than a shorter life path. There are surely rich descriptions of what makes life worthwhile, in which the length of one’s life is *irrelevant*. Consider that someone might think that what makes life go best is the kinds of experiences one has (and not the number of experiences). Or, alternately, that life ought to be described as a series of concrete stages, and that a never-ending period of middle age is simply deficient qua life. To trade off these plausible, if contestable conceptions of a good life as unworthy of support in a liberal society would be shameful.

The reply, of course, is that nothing about the current genetic market precludes an individual from having these kinds of conception. But the central point is that when an industry as large and as powerful as the contemporary life sciences—and one that is projected to become a central element of the U.S. industrial and commercial landscape—promotes a particular conception of wellness, it will affect the practice of certain institutions. A nomination to the Supreme Court would be very different if the nominee has 20 years of life left, compared to if they have 200 years left. Companies may cater wellness plans, or even selection criteria for jobs, to fit only certain phenotypes. Market pressures may *force* a kind of health onto people that does not necessarily make them better off, but is required of them.

VIII. POLICY IMPLICATIONS

The upshot of this is that, in practice, we have much to be concerned about when examining neoliberal, market-based eugenic beliefs in the context of proposed human germline interventions using CRISPR or other, future modalities. These are not reflections on the technology itself, but the institutional and ethical system in which the technology is emerging, embedded, and will be used.

These changes, moreover, are matters of degree. Although bioethics has a love affair with disaster scenarios, these are not necessarily productive.³⁶ What is important is that there is, given a set of eugenic beliefs, a trend we can predict about future use and practice. The confidence interval over that prediction is likely very large, but our policies should reflect the trend and its possibilities.

The function, then, of government should be to ensure that broad public value commitments are represented in shaping the techno-scientific landscape, in addition to the values promoted by the life sciences and its practitioners. We suggest three policy initiatives:

1. *A diverse, community-driven response to health.* First, we suggest that governments and international bodies create a diverse survey of health interests in the community, and identify those that are underrepresented in the current life sciences environment. Given that modern eugenic beliefs are heavily subsidized by private interests, and that these beliefs presently reflect the interests of only a few powerful individuals, it should be the government’s role to identify what

- kinds of value commitments the wider community possess, and assess the role of CRISPR and other genetic engineering techniques in promoting these values.
2. *Ensuring community availability of CRISPR.* If we are to take the transformative value of CRISPR and similar technologies seriously, then its status as exclusionary through, for example, licensing agreements should be held into question. By limiting the range of potential users of the technology, the kinds of benefits we can expect to see from it will be necessarily limited. As a federal funder of pivotal work in CRISPR, the National Institutes of Health should work with investigators to ensure that the technology license remains open—using the “march-in” provisions of the Bayh-Dole Act, which allow a funder to license the technology to “reasonable” users and override licensing provisions by patent holder, if necessary.
 3. *Funding research into underrepresented communities.* Ultimately, the initial set of data on which technology can be developed will shape that technology’s distribution. Funders should work to ensure that these data are reflective of the community, by prioritizing the funding of research that seeks to understand genetics and health in understudied communities.

An objection to these policy proposals is that they could slow innovation, potentially costing lives. We think that these kinds of objections, which in our experience are common in science policy debates, are a red herring. Any form of scientific innovation will “cost lives” in the sense that some individuals are excluded from the benefits of science whereas others are included. In the current regime, a small number of people will benefit initially, with incremental steps towards lives saved, but potentially large numbers of people left out of the innovation process for a long time, and some excluded indefinitely. Our proposal is that resources be spread with an eye towards equity. This may lead to more lives lost initially, but few lives lost later. No one can take the high ground of “saving lives.” The best they can do is articulate whose lives will be saved under their scheme.

IX. CONCLUSION

Most debates about eugenics focus on the possibility that eugenics will occur. We think this is a mistake, as eugenics is, in its own way, already a feature of contemporary genetics. We are already undertaking a project of altering our reproductive options based on our values, and have been doing so using science for hundreds of years.

Instead, we believe that the best way to think about eugenics is to ask what form will eugenics take, and what form ought it take? Here, we’ve highlighted a series of issues that emerge in the context of the modern life sciences, and one picture of the kinds of values that could be promoted using CRISPR-led germ line modification. It is our hope that changes can be made on the level of science policy to circumvent the more problematic aspects of those eugenic beliefs.

REFERENCES[Q9]

1. Ledford H. CRISPR, the disruptor. *Nature*. 2015 Jun 4;522(7554):20–4.
2. Selgelid MJ. Moderate eugenics and human enhancement. *Med Health Care Philos*. 2014;17(1):3–12.
3. Travis J. Inside the summit on human gene editing: a reporter's notebook [Internet]. *Science*. 2015 [cited 2016 Feb 18]. Available from: <http://www.sciencemag.org/news/2015/12/inside-summit-human-gene-editing-reporter-s-notebook>.
4. Jonsen AR. *The birth of bioethics*. New York, NY: Oxford University Press; 2003.
5. Duster T. *Backdoor to eugenics*. New York, NY: Routledge; 1990.
6. Agar N. Liberal eugenics. *Public Aff Q*. 1998;12(2):137–55.
7. Savulescu J. Procreative beneficence: why we should select the best children. *Bioethics*. 2001 Oct 1;15(5–6):413–26.
8. Harris J. *Wonderwoman and superman*. New York, NY: Oxford University Press; 1992. 1 p.
9. Sparrow R. Human Enhancement and Sexual Dimorphism. *Bioethics*. 2011 Apr 26;26(9):464–75.
10. Sparrow R. Enhancement and obsolescence: avoiding an “enhanced rat race.” *Kennedy Inst Ethics J*. 2015;25(3):231–60.
11. Sparrow R. Should human beings have sex? Sexual dimorphism and human enhancement. *Am J Bioeth*. 2010 Jun 30;10(7):3–12.
12. van den Hoven J. Computer ethics and moral methodology. *Metaphilosophy*. 1997 Jul 1;28(3):234–48.
13. Largent MA. “The Greatest Curse of the Race”: Eugenic Sterilization in Oregon, 1909–1983. *Oreg Hist Q*. 2002;103(2):188–209.
14. Nelkin D, Lindee MS. *The DNA mystique*. Anne Arbor, MI: University of Michigan Press; 2004. 1 p.
15. Bell AG. How to improve the race. *J Hered*. 1914 Jan 1;5(1):1–7.
16. Ridley M. *Francis Crick*. New York: Harper Collins; 2012. 1 p.
17. Kevles DJ. *In the name of eugenics*. Los Angeles: Univ of California Press; 1985. 1 p.
18. Calico. Main page [Internet]. 2014 [cited 2016 Feb 18]. Available from: <http://calicolabs.com>.
19. Agar N. *Humanity's end*. Cambridge, MA: MIT Press; 2010. 1 p.
20. Centers for Disease Control and Prevention. *Deaths: final data for 2013*. 2013.
21. Wimo A, Jönsson L, Bond J, Prince M, Winblad B. The worldwide economic impact of dementia 2010. *Alzheimer's Dement*. 2013 Jan 1;9(1):1–11.e3.
22. Achenbach J. A Harvard professor says he can cure aging, but is that a good idea? [Internet]. *Washington Post*. 2015 [cited 2016 Feb 18]. Available from: <https://www.washingtonpost.com/news/achenblog/wp/2015/12/02/professor-george-church-says-he-can-reverse-the-aging-process/>.
23. Corbyn Z. ‘Genetic testing is a responsibility if you’re having children’ [Internet]. *The Guardian*. 2016 [cited 2016 Feb 18]. Available from: <https://www.theguardian.com/science/2016/jan/08/anne-wojcicki-dna-genetics-testing-23andme-interview>.
24. Tiku N. Startup patents eugenics tool to build your best baby [Internet]. *Gawker*. 2013 [cited 2016 Feb 18]. Available from: <http://gawker.com/startup-patents-eugenics-tool-to-build-your-best-baby-1440784102>.
25. Raine A. *The anatomy of violence*. New York: Pantheon; 2013. 1 p.
26. Office of Science and Technology Policy. *National bioeconomy blueprint*. Washington, DC: The White House; 2012.
27. Food and Drug Administration. Letter to 23andme, Inc. Nov 22, 2013.
28. Poge TW. *World poverty and human rights*. New York, NY: Polity; 2002. 1 p.
29. Farmer P. *Pathologies of power*. Berkeley, CA: Univ of California Press; 2004. 1 p.
30. Reitz C, Jun G, Naj A, Rajbhandary R, Vardarajan BN, Wang L-S, et al. Variants in the ATP-binding cassette transporter (ABCA7), apolipoprotein E ϵ 4, and the risk of late-onset Alzheimer disease in African Americans. *JAMA*. 2013 Apr 10;309(14):1483–92.
31. Nozick R. *Anarchy, state, and utopia*. New York, NY: Basis Books; 2013. 1 p.

32. Mehlman MJ, Botkin JR. Access to the genome. Washington, DC: Georgetown University Press; 1998. 1 p.
 33. Lynch JW, Kaplan GA, Salonen JT. Why do poor people behave poorly? Variation in adult health behaviours and psychosocial characteristics by stages of the socioeconomic lifecourse. *Soc Sci Med.* 1997 Mar;44(6):809–19.
 34. Callahan D. Obesity: chasing an elusive epidemic. *Hastings Cent Rep.* 2013 Jan 1;43(1):34–40.
 35. Tucker BP. Deaf culture, cochlear implants, and elective disability. *Hastings Cent Rep.* 1998 Jul 8;28(4):6–14.
 36. Annas GJ. Worst case bioethics: death, disaster, and public health. New York: Oxford University Press; 2010. 1 p.
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