Introduction

DNA, Race, and Reproduction in the Twenty-First Century

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On the day we logged in, the California Cryobank, one of the country's premier sperm banks, had 242 donors available, identified by five-digit numbers. Some had also given themselves cutesy nicknames, such as "Off-the-charts smarts," "Ph.D. pianist," and "Dancing scientist." We could filter the list by various attributes of the donor: physical characteristics (height, eye color, hair color, hair texture, blood type, celebrity look-alikes), "ethnic origin" (American Indian or Alaska Native, Asian, Black or African American, Caucasian, East Indian, Hispanic or Latino, Middle Eastern or Arabic), "self-reported ancestry" (specific country or countries of origin), religion (agnostic/atheist/declined to state, Buddhist, Christian, Hindu/Sikh, Jewish, Muslim, other), "self-reported Jewish ancestry" (yes or no), and education level (bachelor, master, or postgraduate, though many donors were current students, so this could refer either to a degree they had already earned or to a degree toward which they were still working). Some donors had provided descriptions of themselves; "fun facts" listed for each included favorite animal, fantasy lunch date, and favorite food. The price of sperm depended on how much personal information a donor was willing to share with potential offspring. Sperm from donors who agreed to disclose their identity fetched a premium, suggesting an expectation among prospective parents that their children will want to know where their DNA comes from.

This imagined desire stems, at least in part, from scientific and popular understandings of which characteristics genes carry from one generation to the next. Many of these assumptions were on display in the California Cryobank's database. Genetics reaches into numerous domains of human life in the twenty-first century, but it is in the crucible of reproduction—whether accidental or

planned, technologically assisted or old-fashioned—that individuals, couples, and families are forced to confront the science and mythology of genetics and make decisions about which characteristics of themselves and each other they want to reproduce. These decisions are most obvious in the realm of assisted reproductive technology, where the fertility industry represents them as choices available to paying (and typically white) customers. But people who get pregnant from sex also come face-to-face with ideas about genetics when health-care providers offer—or even push—prenatal testing options ranging from carrier screening to amniocentesis, though the availability of these tests and even the opportunity to opt out of them depends on the pregnant person's access to health care. In generating new life, or simply in contemplating reproduction, genetics inevitably comes to the fore via ideas about what makes individuals distinct from one another, what generates affinity between family members, and what endows people with social value. In those ideas, popular and scientific conceptions of race and the patterning of human difference are never far from the surface.

This book emerged from a series of conversations among UC Davis faculty members working across the humanities, social sciences, and natural sciences, as well as the School of Law, the School of Medicine, and the School of Nursing, about how popular, religious, scientific, legal, and medical understandings of genetics come together in a variety of settings to profoundly shape the contemporary human experience. Some of the essays contained here reflect interdisciplinary collaboration; the others were written by individual scholars trying to reach audiences outside of our own disciplines and, we hope, to influence conversations about genetics in a variety of settings, from laboratories to doctors' offices, courtrooms, schools, and houses of worship. All of the essays grapple with how popular and professional understandings of DNA influence society. Some center race, others center reproduction, and others center the intersection between race and reproduction. It is our hope that this volume will help a broad variety of readers think critically about all of the ways they confront DNA and ideas surrounding DNA in their daily lives.

All of the locations listed above—laboratories, doctors' offices, courtrooms, schools, and houses of worship—are places where people with different kinds and levels of expertise interact. They are also sites where significant institutional power differentials are enacted and reinforced by the discourse structures that form knowledge systems. By design, terms of art, jargon, and other habits of language used within disciplines and professions can make it difficult for nonspecialists to engage meaningfully with ideas. In this volume, we have tried to steer away from insider talk and to explain some of the more technical topics from our respective disciplines in everyday language. This, of course, means that some of what we say will be new to all readers, but parts may also be extremely familiar to some. We

hope that our work will be broadly useful for those who have spent many years studying these topics as well as those who are just beginning their studies and those who are simply curious.

In this volume, we treat reproduction as both a site of inquiry and an analytic tool with which to interrogate the human attributes that are widely believed to inhere in DNA. Our contributors focus on race as a social category that points to biology for justification. Race gets perpetuated in part through decisions people make about reproduction, but also gets reproduced through inequitable access to reproductive (and other) health care, along with numerous other social, political, and economic goods. The contexts in which people make reproductive choices are structured by a variety of historical and social circumstances, including those that produce and perpetuate racial difference. While not all chapters directly address reproduction, in one way or another, each addresses the complex, confusing, and inconsistent ideas about the relationship between genetics and identity that circulate among the American public. Understanding the historical, legal, and scientific construction of race and ethnicity is integral to understanding how reproductive choices are, in a sense, prestructured to both enforce and perpetuate notions of genetic identity, race, and ethnicity.

Although some chapters have a wider geographical reach, we focus mainly on the United States for three reasons. First, for most contributors, the United States is the social, historical, legal, medical, political, and religious landscape we know best. Second, race is a historically, socially, politically, and legally constructed set of categories that necessarily differ from place to place and time to time. Nonetheless, given the global hegemony of the United States, the racial categories used here get exported to other parts of the world as well. Third, the United States has fewer regulations surrounding assisted reproductive technologies and gamete donation than most other countries, making it a global center of reproductive tourism. In 2019, 2.1 percent of all births in the United States were the result of assisted reproductive technologies. In California—a major hub for reproductive tourism due to lax regulation—rates range from 3.5 to 5.5 percent of births.[1] The United States is therefore ground zero for debates about how new genetic technologies can and should become part of reproductive decision-making.

We have grouped the chapters in this book into three parts—"DNA and Race," "DNA and Reproduction," and "Race and Reproduction"—though most chapters address all three of our key themes in one way or another. The first part, "DNA and Race," explains how older ideas about race have shaped and been reshaped by new genomic technologies. The second part, "DNA and Reproduction," examines how these new genomic technologies have become part of the landscape of fertility medicine. The third part, "Race and Reproduction," explores how genetic understandings of race and family (including the human family) influence one another. The remainder of this introduction provides some

context for each of the three parts of the book and indicates how later chapters will further elucidate specific themes.

DNA AND RACE

Race and ethnicity, though lacking any stable meaning or clear boundaries, have formed the central axes of identity in the New World since the arrival of European colonists and enslaved Africans. In many ways, race and ethnicity are forms of what the anthropologist Jonathan Boyarin has described as "the rationalization and regulation of identity and difference" that long anchored Christian anti-Semitism.[2] Early efforts to distinguish Christianity from Judaism involved concepts of bodily difference that later reappeared in race science.[3] Exactly what those bodily differences are, however, has continually changed as social and political circumstances have required different criteria of inclusion and exclusion, and as science has continually failed to identify any clear lines of demarcation between racial or ethnic groups, or even between the concepts of race and ethnicity. Indeed, the groupings themselves have continually changed, with no expert agreement on either how many races and ethnicities there may be or on whether any given identity descriptor refers to a race, an ethnicity, or something else altogether.

Race is typically deployed as a classificatory schema that makes reference to the large-scale (often continental) geographic origin of our ancestors. It is thought to be perpetuated by reproduction within categories and interrupted by reproduction between categories. Race categories differ from place to place and have changed over time.[4] Currently, the US government recognizes five races: White, Black, Native American or Alaska Native, Asian, and Pacific Islander or Native Hawaiian. Since 1995 it has allowed individuals to identify with more than one category.[5]

Ethnicity is a separate set of social categories that may be subracial (for example, referring to nationalities within continents) or may cut across racial divisions (for example, referring to language, culture, and/or religion). The US government recognizes only two mutually exclusive ethnicities—Hispanic and non-Hispanic—and allows people of either ethnicity to identify with any number of races (but the US Census requires people of both ethnicities to identify with at least one race).[6] The fact that the US government's definition of ethnicity differs so dramatically from colloquial uses of the term indicates the social and political constructedness and the geographical, cultural, and chronological contingency of the entire concept.

By the middle of the twentieth century, when skin color, hair texture, skull size, and face shape had all failed to produce clear boundaries between presumed racial categories, social scientists concluded that race was socially constructed. Natural scientists, on the other hand, sought a biological basis for it in the emerging science of population genetics. In 1950 the UN Educational, Scientific and Cultural

Organization (UNESCO) published a statement declaring that "the species *homo sapiens* is made up of a number of populations, each one of which differs from the others in the frequency of one or more genes," and that "a race, from the biological standpoint, may therefore be defined as one of the group of populations constituting the species *homo sapiens*."[7] But even that definition didn't adequately fit colloquial notions of race. In 1972 the population geneticist Richard Lewontin found that the majority of human genetic variation occurs *within* racially defined groups rather than between them.[8] In 1977 the US government established a set of race categories for statistical purposes, explicitly stating that "these classifications should not be interpreted as being scientific or anthropological in nature."[9] Nonetheless, some scientists continued to pursue a genetic basis for these categories.

The first two decades of the twenty-first century in particular (since the completion of the Human Genome Project) have seen what critical science scholars Barbara Koenig, Sandra Soo-Jin Lee, and Sarah Richardson describe as "a vigorous reassertion of the coupling of race and genes."[10] Population geneticists have made strenuous efforts to link racial categories to genetic differences, convincing large swaths of the public without producing empirical evidence that race categories have any genetic basis.[11] The overwhelming preponderance of research has found that genes and physical characteristics vary clinally—that is, gradually and continuously—across space, and that genes corresponding to physical characteristics that are commonly thought to cluster in racial groups (for example, skin color and hair texture) vary independently of one another.[12] Large-scale racial definitions therefore fail to capture actual human variation, which is—as the anthropologist Jonathan Marks observes—"historically ephemeral," "genetically porous," and "culturally bounded."[13]

These new efforts to find a genetic basis for race often use the language of *genetic ancestry* to avoid charges of racism.[14] In its most technical sense, genetic ancestry refers to the genealogy of each of our genomic loci. At every point on our genomes, we have inherited one allele from our mother and one from our father. The alleles we inherited from our mother could have come either from her mother or from her father (same for the alleles we inherited from our father), and before that from those people's mothers or from their fathers, and so on. Genetic ancestry describes this path of genetic inheritance.[15] Yet the term has come to mean something else: the race or ethnicity of the people in your genetic ancestry. Notice this slippage. According to one definition, our genetic ancestry consists of the *people* from whom we have inherited DNA. According to the other, our genetic ancestry consists of the social categories those people would have identified with or been classified into, were they alive today. As a result of this slippage, "genetic ancestry" has become a seemingly scientific substitute for race used by scientists and nonscientists alike.

There is a further slippage, which is that a DNA test can't tell you either who your ancestors were (unless their DNA is available for comparison) or to which

social categories they belonged (or with which they would currently identify). Genetic ancestry (as generally understood) is instead determined by identifying genomic similarities between the person in question and contemporary reference samples from various parts of the world. By triangulating in this way, a test might identify someone as having *x* percent "African genetic ancestry" or *y* percent "European genetic ancestry" or *z* percent "Asian genetic ancestry," when what they actually identify are percentages of a person's genome that *resemble those of people currently living in Africa, Europe, and Asia*. These geographical designations are salient to Americans only because they map onto our continentally based racial categories.[16] The concept of genetic ancestry therefore suggests that our ancestors belonged to discrete, genetically bounded populations that correspond to present-day notions of race and ethnicity, and that these identities can be read in our DNA, even though such groupings have never actually existed.[17]

Capitalizing on this line of research, numerous companies now sell Americans quantitative assessments of their "genetic ancestry," equating genetic similarity to reference samples in various parts of the world with an imagined biological autochthony in those parts of the world.[18] Indeed, members of white nationalist groups sometimes use the results of such tests as a basis for membership.[19] These products are designed by scientists who move readily between academia and industry, shuttling scientific and popular notions of ancestry back and forth and blurring them together as they travel.

In the chapter "Are People Like Metals? Essences, Identity, and Certain Sciences of Human Nature," the philosopher Mark Fedyk explores a tension between the statistical logic of classification based on ancestry testing, which partitions a person's unitary identity among categories that sum to 100, and the logic of people's "real-world" identities, which are often multiple, intersecting, and overlapping. For many Americans, DNA ancestry tests—whether people take them or not—play a role in the development or validation of racial or ethnic identity and endow those identity categories with a veneer of biological reality and scientific authority.[20] Fedyk argues that these identity categories, largely invented by the companies that sell the tests, have come to be understood, by scientists and the public alike, as "real essences" that somehow explain who we are and why we are the way we are, even when they don't resemble the ways in which people actually form and express their social identities. Ultimately, he insists that genetic models of identity are no more accurate or scientific, and may be less informative, than understandings of identity that come from the social sciences and humanities.

Although racial categories are fundamentally and irreducibly *social* taxonomies, they are nonetheless *real*. Social classification has material effects that produce biological differences, most visibly in health disparities.[21] The historian Terrence Keel argues that—contrary to the popular notion that science is opposed to religion—Christian thought about race and identity has been integral to both historical and contemporary scientific accounts of human diversity. He suggests

that "racial reasoning strategies" rooted in Christian intellectual history help explain current researchers' preference for "nature" as the cause of different health outcomes rather than social structures that give rise to disparities.[22] The concern over differentiating Christian Europe from "others" and present inclinations toward supposedly natural explanations tend to give precedence to fixed racial categories. The widespread perceptions among scientists and biomedical researchers that the causes of disease are primarily genetic rather than environmental and that racial health disparities are rooted in genetic difference has, perhaps paradoxically, led to racial exclusivity in genomic research. The vast majority of genomic research today is done on white-identified subjects, and white people are its primary beneficiaries.

But how can we argue for greater diversity in genomic research without reinforcing the mistaken and racist idea that race is a genetic category? This is the question the philosopher Tina Rulli answers in her chapter, "A Colorful Explanation: Promoting Genomic Research Diversity Is Compatible with Racial Social Constructionism." Calls to diversify genomic research often rely on and reinforce the assumption that humans are members of discrete "populations" or "ancestry groups," substituting these scientific terms for race and ethnicity.[23] Rulli begins from the scientific findings that human genetic diversity is geographically patterned and that it does not cluster into groups, much less groups that map onto US racial categories.[24] She argues that, due to the history of the ways in which racial categories have been socially, legally, politically, and economically constructed, two things are true. First, a database or study that includes only or primarily white-identified people is also highly likely to lack genetic diversity. Second, individuals who are differently racialized occupy different social, economic, and physical environments, and the same genes could behave differently in these different environments. Rulli contends that, while race is unlikely the *best* proxy for genetic diversity in research settings, it is possible to use race as a proxy for genetic diversity without endorsing racial essentialism or race realism. She cautions, however, against using an individual's racial identity as a proxy for their own genotype in clinical or other settings. More racial diversity in a research sample will likely increase the genetic diversity of the sample, but not because specific racial categories necessarily reflect specific genotypes.

The 1950 UNESCO Statement on Race equated racial groups with populations. However, populations are heuristics that might be useful for answering certain research questions, not biological realities.[25] Similarly, while some researchers treat "genetic ancestry" as a set of fixed, naturally defined categories, the chronological and geographical scale at which populations are identified is totally arbitrary and depends on the question being asked. For example, the same researchers might define populations in terms of countries or towns for one project and in terms of continents for another, and a group of people that might be classified as members of one population at a given point in time (for a specific research purpose) might

be classified as members of two separate populations at an earlier or a later point (or for a different research project). For the purposes of medical and social scientific research in the United States, however, genetic ancestry is usually identified at the continental scale, perpetuating the illusion that the social concept of race is built on a biological substrate of population divisions that have not changed from time immemorial.[26] As the bioethicist Jonathan Kahn explains, "the idea that there are somehow 'pure' types of African, European, or Asian DNA is a fiction, constructed not only by artificially bounding geographic areas but also by arbitrarily designating distinct points in time as marking the temporal moment of purity."[27]

This myth of a "temporal moment of purity," when humans fit neatly into discrete categories, is bolstered by the concept of *admixture*, a term that originated in race science to refer to interracial reproduction and now refers to the mixing (by reproduction) of two populations understood to have been separated in space and/or time, such that both lineages are identifiable (relative to some kind of reference) in the allele frequencies of the offspring. Since admixture refers to populations, and populations are local and relative rather than universal and absolute, admixture, too, is a local and relative concept that can be scientifically useful but doesn't identify anything in the real world. Like genetic ancestry, however, the concept of admixture can reify existing ideas of what constitutes populations and, by extension, racial and ethnic categories. Also like genetic ancestry, the concept of admixture can have social consequences within and beyond scientific contexts.

In their chapter, "Eventualizing Human Diversity Dynamics: Admixture Modeling through Time and Space," the anthropologist Carlos Andrés Barragán, population geneticist Sivan Yair, and philosopher James Griesemer show how the concept of admixture is used in the modeling of ancient migrations, specifically concentrating on the peopling of the Americas. They track the term as it has emerged and proliferated in the scientific literature and show how this genomic knowledge has made its way into popular contexts and back into science. The slipperiness of the term and the opportunities for misunderstanding make admixture a particularly valuable case study. For example, what counts as distinct populations and what timescale marks the divide between introgression, admixture, and migration are still unsettled. Given the ramifications of dividing and defining populations, Barragán, Yair, and Griesemer suggest strategies for reducing misunderstandings of admixture modeling between scientists and those outside the scientific community. They end with a consideration of both the limits and the potential of modeling.

The three chapters in "DNA and Race" consider how recent genomic research has reconfigured and thereby reinforced much older ideas of human difference. There is, perhaps, no better place to see the materialization of popular understandings—held by the public and medical professionals alike—than in the fertility clinic, where individuals and couples make decisions that are thought to have bearing on the racial identity and social characteristics of their future

children. The next part of the book turns to assisted reproductive technology to see how Americans understand race and other aspects of individual identity—specifically intelligence—to inhere in our DNA.

DNA AND REPRODUCTION

Reproduction typically combines the DNA of two individuals, though it is now possible to add the mitochondrial DNA of a third. Nowhere is the idea of building a baby from component parts starker than in the world of gamete donation, where would-be parents choose the person from whom half of their child's DNA will come. Despite the language of "donation," gametes are in fact bought and sold.[28] Most people using donor sperm purchase it from a commercial sperm bank, such as the California Cryobank. People using donor eggs can purchase them from an egg bank, such as Santa Monica Fertility, but given the fact that fresh eggs are somewhat more likely than frozen eggs to produce a live birth,[29] many egg recipients contract with individual donors, either directly or through an agency such as Circle Surrogacy, which maintains a database of individuals interested in selling their eggs. Donor sperm can be used in either intrauterine insemination or in vitro fertilization (IVF); donor eggs must be used in conjunction with IVF. Given the low success rates of IVF, the marketing of gametes is as much the selling of hope or the satisfaction of having exhausted all avenues for remedying infertility as it is the selling of fertility itself. In this selection process, sperm banks and egg brokerages invite prospective parents to consider the process of amalgamating their own DNA with that of a donor, or to consider how the characteristics of two donors will complement one another. In this amalgamation process, clinics and customers typically focus most heavily on the donor's race and/or ancestry and on their intelligence and/or educational attainment.

Direct-to-consumer (DTC) genetic testing companies present customers with a fractionated identity: parts that add up to a whole. One long-running ad for 23andMe showed a racially ambiguous woman traveling the world. As she moves from place to place, viewers realize that she is exploring in the world the ancestries she "discovered" through genetic testing: 29 percent East Asian, 3 percent Scandinavian, 46 percent West African. In each place, she seems to fit right in with the locals, presumably because she shares something fundamental with them—a genetic identity—even though they have lived very different lives. When prospective parents choose a gamete donor, that person's race or ancestry is never left up to chance. Sperm banks typically use several different metrics for this. As we saw in our perusal of the California Cryobank catalogue, donors are asked for their "ethnic origin," which elicits US Census race categories; their "self-reported ancestry," which elicits finer-grained identities, usually corresponding to countries; and whether or not they have "Jewish ancestry," a concept that blends religion, race, and ethnicity. Customers are thereby forced to consider the identity of their donor

in these terms, and some may even imagine what they would want their future child to learn if they were to send a vial of saliva to 23andMe.

In the past, clinics typically abided by the "one-drop" rule of hypodescent for mixed-race donors—meaning that donors with multiple identities were classified according to the one with the lowest social value—to make certain that characteristically minority phenotypes do not "surprise" white consumers.[30] More recently, however, clinics have allowed donors to identify with more than one race. Some (including the California Cryobank) make available the kinds of ancestry percentage breakdowns offered by DTC genetic tests for donors who choose to undergo ancestry testing. These results are reported in geographical terms, but color-coded such that all locations within a given continent are different shades of the same color. The report thus allows customers to easily translate between ancestry and race, implying that race is not just quantifiable but also precisely measurable.

In the chapter "Selling Racial Purity in Direct-to-Consumer Genetic Testing and Fertility Markets," the legal scholar Lisa C. Ikemoto argues that the quantification of donor ancestry, and its conflation with race, advances a dangerously incorrect model of racial diversity. The model implicitly assumes that there are—or once were—"pure" races, and that genetic ancestry testing reveals how these ur-races have combined in individual bodies. Although DTC ancestry testing companies and sperm banks that use ancestry testing appear to celebrate diversity, this model actually naturalizes racial inequality as the product of separate evolutionary processes. As Ikemoto points out, the idea of racial purity emerged in the context of global white supremacy and generally serves to protect the exclusivity of white privilege. In the realm of gamete donation, the use of ancestry testing as a marketing tool invites consumers to literally curate the racial identity of children and families, down to the percentage point.

In addition to classifying donors on the basis of several dimensions of biogeographical identity, sperm banks and egg brokerages also tout the intelligence and educational success of their donors. To be sure, they are responding to market demand, which is driven by a widespread belief, originating in the eighteenth-century eugenic thought of Francis Galton, that a person's socioeconomic status is determined primarily by their intelligence and that intelligence is determined primarily by biological heredity. The consumer-choice approach to gamete donation emerged with the rise of for-profit cryobanks in the 1970s.[31] Alongside these was the Repository for Germinal Choice, a sperm bank established in 1980 by the optometrist and businessman Robert Klark Graham. An avowed eugenicist, Graham sought to make the sperm of Nobel Prize–winning scientists available (for free) to high-IQ women in an effort to stem what he saw as the genetic deterioration of the US population.[32] Prior to the 1980s, when the HIV/AIDS epidemic spurred the rise of human sperm freezing, most sperm was used fresh, obtained from the donor on call—or the one who had most recently made a donation—at the time the recipient came in for her appointment.[33] Donors were typically

recruited from universities and selected by doctors (not recipients) on the basis of their looks and intelligence. DNA testing has recently revealed that some fertility doctors also impregnated unwitting patients with their own sperm.[34] The use of donor sperm in intrauterine insemination was controversial and legally questionable for a long time, and often embarrassing for infertile husbands even after the legality was settled.[35] To provide couples with plausible deniability, fertility clinics sometimes mixed donor sperm with the sperm of the patient's husband.[36] Until fertility treatment became a big business around the turn of the twenty-first century, doctors served as the gatekeepers to fertility treatment, deciding who was worthy of receiving donor sperm and other interventions.[37] Most fertility doctors restricted treatment to white women married to white men; some openly acknowledged their eugenic aims.[38]

Egg donation became possible more recently than sperm donation. For people trying to make babies, purchasing eggs is more expensive than purchasing sperm because retrieving eggs is more physically invasive, time-consuming, and risky for the donor. The technology for successfully freezing and thawing eggs became available much later than the technology for successfully freezing and thawing sperm. Sperm donors are typically compensated somewhere in the range of $4,000 for a series of weekly or twice-weekly donations over a period of several months.[39] Purchasing a vial of sperm will run you approximately $950 to $1,150. For eggs, there is less of a gap between what a donor makes and what a recipient pays, though the recipient usually also pays the donor's medical expenses, and the process of getting pregnant with donor eggs is typically more complicated and costly than is the process of getting pregnant with donor sperm. It is difficult to determine how much eggs cost on average because so many transactions are conducted privately. Additionally, egg donation agencies often let donors set their own compensation, which contributes to price variation. *Wired* has estimated that donors typically make between $8,000 and $10,000 per cycle, but they can charge up to $50,000 or more if they have desirable traits, including higher levels of educational attainment or matriculation at fancier universities.[40]

Once gamete donors are selected, or if a couple uses their own gametes, would-be parents need to decide which embryos to carry to term. This choice is most evident in the case of IVF, where patients often produce more viable embryos than they want to implant. But even people who get pregnant through sex or intrauterine insemination need to make choices about whether to undergo genetic screening or testing that could influence their decision about whether to continue the pregnancy. Indeed, the very existence of such tests is premised on the idea that certain results would lead to a decision to terminate.[41]

Until only a few years ago, in utero genetic testing (through amniocentesis or chorionic villus sampling) and preimplantation genetic diagnosis (in conjunction with IVF) were used only to identify chromosomal anomalies (such as aneuploidy) or straightforwardly genetic conditions that were known to run in parents'

families, such as cystic fibrosis or sickle cell disease. By "straightforwardly genetic conditions," we mean diseases or other medical conditions that are caused by identifiable genomic variants and where the biochemical mechanism by which the variants cause the disease is more or less understood. Many parents faced with the prospect of having a child with a serious genetic disease will choose to terminate a pregnancy or discard IVF embryos that carry the variants responsible, particularly for diseases such as Tay-Sachs. Children with Tay-Sachs suffer seizures, vision and hearing loss, and paralysis, and generally live to only four or five years old. Other conditions that are not fatal but may result in disability present ethical quandaries. Disability activists have expressed serious concern at the prospect of disability screening, arguing that the medicalization of disability results in a perception that "disability invariably equals tragedy," an idea at odds with the lived experience of many people with disabilities.[42] In addition to the medical community's attitude toward disabilities, many parents making reproductive decisions about having children with disabilities are often not disabled themselves and so may have difficulty understanding or anticipating the experiences of people with disabilities.

Technologies for the genetic testing of embryos (prior to implantation) or fetuses (in utero) are often presented as tools for making "healthy" children. But the definition of "healthy" children has become more capacious with the development of new screening technologies. Since the completion of the Human Genome Project, medical geneticists have developed new tools to identify genetic predispositions for conditions that are not straightforwardly genetic, such as heart disease, diabetes, and schizophrenia, which are believed to run in families but are not caused by a single gene and for which the biochemical mechanisms of causation are not known. A relatively new approach for identifying the "genetic architecture" of such complex diseases is the genome-wide association study (GWAS), which tests millions of loci across the genome for single nucleotide polymorphisms (SNPs—variations in individual nucleotides, the components of DNA) that correlate with the disease in question. Unlike straightforwardly genetic diseases like Tay-Sachs or Huntington's, where the biochemical function of the variant is known and the test can reliably predict the current or future presence of the disease, GWAS show that people with some constellation of variants may have some propensity to develop a disease predicated on environmental factors that may or may not be known. The result is a formula for calculating an individual's polygenic score or index, which is widely (but often incorrectly) interpreted as their genetic propensity for developing the given condition.

Scientists and other observers have criticized polygenic scores for a number of reasons. Since the conditions that are subjected to GWAS are heavily influenced by such nongenetic factors as diet, smoking, stress, socioeconomic status, and exercise, the polygenic scores produced by GWAS provide limited utility in predicting disease. Even if such risk factors could be accounted for, polygenic scores predict disease far better among white-identified people than among people of color, because the vast majority of GWAS include only white-identified people in their

discovery samples. The use of polygenic scores in medical settings (for example, to guide treatment or screening plans) therefore threatens to increase health disparities between white patients and patients of color.[43]

Racially structured differences in the predictive power of polygenic scores stem from the racial structure of GWAS themselves. Potential GWAS participants are classified by the continent(s) represented in their "genetic ancestry," and typically only those with continentally homogeneous ancestry are included. Due to the need for enormous samples and the fact that most GWAS are done by researchers based in the United States or Europe, individuals with exclusively "European genetic ancestry" are massively overrepresented in GWAS.[44] As of November 2023, the GWAS Diversity Monitor showed that GWAS participants were (in terms of "genetic ancestry") 94.7 percent European, 3.56 percent Asian, 0.18 percent African, 0.49 percent African American or Afro-Caribbean, 0.33 percent Hispanic or Latin American, and 0.68 percent other.[45] However, recent research has demonstrated that there is enough diversity *within* continents to undermine the findings of GWAS in European discovery samples that were previously thought to be relatively homogeneous.[46]

According to the prevailing "out of Africa" model of human history, individuals with exclusively "European genetic ancestry" comprise only a small fraction of the world's genetic diversity. In contrast, people with more recent "African genetic ancestry" encompass a great deal more diversity.[47] The construction of genetic ancestry for the purpose of GWAS closely matches the construction of race in the United States: GWAS typically include people with *only* "European genetic ancestry," just as the white identity category has historically been constructed to include individuals with *only* European ancestors. People who do not identify as white are therefore more likely to have genetic variants that have not been studied and are thus less likely to benefit from existing genomic research. At this point, polygenic scores for individuals of recent African descent are often no better than random chance for predicting disease risk.[48]

In spite of the fact that polygenic scores don't do a great job of predicting disease even among white-identified people, several new companies have begun to make polygenic embryo screening available to couples and individuals undergoing IVF. In the United States, Genomic Prediction and Orchid use polygenic screening to estimate risk for a number of diseases and medical conditions—including breast cancer, prostate cancer, diabetes of both types, coronary artery disease, and schizophrenia—to prioritize embryos for implantation. The price tag is in the thousands of dollars.[49] Only Genomic Prediction, whose motto is "choice over chance," acknowledges on its website that polygenic scores "perform less well when applied to individuals from distant [from European] ancestry groups (e.g., African ancestry, East Asian ancestry)." In the age of GWAS, "healthy" has come to mean not just disease free, and not just free of genes that are known to cause disease, but also as free as possible of disease risk.[50]

When Genomic Prediction first offered polygenic embryo screening in 2019, its scope exceeded disease risk: embryos were also tested for the risk of short stature and "intellectual disability," the company's disingenuous label for low predicted educational attainment.[51] This latter test was made possible by a series of GWAS of educational attainment that occurred over the past ten years.[52] Due to public distaste, Genomic Prediction quietly dropped "intellectual disability" from its menu of tests at the end of 2020. A 2021 article in the *New England Journal of Medicine* explained that selecting embryos on the basis of the polygenic score for education is unlikely to have the desired effect on children's intelligence or education levels.[53] Few of the SNPs that *predict* high educational attainment can be said to *cause* high educational attainment in any meaningful way. Most simply correlate with environmental predictors of high educational attainment, such as having well-educated parents and living in wealthy neighborhoods.

The chapter by the historian Emily Klancher Merchant, "Reproducing Intelligence: Eugenics and Behavior Genetics Past and Present," places the GWAS for educational attainment into a historical trajectory that reaches back through the behavior genetics of the mid-twentieth century to the eugenics of the late nineteenth century. Merchant demonstrates that eugenics inspired early twentieth-century efforts to measure intelligence and its heritability, or the amount of variance in a sample that is due to genetic variation rather than nongenetic variation, which formed the foundation for classical behavior genetics. GWAS for educational attainment provide a molecular update to this eugenic research agenda, but have not improved scientific understanding of how genes might contribute to individual differences in intelligence, educational attainment, or socioeconomic status. Instead, research probing the results of these GWAS has undermined the eugenic claims that inspired the field, demonstrating that, if genes contribute to these differences at all, direct genetic effects are very small and are largely overwhelmed by nongenetic factors, primarily childhood socioeconomic status.[54] Yet, as science turns up more and more evidence that the effects of genetics on individual differences in intelligence, educational attainment, or socioeconomic status are indeterminate at best, the scientists who produce these results increasingly publish books and articles for the general public claiming that DNA plays a decisive role in these matters.[55]

These books further popular but incorrect ideas that intelligence and socioeconomic success are genetically determined,[56] and these ideas are reflected in and perpetuated by the landscape of gamete donation. California Cryobank has locations in Los Angeles, Cambridge, New York, and Los Altos, which recruit donors from prestigious nearby universities, including USC, UCLA, Harvard, MIT, NYU, Columbia, Stanford, and UC Berkeley. Egg donors are also often recruited from universities and can request higher compensation if they have more education. DonorNexus, an egg brokerage, has a starting charge of $32,000 for its "premier egg donor" program, which allows prospective parents to select donors

"with a specific set of desirable traits, such as higher education, rare ethnicities, professional athletes, musicians, or models."[57] Seeking to highlight donors' youth as well as their accomplishments, the agency describes them as "smart and ambitious *young* women . . . *in the early stages of establishing themselves* in respectable lines of work" (emphasis added). Recognizing that egg purchasers value both beauty and brains, DonorNexus touts its premier donors as "fashion models, beauty pageant queens, actresses, tv hosts, social media influencers" on the one hand and as having "accomplished impressive academic milestones, such as engineering degrees, various graduate degrees, high SAT and ACT scores, law degrees, medical degrees, and PHD candidates [*sic*]" on the other. Such marketing indicates the widespread belief that intelligence, like appearance, is strongly rooted in DNA and therefore is transmitted by our gametes.

Research in molecular behavior genetics has not been limited to GWAS of educational attainment. Following the 2017 release of data from the UK Biobank, a flurry of GWAS claimed to identify the "genetic architecture" of just about every imaginable behavior or social outcome.[58] One of the most controversial was a GWAS of same-sex sexual activity.[59] The suggestion that sexual orientation could have a genetic component is not new. In 1993 the geneticist Dean Hamer and his colleagues found apparent evidence that male homosexuality correlated with certain markers on the X chromosome.[60] The idea that sexuality was genetic seemed liberatory to many LGBTQ Americans, indicating that sexuality was inborn rather than a matter of individual choice or pathology.[61] To others, however, the possibility of a "gay gene" raised the specter of eugenics: if sexuality were genetic, then nonheteronormative sexual orientations could be selected against. To still others, the idea that LGBTQ identity was acceptable only because people "couldn't help it" was both condescending and constraining, especially for people who identified as bisexual. It's also worth pointing out that, while most conservative Protestants believed that you could "pray the gay away," the Catholic Church was willing to accept that sexual orientation may be innate. That does not mean, however, that the Church condoned homosexual activity; it instead taught that such people must remain chaste.

Prior to the turn of the twenty-first century, most American doctors felt that, regardless of whether sexuality was determined by genetic or environmental factors (or both), LGBTQ individuals or couples should not have children. As a result, single people and same-sex couples were denied access to assisted reproductive technologies by the doctors who controlled them.[62] In many countries where assisted reproductive technologies are more heavily regulated than in the United States, these services are still limited to heterosexual couples. Even in the United States, the Food and Drug Administration bars commercial sperm donation by men who have had sex with men in the five years prior to donating. While this restriction is ostensibly intended to protect recipients from HIV infection, there is actually little risk of HIV infection from commercially available

sperm, as donors are required to be tested for HIV and samples are quarantined for six months, at which point donors are retested.

Between 1993 and 2019, research on supposed "gay genes" remained inconclusive, neither validating nor invalidating theories about the heritability of sexual orientation. The 2019 GWAS of same-sex sexual activity suggested that loci across the genome influence sexuality.[63] For those who worked on the study, its results appeared to demonstrate the naturalness of same-sex sexuality without identifying one or two genes that could be selected against.[64] It nonetheless raised considerable concern among LGBTQ geneticists affiliated with the Broad Institute, where the study was carried out.[65] These concerns were vindicated when an app titled "How Gay Are You?"—purporting to calculate an individual's polygenic score for "gayness" using the results of the 2019 study—appeared on the app store GenePlaza.[66] The lead scientists on the 2019 study responded with an open letter denouncing the app and claiming that its developer had misappropriated the results of the study, which, the authors claimed, were not to be used for individual prediction. But individual prediction is exactly how polygenic scores are used in medical genomics and by Genomic Prediction and other companies offering polygenic embryo screening.

Today, parents undergoing IVF can choose to receive a "report card" for each embryo, indicating its risk level for a variety of complex diseases. They can also download raw data for each embryo and then upload the data to any of a variety of websites offering to calculate polygenic scores for educational attainment. Scientists expect that it will not be long before embryo "report cards" include predictions of each embryo's future IQ, height, sexuality, and aptitude for particular vocations.[67] Recent studies have indicated that prospective parents would welcome the ability to select embryos on the basis of such information.[68] Already, parents using gamete donation have the ability to carefully curate the racial composition of their families. The chapters in "DNA and Reproduction" examine the racist and eugenic motives behind these opportunities and consider their potential consequences.

RACE AND REPRODUCTION

As a social category, race has always depended on social institutions—particularly families—to perpetuate it. Reproduction is fundamentally a technology for making families, and the final section of the book turns to the racialization of families and children within them. As we have noted, popular ideas about the genetic foundation of race, ethnicity, and other social characteristics typically make their way into reproductive decision-making when individuals or couples decide to use donor gametes. Whether one goes to a sperm or egg bank, or to an egg broker, what is available is notionally driven by "client choice." In theory, clients can decide exactly what they want in a vast "genetic supermarket," which—in the most optimistic version—is imagined as having "the great virtue"

of "involv[ing] no centralized decision fixing the futures of human type(s)."[69] In actuality, gamete banks and donation agencies seek out the donors who prove the most marketable, and what is marketable closely tracks existing hierarchies.[70] Indeed, while some donor characteristics, such as occupation, are presented to prospective parents as options, others, such as disability, are so stigmatized as to be excluded from the outset.

Genetic ancestry maps present nationalities or ethnicities as finer divisions of continental racial groups. The dynamics of the fertility market, however, suggest that consumers are more concerned about the race of donors than about their ethnicity or nationality. For example, white prospective parents from Western Europe and North America frequently cross national borders (or fly donors across borders) to procure "white" eggs from countries such as Ukraine, South Africa, or the Czech Republic, where donors typically receive less compensation than donors in Western Europe or North America.[71] Gamete recipients seem to care more about the ethnicity of donors when that ethnic identity also has a religious dimension. The medical anthropologist Daisy Deomampo describes an egg purchaser deliberately choosing a Hindu donor because he seemed to "believe that religious identity was . . . embedded in genetic ties."[72] Along similar lines, in addition to filtering potential donors by religion, California Cryobank allows customers to filter by "Jewish ancestry," suggesting that—on some level and for some religions only—a person's ancestors' beliefs and practices are encoded in their DNA. Definitions of race and ethnicity, and the categories used to distinguish people along these axes, are conventions, not facts of nature.[73]

Sperm and egg purchasing sites indicate that brokers and recipients view race and ethnicity as both nonnegotiable and reducible to searchable categories, while other traits, such as education, occupation, and special abilities, may be opportunities for negotiation. Sperm banks and egg brokerages typically present race as a category of consumer choice, even as they rigorously enforce racial boundaries. Staff often take it upon themselves to match donors and recipients on the basis of phenotype and/or identity,[74] or to restrict the use of gametes from white donors to white recipients.[75]

The idea that race and ethnicity are transmitted genetically stems from and supports the institutions that ensure they are transmitted from generation to generation socially and legally. In the purchase of sperm, race is so important to customers that many sperm banks color-code vials according to the race of the donor in order to avoid the kind of mix-up that led Jennifer Cramblett, who is white, to sue Midwest Sperm Bank after the birth of a daughter who was conceived with the sperm of a Black donor instead of the white donor Cramblett had selected.[76] This case indicates two things: First, that whiteness is a kind of property that children inherit from their parents. As the legal scholar Patricia Williams explains, Cramblett's "claim was explicitly based on the deprivation of whiteness as a trait she thought she was purchasing."[77] The sperm mix-up prevented Cramblett's child

from inheriting her racial status. In other words, it prevented her from bequeathing her white privilege to her child and denied her what she considered a "legal right to a monoracial family."[78] Second, and perhaps more obviously, this case indicates that race is widely believed to be transmitted through sperm and eggs to the exclusion of other biological or social mechanisms. For this reason, white would-be parents are typically more likely to choose a non-white gestational surrogate (who gestates but does not contribute DNA to a child) than an egg or sperm donor who is not white.[79]

Prospective parents in search of donated gametes often describe their racial specifications in nonracial terms as a desire to produce children who look like them and who fit in with their broader extended families. Historically, the fertility industry emerged to help white couples expand their families. Clinics therefore tend to construct and market whiteness as "neutral" in the sense of being "unmarked, unencumbered by geographic and ethnic specificity."[80] Clients and brokers rarely need to state an explicit desire to procure gametes that will create children who can "pass" as the biological kin of white heterosexual parents because the notion is so naturalized as to go without saying.[81] Yet the illusion of whiteness as neutrality breaks down when fertility industry clientele expands beyond white couples and individuals. In some cases, prospective parents themselves want donors who share their phenotypic features and/or their racial or ethnic identity, but in other cases they do not.[82] Sometimes these desires come into conflict with one another—for example, when the donor who looks most like a prospective parent does not share their racial or ethnic identity.[83]

The commoditization of race in the fertility industry reveals that what looks like a set of consumer choices is in fact a market formed by existing preferences and prejudices and iteratively reinforced by gamete recipients and brokers.[84] Individuals and couples whose preferences are not aligned with this mainstream market have fewer choices available to them. Practitioners of fertility medicine have long structured the market for assisted reproductive technology in ways that exclude minoritized people. The legal scholar Dorothy Roberts observed over 25 years ago in her essential work *Killing the Black Body* that the fertility industry codes infertility as a white woman's disease in spite of much higher rates of infertility among African American women.[85] This coding both reflects and perpetuates the fact that, even though African American women are more likely to suffer from infertility, they are less likely to be able to access or afford assisted reproductive technologies. However, simply characterizing this inequality as a problem of access or money erases the very real presence of racism in fertility medicine encounters. The medical encounter itself enacts what Davis calls "obstetric racism," in which Black women are subject to racial and gender hierarchies that structure clinical relationships.[86] Finding Black gamete donors is difficult for prospective parents who prefer to do so. For example, of the 234 sperm donors available in the California Cryobank in July 2022, only three were listed as "Black or African American."

According to the legal scholar Camille Gear Rich, our observation is typical: many gamete agencies have no Black donors at all, and those that do have very few.[87] As a result, minoritized individuals wanting to donate gametes and couples seeking gametes from minoritized donors turn disproportionately to informal and unregulated networks of exchange.[88]

The desire for intrafamily racial sameness or blending to match mixed-race couples often rests on unspoken ideas of race as kinship. It is not universal, however. Deomampo has described both white and Asian prospective parents seeking out donors with the other racial identity (white parents seeking Asian donors and Asian parents seeking white donors) in order to create a child who is *hapa* (half-Asian and half-white) because such an identity is valued in Hawai'i.[89] Medical anthropologists working in Asia have also identified a desire for white sperm and egg donors. Prospective parents may describe this preference as an expression of their cosmopolitanism,[90] though the sociologist Amrita Pande contends that this purchasing of white privilege reflects and perpetuates the global valuation of whiteness above all other racial identities.[91]

Prevailing notions of racial identities as primarily phenotypic and genetic mean that they are sometimes construed as socially representative, which means they can be used in an instrumental way. For example, some white Evangelical Christians have championed transracial adoption of non-white children as a means of achieving racial reconciliation.[92] The anthropologist Risa Cromer reveals a recent trend among white Evangelicals to "adopt" non-white embryos (created during IVF but not used by the couple who created them) as a means of addressing "racial conflict."[93] Embedded in this practice is the notion that, somehow, biogenetic phenotype works as a stand-in for the cultural experience of race to such an extent that deep social rifts can be healed through transracial adoption. Evangelical Christians tend to see racial identity as biological and phenotypic. Even as they condemn racism, they characterize it as being only about skin color.

The chapter by the scholar of religion Meaghan O'Keefe, "Evangelical Christianity, Race, and Reproduction," explores white Evangelical Christian ideas of race and how it is reproduced. O'Keefe traces the historical relationship of race science to religion in the United States in order to contextualize contemporary religious and political beliefs about race. The slippage between social and genetic identities we discussed above figures slightly differently in white Evangelical communities. White Evangelicals tend to avoid discussions of racial identity. When such topics do come up, they are often viewed as divisive, and divisiveness is often cast in religious terms: to point out racial discrimination within the Church is to undermine Christ's vision for the Church as the unity of all believers.[94] More generally, Evangelical attitudes toward behavior genetics function in similar ways to Evangelical beliefs about racial politics. White Evangelicals are far more likely to attribute economic disparities between white and Black individuals to the result of poor personal choices. They see claims about racial discrimination as an excuse for

not taking individual responsibility. The theme of individual responsibility carries into genetics, with white Evangelical leaders typically condemning using "your genes" as an excuse for bad behavior (including being gay). The one area in which biology and social roles are considered inseparable is gender. For white Evangelicals, men and women are complementary (they complete one another), and chromosomal sex is determinative.

As we have discussed throughout this introduction, race is widely understood to be genetically transmitted, even though it is maintained and experienced socially and institutionally. While some prospective parents may carefully curate the race of their offspring-to-be, they can't necessarily control how their children will identify or be identified once they are born. In the chapter "How Does a Baby Have a Race?," the public health geneticist Alice B. Popejoy examines how popular understandings of race and its transmission intersect with bureaucratic structures to assign racial identities to newborns. Social scientists and the US government typically define race as a category of identification that is co-constructed between an individual and the society in which they live. Popejoy describes how the process begins at or even before birth, when families, medical personnel, researchers, and governmental agencies apply racialized classifications to infants and their parents. Before the newborn has had an opportunity to develop a racialized sense of self, they are born into a context in which their parents' experiences and even their own prenatal ones are shaped by race, and race is assigned to them through bureaucratic and statistical processes in which they have no input.

CONCLUSION: CROSSING DISCIPLINARY BOUNDARIES

Ideas about how happy, healthy families ought to be formed are mediated by a fairly homogeneous set of institutional and commercial entities, and these entities shape what choices are made in the context of genetic disease and what ethnicity, race, and family resemblance mean. In the realm of reproductive and fertility medicine, people choose from a preordained set of options. These options are structured by racial categories that have been produced and maintained legally, socially, and scientifically over generations. New ideas about what constitutes populations and what ancestry is and is not have more recently developed in the context of genomic research and DNA testing. Popular, legal, historical, and scientific ideas about genetic and racial identities have commingled and combined, creating an amalgamation of sometimes conflicting ideas about who we are and how our self-identities and those identities forced upon us shape our experiences. These topics cross disciplinary boundaries; working in and with human genomics and genetics means thinking seriously about the social consequences of classifying race and ancestry and about distinguishing between health and disease and between favorable and unfavorable social outcomes. Similarly, humanistic

scholarship on such topics needs grounding in scientific approaches, the workings of assisted reproductive technologies, and the intricacies of institutional biomedical research. None of this work can be done in isolation. This book offers a set of reflections and arguments that have developed from our conversations with one another. We hope to create similar opportunities for all our readers to think clearly and talk to one another about the fundamental questions we face together in the genomic age.

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