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The Biopolitics of Life

Biotechnology, Biocapital, and Bioethics

We all live with a concrete awareness that we cannot say No to science, technology and medicine. Even if we wanted to, we cannot say No to the medical complex that appropriates our bodies, defines our state of health, and positions us in a continuum of fitness from the temporarily abled to the permanently disabled. . . . How are we to understand our often intense hunger to say Yes?

—Downey and Dumit (1997:5)

Introduction and Overview

We begin this chapter with an outline of the way health anthropologists approach biotechnology and introduce the reader to some of the debates and international examples of impacts of biotechnologies. We end the chapter with specific case studies of history, ramifications, and applications of these ideas. We talk about the way applications of biotechnologies have formed and been formed by conceptualizations of nature and the ways in which biotechnology has been used to define humanity as separate from both animals and machines. We consider ethical implications of the use of these technologies and, through the lens of biocapital, explore how they interact within the contemporary global economic environment.

We will then consider the ways in which biotechnology has allowed us to shape notions of kinship and how it has enabled us to divide the body and package biomatter in line with the demands of the global market system. We examine the gap between anthropology and the cognitive sciences, and see how advances in biotechnology have forced us to productively question scientific disciplinary boundaries. After that, we examine ways in which biotechnology has allowed us to manipulate the foundational building blocks of life and the ways in which science has dealt with the capitalist structures of development pipelines, corporate infrastructures, and the market.

We offer three anthropological case studies of socially transformative biotechnological application: the development of human Growth Hormone (hGH), the invention of the Polymerase Chain Reaction (PCR) process, and the impacts of visual scan technologies. We close the chapter by considering the combined effect of biotechnologies on how we use them to structure nature, society, and family and a case study of ancestry, conceptions of race, culture, and belonging.

Critical Health Anthropology and Biotechnology

Within health anthropology, biotechnology is used interchangeably to refer to both technology based on biology, and as a shorthand for biomedical

technology. For anthropologists, medical technology can be any type of technology used in healing processes, including a thermometer; crystal singing bowls used for Tibetan healing ceremonies; medical visualization equipment such as ultrasound or a CAT scan; complex laboratory equipment used for genetic testing, as well as the science that went into mapping the genome and developing the testing procedures; or a pipe used to smoke Mapacho, a Peruvian tobacco used as a plant medicine. Biotechnology includes the material culture of health, the research and knowledge to understand and interpret knowledge extracted from bodies and their environment, and technological manipulation of the organic world for health purposes.

It is difficult to imagine health anthropology research that doesn't involve biotechnology in some way or another. As has been discussed elsewhere in this book, anthropologists do not see science as separate from culture. Science and scientific developments take place within particular cultural contexts and are informed by cultural beliefs and practices. They are shaped by the cultures in which they are embedded, and shape those cultures in turn. Health anthropologists engage with biotechnology when we explore cultures of science and scientific endeavor, impacts of health technology on understandings and constructions of personhood, and the complex ways in which technology impacts on health equity. Biotechnology has the capacity to both ameliorate and exacerbate health inequities, and anthropologists have long been important contributors to the complex bioethics debates that surround biotechnology.

When viewed through a global lens, there are striking patterns present in many applications of health technologies: wealthy, first world bodies often benefit at the cost of bodies in the developing world. The health of the wealthy frequently benefits from the ill health of the poor. Clinical trials are undertaken in impoverished parts of the world, often in slum areas where the offer of regular medical check-ups can be an enticement for participation. At their worst, some trials have been found to be scientifically flawed and deeply unethical, with side effects not monitored or recorded, and in some cases trial participants have been left with life-threatening health consequences from their participation (Kamat 2014). Even when undertaken ethically and with scientific rigor, conducting trials of pharmaceuticals and other biomedical products in impoverished areas has deep ethical implications. For the most part, these products will be made most easily available, when proven safe, to wealthy consumers, and are often financially out of reach of people in the communities on which they were tested.

Science, Nature, and Culture

People are meaning making creatures. We make sense of the world through the construction of complex cosmologies that assign a categorical order to everything in the world. The applications of biotechnologies to human bodies often challenge these systems of order and offer many productive inroads for anthropological insight. In their landmark study *Laboratory Life*, originally published in 1979, Bruno Latour and Steve Woolgar state that rather than focusing on the “facts” that scientists “discovered” in their laboratory, they aimed to “determine

how a fact came to acquire its character in the first place” (1986:273). Latour and Woolgar suggest that what they discovered was something that lab scientists had known all along, but wasn’t as well understood outside of laboratories. Discovery is subjective and cultural beliefs, values, and relationships play a significant role in the construction of scientific categories and knowledge. This insight has informed the work of many anthropologists, including David Schneider’s (1984) analysis of the cultural construction of the concept of blood relatedness (more about that later in this chapter), and Emily Martin, whose article “The Egg and The Sperm: How Science Has Constructed a Romance Based on Stereotypical Male-Female Roles” (1991), and has been deeply influential for a generation of scholars working on bioethics and social implications of biomedical interventions. Latour and Woolgar’s articulation of the social and cultural construction of “scientific” knowledge continues to inform health anthropologists’ research into established and emerging health technologies.

Another important contribution to health anthropologists’ understandings of biotechnology emerged from Donna Haraway’s work *A Cyborg Manifesto* (1991), where she suggests that the twentieth century had heralded the breaking down of three previously rigid boundaries that defined what it was to be a human being. The first boundary breach she discusses is the boundary between human and animal. With the development of animal to human transplantation, the idea that organs of animals of other species can be used to treat humans has opened fierce ethical, spiritual, and scientific discussions. Disease transmission across species boundaries, such as avian flu and swine flu, have all impacted on scientific and lay concepts of boundaries between humans and other species. Haraway (1997) developed this even further when she articulated feelings of kinship with *Oncomouse*[™], a laboratory mouse that was genetically designed to be susceptible to particular cancers, so that cancer treatments can be tested on it. Critiques of clinical trials as being gendered, and gender discriminatory, have argued that women’s bodies, especially the bodies of impoverished women, are often used unethically in medical trials (Rajan 2017). The idea of women being treated as “guinea pigs” in clinical trials resonates through much critical biotechnology literature (Arditti et al. 1984, Corea et al. 1987, Finkler 2000).

The second of Haraway’s boundary breaches occurs in the ways in which boundaries between humans and machines are increasingly permeable. With pacemakers, joint replacements, bionic limbs, and other machine-like enhancements, Haraway argued that the cyborg human was no longer science fiction, but very much a reality. Finally, Haraway argued that the physical and non-physical worlds became increasingly less bounded. A quarter of a century later, in light of developments of the internet and virtual realities, this aspect of Haraway’s work appears especially prescient. Haraway’s contribution challenged taken-for-granted assumptions about how people articulate nature and humanity through biotechnology. Her work opened a series of crucial ethical and methodological issues, raising questions about the position of humanity in relation to nature and technology.

In addition to Latour and Woolgar’s repositioning of science-as-culture, and Haraway’s repositioning of personhood by defining human beingness as

being merged with, rather than apart from, technology, there emerged a body of anthropological work focused specifically on the nature of nature. “Nature” had often been posited as the opposite of “culture,” with nature being the natural world created by God or evolution, depending on your belief system, and culture being the parts of the world created by human activity. Marilyn Strathern’s work *After Nature* (1992) suggests that rather than being in an oppositional relationship with culture, nature itself was a cultural construction. Yanagisako and Delaney suggest that calling something “natural” was a way of investing it with particular sorts of power and legitimation (1995). Many of the core debates around bioethics and emerging biotechnologies center on that point: if a technology can be said to be creating something seen as “unnatural,” arguments opposing its development are often strengthened, whereas if discourses of naturalness can be called upon, the ethical argument for a particular technology is often enhanced. For example, when the idea of in vitro fertilization (IVF) was initially introduced as a scientific possibility, opponents argued that the idea of a baby conceived in a test tube was an aberration (against God or Nature or both). Advocates of IVF mobilized the “naturalness” of the desire for people to become parents, especially the “natural” instincts of women to become mothers by whatever means possible, to suggest that fertility interventions such as facilitating the joining of egg and sperm in a test tube rather than a womb were fulfilling a natural desire, and were therefore a morally legitimate use of biotechnology. That nature can be and is taken up by both the opponents and proponents of biotechnologies demonstrates both its malleability and its potential for disruption.

Biocapital: Bodies of Profit

Studies in biocapital explore relationships between forms of life and forms of exchange, including phenomena as diverse as the market value of body organs; attempts to patent genetic material; slavery and human trafficking; economic value of reproductive material and services; and clinical trials of pharmaceuticals (Dumit 2012; Franklin 2003; Rajan 2006, 2017; Rose 2007; Waldby and Mitchell 2006). Biocapital involves “product-making and profit-seeking” by transforming “biotic material and information” into “value, markets, wealth and profit” (Helmreich 2008:464). Biotic material and information can include entire populations or individuals, as well as parts of individuals from organs down to the level of cells, molecules, genomes, and genes.

New capitalist practices see university and corporate biosciences becoming porous to one another, with the circulation of biomaterials between labs governed by novel regimes of buying and selling—regimes set in place by regulatory transformations, primarily in the United States, that permit the holding of intellectual property in biological matter and knowledge. (Helmreich 2008:464)

In the sections that follow we explore a number of case studies in biotechnology that highlight relationships between science, biology, culture, capital, and health. We present ways in which concepts of kinship and personhood have been constructed, deconstructed, and disrupted through increasing normalization of reproductive technologies, biotechnological imaginaries of race and ancestry, and

through the lens of designer baby debates. We look at ways in which molecular biotechnologies break down what it means to be human and ways in which imaging technology challenges knowledge construction and disciplinary boundaries. We examine ways in which market pressures and the culture of the laboratory influence scientific ideas and challenge classic scientific claims of objectivity. We finish by looking at the ways in which combinations of biotechnologies are key in constructing our ideas of self, family, and society at large.

Biotechnology is applicable to all manner of life. In the context of health anthropology, questions of biotechnology tend to revolve around our constructions of the human-self and society. In popular discourse, biotechnology is often reified, given a kind of superhuman agency. From an anthropological perspective, however, the sophistication of technology does not stop it from being a tool for the expression of human desires and the construction of human designs. As we alter the world around us, we also alter ourselves. Biotechnologies are tools that we use on ourselves. Subsequently, the transformations we generate with these technologies are loaded with reflections of our norms, aspirations, and anxieties, and with reflections of power relations, ethics, and inequities of the sociocultural contexts in which they are embedded.

Reproductive Technologies

In the last half-century, in middle- and upper-class industrialized communities across the globe, there has been a profound separation of sex and reproduction (Bates 2010:93). With the advent of reliable and accessible contraception, it is ordinary to have sex without reproducing. With the advent of IVF and associated technologies, it has become technically possible, socially acceptable, and increasingly normalized to reproduce without having sex. Developments in reproductive technology have not only meant changes in the way babies are conceived, but they have also had a fundamental impact on the ways in which we understand (conceive of!) kinship and personhood. Donor sperm has paved the way for social acceptability of a person's biological father and social father being different people. Surrogate gestation, where an embryo is implanted in a woman who is not necessarily the child's biological mother, means a child may be carried and birthed by a woman who is neither her biological mother nor the mother who will raise her. The section that follows will consider the way that biotech-facilitated procedures like IVF, surrogacy, and biomedical interventions in gender complicate and disrupt Western notions of kinship, as well as enrich our understandings of it.

Early anthropology kinship diagrams did not differentiate between different types of mothering and fathering: each person on a kinship diagram had a linear relationship with a male person and a female person who were assumed to be their social and biological mother and father.

Figure 8.1 shows us Hulya, her mother, father, older sister, and younger brother. Aspects of relatedness that did not fit the acceptable Euro-American family model, such as Latin American *comadres* and *compadres* (co-mothers and fathers) or milk kinship (relatedness established through breastfeeding) were

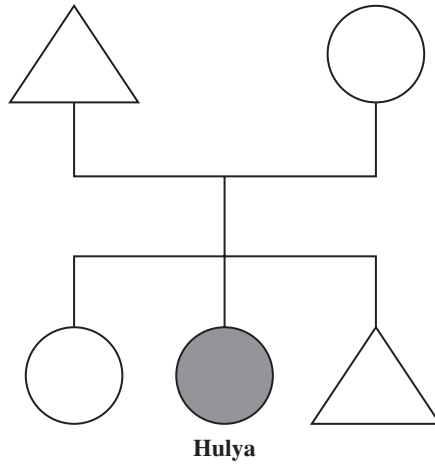


FIGURE 8.1 Hulya's Family.

delegitimized and labeled “fictive” kinship (Altorki 1980; Khatib-Chahidi 1992; Long 1996, 2003; Schneider 1984; Yanagisako and Delaney 1995). So-called fictive relationships were drawn on to kinship diagrams in dotted lines and were differentiated from “real” “blood” relationships. Schneider, in making the point that blood relatedness was a metaphor rather than a scientific fact, drew our attention to ways in which representations of relationships in kinship diagrams conflated the Euro-American concept of blood kinship with a normative social kinship based on Euro-American ideas of what a normal (i.e., good, moral, acceptable) family was (Carsten 2011, Schneider 1984, Strathern 1992, Yanagisako and Delaney 1995).

Looking at the blood groups of family members of one of the authors of this book illustrates this. Figure 8.2 shows the blood types of Debbi, her mother,

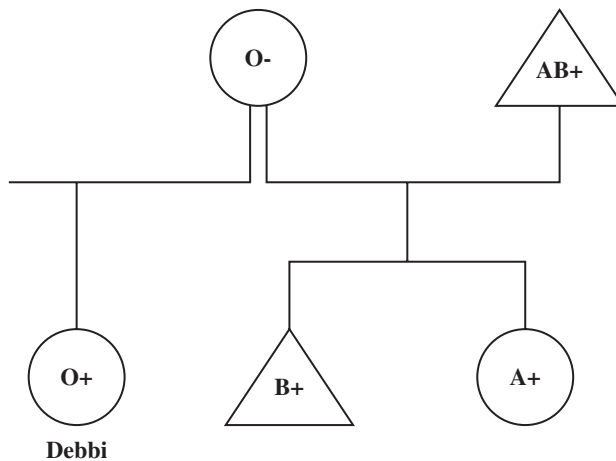


FIGURE 8.2 Blood Types in Debbi's Family of Origin.

her mother’s husband, and their two children. Even though blood relatives are understood to “have the same blood” in folk understandings of Euro-American kinship, it is possible for people to be related and have completely different blood types.

In this case, although everyone is related “by blood” to two or more of the others in the diagram, not one of them share the same blood type. Although Debbi’s mother could safely donate blood to everyone, Debbi could not safely donate blood to her mother, while she could safely donate blood to her stepfather, to whom she is not related “by blood.”

At the same time, people totally unrelated to each other can be the same blood type. Figure 8.3 shows Debbi, her son, and the father of her son. Although Debbi and her son’s father are from different continents and are not genetically related, they and their son all share the same blood type and can safely donate blood to each other.

With the advent of what Nelkin and Tancredi (1989) labeled the new reproductive technologies (NRTs), the ways in which the relatedness of a new human coming into the world is understood has shifted dramatically in Euro-American cultures. Prior to the era of the new reproductive technologies, while adopted children could have different biological and social parents, the “normalized” child-parent relationship was for a child’s mother to be his or her genetic, birth, and social mother, coupled with the expectation that the social father should also be the genetic father.

In some communities around the globe it is now not only possible, but also not especially uncommon, for children to have five different people as part of their parenting cohort: social mother and father, genetic mother and father, and gestational mother. The role of biological mother was previously indivisible. NRTs provide for the possibility for the genetic mother and the woman who carries the child to not be the same person. Genetic and gestational motherhood are no longer inseparable (see figure 8.4).

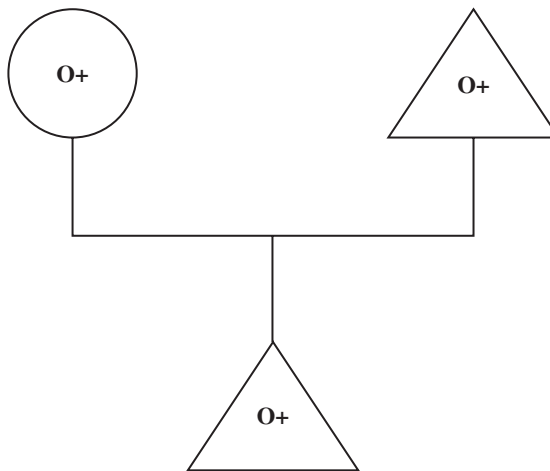


FIGURE 8.3 Blood Types in Debbi’s Family of Procreation.

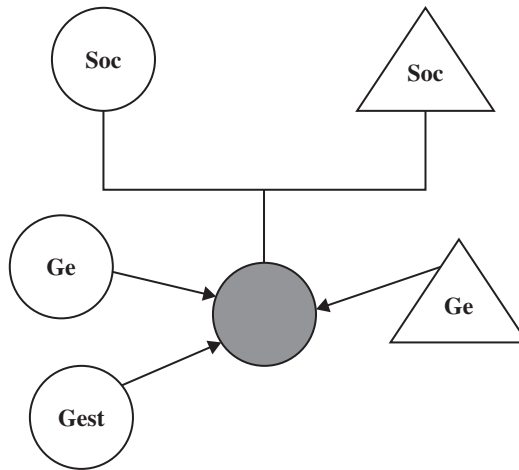


FIGURE 8.4 Social (Soc), Genetic (Ge), and Gestational (Gest) Relatedness.

The increasing divisibility of parenthood is occurring at a time when gender categories are increasingly, and heatedly, contested. Binary gender configurations, where there are just two genders, male and female, and every individual is either one or the other, are being challenged by increasingly fluid gender configurations. While there is a long-standing body of scholarship in anthropology around “third gender” categories (Herdt 1996), binary gender categories have, in recent years, come under much broader public scrutiny. Fluid gender categories are challenging biological determinism, while hormonal and surgical technologies are creating possibilities to change aspects of personhood that were previously seen as inalterable. For many transgendered people, this allows them the possibility to inhabit a body that is in alignment with their internalized sense of gendered self (Herdt 2010, Valentine 2007).

At the end of the twentieth century, there were few countries in the world where same-sex couples could be socially and legally recognized as parents. In less than two decades, the marriage equality movement has meant that in many countries, same-sex couples, or people in gender fluid relationships, can have their kin relationships with children and each other legally recognized. A kinship diagram in an anthropology textbook with parents of the same sex would not have made sense thirty or forty years ago. Now because of technological and social changes in the ways that families are conceptualized, it makes perfect sense for many people (see figure 8.5).

The case of reproductive technology demonstrates how entangled the social and technological are. Carol Delaney suggests that in all cultures, beliefs about creation and procreation are inextricably interlinked (1991). The beliefs we have for how life on earth came into being are consistent with the logic of our beliefs for how new lives come into being. Adoption of new reproductive technologies brings new concepts about creation into the world and shifts the understandings of the communities they impact in their relations with each other and with their environments.

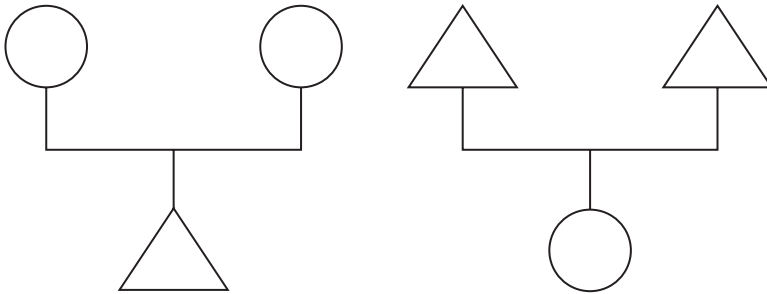


FIGURE 8.5 Kinship Diagrams with Same-Sex Parents.

Reproductive technologies have introduced new ways in which inequities of maternal opportunity are enhanced. There is a long history of women oppressed by status beliefs (including class, color, and/or ethnicity) being forced to relinquish part or all of their own maternal relationships to perform mothering functions to the children of wealthier families. With the advent of NRTs, new inequities have arisen whereby poorer women sell their eggs and/or bodies to contribute toward the production of children for wealthier families (Lock and Nguyen 2010, Pande 2011, Panitch 2013, Whittaker 2014). In an example of biocapital exchange, local beliefs, economics, and laws combine to generate many manifestations of surrogacy relationships: in the United States laws do not prohibit paid surrogacy, and there are many poorer American women who act as paid surrogates for wealthier families, sometimes with their own eggs, sometimes being implanted with a fertilized egg of the social mother and/or father. Famous examples of celebrity children born as a result of surrogacy relationships include Michael Jackson’s children and the children of Nicole Kidman and Keith Urban. In Australia, where the law prohibits paid surrogacy, there are established “trade routes” of families using Thai, Indian, and other impoverished women of color as paid surrogates. In Europe, impoverished Eastern European women act as surrogates for wealthier Western European families. In most cases of paid surrogacy, the pregnancy is not initiated by sex, but in a test tube, and transfer into the womb is facilitated with a speculum, pipette, and dry ice storage to freeze and keep the embryos viable until they are ready to be implanted into the surrogate womb.

Divisible Bodies

While surrogacy involves commodification of whole humans, intersections of globalization, wealth inequity, and biotechnologies have created new “industries” in body parts in the form of body organs being made available, through donation, sale, or theft, for transplant. Anthropologist Nancy Scheper-Hughes (2000) has been central in bringing to public attention global trafficking in transplant organs, while other ethnographic accounts have focused on the meanings of the relationships created through donor transplants (Kisch et al. 2018). Organ transplant is one of the areas where the multidisciplinary nature of medical

anthropology is most stark: for anthropologists this job entails holding power accountable when abuse is uncovered; for many clinician-anthropologists the strength of ethnography is in providing insights that can enhance the effectiveness of medical systems, rather than challenge them.

Permeating all of these areas is the enormous variation within and between cultures in etiquettes, norms, and values around corporeal reciprocity. Taking anthropologist Marcel Mauss's concept of reciprocity articulated in *The Gift* (1925), British sociologist Lloyd Titmuss's landmark book *The Gift Relationship: From Human Blood to Social Policy* (1970), which was named by the *New York Times* as one of the ten most important books in the year of its publication, compared the United Kingdom's system of blood donation in which blood was given without economic recompense, and seen as a gift from donor to recipient, with the system in the United States in which blood is framed as a commodity that the donor sells and the recipient buys. Legal academic Kara Swanson's work *Banking on the Body: The Market in Blood, Milk, and Sperm in Modern America* (2014) explores the commodification of what Long (2016:7) refers to as the nutritive and procreative body fluids. Health anthropologists have made significant contributions to discourses on commodification of the body (Scheper-Hughes and Wacquant 2002). We suggest that there is also value in the anthropological approach to understanding these complex reciprocities as globalized exchanges, some of which involve profit making, but many of which do not.

With the exponential growth of genomic and diagnostic technologies, human beingness is being dividualized (Ott 2018) and globalized in increasingly smaller increments. These increments are transformed into market-ready products, ready for participation in the process of biocapital exchange. While in the 1970s and 1980s reproductive technologies focused on the creation of new humans were emerging, and in the 1990s human body parts were enabled by technology to develop into a global market, a much more recent trend is the emergence of global networks of biobanks that are "structured collections of biological samples and associated data, stored for the purposes of current and future research" (Parodi 2015). Ethnographic attention on the high-tech, globally networked, biobanking industry with its associated utilization of emerging big data set analytics has drawn attention to challenges of standardization of sample collection, heterogeneity of sampling, and ethical considerations around confidentiality and consent (Mason et al. 2016), and has shown that even when disembodied, human tissue retains a "persisting personal and cultural identity" (Dive et al. 2017:301).

Many of the implications of recent developments in big data set analytics are yet to be explored, but one that health anthropologists will no doubt be watching is the implications of big data set analysis on population screening. There is an important difference between diagnostic testing and screening that anthropologists have commented on, that goes almost unremarked in clinical literature. Whereas a diagnostic test is undertaken on a person who is showing signs of a disease, a screening test is undertaken on a healthy, or at least asymptomatic, person who is deemed to be in an at-risk category for a disease. This slippage from testing people to diagnose an already present set of symptoms to

screening an asymptomatic group of people is an increasingly ordinary occurrence in biomedicalized health care (Kaufert 2000). As costs of particular tests go down, statistics become more available, or pharmaceutical companies search for increased sales for diagnostic tests, it is not uncommon for an increasingly larger group of people to have screening recommended. More than medical factors form the basis for recommendations of who should be screened: economic and political factors also play a significant role (Sandall et al. 2004). As Nelkin and Tancredi (1989:10) note, Western biomedical reductionism and the faith in simplistic, numerically constituted data “has obscured the uncertainties intrinsic to such diagnostic tests, and they are widely accepted as neutral, necessary and benign.” They suggest that “the boundaries of the ‘normal’ or the ‘healthy’ are often fuzzy. . . . When interpretive margins are fluid, they can easily be manipulated by diagnostic evaluations cloaked in the neutral garb of science” (1989:19), warning that the use of diagnostic tests for population screening “has always been directly linked to social or medical intervention, through therapy, prevention or exclusion” (1989:23–24).

Bringing the Lab into the Field: Anthropology and the Neurosciences

The development of biotechnologies has significant implications for the way research into cognition and human nature is conducted. In the field of neuroscience and clinical psychology, new biotechnologies are forcing cognitive scientists to deal with questions that have previously been the focus of anthropologists. Recent developments have started to undermine long-standing disciplinary boundaries and are bringing anthropology into closer contact with other scientific and medical traditions. Health anthropology, with its close connections to the biomedical and the anthropological fields, stands to be the connective link between the neuro-cognitive and the anthropological.

Anthropology and the cognitive sciences share a common subject matter—humanity—but have historically approached their subjects in entirely different ways. Cognitive scientists have a strong interest in the internal mechanics of cognition. The individual human subject is the focus of inquiry. Neurology and psychiatry are primarily about the mechanics of the brain and related biological systems. In psychology, the subjects’ interpretive schema and cognitive frameworks are the focus. Anthropology takes an interest in these matters but is largely focused on the shaping effect of environments and social and cultural structures. This difference in focus has been key to the separation of these disciplinary domains. It also underpins their methodologies.

Neuroscience, psychiatry, and psychology have traditionally conducted their studies within a clinical setting. In these disciplines the patients and research subjects were expected to come to the scientists, who would apply the laboratory ideals of isolation and controlled observation to deduce principles of brain function and pathology. The clinic, like the laboratory, houses the various biotechnologies that facilitate the study of the mind. The clinical environment is sterile and can be easily controlled, allowing clinicians to regulate stimuli that

patients/research subjects are exposed to. Imaging machines and other medical diagnostic equipment can be bulky and, due to their complexity, require specialist knowledge to operate. Biotechnologies are often tied to a technological infrastructure that allows data to be collected, analyzed, and interpreted with each step, often needing additional equipment and specialized conditions. For these reasons, the clinic makes a logical and convenient site for the cognitive sciences to operate from. Anthropologists, on the other hand, do their work largely in the places that their subjects routinely occupy.

These circumstances mean that cognitive scientists and anthropologists work with different samples of humanity. It is important to note that this trend is not without exception. For example, social psychologists take their subjects from a variety of different locales and physical anthropologists often work in lab settings. However, the trend toward limited sampling and lab-centered studies is well noted in cognitive sciences. Psychologists Joseph Henrich, Steven J. Heine, and Ara Norenzayan (2010) drew on anthropology and other disciplines to point out the dangers of this sampling trend in the behavioral sciences, suggesting that the people who are the most common subjects of research in fields such as psychology, economics, and cognitive science are in fact outliers on the spectrum of humanity. These people, whose behavior and neurology are supposed to be representative of humanity at large were, in fact, “weird”:

Western, Educated, Industrialized, Rich, and Democratic (WEIRD). In particular, it is about the Western, and more specifically American, undergraduates who form the bulk of the database in the experimental branches of psychology, cognitive science, and economics, as well as allied fields. . . . The sample of contemporary Western undergraduates that so overwhelms our database is not just an extraordinarily restricted sample of humanity; it is frequently a distinct outlier vis-a-vis other global samples. (2010:61, 82)

This article has set the stage for disciplinary crossover, with authors suggesting that cognitive scientists need to diversify their subject base and that anthropologists need to get more involved in experimental studies in their various fields (Henrich et al. 2010:29). However, despite best intentions, the practical restrictions of biotechnologies have made looking at an active brain in a natural environment difficult. Isolation in clinical conditions and relative immobility have been mainstay requirements of neuroimaging. Size of machinery and the desire to control stimuli have contributed to the methodological and disciplinary gap between neuroscience and health anthropology.

Technologies are changing, however. The pace of technological change is increasing as our machines become increasingly sophisticated and integrated into daily life. Biotech is no exception. Brain scan technologies are becoming increasingly compact and resilient. Wireless transmission has allowed the subject of study to transmit relevant data as they leave the lab behind. Experiments with a portable electroencephalography (EEG) system have allowed people to monitor their electronic brain function in real time with their smartphones. This process required the subject to wear an unfashionable swim cap, but the device was lightweight and relatively unobtrusive. This allows the subjects to engage in their

everyday activity as they were being scanned (Stopczynski et al. 2014). A more sophisticated positron emission tomography (PET) has also been tested (Bauer et al. 2016, Melroy et al. 2017).

These early applications of portable biotechnology have delivered new data and have posed challenging questions about previous brain-scan findings. Being able to record the EEG information of people cycling through the streets of Alberta, Canada, has allowed researchers to see that “noise” is a part of everyday life function. In other words, divided attention is a part of complex daily activity and reaction tasks in the real world require a different kind of brain function to reaction tasks done in the lab (Scanlon et al. 2017).

For health anthropologists and cognitive scientists, this technological progression opens a wide range of application. The ability to observe brain function in real time has been used by anthropologists to see inside the heads of their participants by cross-referencing observational data with real-time measurements of arousal, relaxation, attention, and stress as they go about their everyday life (Yasui 2009). Evolutionary anthropologists theorized about the brain structure of our ancestors by monitoring the brain function of contemporary humans engaged in making stone tools (Putt et al. 2017). This kind of research allows medical, physical, and evolutionary anthropology to transgress on the territory previously held by cognitive scientists. Simultaneously, the cognitive sciences stand to benefit as these increasingly portable technologies venture more and more outside of the laboratory.

Molecular Biotechnologies: Tiny Pieces, Giant Infrastructures

Over the last several decades, technological and scientific advances have given people the ability to manipulate the most fundamental blocks of life. Human beings can now transform the function of organisms on a cellular and molecular level, allowing us to treat illness and create new material compounds and even life forms. Molecular biotechnology evokes images of pristine laboratories, complex machinery, advanced treatments, large pharmaceutical brands, and armies of lab coat-wearing scientists. This is a type of biotechnology that regularly captures the public imagination. It represents the level of our current scientific ability and achievement. These biotechnologies are drugs, genetic and cellular therapies, hormones, and vaccines. They allow us to alter the behavior of cells, bacteria, and DNA and to direct their function.

There is a mythology that surrounds the large biochemical and pharmaceutical companies that manufacture these products. That mythology rests on two common presumptions. The first presumption is that science research is driven by an objective credo of scientific progress. In this view, discoveries are shared and built upon by an integrated community of researchers all working toward a unified idea of progress. The second presumption is that research direction in medical biotech is based on a hierarchy of need—the desire to improve health and cure disease. These presumptions are the epitome of humanist enlightenment values and are assumed to be encoded in scientific ethics and the medical

Hippocratic Oath. These presumptions work to instill biotechnological users and manufacturers with credibility in the eyes of the public and hope for the patient. This is what anthropologist Mary-Jo DelVecchio Good (2001) refers to as the “medical imaginary” and the “biotechnical embrace.” This medical imaginary is actively promoted by biotechnology companies and the medical establishment (see figure 8.6).

Working with DNA, the “essential building blocks of life,” is a resource-intensive and labor-intensive process. Laboratories function to isolate biological fragments, and through this isolation lay claim to profits from the production of life-saving medications, therapies, and objective knowledge. These technologies are often thought to be produced through processes of objective science. Those who make them require substantial resources and wield tremendous power. Health anthropologists approach biotechnological products as agents in a human process, intertwining in assemblages with their own mythologies, agency, social context, and culture. Because they are so complex, biotechnologies and the people who produce them are enmeshed in a vast infrastructure and are never outside of economic and cultural pressures (Fukushima 2016). Far from being objective and outside of the influence of subjectivity, biotechnologies are products of a culture of science and capitalism.

The development of molecular biotech rests on a promise and an idea. For those participating in the product-making and profit-seeking, this is a direct investment in the biocapital of our molecular makeup. The development of a new drug or therapy is contingent on an investment in an idea and, in a contemporary capitalist environment, the promise of return. This introduces significant risk for those who are seeking to invest in the expensive process of research and

The image is a screenshot of a Lilly advertisement. At the top left is the Lilly logo. To its right is a navigation menu with the following items: Who We Are, Caring, Discovery, Products, Careers, Investors, Partners, and Newsroom. Below this menu is a secondary navigation bar with: Clinical Development Pipeline, R&D Partnering, Clinical Trials, and Research Ethics. The main headline of the ad is "Better Science. Better Lives." Below the headline is a paragraph of text: "For more than 140 years, we have worked tirelessly to discover medicines that make life better. This determination starts in Lilly Research Laboratories, where our scientists work to discover new medicines that will help solve our world's greatest health challenges." Below the text is a large photograph of a woman in a lab coat pointing at a whiteboard. The word "DISCOVERY" is written in the top left corner of the photograph. At the bottom of the photograph, the text "Invested in Speeding Innovation" is displayed.

FIGURE 8.6 Biotechnology Ad Promoting Biochemical and Pharmaceutical Mythology.

development and this risk is worked into the infrastructure and culture of biotech production. Biotech developers make partnerships at every stage of production and marketing of a new treatment or drug, creating networks and connections to facilitate the development of each product. Charles Mather (2005:1324) has described this process of development as the “drug pipeline”:

The drug pipeline is not seamless. Movement across stages involves institutions and individuals from different domains or sub-cultures including science, medicine, industry, and government. This makes the drug pipeline different from that of other products and developmental assets. . . . One of the dilemmas that pharmaceutical companies face is making the drug pipeline more predictable and thereby ensuring product development and market share. To make the pipeline more predictable companies aspire to control settings and activities outside the domain of industry. Industry seeks to control the pipeline by funding the research programs of academic physician and physician–scientists, financially supporting conferences, rounds, and journal clubs in hospitals and medical schools, running continuing medical education events (CMEs) for non-academic physicians, and giving physicians a wide range of gifts including free drug samples.

This perspective challenges the objective and clinical medical imaginary of biotech and pharmaceutical production (Singer and Allen 2017). It encourages us to see biotechnologies not as passive products of the pure scientific rationality driven by need and progress, but as complex agents meshed in complex structures. Mather (2006) describes biotech products as “entities” that mature through exposure to different stages of development, grow in complexity, and even experience rites of passage.

The development of retroviral drugs to combat HIV/AIDS offers a number of well-documented case studies of the complex intersections between local, national, and international public health policies and practice; local, national, and international activists and advocates; Big Pharma (the global industrialized pharmaceutical industry) and international patent law. While many of the early retrovirals were tested in impoverished communities, once they were registered for use by the Food and Drug Administration (FDA) in the United States, prices became prohibitive for patients in most developing countries. The 1995 TRIPS Agreement (Trade-Related Aspects of International Property Rights), promoted by wealthy nations, mandated minimum standards for the protection of international copyright, including pharmaceutical patents. Although there were some exemptions, protection of patent rights (argued on the basis of the expense of the pharmaceutical pipeline development costs, as discussed above) put AIDS medication out of reach of many people in the developing world. In 2001 the Doha agreement created wider exemptions for developing countries to produce generic medications that made public provision of HIV medication affordable, although the uptake of these has been uneven (Wise 2006). In South Africa, stigma around HIV prevented effective retroviral accessibility for many years (Fassin 2007b). The successful campaign for retrovirals in Brazil has resulted in what Biehl (2007a:1183) refers to as a “pharmaceutically-centered model of public health” in which “the sustainability of the Brazillian AIDS policy has to be constantly renegotiated in light of global drug markets,” while Hicckel

(2012:513) suggests that the continuing “high prevalence of HIV in Swaziland [now eSwatini] is less a biomedical condition than a symptom of neoliberal market policy.” As the global pharmaceutical industry grows ever more complex, the imperative increases for health anthropologists to continue to pay attention to what Whyte and colleagues (2002) refer to as the “social life of medicines” (Hardon and Sanabria 2017).

The Story of hGH—Growing up Growth Hormone

Human growth hormone (hGH) is a hormone that is naturally secreted in childhood from the pituitary gland to stimulate growth. Individuals who are unable to produce this hormone naturally are a well-established medical treatment group, experiencing a range of conditions, most notably pituitary dwarfism. Prior to 1985, these conditions were treated with hGH extracted from cadavers. These treatments came with significant health risks and supply of extracted hGH was insufficient to meet medical demand (Conrad and Potter 2004). With a need identified, the biotechnology company Genentech established a partnership with pharmaceutical manufacturers Eli Lilly and Novo Nordisk to create a drug pipeline for a synthesized version of hGH created through recombinant DNA processes.

In 1985 use of cadaver-extracted hGH was banned by the American Food and Drug Administration. Genentech introduced a synthesized hGH to the market in time to fill the void. This version of hGH could be manufactured in unlimited quantities and the medical need was met. However, the infrastructure for this pipeline was extensive, with a multitude of interested parties seeking return on their investment that the original targeted patient group could not provide. Mather (2006) presents hGH as an example of a biomedical entity with too much infrastructural momentum to stop at having met medical need. Invested parties sought to expand the application of hGH beyond prescribed use.

Anthropologist Alan Goodman (2013) describes height as a condition of economic and genetic circumstances. Nutrition and genes both influence how tall we grow and, for some, height can be an indicator of a socially favorable childhood or “good breeding.” Inversely, shortness has been associated with inadequacy and stigma. Goodman notes that synthetic hGH could now be used to redress these potential “inadequacies.” hGH is a recombinant DNA treatment, a supplement to natural biological processes, and was subsequently applied to a population that was previously not a target of biotechnological intervention. Borrowing from literature in the biotech and medical fields, Goodman (2013:365) notes that “hGH injection transforms short stature, a signifier of individual genetics or group-resource access, into a medically treatable disease.” In direct contradiction of the biomedical imaginary of need-based intervention, due to the economic and social pressure of infrastructural requirements of the hGH pipeline, new biomedical need was created.

Medical sociologists Peter Conrad and Deborah Potter (2004) describe a situation that went even further. Seeking to further extend the market, the hGH industry sought applications outside of medical pathology, into human

enhancement. In addition to treatment of growth hormone deficiency, Conrad and Potter document the use of hGH in antiaging treatments, for cosmetic purposes, and for athletic performance enhancement. A long-standing federal investigation into misuse of this biotechnological intervention found that Genentech had actively cultivated relationships with researchers, medical institutions, and professionals to promote its product. In 1999 Genentech paid \$50 million to settle criminal charges from the FBI and the FDA. The FDA alleged that “Genentech had ‘begun marketing Protropin [a strain of synthetic hGH] for use in the treatment of medical conditions for which it did not have FDA approval’” (Conrad and Potter 2004:191).

The Culture of PCR

The case study above challenges our ideas of the biomedical imaginary and demonstrates that the weight of biotech infrastructure and ever-expanding corporate hunt for profit drive the development of biotechnology beyond the requirements of human medical need. The push for the dissemination is the result of biotechnological infrastructures, but this push also shapes the culture of development in the lab and in the field of research. Medical anthropologists, working alongside research scientists and within biotechnology companies, paint a more complicated and holistic picture of this culture.

Paul Rabinow (1996) offers one early case study in his work on the development of polymerase chain reaction techniques. The development of this technology demonstrates the human and cultural side of the biotechnological infrastructure and process. Rabinow begins his account in the 1970s and 1980s in the United States with a series of legislative and judicial changes specifically designed to turn scientific discoveries into patentable products. Then, and to this day, biotechnologies were and are a high risk and return industry. New technologies offer huge financial returns, but, because these technologies take time and money to develop, they are often risky investments. With sparse direct government funding, researchers in both the private and the not-for-profit sector enter into partnerships with the business world to fund their work. In exchange, researchers make promises of returns. This generates pressure to pick projects on the basis of viability, time, and the commercial need of investor clients. For example, Rabinow (1996:51) notes that private biotech developers were likely to take on contracts to produce new patents for variations of existing commodities, rather than developing completely new technologies. Similarly, diagnostic technologies were considered to be less risky than working on complicated cures.

Polymerase chain reaction (PCR) was developed as a diagnostic tool through the work of Cetus Corporation. PCR is a method that detects and replicates a predetermined sequence within a chain of DNA or RNA inside a solution. If a genetic sequence exists within a strand of DNA it will be replicated (this is called amplification); if it doesn't then no amplification will occur. This can be used as a quick method of finding sequences that relate to genetic diseases or conditions, verifying heredity, forensic comparison, or to produce an abundance of testable genetic material.

This is a highly versatile technology that has since been widely applied across a wide swath of industries and disciplines. Even a degraded piece of DNA can be tested with PCR methods. It has been used in cloning and DNA sequencing and was an essential tool in the mapping of the human genome. Outside medicine it has been applied in environmental microbiology to verify sources of biotoxins within an environment.

The story of the development of this prolific biotechnology offers many insights into the culture and practices of the biotech industry. Rabinow describes a tense, deadline-driven climate. There was regular friction between members of the research and marketing teams, with scientists often being forced to scramble to keep up with promises made by marketing executives. Information about the process development was seen as a valuable commodity, with tight restrictions on the dissemination of the research progress and constant worries about the activities of competing scientific teams. This serves as an example of the protection of biocapital investment, in the form of patented genetic material, over the romantic scientific ideal of collaboration for the purpose of progress. Rabinow (1996:10–11) notes that in the story of PCRs, the romantic view of science as a pure, objective, cooperative, and unified effort is not evident:

Anyone the least bit familiar with the history of science . . . could hardly describe it as “essentially cooperative and communal effort.” This view of contemporary bioscience—shared by many—is historically and anthropologically inadequate.

Visualization Technologies

Another area of technological development in health that has come under scrutiny from health anthropologists is the explosion of medical imaging technologies that has allowed information from inside the body to be accessible to the external gaze. X-rays, ultrasound technology, MRIs, CAT scans, and PET scans have shifted ways in which health and illness are understood and communicated (Braidotti 1991, Burri and Dumit 2008, Downey and Dumit 1997, Joyce 2005). Ultrasound images of unborn babies have profoundly shifted maternal-fetal relationships: being able to visualize a baby in utero changes ways in which mothers and other family members bond with their child to be (Nabhan and Faris 2010). Ultrasound produces “both a newly independent fetus and a medically reinscribed mother under the powerful sign of normative maternal-child health” (Rapp 1997:32). The ultrasound photo has become a common “first photo,” extending a child’s place in their families back to include their time in utero and shifting relationships between families and unborn children.

Joyce (2005) describes ways in which MRI (magnetic resonance imaging) scans move from being a diagnostic tool utilized by health professionals—doctors or radiographers—to help understand enfolded, corporeal bodies, to the machines being ascribed agency and voice in their own right. Rather than merely “revealing” the inner body, Joyce (2005:438) suggests that MRI scans “produce the body, bringing together aspects of physical bodies and cultural, social, and economic factors in unique and locally specific ways.” Joyce (2005:438) shows how representations of MRI scans are authoritative and transparent, and the

privileging of medical imaging technology over other forms of diagnosis, including physical examination of the body of the patient, can lead to a neglect of “the importance of interpretation in the production of health and illness.”

When Technologies Combine

In this section, we present examples of unintended consequences of combinations of biotechnologies, and for this we return to the area of reproduction and the impact of biotechnologies on definitions of personhood for yet-to-be-born persons. Previously, we discussed ways in which new reproductive technologies have created profound shifts in understandings of family and relatedness. In this section we will look at how technology is intertwined with discourses around acceptable and desirable categories of personhood.

The average age of women birthing in most Western countries is rising, and alongside that is an increase in anxiety about delivering babies with so-called birth defects and/or genetic anomalies. The diagnosis of fetuses with chromosomal differences that indicate the child could be born with a disability, and the subsequent termination of pregnancies found to be compromised, involves a range of medical technologies, equipment, knowledge, and specialized clinical environments. There are a number of individual technologies that combine for second-trimester terminations, including amniocentesis, ultrasound, and genetic testing. Amniocentesis involves the gathering of an amount of amniotic fluid, the fluid that surrounds the baby in the womb. Cells of the fetus/baby are present in the amniotic fluid, meaning that a baby’s genetic information may be obtained prior to its birth. Amniotic fluid is obtained with a needle inserted into the uterus through the mother’s abdomen. The accuracy of the placement of the needle into the uterus is guided by high-definition ultrasound. The interpretation of the genetic material is undertaken in a specialist laboratory. Based on the medical interpretation of findings, terminations may be undertaken with active obstetric intervention.

As with new conception technologies, diagnostic and termination technologies have generated deep ethical and moral contestations. Beck-Gernsheim (2000:131) comments on euphemisms used in discourses of disability prevention:

More is at stake here than dental hygiene. What is actually meant here is avoiding the birth of a handicapped child, either by way of renouncing biological parenthood altogether or (more likely in practice) by way of a “tentative pregnancy” (Katz-Rothman 1986) and induced abortion in the case of a genetic deficiency.

The speed with which prenatal diagnostic screening became routine was remarkable. Rapp (1997:36) commented:

Prenatal diagnostic technologies have moved out of academic settings into commercial labs with great speed over the last decade, and the most experimental technologies are often available, for a price, long before their accuracy is fully tested.

First- and second-trimester pregnancy terminations are very different procedures. The medically measured length of a human pregnancy is taken as forty weeks.

First-trimester pregnancy terminations, undertaken at up to thirteen weeks, however contested and ethically problematic in some communities, are relatively straightforward procedures from a medical perspective. Second-trimester terminations, undertaken at between thirteen and twenty-six or twenty-seven weeks, when the embryo is well established as a fetus, are more complex medical procedures. They are significantly riskier for the mother's health, and can be more emotionally complex for both families and the health-care workers.

Based on biostatistical information that more children with "birth defects" or "chromosomal anomalies" are born to older women, in most Western countries, women over a certain age are advised to undertake an amniocentesis, and to terminate the pregnancy should the test indicate that the baby has a "genetic abnormality." When the use of this technology first became widespread, there were ethical concerns around "designer babies." The fear was that amniocentesis would be used to facilitate the genetic testing of a fetus, and fetuses who weren't carrying the characteristics of what their parents required as their "perfect" baby, would be aborted. Characteristics such as height, intelligence, hair and eye color, and sexual preference were all seen as things that parents may choose to abort for. These fears did not immediately eventuate: the mapping of the genome made it clear that genomics is much more complicated than being able to read off a genetic sequence to determine your baby's height, hair color, or potential heterosexuality. In other areas, where there is more certainty offered by the results of the amniocentesis, second-trimester terminations have become increasingly incorporated as a normalized aspect of pregnancy and of maternity care. We will discuss two examples: the termination of babies carrying the gene for Down syndrome in the United States and Australia, and sex selection in India and China.

Anthropologist Rayna Rapp initiated long-term fieldwork in a genetic clinic in New York. Her introduction to amniocentesis and second-trimester terminations came through her own experience, movingly documented in *XYLO: A True Story* (Rapp 1984). Ethnographic research points to troubling bioethical dilemmas between families expecting babies and the medical professionals who care for them (Rapp and Ginsburg 2011). Down syndrome, the iconic condition most commonly referred to when discussing genetic testing, is seen by most doctors as an unarguable reason for pregnancy termination. Although for some women and their partners this is a comfortable decision, for many it is not, and there are a number of examples in the ethnographic literature that point to women feeling coerced to terminate pregnancies (Long 2016; Rapp 2000a, 2000b, 2014). Long suggests that doctors are singularly unqualified to advise on Down syndrome terminations: they are in a profession where their identity is defined by intelligence, and their imagination falls short when it comes to envisaging potential quality of life with a lower-than-average IQ, whereas evidence from families with Down syndrome members suggests that it is much less cut and dried than that (Rapp 2014).

Another manifestation of the combination of amniocentesis and second-trimester termination technologies can be seen in the Fifty Million Missing movement in India, a social media campaign that has been set up to draw attention to the impact of widespread and systematic prenatal sex selection. In use now for more than thirty years as a sex selection technique, the use of

amniocentesis to determine the sex of the fetus, and the termination of pregnancies carrying female fetuses, has become so widespread in a number of countries, including India and China, that the practice has been significantly influencing sex ratio demographics for more than two decades (Allahbadia 2002, Sen 2005).

Disability advocates have long been vocal in their critique of genetic testing and termination (Finger 1984, Gammeltoft and Wahlberg 2014, Kaufert 2000, Rapp and Ginsberg 2011, Saxton 1984). Many of the early concerns of this discourse are now part of day-to-day maternity care (selective termination of Down syndrome and Spina bifida pregnancies, for example), while other fears of gene manipulation to create designer babies had not, until recently, been scientifically likely to eventuate. In 1987 Japanese scientists working in bacterial immunology discovered what is known as the CRISPR sequence. In later research conducted in the late 1990s it was discovered that CRISPR was a unique defense system that allowed some families of bacteria to “hack up and dismantle the viruses—memorizing, interrogating and cleaving foreign DNA” (Kirksey 2016). This system has been harnessed to be able to identify and alter specific gene sequences within a complete genome, making a kind of molecular scissor that allows for the direct modification of genes. Writing in *Anthropology Now*, Eben Kirksey (2016) describes CRISPR as a potential realization of the “designer babies” dream. Kirksey describes an interesting dilemma with the concept of human perfection: perfection is limited by our historical, scientific, and cultural imaginations. Intentional genetic alteration is now possible, and with sequencing technologies, there is a belief that we can control for a much more complex and wide range of characteristics. As noted below, health anthropologists working in this area make the point that desirable characteristics are historically, culturally, economically, politically, and philosophically idiosyncratic.

Prior efforts to create a community of perfect human beings on the basis of cultural ideals have demonstrated the authoritarian danger of applying a fixed moral order to a diverse human biology. Both European Colonial and Nazi ideas of racial superiority and of eugenics have cast a long and dark shadow over the history of biomedicine. Increasing global accessibility of reproductive technologies brings together complex intersections of cultural ideas about lineage, progeny, and ideals of parenthood. The question of agency has a special resonance in individualistic cultures like those prevalent across the Anglosphere. Many ethical trepidations about prenatal genetic intervention are reflections of the “Western” desire to preserve agency and are bolstered by a cosmopolitan appreciation for diversity. These are not universal human priorities. In a world where market forces play a central role in the availability of technologies, a user-pays model of genetics determines application. Less individualistic communities who see children in more directly utilitarian terms are increasingly turning to biotech to generate desired types of offspring. The biocapital available for sale here are the genetic components of idealized childhood traits.

Suli Sui and Margaret Sleeboom-Faulkner (2016) document a growing market for prenatal genetic testing in China. Businesses advertise being able to screen for beauty, health, and even talent. Though these claims are unlikely to be substantiated, the marketplace is relatively unregulated. Simultaneously, the cultural appetite is less tuned to implications on individual agency and cultural

ideas of filial piety and social conformity. In 2009, the city of Chongqing carried out the “talented baby project” where gene testing was used to test for fifty “talent gene” candidates, with those to be raised according to their talent attribution. This project articulates the desire to create a perfect generation, using the best of available state and market methods to create an ideal citizenry forged by a combination of directed nature and nurture. Unwanted elements, such as tendencies for violence, depression, or disability, are left by the wayside on the way to reaching an imagined socially constructed ideal.

One of the major appeals of medical biotechnology is the promise of certainty. Genetic testing offers the chance of looking back through a family bloodline to establish ancestral connection of the likelihood of a genetic illness. For the media and those in the business of selling genetic knowledge, ancestry information is sold as a kind of ultimate revelation of self. Ruha Benjamin (2015:134) has found that we are often tempted to talk about scientific projects in progress as if they were ready made—extrapolating possibilities and transforming them into imminent realities. This kind of certainty is highly appealing in light of parenthood. Each iteration of genetic biotech sparks a conversation about the dangers of runaway technology. In the 1990s and 2000s the ability to screen embryos prior to implantation through IVF sparked a series of discussions about our ability to design a perfect human. The argument went that our ability to foresee illness would lead to a new form of eugenics by design. However, ethnographic studies of the discussions of new tech (like IVF and preimplantation genetic diagnosis conducted by Sarah Franklin and Celia Roberts in 2006) reveal classic parental worries rephrased in new terms. They argue that parenting has always been a question of intervention, guiding, and design. Practices of prenatal care and postnatal parenting techniques have been prescribed by medical specialists since the 1800s, and direct medical intervention has been used to keep babies alive since the invention of medicine. Similarly, the practice of child selection has a long and dark history in the practices of eugenics and selective infanticide. As these technologies shift and change, they continue to reflect desires to pass on a particular type of genetic heritage or meet the requirements of societal norms and local kinship traditions.

Ancestry, Families, and Genetics: Biotechnology and Belonging

New understandings do not seamlessly replace old beliefs (Martin 1994:16). Among researchers, paradigms take time to shift. Among the general public, lay understandings of the processes of science can make it easy for new biotechnologies to be appropriated to new and sometimes uncomfortable ends. Scientific understanding can challenge old social structures and dispel prejudices, but it can also be used to create new identity categories and biases, many of which are legitimized with a veneer of assumed scientific objectivity. Recently, genetic testing has offered a contemporary example of the benefits and risks of the proliferation of new biotech. It also offers insight into our understanding of the idea of lineage and ways in which it relates to our conceptions of self, family, and ancestry.