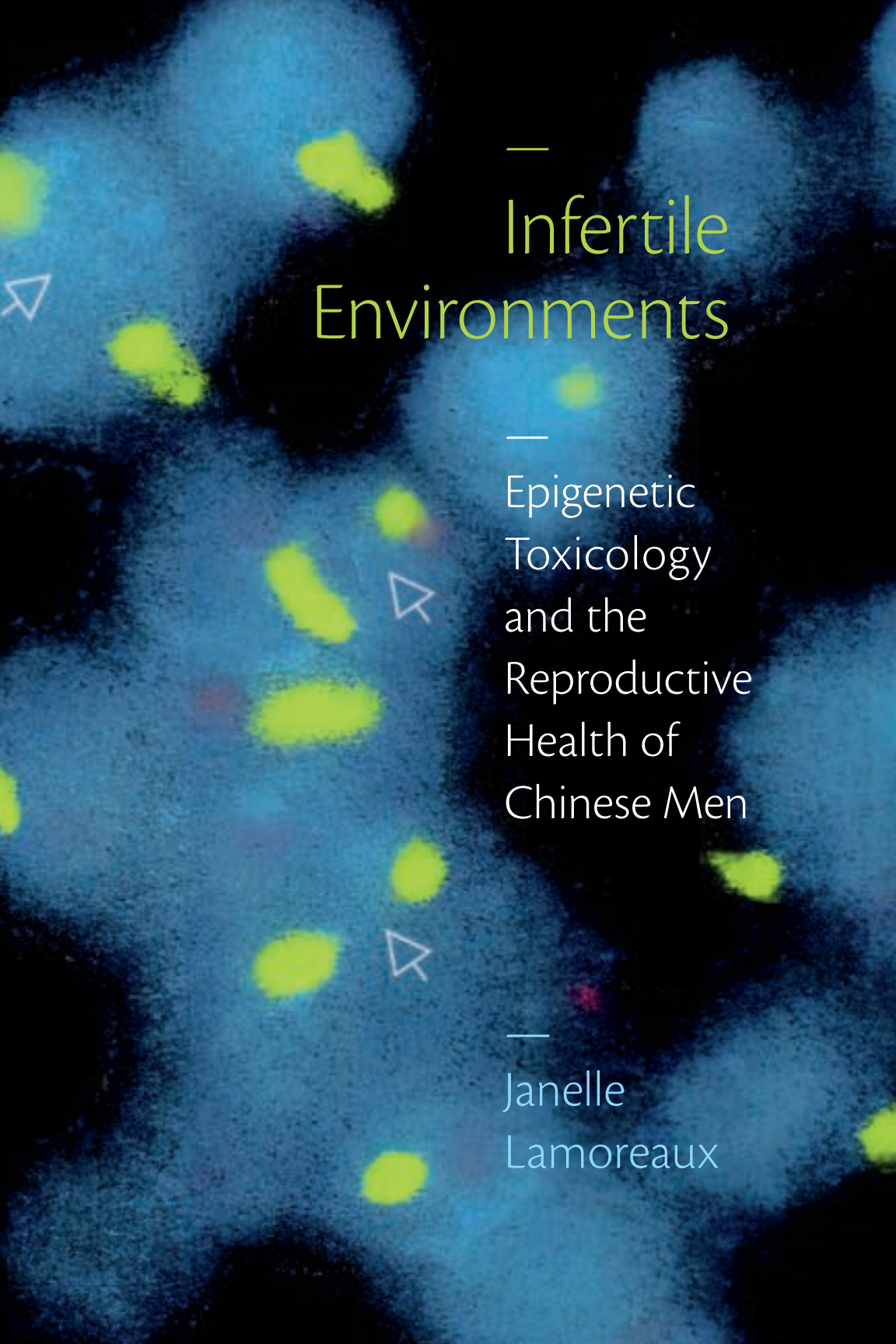
Infertile Environments
Epigenetic Toxicology and the Reproductive Health of Chinese Men
Janelle Lamoreaux

INFERTILE ENVIRONMENTS

Critical Global Health: Evidence, Efficacy, Ethnography
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JANELLE LAMOREAUX

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Epigenetic Toxicology and the Reproductive Health of Chinese Men

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In memory of G.G.S.

CONTENTS

PREFACE

Before returning to school for graduate studies, I worked at Cornell University's Center for Reproductive Medicine and Infertility (CRMI), a fertility treatment clinic in New York City's Upper East Side. As a patient coordinator at a clinic renowned for its high success rates and cutting-edge research, I helped patients from around the world navigate the difficult process of infertility treatment through reproductive technologies. Many of the patients I "coordinated"—a task that involved a combination of administrative processing, appointment scheduling, medical education, and impromptu counseling—had been unsuccessfully treated for infertility prior to their appointment at CRMI. During my two years in this position, between 2004 and 2006, I spoke with hundreds of individuals and couples undergoing treatment for infertility, many of whom had grappled with this diagnosis for some time.

Most of the couples I met were in their late thirties and early forties. Others were younger or older, from their early twenties to early fifties. Most seemed simultaneously frustrated by their infertility and determined to pursue treatment. Others were confused and dismayed, or excited and eager. Some of the patients I treated were single. Others were partnered in gay, lesbian, or queer relationships that remade heteronormative ideas of parenting and

reproduction in creative ways. There were widows pursuing pregnancy with the sperm of their deceased partners, and divorcées making time lines work with the help of best friends. There were former cancer patients pursuing in vitro fertilization (IVF) who had frozen their eggs or sperm before radiation or chemotherapy. There were transnational couples undergoing intrauterine insemination (IUI) because they were never together in the right place at the right time. Some patients were middle-class or low-income and seeking services through a grant program sponsored by the state of New York. But most of the people I helped treat were wealthy, heterosexual couples of a variety of ethnicities, nationalities, religious affiliations, and professions who had been trying to conceive for six months or longer and had not "achieved pregnancy" (as they say, as if such acts are a personal accomplishment) or whose pregnancy or pregnancies "had not resulted in a live birth" (in other words, had ended in miscarriage or stillbirth).

During my interactions with patients, they often spoke about how difficult it was when their predicted path to parenthood had been derailed.[1] Women diagnosed with "advanced maternal age" often expressed the feeling that this was their last chance to be parents. They didn't know they wanted to have children so much until it was too late or had only now met someone with whom they wanted to have kids.[2] In and outside of the clinic, questions of age permeated discussions of infertility, especially "female-factor infertility." Sex-specific structural abnormalities such as polyps and endometriosis also came up, but less frequently. In my discussions with men diagnosed with "male-factor infertility," age was not often brought up. But they too expressed anxiety, often over the phone, during calls that took place after our in-person meetings. I answered nervous questions about the semen-collection process and repeated the details of semen-analysis procedures so many times that I had a script for nearly every nervous query. Other men and women faced the difficult challenge of being diagnosed with "unexplained infertility" and lamented the lack of clarity that such an enigmatic label conferred.

Statistically speaking, unexplained infertility is said to affect approximately 20 percent of those seeking infertility services, with the 80 percent of remaining cases shared equally between male factor and female factor. To me these unexplained diagnoses, as well as the inexplicable dimensions of common biological explanations for infertility, were the most difficult to discuss. In situations where the cause of infertility was more obvious—for instance, in cases of advanced maternal age, structural obstruction, or azoospermia (the absence of sperm)—there seemed to be physical explanations for difficulty conceiving. But with unexplained infertility, answers were less

clear. Low sperm counts, irregular periods, polyps or fibroids, low sperm quality, anti-sperm antibodies—these were conditions often discovered during diagnostic procedures. However, they weren't really causal factors, more like inhibiting symptoms of a bigger problem or broader issue, poorly understood. I increasingly found myself thinking about what was making sperm decline, polyps grow, periods stagger, and cervical mucus become "hostile" to sperm.[3] What were the root causes of infertility, and why weren't they being discussed? Physicians often prescribed reproductive technologies to patients in such unexplainable circumstances; as reproduction scholar Sarah Franklin writes, "Into the breach of explanation is inserted a technological enablement" (1997, 322). A lack of explanation first enabled costly diagnostic procedures, then IUI, then IVF, then IVF with intracytoplasmic sperm injection (ICSI) or pre-implantation genetic diagnosis (PGD) . . .

My desire for a more generous rendering of infertility's cause increased as I was repeatedly confronted with patients' questions of why. Why can't I get pregnant? Why is it so easy for others my age to conceive? Why am I infertile? Such questions take on heightened meaning at a moment when individuals are often blamed for health problems. Questions about why a specific person is infertile can quickly turn into answers that stress individual responsibility for reproductive health. For instance, patients often wondered if they had done something to cause their infertility or were doing something wrong in their efforts to conceive. They looked for suggestions for things they could do, or take, or eat, or abstain from to make themselves fertile. Not only do such pursuits show how determined many people are to meet personal, social, cultural, and familial expectations of biological relatedness.[4] They also show how much people internalize the idea that pregnancy is an accomplishment (Becker 2000). This is especially the case for women, since infertility has historically been conceptualized as a women's problem, and women's bodies continue to take center stage during infertility treatments (Thompson 2005).

While working at the clinic I witnessed the gendered organization of fertility treatments. I watched thousands of women going through an endeavor that demanded weeks, months, and even years of fertility treatment, and the corresponding way that men's role in the process is sidelined.[5] This occurs partially because of physiology—particularly differences in the accessibility of eggs and sperm—and the need to prepare and monitor pregnant people's bodies for surgical procedures and their aftermath. But it also occurs partially because of the way that treatment practices, procedures, and prerequisites are organized (Sandelowski and De Lacey 2002; Thompson 2005). For example, even when couples that I helped treat faced a known

male-factor issue, extensive diagnostic tests were often required of women. These included not only simple blood draws but also more elaborate and expensive procedures such as hysterosalpingograms and laparoscopies. The most common treatment for male-factor diagnosis, ICSI, requires that women undergo IVF, which involves weeks of hormonal injections, multiple transvaginal ultrasounds, and the surgical retrieval of eggs as well as the implantation of embryo(s). The necessary extent of women's role in infertility treatments has been exacerbated by the gendered focus of reproductive science and medicine.

Many scholars of reproduction have more thoroughly explored these gendered aspects of reproductive technologies in and outside of fertility clinics. When I began attending graduate school at the New School for Social Research in 2005 while still working at the clinic, I began reading this social science of reproduction and merging my interest in the gendered experiences of infertility with the causal questions that patients and I had asked. I quickly embraced a feminist critique of the "biological clock" that recognized the structural reasons for people delaying pregnancy and attributed rising infertility rates to the gendered organization of social and economic life (Friese, Becker, and Nachtigall 2006). Still, such reflections on age and work did not seem to capture the concerns of people whose diagnoses fell within the 20 percent of unexplained infertility or even the 40 percent of patients diagnosed with male-factor infertility (which at the time was not commonly linked to age).[6] Although those I had worked with at CRMI researched the causal factors of infertility from the standpoint of individual bodies, I wondered if others were thinking through conditions of life outside the individualized body that might lead to infertility.

Once I stepped outside the clinical setting, both professionally and conceptually, I found that a broader perspective on the potential causes of infertility did exist. In the research of some endocrinologists, andrologists, and even toxicologists, infertility was viewed almost as a side effect—an aftershock of industrialization, institutional policies, inequitable legacies, and pollution. This was especially true in the case of men's infertility, which had a more outward-facing orientation, while research on women's infertility seemed to still be more tethered to the body (Martin 1987). Studies of sperm decline emphasized not only individual behaviors, genes, and physical characteristics but also the effects of occupational settings, pollutants, food, and household products on male developmental and reproductive health. In my reading, it seemed that such research almost characterized male infertility as a proxy diagnosis for a world order struggling to reproduce itself.

This book is an effort to further articulate these high stakes by shifting the study of infertility beyond the individual toward "the environment." Today, *environment* can mean many things, and its usage is often problematically reductive or muddled (Keller 2002). But what happens to the idea of infertility when it is stretched to environmental scales? "The woman in the body" might be situated within multiple contingent relations, infrastructures, exposures, and imaginaries (Petchesky 1987; Martin 1987). Reproduction might be reconsidered as an act that does not "end at our bodies" (Murphy 2013). Reproductive technologies might be reconceptualized to include those techno-scientific artifacts and arrangements of everyday life that exist outside biomedical clinical settings (Haraway 1997b). And all politics might be understood as reproductive politics (Briggs 2018; Ginsburg and Rapp 1991).

To study infertility as a condition that comes about in specific and dynamic political, economic, social, and chemical contexts is to expand not only infertility's etiology but also its applicability. Understanding infertility as an environmental issue moves beyond the individual, beyond the partnership or the choice, beyond clinical diagnosis of advanced maternal age and poor sperm motility, to a wider diagnostic lens. Of course, such an approach is not immune to the gendered stereotypes that permeate infertility treatment and research. Histories of individualism and biological determinism are also conscripted into ideas of environmental health. Consequently, an environmental approach to infertility cannot replace the idea of infertility as individualized reproductive failure. But such a perspective might encourage people to regard infertility as more than an individual's inability to reproduce another individual. The reproductive toxicology I discuss in the remainder of this book is an imperfect tool through which a reworking of infertility might continue.

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Introduction

In 2013 the meteorological association of the People's Republic of China released a green paper on climate change that highlighted both the economic and health effects of pollution. In a description of how urbanization in China had increased the country's carbon footprint, the report briefly mentioned the potential negative influence of pollution on human reproductive health (Chao 2013). Media coverage and commentary quickly focused in on this provocative connection. Journalists began interviewing fertility experts who described a "sperm bank emergency" (*jingzi ku gaoji*) even more exaggerated than sperm shortages that had come before. Since 2002, multiple regional sperm bank emergencies had been declared in China as local sperm banks reported that the quality of donor sperm was in decline (Wahlberg 2018b). Initial speculation about the cause of this decline focused on lifestyle factors, diet, and stress levels. The rise in standards of living during the past thirty years of reform and opening (*gaige kaifeng*) policies had dramatically changed everyday habits, occupations, and living arrangements in China, bringing many people out of poverty. But the potential drawbacks to such economic advancement were also becoming apparent—for instance, through discussions of a decline in men's sexual and reproductive health (E. Y. Zhang 2015).

Ten years after these first regional shortages had been publicized, sperm decline appeared to be both lasting and widespread.

Urological experts attributed the increasingly chronic nature of such "emergencies" to several factors. These included high institutional semen-quality standards, sexually transmitted diseases among potential donors, policy limitations on donation usage, and hesitations to donate biomaterial because of "cultural hurdles" (Wahlberg 2018b, 101; Ping et al. 2011).[1] But unlike past emergencies, men's reproductive health experts were also now more forthrightly drawing connections between the decline of sperm and the rise of industrial pollution. Sperm bank emergencies had gone from regional concerns about the effects of lifestyle changes among China's young men to a topic of national conversation about the pollution of China's environment. In the straightforward words of one sperm bank coordinator, quoted in the *Shanghai Morning Post*, "If the environment is bad, sperm become ugly" (L. Chen 2013).

Many people reacted to this report of ugly sperm in social and print media outlets. Some newspaper commentators made practical suggestions for individuals in light of the lack of immediate solutions to widespread environmental problems. They recommended avoiding smog by staying indoors and eating detoxifying foods to preserve fertility (C. Zhang 2013). But many others interpreted sperm decline as more than an individualized problem, and instead as a broader issue with national and intergenerational dimensions. Hundreds of users of the popular social media platform Weibo responded to the news story. Many made serious jokes, wondering if pollution was perhaps the latest version of China's notorious birth-planning policies. Others stressed the new meaning that old sayings seemed to take on in an era of environmental pollution; as one Weibo user wrote, "Before I didn't understand the saying 'beautiful mountain, beautiful water, and beautiful people.' Now I understand" (kingarthurzj_9006 2013). Still others emphasized the intergenerational stakes of sperm decline in a "bad" environment: "The cost of society's development is sacrificing the next generation. Sad!" (Jinhuozaifendou 2013). Echoing such intergenerational sentiment, the reporter for the *Shanghai Morning Post* who originally reported on the rise of ugly sperm wrote that "in the view of fertility experts, taking care of the earth equals taking care of ourselves and of the next generation" (L. Chen 2013).

Such reactions to the story of ugly sperm showcase an argument central to this book and at the heart of much feminist analysis of reproductive sub-

stances: when people anxiously discuss the decline of reproductive potential, they are talking about much more than a threat to individual fertility. They are also talking about a threat to the reproduction of social, national, and economic order. Such an argument is not just a social scientific talking point; it is an interpretation increasingly made by people around the world who are concerned about the intergenerational repercussions of increasing toxic exposures. How toxicity—in material and immaterial forms—influences the ability of people and other beings to reproduce physically and culturally is increasingly articulated as an urgent question by and for many (Dow 2016; Hoover 2017).

As a cultural anthropologist conducting research in Nanjing between 2008 and 2011, I found that experts, activists, and scholars often connected concerns about reproductive health with reflections on economic, political, social, and environmental change. More so than asking about individuals' responsibility for conditions such as infertility, people were talking about their reproductive health as intrinsically entangled with multiple environments and factors. This book explores how and why reflections on the causal factors of infertility are being reimagined and redefined at a moment of growing attention to toxic exposures and pollution. Why is men's infertility, in particular, and reproductive and developmental health, more generally, such an important lens through which people understand the imbalance of their relationship to one another and to "the environment"? What does the environment mean to those researching and otherwise reflecting on its relationship to reproduction and development?

I approach these questions through a focus on epigenetic toxicology. Today, *toxicology* is defined as the study of the potential harmful effects of "chemicals, substances, or situations" on humans and animals ("Toxicology" 2019). Epigenetic research, frequently referred to simply as "epigenetics," is typically thought of as the study of modifications to genes that affect gene expression without changing the sequence of DNA. Since the turn of the twenty-first century, epigenetic toxicology has increasingly drawn attention to the way that potentially harmful environmental exposures influence DNA expression. But how the environment gets defined in epigenetic research is more complicated than it first may seem. Through a study of toxicologists based in Nanjing who practice epigenetic research, in this book I ask: If "the environment" is to blame for the decline of men's reproductive health, then what kind of environment is it? In part because of epigenetic research, answers to this question have both proliferated and changed.

What Is the (Chinese) Environment?

The Chinese word most often translated into environment is *huanjing*. In modern Chinese *huanjing* frequently describes a natural setting, often in need of protection from humans by humans. But, as with the English word *environment*, naturalness is only one of many meanings and connotations of *huanjing*. Today this term can be found in various conversational venues, government campaigns, and business arenas. Besides the natural environment (*ziran huanjing*), there are investment environments (*touzi huanjing*) and working environments (*gongzuo huanjing*), recreational environments (*yule huanjing*), family environments (*jiating huanjing*), and social environments (*shihui huanjing*) (Hoffman 2006). These multiple environments do more than simply give terminology to a growing set of preexisting entities. Environments are brought into being through the practices that make them knowable objects. Translated from Chinese to English, *huán* means ring or circle, and *jìng* means condition or circumstance. The environment is a circumscribed set of circumstances; enclosure itself makes the environment. Historian Chia-Ju Chang similarly breaks down the individual characters of the word *huanjing*, arguing that in its premodern usage the term was a means of nationalist place making. She calls this place-making practice "environing" (Chang 2019). By using *huanjing* as a verb instead of a noun, Chang dislodges the term's natural and stable connotations. Instead, environments in the making are emphasized.

This book takes inspiration from such interpretations, and from a long history of anthropological thinking that similarly attends to practice, including Judith Farquhar's research on infertility and Chinese medicine (*zhongyi*) that interprets objects as processes (Farquhar 1991).[2] By focusing on epigenetics in practice and on the environment as a process, this book shows how epigenetic environments are brought into being during research. It also shows how environments that are materialized through research practices reverberate with environmental concerns that take place outside of research venues. Environments are not only multiple, enacted by persons and through technologies in various ways (Mol 2002); they also come into being in relation with other environmental forms that simultaneously exist at multiple scales and in numerous domains.

Today, protecting the environment is a large part of the official Chinese Communist Party (CCP) platform and is often a part of people's everyday reflections on the state of China's air, water, land, and food.[3] Environmental protection has been declared a national priority. It is also an international political strategy that foregrounds China's climate-change mitigation and

sustainability efforts. Environmental consciousness has become a marker of both modernity and cosmopolitanism, and it is supported by a government that expresses deep concern about the state of the environment nationally and globally (Hubbert 2015; J. Y. Zhang and Barr 2013). The risk of environmental pollution to reproductive health has now been raised by many as a factor of personal and familial concern and one that potentially undermines the ability of people in China to have and raise healthy children (J. Li 2020; Wahlberg 2018a). But such widespread formal and informal acknowledgment of the likely connection between environmental and reproductive health was less present during the time of my fieldwork.

This book is primarily based on fieldwork conducted in between 2008 and 2011, at a time when the environment was not as prominent of a concern among those I met in China as it is today, more than ten years later. This was before Premier Li Keqiang's 2014 declaration of a war against pollution. It was before the viral circulation of *Under the Dome* (*QiongDing Zhi Xia*), a TED-talk-style documentary made by Chai Jing, a former China Central Television employee, that highlights the link between environmental pollution and health, in particular the health of her young daughter, who was diagnosed with a heart defect in utero. This was before the series of "airpocalypses" that descended upon Beijing and other locations; before the mass adoption of face masks and home air-filtration systems—what anthropologist Matthew Kohrman (2020) calls "filtered life"; before actress Zhang Ziyi announced she was leaving the country out of fear for her young daughter's developing lungs, and before some reacted to this announcement by pointing out that her ability to walk away from pollution was a privilege.

But 2011 was also a time when the quantity of toxic exposures faced by those living in many parts of China was clearly growing. Protests against specific commercial enterprises and development projects, often surrounding the waste generated by industrial and energy projects, had erupted throughout China and were growing in number by the year (Steinhardt and Wu 2016; B. Wang 2019; A. Zhang 2020). Environmental litigation had emerged as a "politically touchy, but not taboo" means of seeking compensation for pollution events (Stern 2013, 2). Toxic chemical exposure was being researched by a growing number of regional and international nongovernmental organizations (NGOs) and being covered by an increasing number of media outlets (J. Y. Zhang and Barr 2013). For many, the environmental protection (*huanjing baohu*) and ecological civilization (*shengtai wenmin*) stressed by the government felt more like an act of transnational diplomacy than an effort to care for the health and well-being of present and future citizens.[4]

In such contradictory conditions, toxicity becomes more than simply a measure of capacity to bring about harmful effects. Toxicity increasingly becomes a material *and* existential concern through which people struggle to make sense of political-economic policies and distributed social hierarchies, as well as their consequences. In the university-rich city of Nanjing, where I conducted fieldwork, graduate students and professors from disciplines as varied as environmental science, medicine, philosophy, and toxicology were thinking through what this burgeoning attention to toxicity and the environment meant for their country, their region, and their lives. My research focused on a small group of toxicologists that I refer to as the DeTox Lab.[5] At the DeTox Lab, research on the reproductive and developmental influences of environmental exposures was the vehicle through which such thinking about toxicity occurred. In the lab's research, the environment is circumscribed at many scales and comes to mean many things. It is the food, air, and water that is taken into people's bodies, as well as the specific chemicals in these substances. It is the factory, the city of Nanjing, the Yangtze River Delta region, and the nation of China. It is a person, a mother, and a body—variably predisposed to influence along gendered and racialized lines. The environment is materialized through their epigenetic research as all these things and more.

Epigenetic Im/Possibilities

Epigenetic research hypothesizes that a wide array of things previously thought to have no impact on genes are now understood to modify gene expression (Landecker and Panofsky 2013). Conditions such as poverty, lifestyle factors such as diet, or events such as famine or trauma are now referred to as exposures or environments that are thought to have epigenetic effects. The way we live our lives, the environments within and around us, and the things we are exposed to are thought to change the expression of DNA, even though they do not change DNA themselves. In addition, epigenetic research often investigates the potential intergenerational effects of these modifications through animal experiments and birth-cohort research on intergenerational inheritance.

Despite contemporary agreement on this general definition of *epigenetics*, the term is actually quite difficult to pin down. C. H. Waddington's 1942 conceptualization of epigenetics focused on developmental effects. Today the term is used by an increasing number of research groups and disciplines to describe a wide variety of research approaches. According to entomologist

FIGURE I.1 This comic was shown during a presentation I attended at an epigenetics conference at the University of Cambridge in 2014. It both questions and reproduces the explanatory power of epigenetics.

Carrie Deans and biologist Keith A. Maggert, such varied usage has led to a lack in consolidation of epigenetic meaning among natural scientists. In an article titled "What Do You Mean, 'Epigenetic'?" they argue that epigenetics has become "a catchall for puzzling genetic phenomena" (2015, 889). Such sentiment seems prevalent among researchers who use epigenetic research techniques, as depicted in a comic that was shown at the end of a presentation at an interdisciplinary epigenetics conference I attended while at the University of Cambridge, which brought together biologists researching across many species and specializations (see figure I.1). The image both questions and reproduces the explanatory power of epigenetics.

Making a similar point from a social scientific perspective, anthropologist Marilyn Strathern (1991) has called epigenetics a "biologist's catchall." Strathern was among the first social scientists to note the turn toward epigenetics in the

reproductive sciences, describing the term's meaning in a 1991 publication as a focus on "everything else besides the gene." This shift placed epigenetics' potential area of research in a different order, in Strathern's words "imagined, hypothetically and thus abstractly, as infinite." Nevertheless, epigenetics, she argued, was concretized through a concept of the environment that could be made to stand for diverse contexts, "as uterus or as trees and mountains" (1991, 586). Since the time of Strathern's observation, the meaning of both epigenetics and the environment continues to simultaneously take on greater ambiguity and more concreteness. Today the infinite space "beyond the gene" continues to be concretized as environments that are made to stand for multiple contexts and things, and epigenetics itself is made to stand for many modes of investigating environmental-influence on gene expression.

Despite or perhaps because of its definitional ambiguity, epigenetics has been touted by many as a revolutionary way of thinking about inheritance (see Carey 2012). Popular accounts in books and magazines often depict epigenetics as a departure from what is often regarded as DNA's iconic place in modern Western consciousness (Franklin 1988, 95; Nelkin and Lindee 2004). Epigenetics has been interpreted as a potential corrective to the gene-centric view of health, disease, and even fate. By moving to that which lies beyond the gene, epigenetics potentially diminishes the power of the gene, showing how biology in general, and in parsed biological units such as sperm, is shaped by what stands beyond it.

However, many remain skeptical of epigenetic research practices and the revolutionary label affixed to such pursuits. Social scientists have shown that so-called post-genomic approaches, which claim to go beyond the gene in their studies of genetic expression and inheritance, often rely upon and conscript a genetic approach (Landecker 2016; Gibbon et al. 2018). In the past, oversimplified ideas of DNA as "the code of life" led to genetic determinism; now, oversimplified ideas of the power of environmental factors in determining future health have led to "epigenetic determinism" (Waggoner and Uller 2015). A fixing of sociocultural factors as stagnant and bounded environments occurs in epigenetic research in ways that sometimes perpetuate gendered and racialized stereotypes (Kuzawa and Sweet 2009; Saldaña-Tejeda 2018; Saldaña-Tejeda and Wade 2019; Valdez 2021), or obfuscates complex structural realities through a reductive vision of environmental factors or "social determinants of health" (Yates-Doerr 2020). In this sense, epigenetics' connection to the essentializing force of genetics is again quite strong. Such persistent essentializing has led historians of science to describe epigenetics as more of a recycling and coexistence with past ways of thinking

about development and inheritance rather than a revolutionary paradigm shift (Meloni and Testa 2014; Peterson 2016).

Still, epigenetic thinking and research offer a depiction of biology that partially overlaps with scholarly work that has historicized and complicated the category of "life itself" (Franklin 2000). Epigenetic research stresses that biology is not something that is given but that is constantly being made and remade, be it through environmental exposures (Fortun 2011) or technological interventions (Franklin 2013a; Hayden 1995; Thompson 2005). Through epigenetics, scientists are—for instance—considering that environments influence bodies and health in a way that is more reminiscent of multiple "alternatives" to Western biomedicine. Moreover, epigenetic thinking also aligns with many Indigenous perspectives on the entanglement of human and nonhuman ontologies (Warin, Kowal, and Meloni 2020). If, then, epigenetics is recreating ontologies (Lock and Palsson 2016), it is doing so through relational vocabularies that have long existed in many communities, languages, and traditions not frequently privileged by biomedicine—an ontological heritage that often elides STS scholars (Todd 2016).

Epigenetic Lineages

A history of epigenetics centered on Europe and the United States often highlights the multitude of approaches to genetic thinking in the twentieth century, which congealed into a dominant theory of genetics and DNA by the century's midpoint.[6] This history often begins by pointing to the overlap of current epigenetic theories with Lamarckian ideas about the inheritance of acquired characteristics (Jablonka and Lamb 2006; Rapp 2005). (Neo-) Lamarckianism went out of fashion in the early twentieth century with the 1900 rediscovery of Gregor Mendel's rules of inheritance—which stated that inheritance works through discrete units passed from parent to offspring. According to historian of science Evelyn Fox Keller, despite Mendelianism's strong influence on the science of that time, the first four decades of the twentieth century continued to be riddled with questions about what actually constitutes a gene (Keller 2002). However, with the 1943 identification of "DNA as the carrier of biological specificity," then the 1953 announcement that "genes are real molecules" made up of deoxyribonucleic acid (DNA), consensus began building around the constitution of the gene. "Thus, by midcentury," Keller writes, "all remaining doubts about the material reality of the gene were dispelled and the way was cleared for the gene to become the foundational concept capable of unifying all of biology" (2002, 3).

But one could also trace a different epigenetic lineage that includes an alternative understanding of what constitutes the gene, as well as a different understanding of genetics' centrality to twentieth-century ideas of inheritance. During China's Republican Era (1912–1949), neo-Lamarckian and Mendelian genetics were not understood as mutually exclusive. Whereas growing exploration into the science of heredity (*yichuanxue*) was informed by the return of Chinese geneticists and biologists who had studied in Euro-America, those practicing the sciences of heredity merged neo-Lamarckian and Mendelian genetics, stressing the interdependence of nature with nurture and connecting their science to a burgeoning commitment to strengthen the Chinese "race" (*minzu*) and nation (Dikötter 1998, 118). This changed after the Communist Party took formal control in 1949, when Mendelian genetics was denounced as bourgeois science and affiliated with the eugenic campaigns of Adolf Hitler and the hegemony of Western science. The "Morgan school of genetics" or "Morganism-Mendelism" was criticized for focusing too tightly on chromosomes as hereditary material and was banned by the CCP for its imperialistic, idealistic interpretation of generational continuity (Jiang 2017).

Following a policy of "learning from Russia," the party instead adopted Lysenkoism, a theory of heredity based on the work of Trofim Lysenko. Lysenko was an agronomist and biologist who emphasized the "relation of an organism of a given nature to its environmental conditions" (Lysenko 2001 [1951], 7). Like neo-Lamarckianism, Lysenkoism stressed the malleability of inheritance and the responsiveness of organisms to their environments. Such an approach, credited by Lysenko to Russian plant biologist Ivan Vladimirovich Michurin, became known as "Michurnist biology" and was sanctioned by the CCP. Michurnist biology's theory of hereditary adaptations to environmental changes fit with socialist dialectical materialism at the heart of CCP doctrine (Schneider 1989). Lysenkoism folded the history of the Chinese people into the history of the material world that surrounded them, arguing that plants and potentially human bodies would carry histories within them (with the understanding, of course, that humans make history).

Geneticists in China were not allowed to openly teach the Morgan school or conduct Morgan-Mendelian genetic research from 1949 until 1956, when transformations in the Soviet Union's political leadership and heightened utilitarian concerns led CCP leader Mao Zedong to readjust national policies (P. Li 1988). This led to the Hundred Flowers movement, where citizens were encouraged to openly express their stances on various issues, including science, during organized events.[7] As a result, some research with

non-Michurnist leanings became sanctioned.[8] But work on both sides of the Michurnism-Mendelism approach came to a halt during the Great Leap Forward (1958–62), a period when a CCP-led campaign to move China from an agricultural to an industrial economy resulted in one of the deadliest famines in history, referred to as The Great Famine or "Three Difficult Years" (*sannian kunnan shiqi*) (E. Zhang, Kleinman, and Tu 2010).[9] Scientific recovery from this devastating famine (1959–61) was brief. The Cultural Revolution began in 1966 and saw the closing of almost all laboratories. Many scientists, regardless of their theoretical commitments, were criticized for following foreigners and losing touch with reality, and eventually sent to the countryside for "reform through manual labor" (P. Li 1988). Self-reliant (*tu*) science was emphasized and perceived as superior to foreign (*yang*) science, reflecting a binary that mapped onto comparisons of Chinese (*zhong*) and Western (*xi*) (Fu 2017).

It wasn't until after Mao's death and subsequent transfers of power that universities and laboratories resumed regular activity. After Deng Xiaoping took power in 1976, the national government reoriented toward economic development through reform and opening policies as well as the "four modernizations" campaign, which included a focus on science and technology. Competitive state funding for scientific research increased, as did the possibility of connecting technological development to commercialization opportunities inside and outside of China. Still, laboratory conditions remained poor through the eighties, even as a national scientific infrastructure was reestablished (Jiang 2015). But by the 1990s, China was developing a place in the increasing internationalization of science and would make major contributions to the Human Genome Project (Z. Chen and Zhao 2009). By the turn of the century, genomic scientific infrastructure, funding, and contributions through international publications and collaborations were growing faster in China than anywhere else in the world (Greenhalgh and Zhang 2020).[10] At this same moment of growth in China's genomic sciences, theories of the centrality of the gene to inheritance, health, and identity were increasingly being questioned by researchers in Europe and the United States.

In the aftermath of the Human Genome Project and its failure to identify meaningful genetic diversity, the limits of DNA's predictive power resulted in renewed interest in theories of gene-environment interaction (Shostak 2013). But it would be a mistake to think of such global rise in a gene-environment interaction approach as the single inspiration for epigenetic research in China, including the DeTox Lab's epigenetic toxicology. Many Chinese scientists had been required to train in both biology and Chinese medicine,

Mendelian genetics and dialectic philosophies—a dual emphasis established in the mid-1950s as part of the CCP's commitment to integrating Western and Chinese medicine, while nevertheless emphasizing the superiority and transformative potential of Chinese medicine (*zhongyi*) (Fu 2017, 132). Many grew up understanding food as medicine, or as operating through a principle of health and medical practice that viewed a correlation between inner states and outer conditions. Many lived through intense moments of socioeconomic and political transformation that had resulted in rapid changes to health, wealth, and everyday living, including changes to medical care, food, and education. Such intellectual and material surroundings shape, though certainly do not determine, how those researchers who I studied make sense of the connections between interior and exterior, exposure and effect, gene and environment. The DeTox Lab built from an idea that genes or DNA, even though important, were never immune to the environment.

Situating Epigenetic Research as Method

As mentioned, social scientific studies have shown that while the idea of epigenetics has the potential to reimagine the limits of the biological, such research can also do harm by reifying gender and racial stereotypes. While this is an important point that I continue to stress in this book, sometimes these same social scientific critiques of epigenetics themselves lack situatedness—a sense of the historical, political, cultural, socioeconomic, and other factors that influence how knowledge comes into being through particular people at certain times in specific places (Haraway 1988). At times, social scientists describe epigenetic research and discourse as if it exists outside the situations in which it is practiced. This obfuscation perpetuates the assumption that the values, ontologies, and imaginaries of the places in which social scientists most frequently study epigenetics (i.e., the United States and Europe) are the universal default, and that social scientists' critiques of epigenetics in general apply to epigenetic research practices and everyday imaginaries of epigenetics everywhere. Certainly, epigenetic research practices work in and through transnational assemblages of scientific infrastructure, research trends, and scientific languages and vocabularies (Ong and Collier 2004). But they, like other scientific practices, are also influenced by socioeconomic inequities (Tousignant 2018), national and regional funding mechanisms (J. Y. Zhang 2012), and ethical expectations and configurations (Ong and Chen 2010). Situated expressions of sexism, racism, nationalism, and individualism also influence the assumptions and stereotypes embedded

in scientific research. In short, the limitations and possibilities of epigenetic research express and produce contingent political, socioeconomic, and historical conditions as well as values, norms, and imaginaries of kinship, gender, race, and inheritance.

This book is methodologically informed by primarily two types of research which both contribute to situating epigenetics. First, I conducted participant observation and approximately twenty-five interviews during fieldwork in China. I formulated this research project between 2008 and 2010, spending time in Beijing, Shanghai, Nanjing, and Chongqing. I eventually settled on Nanjing as the location of my long-term fieldwork, conducted in 2011, primarily because of the location of the Detox Lab but also because of the city's rich history of scientific research and transnational knowledge production. As the former capital of China, Nanjing has long been an educational center and today contains more than forty universities. During fieldwork, I regularly spent time with faculty and graduate students from multiple universities in the city as well as Nanjing residents unaffiliated with these educational institutions. I met these residents—who were employed in various sectors, from energy to tourism—through engaging in local activities and through connections I had made during earlier preliminary research.

In 2011, I lived in downtown Nanjing, where I rented a small apartment in a building occupied primarily by Chinese families. This building was within walking distance of the Nanjing Institute of Medicine and Science (NIMS), where the DeTox Lab is based. At NIMS, most of my time was spent with members of the DeTox Lab. During my days at the lab I observed studies in the laboratory and through such observation learned more about how environments were brought into being during epigenetic research practices. I interviewed DeTox Lab members as well as affiliated physicians and scholars, and I also joined in meals and leisure activities. I sometimes assisted with the work of the scholars I observed and interviewed, copyediting English-language articles before resubmission and English-language presentation slides. I also attended presentations in the Toxicology Department's seminar series, toured various laboratories, and met with faculty and graduate students in and outside the department.

The interpretation of the information gathered through this fieldwork is informed by a second type of research, which might be glossed as "archival." More accurately, this second type of research involved gathering and analyzing information from a variety of scholarly and nonscholarly sources, often areas that seemingly had little to do with epigenetics. Before, during, and after fieldwork, I compiled news articles, scientific articles, policy and

institutional documents, and more informal reflections on infertility and the environment, reproduction and hormones, food and exposures. I also documented conversations with Nanjing locals and observations of everyday life outside the laboratory setting that overlapped with these issues. This information has influenced my interpretation of epigenetic research practices, and some has even been directly incorporated in order to help readers make sense of the contingency of epigenetic research. By bringing together this wide variety of sources, my book explores the ways that doing epigenetic research in Nanjing, during a moment of growing but still largely aspirational attention to environmental pollution, shapes how epigenetic knowledge is produced.

These varied sources and observations were helpful in thinking through why the DeTox Lab's research materialized certain environments and not others. Moving through a variety of research sites—from media to nongovernmental organization (NGO) reports, from hospitals to laboratories, from transnational scientific literature to everyday scientific practice—also gets me away from an idea that the boundaries of the laboratory are clear or that the laboratory is a site of replication (Knorr-Cetina 1999) rather than an environment that itself comes into being in relation to various other environments. Even when this book focuses on what has been called "science in action" (Latour 1987), it also points to the material and existential circumstances—political and industrial histories, institutional infrastructure, gender and ethnic stereotypes and expectations—that shape epigenetic research practices. These circumstances are not the contexts of science; they are a part of scientific practice and inform the scales at which environments are brought into being.

Organization of the Book

This book is organized around five environments that were prominent in the DeTox Lab's research and in conversations and media representations that occurred in and outside the lab. Each environment circumscribes a set of material-existential circumstances of interest to the toxicologists I studied and addresses the threat of living with the embodied consequences of toxic exposures for present and future generations. Each chapter is meant to encourage readers to think differently about what it means to conceptualize and materialize "the environment" through epigenetic research. What does the environment mean to those who study its connection to reproductive health, especially Chinese men's reproductive health? In a moment of in-

creased scientific and activist attention to the environment, who becomes responsible for interconnected, intergenerational health? Each of the book's five chapters offers different answers to these questions.

But—like the environments that the DeTox Lab studies—the chapters also overlap. The national, hormonal, dietary, maternal, and laboratory environments are made to stand apart even though they are partially connected. Materializations of various environments are a means through which toxicologists at the DeTox Lab both oversimplify causality and come to understand relationships between economic, social, industrial, and dietary transformations in men's reproductive and developmental health. The book begins with the DeTox Lab's earliest research and questions of sperm decline, moves on to the human and animal studies that occurred during my fieldwork, and ends with a discussion of their later birth-cohort studies. Despite this linear rendering of time, much of this research, especially in the later chapters, occurred simultaneously. As explored further in the coda, this organization of the text is meant to allow for reflection on how the goals of the both the DeTox Lab's research and the transnational study of environmental health have changed over time as environments increasingly proliferate in and through intergenerational environmental health research.

Chapter 1, "The National Environment," begins in 2005, when the global sperm crisis "washes up on China's shores" ("Sperm Crisis" 2005). Originally articulated by a research group in Denmark in 1992 (Carlsen et al. 1992), the term *global sperm crisis* signaled a decline of sperm counts and quality over the past fifty years that was thought to be linked to environmental change the world over. Debate about such claims resulted in another hypothesis: that sperm decline was not global but instead was a matter of geographic variation. The DeTox Lab researchers extended both hypotheses when they began conducting "toxicogenomic" research on the potential intergenerational effects of damaged sperm DNA in the occupational environment. Though to some extent participating in a kind of DNA fetishization (Franklin 1988; Haraway 1997a), their research highlighted DNA's vulnerability to geographically specific environmental factors, pointing to the workplace as a site through which the embodied effects of China's unique role in the world economy could be understood. Moreover, this initial study's findings reverberated with growing national concern about "population quality" (*renkou suzhi*) amid restrictive birth-planning policies. Subsequent research on men's infertility among the "general population" showed that everyday exposure levels among infertile men in Nanjing were many times higher than those reported from other national settings. This finding created a transnationally comparative

lens through which a toxic national environment came into view. Finding a toxic "national environment" as partially responsible for semen decline, the DeTox Lab articulated the embodied and intergenerational consequences of China's industrial pollution and lax environmental regulations through the framework of genotoxicity.

Chapter 2, "The Hormonal Environment," discusses endocrine-disrupting chemicals (EDCs), which are objects of study in much epigenetic toxicology, through an analysis of a 2010 Greenpeace China report titled *Swimming in Poison*. The report was referenced by toxicologists from the DeTox Lab and was modeled on previously conducted toxicological experiments, but it took on the challenge of making EDC toxicity a matter of public concern. Quite unsurprisingly for the toxicology community, the report found that fish from collection points along the Yangtze River (*Chang Jiang*) showed elevated levels of harmful "environmental hormones" (*huanjing jisu*, also often referred to as EDCs). Scholars have critiqued EDC science and activism for its heteronormative pathologizing of reproductive and developmental harm, drawing attention to the "sex-panic" that emerged around EDCs' "gender-bending" effects. This chapter shows that such sex panic is not necessary for activist success, nor is it a universal obsession in responses to EDCs. Unlike in Europe and North America, media reactions to the report in China did not focus on sex transgression. Instead, reactions focused on food safety, industrial capitalism, and the ecological scope of pollution. Based on this analysis, I argue that the analytic potential of the hormonal environment, and of toxicology more generally, might be better mobilized through cultivating attention to underlying social, political, and economic causes rather than through panic over harmful effects.

Epigenetic research often focuses on the way diet influences the health of future generations, drawing attention to the intergenerational impacts of "food as exposure" (Landecker 2011). The effects of phytoestrogenic plants, or plants that contain EDCs, are of particular concern to reproductive and developmental toxicologists. In chapter 3, "The Dietary Environment," I think through studies of soy consumption and its disputed influences on men's reproductive health, particularly the health of sperm. I show how a US-based study that found negative influences of soy-consumption habits was received in China and motivated the DeTox Lab to launch its own investigation of soy-sperm relations. This comparative study of soy brought a "Chinese body" into being, said to be distinguishable through dietary habits, metabolic capacities, and genetic polymorphisms. In its research on the dietary environment, the DeTox Lab attempted to counter research

assumptions about the negative effects of phytoestrogens on men. Through challenging such research, the DeTox Lab also challenges stereotypes of femininity and masculinity historically aligned with East and West. But they also end up reasserting a familiarly deterministic idea of race as genetically definable, even if interindividually variable, resulting in the racialization of the metabolism. Through its implicitly comparative dimensions, the dietary environment becomes as materially and semiotically fixed as "Chinese men."

Chapter 4, "The Maternal Environment," turns from the laboratory to a partnering hospital to consider the argument commonly made by social scientists that epigenetic research exaggerates maternal blame for inherited conditions. Drawing on fieldwork in a neonatal unit that treats congenital disorders and participates in toxicological research, I show that epigenetic studies of infertility and congenital disorders conducted by the DeTox Lab encourage physicians and patients to deindividualize ideas of maternal responsibility. Toxicologists bring into being a maternal environment that both reasserts maternal responsibility for fetal health and places responsibility on intergenerational human and nonhuman kin, thereby reconfiguring preexisting models of relational personhood to reassert a sense of intergenerational connectivity and collective responsibility. I argue that the understanding of personhood underlying critical social scientific critiques of the maternal environment often relies on a Eurocentric model of personhood and misses the potential of epigenetic research to interpret the person from a relational perspective.

Environmental epigenetic research has been praised by many for its complex approach to genes and biology. But such research has also been criticized for its tendency to reduce complex activities into oversimplified characterizations of environments. In chapter 5, "The Laboratory Environment," I explore the laboratory space in which the environment is both reduced and proliferated. I show how DeTox Lab members demarcated, isolated, and measured the influence of environmental factors in and on animal models, while simultaneously observing the multiple exposures and complex contexts in which all animals live, eat, breathe, interact, and reproduce. In such work the laboratory environment itself becomes one of many environmental factors thought to have epigenetic influences. Through ethnographic depictions of experiments conducted by DeTox Lab members, I show how situating the laboratory in its social, cultural, and environmental settings is not the exclusive analytical purview of science and technology studies. It is also the increasingly necessary work of those who study how environmental factors potentially influence the results of intergenerational animal experiments in the laboratory environment.

In the coda I reflect on the DeTox Lab's birth-cohort research that occurred after I left China and discuss the rise of intergenerational research in environmental health more broadly. I suggest that as a contextualizing force that places individual health conditions within broader social, political, economic, and chemical conditions, epigenetic toxicology and birth-cohort research more generally have the potential to rewrite the boundaries of the reproductive body, deindividualizing reproductive and environmental health responsibility in China and beyond. But they also have the potential to reify reproductive norms and biologically deterministic ideas of race and kin. The epilogue is a short reflection on my own struggles against the individualized burden of reproductive responsibility through a discussion of breastfeeding jaundice and the paradox of plastics.

Reproducing a Toxic China

As toxicologists bring environments into being through epigenetic research, emphasizing the elevated levels of exposure faced in the environments that surround them, a narrative of a toxic China emerges. The story is in many ways familiar. Over the last three decades, after the death of Chinese Communist Party leader Mao Zedong and the embrace of reform and opening policies that integrated China into a global economy, the nation rapidly industrialized. Now the world's largest economy, China is dealing with an economic boom that has come at great costs. Unbridled industrialization and a lack of environmental regulation often characterized as a policy of "pollute first, clean up later" have led to rampant air, water, and soil pollution. In more recent years this pollution has been coupled with the rise of consumption among a growing middle class that is increasingly purchasing products such as automobiles, meat, and other commodities once viewed as luxuries. The growing pollution of China's environment has become a serious burden for its residents, who suffer from environmental health problems, and for the national government, which now dedicates a significant percent of its annual budget to environmental remediation.

The sense of toxic ubiquity that this narrative evokes leaves environmental health scientists and activists in China, as well as anthropologists who study them, in a position of foregrounding Chinese toxicity in ways that are both important and potentially problematic. On the one hand, the scale of China's toxicity is undeniable. Beneath the paradoxical narrative of China's toxic transformation, people's lives are being upended and ended by a rising number of environmental health concerns. There are now more

than four hundred "cancer villages" in the People's Republic of China (PRC) and twenty-five in Jiangsu Province alone (Cheng and Nathanail 2019). A growing number of health concerns are now considered issues of environment health, from cancer to cardiovascular disease, Alzheimer's to low birth weight (Holdaway 2013). These are urgent concerns for Chinese people and increasingly for the PRC government. On the other hand, scholarly and media representations of a toxic China have their own effects.

Anthropologist Ralph Litzinger and interdisciplinary scholar Fan Yang characterize foreign media's obsession with China's ecological disasters as a discourse of "Yellow Eco-Peril." Such discourse depicts China as "a polluting and polluted Other" (Litzinger and Yang 2019, 211). Such depictions depend upon past colonial characterizations of China as the "Sick Man of Asia" (Rogaski 2019). Similarly, Mel Chen shows how an obsession with the toxicity of products made in China problematically racializes toxicity (M. Chen 2012). Such toxic imaginaries are created through a comparative lens, but they also, as Chen as well as Litzinger and Yang note, often decontextualize China from its global economic surroundings, leaving the responsibility for Euro-American consumption and capitalism off the table.

It is then essential that toxicological claims, and the anthropologist's portrayal of them, do not further an idea of toxicity "made in China." The urgency of avoiding such a portrayal has only heightened amid the global spread of the novel coronavirus, COVID-19. (As I write this, the pandemic unfolds, as does a wave of hate crimes against Asian and Asian-American people in the United States and other locations because of a debate over virus origin playing out at the transnational level.) In this book I try to prevent essentializations of Chinese toxicity—not by avoiding the rhetoric and realities of pollution and its effects but by trying to understand how environmental health scientists and activists in China think about and materialize scientific evidence about such issues. I take seriously the findings of those I studied at the DeTox Lab, who demonstrate that people living in the Yangtze River Delta are exposed to more toxins at higher levels than are people in many Euro-American settings. But I also reflect on the presentation of toxic environments and conditions by toxicologists and other environmental actors. By studying the scientific practices in which findings of toxic exceptionalism are materialized and circulated, I hope to approach toxicity as a means of understanding both the discourse and the chemistry of environments.

Accordingly, the title of this book, *Infertile Environments*, is not meant as a description or prediction of a future looming ahead for China. Instead, it is meant to capture an increasingly common anxiety about the connections

between environments and the in/fertility of present and future generations in China and beyond, an anxiety that is rooted in both rhetoric and reality. In subsequent chapters, each focused on a particular environment, I show how epi/genetic research provided an avenue for the DeTox Lab to further stress the crucial role of "the environment" in reproductive health. At a moment when concern about toxicity in China was growing but the government had yet to implement consequential monitoring, regulation, or limitation of industrial pollution, the DeTox Lab used bionormative and heteronormative epigenetic research approaches to explore the inheritable dimensions of economic policies that drive national and regional industrial pollution. Their research provided evidence of the comparatively high levels of toxic exposure endured every day by people living in China. It also brought to the fore an understanding of environments as interior and exterior settings that influence health within and across generations. The title is also, then, meant to speak to my sense that epigenetic research is a flawed but persuasive means of exploring how environments outside the body influence men's reproductive, developmental, and intergenerational health.

NOTES

Preface

1 Sarah Franklin (1997) has written extensively about how infertility is often experienced as a disruption to an assumed life trajectory and how this later makes IVF the obvious choice, for this treatment is framed as "a helping hand" on a well-trod linear path.

2 Similarly, in a binational study of women in the United States and Israel, anthropologist Marcia Inhorn and colleagues show that reasons for pursuing "elective egg freezing" do not typically include career decisions, as often assumed. Instead, 85 percent of those who froze eggs stated "lack of partner" as their primary reason for pregnancy delay (Inhorn et al. 2018).

3 The commonly used description of cervical mucus as "hostile" to sperm is yet another example of how the imagery and vocabularies of war make their way into gendered notions of the body (see Martin 1991).

4 Many scholars have written about how biology and biological relatedness are not fixed notions but are reimagined in practice—for instance, through reproductive technologies (see Franklin 2011, 2013a; Hayden 1995; Thompson 2005).

5 Scholars have written on the incongruity of male and female infertility-treatment experiences (Barnes 2014) and the incongruity of male reproductive science and medicine, including gamete donation (see Almeling 2011; Almeling and Waggoner 2013; Martin 1991).

6 Male infertility and particularly a decline in sperm quality have now been linked to age through ideas of paternal effects and epigenetics. For the history of such findings and reflection on why it took so long to seriously consider the role of men's sperm health in infertility and reproductive research, see Rene Almeling, *GUYnecology: The Missing Science of Men's Reproductive Health* (2020).

Introduction

1 See Vincanne Adams, Kathleen Erwin, and Phuoc V. Le, "Governing through Blood," for a more thorough account of the social, cultural, and political factors surrounding donation in China (Adams, Erwin, and Le 2010), and Ruth Rogaski, *Hygienic Modernity*, for a historical account of the importance of semen (*jing)* in late Qing understandings of health (Rogaski 2004).

2 Other important anthropological texts on practice include "Theory in Anthropology since the Sixties" (Ortner 1984) and the follow-up "Theory in Anthropology since Feminist Practice" (Collier and Yanagisako 1989).

3 The term *China* is used throughout this book to reference the People's Republic of China in a way that admittedly elides engagement with the more-complex histories and politics of how the idea of China—as a nation, a geographic region, and an imagined community—is itself shifting and processual. For more on how China itself is a material and symbolic instantiation of broader values, practices, and borders, see, for instance, the work of Michael Kohrman (2005), Xin Liu (2012), Erik Mueggler (2001), Hentyle Yapp (2021), and Wen-hsin Yeh (2008).

4 The term *ecological civilization* was introduced in the late twentieth century, then incorporated into Communist Party policy documents in the early 2000s. In 2012 Hu Jintao reignited the use of the term, incorporating it into the second work report of the 18th Party Congress and then a constitutional amendment. The term has since been put forth as an alternative development strategy that, building on previous civilizing campaigns, takes more than economic growth into account (see Goron 2018; Zee 2020).

5 All personal names and names of research groups, as well as some institutional names, have been changed to pseudonyms to protect the privacy of those I researched. In addition, the details of some experiments and investigations have also been altered or not specified.

6 Even within US and UK biology there are some notable exceptions to this history (see Keller 1984; Franklin 2007).

7 As part of this campaign, the CCP's Propaganda Department and the Chinese Academy of Sciences (CAS) led an investigation into theories of heredity, resulting in the Qingdao Symposium on Genetics. The symposium was a fifteen-day event that brought together more than 130 people, including 48 senior geneticists, agricultural breeding specialists, taxonomists, and embryologists (P. Li 1988; Jiang 2017).

8 The first cytogenetics laboratory in China was established in 1962 at the Institute of Experimental Medicine in Beijing, and in 1963 a division of medical genetics was established at Peking Union Medical College (Luo 1988).

9 Extensive epigenetic research on this famine now studies the increased likelihood for a range of conditions, including high blood pressure, obesity, and schizophrenia, in subsequent generations of those in utero between 1959 and 1963.

10 There is also increased demand for prenatal screening, genetic counseling, and consumer genetic testing in China, although the predictive power of natural talents and abilities remains broadly interpreted as deeply influenced by various environments—familial, educational, occupational, etc. (see Sui and Sleeboom-Faulkner 2010). Inborn (*xiantian*) and acquired (*houtian*) are often regarded as interconnected phenomena (see W. Zhang and Sun 2015).

Chapter 1: The National Environment

1 The shift in causal factors *from* genes *to* the environment that Carlsen and colleagues describe here aged poorly, for gene-environment interaction soon after became a paradigm that scientists from a variety of fields began to embrace (Shostak 2005).

2 The meaning of *positive* here is meant to be juxtaposed with negative eugenics, most infamously practiced in Nazi Germany, where people with characteristics labeled undesirable were removed from the gene pool—killed and/or sterilized. Jiang's characterization of a historical emphasis on positive eugenics in China might be reassessed in light of the more negative eugenics policy that went into place through the mother and infant health program's restrictions on reproductive-technology use, discussed further in chapter 2 and by anthropologist Jianfeng Zhu (2013).

3 Some exemptions to birth-planning limitations did exist, and women resisted and shaped formal policies through informal work-arounds (Greenhalgh 1994). But the "one-child policy," as it came to be known around the world, was enforced primarily via women's bodies through female contraceptive implantation, dangerous and/or repeated abortions, and a massive sterilization campaign. This policy also resulted in a skewed birth ratio, as high as 118 boys to 100 girls in 2011, according to anthropologist Susan Greenhalgh, who argues that its effects were felt across genders. Girl children were missing, the result of infanticide and abandonment. Many unmarried men, especially poor men in rural areas, were unable to marry or have children, so they became "bare sticks" (*guanggun*). Greenhalgh argues that these men were stripped of the conditions "essential for social and even physical survival": getting married and being able to become a "real Chinese man" by fulfilling one's familial duty to have children (2013, 133).

4 For example, state funding for the development of IVF was originally provided through an application titled "Eugenics: The Protection, Preservation and Development of Early Embryos" (Jiang 2015).

5 Like many studies of reproductive technologies, Handwerker's account focuses on female infertility. Although this focus has been justified by many of the factors I discuss in the preface, including women's burden for infertility, the exclusion of men in such work in some ways reifies their absence from infertile blame (Almeling 2020; Barnes 2014). Still, Handwerker shows that the stigma of infertility