

THE
GENE

AN INTIMATE HISTORY

SIDDHARTHA
MUKHERJEE



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To Priyabala Mukherjee (1906–1985), who knew the perils;
to Carrie Buck (1906–1983), who experienced them.

An exact determination of the laws of heredity will probably work more change in man's outlook on the world, and in his power over nature, than any other advance in natural knowledge that can be foreseen.

—William Bateson

Human beings are ultimately nothing but carriers—passageways—for genes. They ride us into the ground like racehorses from generation to generation. Genes don't think about what constitutes good or evil. They don't care whether we are happy or unhappy. We're just means to an end for them. The only thing they think about is what is most efficient for them.

—Haruki Murakami, *1Q84*

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Prologue: Families

The blood of your parents is not lost in you.

—Menelaus, *The Odyssey*

They fuck you up, your mum and dad.

They may not mean to, but they do.

They fill you with the faults they had

And add some extra, just for you.

—Philip Larkin, “This Be The Verse”

In the winter of 2012, I traveled from Delhi to Calcutta to visit my cousin Moni. My father accompanied me, as a guide and companion, but he was a sullen and brooding presence, lost in a private anguish that I could sense only dimly. My father is the youngest of five brothers, and Moni is his first-born nephew—the eldest brother’s son. Since 2004, when he was forty, Moni has been confined to an institution for the mentally ill (a “lunatic home,” as my father calls it), with a diagnosis of schizophrenia. He is kept densely medicated—awash in a sea of assorted antipsychotics and sedatives—and has an attendant watch, bathe, and feed him through the day.

My father has never accepted Moni’s diagnosis. Over the years, he has waged a lonely countercampaign against the psychiatrists charged with his nephew’s care, hoping to convince them that their diagnosis was a colossal error, or that Moni’s broken psyche would somehow magically mend itself. My father has visited the institution in Calcutta twice—once without warning, hoping to see a transformed Moni, living a secretly normal life behind the barred gates.

But my father knew—and I knew—that there was more than just

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avuncular love at stake for him in these visits. Moni is not the only member of my father's family with mental illness. Of my father's four brothers, two—not Moni's father, but two of Moni's uncles—suffered from various unravelings of the mind. Madness, it turns out, has been among the Mukherjees for at least two generations, and at least part of my father's reluctance to accept Moni's diagnosis lies in my father's grim recognition that some kernel of the illness may be buried, like toxic waste, in himself.

In 1946, Rajesh, my father's third-born brother, died prematurely in Calcutta. He was twenty-two years old. The story runs that he was stricken with pneumonia after spending two nights exercising in the winter rain—but the pneumonia was the culmination of another sickness. Rajesh had once been the most promising of the brothers—the nimblest, the supplest, the most charismatic, the most energetic, the most beloved and idolized by my father and his family.

My grandfather had died a decade earlier in 1936—he had been murdered following a dispute over mica mines—leaving my grandmother to raise five young boys. Although not the oldest, Rajesh had stepped rather effortlessly into his father's shoes. He was only twelve then, but he could have been twenty-two: his quick-fire intelligence was already being cooled by gravity, the brittle self-assuredness of adolescence already annealing into the self-confidence of adulthood.

But in the summer of '46, my father recalls, Rajesh had begun to behave oddly, as if a wire had been tripped in his brain. The most striking change in his personality was his volatility: good news triggered uncontained outbursts of joy, often extinguished only through increasingly acrobatic bouts of physical exercise, while bad news plunged him into inconsolable desolation. The emotions were normal in context; it was their extreme range that was abnormal. By the winter of that year, the sine curve of Rajesh's psyche had tightened in its frequency and gained in its amplitude. The fits of energy, tipping into rage and grandiosity, came often and more fiercely, and the sweeping undertow of grief that followed was just as strong. He ventured into the occult—organizing séances and planchette sessions at home, or meeting his friends to meditate at a crematorium at night. I don't know if he self-medicated—in the forties, the dens in Calcutta's Chinatown had ample supplies of opium from Burma and Afghani hashish to calm a young man's nerves—but my father recollects an altered brother: fearful at times, reckless at others, descending and ascending steep slopes of mood, irritable one morning and overjoyed the next (that word: *over-*

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joyed. Used colloquially, it signals something innocent: an amplification of joy. But it also delineates a limit, a warning, an outer boundary of sobriety. Beyond *overjoy*, as we shall see, there is no *over-overjoy*; there is only madness and mania).

The week before the pneumonia, Rajesh had received news of a strikingly successful performance in his college exams and—elated—had vanished on a two-night excursion, supposedly “exercising” at a wrestling camp. When he returned, he was boiling up with a fever and hallucinating.

It was only years later, in medical school, that I realized that Rajesh was likely in the throes of an acute manic phase. His mental breakdown was the result of a near-textbook case of manic-depression—bipolar disorder.



Jagu—the fourth-born of my father’s siblings—came to live with us in Delhi in 1975, when I was five years old. His mind was also crumbling. Tall and rail thin, with a slightly feral look in his eyes and a shock of matted, overgrown hair, he resembled a Bengali Jim Morrison. Unlike Rajesh, whose illness had surfaced in his twenties, Jagu had been troubled from childhood. Socially awkward, withdrawn to everyone except my grandmother, he was unable to hold a job or live by himself. By 1975, deeper cognitive problems had emerged: he had visions, phantasms, and voices in his head that told him what to do. He made up conspiracy theories by the dozens: a banana vendor who sold fruit outside our house was secretly recording Jagu’s behavior. He often spoke to himself, with a particular obsession of reciting made-up train schedules (“Shimla to Howrah by Kalka mail, then transfer at Howrah to Shri Jagannath Express to Puri”). He was still capable of extraordinary bursts of tenderness—when I mistakenly smashed a beloved Venetian vase at home, he hid me in his bedclothes and informed my mother that he had “mounds of cash” stashed away that would buy “a thousand” vases in replacement. But this episode was symptomatic: even his love for me involved extending the fabric of his psychosis and confabulation.

Unlike Rajesh, who was never formally diagnosed, Jagu was. In the late 1970s, a physician saw him in Delhi and diagnosed him with schizophrenia. But no medicines were prescribed. Instead, Jagu continued to live at home, half-hidden away in my grandmother’s room (as in many families in India, my grandmother lived with us). My grandmother—

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besieged yet again, and now with doubled ferocity—assumed the role of public defender for Jagu. For nearly a decade, she and my father held a fragile truce between them, with Jagu living under her care, eating meals in her room and wearing clothes that she stitched for him. At night, when Jagu was particularly restless, consumed by his fears and fantasies, she put him to bed like a child, with her hand on his forehead. When she died in 1985, he vanished from our house and could not be persuaded to return. He lived with a religious sect in Delhi until his death in 1998.



Both my father and my grandmother believed that Jagu's and Rajesh's mental illnesses had been precipitated—even caused, perhaps—by the apocalypse of Partition, its political trauma sublimated into their psychic trauma. Partition, they knew, had split apart not just nations, but also minds; in Saadat Hasan Manto's "Toba Tek Singh"—arguably the best-known short story of Partition—the hero, a lunatic caught on the border between India and Pakistan, also inhabits a limbo between sanity and insanity. In Jagu's and Rajesh's case, my grandmother believed, the upheaval and uprooting from East Bengal to Calcutta had unmoored their minds, although in spectacularly opposite ways.

Rajesh had arrived in Calcutta in 1946, just as the city was itself losing sanity—its nerves fraying; its love depleted; its patience spent. A steady flow of men and women from East Bengal—those who had sensed the early political convulsions before their neighbors—had already started to fill the low-rises and tenements near Sealdah station. My grandmother was a part of this hardscrabble crowd: she had rented a three-room flat on Hayat Khan Lane, just a short walk from the station. The rent was fifty-five rupees a month—about a dollar in today's terms, but a colossal fortune for her family. The rooms, piled above each other like roughhousing siblings, faced a trash heap. But the flat, albeit minuscule, had windows and a shared roof from which the boys could watch a new city, and a new nation, being born. Riots were conceived easily on street corners; in August that year, a particularly ugly conflagration between Hindus and Muslims (later labeled the Great Calcutta Killing) resulted in the slaughtering of five thousand and left a hundred thousand evicted from their homes.

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Rajesh had witnessed those rioting mobs in their tidal spate that summer. Hindus had dragged Muslims out of shops and offices in Lalbazar and gutted them alive on the streets, while Muslims had reciprocated, with equal and opposite ferocity, in the fish markets near Rajabazar and Harrison Road. Rajesh's mental breakdown had followed quickly on the heels of the riots. The city had stabilized and healed—but he had been left permanently scarred. Soon after the August massacres, he was hit by a volley of paranoid hallucinations. He grew increasingly fearful. The evening excursions to the gym became more frequent. Then came the manic convulsions, the spectral fevers, and the sudden cataclysm of his final illness.

If Rajesh's madness was the madness of arrival, then Jagu's madness, my grandmother was convinced, was the madness of departure. In his ancestral village of Dehergoti, near Barisal, Jagu's psyche had somehow been tethered to his friends and his family. Running wild in the paddy fields, or swimming in the puddles, he could appear as carefree and playful as any of the other kids—almost normal. In Calcutta, like a plant uprooted from its natural habitat, Jagu wilted and fell apart. He dropped out of college and parked himself permanently by one of the windows of the flat, looking blankly out at the world. His thoughts began to tangle, and his speech became incoherent. As Rajesh's mind was expanding to its brittle extreme, Jagu's contracted silently in his room. While Rajesh wandered the city at night, Jagu confined himself voluntarily at home.



This strange taxonomy of mental illness (Rajesh as the town mouse and Jagu as the country mouse of psychic breakdown) was convenient while it lasted—but it shattered, finally, when Moni's mind also began to fail. Moni, of course, was not a "Partition child." He had never been uprooted; he had lived all his life in a secure home in Calcutta. Yet, uncannily, the trajectory of his psyche had begun to recapitulate Jagu's. Visions and voices had started to appear in his adolescence. The need for isolation, the grandiosity of the confabulations, the disorientation and confusion—these were all eerily reminiscent of his uncle's descent. In his teens, he had come to visit us in Delhi. We were supposed to go out to a film together, but he locked himself in our bathroom upstairs and refused to come out for nearly an hour, until my grandmother had

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ferreted him out. When she had found him inside, he was folded over in a corner, hiding.

In 2004, Moni was beaten up by a group of goons—allegedly for urinating in a public garden (he told me that an internal voice had commanded him, “Piss here; piss here”). A few weeks later, he committed a “crime” that was so comically egregious that it could only be a testament to his loss of sanity: he was caught flirting with one of the goon’s sisters (again, he said that the voices had commanded him to act). His father tried, ineffectually, to intervene, but this time Moni was beaten up viciously, with a gashed lip and a wound in his forehead that precipitated a visit to the hospital.

The beating was meant to be cathartic (asked by the police, his tormentors later insisted that they had only meant to “drive the demons out of Moni”)—but the pathological commanders in Moni’s head only became bolder and more insistent. In the winter of that year, after yet another breakdown with hallucinations and hissing internal voices, he was institutionalized.

The confinement, as Moni told me, was partially voluntary: he was not seeking mental rehabilitation as much as a physical sanctuary. An assortment of antipsychotic medicines was prescribed, and he improved gradually—but never enough, apparently, to merit discharge. A few months later, with Moni still confined at the institution, his father died. His mother had already passed away years earlier, and his sister, his only other sibling, lived far away. Moni thus decided to remain in the institution, in part because he had nowhere else to go. Psychiatrists discourage the use of the archaic phrase *mental asylum*—but for Moni, the description had come to be chillingly accurate: this was the one place that offered him the shelter and safety that had been missing from his life. He was a bird that had voluntarily caged itself.

When my father and I visited him in 2012, I had not seen Moni for nearly two decades. Even so, I had expected to recognize him. But the person I met in the visiting room bore such little resemblance to my memory of my cousin that—had his attendant not confirmed the name—I could easily have been meeting a stranger. He had aged beyond his years. At forty-eight, he looked a decade older. The schizophrenia medicines had altered his body and he walked with the uncertainty and imbalance of a child. His speech, once effusive and rapid, was hesitant and fitful; the words emerged with a sudden, surprising force, as if he

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were spitting out strange pips of food that had been put into his mouth. He had little memory of my father, or me. When I mentioned my sister's name, he asked me if I had married her. Our conversation proceeded as if I were a newspaper reporter who had dropped out of the blue to interview him.

The most striking feature of his illness, though, was not the storm within his mind, but the lull in his eyes. The word *moni* means “gem” in Bengali, but in common usage it also refers to something ineffably beautiful: the shining pinpricks of light in each eye. But this, precisely, was what had gone missing in Moni. The twin points of light in his eyes had dulled and nearly vanished, as if someone had entered his eyes with a minute paintbrush and painted them gray.



Throughout my childhood and adult life, Moni, Jagu, and Rajesh played an outsize role in my family's imagination. During a six-month flirtation with teenage angst, I stopped speaking to my parents, refused to turn in homework, and threw my old books in the trash. Anxious beyond words, my father dragged me glumly to see the doctor who had diagnosed Jagu. *Was his son now losing his mind?* As my grandmother's memory failed in the early eighties, she began to call me Rajeshwar—Rajesh—by mistake. She would correct herself at first, in a hot blush of embarrassment, but as she broke her final bonds with reality, she seemed to make the mistake almost willingly, as if she had discovered the illicit pleasure of that fantasy. When I met Sarah, now my wife, for the fourth or fifth time, I told her about the splintered minds of my cousin and two uncles. It was only fair to a future partner that I should come with a letter of warning.

By then, heredity, illness, normalcy, family, and identity had become recurrent themes of conversation in my family. Like most Bengalis, my parents had elevated repression and denial to a high art form, but even so, questions about this particular history were unavoidable. Moni; Rajesh; Jagu: three lives consumed by variants of mental illness. It was hard not to imagine that a hereditary component lurked behind this family history. Had Moni inherited a gene, or a set of genes, that had made him susceptible—the same genes that had affected our uncles? Had others

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been affected with different variants of mental illness? My father had had at least two psychotic fugues in his life—both precipitated by the consumption of *bhang* (mashed-up cannabis buds, melted in ghee, and churned into a frothing drink for religious festivals). Were these related to the same scar of history?



In 2009, Swedish researchers published an enormous international study, involving thousands of families and tens of thousands of men and women. By analyzing families that possessed intergenerational histories of mental illness, the study found striking evidence that bipolar disorder and schizophrenia shared a strong genetic link. Some of the families described in the study possessed a crisscrossing history of mental illness achingly similar to my own: one sibling affected with schizophrenia, another with bipolar disorder, and a nephew or niece who also had schizophrenia. In 2012, several further studies corroborated these initial findings, strengthening the links between these variants of mental illness and family histories and deepening questions about their etiology, epidemiology, triggers, and instigators.

I read two of these studies on a winter morning on the subway in New York, a few months after returning from Calcutta. Across the aisle, a man in a gray fur hat was pinning down his son to put a gray fur hat on him. At Fifty-Ninth Street, a mother wheeled in a stroller with twins emitting, it seemed to my ears, identically pitched screams.

The study provided a strange interior solace—answering some of the questions that had so haunted my father and grandmother. But it also provoked a volley of new questions: If Moni's illness was genetic, then why had his father and sister been spared? What “triggers” had unveiled these predispositions? How much of Jagu's or Moni's illnesses arose from “nature” (i.e., genes that predisposed to mental illness) versus “nurture” (environmental triggers such as upheaval, discord, and trauma)? Might my father carry the susceptibility? Was I a carrier as well? What if I could know the precise nature of this genetic flaw? Would I test myself, or my two daughters? Would I inform them of the results? What if only one of them turned out to carry that mark?



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While my family's history of mental illness was cutting through my consciousness like a red line, my scientific work as a cancer biologist was also converging on the normalcy and abnormalcy of genes. Cancer, perhaps, is an ultimate perversion of genetics—a genome that becomes pathologically obsessed with replicating itself. The genome-as-self-replicating-machine co-opts the physiology of a cell, resulting in a shape-shifting illness that, despite significant advances, still defies our ability to treat or cure it.

But to study cancer, I realized, is to also study its obverse. What is the code of normalcy before it becomes corrupted by cancer's coda? What does the normal genome *do*? How does it maintain the constancy that makes us discernibly similar, and the variation that makes us discernibly different? How, for that matter, is constancy versus variation, or normalcy versus abnormalcy, defined or written into the genome?

And what if we learned to change our genetic code intentionally? If such technologies were available, who would control them, and who would ensure their safety? Who would be the masters, and who the victims, of this technology? How would the acquisition and control of this knowledge—and its inevitable invasion of our private and public lives—alter the way we imagine our societies, our children, and ourselves?



This book is the story of the birth, growth, and future of one of the most powerful and dangerous ideas in the history of science: the “gene,” the fundamental unit of heredity, and the basic unit of all biological information.

I use that last adjective—*dangerous*—with full cognizance. Three profoundly destabilizing scientific ideas ricochet through the twentieth century, trisecting it into three unequal parts: the atom, the byte, the gene. Each is foreshadowed by an earlier century, but dazzles into full prominence in the twentieth. Each begins its life as a rather abstract scientific concept, but grows to invade multiple human discourses—thereby transforming culture, society, politics, and language. But the most crucial parallel between the three ideas, by far, is conceptual: each represents the irreducible unit—the building block, the basic organizational unit—of a larger whole: the atom, of matter; the

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byte (or “bit”), of digitized information; the gene, of heredity and biological information.*

Why does this property—being the least divisible unit of a larger form—imbue these particular ideas with such potency and force? The simple answer is that matter, information, and biology are inherently hierarchically organized: understanding that smallest part is crucial to understanding the whole. When the poet Wallace Stevens writes, “In the sum of the parts, there are only the parts,” he is referring to the deep structural mystery that runs through language: you can only decipher the meaning of a sentence by deciphering every individual word—yet a sentence carries more meaning than any of the individual words. And so it is with genes. An organism is much more than its genes, of course, but to understand an organism, you must first understand its genes. When the Dutch biologist Hugo de Vries encountered the concept of the gene in the 1890s, he quickly intuited that the idea would reorganize our understanding of the natural world. “The whole organic world is the result of innumerable different combinations and permutations of relatively few factors. . . . Just as physics and chemistry go back to molecules and atoms, the biological sciences have to penetrate these units [genes] in order to explain . . . the phenomena of the living world.”

The atom, the byte, and the gene provide fundamentally new scientific and technological understandings of their respective systems. You cannot explain the behavior of matter—why gold gleams; why hydrogen combusts with oxygen—without invoking the atomic nature of matter. Nor can you understand the complexities of computing—the nature of algorithms, or the storage or corruption of data—without comprehending the structural anatomy of digitized information. “Alchemy could not become chemistry until its fundamental units were discovered,” a

* By *byte* I am referring to a rather complex idea—not only to the familiar byte of computer architecture, but also to a more general and mysterious notion that *all* complex information in the natural world can be described or encoded as a summation of discrete parts, containing no more than an “on” and “off” state. A more thorough description of this idea, and its impact on natural sciences and philosophy, might be found in *Information: A History, a Theory, a Flood* by James Gleick. This theory was most evocatively proposed by the physicist John Wheeler in the 1990s: “Every particle, every field of force, even the space-time continuum itself—derives its function, its meaning, its very existence entirely . . . from answers to yes-or-no questions, binary choices, bits . . . ; in short, that all things physical are information-theoretic in origin.” The byte or bit is a man-made invention, but the theory of digitized information that underlies it is a beautiful natural law.

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nineteenth-century scientist wrote. By the same token, as I argue in this book, it is impossible to understand organismal and cellular biology or evolution—or human pathology, behavior, temperament, illness, race, and identity or fate—without first reckoning with the concept of the gene.

There is a second issue at stake here. Understanding atomic science was a necessary precursor to manipulating matter (and, via the manipulation of matter, to the invention of the atomic bomb). Our understanding of genes has allowed us to manipulate organisms with unparalleled dexterity and power. The actual nature of the genetic code, it turns out, is astoundingly simple: there's just one molecule that carries our hereditary information and just one code. "That the fundamental aspects of heredity should have turned out to be so extraordinarily simple supports us in the hope that nature may, after all, be entirely approachable," Thomas Morgan, the influential geneticist, wrote. "Her much-advertised inscrutability has once more been found to be an illusion."

Our understanding of genes has reached such a level of sophistication and depth that we are no longer studying and altering genes in test tubes, but in their native context in human cells. Genes reside on chromosomes—long, filamentous structures buried within cells that contain tens of thousands of genes linked together in chains.* Humans have forty-six such chromosomes in total—twenty-three from one parent and twenty-three from another. The entire set of genetic instructions carried by an organism is termed a *genome* (think of the genome as the encyclopedia of all genes, with footnotes, annotations, instructions, and references). The human genome contains about between twenty-one and twenty-three thousand genes that provide the master instructions to build, repair, and maintain humans. Over the last two decades, genetic technologies have advanced so rapidly that we can decipher how several of these genes operate in time and space to enable these complex functions. And we can, on occasion, deliberately alter some of these genes to change their functions, thereby resulting in altered human states, altered physiologies, and changed beings.

This transition—from explanation to manipulation—is precisely what makes the field of genetics resonate far beyond the realms of science. It is one thing to try to understand how genes influence human identity or

* In certain bacteria, chromosomes can be circular.

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sexuality or temperament. It is quite another thing to imagine altering identity or sexuality or behavior by altering genes. The former thought might preoccupy professors in departments of psychology, and their colleagues in the neighboring departments of neuroscience. The latter thought, inflected with both promise and peril, should concern us all.



As I write this, organisms endowed with genomes are learning to change the heritable features of organisms endowed with genomes. I mean the following: in just the last four years—between 2012 and 2016—we have invented technologies that allow us to change human genomes intentionally and permanently (although the safety and fidelity of these “genomic engineering” technologies still need to be carefully evaluated). At the same time, the capacity to predict the future fate of an individual from his or her genome has advanced dramatically (although the true predictive capacities of these technologies still remain unknown). We can now “read” human genomes, and we can “write” human genomes in a manner inconceivable just three or four years ago.

It hardly requires an advanced degree in molecular biology, philosophy, or history to note that the convergence of these two events is like a headlong sprint into an abyss. Once we can understand the nature of fate encoded by individual genomes (even if we can predict this in likelihoods rather than in certainties) and once we acquire the technology to intentionally change these likelihoods (even if these technologies are inefficient and cumbersome) our future is fundamentally changed. George Orwell once wrote that whenever a critic uses the word *human*, he usually renders it meaningless. I doubt that I am overstating the case here: our capacity to understand and manipulate human genomes alters our conception of what it means to be “human.”

The atom provides an organizing principle for modern physics—and it tantalizes us with the prospect of controlling matter and energy. The gene provides an organizing principle for modern biology—and it tantalizes us with the prospect of controlling our bodies and fates. Embedded in the history of the gene is “the quest for eternal youth, the Faustian myth of abrupt reversal of fortune, and our own century’s flirtation with the perfectibility of man.” Embedded, equally, is the desire to decipher our manual of instructions. *That* is what is at the center of this story.

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This book is organized both chronologically and thematically. The overall arc is historical. We begin in Mendel's pea-flower garden, in an obscure Moravian monastery in 1864, where the "gene" is discovered and then quickly forgotten (the word *gene* only appears decades later). The story intersects with Darwin's theory of evolution. The gene entrances English and American reformers, who hope to manipulate human genetics to accelerate human evolution and emancipation. That idea escalates to its macabre zenith in Nazi Germany in the 1940s, where human eugenics is used to justify grotesque experiments, culminating in confinement, sterilization, euthanasia, and mass murder.

A chain of post-World War II discoveries launches a revolution in biology. DNA is identified as the source of genetic information. The "action" of a gene is described in mechanistic terms: *genes encode chemical messages to build proteins that ultimately enable form and function*. James Watson, Francis Crick, Maurice Wilkins, and Rosalind Franklin solve the three-dimensional structure of DNA, producing the iconic image of the double helix. The three-letter genetic code is deciphered.

Two technologies transform genetics in the 1970s: gene sequencing and gene cloning—the "reading" and "writing" of genes (the phrase *gene cloning* encompasses the gamut of techniques used to extract genes from organisms, manipulate them in test tubes, create gene hybrids, and produce millions of copies of such hybrids in living cells.) In the 1980s, human geneticists begin to use these techniques to map and identify genes linked to diseases, such as Huntington's disease and cystic fibrosis. The identification of these disease-linked genes augurs a new era of genetic management, enabling parents to screen fetuses, and potentially abort them if they carry deleterious mutations (any person who has tested their unborn child for Down syndrome, cystic fibrosis, or Tay-Sachs disease, or has been tested herself for, say, *BRCA1* or *BRCA2* has already entered this era of genetic diagnosis, management, and optimization. This is not a story of our distant future; it is already embedded in our present).

Multiple genetic mutations are identified in human cancers, leading to a deeper genetic understanding of that disease. These efforts reach their crescendo in the Human Genome Project, an international project to map and sequence the entire human genome. The draft sequence of the human genome is published in 2001. The genome project, in turn,

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inspires attempts to understand human variation and “normal” behavior in terms of genes.

The gene, meanwhile, invades discourses concerning race, racial discrimination, and “racial intelligence,” and provides startling answers to some of the most potent questions coursing through our political and cultural realms. It reorganizes our understanding of sexuality, identity, and choice, thus piercing the center of some of the most urgent questions coursing through our personal realms.*

There are stories within each of these stories, but this book is also a very personal story—an intimate history. The weight of heredity is not an abstraction for me. Rajesh and Jagu are dead. Moni is confined to a mental institution in Calcutta. But their lives and deaths have had a greater impact on my thinking as a scientist, scholar, historian, physician, son, and father than I could possibly have envisioned. Scarcely a day passes in my adult life when I do not think about inheritance and family.

Most important, I owe a debt to my grandmother. She did not—she could not—outlive the grief of her inheritance, but she embraced and defended the most fragile of her children from the will of the strong. She weathered the buffets of history with resilience—but she weathered the buffets of heredity with something more than resilience: a grace that we, as her descendants, can only hope to emulate. It is to her that this book is dedicated.

* Some topics, such as genetically modified organisms (GMOs), the future of gene patents, the use of genes for drug discovery or biosynthesis, and the creation of new genetic species merit books in their own right, and lie outside the purview of this volume.