CONVERSATIONS IN MEDICINE AND SOCIETY

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by Dorothy Nelkin and M. Susan Lindee

The DNA Mystique

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3

Sacred DNA

In Stephen Spielberg's popular 1982 film *E.T.*, the extraterrestrial hero, apparently dying, lies on an operating table; suddenly a scientist runs in shouting, "He's got DNA!" Like many other cues in the widely admired movie, this reference to E.T.'s DNA reflects familiar ideas. It is part of a cultural narrative in which DNA is removed from history: this essential molecule is seen, not as a consequence of the conditions under which life evolved on Earth, but as an entity present in all living things regardless of their planet of origin. Indeed, discovering DNA in E.T.'s body is analogous to finding the King James Bible in the hold of a Martian spaceship. Such a discovery liberates the molecular text from history and makes it seem truly universal.

The scientific world view is based on belief in an underlying order in nature, and many scientists search, with nearly religious conviction, for an ultimate, unifying principle that will reveal the most fundamental laws.[1] Physicists in particular have interpreted their work in cosmic terms. Stephen Hawking, in *A Brief History of Time,* proclaimed that scientists reveal "the mind of God."[2] Nobelist Steven Weinberg, in *Dreams of a Final Theory,* searched for the principles that would explain all the laws of nature.[3] Physicist George Smoot has compared the big-bang theory to "the driving mechanism for the universe, and isn't that what God is?"[4] And Leon Lederman, another Nobel Prize-winning physicist, has named the subatomic entity that he believes determines everything the "God Particle." He has stated that he hopes to see all of physics reduced to a formula so simple and so elegant it will fit on a T-shirt.[5]

Biologists, too, have sought to unify biological knowledge through elucidation of the fundamental properties of life. In the 1930s in Britain and the United States, this effort took the form of the "evolutionary synthesis," which seemed to reconcile Darwinism and Mendelism—selectionism and genetics—theories initially seen as contradictory. The architects of the synthesis were able to promote the idea that biological change through time—evolution—could serve as the intellectual centerpiece for the study of life.[6] In the same period, the rise of molecular biology promised to explain life at its most fundamental physico-chemical level, the double helix of DNA.[7] And in 1975 entomologist E. O. Wilson announced a "new synthesis" that drew on both evolutionary biology and molecular biology to explain the human social order in biological terms.[8]

One of the most important entities in the search for an essential, unifying biological principle, then, has been DNA, the so-called "secret of life." In the 1990s geneticists, describing the genome as the "Bible," the "Book of Man," and the "Holy Grail," convey an image of this molecular structure not only as a powerful biological entity but also as a sacred text that can explain the natural and moral order. Former director of the Human Genome Project and Nobelist

James Watson has proclaimed that DNA is "what makes us human."[9] "Is DNA God?" asks a skeptical medical student in an essay in *The Pharos,* a medical journal: "Given [its] essential roles in the origin, evolution and maintenance of life, it is tempting to wonder if this twisted sugar string of purine and pyrimidine base beads is, in fact, God."[10]

Such spiritual imagery sets the tone for popular accounts of DNA, fueling narratives of genetic essentialism and giving mystical powers to a molecular structure. Indeed, DNA has assumed a cultural meaning similar to that of the Biblical soul. It has become a sacred entity, a way to explore fundamental questions about human life, to define the essence of human existence, and to imagine immortality. Like the Christian soul, DNA is an invisible but material entity, an "extract of the body" that has "permanence leading to immortality."[11] And like the Christian soul, DNA seems relevant to concerns about morality, personhood, and social place.

It is not a coincidence that the cultural depiction of DNA shares many characteristics with the immortal soul of Christian thought; those describing DNA often draw on the most powerful images of Christianity to convey its importance. Scientists and popularizers borrow the compelling concepts of one belief system to meet the needs of another in an effort to help their readers see the centrality and power of the gene.

Most cultures have recognized some entity that is relatively independent of the body, but that gives the body life and power.[12] Known in various historical and cultural circumstances as the soul, *yalo, nöos, hun,* spirit, and so on, this entity persists when the body is gone and, containing all its essential elements, can be used to bring the body back (for example on the day of the resurrection of the dead, the final day of judgment). This independent entity is also central to identity or selfhood; as philosopher Richard Swinburne has observed in his study of the nature of the soul, "personal identity is constituted by sameness of soul."[13]

So, too, in contemporary American popular culture, DNA is relatively independent of the body, gives the body life and power, and is the point at which true identity (and self) can be determined. DNA, like the soul, bears the marks of good

and evil: A man may look fine to the outside world, but despite appearances, if he is evil, it will be marked in his soul—or his genes. And DNA also appears to be immortal, containing within it everything needed to bring the body back. Cloning DNA has become, in popular culture, the way to reconstruct the bodies of extinct organisms (the dinosaurs in Michael Crichton's *Jurassic Park*), or to resurrect the characteristics of such past heroes as Abraham Lincoln.

Stories of DNA in popular culture also incorporate the classic myths of Frankenstein or the garden of Eden. Modern molecular genetics promises a "complete" understanding of human life, but such promised knowledge, in the form of genetic engineering and genetic therapy, also commonly appears as dangerous and taboo. Manipulating DNA, in this view, becomes a sacrilege, a violation of sacred ground.

In his analysis of the "sacred and profane," anthropologist Mircea Eliade describes how sacred realities become manifest "in objects that are an integral part of our natural 'profane' world." Thus, human organs in many cultures have been sacralized—endowed with religious valorization.[14] And in a study of theological debates about the soul in the twelfth and thirteenth centuries, historian Carolyn Bynum shows how the issue of personal continuity—the survival of the self or soul—has long focused on actual physical body parts. Questioning "how identity lasts through corruption and reassemblage" of the body, early Christian thinkers debated whether discarded fingernail parings would be reunited with their rightful owners at the end of the world.[15]

The modern cultural concept of genetic essentialism draws much of its power from such theological roots. The gene has become a way to talk about the boundaries of personhood, the nature of immortality, and the sacred meaning of life in ways that parallel theological narratives. Just as the Christian soul has provided an archetypal concept through which to understand the person and the continuity of self, so DNA appears in popular culture as a soul-like entity, a holy and immortal relic, a forbidden territory. The similarity between the powers of DNA and those of the Christian soul, we suggest, is more than linguistic or metaphorical. DNA has

taken on the social and cultural functions of the soul. It is the essential entity—the location of the true self—in the narratives of biological determinism.

Demarcating Boundaries

Anti-abortionists describe the base pairs of DNA as the "letters of a divine alphabet spell[ing] out the unique characteristics of a new individual" at the moment of conception.[16] For right-to-lifers, a complete set of chromosomes is a complete person. The chromosomes define and contain the individual in a "master genetic code." Just as genomics scientists characterize DNA as the "stuff of life," so religious leaders characterize it as a "core of essential humanity." In different ways, these groups are exploring the problem of boundaries: What is the crucial characteristic of humanity? What "makes us human"? That so many voices in the contemporary discourse on the essence of human life should settle on humanity's DNA as an answer to this age-old question is compelling evidence of the iconic importance of the gene as a secular equivalent to the soul. This concept provides biological grounding for the shifting and unsettling boundaries of identity in our time.

Societies commonly draw boundaries to define personal identity and human exceptionalism, but in the late twentieth century traditional demarcations are besieged. Theories of artificial intelligence suggest that human intelligence is not unique but can be experienced by "thinking machines."[17] Virtual reality devices fuse the biological with the mechanical, reducing human "experience" to stimulation of the neocortex.[18] Animal rights activists argue that humans are not exceptional, and therefore that the rights we enjoy should be extended to all other animals.[19] And the evolutionary narratives of sociobiology claim that human social behaviors and cognitive characteristics are simply an extension of those in primates.[20]

New words have entered the language to express the tension over such boundaries. "Cyberspace" is where the mind and computer chip embrace. "Cyberpunk bodies" are "spare, lean and temporary bodies whose social functionality [can] only be maintained through reconstructive enhancements—boosterware, biochip wetware, cyberoptics, bioplastic circuitry, designer drugs, nerve amplifiers, prosthetic limbs and organs, memoryware, neural interface plugs and the like. The body [is] a switching system, with no purely organic identity."[21] The "cyborg"—a word coined in the 1960s to describe a cybernetic organism—stands, in Donna Haraway's formulation, at the "blurred and anxiety-inducing boundaries between human and animal and between organism and machine."[22]

Meanwhile scientific promoters of "biomimicry" predict "a car that could heal itself after a fender-bender" and aircraft exteriors that will be structured like rhino horn.[23] The cover of Bryan Appleyard's study of "science and the soul of modern man" features a robotic hand reaching out to touch a human hand, as in Michelangelo's depiction of the moment of creation.[24] And a computer program, SimLife, the Genetic Playground, promises students a chance to "design an ecosystem, populate it with imaginary plants and animals and, by introducing mutagens, cause havoc as species become extinct."[25] Such diverse images suggest that, in the 1990s, the lines once assumed to be clear cut between "man" and "nature," or "life" and "technology," have been shaded over and obscured, often in troubling and discomforting ways.

The traditional lines of class, race, and gender that once neatly divided the social world have become contentious in new ways, as well. As the old rules for dividing the world and defining one's place in it are undermined, genetic essentialism promises to resolve uncomfortable ambiguities and uncertainties. The genome appears as a "solid" and immutable structure that can mark the borders and police the boundaries between humans and animals, man and machine, self and other, "them" and "us."

The idea that those who have human DNA are irrepressibly human—regardless of how they have acquired that DNA—was implicit in Ridley Scott's 1982 film *Blade Runner,* re-released with a bleaker ending in 1992. Set in 2019 in post-apocalypse Los Angeles, the film explores the problematic status of the mutinous "replicants," short-term human clones created to perform the demeaning and dangerous jobs once performed by those assigned (because of their social class, race, or sex) to the lower strata of society. The replicants provide sex for hire, colonize dangerous territories, and fight wars. These clones supposedly have no real feelings—no fear and no shame—though they were programmed to express such emotions as desire when the expression would please their human users. Programmed to have a four-year life span, they are also believed to have no personal regrets or will to live. The plot of the movie, however, is built around their uncontrollable humanness; for the replicants—as clones with human DNA—want to live. They begin going AWOL in order to find the scientist responsible for creating them, with the aim of convincing him to help them live longer.

The story uses the replicants to explore the problem of ethnic and social class differences and the hopelessness of seeking technological solutions for social problems.[26] But it also explores questions about boundaries by presenting the replicants—manufactured humans concocted of manipulated DNA—as more "human" than the evil corporate planners who made them. Though constructed only to serve society's needs and exploited as slaves, the replicants have a fundamental will to survive. They have identity, selfhood, (false) memories of childhood, and hopes for the future. They are therefore fundamentally human.

Similarly, in a comic book series called *DNAgents,* the Matrix company creates synthetic human beings who look human and act human, but whose "DNA codes have been altered just enough to make them more than human, the perfect special agents to work for Matrix." The company sends the DNAgents on missions that do not always turn out as expected, for the agents prove to be independent, to have an irrepressible human essence. The message: human DNA demarcates the human from the robot, so even constructed

beings will claim human rights if they contain human DNA. As the comic book slogan notes, "Science has made them but no man owns DNAgents."

The same theme appears in the *X-Men* comic book series: shared DNA is the essential characteristic defining humanness and justifying rights and respect. In the futuristic world of the X-Men, mutant humans with dorsal fins and telekinetic powers are the social equivalent of African Americans, Jews, Asians, and other minority groups. Their creator, Dr. Xavier, pleads with the public to accept the "muties," for "we are related, we are all family."[27]

In these science fiction narratives, shared DNA seems to permit the inclusion of those whose differences—in history or in bodily traits—mark them as outsiders. In other narratives, those who share the same DNA are dangerously close to being the same person. Anthropologist and popularizer of sociobiology Melvin Konner suggests that twins separated at birth, when reunited as adults, experience a "strange boundary-blurring union." Who am I? is one of the most basic human questions, Konner notes. Meeting another human being who is genetically identical is therefore, he says, a jarring experience, a challenge to self-actualization.[28] This idea was explored in the 1989 Irving Reitman science fiction comedy *Twins,* in which two brothers separated at birth discovered eerie similarities of habit and taste, despite their profound differences in body type and personal history. Created by scientists at Los Alamos, they were the result of an experimental effort to create a superman by using bits of sperm from six fathers chosen for their genetic excellence. But instead of a single superman the scientists got two baby boys, one endowed with all the desired traits, the other with the leftover "genetic garbage." The good "twin" was meticulously raised on a tropical island, the other sent to an orphanage. But eventually they found each other and discovered they were the same; they had identical gestures and habits and could read each others' minds. While they looked very different, they shared essential qualities as a consequence of their status as "twins."

DNA as a boundary marker and a source of true identity has come to play a practical role through DNA fingerprinting. The public and judicial enthusiasm for this means of identification is further evidence that DNA has taken on a cultural meaning as the essence of the person, for popular

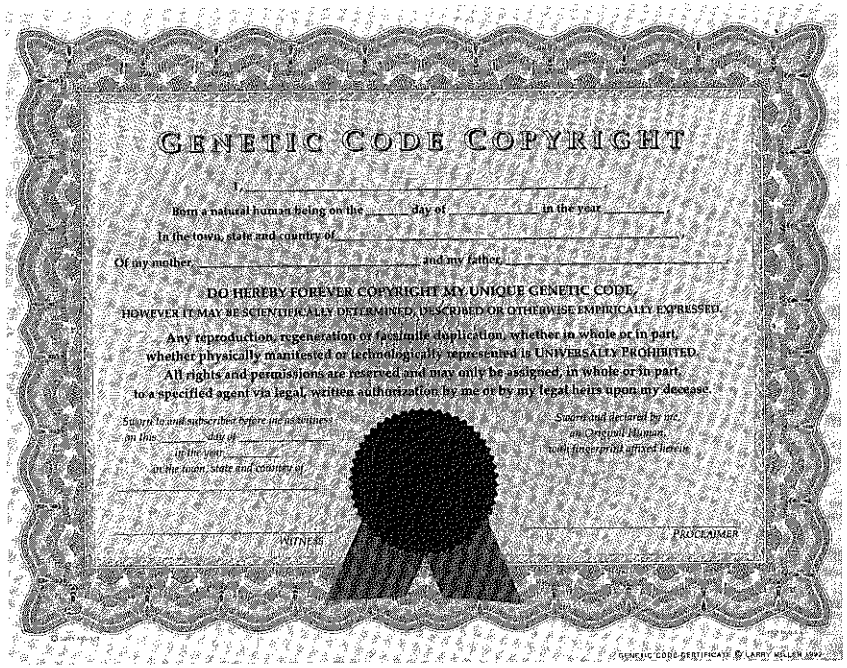
descriptions of this scientific technique emphasize its awesome powers of sorting and identification.

In 1983 Alec Jeffries, a geneticist at the University of Leicester in England, proposed that the DNA contained in biological materials at a crime scene—dried blood or semen, for example—could be used to help identify who had committed the crime. The DNA could be cut up, separated by size, and then compared to a suspect's DNA (which had been similarly processed) for the presence of specific DNA sequences known to vary in human populations.[29] In 1987 Jeffries's technique helped solve a widely publicized British murder case, and since then so-called DNA fingerprinting has become a powerful form of evidence in the courts, used to document whether or not a given suspect was at the scene of the crime.

Press accounts called DNA fingerprinting the "single greatest forensic breakthrough since the advent of fingerprinting at the turn of the century," predicting it would "revolutionize the investigation of violent crimes." A spokesman for a biotechnology firm that conducted DNA fingerprinting announced that the possibility of error in identification was "one in 4 or 5 trillion" to one; a news magazine headline proclaimed DNA fingerprinting a "a foolproof crime test."[30]

In practice, however, DNA fingerprinting is a statistically reasonable—but not infallible—method of identification, and its use in court, as in the O. J. Simpson trial, has been contentious. Laboratories that produce DNA fingerprints are still struggling to control errors.[31] The commonly used DQ Alpha method of testing DNA is not particularly precise: the odds that two people will have the same combination of markers are currently estimated as ranging from one to 20 percent—quite different from the figure of 4 or 5 trillion to one commonly cited in the popular literature.[32] In popular stories, however, the DNA "fingerprint" appears as the "ultimate identifier," an utterly conclusive code establishing the essence as well as the identity of the person.

Such grandiose claims have made their way into various cultural arenas, appearing, for example, as the focus of a New York City gallery art exhibition in 1993. Conceptual artist Larry Miller offered gallery visitors a "Genetic Code


GENETIC CODE COPYRIGHT

I _____

Born a natural human being on the _____ day of _____ in the year _____,

In the town, state and country of _____,

Of my mother _____ and my father _____

DO HEREBY FOREVER COPYRIGHT MY UNIQUE GENETIC CODE,

HOWEVER IT MAY BE SCIENTIFICALLY DETERMINED, DESCRIBED OR OTHERWISE EMPIRICALLY EXPRESSED.

Any reproduction, regeneration or facsimile duplication, whether in whole or in part, whether physically manifested or technologically represented is UNIVERSALLY PROHIBITED.

All rights and permissions are reserved and may only be assigned, in whole or in part, to a specified agent via legal, written authorization by me or by my legal heirs upon my decease.

Sworn to and subscribed before me as witness on this _____ day of _____ in the year _____ in the town, state and country of _____

_____ WITNESS

Sworn and declared by me, an Original Human, with fingerprint affixed herein.

_____ PROCLAIMER

GENETIC CODE CERTIFICATE © LARRY MILLER 1992

Copyright" and invited them to sign it: "I _____ being a natural born human being . . . do hereby forever copyright my unique genetic code, however it may be scientifically determined, described or otherwise empirically expressed," the certificate stated. "Sworn and declared by me, an original human, with fingerprint affixed herein." For $10, Miller would witness the completed forms for visitors.[33] Miller's copyright certificate satirically questioned the cultural construction of DNA as the immortal essence of "an original human." Camille Paglia, however, has taken this concept more seriously: "Behind the shifting faces of personality is a hard nugget of self, a genetic gift. . . . Biology is our hidden fate."[34]

In the plots of many popular stories, physical appearance is not enough to establish identity. A person may look just like, but not really *be,* the accused. Only their DNA, perceived as unique in each individual (except identical twins), can determine identity with certainty. For example, in a recent episode of "Deep Space Nine," the current prime-time

spin-off of the "Star Trek" television series, an alien accused of murder is identified by his DNA, which was compared to a sample in a computer file similar to the FBI databank. Soap operas and made-for-TV movies, moreover, use DNA fingerprinting in stories about efforts to establish identity—whether of a criminal, a suspected father, or a claimant for the family fortune.

In these narratives DNA becomes, in effect, a contemporary soul, the site of identity and self. The privileging of DNA tests and the cultural expectation that they can provide a virtually infallible way to identify individuals reflect the magical power attributed to DNA (and, by extension, to molecular genetics) in American popular culture. This power is even more explicit in the construction of DNA as a modern molecular relic.

The Genetic Relic

A contemporary molecular biologist—one of the pioneers of a technology widely used in genomics research—has founded a company that will produce cards or jewelry containing DNA cloned from musical superstars, athletes, and other secular saints. Kary Mullis, who won the 1993 Nobel Prize for developing the gene amplification technique called polymerase chain reaction (PCR), explained to the *New York Times* that the purpose of such cards will be to educate people about DNA.[35] He has even proposed selling cards with DNA from various primates as a way to illustrate evolution for school children. "The idea is that teenagers might pay a little money to get a piece of jewelry, a bracelet or whatever, containing the actual piece of amplified DNA of somebody like a rock star," Mullis has said.[36] And along the way, they may learn a little molecular biology: "People could use the cards as totems or relics, but they could also learn about genes by comparing different stars' sequences."[37]

Mullis's DNA cards can be understood as a form of contagious magic, the mystical construct that, for example, underlay the widespread distribution of pieces of the True

Cross (on which Christ died) and other Christian relics in the fourth and fifth centuries. In contagious magic, any object that comes in contact with a revered person (or a part of that person's body, such as hair or bone) is believed to be equivalent to the person's whole self, no matter how small or how distant in time. A fragment of bone, a single hair, or a bit of cloth or wood from an object once touched by the person can, in the words of the *New Catholic Encyclopedia,* "carry the power or saintliness" of the person "and make him or her 'present' once again."[38] Such objects, commonly called relics, played an important role in early Christianity. At the height of the "cult of relics" fashionable noblewomen wore around their necks amulets containing such objects as a purported splinter of the True Cross. By the middle of the fourth century, wood from the True Cross "filled the world," though "miraculously the original cross remained whole and undiminished in Jerusalem."[39] The rage for relics had the advantage of bringing the saints directly to the people, and the remains of saints became a symbolic exchange commodity that fostered the spread of Christianity at a pivotal time in Church history.[40] They also became the basis of a brisk and lucrative trade in medieval relics, often enriching church officials.

Like the True Cross in the early Christian period, the bits of celebrity DNA produced by Kary Mullis and his company could "fill the world" without becoming depleted. "We just have to get a little piece of skin, clip a nail, or something from the person, prepare the DNA [and] copy it through PCR." The resulting bit of biological material could then be encased in bracelets, Mullis suggested. "You could say 'here is a sequence' from Mick Jagger, something to do with his lips, say. The jewelry will look like something your gypsy grandmother gave you and in there will be a little speck of DNA." A bit of DNA from a dead celebrity might be particularly appropriate, Mullis told *Omni* magazine. "If we could get permission to use someone like Elvis Presley, we could do a gene of the month, and you could have a collection like stamps." Instead of jewelry, however, the company decided to produce something similar to "a baseball card, with the person's picture and some of their DNA worked right into the card, and some sequence information printed on the back."

Mullis, like early Church leaders, is interested in spreading the faith by bringing celebrity DNA to the people. Molecular relics promise to make the revered person "present" for the follower. And, like relics in the fourth century, DNA cards will educate their owners, enrolling them in the molecular paradigm. Mullis is explicit about this agenda: comparing them to Christian relics, he intends the DNA cards to be a form of popular promotion of molecular genetics.

Molecular relics have also appeared in stories about the investigation of Lincoln's DNA. In February 1991, the National Museum of Health and Medicine appointed a committee to study the technical and ethical feasibility of obtaining DNA contained in bits of Lincoln's hair, bone, and blood stored in museums. Scholars have long theorized that Lincoln might have suffered from Marfan syndrome, a rare genetic condition characterized by weaknesses in the bones and joints, eyes, and heart. Anecdotal evidence links Marfan to high intelligence, and Marfan patients are often tall, with long limbs and fingers, fueling speculation that Lincoln suffered from this disease.

The primary risk in the condition is that the aorta will burst—many Marfan victims die relatively young as a consequence of heart problems. The historical debate about Lincoln as a victim of Marfan syndrome has explored whether the disease could have taken his life at any time even if John Wilkes Booth had failed to assassinate him in April of 1865. "Was the slain president doomed by a disease?" asked a headline in a *New York Times* account of the plan. The "genes define the essence of the person," noted one journalist covering the debate over Lincoln's DNA: "Some scientists suggest that genetic evidence might also one day show whether Lincoln suffered from chronic depression, as several biographers suspect, or from other conditions that affected his decision-making."[41]

In this narrative, President Abraham Lincoln—the entire social, historical, cultural, and biological actor—can be retrieved from relic-like body parts stored in museums in

Washington, D.C. His DNA seems to "make present" the historical figure in all his complexity. Molecular analysis of DNA can reveal the structure of his intelligence and his emotional state, even his decision-making style. And unlike Lincoln's own writings, his speeches, his correspondence or the correspondence of those who knew and observed him in action—unlike these archival documents chronicling his actions and his words—DNA can tell us what his true fate would have been had he not been killed by an assassin. Indeed, Lincoln's DNA, extracted from his remains, is an eternal text that need only be deciphered by contemporary molecular biologists.

As an immortal, historical text, DNA has also been called on to answer questions about geographical migrations and cultural interchange in the distant human past. The Human Genome Diversity Project is an international plan to use DNA from 500 distinct populations scattered around the world in an effort to understand human history. Blood samples containing DNA, to be collected from members of populations as diverse as the Yanomami of Venezuela and the Chukchi of northern Siberia, will be preserved and stored in a repository for future analysis. The project's promoters, most prominently the Stanford University population geneticist Luigi Luca Cavalli-Sforza, suggest that this collection of DNA can explain: the Bantu expansion in Africa, when the first agriculturalists appeared 2000 years ago; the origins of Native Americans and the timing and number of their migrations across the Bering Strait; and the relationships between linguistic groups around the world. Whether such questions can be answered by analysis of DNA has been questioned by critics of the project, including some anthropologists who played a role in planning it.

For us, the Genome Diversity Project is another example of the common construction of DNA as an immortal text, in this case a text in which human prehistory is written. In order to use comparisons of DNA to determine when and how human populations migrated across the Bering Strait, geneticists must make many assumptions about rates of change in DNA, geographical shifts, and early human culture. Like archaeologists they must work with fragmentary

and incomplete evidence that cannot necessarily answer the questions put to it. Yet the range and ambition of the questions proposed suggests geneticists' faith in the molecular text as the "Bible" or "Book of Man," as well as their hopes that DNA can reveal even the most arcane truths of ancient human history.[42]

Richard Dawkins, in his popular 1976 book *The Selfish Gene*, called human beings "survival machines—robot vehicles that are blindly programmed to preserve the selfish molecules known as genes."[43] Dawkins may seem materialist and antireligious, but his extreme reductionism, in which the DNA appears as immortal and the individual body as ultimately irrelevant, is in many ways a theological narrative, resembling the belief that the things of this world (the body) do not matter, while the soul (DNA) lasts forever.

The immortality of DNA in Dawkins's account is grounded in reproductive processes: Genes live forever because they are replicated within living organisms on which they confer survival advantages. But DNA can be immortal in another sense: The molecule itself, in isolation from the living organism, can persist in fossilized form and, at least in fiction, make possible the retrieval of an organism long extinct. This is the basis of Michael Crichton's best-selling 1990 novel *Jurassic Park*, made by Steven Spielberg into a "blockbuster" film in 1993. The story is about corporate scientists who develop an island theme park filled with living dinosaurs. They produce the dinosaurs from bits of DNA extracted from dinosaur blood preserved within insects embedded in amber. The dinosaurs, however, turn out to be more aggressive and destructive than expected. Some of the smaller specimens escape on a supply boat and attack children on the mainland. In the final crisis a corrupt worker, bribed by a rival corporation, destroys the island's security system and is himself consumed by the island's *Tyrannosaurus rex*.

Crichton's plot drew on prevailing narratives of contemporary molecular biology in which DNA contains the complete instruction code for the living organism. While cloning a dinosaur is a theoretical possibility, there are serious practical problems with Crichton's scenario. None of the ancient

DNA thus far retrieved from amber has been complete; and DNA alone cannot make an organism. In all species, DNA interacts with its cellular environment—which includes maternally derived mitochondrial DNA specific to the species—to produce the developing embryo. No complete dinosaur cells survive, however, so that cloning a dinosaur would require the use of a cell from a species believed to be closely related to the dinosaur, such as the alligator. Cloning across species has never been successful, so it is not clear that dinosaurs could be produced even if an entire dinosaur genome were available. But in Crichton's story, if you want to get dinosaurs, all you need is dinosaur DNA. The powerful molecule with magical powers can resurrect the dead, even if the body in question has been dead for many millions of years.

Crichton's tale is a popular catechism promoting the idea of "immortal DNA." But it is also a morality play about forbidden fruit and the dangers of scientists playing God.

Forbidden Territory

In most cultures, some parts of the natural or social world are taboo. So too, DNA, in many stories, is a sacred territory, a taboo arena, that by virtue of its spiritual importance should never be manipulated. As the encoder of an essential self, a genetic soul, the genome has become forbidden ground.

The fear of tampering with genes is explicit in religious publications, where genes appear as "life's smallest components" and the "core" of humanness. In 1983, 21 Catholic bishops and a spectrum of other religious leaders wrote a widely disseminated statement demanding a ban on genetic engineering. Humans have no right to decide which genetic traits should be perpetuated, the statement declared; they have no right to "play God." Articles in religious magazines also express concerns about "tinkering" or "tampering" with genes. In 1989 a writer in the evangelical journal *Christianity Today* asked: "Is it permissible to alter humanness at its core,

to tamper with our essential humanity? Genes are a core that should not be monkeyed with." An essay in the Jehovah's Witness publication *Plain Truth* questioned the hubris of contemporary genetics, which has made "man himself . . . the new God." Hundreds of years from now, the essay predicted, "humans . . . will look at our age and shake their heads in utter amazement. . . . They will wonder how we could possibly have believed that man alone was capable of solving his problems of disease. . . . The real God, not the one fashioned by man's religion and cloned in our image . . . will give us all the good things the genetic revolution promises."[44] To manipulate genes is to move them to the profane realm of engineering and technology. This, it is feared, will compromise their spiritual status. By opposing genetic engineering in these terms, such statements acknowledge the sacred power of DNA.

The sanctity of the genes is also a favorite subject in films about mutants, in science fiction novels, and in numerous revivals of the Frankenstein myth. All depict horrible consequences of genetic manipulation. In these stories, DNA is sacralized or forbidden territory, to be transgressed at a very high cost. They are traditional narratives of divine retribution for violating the sanctity of human life. But since the 1970s, they have appropriated the language of contemporary genetics.

A typical story appeared shortly after the 1976 controversy over recombinant DNA research.[45] Stephen R. Donaldson's *Animal Lover,* published in 1978, is about a geneticist, Avid Paracels, who becomes the victim of "genetic riots" that take place as the public became morally outraged by his efforts to develop a superior human being. Threatening the "sanctity of human life," the geneticist loses his grants and has to abandon his career. He is bitter: "By now I would have been making superman, . . . geniuses smart enough to run the country decently for a change, . . . a whole generation of people immune to disease." He plans his revenge and develops genetically altered animals capable of using advanced weapons, but he is thwarted by a cyborg who mortally wounds him in a climactic battle. "I can't understand why

society tolerates mechanical monsters like you, but won't bear biological improvements," the dying scientist proclaims. "What's so sacred about biology?"[46]

In many subsequent science fiction novels, manipulating DNA leads to the creation of immoral or amoral human beings. The scientist in Robin Cook's *Mutation* (1989) produces a monster when he injects genes for intelligence into his own IVF-conceived baby son. The boy is indeed brilliant, but he is also cruel, emotionless, and totally manipulative.[47] In this and other stories, tampering with genes results in the dissolution of the family as the sacrosanct unit responsible for perpetuating the essential material.

Michael Stewart's *Prodigy* (1991) also features a geneticist who injects his IVF-conceived child with an extra intelligence gene. His wife, convinced of the importance of nurture, objects, saying that it is "just a short step from Mendel to Mengele." But the geneticist insists that "heredity is the dominant factor" and proceeds to manipulate their child's DNA without his wife's knowledge. Their daughter becomes an intellectual prodigy, but also a "living nightmare" with "evil built into her genes." The book's moral: "No man has the right to tamper with the building blocks of human life."[48]

The fear of tampering with genes is not limited to religious publications and science fiction plots. Science critics such as Jeremy Rifkin and some bioethicists express similar reservations. News reports about genetic manipulation also often dwell on potential dangers of genetic engineering. There are "perils" in "uncontrolled tampering," wrote a *Time* reporter. "Lurking behind every genetic dream come true is a possible *Brave New World* nightmare. . . . To unlock the secrets hidden in the chromosomes is to open up the question of who should play God with man's genes." An accompanying image portrayed scientists balancing on a tightrope of coiled DNA.[49] And an illustration for a *New York Times* article on gene therapy featured a drawing imitative of the famous Edvard Munch painting, *The Scream*. A figure stands, horrified, mouth agape, eyes wide open, its hair a mass of coiled DNA.[50]

This sacralization of DNA coexists in popular culture with another, contrasting view of DNA as utterly mechanistic and therefore dangerous in a different way. Some critics of the Human Genome Project express concerns that the ability to manipulate the genome through genetic engineering will desacralize the body by reducing it to a mechanistic entity. How, they ask, can we go on believing that the human body is sacred?[51] But we have observed a different set of images; the gene itself has been endowed with the qualities of a sacred object and the genome has become a fundamental text. In both the language of scientists and the parables of popular culture, the biological structure called DNA has assumed a nearly spiritual importance as a powerful and sacred object through which human life and fate can be explained and understood. Thus a January 1994 cover of *Time* depicts a man, arms extended in a Christlike pose; his torso, bathed in ethereal light, is inscribed with a double helix (see page 17). Such images give mystical and fantastic meaning to a molecular entity, and provide the foundation for the construct we call genetic essentialism.

Conveyed by scientists as they describe the meaning of their research, this idea of genetic essentialism has been readily adopted in popular forums where DNA—the invisible, eternal, and fundamental basis of human identity—has acquired many of the powers once granted to the immortal soul. Like the sacred texts of revealed religion, DNA explains our place in the world: our history, our social relationships, our behavior, our morality, and our fate.