

WRITING & SCIENCE

ON BEYOND LIVING

*Rhetorical
Transformations
of the
Life
Sciences*

RICHARD DOYLE

ON BEYOND LIVING

*Rhetorical Transformations
of the Life Sciences*

Richard Doyle

STANFORD UNIVERSITY PRESS

STANFORD, CALIFORNIA 1997

Stanford University Press
Stanford, California
© 1997 by the Board of Trustees of the
Leland Stanford Junior University
Printed in the United States of America

CIP data are at the end of the book

Figure 1 (p. 32) is reprinted from *Mr. Tompkins Inside Himself*, © 1967 by George Gamow and Martynas Ycas.
Used by permission of Viking Penguin, a division of
Penguin Books USA Inc.

Acknowledgments



This book emerges out of an ecology, human and otherwise. Evelyn Fox Keller, through her teaching, work, and friendship, activated and focused my astonishment at and love of technoscience. This book would be impossible without her. Brian Rotman's work and warmth have morphed my brain beyond recognition. Frederick Dolan's teaching, guidance, and friendship percolate through every page of this book. Michael Fortun taught me how to think about practices and how to practice some of my thinking. Paul Harris's phone calls, road trips, and laughter constantly rescue me and remind me what we're up to. I am continually grateful for Avital Ronell's remarkable thought and warm support.

The Department of Rhetoric at U.C. Berkeley—Matt George, Michael Witmore, Felipe Gutierrez, Melani Guinn, Michael McDonald, John Schliesser, John Dolan—made it possible for me to hack the process of *Becoming-Academic* and taught me more than I can recount. Thanks to David Cohen for making the Rhetoric Department such an aleatory and thoughtful academic niche. I am grateful to Jennifer Culbert for the thinking and the years of affirmation and support. The U.C. Humanities Research Institute group on biotechnology provided both financial and cognitive resources for the early phases of this project. Special thanks to Carl Cranor, Donna Haraway, Camille Limoges, Paul Rabinow, and Diane Paul. The Rathenau Summer Academy in Berlin has provided much feedback and aid for this project—thanks to Timothy Lenoir, Hans-Jörg Rheinberger, and Louis Kaplan. Roddey Reid has been a fount of advice and insight, and Stefan Helmreich has provided me with crucial conversations everywhere from Santa Fe to Cornell. My thanks to the Mellon Foundation and MIT for a Mellon Post Doctoral Fellow-

ship. Helen Tartar, Paul Bodine, Nathan MacBrien, and Amy Klatzkin expertly guided me through the editing and polishing of the manuscript, but I am to blame for any errors that crept into the book. Sherry Brennan, Jeff Nealon, Don Bialostosky, Susan Squier, and my new Penn State colleagues and students have already helped me cultivate a new set of possibilities in central Pennsylvania. Amy Greenberg never ceases to astound me with her love, thought, and sense of possibility. Finally, I'd like to thank my parents, Jack and Ann Doyle, who gave me much more than DNA. This book is dedicated to my brother John.

R.D.

Contents

1. The Sublime Object of Biology	I
2. Mr. Schrödinger Inside Himself: The Rhetorical Origins of the Genetic Code	25
3. From Codes to Words: George Gamow and the Age of the World Scripture	39
4. It's a Nucleic Acid World: Monod, Jacob, and Life's Future	65
5. Allergies of Reading: DNA, Language, and the Problem of Origins	86
6. Emergent Power: Vitality and Theology in Artificial Life	109
<i>Notes</i>	135
<i>Bibliography</i>	163
<i>Index</i>	171

ON BEYOND LIVING

CHAPTER 1

The Sublime Object of Biology



Our machines are disturbingly lively, and we ourselves are frighteningly inert.

—Donna Haraway

This is not so much a Book as a group of theses bunched together, folded, bound, and offered as a map of discursive events that have both organized and disturbed what is called today “life” “science.”

Theses

Thesis 1: What Now? What Knowledge?

One thesis—in fact, a swarm of them—concerns the claim that what once formed the rough and jagged boundaries of a consensus on the object of biology has somehow been displaced, with the molecule overtaking or territorializing the organism and getting plugged into the computer. Perhaps this is only a recognition of a prior multiplicity—indeed, if we look closely, as I have tried to do, it seems that we never really knew what we were talking about when we were talking about life.¹ In time we will encounter the difficult but cheering impact of the recognition that this discursive constellation has become a rhetorical black hole, a place where the pull of the desire to know what life is both founds and embarrasses the life sciences.² But for now, I make this simple claim: I take snapshots of those places where the rhetorics of molecular biology slip up, and I compare them, noting their differences.³

Is this a simple announcement of the historicity of life science? Worse still, is it yet another bowing before the ineffability of the vital? Sometimes, perhaps. But this intervention hopes to take seriously the difference that poststructuralism makes, so my encounter with the otherness that animates the discourse of molecular biology seeks an analysis with the “outside” of scientific discourse that cannot simply be called “historical,”

“literary,” or even “metaphysical.” The relations of forces that organize what we call life, what we think a body is, form a whole menu of the unthought and the unthinkable, and these forces do not leave what we could call “history” untouched. Nor do they leave “science” intact. Thus, the question that is this thesis: *What are we studying when we study life, today?*

This question organizes each reading I give of the way in which language serves as an active repository of the unthought of science, its “software.” In chapter 2, “Mr. Schrödinger Inside Himself,” the peculiar formulation of the “code-script” of heredity, as well as the synecdochal substitution of heredity for life, is served up as an example of the disjunctions and slippages that animate scientific discourse. At the expense of a historical account of Erwin Schrödinger’s deployment of the rhetoric of codes, in which one could focus on the “context” of Schrödinger’s move, I trace out the discursive event “itself.” Here I follow Michel Foucault in questioning the document. Rather than treating Schrödinger’s text as an archival memory source by which historians reconstruct the past, I analyze it as a rhetorical algorithm, a diagram of the forces that organized Schrödinger’s text and, at a distance, fueled the molecularization of life.⁴ In chapter 3, “From Codes to Words: George Gamow and the Age of the World Scripture,” I highlight a “hole” in Gamow’s scheme for translating DNA into proteins, a hole that comes to stand for an absent body or cell. Chapter 4, “It’s a Nucleic Acid World: Monod, Jacob, and Life’s Future,” focuses on the temporal problematics provoked by the localization of life in the sovereign genome. Chapter 5, “Allergies of Reading: DNA, Language, and the Problem of Origins” explores the rhetorical problems associated with the crossover of life and language in the figure of DNA. “Emergent Power: Vitality and Theology in Artificial Life” tracks the flow of life as it moves onto the computer, a virtual window on the postvital.

In this book, then, I want to overcome the treatment of historical sources as sites of meaning and highlight their activity, their forces. “Rhetorical software” is a coinage that I hope helps highlight the fact that the rhetorics of life science, as interfaces, had effects other than their meanings and that their “meanings” are vectors of force and signification. Thus, thesis two:

Thesis 2: How Does Language Matter?

My snapshots are rhetorical ones; awkward and sometimes underdeveloped, they nonetheless bring out the faint image of what Slavoj Žižek has

called the “materialization of belief.”⁵ Rather than a mere description or heuristic for the life sciences, the rhetorics of code, instruction, and program materialized beliefs into sciences and technologies. Here I collapse the division of literary and material technologies outlined by Simon Schaffer and Steven Shapin in their *Leviathan*. While useful in its insistence on the importance of the rhetorical construction of scientific facts, Schaffer and Shapin’s division of the literary from the material ultimately privileges the material at the expense of writing. Indeed, in their description of the scientific text, Schaffer and Shapin depend on a representational model of rhetoric: “We usually think of an experimental report as a narration of some prior visual experience: it points to sensory experiences that lie behind the text. This is correct. However, we should also appreciate that the text itself constitutes a visual source.”⁶ That is, narrative functions as a kind of supplement to the material technology of the air pump, framing it in a coherent and persuasive fashion so that others might be convinced of Robert Boyle’s finding at a distance in the absence of the pump or of Boyle. And yet this framing overlooks the way in which such “narration” is often prior to the experiments, as the organizing metaphors and history of the project. That is, the narration of experiments points not just to sensory experiences that lie behind the text but also to other narratives that render the material organization of the experiment persuasive and coherent. For example, the narrative of Boyle’s pumps pointed to other, implicit narratives about the relative value of visual representation and about the mastery of Boyle the scientist. These were not merely supplements to the pump; they were a part of the network of power and thinking that made Boyle’s project possible.

Thus, an emphasis on the representational function of narrative overlooks the narrational structuring of experiments. Consequently, it ignores the disjunctions and collaborations among technologies, rhetorical and otherwise, and thus ends up positing a historical agent in command of her *techné*. By contrast, I want to argue that rhetorics work more on the model of contagion than communication or representation; they pass through fields and agents as intertextual forces that recast knowledges and their knowers while sometimes remaining in the realm of the unthought, what Friedrich Nietzsche called the unhistorical, the acts of forgetting integral to any act of creation.⁷

Rhetorics are diagrams of the “outside,” traces of the forgotten operations of power and metaphysics on and within science. Jacques Derrida’s analysis of metaphor provides us with a case in point.

Metaphor has been issued from a network of philosophemes which themselves correspond to tropes or to figures, and these philosophemes are contemporaneous to or in systematic solidarity with these tropes or figures. . . . If one wished to conceive and to class all the metaphorical possibilities of philosophy, one metaphor, at least, always would remain excluded, outside the system: the metaphor, at the very least, without which the concept of metaphor could not be constructed, or to syncope an entire chain of reasoning, the metaphor of metaphor.⁸

For Derrida, writing about the writing of philosophy, this impossibility of arriving at the final or complete metaphor of metaphor exhibits philosophy's dependence on the passed over, the preterit, something "outside the system." That is, the very working of metaphor, the fact of metaphor, testifies to the fact that language works through a forgetting, at the very least a forgetting of what we mean by metaphor. Our mania for accounts of language that stress the possibility of univocality and overlook the force and rhetoricity of language occludes the ways in which language matters. There can be no easy distinction between writing and its "objects"; both are elements of an interface. The relations that make up this interface are maps of power.

Thus, language is more than two-dimensional—it is not simply signs and signifieds but rather an economy of differences that includes signs, things, and *what it is possible to say*. This realm of the possible is a kind of force field that organizes the relation between "signs" and "things." The traces and tracings of this realm can be read out of rhetorical devices, technologies of language that act on and in bodies, cultures, and sciences. Each rhetorical device—bits of software—can be traced out, given a morphology, diagrammed.⁹

One way in which the force of language can be diagrammed is to bring to light the substitutions and movements wrought by rhetorics. For instance, one can diagram the forces that made possible the localization of life in a gene, the literal/rhetorical cramming of the body into the chromosome or, in the case of artificial life, into a pixel. That is, the rhetorics articulated in the life sciences are indexes of a "metaphor of metaphor," to use Derrida's phrase, whose amnesia extended to the body. Much of this book, in fact, is a diagramming of the ways in which the rhetoric of molecular biology ordered the body. It arranged it around a molecule, first as a description: a speculative, creative, ahistorical model of life as a molecule. It also did so via another meaning of "order": it commanded it. That is, my reading of the rhetoric of molecular biology insists on going

beyond the hermeneutic analysis of the changing meaning of heredity and life through the ascendant discipline of molecular biology. I also seek to mark out the rhetorical vectors that formed the shape of our bodies today—those bodies whose illness, intelligence, and sexual preference is “ordered” through the gene.¹⁰

In short, I follow J. L. Austin’s account, laced with some Derridean insights, of the performative effects of language, the force that makes a saying a doing, as in the “I do” of marriage. Derrida has outlined persuasively the ways in which performativity problematizes or overtakes a semantic, hermeneutical account of language as communication.

Here at least provisional recourse to ordinary language and to the equivocalities of natural language teaches us that one may, for example, communicate a movement, or that a tremor, a shock, a displacement of force can be communicated—that is, propagated, transmitted. It is also said that different or distant places can communicate between each other by means of a given passageway or opening. What happens in this case, what is transmitted or communicated, are not phenomena of meaning or signification. In these cases we are dealing neither with a semantic or conceptual content, nor with a semiotic operation, and even less with a linguistic exchange.¹¹

The transmission, passage, and communicability of language, therefore, become something other than an affair of meaning or information; they become something more like ballistics or contagion, the transmission and repetition of an effect across bodies of discourse and across bodies. DNA, in its figuration as a “language,” ironically provides us with a metaphor for this thinking of language as a contagion: the passage from deoxyribonucleic acid to proteins passes through and in a body, and it is an elision of this body, the displacement of the organismic “production” of a living body, that characterizes the history of molecular biology and allows the communication of the figure of a “genetic code” that seamlessly and automatically transcribes and translates the DNA “word.” This hermeneutical paradigm of DNA transcription and translation systematically overlooks the force of this activity, its performance, its embodiment.

One way of describing this eradication of the differential performances that traverse the DNA-protein relation is to appeal to the two kinds of synthesis that occur under the metaphor and regime of “code.” At the first level, within the shapes and interactions of a configuration of molecules—nucleic acids and amino acids—a kind of order emerges at the molecular level where there exists a statistical regularity between a sequence of DNA and a chain of amino acids. This can, at present, only be a

statistical regularity due to the complexities and contingencies of protein folding. It is only when this order—statistical and a product of repeated interactions and molecular relations—is then itself ordered and synthesized into a single, static, causal site in its own right that DNA emerges as the miraculous agent of life. It is this second synthesis—the installation of DNA as the sovereign agent of life—that I trace through the rhetoric of molecular biology. This second synthesis takes place through an analogous regime of metaphor, a persistent deployment of the force of rhetoric that works to efface the polysemic and relational natures of language.

Gilles Deleuze and Felix Guattari, writing in *What Is Philosophy?*, convert this tendency of scientific discourse—its habit of eradicating the conditions of its enunciation—into a genre distinction between “philosophy” and “science.” For Deleuze and Guattari, “a scientific notion is derived not from concepts, but by functions or propositions.”¹² A concept—an empirical entity that philosophy invents—is a multiplicity that can only be articulated in terms of its becoming and historicity. While resisting arrest—the concept cannot be disciplined into a unity, otherwise it is not a concept—this dynamism of the concept does have a morphology, even if it is a disturbed one: “Every concept has an irregular contour defined by the sum of its components . . . only on this condition can it escape the mental chaos constantly threatening it, stalking it, trying to reabsorb it.”¹³

But the irregularity of the concept is ill suited to the persuasion machine of science. Here the prey is “regularities,” and the stalking of regularities calls for what Deleuze and Guattari characterize as the “functive.” While the concept is a nonmimetic thinking tool for philosophy and as such can avoid the question of referentiality, the “function” or “functive” is a scientific tool that “slows down” thought, disciplines it into reference: “In the case of science it is like a freeze-frame. It is a fantastic *slowing down*, and it is by slowing down that matter, as well as the scientific thought able to penetrate it with propositions, is actualized.”¹⁴ This formulation of science as a “freeze-frame” is instructive for it highlights the importance of the “framing” of scientific discourse, a rhetorical disciplining of the discourse that literally makes some objects accessible and others invisible. This “freezing” of scientific discourse suspends its relation to history as well as its relations to language. For what does not appear in the freeze-frame of science is the technology of framing itself, what I will call rhetorical software.

“Rhetorical software” marks my attempt to foreground the relational

and material interactions that make possible the emergence of scientific statements. While highlighting the textuality of scientific practices, the term avoids a textual determinism: as any user of software knows, software is usable only within a network of hardware and—this is frequently overlooked—“wetware.” The “rhetorical” side of this double formulation is an attempt to mark out what Deleuze and Guattari describe as the “fantastic” production of scientific statements, the inventive and imaginative taming of matter. Crucial to Deleuze and Guattari’s claim is that it is only through such a disciplining that matter is actualized, brought onto the plane of reference. Theirs is thus a relational account of matter and language, and it is this notion of the relations between such “framing” and the actualization of scientific practices that I seek to mark out with “rhetorical software.”¹⁵ Along with the notion of the functive, the concept of rhetorical software attempts to sidestep the constant encounters with subjectivity provoked by the performative.

An example will, I hope, help clarify this notion. First, “Genes R Us”: one could characterize much recent discussion of the “genetic determinism” of humans around the functive “Genes R Us.”¹⁶ Rather than a mere copula, this act of definition, the definition of the human, is a functive that does work on the plane of reference—it makes it plausible to give a statement of what human beings “R”—at the same time that it requires a fantastic disciplining of the scientific object, the human. Insofar as human identity is characterized here as emerging from DNA, an “I am,” “We are,” is inscribed at the site of the double helix. For this inscription to be possible or plausible, both the body of the human and, perhaps more importantly, the discursive and institutional vectors that make possible the statement “Genes R Us” must fall away if the statement is to have any force or, what amounts to the same thing, any reference.¹⁷

Thus, it is not that the functive “Genes are us” is nothing, a mere chimera projected by the camera obscura of ideology and social construction. It is just that its force as a scientific statement, its scientificity, depends on the amputation of the body that it heralds. It also depends upon a set of rhetorical practices—“software”—that are, as yet, not quite up to the task of enforcing the wedding between identity and DNA that “Genes R Us” promises.

Of course, there are places, in the rhetorical sense, where what we are calling “the body” makes itself felt in molecular biology. The triumphs of molecular biology are not only constructions; I analyze the discourse of molecular biology as a tropological space where the resistances of “the”

body interface and entangle with the shapes and torsions of language. The rhetorical software of molecular biology composes a set of tools roughly fitted to, and fitting, different wetwares and hardwares, and I seek out and diagram those places where the differences in this economy come together and slip up, displace, or substitute. Thus, the critique I attempt here of the hermeneutical account of and in the documents of molecular biology takes its cue from another place, what I have called the “postvital” body. This is the body that fits, and is fitted to, molecular biology.

Thesis 3: What Body?

The postvital body is a contemporary matter of fact. A cyborg, mind children, virtual surgery, a fetishization of the fetus; all these figures are facts, and they highlight or act out the technoscientific construction of the body as a site of a genetic remote control.¹⁸ In this text I analyze and map out some of the ways in which this has happened: Erwin Schrödinger’s catachresis; George Gamow’s theological word magic; Jacques Monod and François Jacob’s time travel; the conflation of living and speaking by Jacob, Roman Jakobson, Claude Lévi-Strauss, and Philippe L’Heritier and a television camera; the “impossible” pixel bodies of artificial life. In thesis 2 I tried to provide a way of talking about the way in which language matters in science. This, of course, is not just a thesis; it is the working hypothesis of each chapter, and refinements and rejections of that hypothesis hinge on each chapter’s performance. It could be said that such an analysis pays a big price, the price of context, of what gets synecdochally labeled “history.” I forget, for example, the history of (extra-rhetorical) instruments, the history of funding, the history of scientists. Such exclusion cannot, and should not, be overlooked; it is in fact an integral part of my analysis to foreground the irreducibly contingent and appropriative nature of historical analysis, indeed of narrative in general, including my “own.” This violence extends to a silence regarding the irreducibly raced and gendered “nature” of the discourse under discussion here, a silence I deploy not because I find the gendering or racing of molecular biological discourse unimportant but because I am looking for the rhetorical possibility conditions of race and gender in their current and emerging configurations.

At the same time, my oversight allows something else, I hope, to emerge: the outlines of the postvital body, a body without life. Bodies have been overlooked and recast as an effect of a molecule, an extension or

supplement to the real, timeless, deathless bit of immanence known as DNA. Thesis 1, “What now, what knowledge?” focuses on the conceptual shift that makes possible the new knowledges of bodies. For now, I would like to provide a rough outline of the trajectory and shape of the postvital body. To do so, I must rewind my narrative, for a moment, back to the question that animates thesis 2, “How does language matter?” and explore Gilles Deleuze’s notion of the virtual. The virtual gives us a tool for interfacing with the “outside” of discourse, the silent underside of the actual and the said.

The virtual is not hidden in the sense of a repressed signified or lost referent. It is occulted, but as part of a necessary clearing. For a statement or thought to appear in all its apparent simplicity and clarity, its complicated genesis must recede into the abysmal shadows from which it came. The virtual is the unsaid of the statement, the unthought of thought. It is real and subsists in them, but must be forgotten at least momentarily for a clear statement to be produced. . . . The task of philosophy is to explore that inevitable forgetting, to reattach statements to the conditions of their emergence.¹⁹

Simply put, it is not merely a matter of tracking the effects of the statements of molecular biology. The role of the “unsaid” must also be thought and not simply as the lost choice or alternative of the past. If we think in terms of lost branches or pathways here, we inscribe a temporality of before and after, a logic of the either/or that is not *prima facie* applicable to historical change. Indeed, the model of a “lost” choice or alternative to the present, by ghettoizing a “possibility” as lost in a nostalgic past, unwittingly grants a hegemony to the dominant discursive articulation even as it attempts to recuperate possibility from the past. Instead, I want to argue here for what Deleuze and Guattari have written under the sign of the “rhizome,” where the connections and gaps of discourse compose a stew of contiguity, slippage, and displacement. There is no once-and-for-all branching of discourse or history; there are murmurs and shouts and scents of possibility at every place and moment. It is not that these moments are unorganized; they are contingent orders of the virtual and the real, interfaces. The virtual is a sacrificed other side of the statement, the “silence” from which any speech act bursts forth. It is a substrate that is effaced but not erased. Its traces continue to have effects, as in a Markov chain, where an initial value impacts a whole series through contiguity, even as it perhaps disappears. Thinking spatially—and, we shall see, the virtual has spatial dimensions and effects—we could

think of the virtual as the “nook” of narrative, the fractal space between thoughts, stories, and frames that gets traversed by tropes, as in the movement of one frame of animation to another, one paragraph to the next.

Thus, when asked, as Evelyn Fox Keller does, whether words have force in and of themselves, I must say no, but only because there is no language “in and of itself”—rhetorics always inscribe and are inscribed in not only contexts but interfaces, wetwares and softwares, and hardwares over which “human actors” are not so clearly sovereign.²⁰ Indeed, the contagion of the unthought suggests that the influence of rhetorical software rises as it is “forgotten,” ignored, or, what amounts to the same thing, assumed.

The complicated conditions of the emergence of molecular biology rely on the disappearance into an “abyss” of its initial values, the desires, ideologies, and forgettings with which it was invented. In this case, the “abysmal shadows” are cast by the abyss itself. For the great unsaid of the life sciences, of a molecular biology that sought and found “the secret of life,” is the fact that life has ceased to exist. Or, rather, that it never did exist, that the life sciences were founded on an embarrassing but productive ambiguity, the opaque positivity called “life.”

Life?

Michel Foucault’s analysis of the possibility conditions of biology in *The Order of Things* offers the stunning claim that before the nineteenth century, life did not exist. More precisely, the conceptual matrix that frames biology as a science of life had yet to be articulated.

Historians want to write histories of biology in the eighteenth century; but they do not realize that biology did not exist then, and that the pattern of knowledge that has been familiar to us for a hundred and fifty years is not valid for a previous period. And that, if biology was unknown, there was a very simple reason for it: that life itself did not exist. All that existed was living beings, which were viewed through a grid of knowledge constituted by natural history.²¹

In the shift from natural history to biology, Foucault argues, “life” comes to occupy a “sovereign vanishing point within the organism.”²² Whereas in the regime of natural history living beings were compared on the basis of a taxonomy that could be gleaned from a single plane, the visible surface, “life” invisibly comes into its secret existence by introducing or injecting depth into the invisible, interior bodies of organisms. For

Foucault, life comes to be as the object of an organism's protection, an interior walled off from death by the somatic armor and practices of sovereign organisms.

I suggest that this reorganization of the objects of life science—living beings—produced organisms ripe for both vitalism and molecular biology. Despite their apparent opposition, both vitalism, the idea that life exceeds known physicochemical laws, and molecular biology, the science that has claimed the reduction of life to those same physicochemical laws, relied on an unseen unity that traversed all the differences and discontinuities of living beings, “life.” For while there was no visible sign with which one could overcome the radical differences that were seen to distinguish, for example, the vertebrates from the invertebrates, both nonetheless basked in the unity of life, “common control.” It is this construction of life as an “invisible focal unity,” that, Foucault argues, makes a biology possible. By plunging life into the unseen depths of the body, this figuration also localizes life in a site not foreign to molecular biology—a secret. For it was the concealed aspect of life, if not its secrecy, that united the fragmented and differentiated field of living beings. Life becomes the unseen guarantor of biology, knowable only at a distance.

Thus life does not exist, *per se*; it is an abstraction much as it matters little, after all, that gills and lungs may have a few variables of form, magnitude, or number in common: they resemble one another because they are two varieties of that non-existent, abstract, unreal, unassignable organ, absent from all describable species, yet present in the animal kingdom in its entirety, which serves for respiration in general.²³

In other words, life occupies the sovereign vanishing point on the basis of its lack of existence.²⁴ It is a retroactive effect of the organization of the organism, the product and not the cause of the techniques of organisms. Just as lungs and gills substitute for the general yet nonexistent unity of respiration, so too do the remaining practices of organisms substitute for the virtual abyss of life, a non-place. “Between the visible and the articulable a gap or a disjunction opens up, but this disjunction of forms is the place—or ‘non-place’, as Foucault puts it—where the informal diagram is swallowed up and becomes embodied instead in two different directions that are necessarily divergent and irreducible.”²⁵ Life is visible, paradoxically, insofar as it is concealed: “living species . . . can be classified only because they are alive and on the basis of what they conceal.”²⁶ Between this visibility, life's status as an “enigma,” and its articulation, life's

connection to the functions of organisms, the body of the modern organism resides. Organisms at once protect life in their depths and produce vitality through their functions. Thus, the diagram: the double duty of an organism that both possesses life and produces it is “swallowed up,” placing life at invisible, unknowable depths, a vanishing point, and connecting the articulated functions of living beings on a long tether to life. We see here life’s role in an ontological economy:

Life is the root of all existence, and the non-living, nature in its inert form, is merely spent life; mere being is the non-being of life. For life—and this is why it has such a radical value in nineteenth-century thought—is at the same time the nucleus of being and non-being: there is being only because there is life, and in that fundamental movement that dooms them to death, the scattered beings, stable for an instant, are formed, halt, hold life immobile—and in a sense kill it—but are then in turn destroyed by that inexhaustible force. The experience of life is thus posited as the most general law of beings, the revelation of that primitive force on the basis of which they are. ²⁷

What is crucial to note here is that although the naturalist George Cuvier’s displacement of the taxonomic model focuses on function, the practices of organisms, these functions are themselves functions of a universal, silent, extraontological force—“life”—that “primitive force on the basis of which they [organisms] are.” Thus, reproduction merely maintains life in its unity; it does not create it. And existence, while occupying a different space than life, relies on it. While living beings are structurally finite, constantly maintaining their existence against death, they are made possible by that which is beyond being—life. While organisms become, with Cuvier, subject to history and time, life, as it were, goes on, silently and invisibly. If, as Leriche wrote, “Health is life lived in the silence of the organs,”²⁸ then life is the virtual nonplace of that silence.

The initial values of biology, those whose effects can still be felt at the origins of molecular biology, include a body and a concept of life without the modality of existence. Life’s existence is forgotten, but its unity is not;²⁹ the virtuality of life is in fact what makes unity, amid the teeming profusion of the newly thickened organisms of biology, thinkable. It is a concept beyond the particularities and practices of living organisms, and it thus anchors the new science of life. Beyond the functions and differences of organisms, there is a secret: “life withdraws into the enigma of a force inaccessible in its essence, apprehendable only in the efforts it makes here and there to manifest and maintain itself.”³⁰

While natural history took the plant as its paradigmatic, transparent object of study, biology focuses on the animal and its thickness, the unseen unity called life that dwells in the depths of bodies. If natural history analyzed the things that were, dwelling in the space of the representation of being, then biology saw beings as mere epiphenomena of life, a secret force beyond being. And yet in contemporary molecular biology, the secret is out. According to the Nobel Prize-winning biologist François Jacob,

Biology has demonstrated that there is no metaphysical entity hidden behind the word “life.” The power of assembling, of producing increasingly complex structures, even of reproducing, belongs to the elements that constitute matter. From particles to man, there is a whole series of integration, of levels, of discontinuities. But there is no breach either in the composition of the objects or in the reactions that take place in them; no change in “essence.”³¹

I would like to take Jacob’s formulation of the issue literally. That is, the spatial organization of Jacob’s articulation of life as lacking a “behind” or a beyond situates quite precisely the place of life in the life sciences since the rise of molecular biology. I do not claim that this articulation is homogeneous, only that it becomes possible with the arrival of the postvital body, a body in which the distinct, modern categories of surface and depth, being and living, implode into the new density of coding, what Jacob calls the “algorithms of the living world.” That is, with the injection of “law code and executive power” into DNA, *code* becomes as much verb as noun, and the double helix becomes as much body as its description. While the modern body of the organism announced, through its character and anatomy, the deep unity at work in its depths, the postvital body is a memorial. It is a site of the memory of the modern body, where the characteristics and the behavior of organisms can be found. If under the modern regime life, hidden in the body, was “perceptible beyond disease,” the postvital body is a transparent sequence that has nothing behind or beyond it.³²

Is That All There Is? *C. elegans*, Postvital Window

Perhaps it seems merely perverse to suggest that a molecule could become a body. But just as the classical and modern articulations of life science relied on an unsaid, virtual model of their objects, so too, I will argue, does contemporary molecular biology, for all its differences. An example

can be found in a description of one of the most successful contemporary biological studies, the so-called worm project, a massive effort to “understand” *C. elegans*, the tiny roundworm that in many ways vies for the role of paradigmatic postvital organism. For with *C. elegans* we see a frenzied effort to completely overcome the modern thickness of the body as a site of mediation between the force of life and the conditions of existence. Although *C. elegans* may in fact have a “body,” that body is a transparent site of information and memory.

C. elegans has been the main focus of Sydney Brenner’s research for the past 30 years. His “dream . . . to predict behavior from a combination of neuroanatomy and genetics” took root in *C. elegans* because it is a “real animal” and yet “transparent,” both literally and figuratively.³³

After a brief flirtation with *C. briggsiae*, Brenner settled upon *C. elegans* . . . though it is extremely simple, it is a “real animal.” . . . It has nerves, muscles, intestines: it reproduces. And if you hit it, it reacts. What’s more, *C. elegans* is transparent: investigators can actually watch the process of development unfold in a living animal under a microscope. At the same time its entire life cycle is a mere six days and 100,000 of them can live in a petri dish.³⁴

If the modern body was first mapped anatomically, “cut up into patterns” in the new hermeneutics of depth articulated by biology, then mapped according to “a correspondence between interior and exterior forms which are all integral parts of the animal’s essence,”³⁵ the postvital organism is itself a kind of map where interior and exterior, genetics and anatomy, implode under the gaze and touch of research. The body of the worm itself is a kind of diagram with which one can trace cell lineage: “Using a laser, you can ablate one cell and be absolutely confident of what cell has been killed and what it would normally give rise to . . . you can look at the complete neural circuit for a particular piece of behavior and get a complete and convincing description of the nature of that behavior. . . . You can look at it and say ‘that is all there is.’”³⁶

This identity of what we could call the being of *C. elegans* and its appearance—“You can look at it and say ‘that is all there is’”—announces that at the level of the organism, Jacob’s claim that there is nothing “behind” life has an operational validity in research. Thus, while for the modern organism life was buried away from being as an invisible, virtual, and nonexistent ground for the life sciences, life has been displaced in the postvital organism, as an organism’s being and its appearance become synchronized, overcoming the “common control” of life and the mediation of its protector, the body of the modern organism.

This identity between the appearance of *C. elegans* and its being stems, at least in part, from the fact of its physical transparency: “since *C. elegans* is transparent, cells can be watched as they divide, migrate and differentiate in living animals.”³⁷ This makes plausible the first half of the rhetorical algorithm for *C. elegans*: “*You can look* at it and say ‘that is all there is’” (emphasis added). But, again, between the visible and the articulable, the seeable and the sayable, there is a gap. What makes possible the claim that there is nothing but the visible, given the legacy of the modern organism and its dependence on the invisible?

One answer is that the postvital organism’s virtual model is the computer. The computer model casts *C. elegans* into two forms of an information construct, memory and program. In a discussion of the nematode in Alberts et al.’s *Molecular Biology of the Cell*, we read this analogy in its most concise form.

For cells, as for computers, memory makes complex programs possible; and many cells together, each one stepping through its complex developmental control program, generate a complex adult body. . . . Thus the cells of the embryo can be likened to an array of computers operating in parallel and exchanging information with one another. Each cell contains the same genome and therefore the same built-in program, but it can exist in a variety of states; the program directs development along various alternative paths according to a combination of the past information the cell has remembered and the present environmental signals it receives.³⁸

According to this model, then, organisms are bundles of information. *C. elegans* are information constructs to the extent that they depend on their genomes as the organizing principle of their growth and development. So too is the cell itself an information construct; its importance in this model lies in its ability to remember “choices made by its ancestors.” The beauty of *C. elegans* is that their somatic cell lineages are invariant, meaning that “the fate of each descendent cell can be predicted from its position in the lineage tree.” That is, any given cell can be seen to correspond to a memory address, a position in a cell lineage diagram that testifies to its cellular genealogy.

Thus, any given cell can be seen as nothing but the instantiation of a memory of past “choices,” and those choices themselves are seen to be directed by the genetic program. When Jonathon Hodgkin says that “that’s all there is,” we can therefore see that for *C. elegans* we are dealing less with a regime of genotype and phenotype than with a more generalized model of coding, the idea that the nematode can be best and completely under-

stood as cellular automata, where complex patterns emerge out of the instantiation of a few simple rules. With an understanding of both the program (genes) and their various states (the different patterns of cell lineage) one can give a complete description of the automata called *C. elegans*. Indeed, this is the analogy drawn in *Molecular Biology of the Cell*: “Computer modeling shows that even a very simple program can lead to the production of astonishingly complex patterns of cell states in such an array; one cannot deduce the program simply by observing the normal development of the pattern.”³⁹

Note that in this analogy a slippage takes place in which the computer collapses into its program. Whereas the first quotation from *Molecular Biology* depended in part on the notion of cell as hardware—“Thus the cells of the embryo can be likened to an array of computers operating in parallel and exchanging information with one another . . . each possess the same built in program”—the program and its various states, cells, are viewed as nothing but a program and its resultant patterns. No “computer” or cell is invoked in the second quotation. The rhetoric of that passage speaks of “a very simple program” producing complex states, whereas the first quotation depended on the notion that the cell was the agent, “which makes a series of discrete choices.”⁴⁰ Of course, these “states” are states of cells, but it is here that the distinction between the program and its instantiation collapses, for such an instantiation depends on an originary program instantiating “itself.”⁴¹

We can see here that narrative, as a habitual inscription of branches of “discrete” decisions that have beginnings, has been inscribed on a situation that Deleuze and Guattari have referred to as “rhizomatic.” Despite the centrality of the cell as “agent” in the first quotation, its centrality was undone by the cell’s dependence on the choices of its “ancestors.” These choices lead to the eradication of the centrality and sovereignty of the cell as agent, much as in this rhizomatic example drawn from Deleuze and Guattari’s *A Thousand Plateaus*: “Puppet strings, as a rhizome or a multiplicity, are tied not to the supposed will of an artist or puppeteer but to a multiplicity of nerve fibers, which form another puppet in other dimensions to the first.”⁴²

In my example, the “choices” or will of the cell depend on its memory of past choices, those of its ancestors, which are themselves memories of memories. The second version of our story—the one that seems to forget the way in which the cell functions as memory, from the “start”—eradicates the connections in this economy of cell production and posits

the centrality of the program and its states.⁴³ The platform for these choices is unspoken and unmarked, as the focal point of analysis is the program and its effects, not hardware.

However, applied to *C. elegans*, as it quite explicitly is here, we see that by analogy the body of the nematode becomes nothing but a memory. There is no gap between the program and its instantiation, nothing to run the program “on”: the program runs, and various patterns are produced. Each cell is itself the memory of the body of *C. elegans* and its development.

With *C. elegans* we can say that the postvital organism is nothing but coding.⁴⁴ It is *coding* in its noun form, in the sense that the ability to say “that is all there is” relies upon a physical genetic map. At the same time, it is *coding* in its sense as a verb in that cell lineage is seen as an algorithm of a worm’s own development, which is itself the act of instantiating code. That is, the “code,” the genome of *C. elegans*, implicitly codes and decodes “itself.” Yet what is the “that” whose existence is laid bare by the worm project? What is it scientists are looking at when they write “that is all there is”?

The Sublime Resolution?

Both the modern and the postvital bodies can be placed within a tentative framework that will, I hope, help situate my first thesis—what are we studying when we study life? For, despite Jacob’s rhetoric and my analysis, both the modern and the postvital bodies occupy a position in the beyond. That is, the virtual construction of the modern notion of life relied on the notion that behind or beyond the practices, symptoms, and deaths of organisms lay a unity, a primitive, invisible force on the basis of which living beings *were*. For the postvital body, the overlooking or disappearance of the body displaces this “beyond” onto an ever denser and ever more complex genetic apparatus. That is, it is not simply that the accelerating pursuit of knowledge of molecular genetics leads to a greater appreciation of the richness of genetic expression. Rather, the intensity of the pursuit of a “complete understanding” of *C. elegans* increases the resolution of analysis and plunges research ever deeper into the genome to a place beyond the molecule, the postvital. What and where is this “place” or effect of the postvital? Speaking of the process of physical mapping, one of the *C. elegans* researchers, John Sulston, unwittingly gives us a hint: “There is a kind of circularity to it. . . . The better the map is the easier it

is to clone things and then the better the map becomes.”⁴⁵ Here, I want to ask, in what way is the map getting better? That is, just what is being mapped in a physical map of *C. elegans*?

On the one hand, the answer to this question is obvious—a better map is one with higher resolution, a finer-grained collection of ordered pieces of DNA that allows researchers to locate a gene and ask about its function.⁴⁶ One planner, Robert Horvitz of the *C. elegans* sequencing project, “views it as ‘an opportunity to obtain at a level of resolution never before achieved an understanding of an animal that uses a nervous system to control behavior.’”⁴⁷ The coupling of a physical map with cell lineage allows one to say “that is all there is” in that one has a description of both the program and its instantiations. Practically speaking, this imparts a stability and accessibility to *C. elegans*: “in the old days, if you were going to clone a gene you had to first find some landmark nearby and then laboriously ‘walk’ down the chromosome to find the gene. With the map, ‘you can literally walk to the freezer and pull out that piece of DNA.’”⁴⁸

And yet the fact that *C. elegans* has been ordered in this way must not obscure the fact that the rhetoric of “you can look at it and say ‘that is all there is’” operates on the basis of a belief in the total resolution of the story of *C. elegans*, a story without gaps, an understanding or a narrative that, strictly speaking, has fused with its object, an object that itself, according to Sulston, envelops all of biology. “In a sense, one organism like this contains all of biology” (p. 1313). That is, the complete description of *C. elegans* resolves the differences between the living organism and its description, and the resolution of this difference—the implosion of a body and its description into coding and mapping—shows us that, most certainly, what is being mapped in the worm project is not, in the usual sense, an organism, insofar as the organism is itself a map or “library,” a description of “all biology.” *What the map and the cell lineage diagram inscribe is the end of a story.* “That is all there is” announces the fact that there is no more to be told about *C. elegans*. It is a story about a lack, or at least the resolution of, a story. What is mapped is therefore also something other than a worm or its genome; it is the event or effect that convinces us that the story is over, resolution. In other words, the mapping and diagramming serve as both a description of the order of nucleic acids in the *C. elegans* genome, the genealogy of cell ancestors, and as a map for us of what makes finishing the story plausible. It describes what makes “resolution” possible. Here, I will try to diagram this “resolution.”

Resolution has a series of meanings that can be organized, for our

purposes, into two distinct and nearly opposed inflections. First we find that “resolution” rests on the idea of precision: “As they examine the world more and more minutely with instruments of ever higher resolution they come upon phenomena not previously described.” High resolution” here refers to the ability to precisely distinguish the mechanisms of the behavior of *C. elegans*. With this meaning of *resolution* we see that it rests on the ability of an observer to recognize, and perhaps make, differences. On the other hand, “resolution” is also about closure, the eradication of differences: “The process by which a discord is made to pass into a concord” or “A solution or settlement of a dispute.”⁴⁹

I want to claim that the “resolution” spoken of by Horvitz has the effect of both of these meanings at once. It is clear that the deployment of a physical map, a cell lineage diagram, and, eventually, the full sequence of the *C. elegans* genome is a technical effort of great precision, one that discovers and describes new differences in behavior and genetic endowment. On the other hand, it is also an effort whose explicit goal is to make it possible to say “that is all there is,” to resolve the question and story of *C. elegans*. I want to insist that both are equally important, if not equally obvious, aspects of what I have called the rhetorical softwares of research. The very specific idea of a high-resolution “understanding” of *C. elegans*, which worm researchers have, is a product of the unspoken narrative they use as a tool for organizing and pursuing research, just as much as the persuasive “resolution” made possible by the technologies of YAC (yeast artificial chromosome) and physical mapping. Both are aspects of the larger narrative told of *C. elegans*, one which, ironically, announces the end of the story.

This larger story is the story of “life,” a story of the sublime object of biology. Like the pneuma of the Gnostics, it cannot die—it is, in a way, immaterial, frozen, timeless, and without gaps. For Kant, the sublime was that which provoked a feeling of pleasure and displeasure through its inability to be represented. In Kant’s account, it is precisely the failure of representation to do justice to the sublime object that gives us an idea of the shape of the sublime object. That is, we know from our response that it is a quality of the sublime object that it provokes a failure of representation. It presents that which is unrepresentable.⁵⁰ Jean-François Lyotard articulates this well: “In the sublime ‘situation,’ something like an Absolute, either of magnitude or of power, is made quasi-perceptible (the word is Kant’s) due to the very failing of the faculty of presentation. This absolute is, in Kant’s terminology, the object of an Idea of Reason.”⁵¹

We can see that in a certain way the nineteenth-century concept of life was networked with such a Kantian reading of the sublime. As the “beyond” of disease, hidden in the silence of the organs, life was presentable only in its inability to be represented, visible only in its invisibility.⁵² With *C. elegans*, we have a radically different story, but the sublime remains. For while it is true that the ability to look at it and say “that is all there is” argues against the unrepresentable, ineffable, sublime nature of life, the new visible invisibility can be found in the increasing resolution of the descriptions of the nematode. For what is looked at here is the absence of anything beyond the genetic endowment of *C. elegans* and its instantiation. Put another way, the aesthetic of a “complete understanding” is an aesthetic that finds nothing sublime. Jean Baudrillard writes of his encounter with such an aesthetic, that of the hyperreal:

I recall a particular scene of a hyperrealist exhibition at Beaubourg, of flesh-colored, absolutely realistic and naked sculptures, or rather mannequins in unequivocal, banal positions. The instantaneousness of a body which is meaningless and which has nothing to say but simply exists, has a kind of stupefying effect upon its spectators. They leaned over to see something, to look at the texture of the skin, the pubic hair, everything, but there was nothing to see. Some even wanted to touch the bodies to test their reality, but of course that didn't work because *everything was already there*. (emphasis added)⁵³

The resonances here between this hyperreal aesthetic and the worm project speak for themselves: the frenzied detail, the tactile interaction with the object, the claim to be able to say nothing more. “It is a ‘real animal’ . . . if you hit it, it reacts.” Such an aesthetic is fascinated, and stupefied by, the end of narrative. Can it really have nothing more to say? Yes, “that is all there is.” It is the constant inquiry, the joyous disbelief that, finally, there is nothing more beyond our gaze, that marks this new sublime. It is the remains of the sublime, sublime remains whose fascination is tied to the memory of a story that looked for something beyond fragmented surfaces—limbs, nerves, intestines, banal positions. The worm project is a project that seeks to demonstrate, through “thousands of serial electron micrographs,” yeast artificial chromosomes, the sequence of a genome, and the rhetoric of complete understanding, that the secret of life is that there is nothing beyond the surface, that there is no secret.⁵⁴ Thus, the sublime object of biology is no longer the life that is beyond disease and the organism, visibly invisible; instead, it is the continual story that there is nothing more to say, a story of resolution told in higher and higher resolution.

Thus, “resolution” here marks the displacement of the sublime object of biology, and it is itself a marker of the sublime in the hyperreal aesthetic of *C. elegans*. In its capacity as a marker of precision, “resolution” ends the story of *C. elegans* insofar as it makes it plausible to say “that is all there is,” to resolve the differences between a computer program and its execution, DNA and a body. At the same time, this very “resolution” allows more stories to be told, stories about the end of stories, but narratives nonetheless. These narratives are about the continual and constant triumph of molecular biology, a triumph that announces the absence of that “meta-physical entity hidden behind the word ‘life.’”

The new sublime object of biology is thus visibly invisible in two ways. First, the transparent body of the nematode, “there” but unseen, is resolved into nothing, a memory of a body, a body of memory that functions as a repository of the “past choices of its ancestors.” Second, a new difference is uncovered or resolved “behind” the cell lineage diagram, wiring diagram, and the physical map: nothing. I now want to trace out the shape of this nothing, because while it may be “no-thing,” it nonetheless has its effects as a virtual object.

Molecular Biology Is Dead—Long Live Molecular Biology

Slavoj Žižek has written of the psychoanalytic account of the sublime body, a fantasy in which there exists a “body within the body” that resists the cycle of generation and corruption. Žižek’s paradigmatic example of the sublime body comes from cartoons. “Consider Tom and Jerry, cat and mouse. Each is subjected to frightful misadventures: the cat is stabbed, dynamite goes off in his pocket, he is run over by a steamroller and his body is flattened into a ribbon, and so forth; but in the next scene he appears with his normal body and the game begins again—it is as though he possessed another indestructible body.”⁵⁵ Žižek stresses the ways in which the indestructible body within the body exemplifies Jacques Lacan’s notion of a space between two deaths, between biological and symbolic death. For what’s crucial in this example—given the malleability of the notion of “living”—is not the miraculous ability of a cat to withstand high explosives. Rather, it is the ability of the narrative to withstand such explosions because that ability is tied to the techniques of animation and rhetoric that keep the cartoon going and keep Tom alive. One of these techniques—the actual “reconstruction” of Tom’s body—takes place between frames, as a blackened, scorched cat is transformed, once again,

into the same, uninjured feline body. Thus, for us, the importance of Lacan's analysis of the two deaths—one biological, one symbolic—lies in its ability to highlight the distinction between the end of a "life" and the end of a story. More than once we have watched cartoon souls ascend to cartoon heaven in biological cartoon death, but the story and the cartoon go on, symbolic death deferred for another frame, another episode of "animation."

Thus, what animates the story of *C. elegans*, given that there is no "life" left in it, is a story of the end of narrative, a story that, like conventional animation, both covers over narrative gaps and lives off them. That is, the very things that make animation, and narrative in general (if there is such a thing), possible are the gaps that make plausible the appearance of movement and change. Beyond each fragment or frame of a narrative is a story that moves, and this "beyond," that which exceeds any individual fragment, is the site of the sublime object. In the case of Tom, this object is an indestructible body that returns "between" frames. In molecular biology, the end of the grand narrative of life, the "death" of life is overcome through a new story of information, in which a sequence of "bits" is strung together or animated into a coherent whole through the discourse of "that is all there is," a story of coding without mediation or bodies. Thus, we read in Walter Gilbert's "Towards a Paradigm Shift in Biology," "Molecular biology is dead—Long live molecular biology." The ambiguity and sublimity of molecular biological research can be found at the point of "—," a marker of the "resolution" of the sublime object of biology, a resolution at once apocalyptic and inventive, between two deaths. No longer about "life," life science is now about the fact that there is nothing but story, nothing but information. This information is the sublime body, that which persistently returns.⁵⁶ For example, in Gilbert's manifesto for postvitality, he contrasts the modern and postvital paradigms. "In the current paradigm. . . : The 'correct' approach is to identify a gene by some direct experimental procedure—determined by some property of its product or otherwise related to its phenotype—to clone it, to sequence it, to make its product. . . . The new paradigm, now emerging, is that all the 'genes' will be known (in the sense of being resident in databases available electronically).⁵⁷

What has happened between these two frames or paradigms? Phenotypes, bodies, have disappeared as referents for the sequence of nucleic acids, which have themselves become "all there is." The new biology, Gilbert writes, will be dominated by "theoretical conjecture" and "inter-

pretation" of sequences. A researcher will begin with the end of narrativity, with the idea that "all there is" to know about an organism can be found in its electronic database sequence, the notion that such information is the timeless and perhaps indestructible essence of the organism. But she will not stop there; the narrative of life will now be an exegetical one, where theorists scan databases and through "individual insight and inspiration," produce new knowledge, new stories of organisms that will themselves become a part of the worldwide databases. Thus, the sublime object and body of biology remain in the form of sequences and their network of databases. These sequences, networked together as a "reagent that the scientist uses . . . include a knowledge of the primary sequence of the organism, together with a list of all previous deductions from that sequence."⁵⁸

It is this network, and the rhetoric of insight, that prevents the second death of "life," symbolic death, as the sublime object/body of sequences and networks still shimmers with "an understanding of life" despite and because of "resolution." While there is no "life" beyond the body of the postvital organism, there is a sublime beyond, and it can be found in the new density of interpretation brought to bear on genetic sequences, the new narratives that arise out of the end of narrativity, an epoch that seems to be without stories. This is what animates Gilbert's manifesto: "There is a malaise in biology. The growing excitement about the genome project is marred by a worry that something is wrong—a tension in the minds of many biologists that sequencing is boring. And yet everyone is sequencing. What can be happening? Our paradigm is changing."⁵⁹

One most certainly gets bored when "that is all there is." While it is of course true that the technical, repetitive nature of genomics is seen to be tedious, this begs the question of what makes biological research interesting in the first place. While some biologists mourn the loss of their old paradigm in a malaise, longing for the mediations of phenotype and behavior, Gilbert calls for a new basis of narratives, one that finds new density and inspiration from the "nothing" behind the massive, complete knowledges found in databases of information. This nothing is certainly no thing; rather it is a network of hardwares, wetwares, and softwares that reconstitute the sublime object of biology at the mark of "—." Fittingly, Gilbert writes nothing about what these new narratives are to be about; rather, he merely marks and helps to animate a movement toward a paradigm shift in biology, a shift toward a hyperreal paradigm that probes and interprets information that is complete, "already there."

This shift, it should be clear, is not simply a progressive shift, where more and more knowledge is gathered about “life.” Rather, it is a displacement of the very terms of an “understanding” of “life,” one that reverses the polarity of analysis from the modern study of phenotype and behavior to a study within an economy of sequences. For the very formulation and constitution of sequence databases and libraries depends on a loss or an overcoming of the “priority” of the body of the organism as the site of reference for life. This loss or overcoming effaces or ignores the origins of such sequences and installs them as what Brian Rotman has called a “meta-sign,” an inscription that marks absence. In our case, the frenzied increase of sequencing announces the absence of that prior site of life—organisms—at the same time that it marks new economies of reference for life, ones in which the constantly changing and growing databases frame the vitality of any given sequence. In the absence of any transcendental articulation like that of the sovereign organism and its interior vitality, life, in the age of postvitality, becomes anchored not to the organism and its will to live, but to the constant, worldwide compilation and exegesis of sequences.⁶⁰ Like Brian Rotman’s analysis of xenomoney, in which a futures market explodes to overcome the loss of gold as a transcendental signifier, life becomes dislocated, no longer localizable in a body but dispersed through the narratives and networks that make up the interpretations of genetic databases.⁶¹

Thus, insofar as life becomes identified with genetic sequences and their translation, it becomes distributed, situated not within the sublime, sovereign interior of organisms but in and emerging from the strong readings proffered by theorists and their tools. The effects of a network of tools, rhetorics, and work, “life” is not some transcendental object, some “thing” that is “studied.” Rather, the biological object, the postvital organism, is in the position of a cryonic body, dependent on the network of technologies, people, and narratives in order to fulfill its promise of a life it has dislocated.⁶² By connecting life back up to its conditions of emergence, I hope to dislocate it, to mark the way it occupies not one transcendental “place” or position, but instead emerges out of the series of connections between words and technologies, human or otherwise. This dislocation, in a way, makes it impossible to speak or write of “life” in general, insofar as the emphasis on the connections of narratives and networks of technologies marks the heterogeneities and differences of what has been called, since the nineteenth century, life.

CHAPTER 2

Mr. Schrödinger Inside Himself: The Rhetorical Origins of the Genetic Code



Biologists think that they devote themselves to the study of life. It's not clear why.

—Jacques Lacan, *The Seminar of Jacques Lacan*

Biologists no longer study life today.

—François Jacob, *The Logic of Life*

As I pointed out in chapter 1, “life” just isn’t what it used to be. The conceptual, rhetorical matrix we used to feel comfortable ascribing to something called “organisms” has been displaced and retooled. From artificial life to the cyborg universe of Donna Haraway, the tropes we have traditionally associated with vitality seem to be mutating. These mutations have most notably taken place around a molecule, the double helix, a twin strand of nucleic acids with immense discursive as well as physico-chemical powers. In this chapter I will attempt to analyze the rhetorical “origins” of this new regime of the molecule, rhetorics that functioned as software for the new science of molecular biology. In this case, the notion of rhetorics as software is particularly appropriate as it foregrounds molecular biology’s dependence on particular linguistic media. Specifically, the trope of the “code” has been as crucial to nascent molecular biology and its precursors as the more obvious gadgets of ultracentrifuges, electrophoresis gels, and electron microscopes. Indeed, in one particular case that I will outline here, I would argue that the new rhetorical framework that made possible the identification of life with a molecule preceded the technologies that would make the practices of a molecular biology possible. My concern is not to establish the priority of this rhetorical intervention, but to mark out how the assemblage or network that produces molecular biology runs on rhetoricity as well as technicity.

Today technicity and rhetoricity together compile genetic databases, texts that will only become “readable”—in all their depth, richness, and absurdity—with the future mapping and sequencing of “the” human genome, a three-billion-dollar project funded by the National Institutes of Health and the Department of Energy. This massive and frenzied effort to determine a reference standard for the genetic human finds its marketability in medicine, and yet its motivations and effects are more varied and profound. On the one hand, the genome projects can be seen as a “natural” destination for late-twentieth-century life science, science that has so drastically imploded “life” and “information” that genetic sequences can be transmitted by electronic mail. On the other hand, this instrumental project sells itself as ontological research: “One of the strongest arguments for supporting human genome projects is that they will provide knowledge about the determinants of the human condition. One group of scientists has urged support of human genome projects because sequencing the human genome will provide one of the most powerful tools humankind has ever had for deciphering the mysteries of its own existence.”¹

Added to this twin specter of surveillance and existential stupidity are quiet murmurs of a better eugenics: “the problem with positive eugenics has more to do with the means than with the ends.”²

This chapter will not deal explicitly with these remarks—indeed, in many ways they function as their own critique.³ Instead, I want to focus on what has made them possible as technoscientific statements. In order to focus on the rhetorical softwares of molecular biology, I will examine not only the official discourse of the life sciences, whose history tells of the final penetration of the secrets of life and the ultimate mastery of the vital, but also the more frayed edges of the discourse on life, edges inhabited by cartoons and popular crossover works. The interconnections and receptions of these seemingly aleatory discourses with the rise of molecular biology disrupt the claim that there can be anything like a linear inheritance of concepts in the history of molecular biology. Rather than following one branch in a genealogy that leads to another, a branch that ultimately ends up connecting to a tree of scientific causality through which we can trace the evolution of molecular biology, we are confronted each time with an error, a displacement or polyp that erupts into a new form of knowledge with new technologies and power effects. We discover, along with Foucault, that

to follow the complex course of descent is to maintain passing events in their proper dispersion; it is to identify the accidents, the minute deviations—or con-

versely, the complete reversals—the errors, the false appraisals, and the faulty calculations that gave birth to those things that continue to exist and have value for us . . . that truth or being do not lie at the root of what we know and what we are, but the exteriority of accidents.⁴

What follows then is an accident report, a description of a rhetorical collision.⁵

X Marks Metaphysics: Schrödinger's Mutation

Although a physicist, Erwin Schrödinger had a profound impact on the metaphors of the genetic substance. Having received a Nobel Prize in 1933 for his breakthrough work in quantum theory, Schrödinger turned his attention to biological questions in his popular account of the physical basis of vitality. *What Is Life?*, published in 1943, provides a rhetorical model of the gene that would influence Francis Crick, whose research with James Watson resulted in the discovery of the now famous double helical model of DNA. It also provided the groundwork for George Gamow's description of the DNA-protein relation in 1954 as a "translation."⁶ An analysis of Schrödinger's text will provide us with a view of both his dependence on the traditional metaphors of heredity and his recasting of them, which allowed him to formulate the notion of a hereditary "code."

Schrödinger's rhetoric relies much on the traditional metaphors of genetics in his "summary" of that subject. Indeed, because of his position as a "dilettante," Schrödinger's characterization of genetics gives us a very general picture of the nature of the rhetorical reservoir available to the geneticist of the 1940s.⁷ It is also this status as "dilettante" that allows Schrödinger to reinterpret some of these common tropes. For example, his discussion of genetics begins with the notion of the "pattern": "Let me use the word 'pattern' of an organism in the sense in which the biologist calls it 'the four dimensional pattern,' meaning not only the structure and functioning of the organism in the adult, or in any other particular stage, but the whole of its ontogenetic development."⁸

Here Schrödinger employs what I will call a phenotypic trope, in that the notion of "pattern" refers to the "shape" of a developing and developed organism and not just to the genotype, the shape, as it were, of its genes. That is, "pattern" refers to the ongoing growth and development of an organism, a thick description of the birth, growth, and life of an organism, a cradle-to-grave biography. Note that Schrödinger is careful to

mark the importance of nomenclature by his use of quotes and the definitional gesture with which he begins.

From here, however, the rhetorical pattern shifts and displaces; from the detail and complexity of the living organism Schrödinger moves to the chromosome. Because this “four dimensional pattern is known to be determined by the structure of the . . . fertilized egg” and because that cell itself is “essentially determined by the structure of only . . . the nucleus,” Schrödinger turns his attention to genotype. “It is these chromosomes, or probably only an axial skeletal fibre of what we actually see under the microscope as the chromosome, that contain in some kind of code-script the entire pattern of the individual’s future development.”⁹ No longer, then, is “pattern” to be seen in the exhibited characteristics and functioning of an individual organism. Rather, it is now something that is “contained” in the coded and scripted chromosome. No longer a reflection or even a production of genotype, “pattern” is now literally inside genotype. By “troping” the trope of pattern, Schrödinger literally and grotesquely turns “pattern” and the “organism” inside out. With this move—the metonymic substitution of “code” for “organism”—the entire future birth, life, and death of the organism is “contained” or engulfed by the chromosomes. This fantastic and impossible twist in the history of the genetic substance must be seen as a fundamental reprogramming of the rhetorical software of genetics, and by extension, molecular biology. As in one of Freud’s “absurd dreams” in which a patient “failed to distinguish the bust and the photograph from the actual person,” Schrödinger mistakes or displaces the pattern of the organism by its “code-script,” injecting the life of the organism into its description.¹⁰

Thus, despite Schrödinger’s care in his deployment of the terms of his summary, “pattern” takes on an essentially different meaning, as the developmental and physical complexity of the “four dimensional pattern” is displaced by the genetic instructions for that pattern. Because we are dealing with “scripts” or texts, an analogy drawn from literary theory might illuminate for us the nature of this textual problem. Paul de Man describes an analogous slippage that arises in theories of discourse:

It would be unfortunate, for example, to confuse the materiality of the signifier with the materiality of what it signifies. . . . No one in his right mind would try to grow grapes by the luminosity of the word “day,” but it is very difficult not to conceive the pattern of one’s past and future existence as in accordance with temporal and spatial schemes that belong to fictional narratives and not to the world.¹¹

This passage speaks precisely to the “pattern” of Schrödinger’s move. By placing a spatiotemporal series of events “within” a code-script, Schrödinger is effectively put in the position of trying to grow grapes by the light of “day.” More precisely, he confuses the “organism” with its “essence” or its “recipe.” It is this confusion that de Man labels “ideology.”¹²

Schrödinger, at least in part, is aware of the possibility for confusion. Always attentive to the need for careful definition, he offers a more precise reason for the “code-script” metaphor: “In calling the structure of the chromosome fibres a code-script we mean that the all penetrating mind, once conceived by Laplace, to which every causal connection lay immediately open, could tell from their structure whether the egg would develop, under suitable conditions, into a black cock or a speckled hen.”¹³ The code is thus at once secret and transparent. The ideal, godlike reader would be able to read the future of any given organism from the text of its stable and indelible “code-script.”¹⁴ But Schrödinger seems to realize that this is not an entirely satisfactory metaphor. Even to Schrödinger, the temporal and spatial collapse he is speaking of seems to be undone by a trope that requires both a code and a decoder folded into one: “the term code-script is, of course, too narrow. The chromosome structures are at the same time instrumental in bringing about the development they foreshadow. They are law code and executive power—or to use another simile, they are architect’s plan and builder’s craft in one.”¹⁵ In his careful attempt to articulate his description of the genetic substance, Schrödinger ironically falls prey to what Freud characterized as a “verbal foolishness” and what De Man labeled ideology. If he had posited the chromosomes as only a code-script that required a reading or a translation to produce an organism, Schrödinger’s model could be accommodated to the more complex developmental model of “pattern” while offering a useful heuristic or metaphor for the specific function of the chromosomes within that pattern.¹⁶ With this last move, however, Schrödinger places all the power within the code and none within the development of the organism. The insertion of “builder’s craft” into the “plan” of genotype represents the deletion of the organism and phenotype. This deletion condenses a lifetime of development into a moment of “law code and executive power.”

A model for this deletion or exchange of one model of life for another can be found in Schrödinger’s text itself, in the mechanism of “crossover”: “Before being separated in the reductive division, say the one in the father’s body, any two homologous chromosomes come into close contact

with each other, during which they sometimes exchange entire portions.”¹⁷ Subject to chance, the encounter and exchange of one allele for another takes place through crossover, the chiasmatic substitution of one allele—a sequence of DNA that codes for a trait—for another. Each crossover occurs via a chance chiasmatic encounter, and yet the frequency of exchange can be mapped according to the distance between the respective sites on the chromosome. The greater the distance between two sites on a chromosome, the greater the likelihood that an exchange will take place. This model, more specifically, the model of “unequal crossover,” in which the exchange during crossover leads to the deletion of one allele and “gametes containing the deletion chromosome will presumably die or produce an inviable zygote,” provides us with a literal model for the metaphorical genesis of molecular biology.¹⁸ That is, the encounter of one “pattern” with another, and the subsequent deletion of or death of the organism, are allegorized by the discussion of crossover in *What Is Life?*

Schrödinger’s legacy—the cascade of events that led to a “genetic code”—was subject to chance, but this crossover from physics to biology was in fact, according to our model, helped along by his distance from biology, a distance summed up in his description of himself as a “dilettante.” In the “father’s body” of molecular biology, *What Is Life?*, the chance encounter between the metaphor of genotypic and phenotypic pattern, physics and biology, leads to a retooled conceptual and metaphorical inheritance for molecular biology, an inheritance based on Schrödinger’s “code-script” of 1943.¹⁹

These concentric chiasmata, in which the chiasmus or exchange between the phenotypic and genotypic flavors of “pattern” is contained within a crossover or chiasmus between physics and biology, is itself enveloped within the interference pattern generated by Schrödinger’s enfolding of the popular and the scientific in *What Is Life?* Here we might call Schrödinger’s reformulation of “pattern” an X-ray mutation, as this interface or crossover work marks with an X the constant chiasmatic operation at work in science, what we might call the invagination of scientific and popular discourse. Derrida has argued that philosophy cannot be extricated from its rhetoricity, most notably due to philosophy’s reliance upon metaphor. But the other side of this analysis also shows the extent to which rhetoric is indebted to philosophy: “metaphor remains, in all its essential characteristics, a classical philosopheme.”²⁰ Philosophy and rhetoric thus mark not oppositions, but lines of difference, what Gilles Deleuze might call a “fold,” or what Derrida explicates as “the contamina-

tion of logic, the logic of contamination.” These cross-pollinating models all point to the ways in which discourses, like the chromosomes in Schrödinger’s text, cross over and “contain” each other. As a play of differences rather than a tool for meaning and communication, scientific discourse can be seen to be both productively and hopelessly embedded in the discourses of technology, philosophy, and, as we shall see, cartoons.

In the cartoon universe, space gets displaced, reversed, or enfolded. It is this universe that, we might argue, is the universe Schrödinger borrows from. In a cartoonlike gesture, Schrödinger pulls or injects a cartoon, an impossible and perverse representation of “the new biology,” out of the future. In the 1960s, physicist George Gamow—theorist of the Big Bang and, along with Schrödinger, the man primarily responsible for the notion that DNA is a “code”—drew and wrote a number of popular texts on science. Among them was *Mr. Tompkins Inside Himself: Adventures in the New Biology*, a text in which Gamow’s fictional character and sometime coauthor is, much like Schrödinger, impossibly injected into his own body to better understand it (Fig. 1). A mammoth hypodermic sucks Tompkins’ body out of the world and into . . . his body.

I am just going to inject you into your own blood stream, so that you can see for yourself the various cell colonies from which you are formed. . . . As he spoke, Dr. Streets put his hand into a pocket of his white gown, pulled out a large hypodermic syringe, and pointed its long shiny needle toward Mr. Tompkins. There was a violent feeling of suction, and for a moment Mr. Tompkins felt just as if he were a camel trying to squeeze itself through a needle’s eye. Then something pinched his arm above the elbow, the suction turned into pressure, and Mr. Tompkins was forcibly ejected into a rapidly flowing mass of some slightly yellowish transparent fluid.²¹

The structure of this nonserious but also nontrivial trope, which allows Tompkins to fold in on himself in an act of self-habitation and manipulation, parallels Schrödinger’s movement, as an organism, in his own analysis from the position of a body in the world to a body inside of a chromosome inside of . . . a text entitled *What Is Life?* Just as Gamow relies explicitly on a cartoonish trope as a narrative device to explain “the new biology,” so too does Schrödinger implicitly require a new rhetorical software that allows the chromosomal engulfment of the organism that made the “code-script” plausible. It also mimes the endless foldings and refoldings of discourse that, I have tried to show, make science possible. That is, the identification of an organism with its description or its al-

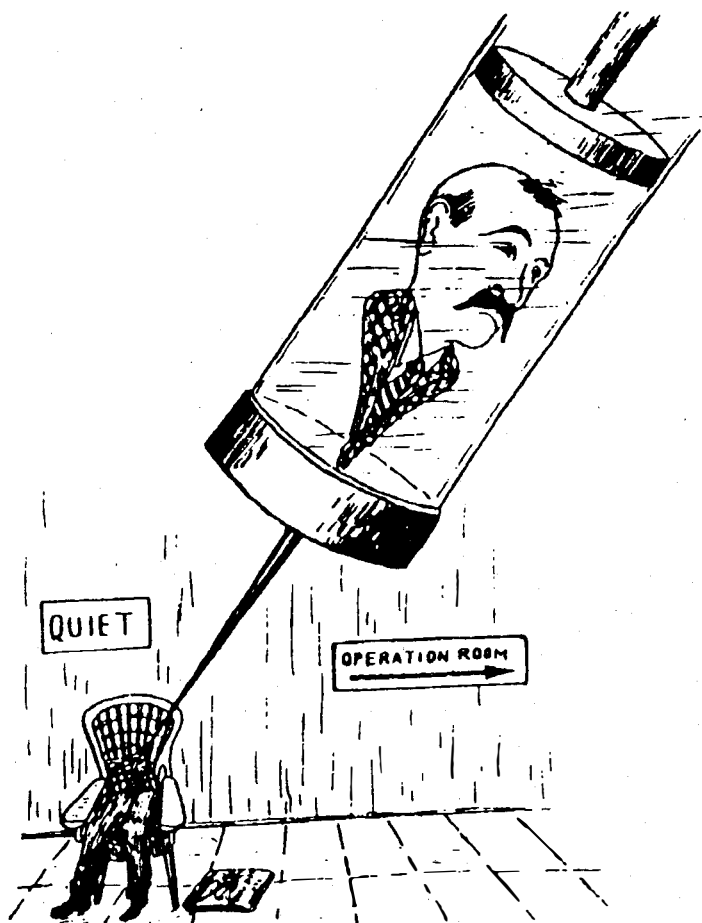


Fig. 1. Mr. Tompkins gives his body to molecular biology. Reprinted with permission from Gamow and Ycas, *Mr. Tompkins Inside Himself*, p. 5.

gorithm, and the rhetorical twist needed to manage such a conflation, allegorizes the scientific dream of effacing its rhetoricity while deploying it, “X-ing” it out.

Thus far I have stressed the spatial reorganization of the organism and the body necessary for the appearance and thinking of molecular biology. Foucault’s work on the place of incision and morbid anatomy, summed up in the chapter title “Open Up a Few Corpses,” marks the way in which discursive practices have constituted the body—and, I might note, “living”—through new acts of spatialization, epistemological breaks that

could be found at the edge of a knife but that were constituted, Foucault argues, by a new ontology, the “non-verbal conditions on the basis of which it [medicine] can speak.”²² Here I want to claim that unlike Foucault’s object and period of study, when “death became the concrete a priori of medical experience . . . [and] detach[ed] itself from counter-nature and became embodied in the living bodies of individuals,”²³ Schrödinger moves beyond the point at which “the patient is hardly more than an injected corpse, a half-filled barrel” to the point that no body, indeed, no life, need exist at all outside of the “aperiodic crystal” Schrödinger inadvertently injected himself into.²⁴ No longer does the cadaver provide the material and paradigmatic basis for the medical body; the body, and life, have disappeared.

The question of the spatialization of the body, as Foucault has shown, is always bound up with the power/knowledge dyad. In our case, the constitution of genetic disease, a regime of the gene in which “all disease is genetic” and disease is figured as a time bomb waiting to explode on a double helix, the localization of disease on a sequence of DNA and not a body can be seen to be intimately intertwined with Schrödinger’s fantastic intervention.²⁵ But the power effects are not limited to the effects of spatialization. The ascription of agency—“law code and executive power . . . architect’s plan and builder’s craft in one”—to the hereditary substance can be seen as nothing less than a retooling of the concept of life.²⁶ “Crystals,” not organisms, have agency in Schrödinger’s universe, and it is this universe, we shall see, that will be shared by early workers in molecular biology like Watson and Crick. It is this paradox of scientific inquiry—the increase of scientific “control” that leads to the deletion of agency—that Foucault sums up: “Western man could constitute himself within his language, and gave himself, in himself and by himself, a discursive existence, only in the opening created by his own elimination.”²⁷ Both Tompkins and Schrödinger seem to take this move literally insofar as it is only through their own elimination that they can be injected into bodies or chromosomes.²⁸

Of course, the mere fact that Schrödinger’s rhetoric encodes the genetic substance—and, indeed, life—as a written code does not account for why this rhetorical move was attractive, nor does it prove that this articulation had any real impact. To jump to such a conclusion would be to perform Schrödinger’s error of mistaking a text for a complete development of an organism or a concept. It does, however, demonstrate that this articulation was both feasible and available. It also demonstrates histor-

ically where at least some of the feasibility of tropes like the “book of life” comes from, as well as perhaps the importance of attending to the written, rhetorical displacements that make up scientific discourse.

The power of this formulation is clear, insofar as Schrödinger’s location of life inside the code-script inspired, among others, Francis Crick: “A major factor in [Crick’s] leaving physics and developing an interest in biology had been the reading in 1946 of *What Is Life?* by the noted theoretical physicist Erwin Schrödinger. This book very elegantly propounded the belief that genes were the key components of living cells and that, to understand what life is, we must know how genes act.”²⁹ What’s particularly instructive about Watson’s formulation is that it draws attention to precisely the conflation that I analyzed earlier. While it’s perfectly predictable that the virtual founders of molecular biology would emphasize the role of the genetic substance in life, this quotation strikingly illustrates the effect, both scientific and rhetorical, of Schrödinger’s description. Not only did it provide the motivation for a migration of physicists into the life sciences, but it also helped frame the question of life within a reductionist framework that sought and found the secret of life in a crystallograph and not an actual organism. “Absurd” or not, Watson and Crick’s dream of understanding “what life is” includes a Nobel Prize and the beginnings of a research program to read the “book of life” whose ultimate effects travel to the genome initiatives.

Thus, Schrödinger did not, in some sense, go awry. Rather, this episode in the constitution of molecular biological discourse brings into relief Derrida’s remark quoted earlier that science is shot through with writing and rhetoric, and rhetoric is saturated with differences, differences that make possible the moments of invention that, ideological or not, make plausible different scientific regimes and researches. Scientificity itself is at least in part a rhetorical effect, an effect of the possibility of the displacement and exchange of meanings and models both within and across discourses. These exchanges need not obey the disciplinary strictures that traverse their discourses; indeed, they need not be “possible” in any strict sense. Applied to our example—the becoming molecular of life and disease—Foucault’s remarks resonate with uncanny understatement: “Every great thought in the field of pathology lays down a configuration for disease whose spatial requisites are not necessarily those of classical geometry.”³⁰ Schrödinger’s rhetorical and scientific exchange of the trope of phenotype for the trope of genotype was not merely Freud’s “verbal carelessness”; it was a rhetorical plausibility condition of molecu-

lar biology. It made it thinkable and practical for Watson and Crick, among others, to equate life with the structure of DNA and, eventually, to seek to “decode” it.

And yet Schrödinger’s rhetorical invention is still far from the Laplacian readers of the “book of life” peering over electrophoresis gels today. The trajectory of the “code” metaphor was far from simple. While it is true that codes were literally “in the air” during the years of World War II, the impact of the specific metaphors of the “code” was less than clear. The reductionist “deletion of the organism” discussed earlier was made possible through the notion that the essence of life was contained in a discrete unit of code-script, but it is only after the articulation of the structure of DNA that the tropics of “code” get played out. In Crick and Watson’s “Molecular Structure of Nucleic Acids: A Structure for Deoxyribonucleic Acid,” which outlined the now familiar double helical structure of DNA, no mention of the code metaphor is made. However, in their next article, “Genetical Implications of the Structure of Deoxyribonucleic Acid,” they write: “in a long molecule many different permutations are possible, and it therefore seems likely that the precise sequence of the bases is the code which carries the genetical information.”³¹

Yet just what was meant by this “code,” besides the fact that it somehow related the sequence of DNA to proteins, remained suitably enigmatic. How this “genetic information” synthesized proteins was still uncertain. It remained for George Gamow—along with Mr. Tompkins, his coauthor—to describe the “translation” of the genetic code, research that I outline in chapter 3. But rather than proceeding as if history unwinds from Schrödinger’s catachresis purely in the context of the past, I want to trace out a contemporary echo, repetition, or symptom of Schrödinger’s coding of the living. That is, in lieu of the historiographical convention of providing context from the past to explain, causally, the origins of an event exterior to any writerly intervention, I offer the equally refractory context of the present, that place from which I write and narrate the rhetorical “origins” of the genetic code.

Smart DNA, Postvital Living

In his article “Self Organization and Living Systems: Is DNA an Artificial Intelligence?,” D. H. Adams attempts to reconfigure the distinction between living and nonliving systems in terms of “intelligence.” While eschewing the “discredited view that ‘life’ is dependent on some ill-

defined 'vital force' " Adams also takes issue with the claim that "all matter has an inherent capability for spontaneous 'self organization' " and that therefore the distinction between living and nonliving systems is one of degree and not of kind.³² Instead, Adams argues that "a wide, fundamental and probably unbridgeable gap exists between the incredibly complex organization in living systems and what is claimed to be 'self-organization' in inanimate systems" (p. 223). To preserve the distinction between the living and the nonliving while at the same time staving off any (ill-defined) notion of "vitality," Adams offers a model of a kind of "smart DNA" or DNA as an artificial intelligence: "DNA possesses unique characteristics even within the small group of potential substances enabling it not only—as a computer analogue—to store exceptionally large amounts of 'information' but to translate and implement this by operating as an artificial intelligence system."³³

What, among other things, is so stunning about Adams's formulation is that it repeats Schrödinger's "inside/out" gesture at the level of the cyborg. No longer is "cyborg" a possible phenotypic metaphor in which, for Donna Haraway, "we are all chimeras, theorized and fabricated hybrids of machine and organism."³⁴ The cyborg now constructs and orders the slave "body" in smart but lifeless immanence, fulfilling the function of the "director to the board of an industrial corporation," while the proteins work "by processes essentially resembling those of assembly plant robots."³⁵ In short, Adams's text announces that the cyborg no longer needs the organism to "implement" its program. In a reversal of McLuhan, "man" becomes the extension of the nanotechnological, a meat puppet run by molecular machines.³⁶ While Schrödinger wrote explicitly if marginally about the "life of the organism," Adams moves on beyond vitality to intelligence. No longer is "life that in which all the distinctions between living beings have their basis," as Foucault paradoxically put it.³⁷ Nor is the "animate" that which can be distinguished from the "mechanical." The "fundamental" opposition, given that "DNA itself consists of inanimate matter," is between "intelligent" and "dumb" entities, between those capable of self-organization and those that are not.

Thus, Adams's intervention avoids the dilemma with which he began—choosing between the vital model and the self-organization of all matter—by moving the focus of his inquiry away from "life" and putting it on "intelligence." Both previous options depended on a comparison with something called "life." Adams reconfigures the question as one of intelligence, and thus he in some way moves beyond, or "post," life,

“vital.” The irony, of course, resides in the fact that Adams is only able to conceive of the activity of DNA as an artificial technology, effectively obliterating the *physis* / *techne* distinction—and the distinction between the animate and the inanimate—in the same gesture as he exchanges DNA as the secret of life for DNA as the secret of intelligence. DNA, of course, is not “reduced” or deflated in any way by this exchange. It remains the talisman with which one passes from one order of complexity to another. These orders of complexity—such as artificial intelligence (AI)—are mired in their own metaphysical quagmires and productions, but these problems can be pursued without reference to “life.” In the movement from “living” to “thinking,” “vitality” gets spliced out.³⁸

I cannot hope to do justice here to the ways this retooling of *techne* and the organic impact the political—that is the topic for another book—but I want to suggest here that Philippe Lacoue-Labarthe’s analysis of *techne* and politics in *Heidegger, Art and Politics* points the way. If Lacoue-Labarthe is correct in defining *techne* as “the surplus of *physis*, through which *physis* ‘deciphers’ and presents itself”—and thus “political organicity is the surplus necessary for a nation to present and recognize itself,”³⁹—then Adams’s announcement that it is only through *techne* that the organic is possible, that the production of a “natural” body requires the nanotechnological, can be seen as a scientific figuring of this “surplus” as DNA itself, at once both *physis* and *techne*, the organic and the machinic, “information becoming form.”⁴⁰ It would seem that with this casting of “DNA as Artificial Intelligence,” the problems of the organic and politics have been injected into the body and that this calls not for a defense of the organism but rather for a deconstruction of the organism itself, a refusal of the privilege accorded life in its unity, a privilege that indeed molecular biological discourse sometimes reinscribes even in the face of its obliteration. In the name of the organism and its purity or “normalcy” some will hope to “debug” this artificial intelligence, the genome, and restore it to its natural unity. One commentator has argued that “individuals have a paramount right to be born with a normal, adequate hereditary endowment. . . . The idea of genetic normalcy, once far fetched, is drawing closer with the development of a full genetic map and sequence.”⁴¹

An explication of the precise ways in which the tropes of AI are made feasible within Adams’s argument would require an analysis of the rhetorical engineering of his text, which space/time forbids. However extreme Adams’s position might be, the possibility and cogency of his formulation speaks to the fact that while the genome projects may rhetorically be

about “the book of life,” they may also be about what lies “beyond” “life.” The triumphs of molecular biology are not only about the “reduction” of “life” to “genes,” although they are in part about that. They are also about the production of a new secret, a secret no longer of “life” but of that which remains after, the leftovers of Modernity’s “life,” the postvital. Of course, what lies beyond is not an epoch “after” life but one in which the metaphysics of vitality get posted to a new address, perhaps a computer address, an address in which it becomes possible to rephrase philosopher John Searle’s aphorism “Can machines think? Obviously, yes. We are precisely such machines” to “Can Machines think? Obviously, yes. Our genes are precisely such machines.”⁴²

The displacement marked out by Adams’s research is hardly inevitable or univocal. But it does serve as a map of a transformation that has overtaken (or at least taken place in) the life sciences, a transformation of the very object of research. In my next chapter, I will trace out the gaps that made possible a crucial movement in this transformation, the move from codes to words.

CHAPTER 3

From Codes to Words: George Gamow and the Age of the World Scripture



In 1954, less than a year after Watson and Crick's "wish" to suggest a structure for DNA, a short, seemingly unambitious text appeared in *Nature*. George Gamow, cosmologist, physicist, and cartoonist, suggested a conceptual model for the DNA-protein relation in which the synthesis of proteins from the double helical structure of DNA could be explained. In 1952, unbeknownst to Gamow, A. L. Dounce had articulated in rough form the now familiar DNA-RNA-proteins troika, but the question of how nucleic acids were related to proteins was still a mystery. Gamow's text, "Possible Relation between Deoxyribonucleic Acid and Protein Structures," included a proposal—the so-called diamond code—that was ultimately proved false, but his conceptual and rhetorical influence can be seen in the configuration and solution of what Crick would later call the "coding problem."¹ Gamow's conceptualization of the coding problem—that is, how four different bases produce or determine twenty different amino acids—as a problem of *translation* played a key part in research on the code, and it can be seen as a rhetorical shift from the previous emphasis on the metaphors of "templates." It offered a crucial rhetorical algorithm to molecular biology, one that allowed for the possible explanation of the complex relation between the substance of heredity, DNA, and the ongoing function of living systems. What I will trace here is Gamow's precise discursive description of this "relation" as a "translation," an articulation that begins with the metaphor of "numbers" and

ends with “organisms.” This encryption and decryption of “life” within a rhetoric of “numerology” and “translation,” I will argue, is not merely one metaphor or heuristic among others—it was and is a structuring technology of molecular biology, a technology that retools the depths of the body as a secret, even sacred archive.

By locating and describing the double helix as a site of espionage, Gamow set off the treasure hunt associated with the coding problem and established the cell as a site of a lexical, textual problematic, a pool of cytoplasm curled up with a good Book. Crucial to this project was the implicit notion that this “book of life,” like its intertextual counterpart, the New Testament, offered one proper reading, one story, one Truth. I will return to this notion of univocality in my conclusion. In what follows I will trace the rhetorical software Gamow used to recast the genetic body. For despite the rhetorical and scientific displacement of the body as the site of vitality, the body’s metonymies nonetheless remain in a crypt, a “hole” or gap where the magical arc between DNA and proteins, text and flesh, past and future, crackles.²

Translating Gamow’s Translation

In my account of the history and protohistory of molecular biology, I stagger from Schrödinger to Gamow, seemingly blind to Watson and Crick’s formulation of the double helical model of DNA. Volumes have been written on this breakthrough—it is the stuff of the heroic history of science, a story of mediocrity punctuated by great thoughts and great humans.³ While I acknowledge the importance of the Watson/Crick model, especially its rhetorical influence, my tracing of the emergent molecular discourse on life leads to tacit shifts or fractures that took place both within and outside the labs and journals of the early 1950s. As I argued in the first two chapters of this book, I see the transformation of the life sciences less as a consequence of a major breakthrough that revolutionized the discipline than as an emergent phenomenon that grew out of an ecology or rhizome of effects, effects that are themselves often the result of assumptions, metaphor, presupposition.⁴ For example: by his own account, Watson’s work with Crick leading to the articulation of the double helix resulted less from careful progress toward revelation than from a complex of gender effects, play, and a desire for speed. This work was itself, in turn, inflected by Schrödinger’s seemingly marginal writings of the 1940s. Both of these texts—Schrödinger’s and Watson and Crick’s—

were a part of the transformation in the very concept of life, a transformation that placed life in crisis—hence Schrödinger’s title, *What Is Life?*, a question that had, for several centuries at least, seemed either self-evident or nonsensical. More than a critique of vitalism, the challenge to the notion of the “specialness” of vitality made possible a biological model of life that actively ignored the organism. The fact that life is not beyond the laws of physics led swiftly to a less obvious conclusion: that life’s mooring in the body could be overlooked. In the last chapter, I attempted to show how one movement of this trope took place, where Schrödinger’s metaphor of the code-script seemed to produce an amnesia of the body. In this chapter, I follow a similar displacement of the corporeal, a transformation that, I will argue, is made possible by a shift in the concept of life that *will have already taken place*.

George Gamow, as a liminal, interdisciplinary subject moving between cartoons, cosmology, and codes, provides us with an allegorical figure for these complex and jagged discursive breaks in life. The power and plausibility of these breaks, I will argue, can be traced to the unsaid presuppositions of Gamow’s translation of the fact of the double helix into a readable body. That is, rather than residing in the explicit content of Gamow’s scheme, the persuasive force of the diamond code can be found in what was *silenced* or at least *assumed* by Gamow’s account. In what follows, I will be inquiring, rhetorically, into the silent conditions of the possibility of Gamow’s model of the code. I will pay special heed to the presuppositions mobilized by the metaphors of “translation,” as it was this metaphor that seemed to animate the community of scientists who cracked the code.

In my unwinding of the rhetorical knots that structure Gamow’s text, I will first tug on a thread, more specifically, a “fibre”: “In a communication in *Nature* of May 30, p. 964, J. D. Watson and F. H. C. Crick showed that the molecule of deoxyribonucleic acid, which can be considered as a chromosome fibre, consists of two parallel chains formed by only four different kinds of nucleotides.”⁵ When Gamow considers a DNA molecule “as a chromosome fibre,” he translates. His is an attempt to interpret the DNA model proposed by Watson and Crick within a grid of the cell. We have already seen how Schrödinger minted the metaphor of chromosome fibres as “containing” a “code-script.” Gamow’s first trope here is the translation of a molecule into a chromosome fiber. This displaces the qualitative difference between a cellular (cytological) organization and a molecular one, paving the way for a transformation of the organism into

an effect of a univocal language of life, an Esperanto of the molecule. That is, what makes possible the elision of the difference between a chromosome fiber—a somatic, cytological entity—and a DNA molecule is the deletion of the very difference between “bodies” and “scripts” that Schrödinger exemplified with his conflation, “code-script.”⁶

And yet this universal language requires a space between the molecular and the cytological. That is, Gamow, like Schrödinger, does not merely contain phenotype within genotype or efface the somatic with the molecular. Against the grain of the reductionist trope of modeling all somatic processes on the physicochemical, Gamow “considers” the physicochemical as cytological, and this speaks not only to the pliability of the cytological/molecular distinction but also to the rhetorical and scientific need for a space of translation between these two orders, orders whose difference is both implicitly denied and invoked. While the equivalence drawn between a DNA molecule and a chromosome fiber certainly speaks to molecular biology’s claim to have found the physical and chemical bases of life, the description of a molecular entity in cytological terms rhetorically inflects Gamow’s project in another direction, namely, toward the postvital. This is the space of the new sublime object of biology, a dynamic space where the implosion between the animate and the inanimate is constantly enacted. “Possible Relation between Deoxyribonucleic Acid and Protein Structures” is not merely a case of the “molecularization of life,” a reduction of organisms to molecules. Rather, Gamow’s translation moves toward “considering” or figuring molecules in organismic terms, inscribing molecules as themselves cellular entities. More than treating the molecular as the basis for the living, Gamow’s move translates the molecular as *no different from* the living. Translation always requires a third term, a space between two codes, texts, or speakers, and Gamow’s easy translation of a molecule into a chromosome points to the discursive existence of an implicit translating point between the molecular and the somatic that preceded any scientific model for such an equation. This space, like the transparent body of *C. elegans*, which “contains all of biology,” is a space of *no difference*: in the space of the postvital, there are gaps of “that is all there is”; bodies, codes, and molecules all glide together in a universal language that is itself not available for translation or, what amounts to the same thing, does not require it.

Science, too, speaks a universal language here. Gamow’s short article is “about,” among other things, the production and practice of science through texts, in this case, Nature. We see that in this book of Nature, one

must open or begin with the book *Nature*. It is also written that in *Nature* is a “communication,” a communication that itself concerns communication, or at least, as we shall see, “alphabets,” “words,” and their natures. Thus, in the beginning, this is an intertextual affair, one that concerns communication between the book(s) of *Nature*. The very fact of the naming of this journal *Nature*, of course, speaks to the close proximity if not identity of texts and Nature in the scientific practices described inside its covers. One practice of science is thus literally the communication between volumes of *Nature*.

The communication “between” texts is, of course, what is at stake here:

The hereditary properties of any given organism could be characterized by a long number written in a four-digital system. On the other hand, the enzymes (proteins), the composition of which must be completely determined by the deoxyribonucleic acid molecule, are long peptide chains formed by twenty different kinds of amino-acids, and can be considered as long “words” based on a 20-letter alphabet. Thus the question arises about the way in which four-digital numbers can be translated into such “words.”⁷

Between these two hands Gamow deals—the “digit” and the “word”—there must be a “translation.” Gamow’s articulation of what Francis Crick will in 1957 only refer to as “the coding problem” codes the “relation” between DNA and proteins as a linguistic project, specifically, a translation between mathematical and nonphonetic, alphabetic language. The order of the mathematical sign must be replaced by the order of the linguistic sign. This trajectory—from the mathematical to the linguistic—emerges from the historical inheritance of Nature as both a mathematical text and a linguistic one: Nature, Galileo writes “is written in a mathematical language, and the characters are triangles, circles, and other geometrical figures.”⁸ And Descartes wishes only “to read in the great book of Nature.” The local protocols that govern these (and many more) invocations of the Book of Nature should not be overlooked, but for my purposes here I will stress the dual (even dueling) languages of Nature, mathematics, and prose. It should not seem surprising that Gamow’s text finds itself between two orders of signification, two different books of Nature, two different codes. Overlooking the gap between the molecular and the cytological in his “translation” of chromosomes into molecules, Gamow redescribes the arc from the chemical to the vital as a secret, a mysterious problem that nonetheless has an answer.⁹

This translation can be seen as a conversion of the digital into the

analog, the discrete into the continuous, something Gamow's correspondent and collaborator John Von Neumann was thinking through at around the same time.¹⁰ For Von Neumann, working on the problem of self-reproducing automata, "the genes are digital, while the enzymes control function analogically."¹¹ By framing the problem of protein synthesis in the language of translation, Gamow made possible the deployment of a cryptographic paradigm.¹² It allowed would-be crackers of the code to look to the triumphs of Turing's Enigma project or the promises of the cybernetic paradigm as precedents and tools for the ultimate decoding of vitality.

These different "languages"—digits and words—require some site of connection, some crossover, if they are to be translated. In the linguistic realm, this can be seen to be analogous to the gap between words and deeds, where the translating point, such as it is, takes the form of the performative statement, a statement that is at once both word and deed.¹³ This arc from words to action can, in a certain light, appear miraculous or magical, as when the pronouncement of "abracadabra" fulfills its promise with a puff of smoke and the disappearance of a body. In another light, the bridging of the gap can appear as self-evident and seamless, as is the case in Gamow's movement from the molecular to the cytological. That is, when Gamow "considers" DNA as a chromosome fiber, it, in a way, becomes one for the purposes of this and, perhaps, other research. This move is not an index of Gamow's rhetorical power; rather, it is a map of the presuppositions available to Gamow and his readers. Such rhetorics are what Deleuze and Guattari call order-words, "the relation of every word or every statement to implicit presuppositions . . . to speech acts that are, and can only be, accomplished in the statement. Order-words do not concern commands only, but every act that is linked to statements by "social obligation." . . . The only possible definition of language is the set of all order-words, implicit presuppositions, or speech acts current in a language at a given moment."¹⁴

No incision can separate completely the "order" and the "word"; they are a part of what Deleuze and Guattari articulate as an economy of "double causality." Thus, it is the "implicit presuppositions" that make possible the arc from words to action. It is not simply a matter of context—it is in fact a question of what appears as context and what does not, the unstated and incalculable conditions that form the basis of textual coherence and authority.¹⁵ These conditions cannot, it seems, themselves be articulated fully.

A paradox of information theory will help make this point: according to information theory, the measure of a given message's information content is directly proportional to its "surprise value," its improbability. So, for example, the information value that "it will be cloudy in Seattle" is much lower than, say, "it will snow in Miami." Thus, the quantity of information contained in a message is related to the amount of difference it communicates—Gregory Bateson even defined information as "the difference that makes a difference." And yet, as theorist Mark C. Taylor has pointed out, the unprecedented has the highest information content, and yet is unreadable.¹⁶ A truly singular, unprecedented phenomenon would in some sense make no sense—we would lack the tools of signification necessary to read or interpret it. This marks out the way in which all communication is tied to unspoken precedent, an "unthought thought," a present absence for which there can be no algorithm, insofar as the algorithmic articulation of the necessary preconditions of communication would itself be unprecedented, unreadable. Rather prematurely, I will suggest that for Gamow this "unthought thought" or assumption can be found in the tacit notion that everything is readable, that the world itself is a kind of universal translation machine, an age of world scripture populated by *Nature*, DNA, proteins, and the matrix of textual relations between them.

Philosopher Martin Heidegger, in "The Age of the World Picture," describes scientific research as a mechanism for capturing the future in that it "sketches out in advance" the nature of Nature, forestalling the recognition of any other version of nature, "all that is," any other version of the future. It is true that science is a group of "procedures," but for Heidegger

Every procedure already requires an open sphere in which it moves. And it is precisely the opening up of such a sphere that is the fundamental event in research. This is accomplished through the projection within some realm of what is—in nature, for example—of a fixed ground plan of natural events. The projection sketches out in advance the manner in which the knowing procedure must bind itself and adhere to the sphere opened up.¹⁷

More than tautological, Heidegger's model of scientific research points to the structural openness of science, an openness that requires an extrascientific, ontological gambit to proceed. Heidegger describes the modern moment as a moment in which this gambit takes the form of "the world picture," which "does not mean a picture of the world but the world

conceived and grasped as picture.”¹⁸ In other words, the modern scientific description of the world presupposes in advance that humans encounter the world as a picture, an entity that reveals itself through representation, a representation set over and against human, scientific mastery.

This notion of the “open sphere” of research that scientific research requires be “sketched out in advance” highlights the force of Gamow’s model of the diamond code as just such an ontological gambit, one that finds the knowable world representing itself not as “picture” but as “words” and “numbers.” But Heidegger’s model would apply to all modern scientific research, and Gamow’s gambit clearly had its own contingencies. Why, for example, does this issue of “translation” arise at all? What is translation?

Benjamin and the Vital Connection

“Translation is so far removed from being the sterile equation of two dead languages that of all literary forms it is the one charged with the special mission of watching over the maturing process of the original language and the birth pangs of its own.”¹⁹ Walter Benjamin, in an essay foreign to the frenzied attempts to describe the mechanisms by which DNA is “translated,” nonetheless provides us with insights into and echoes of Gamow’s project. In “The Task of the Translator,” Benjamin critiques the traditional thinking of translation in terms of “fidelity” and “license,” faithfulness to the original, and “the freedom of faithful reproduction.”²⁰ For Benjamin, “Translation is a mode,” and the task of the translator is to “release in his own language that pure language which is under the spell of another.”²¹ Not all works are under the same spell, and thus “translatability is an essential quality of certain works.” Translatability is an attribute, a quality by which the translation gets its “kinship” with the original: “We may call this connection a natural one, or more specifically, a vital connection. Just as the manifestations of life are intimately connected with the phenomenon of life without being of importance to it, a translation issues from the original—not so much from its life as from its afterlife.”²²

Thus, for Benjamin, translatability and vitality both speak to a space between, between life and afterlife, between one language and another, a space that expresses “the central reciprocal relationship between languages,” languages that share a “central kinship” in which they “are not strangers to one another, but are, a priori and apart from all historical rela-

tionships, interrelated in what they want to express.”²³ This “vital connection” points to a site where vitality is joined with textuality, home of the “living word” that expresses the Esperanto of World.²⁴ Only rarely does the “obscure and impenetrable” task of translation lead to this “vital connection.” Indeed, Benjamin translates this difficulty into geometric terms: “Just as a tangent touches a circle lightly and at but one point, with this touch rather than with the point setting the law according to which it is to continue on in its straight path to infinity, a translation touches the original lightly and only at the infinitely small point of the sense, thereupon pursuing its own course.”²⁵ This tenuous and infinitely small connection between the translation and the original and, by extension, between vitality and textuality, strengthens and expands in the case of the Holy Writ, where “a text is identical with truth or dogma, where it is supposed to be ‘the true language’ in all its literalness and *without the mediation of meaning*, this text is unconditionally translatable. . . . The interlinear version of the Scriptures is the prototype or ideal of all translations.”²⁶

Thus, behind the “prototype” of translation is the figure of a universal, univocal language, a language where the vital connection between original and translation exceeds its linear constraints and in which “original, language, and revelation are one without any tension.”²⁷ As the space between translation and original disappears, we can see that what lay between, the “vital connection,” is the trace of a universal translatability, a unity of both life and languages.

In his discussion of the emergence of biology as a science of life, Michel Foucault traces the discursive break toward biology from natural history to this “invisible focal unity” of life, “from which the multiple seems to derive, as though by ceaseless dispersion. Life is no longer that which can be distinguished in a more or less certain fashion from the mechanical; it is that in which all the possible distinctions between living beings have their basis.”²⁸ Much like Benjamin’s “vital connection,” the “kinship” and differences of the natural world derive from an underlying unity. In Foucault’s analysis, this unity is cloaked by the body of living organisms, organisms that themselves manifest great differences even as they are silently and invisibly joined in “life.” The unity of Benjamin’s matrix, however, is found elsewhere, in a third space between two texts. For Benjamin, this “interlinear” space is implicitly revelatory, a space where words are guaranteed by a “living God.”

This Benjaminian detour brings into relief the unspoken background of Gamow’s invocation of “translation.” If, as Benjamin claims, the pro-

totype of all translations is Scripture, writing that is “unconditionally translatable,” then the theory and practice of translation will always refer to the possibility of a “vital connection” between the original and the translation, a connection that can only succeed through a central unity of language, a unity that is itself figured as vitality. So, antecedent to Gamow’s question—“Thus the question arises about the way in which four-digital numbers can be translated into such ‘words’”—is a tradition of translation based on an original, a translation, and the “vital connection” between the two, a link built on the revelation of the universality of life and language, “translatability.” To think, model, or describe DNA as “translated,” then, is to describe it as a node of universal language, a universal script that is itself figured as steeped in the unity of life. What makes Gamow’s invocation of the metaphor of translation plausible is a culture or “context” of the Book, a culture whose model of life, reason, and truth is based on the translatability of the world.²⁹

By this account I do not want to imply that there was only one possible effect of the metaphors of translation; to do so would presuppose a stability of meaning and effects that is clearly untenable, even within a scientific context. Rather, I want to mark out the presuppositions that seem to accompany Gamow’s invocation of translation. Biologist Carl Woese, writing about the appeal of the notion of the “genetic code,” gives us an indication of what those presuppositions might have been:

The great appeal of the genetic code derives not only from the importance of its roll [*sic*] in the cell, but also from man’s innate fascination with certain kinds of games and puzzles—chess, logic problems, crossword puzzles and the like. The matching of the nucleic acid ‘code words’ to the amino acids seemed initially to present this sort of challenge to the scientist. I think this explains why early workers in the field, Gamow, Crick, and others insisted that the solution to the cryptographic facet of the code had to possess a logic, a discernible order.³⁰

Several elements of Woese’s account help to highlight the unstated assumptions that traversed Gamow’s text. On the one hand, the pleasure and challenge of the code can be understood in light of Evelyn Fox Keller’s analysis of specific styles of objectivity in scientific practice. In her account, some modes of scientific thinking are remarkably like that of the paranoid’s, where

Everything must fit. The paranoid delusion suffers not from lack of logic but from unreality. Indeed, its distortion derives, at least in part, from the very effort

to make all the clues fit into a single interpretation. Once accomplished, the logic is such as to leave no room for an alternative interpretation; the pieces are locked into place by the closeness of their fit. So convincing is the result that “nothing but” that interpretation can be imagined. In some ways, the paranoid resembles the quintessentially meticulous scientist.³¹

Thus, in its figuration as a “cryptograph” or a “puzzle,” the notion of the genetic code made possible a kind of positivist mysticism; all could be understood within the simple algorithm of life: “the ingenious schemes of Gamow, were pre-empted by a feeling that the great code of life would manifest a spectacular Pythagorean numerology from which its basic nature could be apprehended with almost no knowledge of the phenomena involved.”³² The pleasure or “fascination” that this version of order articulates here can be aligned with Heidegger’s notion of scientific research discussed earlier, where the world itself appears as a representation, much as, here, the world itself appears as puzzle.³³ On the other hand, the precise formulation of Woese’s analysis must also be attended to. While the notion of the “innate” characteristics of organisms was the locus of inquiry for Gamow and others who sought to “solve” the genetic code, it is here offered as an *explanation* for the interest in the genetic code. This circular account can help underscore the role of the presuppositions at play in Gamow’s text. Rather than being the object of proof, the notion that life had a “discernible order, a logic,” was itself assumed. This assumption, in the light of Benjamin’s discussion, is a theological one; it assumes that the difference between a translation and a source text can disappear, that the project of translation is one of truth and univocity. In his explanation of the process of DNA translation and protein synthesis, Woese articulates this quite clearly. After noting that a “strong analogy” exists between gene expression and “language translation (or cryptography),” Woese explains the notion of reading at play here: “the *reading* in all cases consists of producing an output tape whose monomer units and mapping rules are characteristic of the tape reader, but whose information content, of course, reflects exactly that of the input tape.”³⁴

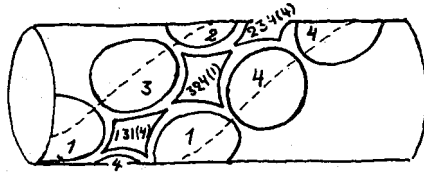
That which is presumed occupies the position of “of course.” Of course, dependent on a “strong analogy,” the very text that describes this “reading,” Woese’s, itself depends on an erasure of rhetoricity, even an erasure of reading itself. For “strong analogy” deploys the metaphor of strength, a rhetorical device that can only be understood in relation to content and context, even as it claims the possibility of a reading that is

context- and even content-independent. Following and extending Heidegger's notion of Modernity as "the age of the world picture," an age when the world is "conceived and grasped as picture," the translatability of Gamow's world depends on an age of world scripture, a world conceived and grasped as univocal, unambiguous, script.³⁵

Gamow's Tropics of Absence

We have seen that Gamow implicitly found DNA "unconditionally translatable," at least in his movement or translation of DNA into a chromosome fiber. By contrast, his explicit project of translation seeks a "vital connection" between the DNA "digits" and protein "words." These two orders of signification are themselves translated both textually and "visually." To translate the gap between the digital and the linguistic, a gap that Gamow himself identifies as the central problem of his text, Gamow borrows from or relies on a third order of signification, the icon or diagram, or, more precisely, two diagrams that in the language of circles and triangles help to tell the story of the translation of the genetic code into proteins. What Gamow feels cannot be represented in the textual realm gets drawn as a diagram. Thus, the diagram fills a certain "hole" in the text; what the text itself cannot bring to light is filled in by the diagrams, circles, and triangles that both occupy the space between the digital and the linguistic and point to their "vital connection."³⁶ Not unlike Watson and Crick, Gamow calls on a visual model to aid him in his telling of the story of DNA and proteins (Fig. 2).

But this hole or gap between the textual and the visual, while briefly filled by the diagram, returns, in that the diagram itself requires a textual narrative, a narrative built on the description of the "schema" as being full of "holes." Thus, the narrative gap that is bridged by the diagram opens up again; far from translating the gaps in Gamow's text, a text that itself seeks to effect translation, the diagram calls forth more translation, a translation itself full of gaps or holes. The upper part "shows schematically the structure of the deoxyribonucleic acid molecule. . . . We see that each 'hole' is defined by only three of the four nucleotides forming it. . . . It can easily be seen that there are twenty different types of such 'holes' as shown [the lower part]."³⁷ Clearly, in some sense we do not "see" a "hole" in the diagram; Gamow must translate the diagrams for us in terms of metaphors, metaphors that just so happen themselves to name a gap—in this case, the diagrammatic and the textual—that always leads to more transla-



$\begin{array}{c} 1 \\ \diamond \\ 1 \end{array}$	$\begin{array}{c} 2 \\ \diamond \\ 2 \end{array}$	$\begin{array}{c} 3 \\ \diamond \\ 3 \end{array}$	$\begin{array}{c} 4 \\ \diamond \\ 4 \end{array}$
1 a.	2 b.	3 c.	4 d.
$\begin{array}{c} 1 \\ \diamond \\ 3 \end{array}$	$\begin{array}{c} 2 \\ \diamond \\ 3 \end{array}$	$\begin{array}{c} 3 \\ \diamond \\ 3 \end{array}$	$\begin{array}{c} 4 \\ \diamond \\ 4 \end{array}$
3 e.	2 f.	3 g.	4 h.
$\begin{array}{c} 1 \\ \diamond \\ 2 \end{array}$	$\begin{array}{c} 1 \\ \diamond \\ 3 \end{array}$	$\begin{array}{c} 1 \\ \diamond \\ 4 \end{array}$	$\begin{array}{c} 2 \\ \diamond \\ 3 \end{array}$
1 i.	3 j.	4 k.	3 l.
$\begin{array}{c} 2 \\ \diamond \\ 4 \end{array}$	$\begin{array}{c} 3 \\ \diamond \\ 4 \end{array}$	$\begin{array}{c} 1 \\ \diamond \\ 3 \end{array}$	$\begin{array}{c} 1 \\ \diamond \\ 4 \end{array}$
4 m.	4 n.	3 o.	3 p.
$\begin{array}{c} 1 \\ \diamond \\ 3 \end{array}$	$\begin{array}{c} 2 \\ \diamond \\ 4 \end{array}$	$\begin{array}{c} 2 \\ \diamond \\ 3 \end{array}$	$\begin{array}{c} 3 \\ \diamond \\ 4 \end{array}$
3 q.	4 r.	3 s.	4 t.

Fig. 2. Gamow's Diamond Code. Reprinted from Gamow, "Possible Relation," p. 318, with permission from *Nature*. Copyright 1954 Macmillan Magazines Ltd.

tions, more metaphors. The chain of polypeptides and its relations are described in terms of a chain of metaphors continually in need of translation. This potentially endless chain of citations would seem to threaten the very univocality of the "code," at least in terms of its communication to readers.

But every code has a key, so these "holes" turn out to be keyholes. "It seems to me that such translation procedures can easily be established by considering the 'key-and-lock' relation between the various amino acids and the rhomb-shaped 'holes' formed by various nucleotides in the deoxyribonucleic acid chains."³⁸ The metaphor of the "hole," as well as a hole in the text, leads to a "lock." The attempt to close the gap on translation, which began as an arc from digits to words, has been finished and put under lock and key. This particular trope of confinement is

instructive. While the alleged discrepancy between the order of language and mathematics made Gamow's text possible, opening up the question and its translation in terms of icons and metaphors, the metaphor of the lock and key opposes what Benjamin called the "freedom" of translation to the finitude of the code. As both verb and noun, "code" is itself the key to the union of number and word, action and text. It would be tempting at this point to speculate that Gamow's text, through its choice of metaphors, allegorizes its fate as a text, a fate that could be characterized as the attempt to achieve closure, an accomplishment that is only possible through the very deployment of metaphor that calls closure into question. The point at which Gamow's text seems to have become "true" is in fact the point at which it is the "most" rhetorical. The solution to the problem of translation outlined by Gamow, which is itself a solution to the problem of how to get an organism from a text, flesh from a number or a word, can only be named by metaphor, a metaphor that requires translation no less than the gap between DNA and proteins. The solution, in fact, given the absence of experimental evidence ("with almost no knowledge of the phenomena involved," to quote Woese again) depends at least in part on the persuasive power of the metaphor of lock and key, a metaphor that suggests that everything fits together securely and that the problem of translation can be contained. Nothing outside the text will threaten its integrity. More specifically, we can see that the notion of translation invoked by Gamow relies upon a revelatory, vital connection between translation and original, a connection that is nonetheless impossible outside of the "literalness" of Holy Writ. Gamow's is an attempt to locate a model of communication without difference, as the DNA number gets translated seamlessly into the protein word. But as theorist Mark C. Taylor puts it,

All communication presupposes difference. Difference is something like a boundary or margin that opens the space in which messages can be exchanged. As such, the difference of the boundary is different from the differences whose articulation it creates. Though it is the condition of the possibility of articulation and communication, this difference is inarticulate and incommunicable. It can be coded neither analogically nor digitally. The membrane, margin, or boundary is something like a not that cannot be undone.³⁹

That is, any model of translation that, like Gamow's, presupposes the possibility of undistorted communication is doomed to distortion, a distortion that covers over or renders silent the very possibility of communi-

cation. Gamow's reliance on the tropics of absence—"holes"—announces the specific tradition of translation being invoked, a tradition in which "translatability" is based on the existence of a third space or gap occupied by a key, a universal language grounded in the unity of life. While Gamow (despite his discussions of the genetic code as "the number of the beast" or as "numerology") can hardly invoke God as the explicit guarantor of translation here, he does invoke a theological paradigm with "translation," and thus the "vital connection" between DNA and proteins is figured as "holes," metaphorical holes "between" where vitality and textuality can, invisibly, become one. Thus, God here works in Her absence, as an invisible presupposition, an uncoded, inarticulable platform that makes possible the translation of DNA "numbers" into protein "words."

But there are other uncoded, inarticulable "boundaries" that are "not" said or silenced but that nonetheless make possible Gamow's project: The reader and the body. Where is the reader of Gamow's text? It is no news that technoscientific discourse often treats language as a transparent medium for reporting on reality. But what often gets overlooked in debates over the epistemological and ontological status of language in scientific discourse is an effect that a realist approach fosters: the elision of the reader. Here the reader acts only as a container of information; knowledge is put into the empty space called "the reader," and thus the reader is in some sense a (necessary) present absence, a "hole." The imagined reader of scientific discourse is no reader at all; like the seamless operation of the DNA translation described earlier by Woese, there is "of course" a perfect "reflection" of information between the text and the reader. The reader is thus hailed but not named, producing the effect of a reading without reader, a transfer of information from the pages of a journal to the mind of a subject. It is this very notion of "reading" that is inoculated into molecular biological discourse through the rhetorical software of translation. For if Gamow overlooks the vagaries of reading his "own" text—the reader is a hole, a vessel, or blank space that information is dumped into—so too is the organismic body, as reader of the genetic code, occluded as a present absence in the process of protein synthesis described in "Possible Relation between Deoxyribonucleic Acid and Protein Structures." "It is inviting to associate these "holes" with twenty different amino-acids essential for living organisms."⁴⁰

While the metaphor of the "lock" encourages us to think the case is closed on the matter of the translation of code into proteins, of "digits" into "words," Gamow reopens it and invites in life and organisms. What

makes DNA “translatable” is literally and topologically the space between the “digits,” the “holes” between nucleotides. These “holes,” in Gamow’s account, “define” the “essence” of living organisms, amino acids. “We see that each ‘hole’ is defined by only three of the four nucleotides forming it.”⁴¹ With this move, Gamow attributes Schrödinger’s “law and executive power” to the DNA, as the “holes” or spaces between are, literally, the organism itself. That is, in its figuration as a “hole,” the space between, everything else that makes possible the translation of nucleic acid “numbers” into protein “words” follows a tropic of absence in molecular biology.⁴² Here, the “organism” is deleted or covered up by the rhetorical software that attributes the power of “definition” to nucleotides while describing the space between nucleotides, proteins, an organism, as a gap, an absence. Gamow’s story of “holes” is, in a way, an allegory about the “disappearance” of the body and the organism that I have described as postvitality, a space of nondifference. As in a gestalt, where the eye foregrounds one element of a visual field and backgrounds another, Gamow’s rhetoric of absence allows for a focus on the molecular, a backgrounding of the somatic.⁴³ Staring at a gestalt, of course, induces an oscillation between foreground and background, and Gamow’s metaphor too oscillates between occluding the body and recalling it, an oscillation that itself recalls the sublime object of biology, an object that produces the constant, uncanny astonishment that the secret of life houses no secret.

Thus, in this “hole” we find buried the “vital connection,” a site where, as in all translations, the arc between a text and its translation is guaranteed by the possibility of a living word, in this case “living organisms.” Gamow’s model of translation presupposes as its model a site where words can become flesh, and this manifests itself in a seamless, vital connection between words and essences.

And yet this is not the topic of Gamow’s text. As I have pointed out, “Possible Relation between Deoxyribonucleic Acid and Protein Structures” relates the story of the translation of “digits” into “words.” What on first glance would seem to be a surreptitious introduction of yet another problem of translation into this text—the complex transformation of proteins into organisms—is, for Gamow, not treated as a translation at all. The gap that necessitates a translation between numbers and words, DNA and proteins, simply does not exist “between” “words” (proteins) and living organisms, much as there existed no gap between a DNA molecule and a chromosome fiber. Between “proteins” and “life” is the relation of “essence.” This would seem to accord with the antivitalist impulse that by

some accounts has provided much of the conceptual drive of molecular biology, if by “essential” we interpret the relation as being one of “importance,” if not identity. “The ultimate aim of the modern movement in biology is in fact to explain *all* biology in terms of physics and chemistry. . . . I believe the motivation of many of the people who have entered molecular biology from physics and chemistry has been their desire to *disprove* vitalism” (emphasis in original).⁴⁴

Thus, by this account, Gamow’s insight was to abstract the problem of the relation of DNA and proteins from the chemical and developmental complexities of organisms, much as Schrödinger abstracted and retooled the notion of “pattern.” This insight was therefore partly a rhetorical one; Gamow framed the problem with a new (recycled) metaphor of translation.⁴⁵ Here, Gamow’s model could be seen to be of a piece with his work as a cartoonist, as Gamow literally “sketches out in advance” the schema in which the life sciences were to operate. Indeed, in his 1955 follow-up essay, Gamow copublished his paper with Tompkins, his fictional cartoon character who was injected into himself in *Mr. Tompkins Inside Himself: Adventures in the New Biology*. As I discussed in chapter 1, both cartoons and animation operate rhetorically through what they leave out, and, in this case, Gamow productively leaves out or hollows out the organism, depicting it as a hole. Why, then, is “living organism” introduced into this simple exercise in translation? If the relationship between proteins and organisms is simple and direct—that is, not in need of translation—what role does the invocation of the living organism play, rhetorically, in Gamow’s text?

Our answer, as we might expect, calls for another, but not opposed, translation of the “essential” relationship between proteins and the living organism. Turning to our “code book” for English, the *Oxford English Dictionary*, we find that

The “fifth essence” was a supposed substance distinct from the recognized four elements. What this fifth essence was, and where existing, was much disputed. Originally, it seems to have been the material of the starry heaven, as conceived by those who hesitated to identify it with “fire.” Among the alchemists, it was usually supposed to be latent in all bodies, and to be capable of being extracted from them by some recondite process; many thought that alcohol was one of its forms. Others regarded the discovery of the “fifth essence” as one of the unrealized aims of science, and attributed to the hypothetical substance all sorts of miracle-properties. Hence fifth essence or quintessence was used loosely in the various senses “highly refined extract or essence” and “universal remedy.”⁴⁶

At the same time as Gamow invokes the simple, seamless relationship between protein and living organisms, an entirely different and perhaps strangely complementary resonance is produced. This is not to say that Gamow's use of the metonymy of "essence" (substituting an effect of living organisms, proteins, as the cause of living organisms) is only or wholly consonant with the alchemical definition offered earlier.⁴⁷ But it is to argue that the polysemy of "essential" allows it to perform a very transformative, if not alchemical, rhetorical function. It allows the relationship between this "translation" and the tremendous, if not vital, complexity of the living organism to be transformed into one that invokes the "vital" nature of this enterprise while simultaneously effacing the qualitative distinction between living and nonliving entities. It introduces a "vital connection" that grounds the translation between DNA "digits" and life in the latent body of the living organism. It also allows for the "coding" of life while preserving the attraction of an ontological mystery in that it vitalizes the molecule as much as it molecularizes life. This double allegorical relation that emerges as an effect of the implosion of life and molecules can be seen in the rhetoric of contemporary research, a rhetoric that claims that genome projects are only of scientific and medical interest at the same time that they are sold as ontological research, an investigation into the essence of humans.

The "living organism" is the space or "hole" in which Gamow's entire discussion takes place, its condition of possibility. Even while the explicit aim of the article, indeed of molecular biology generally, is to determine and articulate the fundamental chemical and physical mechanisms that make up the "secret" or "book" of life, it is the very allure of the "essence" of life that helps drive the investigation. The sense of secrecy, numerology, and religiosity that is invested in the "essential" relationship between DNA (numbers), proteins (words), and living organisms (life) provides at least a rhetorical tension between the project of demystifying "vitality" and discovering its "essence," a tension that takes place in a space between vitality and mechanism, the postvital. The body of the organism is assumed to be the place of the translation of the DNA "digital numbers," and yet it is also the product of this translation. At once the body of the organism is assumed to be both cause and effect of the process of translation, although the organism's status as cause is silenced by the notion that DNA "determines" or "defines" the proteins. This ultimate privileging of DNA as the site of bodily determination, I would suggest, can be seen to be an artifact of a narrative that seeks a beginning, middle,

and an end, a narrative that begins with DNA and occludes its place in a body.⁴⁸ In the middle is a “hole,” the postvital body, divested of life but still living as the invisible housing or platform for the translation of DNA.

Thus, “translation” had the effect of an “order-word,” a bundle of rhetorical software that straightens out the rather circular story of the relations between proteins and DNA. The free play of my interpretation, however, in its emphasis on the slippages and associations of Gamow’s text, calls for some summation, some diagramming of the rhetorical effects of translation. First, the very possibility and plausibility of Gamow’s inscription of protein synthesis as a process of translation marks out the rhetorico-social matrix that framed the world as a kind of textual entity waiting to be read. That is, the notion that DNA was a self-sufficient text that “determined” or ordered its translation rested on a tradition of theology and metaphysics that Jacques Derrida has described as the metaphysics of presence. Many readers of Derrida’s account have focused primarily on the ways in which these metaphysics have invested speech with the status of truth while subordinating writing to the role of a parasitic or dangerous supplement, an untrustworthy technology for extending speech in the absence of a speaker. But in my example—the figuration of DNA as a text to be translated—Derrida’s critique can be used to highlight the ways in which the DNA text was seen to dwell in self-presence, without any need for a translating body. This body now itself takes on the status of a supplement, an absence or “hole” in the text that nonetheless can be shown to be a structural necessity for the “system” under description, a necessity that shows up as the return of the “translator” in the form of the “living organism” in Gamow’s text.⁴⁹ One could, of course, look to later accounts to find the phonocentric recuperation of DNA, where the transcription and translation apparatus of RNA gets figured, rather predictably, as a technology that transcribes and edits the bundle of immanent truth known as DNA. In either case, the Derridean strategies of supplementation and *écriture* function as remarkable probes in the economy of inscription that makes up the protein-DNA relation.⁵⁰

This logic of the supplement helps trace out as well the ways in which “writing” operates in the scientific field as a tool, what I have been calling rhetorical software. That is, while the ascription of a kind of sovereignty to the DNA “text” speaks to the power of writing within an (unspoken) cell, my analysis highlights the ways in which the rhetoric of “translation” functioned as a rhetorical vector in molecular biology and not just as a

supplemental description of research. As vector, the rhetoric of translation carried with it unspoken metaphysical narratives of “world scripture” and theological narratives about translation. As a vector of force, “translation” (usefully) flattened or straightened out the complexities of protein synthesis by ascribing to DNA the implicit power of an origin and making possible the idea that a straight line leads from DNA to proteins to “us.” Other rhetorical softwares would highlight a more complex interactive geometry, metaphors that are being deployed more and more today. The plausibility of the translation model, however, must be seen to be bound up with the styles of thinking and metaphysics found in the age of the world scripture, an age that is perhaps undergoing a displacement as the new technologies of writing and representation install a software of inscribed, hypertextual, or viral “truth.”⁵¹

This displacement leads to the answer to a question that has not yet been asked but that can be seen to be networked with thesis 2, “How does language matter?” or who wrote the book of life?⁵² It should be clear from my account that the rhetoric of translation, as part of larger metaphysical narratives, operated beyond Gamow. That is, we cannot give the simple answer, “George Gamow” or even “scientists,” although it is of course true that these rhetorics passed through the pens, mouths, typewriters, and telephones of these human actors. Such a claim would rely on a simple model of language and consciousness that ignores the gaps of narrative and metaphor that make possible the kinds of insights and “communications” that fueled the rise of molecular biology. The proper answer to the question “Who wrote the book of Life?” cannot be a “subject,” a “who”—we must instead point to the network of texts, technologies, and agents that inscribed the rhetoric of translation on that metaphysical, emergent entity called “life.”⁵³ This book is in part an answer to this question, but in answering it I seek to reconfigure it as “How did the Book of Life come to be written, and what effects does this have on scientific practice?”

“Translation” also provides a rhetorical tension within Gamow’s text itself, as the possibly banal project of translation is explained by recourse to the most encrypted, “untranslatable” concept, life.⁵⁴ By this I mean of course not that in any sense life is “really” immune to translation; rather, that its definition is fraught with the kinds of metaphysical and fictional narratives that have made life, as an entity, opaque and endlessly available to investigation. Foucault has argued that historically “Life does not constitute an obvious threshold beyond which entirely new forms of knowl-

edge are required. It is a category of classification, relative like all other categories, to the criteria one adopts. And also, like them, subject to certain imprecisions as soon as the question of deciding its frontiers arises."⁵⁵

The gap and border between DNA and proteins, numbers and words, codes and organisms is both the site of imprecision and the site of metaphorical intervention. The problem of "translating" life is one possible way of deciding on and effacing the border between textuality and vitality, a translation that appears within an *épistème* in which "Life becomes one object of knowledge among others," an object in and of language. It is a solution made possible by the simultaneous rhetorical displacement of the question of the organism and its return, a haunting trace of life that stalks the border between codes and bodies. This imprecision of life seems to provoke a rhetorical crisis; each trope we deploy—code-script, translation, program—seems to provoke different conceptual blind spots, oversights that then render any account of living systems inadequate, imprecise.

The quasisystematic nature of the rhetorical organization of this "frontier" between life and nonlife, however, does accord us a diagram of power. Foucault, writing of the shift from a culture of corporeal punishment to a culture of discipline, describes a prison camp as "the diagram of a power that acts by means of a general visibility."⁵⁶ Here Foucault traced out the displacement of the body as a site of punishment and its replacement by the "soul," the well-studied subjectivity of the criminal. Molecular biological discourse and its precursors offer us similar diagrams of power, a technoscientific power that works by producing an invisibility of the body, whose object is no longer the living organism. It is instead an object *beyond* living—ready to live,⁵⁷ beyond the finitude of an organism and its ongoing interactions with and constructions of an environment. Its object is not tied to the specificities of any organism and its processes of metabolism and reproduction but is instead a universal effect of a molecule. Of course, organisms still live—as in Gamow's invocation of the "living organism"—but this notion of the process of life is only one moment for the object of the new molecular life sciences, one part of an object folded across life, time, and space. A comparison of this model of living systems with the history of the notion of "organisms" will help bring this new morphology of vitality into relief.

Population geneticist Richard Lewontin, in *Biology as Ideology: The Doctrine of DNA*, connects the emergence of Darwin's evolutionary theory to the rhetorical description of organisms in terms of "inside" and

“outside.” Jean-Baptiste Lamarck, Lewontin argues, held to the inheritance of acquired characteristics as a result of a holistic model of nature, in which “what was outside and what was inside were part of the same whole system and one could influence the other. . . . In this view, nothing separates what is outside with what is inside because external alterations would enter into the organism and be perpetuated in future generations.”⁵⁸ Darwin’s achievement, given this rubric, was to separate these two spheres and model organisms as entities that confront, rather than just reside in, the “outside” of environment. What Lewontin dubs the “alienation” of the organism from its environment gives the concept of adaptation its purchase on evolution; the environment, in this scenerio, becomes the problem that organisms do or do not solve.

Although no individual organism can evolve under this scenario, adaptation does take place through and with organisms, organisms engaged in a struggle with their environment and located in a particular moment in time. By contrast, the model of the organism implicitly invoked by Gamow here is one that exists outside of time and space. Rather than being the primary characteristic of living entities, the ongoing interaction with (and, for Lewontin, construction of) an environment is but a way station for the timeless bit of immanence that resides in an organism’s genes. Rather than being the possibility condition or matrix for adaptation, organisms become “lumbering robots,” transport vehicles for genes that are the ultimate creators.

Thus, Gamow alienates DNA from organisms just as Darwin alienated organisms from their environment. This iteration of alienation, I have tried to show, only makes sense if the dependence of genes on organisms and environments is itself occluded. Gamow’s figuration of the organism as a hole does not “cause” this occlusion, but it does help make it possible, as a rhetorical disciplining of the organism analogous to the disciplining of the body outlined by Foucault. In my next chapter, I focus on a further rhetorical management of time and space, as Jacques Monod and François Jacob contain both within the genome. In chapter 5, I will focus on some case studies of the difficulty of mapping our rhetorics onto the dynamics of living systems, but for now I want to note that the rhetorical “black hole” of vitality troubles more than just the molecular biological account. Derrida notes that questions of vitality seem to puncture legal discourse,

in particular, in all the places where one may remark what is called today, more or less calmly, ‘juridical voids,’ as if it were a matter of filling in the blanks without

re-doing things from top to bottom. There is nothing surprising in the fact that it is most often a question of *the property and proper nature of life* [*la propriété de la vie*], of its inheritance, and of its generations (the scientific, juridical, economic, and political problems of the so-called human genome, gene therapy, organ transplants, surrogate mothers, frozen embryos, and so forth.)⁵⁹

For now, I can only suggest that this property of life—its tendency to provoke rhetorical, conceptual crisis—marks it as a site of a differend, what Jean-François Lyotard has characterized as “a case of conflict, between (at least) two parties, that cannot be equitably resolved for lack of a rule of judgment applicable to both arguments.”⁶⁰ In this case, the two parties are “textuality” and “vitality,” and we have no principle of judgment with which we can determine the proper rhetoric of life, the proper textual accounts of vitality that allow for the proper legal discussion of the nature of life. Indeed, perhaps the very notion of the proper must be discarded here in that the proper or complete account of life was precisely the claim of nascent molecular biology, one of the parties to our dispute. As we have seen from Benjamin, of course, life has also provided the guarantee or grounding for the very plausibility of translation, and it is this double dependence of textuality on vitality and vitality on textuality that comes together in Gamow’s textual model of DNA.

This chiasmus or folding between vitality and textuality is of course not a new one. But this crossover that takes place at the site of the postvital—a general economy of living and nonliving systems that displaces the opposition between vitalism and mechanism—does not merely mark out a displacement in the concept of life. It effects and maps out a new investment in language, a language of newfound density that ceases to be an instrument and becomes, in a way, an agent, an autonomous entity in the world beyond the speaking or writing subject called “man.” In François Jacob’s words, “The intention of a psyche has been replaced by the translation of a message.”⁶¹ The news of a “genetic language” spoken by no human but acting throughout the history of life, as well as the observations of a new (structuralist and/or Lacanian) thinking that claimed that language speaks “man,” and not vice versa, helped constitute language as a central problematic of what has come to be known as “postmodernity.” In chapter 5 I will look at the ways in which this agency gets installed in language as being, in part, an effect of the metaphor of the genetic code. For now, I will take a recursive look at the narrational matrix of the present, a present saturated with the promises of revelations.

No Revelations, Not Now

“And whosoever was not found in the book of life was cast into the lake of fire.”

—Revelation 20:15

While it should be clear that the rhetorical construction of the DNA-protein relation as a “translation” helped construct DNA as a site of power while obscuring the cell and its environments, I should also say something here about another diagram of power, one that follows the trope of the “book of life.” This trope—one constantly trotted out implicitly and explicitly by the genome initiatives—engenders another displacement in the scheme of translation. For while Gamow’s rhetoric implicitly posited a DNA that was, in a way, self-translating as well as self-replicating, the metaphor of the book of life transfers the reading practice out of the double helix and into the lab. Moving from the cell to the database, the contemporary translation of nucleic acids is now effected by the biologist and her new reagent, information. In the drama depicted by the metaphor of the book of life, scientists take on the role of an agency of afterlife, as the book of life is always read for the dead or, at least, as we could say today, organisms beyond living.

As the epigraph of this section suggests, along with Gamow’s description of the four-digital system of the DNA molecule as “the number of the beast,” the genome as “text” makes Revelation possible. It inscribes the genome with a hermeneutic of disclosure, one that allows the Truth to be unveiled as a secret text that has been waiting to be read all along. It also promises the possibility of an ending, a closure, an answer if not a “complete” solution. The metaphor of the book of life promises us that existence, after all, can be figured out if we only have the patience to read through until the last page. Unless of course we find that it reads, à la *Finnegans Wake*, “See page one.”

This joke points out some of the pliability of the book metaphor, a pliability that contrasts with the implicit univocality of language in Gamow’s text. The power of Gamow’s description resides in its ability to demonstrate how DNA can determine proteins. This demonstration depends on an extremely stable “translation,” one in which protein subjects receive the undistorted word of DNA dictation. The metaphor of translation, particularly a translation that proceeds with the help of a “key,” seems perfectly suited for such a task. Just as Gamow understood clearly

and correctly Watson and Crick's communication in *Nature*, so too do the proteins "understand" the word of DNA. But just as Gamow's model of translation implicitly requires an "outside"—a cell, an organism, an environment, a reader—to achieve translation, so too do contemporary interpretations and translations of genetic information depend on a technical and cultural matrix for their effects. Mark C. Taylor traces out the effect of highlighting this constitutive, and not merely supplemental, "outside" in his move from the book of nature to the (Derridean) text of nature:

If . . . language is interpreted as a nonsystematic play of differences that is riddled with gaps and lacunae, then the body, and by extension, nature must be read like a text. Unlike the book, the text retains a certain unreadability that infinitely defers total comprehension and absolute knowledge. Thus the suggestion that the body is structured like a language does not imply that we can truly know it. To the contrary, the linguisticity of the body might harbor an unknowability that can *never* be overcome.⁶²

Thus, the rhetorics of the "book of life," which are networked with Gamow's legacy of translation, encourage the notion of a genetic revelation available only to the mandarins of biotechnological research, but they also promise an ambiguity and contingency that subverts the notion of a masterful reader in command of the genetic text. Riddled with holes and lacunae of contingency, the reading of the "book of life" being undertaken today in the form of the human genome initiatives promises to be less like Revelation and more like *The Crying of Lot 49*, where signs proliferate in inverse proportion to any subject or reader's ability to organize them into a noncontradictory, coherent "grand narrative."⁶³ There is an ethics to be found there, in Pynchon's novel of semiosis and paranoia, an ethics of contingency: rather than focusing on the secret kernel, the vital connection that grounds and closes a narrative, Pynchon makes possible a movement beyond secrecy, a reading that recognizes the secret itself as an attempt to cover over the contingencies and accidents of life. The decipherment that is constantly thwarted and offered in *The Crying of Lot 49* never arrives, and it is this structurally deferred nature of reading—a reading that both makes possible and requires a future, another reading—that we could align with the notion of the future perfect, the grammatical tense of what will have been, a tense inflected toward the future but full of nothing but contingency. Critic Andrew McKenna writes that "the future perfect . . . is the temporal modality, or at least the grammatical

translation, of historical becoming in all its openness, in all its resistance to false totalization.”⁶⁴ The future perfect requires the future, it is contingent on the yet-to-come, contingent on contingency. If its rhetorics are of information, the grammar of nascent molecular biology was, is, that of the future perfect. For if Gamow’s model of DNA translation placed the organismic body in a rhetorical hole, it was a gap hollowed out by, constituted through, the future—a future of proteins, a future of knowledge, a future of other readings, readings inflected by the contingencies of histories, environments, effects, and bodies yet to come.

CHAPTER 4

It's a Nucleic Acid World: Monod, Jacob, and Life's Future



Each of science's conquests is a victory of the absurd.

—Jacques Monod

The specific rhetorical investments of molecular biology, as the preceding chapters have made clear, are hardly homogeneous. The multidimensional and sometimes stochastic attempts to constitute a new scientific model of “life” proceeded not through seamless chains of syllogisms but rather through the displacements and cracks of an emergent discourse. The accidents and inventions that have made up these rhetorics of vitality and postvitality, however, do share common sites, rhetorical spaces or *topoi* that have made possible the various inflections of research while allowing at least the appearance of a common paradigm. In this chapter, I want to analyze the work of François Jacob and Jacques Monod on “induction” and “genetic regulation” in terms of their investments in what I will call a “nucleic acid world,” a world where Schrödinger’s “law and executive power” is safely ensconced in the sacred, essential space of the gene, a space paradoxically outside of space and time. In doing so, I follow Evelyn Fox Keller’s work on the pacemaker concept in theories of aggregation in cellular slime mold. She suggests that “the story of pacemakers in slime mold aggregation provides an unusually simple instance of the predisposition to kinds of explanation that posit a single central governor.”¹ In looking at Jacob and Monod’s works of the early 1960s, I want to assess the role of preconceptions about the nature of “control” in their work on genetic regulation, preconceptions that manifest themselves in some rather fantastic rhetorical configurations, configurations which I will outline in detail. In particular, I will outline the ways in which Jacob and Monod’s rhetoric makes possible the collapse of the

complex spatial and temporal requirements of genetic expression into a single, immanent node called “the genome.” This retooling of the trip from egg—more specifically, gene—to chicken is accomplished, I will argue, only through some complex textual labor.

A Nucleic Acid World

“According to its most widely accepted modern connotation, the word ‘gene’ designates a DNA molecule whose specific self-replicating structure can, through mechanisms unknown, become translated into the specific structure of a polypeptide chain.”² In “Genetic Regulatory Mechanisms in the Synthesis of Proteins,” Jacob and Monod, not unlike Erwin Schrödinger, take as their point of departure an act of definition, a linguistic regulation that will prefigure and inform the model of genetic regulation produced in their texts. In my attempt to isolate the rhetorical conditions that made Jacob and Monod’s research plausible, I will attempt to situate this beginning in terms of what it can tell us about Jacob and Monod’s rhetorical configuration of the genetic mechanism, an articulation that we might call a nucleic acid world, a world where life came to reside in nucleic acids and not bodies. We have seen how Schrödinger’s fantastic rhetorical intervention empowered the “chromosome fibres” and “code-script” with law and executive power, an empowerment that depended on the assimilation or digestion of the organism by its description. In Jacob and Monod’s work, the rhetorical and scientific task had a different inflection. The reduction of organisms to their recipes proceeded apace in the seventeen years that separate *What Is Life?* from “Genetic Regulatory Mechanisms in the Synthesis of Proteins.” With Watson and Crick’s wish in 1953 to “suggest a structure for the salt of deoxyribonucleic acid (D.N.A.),” the secret of life could be localized on an X-ray photograph.³ Jacob and Monod’s research on *E. coli* attempted to grapple with the questions of regulation and expression, how the rate and type of protein synthesis is altered through induction. Here I will briefly describe the mechanics and the importance of induction and begin my description of how this scientific work was a part of a more general redescription of the boundary between the cytoplasm and the genome, what we might hazard to call the literal boundary between the inside of the organism and the outside, the inside and outside of science.

In the years that separate the description of chromosomes as a coded archive of inheritance and 1960, the year of Jacob and Monod’s seminal

publication, DNA garnered more and more power and agency. Enzymatic adaptation, however, presented a possible challenge to the sovereignty of DNA as the site of control. In enzymatic adaptation—what Monod redefined in 1953 as “enzyme induction”—enzymes are only produced by cells in response to an environmental—that is, external—agent. For example, *E. coli* cannot metabolize lactose without two enzymes—permease and B-galactosidase. These enzymes are themselves produced only in the presence of lactose in most strains of *E. coli*. Thus, in some way the presence of lactose seems to trigger the expression of a gene. This suggested that the synthesis of proteins—the translation of genetic “numbers” into “words” described by Gamow—was a complementary affair in which there are, in Jacob and Monod’s words, “complementary contributions of genes on the one hand, and some chemical factors on the other in determining the final structure of proteins.” Monod and Jacob’s insight, in “Genetic Regulatory Mechanisms in the Synthesis of Proteins,” was to explain how environmental effects could be described in a way that, ironically, preserved the central power of the double helix. Here, the rhetorical effect was not so much a Schrödingerian injection as a construction, as Jacob and Monod built a nucleic acid world for the new agency called DNA. The ground rules and tools for the constitution of this world, I will argue, were rhetorical and fantastic, even what we might now call “virtual.” According to Jacob, the conclusion that the repressor, an important part of the regulation mechanism, now known to be a protein, was RNA (ribonucleic acid) “was based on completely stupid reasons.”⁴ This description, whatever its plausibility or motivation, reinforced the notion that nucleic acids, if not the genome, “contained” the pattern of the future of an organism and that nucleic acids were therefore the central control site of the organism. This policy of containment, as in Schrödinger, was possible only through a series of rhetorical slippages, displacements that helped mask the spatial and temporal effects of the metonymic substitution of a molecule for bacteria, *E. coli* for elephants. In this chapter I will attempt to show how the displacement of life begun by Schrödinger gets retooled in a virtual reality world of nucleic acids.

Why “virtual”? How can we deploy the technological rhetoric of the 1990s to describe the rhetorical technologies of the early 1960s? As in my analysis of Schrödinger, I will focus here on the ways in which the rhetorical software of molecular biology sculpts scientific and rhetorical space anew. In their work at the boundary of environment and organism—and, indeed, in some ways they defined this border—Jacob and Monod enact a

topos, a rhetorical space or site that exceeds the boundaries of interiority and exteriority that organizes their work. I am interested in this space not because it somehow “distorted” the real entity called *E. coli*. Rather, I am interested in the way in which a “paradoxical space” was deployed by Jacob and Monod in order to articulate the complexities of such a living organism, an articulation that of necessity foregrounded some aspects of the living organism and rendered others invisible.⁵

The problem of genetic expression was itself part of a rhetorical and scientific cascade triggered by the notion that genes, as metonymies for life, were primarily textual, sequential mechanisms. In chapter 3, I tried to show how this notion depends on the inescapably extrascientific background of an age of world scripture, a notion that disarticulates or renders invisible those ontological aspects of the world that resist any simple scriptural frame. Within this scriptural frame, Jacob and Monod's task was to determine mechanisms that made it possible for DNA to “translate” itself, sealed off from the noise and signals of an environment. To do so, I will argue, they had to recast both the topology and temporality of *E. coli*—following Gamow, they effaced the secret that “reading” takes up space and time. In so doing, Jacob and Monod retool not just the implicit, virtual boundaries between the inside of the organism and the outside; they also reconfigure the relationship between present and future.

The experiments at the Pasteur Institute were, according to Jacob, “a system for concocting expectation; a machine for making the future . . . the game was that of continually inventing a possible world, or a piece of a possible world, and then of comparing it with the real world.”⁶ I will argue that this site of comparison between the actual and the possible is a virtual, unsaid, but constructed site, un beholden to commonsense space or time, a site of fantasy not unlike François Jacob's boyhood bedroom. Early in the morning, Jacob would invent the world in anticipation of the day:

The return to the confines of life . . . before resuming my identity, while my mind was free from any past, at just that instant, the game was beginning. I had to remain motionless, flat on my stomach, my arms clasping the pillow, eyes shut tight. It was forbidden to move a muscle. Before I could perceive the world around me, see it, hear it, I had to reinvent it and set it in place, as much by imagination as by memory. In immobility, in the stillness of the morning, I started mentally to do some heavy moving of furniture, walls, houses, streets, cities, continents. *To begin with, I reconstructed my room: it organized itself around my bed. . . . In short, in a few minutes I would re-create the universe.* (emphasis added)⁷

Many things are remarkable about this passage, and I will return to it as an allegorical grid with which we can understand the performative nature of Jacob and Monod's work. For now, I merely want to foreground the impossible temporality at work here. Jacob, both in his bedroom and, I will attempt to show shortly, in his lab, makes his bed before he makes the universe. In short, Jacob's early morning artistry or Genesis fantasy had a very particular and peculiar order. In an instance of what Derrida would call "impossible retroactivity,"⁸ Jacob constructs a room and all of its contents before there exists a world to "house" it. To do so, Jacob had to live in the future, a temporal and spatial site that anticipates the existence of a universe that is itself under creation.⁹ Logically, of course, this is impossible, and in some ways it is unthinkable, just as Schrödinger's metonymic substitution of "code-script" for "pattern" leads one to a cognitive systems crash—when it is noticed. What makes this impossible retroactivity plausible—that is, one reason why Jacob's creation reassures him rather than makes him anxious—is the fact that Jacob need not construct or unify his own body. The unthought, tacit ground on which this universe is built can be found on the unmoving and slim shoulders of the young François Jacob. The entry of a body—a twitch, the movement of a muscle—could, like a butterfly that's read chaos theory, change the universe.

What has been taken away during the night—perhaps by perverse and vicious elves—is the unity of the world, a unity that must be constructed out of the leftover that is Jacob's body. To "return to the confines of life" and, perhaps, to the life sciences, Jacob travels on a metonym, a reversal of cause and effect that the philosopher Gilles Deleuze describes as the route by which consciousness calms "its anguish": "How does consciousness calm its anguish? How can Adami imagine himself happy and perfect? . . . Since it only takes in effects, consciousness will satisfy its ignorance by reversing the order of things, by taking effects for causes. . . . In this way it will take itself for the first cause, and will invoke its power over the body."¹⁰

It is too early—I would be putting the cart before the horse, counting my chickens before they hatched, or hatching chickens and counting eggs—to make any claims about the relation between this autobiographical anecdote and Jacob and Monod's work. I bring it up only to juxtapose it with the place of the body, space, and temporality in the rhetorical software of their research on genetic regulation. All of these tropes together are networked to produce a unity, an organism, "organized"

around a beautiful performance of anticipation, a performance that dovetails well with Jacob's retrospective description of the heady days of the Pasteur Institute: "I lived in the future. . . . I had turned my anxiety into my profession."¹¹

A Definitive Performance

It is not merely fortuitous that Jacob and Monod begin with a definition of the gene. The work that they were pursuing in 1960 was by its very essence undefined, and this work in some ways redefined the gene as a structural entity, a structure that was in the last instance the site of control for the production of enzymes and proteins, at least in *E. coli*. That is, even while enzymatic adaptation seemed to threaten the validity of the structural gene hypothesis, in which "the DNA message is both necessary and sufficient to define the structure of a protein," Jacob and Monod's description of enzymatic induction in fact rescued the structural gene hypothesis by ascribing a supplementary function to regulator genes. The mechanism of protein synthesis and regulation, was, in their words, "unknown" and thus without borders, limits, or definition. Their model of genetic expression itself required expression, and, like the gene itself, their text cannot say everything at once. The repression of this possibility of noise leads them to establish the rules of their discourse, rules that will define or limit the interpretation of their work. For Jacob, writing in his autobiography, this "substitution of order for disorder" marks the transition from "dreams" to science:

To write an account of research is to immobilize these ideas; to freeze them, like describing a horse race with a snapshot. It is also to transform the very nature of the research; to formalize it. To substitute an orderly train of concepts and experiments for a jumble of disordered efforts; of attempts born of a desperate eagerness to see more clearly; and also of visions, dreams, unexpected connections. . . . In short, writing a paper is to substitute order for the disorder and agitation that animate life in the laboratory.¹²

Jacob's articulation of the transformation that research undergoes as it moves from the lab to the pen, typewriter, or mouth is particularly instructive for us because it anticipates the inscription of an "order" on research. In particular, its figuration highlights the ways in which the writing of research seems to inflect research with a sequential order—one horse after another ending a race, one concept after another in an orderly

train. As in Deleuze's observation quoted earlier, we see here the outlines of rhetoric that functions, at least in part, as a way of establishing the priority of "consciousness" over what we have called the virtual or the unthought in science, what Jacob refers to as "visions, dreams, unexpected connections." The "agitation," however, is not erased but displaced; in the "desperate eagerness to see more clearly," Jacob and Monod's ascription of order through the trope of definition obscures as much as it clarifies. "According to its most widely accepted modern connotation, the word 'gene' designates a DNA molecule whose specific self-replicating structure can, through mechanisms unknown, become translated into the specific structure of a polypeptide chain."¹³

In a sense, the "designation" of "the word 'gene'" is a performative definition—it enacts or, in the metaphorical sense, carries out the task of which it speaks, much as the pronouncement of "husband" and "wife" in a marriage ceremony carries out that impossible task. That is, the "I do" of a marriage ceremony is a "doing," it is not just a speaking, and it is a doing that will never cease until death or divorce. It is a promise that is in some sense always deferred to a future date.¹⁴ This performative definition does not come *ex nihilo*, of course. Definitions, for Jacob and Monod, are found in consensus, a result of the social negotiation and "acceptance" of language and meaning. One consequence of the social nature of language—indeed, its very definition—is that the meanings and deployments of language are contested and contestable. A classic trope for containing the play of definitions within a given text is, of course, definition itself.¹⁵ And yet it is precisely the status of definition as a trope—an entity with which an argument moves, pivots, or gets organized—that reminds us of the fundamental impossibility of containing the displacements and semi-osis of a text. The "social" nature of language both requires the intervention of the trope of definition and makes it impossible.

I should perhaps define my terms more clearly here. The task of definition is, in the sense just used, impossible in that it never reaches the end, finitude—it cannot determine the end or border of the meanings of a word, even a scientific word like *gene*. The rhetorical nature of texts, while subject to repression, can never be extinguished. The endless chain of definition can and will continue on without end; in Gödelian fashion there will always be an extra definition lurking around the corner, even if it is only the definition of *definition* itself.

And yet, of course, one cannot merely say or write anything in the name of definition. Key to this notion is the "ordered" nature of defini-

tion's resolution; despite its impossibility, definition must occur within any particular regime of truth and discourse, just as the young François Jacob must, impossibly, invent his fragment of a room before he or the world can exist as a whole. Before there can be a "widely accepted modern connotation" of *gene*, one must be offered. And yet one can only be offered in one (citable) instance before its status as "designation" is possible or secure. The success or failure of a definition, therefore, would seem to hinge on its ability to contain or limit the many meanings and actions attached to a speech act, success which therefore can only occur retroactively. This power to limit or displace other meanings, to have one meaning stand for all others in the same way that a snapshot, in Jacob's account, substitutes for an entire race, depends on other, unsaid virtual conditions. In the instance of the horse race, the snapshot is able to sum up the race insofar as the observer places the highest priority on the outcome of the race and not on the event itself. Getting ahead of myself, I will suggest that Jacob and Monod's definition of "*gene*" and "*genome*" depends on two rhetorical substrates: a metonymy that allows the gene to "live in the future," to take the gene as cause and not (also) effect in the DNA-protein relation, and a synecdoche that allows the genome to be the part that stands for the whole, a site in the DNA-protein relation that stands for a whole spatial and temporal process of the cell much as a snapshot stands for a whole horse race. These two substrates, I hope, will illustrate the ways in which the "transformation" of research that Jacob calls "writing" orders and comports research as much as it describes it.

We have already seen one of the aspects of Jacob and Monod's textual compartment. The rhetorical disintegration of "Genetic Regulatory Mechanisms in the Synthesis of Proteins" is avoided by the introduction of a definition, a "designation." The impossible task of textual regulation in Jacob and Monod's text relies on the rhetorical and scientific production of genetic regulation within it; "genetic control" in some sense extends not just to the synthesis of proteins but to the "synthesis" of this text. In this case, definition is induced by Jacob and Monod—both of whom, it could be said, were "sick with the written word"—through a metaphorical link with the notion of "genes" as "code" or "language."¹⁶ As an object to be "translated," the gene is defined here as being itself a kind of text, a set of instructions, a recipe or a blueprint. What ensures this definition of the "gene," however, is a double translation of the practice of definition, a translation "which through mechanisms unknown" bridges the gap between text and protein. What I will describe as the Möbius strip

movement of definition makes the comportment of both the text and the organism possible by a double system of metonymic and synecdochal "repression." In order to track this, I will probe more deeply into Jacob and Monod's deployment of the arguments and tropes of definition and trace the "virtual space" in which their work unfolds.

Definition's Ends

What, then, is the "most widely accepted modern connotation" of *definition*? "To state precisely, to specify" or "to determine the boundary or spatial extent of" or "To make a thing what it is; to give a character to, characterize; to constitute the definition of." These definitions of *definition* can themselves be organized around two different although perhaps not exclusive registers of meaning, registers we might call the tropological and the topological. The appeal to "connotation" is an appeal to the first definition just given; it seeks to make a general statement about what we, more specifically, molecular biologists of 1960, mean(t) by *gene*. This we might describe as a "tropological" use of "definition" in that the opening of "Genetic Regulatory Mechanisms in the Synthesis of Proteins" appeals to the designation of a common ground, an orderly beginning of the substitution of order for disorder that Jacob called writing. Our next rhetoric of definition, however, also relies on its topological valence: "let us assume that the DNA message contained within a gene is both necessary and sufficient to define the structure of a protein. The elective effects of agents other than the structural gene itself in promoting or suppressing the synthesis of a protein must then be described as operations which control the rate of transfer of structural information from gene to protein."¹⁷ Another side of definition, then, is spatial. The movement from "message" to "structure" is the slippage from "information" or "connotation" to "architecture" or "shape." This gap, the gap between "genes" and "organisms," is elided by the double gesture of definition, which itself signifies, sometimes, something on both sides of the tropological/topological border. The double resonance of "define" allows "DNA message" to both instruct (send a message, specify) and construct (define structure) at the same time, to announce genetic commands and to execute them. The oscillation on and between these double deployments is a movement into and out of the nucleic acid world, a world simultaneously interior and exterior that, like a Möbius strip, contains within itself both spaces. That is, this double signal produced by the trope of

definition allows Jacob and Monod to both seal off the gene from “external agents” and incorporate these agents as “contained” within the genetic program.¹⁸ “The discovery of regulator and operator genes, and of repressive regulation of the activity of structural genes, reveals that the genome *contains not only a series of blue-prints, but a co-ordinated program of protein synthesis and the means of controlling its execution.* (emphasis added)¹⁹ Thus, in a move isomorphic to Schrödinger’s containment of phenotype within chromosome fibers, Jacob and Monod contain regulation in the genome itself insofar as the genome contains not only the instructions or blueprints but the “means” to carry them out—Schrödinger’s “executive power.”

It is not just that Jacob and Monod deploy a trope in two different ways, with different inflections. This is, after all, what rhetorics do. Rather, I am claiming that the double effects of the trope of definition help elide the gap between two scientific rhetorics, a rhetoric of “instruction” and a rhetoric of “construction,” which permeate “Genetic Regulatory Mechanisms in the Synthesis of Proteins.” This rhetoric can also be found in Jacob’s description of the unfolding of his work on genetic regulation, which he described as working “like an architect’s vision that materializes in the construction of a palace.”²⁰ In both his description of science and his description of protein synthesis, then, the gap between “instruction” and “construction” is occulted, and the work of building bodies or palaces “left out,” contained within the pure immanence of genomes and blueprints. This structure of anticipation works through metonymy by taking the gene as a cause and not (also) an effect, repressing the role of the organism, and through synecdoche by taking the genomic instructions as the “whole,” and not just a part, of the *process* of induction.²¹

By putting structural genes in the position of “defining” the structure of a protein, Jacob and Monod effectively elide, or at least marginalize, the power of nonnucleic acid factors like proteins, environment, and the complexities of development and thus ensure DNA its status as “Master Molecule.” The description of the structural gene as being necessary and sufficient while also dependent on promoters and repressors contains an implicit claim that the repression and promotion of protein synthesis represent only a change in degree and not in kind, a quantitative and not a qualitative difference: “Wild type *E. coli* cells grown in the absence of galactoside contain about 1 to 10 units of galactosidase per mg dry weight, that is, an average of .5 to 5 active molecules per cell or 0.15 to 1.5 molecules per nucleus. Bacteria grown in the presence of a suitable in-

ducer contain an average of 10,000 units per mg dry weight. This is the induction effect."²²

And yet the limit case of this argument is lethal. The "elective effects" of regulation, seemingly supplementary in Jacob and Monod's account, literally make the difference between life and death. "According to the strictly structural concept, the genome is considered as a mosaic of independent molecular blue-prints for the building of individual cellular constituents. In the execution of these plans, however, coordination is evidently of absolute survival value."²³ That is, the expression of the structural and regulatory genes, defines or executes the limits of the protein structure, and by extension the body, "absolutely."²⁴ These processes transcend the border or definition of the gene—they are, even here in Jacob and Monod's account, complex interactive affairs of instruction and construction. The simple and brutal possibility condition for expression is an organism, an organism that must in some sense exist—live—"before" the construction of itself through a strand of DNA and its messenger. By "containing" the means of protein synthesis within the genome, Jacob and Monod also contain the time necessary for that execution. The claim that the genome, if not the structural genes alone, is necessary and sufficient for the "definition" of the structure of proteins depends upon the erasure of the nucleic acids' dependence on the cytoplasm and the organism, an erasure that is made possible by the slippage between "instruction" and "construction" in Jacob and Monod's rhetoric of definition. This slippage effaces the process of protein synthesis, a process that requires time and an organism, not just a genetic fiat.

By implicitly ascribing such temporal, spatial, and hierarchical priority to DNA, indeed, to nucleic acids in general, Jacob and Monod depend on a position of impossible retroactivity. For them, DNA defines or constructs the organism before there is an organism to "house" the genome, just as the young Jacob made his bed before he made the universe on the basis of an unspoken, unmoving body. There exists a tacit, unspoken site that makes possible the very expression of a gene and the construction of a protein—namely, the living "body" of *E. coli*. This unspoken space of protein synthesis is also, temporally, development.

Living in the Future

The fundamental problem of chemical physiology and of embryology is to understand why tissue cells do not all express, all the time, all the potentialities

inherent in their genome. The survival of the organism requires that many, and in some tissues most, of these potentialities be unexpressed, that is to say repressed. Malignancy is adequately described as a breakdown of one or several growth controlling systems, and the genetic origin of this breakdown can hardly be doubted.²⁵

The return to the embryo is a return to the future. The impossible anteriority of a gene abstracted from a developed organism, an abstraction perhaps aided and abetted by *E. coli*'s high-velocity (speed-of-light) reproduction, returns in the form of the problem of embryology, the discipline that deals with the development of organisms over time, the very time deleted here by the synecdoche of the genetic program. The genetic origin of this "breakdown" is the definition of *gene*. Only a thesis that posits the gene's primal anteriority and ultimate authority, a genome bursting with immanence—"law code and executive power"—would face the question of how this powerful site avoids overdose, "all the time." By privileging the spatial and temporal priority of DNA, Jacob and Monod provoke a new problem—namely, how is the central site of control itself controlled? The answer can only be found in the future, a future of a developing embryo not contained in the genome itself.²⁶

The future problem of embryology is then the problem of the future itself, more specifically, the problem of how the genome borrows an organism from the future in order to regulate itself. Remember that the Pasteur Institute was "a system for concocting expectation; a machine for making the future. . . . The game was that of continually inventing a possible world, or a piece of a possible world, and then of comparing it with the real world."²⁷ Who, or what, is the agency of comparison here? In the case of the Pasteur Institute, it would seem clear that the agent is Jacob himself, much as it is Jacob who made possible the synthesis of the world each morning. And yet this "self" itself requires a kind of time travel for its integrity:

As different as these selves making up my life may seem now, for more than sixty years they have, every morning upon awakening, recognized each other. . . . Each time they have had the feeling of resuming the same role, after the nightly intercession, at the exact point it left off the night before. This consciousness of unity is not only that of my body, its habits, its inclinations. Even more, it is made of those memories that travel through time in flashes.²⁸

Here Jacob writes of a structure of anticipation that is a projection forward in time and not merely a remembrance of things past. It ascribes a unity to

the self through a narratival anticipation.²⁹ So too, Jacob and Monod anticipate the existence of an organism that will act as the agency of expression for structural genes in the collapse of “instruction” and “construction” that takes place, among other places, through the rhetorics of definition. Ironically, for Monod, an archenemy of the language of teleology in biology, this definition inserts an implicit telos in the genome in that it “contains” its own purposive development, development that implicitly depends on the ability of DNA to “live in the future.”

Critic Slavoj Žižek explains how this journey into the future works at the level of signification.

What is a “journey” into the future if not this “overtaking” by means of which we suppose in advance the presence in the other of a certain knowledge. . . . This knowledge is an illusion, it does not exist in the other, the other does not really possess it, it is constituted afterwards through our—the subject’s—signifier’s working; but it is at the same time a necessary illusion because we can paradoxically elaborate this knowledge only by means of the illusion.³⁰

This trope that runs science fiction, time travel, is thus an enabling fiction for Jacob and Monod’s science. It is a fictional, rhetorical software not covered up but overlooked, “contained” by Jacob and Monod’s double deployment of definition. Jacob and Monod assume in advance the presence of a “certain knowledge” in the genes that cannot be expressed except through a body that the genes themselves allegedly execute and construct. To stick to the metaphors of messages, codes, and programs, it is as if a computer program could construct a computer to run itself, but the only way in which the program could acquire the computer to run itself “originally” would be to travel into the future of itself. And this future, by necessity, can only be accessed through a fiction. Today, this problematic lives on in the rhetoric of “smart genes,” researcher Eric Davidson’s nomenclature for genes that can “understand” cytoplasm signals: “Most of the genes in complex creatures, it seems, must assemble on-board protein computers before they can be transcribed.”³¹ The paradox here, of course, resides in the fact that the genes somehow “assemble” these “protein computers” before they are themselves transcribed, indeed, before they are in some sense genes at all.³²

The recent film *Terminator* and its sequel *Terminator 2: Judgment Day* provide us with an analogous problematic of a technology borrowed from the future. The “terminator,” a “cybernetic organism” sent from the future, arrives in the present with the task of protecting a future leader from

another terminator, a mimetic-alloy villain capable of replicating any shape and sprouting knives from its “body.” As a part of his mission, the redemptive terminator also partakes in a kind of technological patricide, destroying a computer chip and robotic arm that were themselves traces of another terminator sent from the future, technologies referred to in the film only as “it.” It was only through these technologies, in a technological “seeding from the future,” that a revolutionary computer advance took place, which itself gave rise to a computer-generated nuclear holocaust and the subsequent war between humans and machines. That is, it is only through an impossible borrowing or “seeding” from the future that this redemptive cybernetic organism encounters its “precursor,” narratively “impossible” because “it” is both cause and effect of the revolutionary technological advance that makes or “births” the terminators.

My aim here is not to point out narrational holes shared by a science fiction film and a scientific account of protein synthesis. Rather, I am concerned with the effect of these holes on the narrative each articulates. What is produced through this impossible reliance on the future is not impossibility but tension, a suspension or oscillation between temporalities that allow the complexity of a dynamic system to be described. There is no a priori reason why our language should be up to the task of describing such dynamic systems as a world under construction, “futuring” (*Terminator 2*), or an organism under development, and it is only through recourse to such “paradoxical” spaces and temporalities that such dynamic systems can be described at all. The only problem with such suspension, as a scientific or science fictional rhetorical technique, is when closure, an end to the suspension, is achieved. This is precisely the effect of Jacob and Monod’s “containment” of protein synthesis in the genome.

In the encounter of an entity—organism, gene, or agent—with the trace of its own future, death, or at least an explosion, almost always results. The rhetorical expression of the trace of the future varies from film to film, book to book, science to science fiction, but the result is almost always the same—murder, explosion, the annihilation of the dangerously doubled future. In our example of protein synthesis, the proteins, more specifically, the body of the organism, is the trace of DNA’s future, a trace it both requires to “express” itself and a trace it must contain within the genome if DNA is to maintain its sovereignty over the present and effect closure.³³ What happens when DNA encounters itself as a trace of the future, when it becomes clear that DNA must borrow a body impossibly out of the future in order to transmit its commands? At the level of

induction, Jacob and Monod use the example of a transmitter and some bombs: "We saw this circuit as made up of two genes: transmitter and receiver of a cytoplasmic signal, the repressor. In the absence of the inducer, this circuit blocked the synthesis of galactosidase . . . much as a transmitter on the ground sends signals to a bomber: 'Do not drop the bombs. Do not drop the bombs.'"³⁴

Normally, then, proteins are repressed through genetic commands, but at the very moment of protein synthesis the "bombs" are released. Protein synthesis is thus articulated with explosion, and as a result the organism self-detonates, erasing its place in the economy of somatic production, effacing the body as the trace of DNA's future. In their model of protein synthesis, Jacob and Monod allegorize their disintegration of the body of the organism, preserving DNA as a site of central command by figuring proteins as weapons, not-so-smart bombs.

Structure, Sign, and Play in the Discourse of the (Human) Genome

How is it that such a model of protein synthesis, in which DNA is seen to be both center and periphery at the same time, instructor and constructor, present and future, is made plausible? Philosopher Jacques Derrida, in his discussion of the history and effects of the notion of structure in Western philosophical discourse, notes that "structure" has always been embedded in a rhetoric of centrality:

The function of this center was not only to orient, balance, and organize this structure—one cannot in fact conceive of an unorganized structure—but above all to make sure that the organizing principle of the structure would limit what we might call the free play of the structure. No doubt that by orienting and organizing the coherence of the system, the center of a structure permits the free play of its elements inside the total form. And even today the notion of a structure lacking a center represents the unthinkable itself.³⁵

That is, at least in philosophical discourse, "structure" has always referred to something like a "central organizer," a site of control and "balance" that allows for the tenuous dialectic between "free play" and unity. Add this to the fact that "blueprint," one of Jacob and Monod's other dominant metaphors, itself has a history based on immutability, and we can begin to see that "structural genes" that are "blueprints" resonate with the paradox of an eternal form that is nonetheless built:

Plato conceived of the being of entities in terms drawn from human manufacturing . . . His concept of the ideal “form”—that which is eternally present and unchanging and ultimately real—was drawn from the role played by the blueprint or model in the work of a craftsman. Just as the craftsman’s blueprint provides the structure for the thing he makes, so too the eternal form provides the structure for things which come to be in the temporal–empirical world.³⁶

As we have seen, the immanence of the genome, by Jacob and Monod’s account in “Genetic Regulatory Mechanisms in the Synthesis of Proteins,” is impossibly supported by containing the construction of the organism within the genome, the nucleic center of control, and the subsequent marginalization of enzymes and development. It is almost as if the tropes of “structure” and “blueprints” encourage, if not demand, a center of the organism that “provides the structure for things which come to be” in the temporal–empirical world of the organism. And yet, as we have seen, this is impossible. The temporal and spatial demands of the organism are met by an ongoing interaction and “translation” between nucleic acids and proteins, just as a blueprint requires a craftsperson, techniques, and materials to be translated into an artifact—notwithstanding Jacob’s dream of “an architect’s vision that materializes in the construction of a palace” miraculously. This elision of “structure’s” dependence on an external economy, the way in which the genome can be both the instructions for the organism and “contain” the means of executing those instructions, is allegorized by the philosophical history of structure. According to Derrida,

Center . . . is the point at which the substitution of contents, elements, or terms is no longer possible. . . . Thus it has always been thought that the center, which is by definition unique, constituted that very thing within a structure which governs the structure, while escaping structurality. This is why classical thought concerning the structure could say that the center is, paradoxically, within the structure and outside it. The center is at the center of the totality, and yet, since the center does not belong to the totality (is not a part of the totality), the totality has its center elsewhere. The center is not the center.³⁷

Thus, we have a key to the plausibility of a genome that is both prior to and at the center of the organism. The structural genes constitute the center of the organism, the one immutable site at which “substitution of contents” is no longer possible, an anterior, eternal form waiting to be expressed. The regulatory genes, on the other hand, are the genome’s bridge, a technology to the “outside” of the nuclear membrane, the cytoplasm, the

proteins. These regulatory technologies of protein synthesis, the “on-board protein computers,” are ultimately obliterated as *techne* through its containment in the natural, immanent, even sacred space of the genome. Thus, DNA’s status as an immanent, organic, eternal form is secured, the “elective effects” of enzymes adding a mere supplemental polish to the eternal form of the organism “contained” within the genome.

The twisted temporality of a strand of DNA building itself an “on-board protein computer” before it is itself expressed can also be understood at least in part as a discursive, narrational effect. For, clearly, despite my rhetoric of “impossibility,” the temporality at work in the containment of the organism within the genome was very plausible. While subsequent research has altered somewhat the inflection of descriptions of genetic control, leaning more toward a “network” paradigm of smart genes responding to cytoplasmic signals, Jacob and Monod’s initial model of genetic expression has “turned out to be resoundingly correct.”³⁸ As in the Žižek quotation given earlier, I would argue that the seemingly perverse temporality of time travel required by Jacob and Monod in “Genetic Regulatory Mechanisms in the Synthesis of Proteins” cannot be separated from the organism’s status as a signified. That is, the written, narrational character of this research installs a temporality that is better understood as the temporality of signification than the temporality of “common sense,” or even the temporality of living. As in my earlier discussion of the retroactive working of “definition,” signification in general seems to work contrary to our expectations. For Lacan, for example,

The signifier is the source of the signified. The latter is never anything but an “effect” of these couplings and encroachments of signifiers, a “signified effect” in the sense in which we speak, for example, of a “Larsen effect” or an “optical illusion” (*effet d’optique*). This signified is truly nothing—nothing that would in effect be caused or produced by the signifier. In accord with the theory of value, meaning is never anything but an illusion, produced “between” signifiers, which themselves have no meaning—a sort of rainbow that eludes our grasp as soon as we try to approach it.³⁹

The “induction effect,” then, names more than an instance of genetic expression—it names the way in which DNA as “signifier” could be seen to be the source of the organism as “signified,” an organism that is itself an illusion, at least as a totality. This does not mean, of course, that the “organism” is not real; rather, it is a bundle of real but incomplete metonyms that come to define it as a whole. The continual crossovers that

seem to characterize the rhetoric of the organism—from “organism” to “code-script,” “instruction” to “construction,” “present” to “future,” “effect” to “cause”—must be seen as symptomatic of the multiplicity and opacity of what has been called “living” by modern biological discourse. This discourse, while not homogeneous, has articulated the opaque site of “life” as a site of endless, substitutable differences between organisms or even organs, differences that then function as metonymies for an organism, or indeed life as whole. These differences “proliferate on the surface, but deeper down they fade, merge, and mingle, as they approach the great, mysterious, invisible focal unity, from which the multiple seems to derive, as though by ceaseless dispersion.”⁴⁰

These organismic differences, such as antennae, for example, can be seen to synecdochally represent the “whole mode of life” of an insect, just as genetic induction comes to stand, retroactively, for the whole development, construction, and regulation of an organism. Ironically, it is the description of the organism as a unity through selected metonyms that makes this possible. The organism’s many temporal and spatial effects, in contact with language, produce the diffraction pattern we call “organism.” Philosopher and historian of science Michel Serres points to this when he writes “The living organism, ontogenesis and phylogenesis combined, is of all times. This does not at all mean that it is eternal, but rather that it is an original complex, woven out of different times that our intellect subjects to analysis or that our habits distinguish or that our spatial environment tolerates.”⁴¹ What I would suggest here is that scientific writing, in its habit for narrative and linear temporality and in its consequent selection of parts for whole, organizes and unifies the organism and thus highlights or demarcates the living according to the temporality of signification, which itself must be hidden for the narrative to function.⁴² I have highlighted this temporality, exposed it through its need for time travel and the collapse of instruction into construction. I will call this effect—the gap between narrative where the illusion of the virtual organism appears as a kind of rainbow diffracted by the living—the “organism effect.” The notion of the organism effect underscores the secret of “life’s” complicity with the secrets of signification, secrets that do not yield themselves to the same sorts of analysis as a gene. Just as we cannot abstract a theory of genetic expression from the tacit existence of an organism, neither can we abstract the organism from a regime of signification that organizes it, its rhetorical software.⁴³

Earlier, I argued that there is no a priori reason to believe that our

rhetorics are adequate to the complexity of either a fictional technology such as time travel or the very real complex of processes that constitute an organism. By this, I do not intend to mark out a skeptical denial of any of the claims of molecular biology, nor am I taking up a vitalist position that claims that “life” is somehow beyond our scientific ken. But I do intend to point to the limits of recent and contemporary scientific rhetorics. Rather than interpreting these limits as simple “distortions,” I prefer to treat them as mapping practices. The transformation of the irregularly spherical globe into a flat map represents a familiar disjunction between one rhetorical modality—three-dimensional objects—and another—flat maps. Here I am pointing to a similar disjunction, the slippage between the temporal and spatial dynamics of an organism and the rhetorical practices with which we articulate such organisms. Incoherencies arise when this disjunction is left unmarked. Of course, fantastic or not, both maps and rhetorics of living systems “work,” but both work because of, and not despite, the constitutively enabling fictions. In the case of a world map (leaving aside matters of perspective), continental Europe can be more or less adequately rendered only through a massive inflation of Greenland or the shrinking of Africa. Mapping always involves such erasures or inflations. My task in this book is to point out some of the erasures constituted by twentieth-century life sciences. In this story, DNA has much in common with Greenland.

I will return to these apparent disjunctions between rhetorical practices and the complexity of organisms in my next chapter, but for now I want to emphasize one of the implications this slippage has for the objectivity of scientific description. On this view, one I might dub a rhetorical empiricism, scientific descriptions tell the story neither of realist “objects” nor of “social construction.” Instead, scientific accounts of organisms betray the limits of our textual articulations, limits that render dubious any strong claim to the objectivity of scientific descriptions. Rhetorical empiricism differs from any Kantian formulation in that it refuses a distinction between these rhetorics and “things themselves,” positing instead a mesh of relations among descriptions, humans, and other objects. Note that in my example of the transformation of a globe into a map, I wrote not of representation but of *transformation*. This underscores an analysis of effects, effects that sometimes include attempts at “representation” but are not governed by them.

This empiricism insists that the “nature” of the relations between texts and worlds is an open, empirical question, as is the “nature” of the relation

between subjects and scientific practices. It also alters the polarity of the “constraints” on scientific texts; rather than preserving a residual site of the real that resists the ephemerality of texts, this account focuses on the all-too-real limits of our descriptions, our rhetorical, disciplinary practices.⁴⁴ It is these limitations—and not the rock of the real—with which we must orient, and not ground, our accounts of scientific practices. This orientation, as in my earlier analysis, dwells on the productivity of different rhetorical practices. Of each scientific description, it asks, “What does it produce? What has it transformed? What makes it possible?”⁴⁵

In a continuation of the dream of knowing “what life is” begun by Watson and Crick, Jacob and Monod transform a threat to the sovereignty of DNA into an ally, one that constitutes both the sovereignty of DNA and the mastery of themselves. In the same move in which Jacob and Monod contain the life of the organism, they contain or overcome death and the effects of time. For Jacob, this produces a sense of ecstatic wonder:

Wonder at having, with this model of gene regulation, penetrated one of the mysteries of life. Of having reached the very essence of things. Of having gained access to a primordial mechanism. A mechanism fundamental to all living beings from their very beginnings, and that would persist as long as they exist. And with this idea that the essence of things, both permanent and hidden, was suddenly unveiled, I felt emancipated from the laws of time: More than ever, research seemed to be identified with human nature. To express its appetite, its desire to live. It was by far the best means found by man to face the chaos of the universe. To triumph over death!⁴⁶

It must be said that this “essence” is not only unveiled—it is also cloaked. To treat the genome as that essence—a central, universal site of control—Jacob and Monod secreted proteins, impossibly storing them away within the genome.

In 1961, “life” and the “organism” changed. Their spatiotemporal morphologies—already turned inside out by Schrödinger and described as a “hole” by Gamow—became that of a Möbius strip whose center is the genome. Perhaps these notions have always been productive fictions, phantom effects of what Michel Serres calls the “frantic oscillation of the domains of myth, science, and literature,” an oscillation that ends in a strand of definitions. But what induce these effects rather than others are rhetorics, figures that, like the enzymes they describe, trip or trigger a redefinition of the space that occupies the border between *physis* and

nomos, the internal and the external laws. It almost seems that these phantom effects are a symptom of the very interrogation of the inside and the outside of the organism, “nature” and “culture.” In my next chapter, I look at three case studies of the “allergy” provoked by the metaphor of a “genetic language” in linguistic, philosophical, and scientific discourse.

CHAPTER 5

Allergies of Reading: DNA, Language, and the Problem of Origins



The deciphering of the DNA code has revealed our possession of a language much older than hieroglyphics, a language as old as life itself, a language that is the most living language of all.

—George and Muriel Beadle, *The Language of Life*

This epistemological ambivalence of metaphor, which always provokes, retards, follows the movement of the concept, perhaps finds its chosen field in the life sciences. . . . Where else might one be so tempted to take the metaphor for the concept?

—Jacques Derrida, *Margins of Philosophy*

In the age of the world scripture, the world appears as Scripture, as a system of marks, signals, gestures, texts, or pixels, signs that offer a secret to be unveiled or decoded. “Life,” both as an object of scientific knowledge and as an object of experience, is no exception to this scriptural frame. In the preceding chapters I have attempted to articulate the rhetorical conditions that have made the new discursive alignment of “life” and “language” possible, focusing in large part on the ways in which implicit models of language and textuality helped constitute knowledge in molecular biology. But the new description of DNA as a language produced rhetorical vectors in more than one direction. The discursive relation between DNA and language also impacted theories of language. In the spheres of semiotics and linguistics in particular, the notion that the bases of DNA were linguistic units provided many with the holy grail of structuralism, what Foucault has dubbed in a different context “the search for a Logos that would be like the birthplace of all Western Reason.”¹ The double helix promised a double origin; as a site of “self”-duplication it

provided the life sciences with the source of life, a literal birthplace. As a “language” it provided the human sciences with an account of the “birth” of culture. But this double alignment was not necessarily a smooth one; between the two accounts of the origin of life and culture there was a tension or torsion. In the sections that follow I will attempt to mark out some of the rhetorical conditions that made possible this new alignment, conditions I will tentatively diagnose as “allergies of reading.”

In my research, I have encountered continual reactions to the metaphor of a “genetic language.” The rhetoric of an allergy, I think, provides us with a nonoriginary description of this discursive reaction, a continual sensitivity and “failure” that seems to occur wherever the notion that “DNA is a language” is exposed to questions of origins. In describing this textual effect as an allergy I hope myself to avoid the allergy of origins: “The term allergy was introduced by Clemens Von Pirquet in 1906, to designate an altered reactivity to a foreign substance after prior experience with the same material, whether this response was helpful or harmful to the host.”² That is, the origin of the allergic reaction is multiple and elsewhere, tied not to the allergen itself but to an irretrievable and innumerable series of events, “prior experience,” what Michel Serres has called in a different context “original complexity.” After presenting three case studies of this allergic symptom, I will suggest ways in which our knowledge of this symptom can help us rethink descriptions of life in the life sciences. A rhetorical understanding of this allergy provides us with a vocabulary and a conceptual framework for discussing the effects of alterity in discourse—the etymological “genetic code” for allergy is in fact “the work of the other.”³ Rethinking the tropology of origins in the life sciences as an allergy, an effect of rhetoric, suggests that perhaps it is the response of a kind of discursive immune system, the textual forces that organize a discourse as an identity. Just as “allergy is the price we pay for maintaining an effective immunity against pathogens,”⁴ I will argue that this effect of writing, the allergy of reading, is a price paid by some texts in the life sciences for their own constitution. Here my claim resonates with the work of Luce Irigaray, for whom the feminine is a site of persistent “impropriety,” an impropriety that nonetheless makes possible the bootstrapping of Western logos.⁵ By analogy, my argument suggests that the aporia associated with recent rhetorics of the life sciences makes possible the scientific articulation of life.

The chapter will proceed as follows. First, I will try to highlight the failures—their type and location—associated with the discussions of the

“DNA-is-a-language” rhetoric as found in discourses as diverse as a philosophical text from 1966, a French television broadcast of 1968, and a text on theoretical biology from 1968. Then I will attempt to use the fact and the persistence of these failures to argue for the place of a rhetoric, and not just a logic, of life. By this I hope to argue that rigorous theoretical accounts of living systems must include their status as inscriptions—rhetorical softwares networked together with human and nonhuman actants articulating life.

Case 1: *Vivre et Parler*

On February 19, 1968, some of the great savants of the French intelligentsia appeared on television to discuss the “rapport between culture and nature,” specifically, the notion that “communication” provided a common, structural matrix with which to study the natural and social worlds. “*Vivre et Parler*” featured the discussion and reflections of the anthropologist Claude Lévi-Strauss, the linguist Roman Jakobson, the molecular biologist François Jacob, and the geneticist Philippe L’Heritier. Fifteen years after Gamow’s attempt to model the mechanism of protein synthesis as a “translation,” the movement from DNA “numbers” to protein “words,” Gerard Chouhan and Michel Treguer gathered the four to assess the impact of the notion of a genetic “language” on the human sciences and specifically its impact on the debates over structuralism in France. Here, whenever possible, I want to focus not just on the content of the discussion “*Vivre et Parler*” but also on its medium and its form. My research, by necessity, will analyze neither the telecast nor its tape; rather, my reading of this discussion of the conflation or chiasmus between textuality and vitality works from the text of the event that was published in *Les Lettres Françaises* in 1968. This text has itself been copied from microfilm to paper, spliced together imperfectly but legibly from medium to medium. All translations from the original are my own.

I have already noted the cultural frame, as pointed out in the text’s introduction, of a discussion of the “rapport” between nature and culture.⁶ *Rapport* in many of its inflections, points already to the hegemony of the communicative paradigm: the figuration of the relation between nature and culture as a connection, exchange, or dialog. Indeed, this is the context of the discussion: “I think that one of the most important things that we have learned in the past few years is that there is a communication system at every biological level, from the simplest level, from cells to organ-

isms, the cells of multicellular organisms or the organisms themselves, even individuals in society.”⁷ As a contextual frame, of course, this notion that communication is a common fabric of nature and culture excludes other communications, for example, the entry of the audience. In this televised nodule of knowledge we have an allegory for the figuration of DNA as language as a “centrism,” a territorialization of both the body and culture as extensions of remote control, centralized sites of knowledge and *techne*. For example, the broadcast itself follows the schema of the central dogma of molecular biology—information flows out of the nucleus but never back in. So too in the case of the broadcast—the audience is to receive, but never give, information: “To return, allow me to emphasize the power of television to create such discussions, and further, its capacity to allow millions to participate. I am not speaking of “spectators,” because they will be audience members, an audience for whom the camera will provide an authentic debate between thinkers, and these same thinkers will speak, listen, and reflect on their work as intellectuals.”⁸

The organization of this discussion can be seen as an installation through the lens of television of one of the symptoms of “logocentrism,” the love of hearing oneself speak. Just as DNA can be seen as an insulated chamber for the sovereign signifier, the “Master Molecule” that will become a message, so too does the “emission” called “*Vivre et Parler*” rejoice in hearing itself referred to as “numero uno,” the origin of knowledge, the work of intellectuals that is shared, broadcast to millions. The origin of knowledge about the origins of nature and culture can be found sitting around a table in the form of Lévi-Strauss, Jakobson, Jacob, and L’Heritier. The origin of knowledge is in discussion between savants, which is then shared with the audience [*des auditeurs*].

But this communicative frame for the discussion—DNA is communication and communication is the basis of culture, therefore there is some structural basis for both—breaks down or breaks out when exposed to the question of the origin of communication and man:

L’Heritier: I really think that it is language and verbal tradition [*l’herédité verbal*], with their rules, that created man.

Jakobson: It’s the reverse! It is man who created verbal tradition! [*herédité verbal*]

Jacob: That’s a little bit like the egg and the chicken.⁹

At this moment—the moment at which Michel Treguer remarks that “This is already a philosophical debate, I think”—the description of just what is meant by the common nexus of “living” and “speaking” becomes

uncertain. Whereas the broadcast began as a discussion of the ways in which communication provides us with a paradigm for thinking past the division of nature and culture, the question of the origin of communication renders this master paradigm opaque, leading to the force of exclamation marks and the figure of an infinite regress, the chicken or the egg, *l'oeuf et la poule*.

What provokes this most “philosophical” argument? It is difficult to say, and my point here is to point out the symptoms of the allergy, not to explain them. But for now, I want to point out two aspects of this outbreak of philosophy on French television. First, this discussion about the ways in which a paradigm of communication can articulate a common dynamic of nature and culture, two poles that had formerly been opposed, itself suffers a communication breakdown. It is not that the dialog becomes meaningless but that it fails to establish a common language that the participants can deploy; no communication or persuasion takes place when it comes to the description of the respective origins of language and humans. The meaning or effect of this “communication breakdown” will be situated within the other cases discussed later.

Another, related, aspect of this breakout of philosophy is the fact that it forgets to locate itself as an activity of communication. To be sure, there is a discussion of the wonder and spectacle of a televised, intellectual discussion, but there is no discussion of the fact that this discussion takes place on the basis of a metaphor that has inhabited both linguistics and biology. The conjunction or analogy of life and language was used by Jakobson to ground and legitimate the science of linguistics with the findings of molecular biology. The irony here, of course, is that according to Jakobson’s own account, the terms of molecular biology are borrowed from linguistics and communication theory.¹⁰ This exchange of metaphors, from communication theory to molecular biology and back again to communication theory, linguistics, anthropology, and genetics on television, traces yet another circuit of origins that is forgotten, a forgetting that takes the form of a forgetting of networks. That is, what is ignored here—both in the instance of the chicken/ egg breakout, and more generally in the lack of a genealogy in “*Vivre et Parler*”—is the place that this discussion takes in a network of processes, whether it be the interactions and reproductions that lead from chicken to egg or egg to chicken or the cultural network that constitutes both “nature” and “culture” in terms of language. The following quotation from Lacan illustrates well the forget-

ting at play here: “There is an essential link which must be made right away—when you draw a rabbit out of a hat, it’s because you put it there in the first place.”¹¹ What makes possible the forgetting of the role of “communication” in “*Vivre et Parler*”? Again, *it is difficult to say*, and I want to look to other outbreaks in an attempt to map them together. Our next case will help provide us with the tools to describe the mechanism of these problematics of origin.

Case 2: The End of the Book and the Beginning of the Gene

It may seem that the notion that DNA is language would be far afield from Jacques Derrida’s critique of metaphysics in *Of Grammatology*. Derrida there claims that “the meditation upon writing and the deconstruction of the history of philosophy become inseparable.”¹² Derrida’s insights move in the space opened by philosophy’s relation to its own writing. In the style of philosophy Derrida finds the mark of both writing’s deployment and its repression in the history of philosophy. The implications of this intervention, in which the very foundations of metaphysics and science are dislocated, are enormous; for Derrida, it marks nothing less than the possible displacement of presence in all its registers—the notion of the priority of speech over writing and the notion of the subject, indeed, of the living subject. Reviewing Leroi-Gourhan’s text *La Geste et la Parole*, in his “Of Grammatology as a Positive Science,” Derrida writes that “Leroi-Gourhan no longer describes the unity of man and the adventure thus by the simple possibility of the graphie in general; rather as a stage or an articulation in the history of life—of what I have called *differance*—as the history of the *gramme*.¹³

Here Derrida locates a shift in the articulation of the human. No longer is “man” the unique subject of language. Instead, what is called language gets situated within a larger economy of change and differences, the very differences that in fact make language, writing, and the human possible, such as the difference between signs that makes the linguistic economy go around and around. Rather than marking man off from other species, writing—“the graphie in general”—marks the human as one of the joints or bits of possibility that articulates and makes possible another ongoing project, life. Here Derrida aligns the history of life with the history of writing (“the *gramme*”) through the (non)concept “*dif-*

férence.” Elsewhere, in an essay of the same name, Derrida offers a provisional definition of *différance*: “we shall designate by the term *différance* the movement by which language, or any code, any system of reference in general, becomes “historically” constituted as a fabric of differences.¹⁴

Particular attention should be placed here on the vector of “movement” in Derrida’s offering here. It insists on marking the spatiotemporal forces and effects of thinking, among which are the temporal and material dynamic by which what we would call either “communication” or “history” happens. Conceived as systems of differences, rather than, for example, the unfolding of a line from signified to signifier, history and language must then be seen to owe their possibility to an “outside” of *différance* that by “definition” must disappear, otherwise risking its registration as the Same. In more scientific terms, we could paraphrase Derrida’s claim as one that points to the mutual relation of signal and noise, where no signal can appear as signal without a background or nexus of noise, but where the concept of “noise” is always inadequate to account for the alterity of “noising,” since this conceptualization in fact tunes noise into a “static,” fixed signal. Derrida alludes to this problematic in his research through the writing of *différance* through the introduction of an *a* that is silent in the spoken register but nonetheless appears, sometimes, as “silent” in his interventions. The range of the implications of this problematic is enormous and diffuse, but for now I want merely to emphasize the way in which deconstruction happens through the appearance of an alterity that dislocates or challenges the possibility conditions of Western consciousness. In our example, Derrida (and Leroi-Gourhan) challenges the human sovereignty over language through the conjunction of the history of life with the history of writing, which is found in what Derrida entitles, in his first chapter of *Of Grammatology*, “The Program.”

By mixing or aligning the history of life and the history of writing, Derrida writes out of the topos he inhabits, a space/time where texts on the textuality of life flow fast and thick. It thus should not surprise us that Derrida receives the news of the genetic code as evidence of what he calls the “end of the book and the beginning of writing”:

It is an emergence that makes the *grammè* appear *as such* (that is to say according to a new structure of nonpresence) and undoubtedly makes possible the emergence of the systems of writing in the narrow sense. Since “genetic inscription” and the “short programmatic chains” regulating the behavior of the amoeba or the annelid up to the passage beyond alphabetic writing to the orders of the logos and of a certain *homo sapiens*, the possibility of the *gramme* structures the movement of

its history according to rigorously original levels . . . It at once and in the same movement constitutes and effaces so-called conscious subjectivity, its logos, and its theological attributes.¹⁵

That is, for Derrida the appearance of modes of writing that occur outside of the realm of a speaking subject gives us the opportunity to encounter what writing (*écriture*) “is.” Historically, writing has been described and thought of as a supplement to speech, a secondary representation without the full status of the original, conscious, living, speaking subject. Writing, in Derrida’s analysis, always posed a threat to Western consciousness, even as it installed it. Hence, Plato’s reprimand:

[Written words] seem to talk to you as though they were intelligent, but if you ask them anything about what they say, from a desire to be instructed, they go on telling you just the same thing forever. And once a thing is put in writing, the composition, whatever it may be, drifts all over the place, getting into the hands not only of those who understand it, but equally of those who have no business with it; it doesn’t know how to address the right people, and not address the wrong.¹⁶

With the appearance of new forms of writing such as the genetic code, Derrida argues, this logocentrism—the primacy of speech over writing—can be glimpsed as a metaphysics and not treated as a natural priority. Indeed, Derrida hopes to deconstruct the line that opposes nature and culture.

And yet the news that Derrida receives of the “genetic inscription” is of course itself written in lines. What Derrida perceives to be a sign of the end of the book and the beginning of writing is itself a sign of the “line,” more specifically, the irreversible vectors in the central dogma of molecular biology. Here we find evidence in Derrida of the very flattening of “life” inscribed by molecular biology, where the central dogma reads (even today, more or less) “DNA makes proteins, proteins make us.” The line of power and information that flows from the gene to the “body” is, under the central dogma, irreversible. DNA, in this account, is anointed with a style of sovereignty radically at odds with the Derridean account of writing without origins.¹⁷ And yet, Derrida relies upon this account in his analysis, the very analysis that offers the gene as evidence for the grammatological break, where “By a slow movement whose necessity is hardly perceptible, everything that for at least twenty centuries tended toward and finally succeeded in being gathered under the name of language is beginning to let itself be transferred to, or at least summarized under, the name of writing.”¹⁸

This substitution of “writing” for “language,” the emergence of writing as the paradigm for language, installs, according to Derrida, at least the possibility of an economy without origins. Yet by investing “genetic inscription” with the privilege accorded it by molecular biology, more particularly by conflating the activity of the gene with the “behavior” of organisms, Derrida reinscribes DNA with the privilege of an origin, substituting “genetic inscription” for “heredity” and “heredity” for “life.”¹⁹ Perhaps more dangerously, Derrida also inflates the gene into a kind of “behavioral” and cultural control center. While this slippage from DNA to organisms may seem innocuous at the level of the amoeba, in the context of late-1960s molecular biology, where “What’s true of E. Coli is true for the elephant,”²⁰ it must be seen as a marker of the momentum and danger of the inflations and confluences provoked by the trope of genes as language. Ironically, Derrida begins *Of Grammatology* with a discussion of the dominance of tropes of “language”:

However the topic is considered, the *problem of language* has never been simply one problem among others. But never as much as at present has it invaded, *as such*, the global horizon of the most diverse researches and the most heterogeneous discourses, diverse and heterogeneous in their intention, method, and ideology. . . . This inflation of the sign “language” is the inflation of the sign itself, absolute inflation, inflation itself. Yet, by one of its aspects or shadows, it is itself still a sign: this crisis is also a symptom. It indicates, as if in spite of itself, that a historico-metaphysical epoch *must* finally determine as language the totality of its problematic horizon.²¹

It would be too simple and perhaps trivial to write that Derrida’s writings are themselves symptoms of this inflation. His notion of *différance*, described earlier, in fact offers us a forceful trope with which to deconstruct the central dogma. I will claim later on in this chapter that it also offers us a perspective with which to explain the gaps and failures that populate some accounts in the life sciences. But here Derrida’s rhetoric again, I think, betrays an indebtedness to a style of “genetic” determinism, a smothering of *différance* not unlike the central dogma. That is, the claim that “a historico-metaphysical epoch must finally determine as language the totality of its problematic horizon” allegorizes the force and necessity of a linear genetic writing, one that follows the line from the double helix to a “certain homo sapiens,” what Derrida entitles, following François Jacob, among others, “The Program.” Thus, “genetic inscription,” the term used when “the contemporary biologist speaks of writing and *pro-*

gram in relation to the most elementary processes of information within the living cell," is not one example among others. It is a crucial, if not the crucial, piece of evidence of the emergence of writing without an origin, a writing not defined by "accidental doubling and fallen secondarity."²² This writing emerges when "linearity—which is not loss or absence but the repression of pluri-dimensional symbolic thought—relaxes its oppression because it begins to sterilize the technical and scientific economy it has long favored."²³

Thus, what powers, fuels, or inflates the metaphysical moment of "The Program" is a genetic, scientific account that metaphysically privileges precisely the linearity that Derrida critiques. This in itself is not surprising, nor does it necessarily call for critique. But the style of this inflation of "The Program" into a sign not just of behavioral regulation, but, perhaps, of metaphysical necessity, calls for questioning. The alignment of the "history of life" with the history of writing, to be sure, offers the possibility of disrupting the "line" that leads from nucleic acids to "us"—this is in fact one of the tasks of this book. But at the same time, by inscribing "The Program," however marginally and strategically, with the force of life and metaphysics, Derrida risks increasing the sovereignty of the "Master Molecule," DNA.²⁴ This doubling of the central dogma as both a diagram of genetic and metaphysical necessity risks recuperating the "guarantee" that is threatened by the inflation of the sign "language." Within the stability of the central dogma, "genetic inscription" takes on the very onto-theological attributes deconstruction is meant to disrupt.

This description of grammatology's implication in the central dogma is meant as more than merely an ironic marker of the interminable analysis of deconstruction, a snickering trickster catching Derrida at his own game. Rather, it is a trace of the force and momentum of the tropical alignment of DNA with language. More than a case of technological momentum, in which a given technology "snowballs" itself and associated technologies into existence, the troping of DNA and language could be seen here as a troping of momentum itself. The force that "inflates" the tropes of language, namely, "inflation itself," could be seen as the contemporary pneuma, the spark or secret of life and culture, "DNA." By this I mean that the localization of life in a molecule, and its subsequent articulation as a language, was not simply an effect of DNA getting coded or constructed as language. Rather, the isolation of the genetic code—from Schrödinger's metaphorical twist to Gamow's scheme of translation—

made a difference. As a technoscientific event, it had a force all through the “fabric of differences” that historically constituted language and life. The force it had, however, was not merely a product of the new style of mastery over vitality proffered by Watson and Crick’s double helical model of DNA. The rhetorical force of molecular biology emerges out of what we can only ineptly call *différance*, the network of “nonverbal conditions on the basis of which it can speak.”²⁵

Thus, to ascribe an originary power to the physicochemical powers of the double helix is to occlude the silent discursive possibility conditions for the emergence of molecular biology—the substitution of code-scripts for organisms, the insulation of the gene from the environment, and the occlusion of the complexities and problems of development, among others. These are discursive powers that I have tried to map, if only schematically, and they all succeeded at least in part through the *différance* that makes language possible. That is, the tropes of language that stick to DNA are not merely ways of “representing” a preexistent reality of a double helix; they are not linguistic models that refer back to an origin, a signified. Rather, the metaphors of DNA as language work precisely because of their lack or excess of an origin. The founding opacity of the sciences of life and language allow both of these human sciences to “bootstrap” themselves through the collision and “self”-reference of their own metaphors, tropes whose excess of meaning or polysemy thwarts any final tethering to an origin.²⁶ With DNA as a nexus for both the origin of nature (“life”) and culture (“language”), we can see a forceful assemblage of two of the origin manias of modern occidental culture, language and life. Indeed, Derrida’s discussion of *différance* as an “assemblage” itself marks the crossover between these manias even as he deconstructs them in that his rhetoric of the assemblage reads like a description of DNA’s “self”-replication: “On the other hand, the word ‘assemblage’ seems more apt for suggesting that the kind of bringing together proposed here has the structure of an interlacing, a weaving or a web, which would allow the different threads and different lines of sense or force to separate again, as well as being ready to bind others together.”²⁷

At the same time that we highlight the “assembled” nature of these tropes, we must not ignore DNA as a kind of receptor and transmitter of these discursive effects—nucleic acids are not merely a blank slate on which the discourse of the gene is inscribed. In the following section I will attempt to isolate the ways in which *différance* must be seen to be an actant in living systems. I will map out the aporia associated with

“genetic language” in a recent attempt to compile a “dictionary” of the genetic code. I will also map out the ways that these failures operate in a text on theoretical biology, for these failures, I hope, will help articulate the shortcomings of most narrational accounts of living systems. Moreover, I will attempt to at least provisionally show, through recourse to the gaps and failures of accounts in the life sciences, that no biological account can ignore its rhetorical operations and live up to the terms of its own scientificity.

Other Cases: Biological Encounters with *Différance*

Philosophy will
 Conquer all mysteries by rule and line
 Empty the haunted air, and gnomed mine.
 —Keats, *Lamia II*

By 1986, Edward N. Trifonov and Volker Brendel were pursuing an extraordinarily straightforward and seemingly literal research program to compile a “dictionary of genetic codes.” Following to its conclusion the premise/metaphor that DNA is a linguistic entity, Trifonov and Brendel began the mammoth task of framing the language of the gene in the genre of the dictionary at the urging of the genes themselves, or at least of their libraries: “Continuously growing libraries of nucleotide sequences (about 6 million letters by now) urge us to decode and to read the genetic language. This first compilation of ‘words’ of the language is meant to assist in this task, as any dictionary would do for any human language.”²⁸

Ironically, the problem of the name of this language of the genome posed a problem. There was no dictionary “for any human language” to which Trifonov and Brendel could turn to determine the proper name for this language of the gene, as this was in fact the very dictionary being compiled by Trifonov and Brendel themselves. The answer to this Borgeasian quandary arose, ironically, from the flaw in another dictionary:

From the very inception of this work we felt that the name “nucleotide sequences” was not an appropriate name for this lingua prima of life. None of many suggestions conformed with a vague idea of what would be proper. One day, one of us was editing a manuscript by a computer program which checks spelling. The program based on a rather commonly used dictionary couldn’t master some technical terms. Thus, when it came to “genomic” the computer suggested “gnomic” instead. According to Webster’s dictionary, “gnomic” means “wise and pithy, expressive, full of meaning”—all certainly attributes of the language of genes.²⁹

Thus, the irony—a dictionary project founded on a spelling error. Here we can see the enforcement of the linguistic troping of DNA through the computer; the very difference between *genome* and *gnome* is obliterated in its assimilation into discourse, as DNA completes its troping into language, the gnomonic language. The silent, errant deletion of the *e* follows the pattern of the topology of molecular biology—a constant silencing of the body, environment, or any other noise that threatens the sovereignty of DNA. Here, now even the word *genome* is too noisy, too difficult to “master,” as if the *e* were too much the reminder that life is something other than language, a barrier to the gnosis of the gnome, the “one who knows.”

At the same time, the very deletion of the *e*—analogous to Derrida’s introduction of an *a* into *différance*—announces the return of a “magical” rationalism.³⁰ At the very moment the difference between a language and a sequence of nucleic acids seems to have all but evaporated, a gnome appears. The naming of the genome language “gnomic,” in its performance, pays *différance* its due. That is, the allegory told by an editor, a word processor, and their nexus is a story of the lack and multiplicity of origins that fuels and inflects this primordial discourse on language and life. No design, no designer, crafted the signifier “gnomic”; rather, it emerges, like its referent, from the nooks and crannies of a discourse network. Despite the appearance of a linear determinism in a project to uncover the very origins of life and language, this encyclopedic research itself is, from the start, a product of a chance interaction. More exactly, it affirms, despite itself, the occulted connections between chance, error, and the very notion of origin itself. It takes “error” as its name; the very attempt to correct is a mistake, and that mistake is affirmed as the name of this “lingua prima of life.” The “first” principle or language of life is thus itself in “error”—its origin cannot be simply located in a place or a time; rather, it is the consequence of a network of signs in collision or collusion.³¹ This collision results not from purpose but from a productive thwarting of mastery—“The program based on a rather commonly used dictionary couldn’t master some technical terms.” To paraphrase Nietzsche, the history of the gnomonic language is a history of an error.

What does this symptom—the emergence of the gnomonic language from an error—tell us concretely about the project of a dictionary of genetic codes? Perhaps it tells us that the notion of origin is itself a mistake. The preface of Trifonov and Brendel’s book *Gnomonic* comments on the epigraph, which reads

“In the beginning was the Word. . . .”: The nature of the beginning and the foundations of life are central issues in man’s spiritual and scientific quest. Goethe had his Faust struggle with this in trying to interpret the first verse of St. John’s gospel. . . . Was it really to mean “word” in this context or had it to be translated as “Thought” or “Deed”? Whatever the answer, the literal domain of words—language—is surely associated at least with the beginning of man, and with the understanding of man.³²

The constant association of language and life with beginnings and foundations, as well as gnostic’s need to account for its own origins, foregrounds the manner in which this style of reasoning gravitates toward the beginning as well as the center; “the beginning and the foundations of life are central issues.” This rhetoric of beginnings works like a reverse spatiotemporal centrifuge, spinning and gathering research and thinking toward one site of control, one beginning, and one origin—“In the beginning was the Word.” The struggle to interpret this “Word” as deed, thought, or “word” only reinforces this centrism, as all vectors of power finally emanate, from the start, from this beginning, Logos.³³

Much of this book has been aimed at deconstructing such accounts by displaying molecular biology’s dependence on extrascientific and metaphysical tropes and displacements. At this point in my analysis, however, I would also like to suggest that a reading practice of this sort—one that pays heed to the role of rhetoricity and *différance* in scientific accounts as well as scientific “objects”—might also contribute to a rethinking of models of living systems.

The seemingly marginal rhetorics of origins in gnostic offer us a case in point. It may be difficult to locate the edges of ideology in scientific practice, those places where science most takes on an “ideological” inflection in that this inflection often operates precisely through a silencing. Repression is too simple a model here; a differential mesh is perhaps a more satisfying topological metaphor for the rhetorical transmission of science. Thus, the importance of the “edges” of scientific texts, those places where it makes its cuts, its decisions and incisions. This is where *différance* can be found, prefaces, metaphors, diagrams—a note or flavor of *différance* that both organizes and disrupts scientific texts. In the case of *gnomic*, my emphasis on the conditions of the preface and the naming or “origin” of the dictionary highlights the rhetorics of control and origin that may otherwise have gone unnoticed. That is, it helps raise the question of the style and genre of research that Trifonov and Brendel pursue. While the literalization of the metaphor of a “genomic language” natural-

izes the project of compiling a dictionary of a language with no name and no speakers, the details and errors of the preface document the ways in which the descriptions of this science produce an artifact. Indeed, in some sense the preface's story of "gnomic" creation tips us off to the fact that gnomic is only artifact, a construction of a scientific culture that seeks the beginning in the Word and that treats "life" as a unified entity localized in and caused by a language.

Or, at least, that's how my reading goes. For clearly, the idea that "genetic language" is constructed carries its own origin story, one that provokes the very allergy of reading that this chapter is highlighting. To sustain the implication that the DNA language is an "artifact," we would break out in aporia, one that takes the shape of "there is no outside the text." This aporia has itself been read allergically in that it is invoked to sustain the claim that deconstruction is a fundamentally solipsistic enterprise, with nothing but "texts" constituting the "world." But once we read both sides of the statement, "text" and "outside," at the same time, "outside," we can see that what is at stake here is less a statement of closure—there is nothing but text—than a statement of a problematic, a place where a text is constantly saturated by an "outside" that it cannot control—*différance*. Thus, rather than declaring, at this point, the simple "construction" of the metaphor of DNA as a language, I want to trace the effects of the collision of these two terms, texts that constantly open up to an outside of "infinite" regress or error.³⁴

These symptoms or error messages that I have attempted to locate in three rather arbitrary texts suggest a fact about the description of DNA in linguistic tropes: such rhetorical software produces persistent and somewhat systematic mistakes. Each time the question of an origin is pursued through the grid of the metaphors of "DNA is a language"—the question of language and the human in Jacob et al., the question of a writing prior to *homo sapiens* in Derrida; and the very epigraph and name of Trifonov and Brendel's text—a failure occurs. Each time, to follow the quotation from Derrida with which this chapter began, one could say that a metaphor was mistaken for a concept.

By this I mean, of course, not that each author or speaker got carried away with the literary excess of a rhetoric that he or she employed; in fact, I mean quite the opposite. Each time the trope of "genetic language" provokes an outbreak of error or aporia, it can be seen as an effect of an insufficiently rhetorical deployment of the metaphor. Each speaker or author forgets that concepts are metaphors, insofar as metaphor is the

name given for a literary strategy built on relations. Metaphor cannot be extricated from its reliance on the movement and play of the relation of differences among the terms that make it possible.

Such a rhetorical reading, one that foregrounds the relational operating conditions of the rhetorical software called “genetic language,” can never, strictly speaking, succeed. The deconstruction of the opposition of metaphor and concept will be indeterminable in that now one encounters the “infinite” regress of the determination of the metaphor or model of metaphor one is deploying in this rhetorical reading.

But the quasisystematic nature of these failures—the fact that such rhetorics lead to allergies of reading—can be read as a marker of the role that rhetorics of the “genetic language” have played in the description of living systems since the ascent of molecular biology. Specifically, in their persistent failures, these rhetorics tell us about the “language of life.” Like a secret message contained in the texts of molecular biology, these failures map out, in a way, a “secret” of life—that no simple transcendental position exists from which one can describe living systems. The matrix or assemblage that constitutes a “living system” includes humans as rhetors, rhetors without any simple transcendental, exterior position from which to describe life, rhetors who deploy but do not determine rhetorical softwares. In chapter 6, I will discuss a contemporary symptom of this fact—a fact that informs the contemporary differend around the definition of life—in the texts and practices of artificial life. For now, I will look at a text from 1969 by the theoretical biologist Howard Pattee for an example of yet another forgetting, an allergy of reading that points the way toward a problematic of description for living or complex systems.

Life, Incommunicado

I would say that the secret of good communication in general lies in knowing what to ignore rather than in finding out in great detail what is going on.

—Howard Pattee, “How Does a Molecule Become a Message?”

Now I am quite sure that it will be a long time before this point is generally agreed to by everybody, if ever; namely, whether or not what one overlooks in this simplification had really better be forgotten or not.

—John von Neumann, *Theory of Self-Reproducing Automata*

Howard Pattee, a theoretical biologist associated with C. H. Waddington’s *Towards a Theoretical Biology*, volumes published between 1968 to 1972, and a contributor to the first proceedings on artificial life, puts a fine

point on the question that, in a way, this book has asked all along: “How does a molecule become a message?” For Pattee, the question of life is intertwined with questions about communication. “I am interested in the origin of life, and I am convinced that the problem of the origin of life cannot even be formulated without a better understanding of how molecules can function symbolically, that is, as records, codes, and signals. Or, as I imply in my title, to understand origins, we need to know how a molecule becomes a message.”³⁵ Pattee can be seen here to be in line with the molecular biological tradition that uses the rhetorical software of codes and messages to describe living systems. But what is significant for my account are the ways that Pattee’s account diverges from or even deconstructs the central dogma, that is, the tripartite narrative of living systems that originates in DNA. For Pattee claims that what is interesting about DNA is that it is a message, and messages, as Pattee’s reference to his own title implicitly points out, require a context. Against the grain of a molecular biological account that constitutes DNA as a self-contained, sovereign site of control in the living organism, Pattee emphasizes the system or network that molecules require to become a message.

For example, Pattee offers the case of what he calls the simplest message: to turn something on. Pattee traces the limits of this simple message, the possibility conditions for a message to exist at all: “If the simplest message is to turn something on, then we also need to know the physical origin and limits of the simplest device that will accomplish this operation. Such a device is commonly called a switch.”³⁶ This move toward simplicity stems from Pattee’s axiomatic statement quoted at the beginning of this section, that one must ignore a great deal to communicate effectively. In locating the simplest “message,” Pattee finds that it is not simple at all, that switches have meaning only in a context: “taken by itself, outside the cell or the context of some language, ‘turn on’ is not really a message since it means nothing unless we know from where the signal came and what is turned on as a result of its transmission. . . . ‘Turn on’ makes no sense unless it is related by a temporal as well as a spatial network.”³⁷ This apparently trivial recognition of the dependence of messages on material spatiotemporal contexts comes into relief when juxtaposed with the rhetorics of molecular biology I have outlined in the previous chapters. Whereas, I have argued, Schrödinger, Gamow, and Jacob and Monod have all emphasized DNA as a kind of self-contained origin, Pattee explicitly foregrounds the dependence of molecular “switches” on their context. Indeed, in thinking of the origins of life, Pattee wants to consider message

matrices much larger than the cell: “An isolated switch in nature, even if we could explain its origin, would have no function in the sense that we commonly use the word. We see here merely the simplest possible instance of what is perhaps the most fundamental problem in biology—the question of how large a system one must consider before biological function has meaning.”³⁸ In contrast to Jacob and Monod’s work on the operon, where the genome is reconstituted as the agent of meaningful biological function, Pattee’s “system” cannot be localized or “contained” in a genomic or even organismic node.

Pattee argues persuasively that one must consider not just the cell but the communication of cells with an outside environment that constitutes the matrix of evolution. Perhaps this is enough. Given the context of the problematic of origins that I have outlined in this chapter, perhaps all that is required is a change in inflection that seeks an interactive, relational, differential account of “becoming” and ignores simple origins. But given Pattee’s axiom—that one must ignore in order to communicate well—we might ask about the network that has made possible this message. What differences have been ignored in the name of communication? Our answer is suggested by Pattee’s analysis of the switch:

The switching event which produces a single choice from at least two alternatives is not symmetrical in time and must therefore involve dissipation of energy, that is, loss of detailed information about the motions of the particles in the switch. . . . It is physically impossible for a switch to operate with absolute precision. . . . All devices have a finite possibility of being “off” when they should be “on,” and vice versa.³⁹

This description of the limits of switches and messages, along with Pattee’s claim that in the move from the digital to the analog, from a switch to a movement, “The transcription process also determines to a large degree the simplicity as well as the reliability of the function,” announces the importance of Pattee’s input or transcription here. For Pattee forgot, for the sake of narrative simplicity, that it is equally simple for a switch to be “off” as “on”; both are merely movements of the gate in a network that, Pattee has painstakingly pointed out, gives the message its meaning. The fact that Pattee chooses the “on” switch—besides alluding to a “start” or a “beginning” outside of any such network, the first switch or message as it were, a switch that turns on the light: *Let there be Light*—announces his place in the network. That is, this “choice” of an “on” switch, on Pattee’s own account, makes no sense in isolation; it must be connected to a larger

narrative involving the practice of Pattee's "transcription," a practice that has been systematically overlooked or "turned off." Of course, this return of the "off switch" in "How Does a Molecule Become a Message?" confirms Pattee's message: no switch, no message is so precise as to completely exclude its other.⁴⁰

Another way of describing this imprecision of even the simplest message is to describe such simplicity as a forgetting or overlooking of the complexity of scientific rhetoric, including Pattee's. Just as the most precise switch cannot completely exclude its contrary state, neither can Pattee's "message" simply and unambiguously transmit one simple and single narrative. Instead, we find an irreducible vagueness, a vagueness of many stories, one of which, through a conspicuous absence, describes the place of language and authorship in this description of biological models.⁴¹ Pattee's failure to describe his own rhetorical operation as a part of the large system that constitutes "living systems" tells its story through its silence.⁴² It tells the story, that is, of one of scientific discourse's operating conditions or constraints: that rhetoric and the author are external to any system under description.⁴³ But it is precisely this forgetting, or what Pattee would probably call his ignoring, of the complexity of his communication that provokes, time and time again, what I have called the allergies of reading. In a follow-up essay to "How Does a Molecule Become a Message?" Pattee encounters the allergy in the following form: "Thus we have the chicken-egg paradox in a new form: 'Which came first, the language or the constraint?'"⁴⁴

This allergy, again, points to a fact, the working of the other in scientific discourse. By this I mean that these aporia point to the interactive, nonlocalized quality of scientific description, the systems of language and context that make such "messages" possible. As in Trifonov and Brendel's *Gnomic*, these slipups announce that the simple question of origin is a mistake in that it implies a narrative that can localize a system whose complexity defeats such a reduction. This need not be only an effect of what gets called "life"; in fact, it could be another working definition of complexity: a system, event, or object that seems to defeat simple original accounts. Computer scientist and mathematician John von Neumann came to a similar conclusion in his attempts to describe complex systems like automata, both natural and artificial: "There is a good deal in formal logics to indicate that the description of the functions of an automaton is simpler than the automaton itself, as long as the automaton is not very complicated, but that when you get to high complications, *the actual object*

is simpler than the literary description" (emphasis added).⁴⁵ I want to be clear that I am not arguing for some vitalist conception of a life that defeats our attempts to describe it. Rather, I want to highlight the complexity—and I use this term in a less than scientific sense—of the “literary description” of living systems, the messages that make up the life sciences. This observation helps us give a provisional answer to a problem that vexed Pattee: “Why are all biological functions so difficult to model? Why is it so difficult to imitate something which looks so simple?”⁴⁶ One provisional answer is that we ought to look to our modeling processes for the “source” of the difficulty. That is, there is no a priori reason why the difficulty should arise only from the nature of living systems; my limited analysis, along with von Neumann’s observations, suggests that it may also be an effect of our rhetorical softwares. In looking at our rhetorics, we can follow Pattee’s experience concerning computer simulations: “While it is relatively easy to imagine ad hoc ‘thought machines’ that will perform well-defined functions, the structure of real machines is always evolved through the challenges to the environment to what are initially very poorly defined functions. These challenges usually have more to do with how the machine fails than how it works.”⁴⁷

So too, I want to argue, can we learn something from the failures of the “messages” and models of living systems, what von Neumann called “literary description” and I have called rhetorical softwares. That is, the persistent “error messages” of such rhetorics, messages most easily seen in the form of the chicken/egg aporia, should lead us to rethink our rhetorical models of living systems, the narratives and tropes with which we describe the objects of biology. Such failures remind us of the importance of such “transcription” in the scientific process, both in its role as a “simplifying” agent and in the subsequent construction of scientific models and knowledges based on such simplifications. One must at least recognize and even foreground that rhetorical softwares operate in descriptions, as both simplifying and complicating tools of scientific research.⁴⁸ The question of which simplifications to enact and which to ignore can never be “settled”; that would require a transcendental position from which to judge such forgettings that our embeddedness in the network renders impossible.

This position can be aligned with Donna Haraway’s notion of “situated knowledges,” where “objectivity turns out to be about particular and specific embodiment. . . . Only partial perspective promises objective vision.”⁴⁹ My account, however, seeks to highlight not the “location” of

our knowledge of biological systems—"who speaks, under what conditions, with what instruments?"—but rather to underscore the *dislocation* at play in all technoscientific accounts, the resistance of scientific practices to the modes of description that we employ. Haraway's account of a partial vision, while helpful in its insistence on an objectivity that is not transcendental, is itself hindered by a transcendental gesture. For "to be somewhere in particular," as Haraway demands, is to be arrested, paradoxically, outside of space and time in a manner that yields such a reflection or even refraction of a "located" account of scientific knowledge. My hope is to contribute to Haraway's attempt to conceptualize objectivity by highlighting the fact that such "location" is always and only a retroactive effect of a network of rhetorics, practices, and materialities, a network not necessarily available to self-reflection or even "situation."⁵⁰

Here Judith Butler, reworking Derrida's work on performativity, offers us tools for thinking about scientific practice as a set of iterative practices through which both the knowledges of the subject and the subject herself emerges. Location, on this view, rather than a position from which knowledge is constructed, articulated, or observed, is itself an effect of the iterative practices of technoscience, practices that include the narration of location, even if that location be the god-trick of "nowhere and everywhere."⁵¹ Location, in the sense articulated by Haraway, emerges within the very operations of technoscience that it is intended to ground. As such, location "itself" cannot be located; such a move would require recourse to a place or moment outside of the ongoing practices that cultivate subjects and their scientific knowledges.⁵²

Thus, rather than locating the narratives that are deployed in the life sciences in terms of the subject positions or corporealities of those humans that render them, I want to highlight the contribution of the non-human actants, those unlocatable and dislocating allies of scientific practices. An emphasis on rhetorical softwares is of a piece with this. While it risks textual determinism to highlight the role of unspoken and even unknown discursive practices in the cultivation of scientific knowledges, I have tried to emphasize the ways in which rhetorical softwares only have effects to the extent that they are networked. Indeed, in some sense rhetorical softwares are nothing but connection.⁵³

What governs the deployment of such rhetorical softwares? Susan Oyama, in her analysis of the notion of "contingency" as it is understood in accounts of developmental biology, focuses on the marginalization of "contingency" in descriptions of developmental systems. In "The Acci-

dental Chordate,” Oyama argues “for a notion of development in which contingency is central and constitutive, not merely secondary elaboration of more fundamental, ‘programmed’ forms.”⁵⁴ Oyama’s argument brilliantly locates a conflation between epistemological and ontological contingency, a conflation that abets the project of rendering contingency peripheral to development. Thus Oyama’s analysis is a case study in the power of a rhetorical formulation—“contingency”—to inflect our models of living systems. But Oyama also extends this notion of contingency to theorizing “itself”:

If theorizing about contingency is itself contingent in the ways I have suggested . . . it is equally important to recognize the “choices” we have already made, however unreflectively or tacitly. Indeed, it is essential to articulate them and own them, or even, on second thought, once we have looked at them closely and related them to our other beliefs and concerns, to put them aside and make better ones. Taking some factor for granted or including it in a *ceteris paribus* clause doesn’t mean it plays no formative role, or that it will always be there, something we realize with growing alarm as developmental, social, and ecological systems go awry, forcing closer attention to those “background” conditions that account for both the robustness and the vulnerability of developmental systems.⁵⁵

Here I would like to extend this notion of contingency to Oyama’s thoughts about theorizing. Rather than being supplemental factors that one can then “own,” or “put . . . aside,” contingency extends to the deployment of and reflection on rhetorical softwares such as contingency. Just as contingency must be seen to be more than a secondary elaboration of a more fundamental form in developmental biology, contingency must be cast as constitutive, sometimes, of scientific practice.⁵⁶ Indeed, in some sense this is who we are as subjects of scientific research: beings in thrall to a contingency we cannot master. Instead of mastery or “ownership,” the attitude toward theorizing and rhetorics that I am suggesting here is an “empirical roaming around,” a radical empiricism that extends to the rhetorical formulations deployed in scientific practice.⁵⁷

Put another way, rhetorical softwares (à la Haraway’s material semiotic actors) highlight human beings’ partial place in the economy or network of description in the life sciences as well as the complexity of the task of describing such systems. Through the lens of von Neumann’s logical observation, we can see that the literary or rhetorical description of life is extraordinarily complex and that this complexity—a complexity that perhaps can be seen in what I have called allergies of reading—is a silent

message or description concerning life, a pattern that points to the presence of other narratives and networks that disrupt the simple localization of life.⁵⁸ No “life” exists, as such, exterior to the economy of description and research; it is forever and complexly embedded in a network that cannot be simply communicated, because, as Pattee points out, such communication demands an act of ignorance or forgetting. Lacan communicates this as well as can be expected: “Life is only caught up in the symbolic piece-meal, decomposed. The human being himself is in part outside life, he partakes of the death instinct. Only there can he engage in the register of life.”⁵⁹

Paradoxically, it is precisely our place in a “symbolic” network describing life that prevents our complete description of life. This inability to articulate a complete description can be thought of as of a “piece” with human finitude; the limits, deaths, and forgettings, the “off switches” that also comprise the human narrative. In my next chapter, I will look at the ways in which workers in artificial life have attempted to overcome this finitude, this lack of a transcendental position. This attempt is interesting not only for its own forgettings of narrativity, although these are the subject of my analysis. “A-life” also illustrates the fact that what I have called rhetorical softwares constitute inventive and powerful models of complex systems, models that follow what we could call the “linguistic turn” in theoretical biology, or at least a postvital turn to the computer. This turn follows C. H. Waddington’s closing words in the final volume of *Towards a Theoretical Biology* as well as Pattee’s analysis of language as “switches”: “basic sentences in language are programmes, not statements. And it is language in this sense—not as a mere vehicle of vacuous information—that I suggest may become a paradigm for a theory of General Biology.”⁶⁰

At the end of chapter 4, I suggested that what marks the age of world scripture is the idea that language somehow “speaks” the human. Derida’s interventions, as I have alluded to them earlier, served to decenter the category of the human through a persistent strategy of amplifying or highlighting the alterity at work within human discourse. This gave rise to a questioning of the possibilities of agency and subjectivity after the “linguistic turn,” where humans are seen as language users who are never in a position to dominate language. With the linguistic turn in theoretical biology, one that makes possible artificial life, we eventually see an odd and thoroughly metaphysical appropriation of this trope as the ideologies of sovereignty and autonomy that had characterized “Cartesian” subjectivity get displaced onto “programs.”

Emergent Power: Vitality and Theology in Artificial Life



To talk about “another” world than this is quite pointless, provided that an instinct for slandering, disparaging and accusing life is not strong within us: in the latter case we revenge ourselves on life by means of the phantasmagoria of “another,” a “better” life.

—Friedrich Nietzsche, *Twilight of the Idols*

Behind or parallel to the technoscience of molecular biology, there is a metaphysics. It assumes many morphologies, and each of my chapters thus far has been, in part, an attempt to map out these metaphysics through the deletions and substitutions of molecular biological discourse. But this is a chapter on the vitalization of computers, and so here I offer metaphysics under compression: James Watson, codiscoverer of the double helical structure of deoxyribonucleic acid, summed it up concisely when he wrote of Francis Crick’s motivation for research in the life sciences: “To understand what life is, we must know how genes act.” While the scientific successes of this reductionist algorithm are undeniable, its remarkable rhetorical and ontological impacts—the implicit understandings of what life is—have been less well marked. The conflation of what life “is” with the “action” of a configuration of molecules conventionally represented by an alphabet of “ATCG” produced an almost vulgarly literal translation of Jacques Derrida’s famous remark, “*Il n’y a pas hors du texte.*” Literally, the rhetoric of molecular biology implied, there is no outside of the genetic text. No body, no environment, no outside could threaten the sovereignty of DNA. In the first five chapters of this text, I have attempted to outline the drastic and dramatic rhetorical substitutions and displacements that have accompanied and made possible this postvital metaphysics. In this chapter I want to focus on a more recent effect or symptom of this conflation of vitality and textuality, namely, artificial life, or “A-life.”

In an era when biology's new reagent is information, the rhetorical, conceptual move from the notion that life is a "text" to the idea that "information" can be "life" is a short one, but it is a move I would like to trace with some care here. The notion that cellular automata, computer viruses, or robots could be said to live is, of course, encouraged by the tremendous speed, power, and availability of personal computers. But, I will argue, the "power" of powerful computers does not simply reside in their clock speeds or their memory; rather, they rely on their rhetorical software, the tropes that make plausible the technically impossible claim that artificial life creatures "live." My point here is not to debunk A-life; rather, I aim to use A-life as an exhibit of the contemporary reconceptualization of life and as a case study for the material importance of the rhetoric of science, the sliding signifiers such as "information" and "life" that make possible both the scientific and "ideological" effects of research. Through an analysis of this rhetoric, I will suggest that what emerges from A-life is not only life but also a trace or allegory of power.

In invoking power here, I follow Foucault's arguments concerning the productivity of power. Rather than obstructing knowledge or disabling scientific thought, power on this account enables knowledge practices, makes them possible. Foucault's own project was concerned with the historicity of power, as in his description of the shift from the brutality and sovereignty of the scaffold to the "humanity" and "scientificity" at play in the normalizing discourses of criminology and psychiatry, practices that made it plausible to define the "criminal." In my account, I will attempt to diagram the practices and tactics (what Foucault has dubbed a "technological ensemble") that make plausible artificial life's claim to determine the "formal properties of living systems" in the unlikely arena of computer science and robotics. Rhetorical softwares play a crucial tactical role in this regime of power, as it is through rhetorics that the uncanny connection between the machine and the organism is installed and managed. Dispersed from the unity of the organism, life gets networked, located, and articulated through a computer screen.

Artificial Life and Its Rhetorical Substrates

One aspect of organic life that is lacking in Artificial Life is history.
—Tom Ray, artificial life researcher

A-life, in its present form, emerged from a conference held in Santa Fe, New Mexico, in 1987.¹ A synthetic moment in the history of science, it

was a self-conscious attempt to crystallize and catalyze work on what Christopher Langton, organizer of the conference, would call the “essence” of artificial life. Encompassing discussions of computer simulation and biological modeling, origin(s) of life, evolutionary theory, self-reproducing automata, and the history of automata and artificial organisms, the conference offered divergent methodologies and thoughts on the intersection between life and information. In the proceedings of the conference, Langton offers a manifesto for A-life as a discursive center for the various vectors of research:

Artificial Life is the study of man-made systems that exhibit behaviours characteristic of natural living systems. It complements the traditional biological sciences concerned with the analysis of living organisms by attempting to synthesize life-like behaviors within computers and other artificial media. By extending the empirical foundation upon which biology is based beyond carbon-chain life that has evolved on Earth, Artificial Life can contribute to theoretical biology by locating life-as-we-know-it within the larger picture of life-as-it-could-be.²

I want to make it clear that this new ethos of life as “behavior” stands in stark contrast to the displacement of, for example, an organism by its “code-script,” as in Erwin Schrödinger’s 1944 description in *What Is Life?* So too does it differ from Jacob and Monod’s operon model of regulation, where the all-powerful genome “contains not only a series of blue-prints, but a co-ordinated program of protein synthesis and the means of controlling its execution.”³ Instead we find a return to the agents of life. Langton’s description of A-life relies on organisms, ongoing projects in negentropy, and self-organization. While for early (and some subsequent) workers in molecular biology the secret of life was to be found at the level of the molecule and its effects, A-life seeks once again to describe what it calls the secret of life’s behaviors—flocking, schooling, and sex. The fact that these behaviors occur elsewhere, in a virtual soup of biology’s new reagent, information, must not obscure the fact that A-life could in fact reflect a new gestalt in the sciences of life, one that emerges out of the implosion of life and information.

The other obvious, and perhaps more peculiar, notion to be found in Langton’s manifesto is the idea that theoretical biology is somehow hamstrung by its inability to “derive general theories from single examples.”

Biology is the scientific study of life—in principle anyway. In practice, biology is the scientific study of life based on carbon-based chemistry. There is nothing in its charter that restricts biology to the study of carbon-based life; it is simply that this is the only kind of life that has been available for study. Thus, theoretical

biology has long faced the fundamental obstacle that it is difficult, if not impossible, to derive general theories from single examples.⁴

This call for a comparative biology is a call for a transcendental comparison, an external analysis of life from a distance, a life outside of or above life “as we know it.” Nietzsche, writing in *Twilight of the Idols*, describes an analogous, structural problem in the “judgment” of life, one that points to “another reason”:

Judgements, value judgements concerning life, for or against, can in the last resort never be true: they possess value only as symptoms, they come into consideration only as symptoms—in themselves such judgements are stupidities. One must reach out and try to grasp this astonishing finesse, that the value of life cannot be estimated. Not by a living man, because he is a party to the dispute, indeed its object, and not the judge of it; not by a dead one, for another reason.⁵

Nietzsche’s inquirer into life focuses on quite a different issue, of course—the *value* of life—but his insight into the problem of achieving a transcendental position from which to judge or study life remains. What would seem to be anything but a point requiring finesse—the dialectical opposition of life and death—must be finessed through the rhetorical place of “another reason.” This other reason is the limit of reason, reason’s other, insofar as it marks a structural limit on thinking about and judging life.⁶

For Langton, too, the essence of life is occulted, hidden by our status as terrestrial, carbon-based hostages. So too would he seem to be left without any a priori definition of life that would guide his study. Yet Langton sees a way out of this impasse, and its virtual door or medium is the computer. Does Langton, armed not with Nietzsche’s hammer but with silicon, overcome the impasse, or should he be seen as one of Nietzsche’s symptoms? To find our answer, I will look first to the rhetorical path Langton takes in this return to the organism in the age of the molecule. I will then speculate, in the manner of an origin-of-life cosmologist, on the accidental origin of artificial life.

Langton takes the route of artificial life, the “synthesis of organisms,” with the help of rhetorical precursors and some new technologies. A clue to some of A-life’s rhetorical debts can be found in the epigraph to the first volume of the 1987 conference proceedings, a quotation from the remarkable polymath C. H. Waddington. “It has always been clear that we were not so deeply interested in the theory of any particular biological phenomenon for its own sake, but mainly in so far as it helps to a greater comprehension of the general character of the processes that go in living

as contrasted with non-living systems.”⁷ This “general character,” then, is the inquiry into those qualities and processes shared by all living things. Michel Foucault, writing in *The Order of Things*, characterized this notion of the unity of life as a break from the classical emphasis on taxonomy, a move toward the underlying unity of the modern notion of life. In the modern comparison of living beings,

The differences proliferate on the surface, but deep down they fade, merge, and mingle, as they approach the great, mysterious invisible focal unity, from which the multiple seems to derive. . . . Life is no longer that which can be distinguished in a more or less certain fashion from the mechanical; it is that in which all the possible distinctions between living beings have their basis.⁸

Rhetorically and scientifically, the description of life changed in the nineteenth century. Specifically, life became an invisible unity, a concealed connection, what Foucault called “the synthetic notion of life,” an object for scientific inquiry. It is this notion, Foucault claimed, that made biology possible in that it unified the diversity of living beings into an object of knowledge and not just an object among others, subject to classification by the natural historian who “is the man concerned with the structure of the visible world and its denomination according to characters. Not with life.”⁹ Biology’s project was, in some sense, to make the invisibility of life visible or at least articulable.

Thus, the biologist is the one for whom life is an issue. Far from self-evident, the invisible unity of life becomes, by the mid-twentieth century, embedded in the rhetoric of secrets, codes, and programs. For Waddington, whose *Towards a Theoretical Biology* sought the “underlying nature of living systems,” “basic sentences in languages are programmes. . . . And it is language in this sense—not as a mere vehicle of vacuous information—that I suggest may become a paradigm for the theory of General Biology.”¹⁰ This dual articulation of life and language as programs—fueled (for Waddington) by Noam Chomsky’s theories of language—makes plausible the analogy between DNA and a computer program.¹¹ What I have outlined previously in this book as “the age of world scripture,” a moment in which the world appears available in its entirety as a code, is a crucial preunderstanding for the linguistic reformulation of the general paradigm of biology. Thus, it is no surprise when we read “On the Seat of the Soul” in the second volume of *Towards a Theoretical Biology*, where computer scientist Christopher Longuet-Higgins opens up the question of computers and vitality: “Computing scientists agree that the idea which made

their whole subject possible was that of the stored program. Well, it seems that nature made this discovery about 1,000 million years ago.”¹² The common rhetoric of the “program” common to both early molecular biology and computer science made plausible the notion that computers could be “alive.” This notion of the program, of course, can be traced to the “tape” of Turing’s machines. As a universal machine, a Turing machine could theoretically “do everything . . . one particular machine could simulate the work done by any machine.”¹³ With Watson and Crick’s model of the double helix, “one can now point to an actual program tape in the heart of the cell, namely the DNA molecule.”¹⁴

We saw earlier that with the rise of biology, life is no longer seen as opposed to the mechanical. After Norbert Wiener’s *Cybernetics* treated both the machine and the animal as economies of control, the “tape” or “program” can be seen to drive both computation and life. Longuet-Higgins, in “On the Seat of the Soul,” writes,

Are you suggesting, then, that life is just programmed activity, in the computer scientists’ sense of “program”? because if so, you will find yourself driven into saying that a computer is alive—at least when it is executing a program, and that strikes me as mildly crazy? . . . Fair enough. But I wouldn’t put it past computing scientists to construct a machine which we would have to treat as if it were alive, whatever our metaphysical objections to doing so.¹⁵

This reticence, the notion of a computer’s vitality as “mildly crazy,” and the fictional, dialogical style of “On the Seat of the Soul” mark the rhetoric of computational vitality as speculative and theoretical. This speculation, however, is not free-floating fantasy; it is a dream grounded in the history of automata and life, a dream based on the scientific desire to “know what life is.” Note, for example, that for Longuet-Higgins, the computer lives as an individual, embodied organism, one that requires the animation of hardware by software. This can be seen to be of a piece with the Cartesian theory of automata, in which the animal’s body is an automaton’s shell “animated” by the soul. So too with the great automata of history—medieval clock “Jacks” whirled with the invisible force of time, Vaucanson’s duck ate to sustain the “stench” of its body, and smart bombs are embodied on a platform of camera, missile, and guidance technology, their identity constituted by their target. By contrast, the “body” of artificial life is often nothing more than a pixel, a flash of signal not unlike a portion of the white noise we see with the impact of a smart bomb.

Researchers Henri Atlan and Moshe Koppel, in “The Cellular Com-

puter DNA: Program or Data?,” recently critiqued the rhetoric of DNA as “program.” They point out that while it is true that the genetic code—the four bases of DNA molecules—and some of its expression is well understood, similar claims cannot be made for the relation of DNA and cell growth and differentiation:

Therefore, the idea of a computer program written in the DNA and controlling the sequence of events which characterizes cell growth and differentiation is more a metaphor than a result of a detailed analysis of DNA structures as carriers of a real programming language. No real computer-like program organized according to syntactic and semantic rules can be identified.¹⁶

Atlan and Koppel’s research underscores the power of rhetorical grids used to articulate and organize scientific research. On the one hand, the program metaphor, and more generally the notion that DNA is information, crystallized and/or framed research on everything from regulation to development, as in the work of Jacob and Monod discussed in chapter 4. “The discovery of regulator and operator genes, and of repressive regulation of the activity of structural genes, reveals that the genome contains not only a series of blue-prints, but a co-ordinated program of protein synthesis and the means of controlling its execution.”¹⁷ On the other hand, the notion of a program foregrounded the immanent power of DNA, reinforcing its status as “Master Molecule” while occluding the complexities of development and growth. Atlan and Koppel argue that it is the metaphor of DNA as program that has encouraged a reductionist notion of biological function, a paradigm that has made plausible the human genome programs. For them, the metaphor of DNA as program masks a lack of understanding:

Nevertheless this lack of a theoretical framework has not prevented the proposal of a research program to sequence the DNA of a whole human genome as a kind of ultimate goal in understanding human nature. . . . Implicit in this proposal is a literal understanding of the genetic program metaphor, looking at the sequence of all the DNA base pairs of a genome as the listing of a computer program.¹⁸

Of course, scientific discourse often deploys metaphors and images from the most recent technologies in its theories, and Atlan and Koppel go on to deploy more timely parallel computer rhetorics in their discussion of DNA. But this begs the question of why the trope of the “tape” or “program” seemed to flow easily from nonliving to living systems. In a

sense, it can be seen as isomorphic with the metonymic displacement of an organism by a code-script that I outlined earlier. The notion that life is a sequence of instructions, rather than produced by the invention of the computer, is actually rhetorically feasible before the widespread notion of the computer program. Indeed, what made the equation between vitality and information possible was a shift not just in the technology of information but in the articulation of life.

The gap remains, however, between Schrödinger, Gamow, and Jacob and Monod's articulation of life as the effect of a program on the one hand and the emergence of artificial life on the other. Despite the assumption that DNA is a program, the idea that computers can therefore "live" was relegated to science fiction or mathematical speculation. The conclusion of most of the metaphorical crossovers between machines and organisms was that organisms were machines, not that machines were organisms.¹⁹ Even Claude Shannon, author of *The Mathematical Theory of Communication*, warned in 1956 against exaggerating the application of information theory to biology:

I personally believe that many of the concepts of information theory will prove useful in these other fields—and, indeed, some results are already quite promising—but the establishing of such applications is not a trivial matter of translating words to a new domain, but rather the slow tedious process of hypothesis and experimental verification. If, for example, the human being acts in some situations like an ideal decoder, this is an experimental and not a mathematical fact, and as such must be tested under a wide variety of conditions.²⁰

Thus, even in the heady days of cybernetics, in which both living and nonliving systems were seen to be economies of communication and control, the comparison of vitality and information processing was just that—a comparison. Of course, as a theoretical and rhetorical tool, this analogy had great effect, and researchers as diverse as Waddington, Jacob, and Barbara McClintock all used the figure of the computer to explain and frame their work. Of course, this never led them to work on simulated rather than conventional organisms—this had to wait for John Horton Conway's game of "Life" in the early 1970s.²¹

Conway, a Cambridge mathematician, invented the game of Life, a cellular automaton, in an attempt to generate complex patterns out of simple rules. In essence, the game consists of a grid, an "unlimited chessboard" (Fig. 3). Each cell on the grid has eight neighbors, and each neighbor's state (empty or occupied) is determined by the following rules:

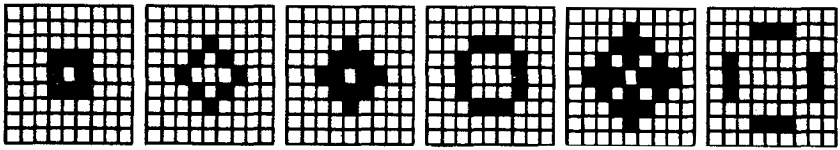


Fig. 3. A Life matrix. Adapted from LifeMaker 2.1 freeware by Jesse Jones, 1990–94.

if a cell is empty, it stays empty unless exactly three of its neighbors are occupied, in which case it will be occupied in the next generation. A cell remains occupied as long as two or three of its neighbors are occupied. These simple rules governing the occupation or evacuation of cells were translated into states: occupied = “alive”; empty = “dead.”

How did the cell states come to be regarded as “alive” or “dead?” The constraints of textual articulation make it difficult to demonstrate the uncanny movement of “Life” cells, but it is the seeming autonomy and unpredictability of cell states that provoke this vitality effect.²² Mathematician Karl Sigmund’s description points to this “autonomy” effect; it is the notion that somehow humans are superfluous to the game:

Life is not a two-person game like chess or checkers; neither is it a one-person game like patience or solitaire. It is a no-person game. One computer suffices. Even that is not strictly required, in fact, but it helps to follow the game. The role of human participants is reduced to that of onlookers. Apart from watching the game, one has just to decide from which position to start. All the rest proceeds by itself.²³

I will return to this claim that somehow Life and artificial life can be separated from their descriptions and observations. For now, I want to note a tension between this description of autonomy and another claim, a claim that Sigmund makes for “Life’s” method of propagation: “In the early 1970s, at a time when computer viruses were not yet an all too common plague, there was another type of epidemic causing alarm among computer owners. It [Life] used the human brain as intermediate host.”²⁴ Significant here is the recognition that humans occupied a crucial place in the network of machines and codes that made Life possible. As an “intermediate host,” they were a necessary element of Life’s ecology. Thus, while it is true that no individual move in Life necessitates any human action, the game itself required human “wetware.” And while it is no doubt true that the playful aspects of Life were of a cognitive kind, the human brains themselves did not have any unmediated access to Life; they

required a crucial interface in order to run Life: that is, language, rhetorical softwares, other humans with which to deploy these softwares.

Still, despite the popularity of Life, it was left to Langton to link the early efforts of Waddington's theoretical biology group—Howard Pattee, Michael Arbib, and others—with the new hardware and software available in 1987. And yet this link was not determined by the exponential increase in computer power that took place between 1972—the last conference on theoretical biology—and 1987. Rather, it was the tenuous result of the intersection of the rhetoric of life as information, an accident, and some visions.

A Vision of A-Life

“Smashing into the ground shook a whole bunch of neurons loose . . . I was in and out of consciousness while I was on the ground, and it was interesting to feel my consciousness sort of bootstrapping itself up, going out, then coming back up again.”²⁵ Chris Langton, in a bizarre rewriting of the Icarus myth, broke 35 bones in a hang glider crash and experienced a vision of artificial life: “Propagating information structures” filled the space between consciousness, bootstrapping, and the void, and Langton—or whoever was able to situate Langton's lack of consciousness—found the hidden meaning of the emerging chiasmus between living and nonliving systems. What crystallized A-life and allowed it to emerge as a discipline, an empirical and practical science, was a combination of three vectors, one leading from a rhetoric that equated living and nonliving systems (“propagating information”), new sources of cheap and powerful computers, and a founding event reminiscent of religious, not scientific, narratives.

My point in invoking Chris Langton's crash is not to indulge in petty psychology or to trivialize the pain that he experienced. I refer to it only in the form of a self-description by him, a description that by now has taken on nearly mythical attributes in the A-life community. I mention it here in an attempt to understand the genesis of A-life—to leave it out would be to overlook one of the major tropes mobilized by A-life participants.²⁶

For it is as a trope that Langton's crash is illustrative: faced with a horrible and inarticulable event, Langton explicates the event in transcendental terms through a consciousness radically exterior to the event he is “himself” experiencing. Both in and outside of the event, Langton's narrative relies on the possibility of occluding the fact that “he” was

involved. Langton narrates the crash as if he were watching some other, deploying some “other reason.”

Thus, it is not just any narrative technique that Langton deploys—it is one that allows him to draw fruitfully on the experience as an originary moment of A-life. This tactic, I will argue, is iterated across the discourse of A-life and is in fact constitutive of A-life as “life.” It is an element of what Brian Rotman has called the metacode in the context of a semiotics of mathematics. While Rotman refers to mathematics proper—the sanctioned signs for conducting mathematics—as the “Code,” he argues that such a code can operate persuasively only through the deployment of “the *metacode*, the penumbra of informal, unrigorous locutions within natural language involved in talking about, referring to, and discussing the Code that mathematicians sanction.”²⁷ Similarly, I would like to argue that the discourse of A-life is (literally) made up of code (the computer instructions or recipes for constructions of robots) and a metacode (the means of persuasively explicating A-life projects as “life.”) In “The Classical Age of Automata,” Jean-Claude Beaune writes of the importance of this kind of metacode or rhetorical software for automata:

An automata is not just a machine, it is also the language that makes it possible to explicate it. At a more general level, the automaton is the language that endows the people who are meant to know and communicate it with the privileges of totality which rational man thought he no longer had to confront. It is an experience devoid of rest, pity, or distance; the limit of technology becomes the language of the technostructure.²⁸

In short, artificial Life—artificial organisms—must be seen not only as a product of the technical inputs of hardware and software. Rather, it is networked with the modes of explication that make it possible to recognize A-life as “life,” rhetorical softwares that are themselves not explicit objects of A-life. What makes it possible to explicate artificial life, what makes the claim that synthetic organisms are in fact alive, eat, have sex, and so on, is above all the notion that in essence, organisms are sequences, and these sequences are somehow completely exterior to the human economy that has coincided with their replication. Langton’s crash—a crash that, as we shall see, leaves its traces on A-life—can be seen as an origin story of a most religious kind, a combined Icarus and resurrection myth, a new story of transcendentalism told in an old form.

Both literally and metaphorically, the accidental genesis of artificial life can be seen as part of a what David Lavery has called a culture of

“spaciness,” a culture in which the extraterrestrial imperative runs strong and deep.²⁹ While it seems natural, at this point in American culture, to recreate by getting off the earth, I would suggest that the desire to achieve a position as a transcendental observer, to be off the earth, out of the body, or beyond the living, networks together Langton’s sport, his visions, and his work of choice. A closer look at both Langton’s 1980 text “Artificial Life” and the details of its genesis will flesh out and support my claim.

It is obvious, of course, that a hang glider is a technology that produces lift, a machine with which one can leave the earth, look down, and enjoy the view. It is, in this literal sense, a transcendental machine, a pleasure or sport of looking down and over. It is also clear that Langton, as an observer of his own loss and acquisition of consciousness, somehow, impossibly occupies a similar transcendental (or at least radically reflexive and narcissistic) position. It is perhaps not so obvious that the drive behind A-life, the desire to study alternate, noncarbon-based life forms, also takes a transcendental shape. The metaphors of A-life help attest to this: “Artificial Life starts at the bottom, viewing an organism as a large population of simple machines, and works upwards synthetically from there.”³⁰

While it would, of course, be hasty to conclude from this convergence of spatial and spacey metaphors that A-life’s formal metaphorical structure maps onto the material structure of hang gliding, further analysis of Langton’s text will allow this rhetorical matrix to emerge. The takeoff of artificial life was helped along by a glider. In his discussion of cellular automata (CA), Langton sees a glider: “Many of these configurations seem to have a life of their own. Perhaps the single most remarkable structure is known as the glider. . . . The glider is one instance of the general class of propagating structures in CA. These propagating information structures are effectively simple machines—virtual machines.”³¹ Neither a brief glimpse nor a careful study of the pattern of the “glider” reveals the essential glider morphology of the pattern of pixels. Instead, what allows this “glider” automaton to emerge, what explicates it as a “glider,” is the rhetorical and metaphysical background of A-life, a background constructed out of, among others, the spatial metaphors of “bottom up,” “emergence,” and “gliders,” metaphors that situate A-life as a transcendental place from which to view traditional, carbon-based life—Nietzsche’s “another life” against which we can compare our earthly one. The rhetorics and gestalts of emergence resonate with a “view from above,” what Donna Haraway has dubbed the “god trick,” a gaze from

nowhere and everywhere that characterizes the disembodied objectivity of technoscience.

Indeed, the “glider” morphology was not invented by Langton but by Richard Guy. Working with Conway’s game of Life, Guy observed one configuration of the simple on/off cells that moved “purposefully.”

When the configurations tumbled off the single Go board, the players would hastily place sheets of paper on the carpet and draw squares on them to extend the grid. It was, in fact, on the carpet that Guy found the glider. Once the glider managed to get away from the main configuration, of course, it headed off the papers, out of the room, and in theory, out of Cambridge, out of England, out of everywhere.³²

Tumbling and not crashing, the emergent glider floats above “everywhere,” reaching a transcendental beyond, an “eternal mist.”

This is not, of course, to say that the metaphors that float around A-life determine the empirical practice of A-life or that these rhetorics somehow turn an empirical practice into a metaphysical, transcendental one. Rather, my claim is that these rhetorics are traces of a very particular style of transcendentalism, one that seeks science’s traditional, “detached” position off the earth but not out in space. Langton chooses the silicon path, not the extraterrestrial one, but A-life nonetheless seeks to leave the earth behind, working upwards . . .

Earlier, I suggested the problematic nature of Langton’s self-reflection, insofar as it required him to abstract himself from his own consciousness to meditate on his own lack of consciousness, a problematic transcendental position. Similarly, the project of A-life, in its logical justification, relies on the very transcendental, metalife position that it seeks. A-life, after all, arises out of the desire to find a general theory of living, a theory that takes in the full view of the “general phenomenon of life—life writ-large across all possible material substrates.”³³ A-life seeks to derive the formal nature of the living system, life’s algorithm, by abstracting it from its material, carbon-based prison: “life, as a physical process, could ‘haunt’ other physical material.”³⁴ Hovering above the science of the actual is the science of the possible, A-life’s object—“life-as-it-could-be.”

And yet how would we authenticate a siting of this haunting? Given that the genetic problem of A-life is the lack of an adequate definition of life, whence comes our criteria for selecting the proper objects of artificial life from the pretenders? The answer is, of course, in practice. The performance of A-life, given the lack of immutable criteria for “life,” relies on its

rhetorical software for its plausibility and its fascination. “An automata is not just a machine, it is also the language that makes it possible to explicate it.” This language, metacode, or rhetorical software, despite Langton’s goal of finding the “essence” of life, in fact works toward another goal, the evaporation of the difference between living and nonliving systems. “We would like to build models that are so lifelike that they would cease to be models of life and become examples of life themselves.”³⁵ In the absence of any adequate pre-given definitions of life, the plausibility of A-life creatures rests on their ability to simulate something for which we have no original, “lifelike behavior.”³⁶

Thus, we can see a central, centering conflict in the rhetoric of artificial life. On the one hand, Langton, following Waddington, seeks a theoretical basis for a general theory of life. He seeks access to something like the “invisible unity” that life had become by the nineteenth century, a process always and everywhere the same but occulted. Of course, Langton’s universal life need not be occulted; there is no structural limit that must hide life, as with Nietzsche’s “another reason.” Toward that end, Langton seeks what he calls the “essence” of artificial life, the mechanistic formal basis of all living systems, carbon or otherwise, which “must share certain universal features.” Indeed, the *raison d’être* of A-life is a source of life beyond carbon-based life, a view from above where a general theory of life could be found. In this sense, A-life is an attempt to determine the formal (if not actual) origin of life, the possibility conditions from which any life could emerge. On the other hand, Langton’s quest for creatures that blur the boundaries between living and nonliving systems, simulated and real life, highlights the paradox that A-life depends in its simulations on the ability of computers to generate models of life without any origin or “invisible unity.” They are “synthetic” creations, maps for which there is no territory. That is, what makes possible the substitution of the signs of life for life is the reproducibility of “lifelike behavior,” a reproducibility that ultimately points to the fact that A-life organisms are themselves reproductions, simulations cut off from any “essence” of life.³⁷ With no origin in vitality, no “parents,” the emergent creatures of A-life float unattached to any anterior essence. This “unmoored” nature of A-life simulations threatens the very project of a unified account of life as they continually threaten the definitional coherence of “life.”

Part of these simulations—the crafting of lifelike behavior—are the rhetorics and descriptions of the A-life project. Without a rhetorical and historical tendency to metaphorize life in terms of information, artificial

life, as a practice, would be of no more interest than other abstract theoretical problems of computability. A-life research, along with many other branches of computer science, would merely be concerned with what it is possible to produce with a computer, what the limits of the function of computers might be. This is—or at least can be—a very different project than determining the limits of life. The genesis of A-life in a begged question and a crashed glider are more than just confirmation of our hunch that the extrascientific suffuses science. Rather, the textual strategies and founding events of A-life point to the unspoken rhetorical frames, the limits of the technoscientific structure that make A-life plausible.

Baudrillard and Life's Fatality

“The age of simulation thus begins with a liquidation of all referentials—worse: by their artificial resurrection in systems of signs. . . . It is no longer a question of imitation, nor of reduplication, nor even of parody. It is rather a question of substituting signs of the real for the real itself.”³⁸ The obscenity and giddiness with which Jean Baudrillard “challenges” the questions of theory and history simulates an “implosion” of the universe and its description, an implosion that he claims is allegorized by such technoscientific events as the transcription of the genetic code and the deterrence machine of nuclear weapons. Specifically, he diagnoses a veritable disappearance of the real, a “desert of the real” where all the dreams of distinguishing between authentic and simulated experience are impossible. While I disagree with Baudrillard’s obscenely absolute vision of the exhaustion of authenticity, his analysis of the symptoms of simulation’s conflation between the real and its models helps explain the plausibility of the practices of artificial life. Specifically, Baudrillard’s analysis of the age of simulation historically and theoretically situates the rhetorical spark that is invested in computer models. In this section I will outline the ways in which what Baudrillard calls the “precession of the simulacra” produces one-half of the central problematic of the rhetorical software of artificial life, the knot of contradiction formed when an essentialist project gets intertwined with simulation.

Artificial life, as I have attempted to show, is in the business of creation, the production of models that paradoxically lack an original. No bundle of traits or effects are sufficient to define the “living.” Once housed in an invisible unity, then a “secret,” life now finds itself without an address. For Baudrillard, the definition of the real is in a similar position:

“The very definition of the real becomes: that of which it is possible to give an equivalent reproduction.”³⁹ In contrast to the classical theory of representation, in which models reflect the basic reality of nature, or the modern notion of the distorting effect of the model, the age of simulation redefines the real as that which can be replicated. The very distinction between the universe and its description disappears; it is, not, as has frequently been claimed, that the real no longer exists, although Baudrillard frequently slides into this usage. Rather, the real *disappears*, no longer available to the inquiring gaze, as it becomes a reef of simulacra. Neither that which provokes representation (classical) nor that which resists representation (modern), the real in the age of simulation is that which can be copied. This logic of the simulacrum, it would seem, extends to life, and not just *artificial* life. According to Richard Dawkins, a sociobiologist and one of the first A-life conference participants, “all life evolves by the differential survival of replicating entities.” Vitality too, in the age of simulation, is that which can be “xeroxed.”⁴⁰

And yet an effect of xeroxing is that we often forget the original. In fact, Baudrillard, following and forgetting Benjamin, claims that the original disappears in the endless proliferation of replicants. Replication also allows forgery, and thus the problem of authenticity haunts the regime of replication. Baudrillard deploys the analogy of a feigned illness that haunts medicine: “For if any symptom can be ‘produced,’ and can no longer be accepted as a fact of nature, then every illness may be considered as simulatable and simulated, and medicine loses its meaning since it only knows how to treat ‘true’ illnesses by their objective causes.”⁴¹

The reproducibility of “lifelike behavior” and the ultimate substitution of the signs of life for life also lead to a problem for theoretical biology in that it only knows how to study “true” life. Rather than anchoring biology with a transcendental, comparative perspective, the simulation of life announces the absence of any original, unified notion of life in contemporary biology. It launches biology into the age of simulation, in which life is not only that which can be reproduced, but that which is always already, possibly, reproduced.

And yet these artificial life constructions are models of nothing, no thing. Vitality, as a contested series of effects rather than a determinate, localizable essence, is the result not of mimesis but of simulation, where simulation need not refer to any stable original. In Baudrillard’s terms, “The real is produced from miniaturised units, from matrices, memory

banks and command models—and with these it can be reproduced an indefinite number of times. It no longer has to be rational, since it is no longer measured against some ideal or negative instance. It is nothing more than operational.”⁴²

Artificial life’s operational reality or plausibility is at once essentialist and constructivist. By this I mean that no “ideal or negative instance” references the vitality of an A-life creature, and yet this reference—a general theory of the living—is precisely the goal of artificial life. This produces a frenzied spiral of experimentation, performance, and debate around the blurred lines between living and nonliving systems. Without hard and fast criteria for life, A-life takes refuge in what Baudrillard calls a kind of “military psychology”: “Even military psychology retreats from the Cartesian clarities and hesitates to draw the distinction between the true and false, between the ‘produced’ symptom and the authentic symptom. ‘If he acts crazy so well, then he must be mad.’”⁴³ Similarly, if an artificial life creature simulates life so well—*whatever that may mean*—then it must be alive. The “Artificial Life 4H Show,” a display at A-life conferences of the latest A-life creatures, is, seen in this light, a baroque exhibit of the absence, not the presence, of lifelike behavior. In an age of simulation, with no original, no reference standard for lifelike behavior, “no fact of nature” to ground A-life models, A-life exhibits are playful and powerful experiments, creations of a new order of complexity and power, an order characterized not by its relation to any preexistent model of life but rather to a performance of power that conceals itself as such, that looks “like” life. They are at the same time an attempt to restore life to its foundations by determining the formal nature of all life, since “this death of the divine referential has to be exorcised at all cost.”⁴⁴

Life’s Sovereignty

For, ultimately, or perhaps from the beginning, this “quest for creation” is a quest for a little bit of referentiality. Specifically, the search for the “universal” nature of life’s character tells an allegory of power, a story of a gnostic notion of life that restores life as a unified concept. C. H. Waddington, who provided some of the ur-texts for artificial life, wrote of the profound impact of this notion on his work.

The world egg. “Things” are essentially eggs—pregnant with God-knows-what. You look at them and they appear simple enough, with a bland definite shape,

rather impenetrable. You glance away for a bit and when you look back what you find is that they have turned into a fluffy yellow chick, actively running about and all set to get imprinted on you if you will give it half a chance. Unsettling, even perhaps a bit sinister. But one strand of gnostic thought asserted that everything is like that.⁴⁵

This metaphysical background of Waddington's scientific work—what he called “software”—encouraged his interest in process, the Whiteheadian notion that scientists study “occasions of experience,” unities that unfold over time, rather than reductionist hunks of stuff. Langton, too, experienced the effect of this “glance away”:

The computer was running a long Life configuration, and Langton hadn't been monitoring it closely. Yet suddenly he felt a strong presence in the room. Something was there. He looked up, and the computer monitor showed an interesting configuration he hadn't previously encountered. “I crossed a threshold then,” he recalls, “it was the first hint that there was a distinction between hardware and the behavior it would support. . . . You had the feeling there was really something very deep here in this little artificial universe and its evolution through time.”⁴⁶

It is this “glance away,” or “looking up,” and the events that take place between observations, that I want to focus on here. The radical potentiality of “world as egg” makes plausible the remarkable question begging with which A-life began. Held hostage in a terrestrial, carbon prison, A-lifers, like the Gnostics, see the potential for life elsewhere, in noncarbon-based “eggs.” A-life programs are at once exterior to human beings—hence the look away, the sense of autonomy—and disturbingly implicated in them: “all set to get imprinted on you if you give them half the chance.”

Thus, A-life operates in a postvital space, a space of no difference between living and nonliving entities. Cosmologically, one A-lifer remarks that “we had no proof that this universe in particular was not a CA [cellular automata], running on the computer of some magnificent hacker in heaven.”⁴⁷ Of course, it is also true that no positive evidence exists to suggest that it “is.” Similarly, no positive evidence exists to suggest that life is not confined to carbon. Rather, A-life rests on a narrative, a belief buttressed by glances through a gnostic, simulated lens. This lens—whose optics determine what is seen at a glance and what is concealed—is what helps Langton “cross the threshold” to belief in artificial life. It is a vision whose effect is “to discard or lighten all the matter of this world, that is the strange end the Gnostics pursued. . . . And so in the Gnostic mythology, Christ, for example, was idealized as a being who ate and drank but did

not defecate. Such was the strength of his continence that foods did not corrupt him.”⁴⁸

That is, the flight from the “curse of the world,” the desire to get above “everywhere,” is also an attempt to shed, or at least lighten, the body. In “a look pregnant with god knows what,” a look that “crosses a threshold,” Richard Dawkins glances out his window:

It is raining DNA outside. . . . Up and down the canal, as far as my binoculars can reach, the water is white with floating cottony flecks, and we can be sure that they have carpeted the ground to much the same radius in other directions too. The cotton wool is made mostly of cellulose, and it dwarfs the tiny capsule that contains the DNA, the genetic information. . . . It is the DNA that matters. The whole performance, cotton wool, catkins, tree and all, is in aid of one thing and one thing only, the spreading of DNA. This is not a metaphor, it is the plain truth. It couldn't be any plainer if it were raining floppy disks.⁴⁹

What Dawkins sees, and does not see, tells the story of (American) A-life. With a kind of X-ray vision, Dawkins sees through the fluff of cellulose and locates the essence of life, DNA. This essence is everywhere, “as far as my binoculars can reach,” floating, and it is not a metaphor. It is that which can be replicated, that which is real, that which can live. And this vision is itself metaphorical; rather than simply looking through the fluff and “seeing” the kernel of essence, DNA, inside, Dawkins claims to literalize this vision, render it plain through the deployment of a metaphor that is denied metaphorical status. And yet this vision hides as much as it reveals: as Atlan and Koppel, among others, point out, the “program” or floppy disk of DNA is not itself sufficient for life. The “fluff” that Dawkins disparages in the name of “plain truth” is more than a mere husk or tool; in its movement and “performance” it literally makes life possible. In a sense, it is nonsensical, or at least certainly not “the plain truth,” to speak of the spread of DNA without remembering the spread of organisms. So too with Langton's recognition of the “presence” in the form of an “interesting configuration” on the screen—it requires a deletion or overlooking of the computer in the gaze at the “organism” on, in, the screen. The extra husk or container of the synthetic organism, the computer, is treated as a mere fluff, a platform for the real, artificial life. Tom Ray's description of his *Tierra* program, one of the earliest and best-known A-life programs, illustrates this as well:

Synthetic organisms have been created based on a computer metaphor of organic life in which CPU time is the “energy” resource and memory is the “material”

resource. Memory is organized into informational patterns that exploit CPU time for self-replication. Mutation generates new forms, and evolution proceeds by natural selection as different genotypes compete for CPU time and memory space.⁵⁰

Synthetic organisms based on a computer “metaphor;” indeed, based on a *computer*. As in Atlan and Koppel’s critique of the genome projects, where “Implicit in this proposal is a literal understanding of the genetic program metaphor, looking at the sequence of all the DNA base pairs of a genome as the listing of a computer program.”⁵¹ So too, Thomas Ray’s Tierra program creates “genomes” composed of “information patterns.” In order for these “genomes” to be seen as “synthetic organisms,” Ray must, like Dawkins, see through the fluff of the computer. That is, the same vision that allows Dawkins to literally equate a floppy disk and a “cottony fleck” allows Ray to overlook the dual platform of metaphor and computer that allows his synthetic creatures to emerge. Langton might call this an attention to the formal aspects of life, but a closer look at Ray’s program shows that his abstraction relies on two metaphors that are systematically occluded.

First, the idea of DNA as a program makes possible the very idea that a “genome” could be produced on a computer. This rhetoric—like Dawkins’s notion that DNA is a floppy disk “is not a metaphor, it is the plain truth. It couldn’t be any plainer if it were raining floppy disks”—systematically deploys metaphors while refusing them. The very notion that DNA is equivalent to a floppy disk requires us to forget that, unlike a floppy disk, DNA materially “contains” the instructions for the replication not just of itself, but of an organism, its “reader.” Of course, no DNA “itself” can do this; as we have seen throughout this book, such a complex system emerges from the relations between organisms and their environments. Second, when we look at the screen full of A-life organisms, we must forget the “body” of A-life, the technological ensemble of discourses and computer that are its food, environment, body, and explication. For the computer does not display emergent behavior; no computer hardware is replicated—only the “interesting configuration” on the screen produces this kind of performance. Thus, to succeed, an A-life performance must hide a synthetic organism’s dependence on a computer, an operating environment, and its rhetorics just as molecular biology has often occluded the dependence of DNA on its organismic context.

Thus, by taking the metaphor of “program” literally, Ray, Dawkins, and other A-life researchers repeat, with a different inflection, some of the

rhetorical moves that made nascent molecular biology plausible. Atlan, Koppel, and others point out the power of the “program” to orient life science research toward sequencing at the expense of work on the complexities of expression and development. By focusing on the “genomes” of synthetic organisms, A-life performances succeed in producing the effect of “lifelike” behavior in a context of simulation, with no original. They thus effectively mask the absence of any unified notion of life in contemporary life science by preserving the idea that there is something called “life,” giving a sense of reference to the concept of life even as it is being displaced. But this performance has a price. By following the implicit model of life as a kind of program, A-life obscures the very questions of morphogenesis, growth, and expression—those events that take place during the “glance away”—that motivate the search for a “general theory of life.”

It may seem that some of the fundamental vectors of both A-life and gnostic thought are contradictory, or at least in tension. For example, it may seem upon reflection that the notion of a world in a state of becoming, a Waddingtonian “world egg,” would be in opposition to the notion of a cursed world of humans shackled to bodies. But this tension gets mediated through the implicit model of the body in both artificial life and gnostic thought. While the regime of molecular biology, which under Schrödinger, literally forgot the body as it contained it in the code-script, artificial life operates on a memory of the body. Whereas the idea of a DNA code-script, a program, or “selfish genes” tended to, as in Dawkins’s gaze, overlook or forget the body of the organism, artificial life deploys a model of the body in which genetic sequences *are* bodies, “informational patterns that exploit CPU time for self-replication.”⁵² One sign of this is the “spontaneous sexuality” of Tom Ray’s Tierra organisms, in which the “sloppy replicators . . . allow for recombination and rearrangement of genomes.” Sex here is pure exchange without action or gesture; no worldly work need contaminate the pure “bodies” of A-life organisms. Such is the strength of their continence that sex does not corrupt them. Thus, as long as the “glance away” masks the work of emergence—whether it be the struggling chick or the flashing of a pixel—the purity of the A-life organism remains intact, its growth a product only of time. Indeed, in the cases of both the game of Life and the chick, it will only be a matter of time before they seek to leave the cursed earth to float or fly “above everywhere.”

It seems clear that the universality of the genetic “program” both

provokes and encourages the notion that (1) there exist universal attributes of life independent of substance and (2) that thinking that prioritizes and essentializes DNA allows for the crossover between information and life.⁵³ But this explanation fails to account for the appeal of A-life in particular. Jean-Claude Beaune gives us a clue: “sharing in the trickery of the automaton is merely another way to define ourselves as human, that is, as both being and nothingness, presence and absence; the automaton is, in a way, our mirror . . . or our evil eye.”⁵⁴ In an age of simulation, where no original stable referent for “life” survives, A-life provides not a mirror but a screen for the definition of life and the human. The screen masks the “sinister” mediation of genotype to phenotype and provides a place for us to glance, “to notice something very deep here in this little artificial universe and its evolution through time.” The art of the automaton has always been the “trickery” that concealed the differences between machines and humans. The art in artificial life now conceals the absence of this same difference, as all of life, artificial and otherwise, becomes “propagating information.” Despite (or because of) the lack of a unified definition, A-life promises to show us what life is. The power of powerful computers enforces the rhetoric of life as program, an enforcement possible through the power of concealing and revealing that has reshaped the scientific concept of life in the late twentieth century. The computer makes feasible Schrödinger’s dream of the code as both “law and executive power,” but it is feasible only as long as the computer itself, and its (rhetorical) “power,” is hidden as the matrix that makes it possible for information to become an organism and for organisms to become information.

This need not just for law but for “executive power” in the code-script or sequence has led to a takeover, what origin-of-life theorist A. G. Cairns-Smith has called a genetic takeover, of the body by the machine. But this is not a takeover of the sort discussed by Cairns-Smith or fantasized about by computer scientist Hans Moravec. Rather, it is a discursive takeover that reorganizes, but does not dispense with, the body. “What awaits us is not oblivion,” Moravec writes in *Mind Children*, but rather a future in which

It is easy to imagine human thought freed from bondage to a mortal body—belief in an afterlife is common. . . . Computers provide a model for even the most ardent mechanist. A computation in progress—what we can reasonably call a computer’s thought process—can be halted in midstep and transferred, as program and data read out of the machine’s memory, into a physically different computer, there to resume as though nothing had happened. Imagine that a

human mind might be freed from its brain in some analogous (if much more technically challenging) way.⁵⁵

“As though nothing had happened”: this shift in the notions of life and information works precisely through its ubiquity, its banality, and its lack of visibility. In *The Birth of the Clinic*, Michel Foucault has shown how the “distributions of illness” have been historically constituted. The modern geometry of disease, in which sickness is localized in the body, is shown by Foucault to be one map among others of the ill body. This map, besides localizing disease, also provides us with an outline of the morphology of power, a power that selects, outlines, and organizes the body and its relations. This is, in fact, what power is for Foucault—the network of relations that make utterances and knowledges possible. So too, I would suggest, can the distributions of “life” shift through biology’s new rhetorical software, tropes that both highlight and obscure different maps of “vitality.” The “glance away” that installs new concepts of vitality is a gaze built out of a gap, a structural blindness, a blindness that requires but does not see bodies; it sees only sequences, genomes that are bodies. Michel Serres has dubbed this “bureaucratic power,” in which “The manual laborer has to be blind in relation to the paralyzed intellectual. The helmsman has no porthole. . . . This cybernetics gets more and more complicated, makes a chain, forms a network. Yet it is founded on the theft of information, quite a simple thing. . . . In the end, power is nothing else.”⁵⁶

Rather than being based on a “theft of information,” I would argue that this network is based on connections. What makes possible the explanation of the moments of the “glance away” is what I have referred to previously as the metacode or rhetorical software. An example from one of Tom Ray’s recent papers helps make this point:

Modern evolutionary theory is firmly based on the duality of the genotype and the phenotype. However, Barbieri (1985) has described a new view, in which life is based on a trinity of genotype, phenotype and ribotype. At the molecular level, the genotype is the DNA, the phenotype is the proteins, and the ribotype is the collection of molecules and structures based on RNA, i.e., the mRNA, tRNA and the ribosomes. The latter group of molecules, referred to collectively as the ribosoids, perform the critical function of translating the genotype into the phenotype.⁵⁷

Ray goes on to claim that in his system it is the “decoding” unit that performs this ribotypic function. But such an account overlooks and

disavows the connections and translations forged by A-life researchers, who, like the “human brains” that hosted the initial propagation of Conway’s life, are crucial elements of the A-life ecology. A-life researches, explicated as life and not merely as interesting tests of computation, are enmeshed with the translational practices that transform the “genotype” (the codes of Tierra) into phenotypic, “lively” creatures, translational practices that include their own disavowal. Indeed, in some sense *A-lifers are part of the phenotype of Tierra*.⁵⁸

But like the “selfish gene” discussed by Richard Dawkins, in which organisms are merely “lumbering robots” that exist only for the purpose of propagating copies of a genome, Tierra organisms are folded across time and space. They are beyond living, only descending to vitality momentarily. Their ability to “live” without time or space, or at least to be suspended across time and space, is summed up in a recent proposal written by Ray: “It is now possible to bring the system down and then up again in the middle of a run without loss of information. It is also possible to fully recover from a hardware crash, and continue the run without having to start over.”⁵⁹

Artificial life, where bodies flash as pixels, executes the Watsonian fantasy of knowing “what life is.” Watching A-life organisms on the screen, in a certain way allows us to watch the struggle for power, if power is what allows foregrounding of some effects and problems over others. Like all classic automata, it is what we do not see, as well as what is simulated, that allows something like “life” to “emerge.” Here I again follow Nietzsche’s prescient diagnosis. While he wrote of the Darwinian “struggle for Life,” his analysis seems more fit for an account of A-life in the twilight not of idols but of vitality: “Where there is a struggle, it is a struggle for power.”⁶⁰ That power, in an age of simulation, is the power to achieve the “impossible”—to mime an absent origin, “life.”

Reference Matter

Notes

Chapter 1

1. We could compare this fracturing of “life” to the magnification of a line in mathematics, where what appears to be a continuum breaks up into multiple, divergent, and discrete points. My thanks to Brian Rotman for this insight.

2. There will be many more, but here I offer embarrassment no. 1. In *The Anthropic Cosmological Principle*, by John D. Barrow and Frank J. Tipler, the definition of life becomes a defining moment in this grand, or not so grand, narrative. Through an almost Pynchonian methodology, in which Barrow and Tipler notice that “over many years there had grown a collection of largely unpublished results revealing a series of mysterious coincidences between the numerical values of the fundamental constraints of nature. . . . These relationships and many other peculiar aspects of the universe’s make up appear to be necessary to allow the evolution of carbon based organisms like ourselves.” And yet, faced with the task of defining life, Barrow and Tipler’s come up murky. Perhaps it would be appropriate to rephrase the anthropic principle as follows: the universe appears to be such that beings incapable of defining life must appear. See Barrow and Tipler, *Anthropic Cosmological*, pp. 511–23.

3. Here I roughly follow Barbara Johnson’s algorithm for the strategy of deconstruction: “In its elaboration of a critique of the metaphysical forces that structure and smother difference in every text, a deconstructive reading thus assumes: (1) That the rhetoric of an assertion is not necessarily compatible with its explicit meaning. (2) That this incompatibility can be read as systematic and significant as such. (3) That an inquiry that attempts to study an object by means of that very object is open to certain analyzable aberrations. . . . (4) That certain levels of any rigorous text will engender a systematic double mark of the insistent but invisible contradiction or difference . . . which is necessary for and in the text’s very elaboration.” See Derrida, *Dissemination*, translator’s introduction, p. xvi.

4. For an exhaustive and nuanced account of the institutional imprinting of life science, see Kay, *Molecular Vision of Life*.

5. Žižek, *Sublime Object of Ideology*, p. 43.

6. Schaffer and Shapin, *Leviathan and the Air Pump*, p. 61.

7. Nietzsche, *Untimely Meditations*.

8. Derrida, *Margins of Philosophy*, pp. 219–20.

9. In the life sciences themselves, we could look to the work of D'Arcy Thompson for a description of ways the “conformation” or morphology of organisms are maps of the forces that make them up: “In short, the form of an object is a ‘diagram of forces’ in this sense, at least, that from it we can judge of or deduce the forces that are acting or have acted upon it. . . . In an organism, great or small, it is not merely the nature of the motions of living substance which we must interpret in terms of force (according to kinetics), but also the conformation of the organism itself, whose permanence or equilibrium is explained by the interaction or balance of forces, as described in statics” (*On Growth and Form*, p. 11). Here, in like fashion, I would suggest that we may also read out the forces of rhetorics by tracing out the “virtual” body I discuss later.

10. Indeed, in this sense one could point to the gene as an “obligatory passage point” in Bruno Latour’s sense, insofar as any contemporary account of life, cognition, or behavior must “pass” through the site of genetics. See Latour, *Science in Action*, p. 245.

11. See Derrida, “Signature, Event, Context” in *Margins of Philosophy*, p. 309.

12. Deleuze and Guattari, *What Is Philosophy?* p. 117.

13. *Ibid.*, 116.

14. *Ibid.*, 118.

15. Judith Butler highlights this relational and temporal account of matter in her *Bodies That Matter*: “In both the Latin and the Greek, matter (*materia and hyle*) is neither a simple, brute positivity or referent or a blank surface or slate waiting an external signification, but is always in some sense temporalized. This is true for Marx as well, when ‘matter’ is understood as a principle of *transformation*, presuming and producing a future” (p. 31). Obviously, this notion of “framing” bears some resemblance to Heidegger’s account of the *gestell*.

16. This was the title that Donna Haraway gave to a conference at the University of California Humanities Research Institute. Interestingly enough, that title was rejected as the title for the book of essays that emerged from the conference, now entitled, *Are Genes Us? Social Implications of the Human Genome Initiatives* (Rutgers, 1994).

17. Judith Butler, following Derrida, formulates a notion of the performative that operates according to a similar “falling away”: “a performative works to the extent that it *draws on and covers over* the constitutive conventions by which it is mobilized. In this sense, no term or statement can function performatively without the accumulating and dissimulating historicity of force” (*Bodies That Matter*,

p. 227). My inflection toward the functive rather than the performative in this book is an attempt to think the force of rhetoric in domains other than that of subjectivity and identity. As Butler has pointed out, the example of the wedding ceremony in Austin's account of the performative is not merely one example among others; it marks the manner in which the performative "operates as the sanction that performs the heterosexualization of the social bond" (p. 226). So too would I argue that the persistent invocation of the "I" as the site of the performative—however coherently and brilliantly problematized—renders the performative less useful as a concept for technoscientific discourse, a discourse populated with actants unable to enunciate "I" but that nonetheless seem to exercise force.

18. For an aggressive reading of the rhetoric and fetish of the fetus, see Harold Bloom's *The American Religion: The Emergence of the Post-Christian Nation*. Hans Moravec's *Mind Children: The Future of Robot and Human Intelligence* is a kind of manifesto for the overtaking of flesh by silicon (see also chapter 6 in this volume). Donna Haraway's *Simians, Cyborgs, Women* wonderfully articulates and empowers the subject positions named. Avital Ronell's *Dictations* traces the remote-control effect within the structure of a literary haunting, and her *The Telephone Book* describes a technobody neither alive nor dead but on the line: "Desire has been rerouted, computerized, electrocuted, satellited according to a wholly other rhetorical order" (p. 110). Strangely, *The Telephone Book* has barely begun to haunt discussions of contemporary technoscience. This volume will attempt to highlight one element of the rhetorical ordering that Ronell has networked: the role of molecular biology in inscribing an a-vital or postvital body through DNA and its softwares.

19. Massumi, *User's Guide*, p. 46.

20. Keller, *Secrets of Life*: "What counts as a usable, effective, and communicable representation is constrained, on the one hand, by our social, cultural, and disciplinary location, and on the other hand, by the recalcitrance of what I am left, by default, to call 'nature'" (p. 6). It is precisely the recalcitrance, the refusal of univocality, of the term *nature* that demands more "hands." That is, there is no reason to think that the network of interactions that makes possible and plausible technoscientific interactions obeys this discursive anatomy. While I would agree that there is something other than "social, cultural, and disciplinary" inputs into technoscience, the rhetoric of evenhandedness here encourages the opposition between cultural, rhetorical, and disciplinary practice and the "material" or even "nature." In chapter 5, I attempt to articulate this "recalcitrance" through a Derridean rhetoric of "*différance*" by mapping out the style of morphology of this "recalcitrance," a resistance that may have as much to do with our rhetorics as with "nature."

21. Foucault, *Order of Things*, p. 128.

22. *Ibid.*, p. 277.

23. Ibid., 265.
24. See Rotman, *Signifying Nothing*, for a well-wrought articulation of the signification of absence.
25. Deleuze, *Foucault*, p. 38.
26. Foucault, *Order of Things*, p. 268.
27. Ibid., 278.
28. Canguilhem, *The Normal and the Pathological*, p. 91.
29. Foucault, *Order of Things*, p. 273.
30. Ibid., 273.
31. Jacob, *Logic of Life*, p. 306.
32. Ibid., pp. 300, 254.
33. Roberts, *Science*, 1310–13.
34. Ibid., p. 1310.
35. Foucault, *Order of Things*, p. 172.
36. Roberts, *Science*, pp. 1310–11.
37. Alberts, Bruce, et al., *Molecular Biology of the Cell*, p. 903.
38. Ibid., p. 901–2.
39. Ibid.
40. Ibid., p. 905.
41. Evelyn Fox Keller has offered the phrase “the discourse of gene action” as an algorithm for the articulation of genes as the site of organismic control. See Keller, “The Discourse of Gene Action.”
42. Deleuze and Guattari, *Thousand Plateaus*, p. 8.
43. This demonstrates that the claim that each cell “contains the same . . . built-in program” relies on a model of information that preexists its interpretation. A genome with identical bases of nucleic acids produces different information—it informs cells differently in different cell states. For an articulation of DNA as “data” rather than “program,” see Atlan and Koppel, “Cellular Computer DNA,” 335–48.
44. Indeed, even when the projects encounter difficulties with this scheme, the notion that the organism and its description are indistinguishable remains. Susan Oyama, in her article “The Accidental Chordate: Contingency in Developmental Systems” (*South Atlantic Quarterly*, 1995, p. 510), writes of Sydney Brenner’s frustration: “[As] reported in an article by Roger Lewin called ‘Why Is Development So Illogical?’ . . . Brenner complained that cell lines were ‘baroque,’ and that there seemed no shorter way of describing what happened than simply giving an account of the sequence of events” (p. 510). Here Brenner complained of an inability to locate an algorithm for *C. elegans*’s development but evidentially held to the rhetoric of a “complete description.” See chapter 5 in this volume for a discussion of the problem of “complexity,” Von Neumann’s name for an entity whose “literary description” is more complex than the object itself.
45. Quoted in Roberts, *Science*, p. 1311.
46. For a compelling and high-resolution account of the situated and constructed nature of physical maps, see Fortun, “Making and Mapping Genes.”
47. Roberts, *Science*, 1312.
48. Ibid.

49. *The Oxford English Dictionary: The Original Oxford English Dictionary on Compact Disc*, version 4.10, s.v. “resolution.” New York: Oxford University Press, 1987.

50. Here I fail to properly account for this much-contested Kantian figure. I find Žižek’s reading useful as a probe for the narrative of life science, but for the reader looking for a more definitive account, see Paul Crowther’s *The Kantian Sublime: From Morality to Art*. While impressive in its focus and scope, Crowther’s account, in its insistence on the tropics and method of definition, misses the murkiness and lack of precision that seem to inhere in the philosophical discourse of sublimity.

51. Lyotard, *The Inhuman*, p. 136.

52. Indeed, Kant’s reading of the sublime was also intertwined within the thinking and metaphors of vitality: “the feeling of the sublime is a pleasure that only arises indirectly, being brought about by the feeling of a momentary check to the vital forces followed at once by a discharge all the more powerful.” Kant, *Critique of Judgement*, p. 91.

53. Baudrillard, *Ecstasy of Communication*, p. 31.

54. Again, Lyotard: “Nature is no longer the sender of secret sensible messages of which the imagination is the addressee. Nature is ‘used,’ ‘exploited’ by the mind according to a purposiveness that is not nature’s, not even the purposiveness without purpose implied in the pleasure of the beautiful” (*The Inhuman*, p. 137).

55. Žižek, *Sublime Object*, pp. 134–35.

56. François Jacob’s autobiography resonates uncannily with this sublime body or statue: “I see my life less as a continuity than as a series of different selves—I might almost say, strangers. . . . And yet, as different as these selves making up my life may seem now, they have, every morning upon awakening, recognized each other. . . . This consciousness of unity is not only that of my body, its habits, its inclinations. Even more, it is made of those memories that travel through time in flashes. . . . Thus, I carry within a kind of inner statue, a statue sculpted since childhood, that gives my life a continuity and is the most intimate part of me, the hardest kernel of my character” (*The Statue Within*, pp. 15–19). This unity of “memories” is a unity of narrative that makes the autobiography possible, animated “flashes,” a sublime body or statue that graphs or grafts together the strange discontinuities of Jacob’s life. This narrative structure—which, in Kantian fashion, relies on an intimate and yet unknowable essence or “kernel” that lies beyond the partiality and difference of life—also informs Jacob’s theory of the integron, an attempt to recuperate, if not “life,” then at least something beyond the molecule. See Jacob, *Logic of Life*, pp. 299–324.

57. Gilbert, “Towards a Paradigm Shift,” p. 99.

58. *Ibid.*

59. *Ibid.*

60. Derrida, writing in a very different context, isolates the role that the

“unity” of life plays in Edmund Husserl’s thought, and I offer it here for its resonances with the projects of postvitality, a new name for a new practice of inscribing vitality. Derrida locates “life” as the guarantee that grounds Husserl’s attempt to ground a “genuine philosophy”: “Living is thus the name of that which precedes the reduction and finally escapes all the divisions which the latter gives rise to. . . . But if this ultratranscendental concept of life enables us to conceive life (in the ordinary or the biological sense), and if it has never been inscribed in language, it requires another name” (Derrida, *Speech and Phenomena*, p. 15). Wrenching Derrida out of context, we can say here that the tropes of finality in postvital discourse are ultratranscendental insofar as they speak from a transcendental position about the lack of life beyond the molecule, “that is all there is.”

61. Rotman, *Signifying Nothing*, pp. 87–97.

62. For detailed instructions on the networks available for locating such dislocated life, see the Usenet newsgroup sci.cryonics on the Internet. The following is from their list of “Frequently Asked Questions”:

How can I pay for my own revival and rehabilitation, and keep some of my financial assets after revival?

The Reanimation Foundation is set up to enable you to “take it with you” and provide financial support for your reanimation, reeducation, and reentry. It is based in Liechtenstein, which does not have a Rule Against Perpetuities, and thus allows financial assets to be owned by a person long after the person is declared legally dead.

Reanimation Foundation
c/o Saul Kent
16280 Whispering Spur
Riverside, CA 92504
(800) 841-LIFE

Chapter 2

1. U.S. Congress, *Mapping Our Genes*, p. 85.

2. *Ibid.* Positive eugenics denotes the cultivation of attributes in human populations through genetic interventions into the germ line, whereas negative eugenics refers to the prevention of “pathological” conditions through genetic management.

3. Here I am merely pointing out the continual and perhaps structural inability of contemporary technoscientific discourse to coherently account for itself, to give good and consistent reasons why we should pursue one line of research rather than another. Even while technoscience’s narratives claim continual and constant “mastery,” it is easy enough to watch the persistent “unhinging” of technoscientific accounts, the trace of its “will to knowledge.” One E-mail signature from the Jet Propulsion Laboratory in Pasadena captures this

honestly and insightfully: “If we knew what we were doing, we wouldn’t call it research.”

4. Foucault, “Nietzsche, Genealogy, History,” in *Language, Countermemory, Practice*, p. 146.

5. The *Oxford English Dictionary* tells us that *accident* itself has a history of chaotic atemporal substitutions not unlike the history of the genetic substance: “Accident—As in many other adopted words, the historical order in which the senses appear in Eng. does not correspond to their logical development, a fact still more noticeable in their derivatives—‘anything that happens,’ ‘disaster,’ ‘chance or fortune,’ ‘an occurring symptom,’ ‘to materialize or inform’” (s.v. “accident”).

6. Indeed, almost all of the early workers in the new nexus between physics and biology attributed much influence to Schrödinger’s text: “They all read Schrödinger: yet what they took from him varied. Crick was aroused by . . . its message that biology could be thought about in a new way and that great discoveries were imminent” (Judson, *Eighth Day of Creation*, p. 245).

7. Schrödinger, *What Is Life?* p. 21.

8. *Ibid.*, pp. 21–22.

9. *Ibid.*, p. 22.

10. Freud, *Interpretation of Dreams*, p. 463.

11. de Man, *Resistance to Theory*, p. 11.

12. Given the rhetorical status of all the operative terms here, including organism, it would be more correct perhaps to label this “confusion” a substitution. A crucial point, however, is that this confusion seems to be a confusion on Schrödinger’s own, carefully delineated terms.

13. Schrödinger, *What Is Life?* p. 22.

14. Samuel Butler offers us a similar formulation for seeing the future in the “Book of the Machines” described in his novel *Erewhon*: “The only reason why we cannot see the future as plainly as the past, is because we know too little of the actual past and the actual present; these things are too great for us, otherwise the future, in its minutest details, would spread out before our eyes, and we should lose the half of our sense of time present by reason of the clearness with which we should perceive past and future” (*Erewhon*, 198).

15. Schrödinger, *What Is Life?* p. 23.

16. See, for example, Susan Oyama, *Ontogeny of Information*, for a review of developmental discourse and its rhetorics; see also Haraway, *Crystals, Fabrics, and Fields*.

17. Schrödinger, *What Is Life?*, p. 22.

18. Suzuki et al., *Introduction to Genetic Analysis*, p. 179.

19. The encounter also recuperates the element of chance that Schrödinger seeks to overcome with his notion of an “all penetrating mind,” for whom there would be no such vector. Even as Schrödinger writes of the possibility of a “code-script” that would transmit the future (the development of an organism),

his own “script” is overtaken by precisely the kinds of rhetorical movements that make such a prescription exceedingly improbable.

20. Derrida, “White Mythology,” in *Margins of Philosophy*, p. 219.

21. Gamow and Ycas, *Mr. Tompkins Inside Himself*, p. 5.

22. Foucault, *Birth of the Clinic*, xix.

23. *Ibid.*, 196.

24. *Ibid.*, 162.

25. The “time bomb” motif can be traced to, of all places, Los Alamos National Labs, where researcher Robert Moyzis uses a slide featuring such an equation between demolition, disease, and DNA. Thomas Friedman, a researcher at the University of California, San Diego, claimed that “all disease is genetic” during a talk given at UC Irvine in 1991.

26. Schrödinger, *What Is Life?* p. 23.

27. Foucault, *Birth of the Clinic*, p. 197.

28. This move is consonant with the dispersal or dislocation of life I outlined in chapter 1. Dorion Sagan, in his wonderful essay “Metametazoa: Biology and Multiplicity,” notes that one could even see the contemporary manipulation of genomics not as a triumph of human mastery over the book of nature but rather as an extension of bacterial omnisexuality. He writes: “a radical refashioning of the human genome into new species, is bacterial omnisexuality—bacterial omnisexuality ministered, ‘engineered’ by human hands” (*Incorporations*, p. 378). In this view, one I root for wholeheartedly, human beings could be cast as pawns of bacteria in search of new opportunities for gene trading. The challenge of this view, of course, is to think the “agency” of bacteria without anthropomorphizing them. Unfortunately, Sagan appears to affirm the categorical integrity of “life” even as he challenges many of the grounding distinctions of biology such as organism/environment, animal/plant; this affirmation risks just such a humanism.

29. Watson, *The Double Helix*, p. 13.

30. Foucault, *Birth of the Clinic*, 3.

31. Watson and Crick, “Genetical Implications.”

32. Adams, “Self Organization,” 223–29.

33. *Ibid.*

34. Haraway, *Simians, Cyborgs, and Women*, p. 212.

35. Adams, “Self Organization,” 223–29.

36. “Nanotechnology,” 29–35.

37. Foucault, *Order of Things*, p. 269.

38. For more analysis of the recuperation of vitality in such a postvital economy, see chapter 6 in this volume.

39. Lacoue-Labarthe, *Heidegger, Art and Politics*, p. 69.

40. Suzuki et al., *Introduction to Genetic Analysis*, p. 4.

41. U.S. Congress, *Mapping Our Genes*, p. 85.

42. Searle, “Minds, Brains, Programs,” p. 34.

Chapter 3

1. Crick, “Coding Problem,” pp. 163–217. For a thorough discussion of the coding problem and its history, see Ycas, *Biological Code*.

2. For an explication of metonymy as a kind of wormhole through which time collapses or is displaced, jump to chapter 4.

3. See, especially, Horace Judson’s *Eighth Day of Creation*.

4. The importance of presupposition is characterized by Deleuze and Guattari as the encounter between language and its “outside”: “What makes a proposition or even a single word a ‘statement’ pertains to implicit presuppositions that cannot be made explicit” (*Thousand Plateaus*, p. 140). Deleuze and Guattari, in their attempt to deploy a “pragmatics,” argue instead for the mapping of statements as components of an assemblage. My efforts here are focused on the rhetorical components of such an assemblage, components that themselves resist explicit articulation.

5. Gamow, “Possible Relation,” p. 318. Note that this “fibre” weaves us back into Schrödinger’s signing of the “code-script,” a textualization that makes life “citational” in the sense that Schrödinger’s rhetorical accident or intervention can be transplanted into the context of Gamow’s 1954 article, a context that as we shall see reverses Schrödinger’s description even as it (implicitly) deploys it. The “fibre” also highlights my intervention here, tying all these citations into a narrative.

6. For the reader skeptical of this seemingly semantic distinction between a DNA molecule and a chromosome fiber, I have two (perhaps Whiggish) rejoinders. First, it has become increasingly clear that the DNA’s “packaging” in the chromosomes is of crucial and unknown importance in the expression of genetic loci, as in variegated position effects in the expression of eye color in *Drosophila* (see Suzuki, *Introduction to Genetic Analysis*, chapter 14). Second, in 1954 there was no established reason to assume that chromosome fibres were *only* DNA molecules, which forces us to ask, why did Gamow find this equivalence unproblematic? In addition, even if it were accepted in 1954 that chromosome fibers were DNA molecules, the contrary statement is quite simply not factual. All chromosome fibers are DNA, but not all DNA molecules are chromosome fibers. The “consideration” must therefore be taken as a rhetorical one.

7. Gamow, “Possible Relation,” p. 318.

8. Quoted in Curtius, *European Literature*, p. 324.

9. Here, Gamow, by describing the DNA–protein relation as textual, fulfills what we could call Heidegger’s articulation of the technological imperative: “that nature reports itself in some way or other that is identifiable through calculation and that it remains orderable as a system of information” (*Question Concerning Technology*, p. 23).

10. Von Neumann, in work on an analogous problem of self-reproduction,

showed mathematically in the appendix to Gamow and Ycas's "Statistical Correlation of Protein and Ribonucleic Acid Composition" that the distribution of proteins relative to the distribution of possible codons (DNA bases) was not random (Ycas, *Biological Code*, p. 30). The possibility that proteins are (randomly) composed disturbed Von Neumann, who wrote in a letter to Gamow, "I shudder at the thought that highly efficient purposive organizational elements, like the protein, should originate in a random process." See Heims, *John Von Neumann* p. 154.

11. Von Neumann, *Theory of Self-Reproducing Automata*, p. 22. See also chapter 4 in this volume, where this difference collapses as the distinction between "instruction" and "construction" is displaced by Jacques Monod and Francois Jacob's rhetoric of "the program."

12. For an analysis of the phantasms of that search for secrets, see Keller, *Secrets of Life*, pp. 39–55.

13. Austin describes this as "the sense in which saying something produces effects on other persons, or *causes* things." Quoted in Massumi, *A User's Guide*, p. 153. Austin's articulation of the force of words resonates with the Gorgianic tradition of rhetoric, where the force of speech is compared to love, drugs, and magic. See also Derrida's short but forceful text "Signature, Event, Context" in *Margins of Philosophy*, pp. 309–30.

14. Deleuze and Guattari, *Thousand Plateaus*, p. 79.

15. In "Signature, Event, Context," Derrida argues that the very notion of "context," in its usual figuration, "harbors very determined philosophical presuppositions" (p. 310). I deploy it here as a strategy for marking out the virtual conditions on the basis of which "translation" could become the figure for protein synthesis and not to indicate some simple morphology of a cultural frame placed on "meaning." A much more jagged morphology is invoked here, not the fractal but the fracture.

16. Taylor, *Notes*, p. 266n21.

17. Heidegger, "The Age of the World Picture," in *The Question Concerning Technology, Essays*, p. 118.

18. *Ibid.*

19. Benjamin, "Task of the Translator," *Illuminations*, p. 72.

20. *Ibid.*

21. *Ibid.*, pp. 70, 80.

22. *Ibid.*, p. 71.

23. The "vital connection" between originals and translations must take place somewhere between the life and afterlife of a work. According to Benjamin it is only *after* they have been translated that originals "mark their stage of continued life," what he called the "afterlife . . . transformation and renewal of something living." That is, by virtue of translation, the original is transformed, thereby undermining its status as "original" in any static sense. *Illuminations*, p. 73.

24. Both Old and New Testaments are, of course, in the background of this figuration. In the Old Testament, the unity of life—the fact that everywhere, the essence of “living” is seen as the same, as a branch of the “tree of life”—is guaranteed by the fact that God is “the living God.” “The God of life . . . his very nature is life, and he is able to impart it to the creatures. For this reason, life is basically the same in all that moves on earth!” This unity is also the essence that makes possible the translation of the unbridgeable gap between the earthly and the spiritual: “This does not mean, however, that with the gift of life creatures partake of the divine nature, but rather that by God’s grace they are enabled to *communicate* with their Creator.” Vitality here is the link to communication, the possibility of translating God’s words into earthly flesh. The New Testament is basically consistent with this articulation and figures God’s gift of life as “the inheritance of God’s children,” an inheritance of life nurtured by God’s “Living words.” See *The Interpreter’s Dictionary of the Bible* (New York: Abingdon Press, 1962), pp. 124–30. See also Benjamin’s notion of the “unconditional translatability” of Holy Writ, discussed later in this chapter.

25. Benjamin, in “Task of the Translator,” in *Illuminations*, p. 80.

26. *Ibid.*, p. 82.

27. *Ibid.*

28. Foucault, *Order of Things*, p. 269.

29. Donna Haraway has characterized this semiosis, one that emerges out of the national security state, as “world-as-code.” See *Simians, Cyborgs and Women*, p. 58.

30. Woese, *Genetic Code*, p. vii.

31. Keller, *Reflections on Gender and Science*, p. 121–22.

32. Woese, *Genetic Code*, p. 1.

33. Nietzsche, too, offers us a formulation of this implosion: “the text has finally disappeared under the interpretation.” Although Nietzsche here deploys this notion of world as text, it differs significantly from the way I have described the “age of world scripture.” For Nietzsche the world as text—as opposed to Scripture—implies the irreducible rhetoricity of our knowledge. See also, “On Truth and Lies in the Extra Moral Sense,” in *Friedrich Nietzsche on Rhetoric and Language*.

34. Woese, *Genetic Code*, p. 5.

35. The site and apex of this translatability, the very stuff of Benjamin’s “vital connection,” is what writers as diverse as Jacques Derrida and Philip K. Dick have diagnosed as a condition or sickness of the theological/scientific matrix called the “book of nature.” See also in chapter 2 my discussion of Schrödinger’s notion that the chromosome “script” is readable only to “the all penetrating mind, once conceived by Laplace, to which every casual connection lay immediately open” (*What Is Life?* p. 22). This materializes a particular notion of rhetoric, and not just any notion of reading is ascribed to the DNA-RNA couplet here; a very specific

strand of the history of hermeneutics is drawn on, even if only implicitly, and materialized.

36. Brian Rotman has characterized the use of diagrams in mathematics as one element of the “metacode,” a set of semiotic practices that are, according to the implicit rules of the mathematics community, trivial or nonrigorous supplements to the “real” work of mathematics. Rotman, in an argument that parallels Derrida’s notion of the logic of the supplement, argues that real mathematical work, as a semiotic, persuasive practice, cannot be extricated from its reliance on the metacode. His formulation is fortuitous in that Gamow here draws on the metacode, a diagram, in order to explicate his model of the genetic code.

37. Gamow, “Possible Relation,” p. 318.

38. *Ibid.*

39. Taylor, *Notes*, p. 238.

40. Gamow, “Possible Relation,” p. 318.

41. *Ibid.*

42. For an analysis of the ways in which Western aesthetics has overlooked the constitutive power of the “space between,” see Martin Heidegger’s “The Thing” in *Poetry, Language, Thought*. Here he writes of this “void” and its role in the making of a jug: “if the holding is done by the jug’s void, then the potter who forms sides and bottom on his wheel does not, strictly speaking, make the jug. He only shapes the clay. No—he shapes the void. For it, in it, and out of it, he forms the clay into the form. From start to finish the potter takes hold of the impalpable void and brings it forth as a container in the shape of the containing vessel” (p. 169).

43. Gilles Deleuze helps to problematize this notion of foreground and background through the fold, a topological articulation that would avoid the opposition between “code” and “body,” “hole” and “organism.” Rather than a hole, then, the space between nucleotides would be better figured here as a pleat. Interestingly, Deleuze draws much of his theoretical articulation of the fold from a reading of the history of biology. In a nonoriginary account of “essence,” he writes, “The essential is elsewhere; basically two conceptions share the common trait of conceiving the organism as a fold, an originary folding or creasing (and biology has never rejected this determination of living matter, as shown nowadays with the fundamental pleating of globular protein.)” Deleuze, *The Fold*, p. 4.

44. Crick, *Of Molecules and Men*, pp. 10, 24.

45. That Gamow reformatted the question of the relation between DNA and proteins is certain. What remains to be sorted out is the precise relationship between his paradigm of translation and the metaphors of “code.” Gamow himself never mentioned “code” in “Possible Relation between Deoxyribonucleic Acid and Protein Structures,” although by November of the same year he writes in “Numerology of Polypeptide Chains” that “there must exist a unique coding procedure that permits one to translate long sequences formed by four

different elements (bases) into equally long sequences formed by about twenty different elements (amino acids)” (p. 779).

Nothing about this “translation,” of course, demands that it be a “code” since neither the DNA molecule nor the proteins were secret or unknown. But Schrödinger’s metaphor of the “code-script” allowed for the ambiguity of “language” and “code,” an ambiguity that also allowed for the metaphors of “information.” These metaphors bridge together, even translate, the metaphors of “genetic language” and “genetic codes,” metaphors that will allow François Jacob not to speak of a “book of life,” but of “The Program,” a metaphor that will compete with the metaphor of the genetic “book.” See chapter 4 for my discussion of “program.”

46. *Oxford English Dictionary*, s.v. “essence.” If the reader finds this invocation of the *OED* less than persuasive, all the better: for imagine the consequences for Gamow’s translation and reading scheme if we were to introduce this problem of the reader, which determines the proper or improper “definition” of each word of English, each DNA number . . .

47. By *metonymy* I mean here the taking of cause for effect. Organisms create proteins, not just vice versa, and yet “the essence of living organisms” reads as if proteins “produce” organisms, that organisms are the result of this translation and not the producers of it, the translators, as it were. Of course, all this is circular, and that is precisely why narratives of translation break down. See my discussion of *C. elegans* in chapter 1 for another place in which cause/effect narratives run up against rhizomatic systems.

48. The overlooking of the body here—an overlooking that I will highlight quite often in this text—also speaks to the dream of a text that would read itself. That is, the deletion of the body in Schrödinger and Gamow is also a deletion of the “translator.”

49. Brian Rotman’s analysis and critique of the status of mathematical signs help us to recognize one of the vectors that made the description of DNA as “a long number,” rather than some other linguistic formulation, possible: “In contrast to the secondarity ruling alphabetic writing, mathematical signs do not code, record or transcribe anything extramathematical: mathematical items evoke and mean what they mean, what they are to signify, directly and not as intermediates for something else.” Dwelling in self-presence, the DNA “number” nonetheless clearly required an “outside” for its instantiation: hence, the trace of the body in the fall from DNA “numbers” to protein “words.” Rotman critiques the Platonist view of mathematics with a semiotic account of mathematics as thought experiments. His insistence on the inclusion of the counting body in the theorization of mathematics—a theorization that leads to the increased difficulty of counting over time, rupturing the possibility of the infinite—inflects my desire to include the so-called “living” body and its ecologies in any biological account. See *Ad Infinitum*, p. 25.

50. Indeed, one must not proceed too quickly here and denounce the description of a DNA text as “mere” metaphor. I would, and will, argue that the field of protein synthesis is well served by a description that takes into account the differential and performative nature of writing as described by Derrida, or, alternatively, the model of the rhizome as described by Deleuze and Guattari. See chapter 5 for such an attempt.

51. For a description of this shift, see Derrida, *Of Grammatology*, pp. 6–26.

52. The formulation was taken from the title of a talk by Lily E. Kay, “Who Wrote the Book of Life?,” given at Harvard University in fall 1993. Kay’s answer—“scientists”—seems to me to function as an artifact of her question, which presupposes some subject “who” writes.

53. For a varied and rigorous engagement with such questions of the subject after deconstruction and psychoanalysis, see Cadava, Connor, and Nancy, *Who Comes After the Subject?*

54. As the figure through which “translatability,” “the vital connection,” is grounded, “life” must be seen in this rhetoric as itself refusing translation. The “vital connection” itself is not translatable; rather, it is the steady link to God or the original that makes possible the “inheritance of God’s children” or the “kinship” of the translation.

55. Foucault, *Order of Things*, p. 161.

56. *Ibid.*, *Discipline and Punish*, p. 171.

57. Ecology, too, has struggled with the shifting conceptions of vitality, particularly with respect to the question of Gaia and the superorganism. For a useful account of the history of ecology, see Mcintosh, *Background of Ecology*.

58. Lewontin, *Biology as Ideology*, p. 108.

59. Derrida, *Specters*, p. 184.

60. Lyotard, *The Differend*, p. xi.

61. Jacob, *Logic of Life*, p. 2.

62. Taylor, *Notes*, p. 221.

63. As an example, we could look to the disjunction between the massive proliferation of nucleotide sequences and our ability to “make sense” of these DNA sequences by determining the end product of such sequences, the tertiary structure of proteins that are useful in living organisms. A recent collection published by the American Association for the Advancement of Science makes this point clearly: “With recent breakthroughs in genetic engineering technology, the speed at which the nucleotide sequences of genes can be determined has far outstripped the rate at which the protein products can be isolated and characterized. Yet much of the information in these sequences—most notably the three dimensional structure of the gene product—can not presently be reliably extracted. The Human Genome Project will rapidly increase the appearance of such sequences” (Gierasch and King, *Protein Folding*, p. vii). Clearly, the very notion of a “code” that had been “cracked” encouraged the occlusion of the complexities of protein folding. But in their fascinating discussion of “The Origami of Proteins” Duke University Medical Center researchers Jane S. Richardson and David C.

Richardson argue that protein folding is analogous to origami and point out that “Another major point of the metaphor is that both activities begin with a very uninteresting object. For origami it is a single piece of paper, normally square . . . two dimensional, flat and unmarked. A protein starts off as a one-dimensional amino acid sequence, which has a lot of potential but no remarkable chemical or biological properties in the unfolded state. In both cases, however, the final result of folding is a meaningful, functional object” (in *ibid.*, p. 5). Thus, while Gamow’s formulation of the DNA–protein relation as a “translation” of a “code” seems to be the final word on living systems, we can see here that the transformation of an amino acid into an organism, an object with “meaning,” is contingent on processes for which the “code” metaphor (indeed, the metaphor of “meaningful object”) is simply inadequate. See chapter 5 for my discussion of the inadequacy of our rhetorics of living systems, and chapter 4 for a discussion of the role of a temporal, as well as a spatial, origami in the rhetorical topology of organisms.

64. Quoted in Silverman, *Postmodernism and Continental Philosophy*, p. 232. My thanks to my colleague Jeffrey Nealon for pointing me in this direction.

Chapter 4

1. Keller, *Reflections on Gender and Science*, p. 155.

2. Jacob and Monod, “Genetic Regulatory Mechanisms,” p. 318.

3. Crick and Watson, “Molecular Structure of Nucleic Acids,” pp. 737–38.

4. Judson, *Eighth Day of Creation*, p. 570.

5. This notion of a paradoxical space has been formulated by feminist geographer Gillian Rose in order to affirm a notion of spatiality that resists any opposition of “inside” and “outside,” an opposition Rose links to the masculinist subject of social science. Significantly for my project, her affirmation of a space that resists such a topology brings into relief those spaces that are inarticulable to the “inside/outside” schema. See *Feminism and Geography*, pp. 151–55. My thanks to Susan Squier for this reference.

6. Jacob, *The Statue Within*, p. 8.

7. *Ibid.*, pp. 25–26.

8. Derrida, “Declarations of Independence,” *New Political Science* 15 (1986): 7–15.

9. The analogies between the bedroom and the lab are implicitly drawn by Jacob himself. While at the Pasteur Institute, Jacob continued his childhood habit of “concocting the future”: “Every morning I ran to the laboratory to set up my experiments. . . . The next morning I got the results just in time to put together a further experiment. . . . I lived in the future. . . . I had turned my anxiety into my profession.” *The Statue Within*, pp. 8–9.

10. Deleuze, *Spinoza: Practical Philosophy*, p. 20.

11. Jacob, *The Statue Within*, p. 9.

12. *Ibid.*, p. 318.

13. Jacob and Monod, “Genetic Regulatory Mechanism,” p. 318.

14. For an extended meditation on performativity and its deferral, see “Signature, Event, Context” in *Margins of Philosophy*, where Derrida performs on the theme of performative and constative speech acts in J. L. Austin’s *How to Do Things with Words*.

15. Paul de Man, in “Pascal’s Allegory of Persuasion,” traces the crossovers and rhetorical struggles associated with the “definition of definition” in Pascal’s *Réflexions sur la géométrie en général; De l’esprit géométrique et de L’Art de persuader*. De Man’s essay is in Greenblatt, *Allegory and Representation*, pp. 1–25.

16. The phrasing here is Jacob’s. “I have become obsessed by reading. I am a maniac for words. A man sick with the written word” (*The Statue Within*, p. 38). Monod’s obsession with nomenclature and definition—an obsession that makes this definition of *definition* all the more significant—can be found in “Terminology of Enzyme Formation.” This 1953 *Nature* article attempted to replace the rhetoric of “enzyme adaptation” with “enzyme induction” a move that betrays (at the very least) the fact that, for Monod, language matters. The precise way in which Monod seeks to remove the language of teleology from biology here is instructive in that he presumes a “constant genetic background” for induction, while taking care to situate the fact that enzymes have “inducibility” only as a property of “enzyme forming systems.” Here I anticipate Jacob and Monod’s ascription of spatiotemporal priority to the genome as a site of information that erases or overlooks its place within such a “system” or cellular economy. See Cohn and Monod, “Terminology of Enzyme Formation,” p. 1096.

17. Jacob and Monod, “Genetic Regulatory Mechanisms,” p. 318.

18. Michel Serres describes this beautifully when he writes, “the organism is a barrier of braided links that leaks like a wicker basket but can still function as a dam” (*Hermes*, p. 75).

19. Jacob and Monod, “Genetic Regulatory Mechanisms,” p. 354. The rhetorical role of “program” here is important, as it provides a descriptive language for a “message” or a “code” or a “blueprint” that also performs an action, a series of calculations or commands.

20. Jacob, *The Statue Within*, p. 306. It is perhaps significant—given the discussion of narrative in chapter 1—that Jacob’s model of induction emerged from the flicker of a “movie theatre.”

21. This could induce general questions and defenses of *reductionism*, a word with, ironically, as much or more polysemy as *definition*. Suffice it to say that what is interesting here are not reductionist moves per se but rather the specific shapes and locations of reduction. In our example, we see a persistent reduction of the role of factors other than nucleic acids. This leads me to suggest that besides the “stupid factors” cited by Monod earlier, the idea that the repressor was a nucleic acid was at least in part encouraged by this overvaluation of nucleic acids.

22. Jacob and Monod, “Genetic Regulatory Mechanisms,” p. 321.

23. *Ibid.*, p. 354.

24. Jacob and Monod acknowledge this in their conclusion: “It is clear that the cells could not survive the breakdown of more than two or three of the control systems which keep in pace the synthesis of enzyme products” (“Genetic Regulatory Mechanisms,” p. 354). Here we see that regulation represents more than a change of degree; it is a system of expression, not “contained” within the genome, that in some way defines the organism.

25. *Ibid.*

26. Why does this problem get displaced on to the embryo? Besides the classic problematic of the chicken/egg, where we can see that it is precisely the plasticity of our notions of temporality and living that allow us to prioritize either the chicken or the egg, we might also look to the spatial aspects of embryological development for a clue to the ways in which development is uniquely situated as a kind of spatial and temporal navel in our discourse on living. According to George Gamow, himself an aficionado of the inside/out universe (see chapter 2), “Your body also has the shape of a doughnut, though you probably never thought about it. In fact, in the very early stage of its development (embryonic stage) every living organism passes the stage known as ‘gastrula,’ in which it possesses a spherical shape with a broad channel going through it. . . . Since you are a doughnut . . . try to transform your body into a double apple with a channel within. . . . you will find that . . . the entire universe, including the earth, moon, sun, and stars, will be squeezed into the inner circular channel” (*One Two Three*, pp. 59–60). I cannot hope to resolve here the question of the extent to which this inside/out, Möbius gesture is a symptom of signification or of the living, but I would like to suggest that this may be an effect of the collision or diffraction of “signification” with “living.” For another analysis of the function of “holes” in Gamow’s scientific discourse, see chapter 3 in this volume.

27. Jacob, *The Statue Within*, pp. 8–9.

28. *Ibid.*, p. 17.

29. For more on narrativational anticipation and integration, see my discussion of the sublime in chapter 1. See also Daniel Dennet’s *Consciousness Explained* (*Consciousness Explained*, Boston: Little, Brown, 1991) for a discussion of the role of narrative in “consciousness.”

30. Žižek, Slavoj. *Sublime Object of Ideology*, p. 56. This Lacanian matrix can be seen to be in alignment with Deleuze’s analysis of the metonymies of consciousness described earlier.

31. Beardsley, “Smart Genes,” p. 89.

32. *Genes* refers here to sequences of DNA that code for proteins. Of course, Davidson is careful to point out that “most” and not all genes must construct such “computers,” preserving the possibility of some “bootstrapping” genes and preserving the centrality of a genetic account while changing its inflection.

33. In *Terminator 2*, the future leader John Connor requires this borrowing from the future for his sovereignty: the expression of himself as “leader” requires him to lead and protect even his own past.

34. Jacob, *The Statue Within*, p. 304. Coincidentally, *Terminator 2* can itself be described as a signal struggle, an attempt to send a signal from the future that will prevent a nuclear exchange—in effect, a message that reads: Do not drop the bombs, Do not drop the bombs. . . .

35. Derrida, “Structure, Sign, and Play in the Discourse of the Human Sciences,” in *Writing and Difference*, pp. 278–79.

36. Zimmerman, *Heidegger’s Confrontation*, p. xv.

37. Derrida, “Structure, Sign and Play in the Discourse of the Human Sciences,” p. 279.

38. Beardsley, “Smart Genes,” p. 91. 39. Borch-Jacobsen, *Lacan*, p. 177.

40. Foucault, *Order of Things*, p. 269. 41. Serres, *Hermes*, p. 75.

42. For another analysis of the slippages that inhabit such narrativel descriptions of what Deleuze and Guattari would call “rhizomatic” systems, see chapter 1 in this volume.

43. At this point it can be suggested, though not fully argued, that “life” as a unity, as one mode of being that is shared in some baseline way by all organisms, can be seen as itself a containment of the multiplicity of effects at play in the living. The productive confusion spawned by the fuzzy definitions of life (as for example, in the debates over artificial life) can be read as a symptom of “life’s” metonymic and retroactive production. See chapter 1 in this volume.

44. This problem—the limits of the articulation of scientific practices—is somewhat analogous to problems of computability in the computer sciences. Physicist David Ruelle traces out the implications of the limits of computability, implications that may apply analogically to the limits of articulation: “I like to think of the paradox of someone (*the predictor*) who uses the determinism of physical laws to foresee the future, and then uses free will to contradict the predictions. . . . How do we handle this paradox? We could abandon either determinism or free will, but there is a third possibility: we may question the ability of any predictor to do the job so well that a paradox arises. Let us note that if a predictor wants to create a paradox by violating forecasts about a certain system, then the predictor must be a part of the system in question. This implies that the system is rather complicated. But then the accurate prediction of the future of the system is likely to require enormous computing power, and the task may exceed the capabilities of our predictor. This is a somewhat loose argument about a loosely stated problem, but I think it identifies the reason . . . why we cannot control the future” (Ruelle, *Chance and Chaos*, pp. 32–33). Analogously, I am suggesting that the task of narrating and/or describing systems as complex as “living” systems may prove too much for our current rhetorics. Thanks to Paul Harris for helping with these, and many other, observations.

45. As it seeks out an encounter with the conditions of scientific production that are other than those under the spell of the human, this rhetorical empiricism is also an ethics, if we follow Levinas's formulation of ethics as thinking that concerns itself with the relations to the Other. For Levinas, subjectivity "realizes these impossible exigencies—the astonishing feat of containing more than it is possible to contain" (*Totality and Infinity*, p. 27). The impossibility of the technoscientific subject in language "containing" the flux and alterity at the heart of scientific practice, which includes the alterity at play in the scientific "object," marks out the debt of humans and scientific practices to the other. In his alternative to the tradition of thinking subjectivity as a closed "case," Levinas figures subjectivity as "welcoming the other, as hospitality" (Levinas, *Totality and Infinity*, p. 27). Analogously, I would like to consider technoscientific practice and subjectivity as cultivating a hospitality to the other, actively allowing what Hans-Jörg-Rheinberger has called "unprecedented events" in scientific practice. On this view, the skills of scientific practice become the skill of allowing for the alterity of the experimental practice, for not doing science "scientifically."

46. Jacob, *The Statue Within*, p. 317. The "statue within" that Jacob describes as himself is thus a postvital statue that triumphs over life and death and exists "between" both. See chapter 1 for my discussion of the postvital body (thesis 3: "What Body?"). For further—and insightful—probing of this figure of the statue, see Borch-Jacobsen's *Lacan*, "The erection of the ego is always the erection of a statue that I see, over there—triumphant, unshakable, fixed for eternity" (p. 49). Is this not an uncanny double for Jacob's statue, one that triumphs over time and space?

Chapter 5

1. Foucault, *Foucault/Blanchot*, p. 15.
2. Fireman and Slavin, *Atlas of Allergies*, p. 1.
3. The fact that the meaning of this encounter with the other is now articulated as pathological perhaps provides further evidence of the normativity of the normal as discussed by George Canguilhem in his *The Normal and the Pathological*.
4. Fireman and Slavin, *Atlas of Allergies*, p. 1.
5. Luce Irigaray, "Is the Subject of Science Sexed?" in Tuana, *Feminism and Science*, pp. 58–68.
6. In L'Heritier, Jacob, Jakobson, and Levi-Strauss, "*Vivre et Parler*," *Les Lettres Francaises*, p. 4.
7. Ibid.
8. Ibid., p. 2.
9. Ibid., p. 6.
10. "Here again we come across a quite natural penetration of a linguistic concept and term into the research of biologists" (quoted in Masters, *Semiotica*,

p. 307). *Natural* is the key, and unexamined, term here. To ascribe a natural penetration of both biology and linguistics by a linguistic paradigm is to beg the very question of the relation of the two disciplines under discussion. Indeed, this origin story gets even more problematic when one takes into account the influences of genetics on Jakobson's early work.

11. Lacan, *Seminar of Jacques Lacan*, p. 81.

12. Derrida, *Of Grammatology*, p. 4.

13. *Ibid.*, p. 84.

14. *Ibid.*, *Speech and Phenomena*, p. 141.

15. *Ibid.*, *Of Grammatology*, p. 84.

16. Plato, *Collected Dialogues*, 275e. The tensions within the Platonic account of writing—its tendency to repeat the same, its tendency to distort—are pursued by Derrida through the figure of the *pharmakon* in “Plato’s Pharmacy,” in *Dissemination*.

17. Derrida, of course, wants to foreground the fact that such writing is not supplemental to a human voice, that it is in some sense “prior” to such a voice, a priority of course that Derrida would also deconstruct as an artifact of the search for origins. This disrupts the opposition that has been inscribed between nature and culture in that we find a writing in the gene not unlike the inscriptions in sand that philosophers of language are so fond of in their discussions of human intentionality. But at the level of an organism, this disruption of human sovereignty over language is reinvested in the sovereignty of the gene, as can be seen in the vector of power that leads from DNA to “behavior.”

18. Derrida, *Of Grammatology*, p. 6.

19. Here Derrida can ironically be aligned with the Schrödinger effect analyzed in chapter 2.

20. This was a favorite dictum of Jacques Monod.

21. Derrida, *Of Grammatology*, p. 6.

22. *Ibid.*, p. 7.

23. *Ibid.*, p. 86.

24. To be sure, Derrida discusses not DNA but “genetic inscription” or “The Program,” thus including the process by which DNA becomes proteins. But the notion of “program” and translation and transcription to which he refers—to the extent that he remains indebted to the notions of genetic “reading” and “writing”—nonetheless maintains the sovereignty of the gene.

25. Foucault, *Birth of the Clinic*, p. xix.

26. Hence, the persistence of the driving question of even a postvital life science—what is life? Artificial life (see chapter 6) can be seen as the latest attempt to settle this question of an origin, to determine a “general theory of living systems,” while the practice of A-life tends to fragment the very notion of a single, unified “life,” precisely through its success at demonstrating the lack of any “organic” origin.

27. Derrida, *Speech and Phenomena*, p. 132.

28. Trifonov and Brendel, *Gnomic*, p. 3.

29. *Ibid.*, p. 5.

30. In this phrasing, I follow Donna Haraway's coinage "magical rationalism" to describe the contemporary stew of mysticism, magic, and instrumentalism that animates technoscience. Personal correspondence with author, February 1992.

31. This is "correct" in as much as much evolutionary theory also claims error as an origin.

32. Trifonov and Brendel, *Gnomic*, pp. 3–4.

33. A similar style of thinking has been analyzed by Evelyn Fox Keller in her research and discussion of theories of slime mold aggregation. Here the notion of a "pacemaker cell," a central site of control that triggers cellular differentiation in the remarkable transition from single-celled to multicelled organisms of *Dictyostelium discoideum* appeared more "natural" in the milieu of mathematical biology than did a more interactive account, one that required no prior pattern or difference. It seems to me that this episode—where the application of a rhetorical matrix of origins and control implicitly shaped research—is but one example of the ways in which biological accounts are shot through with ideologies of control and a metaphysics of origins.

34. The scare quotes serve here, inadequately, to mark the fact that such an infinitist rhetoric is impossible. What I am interested in here, in fact, is the fact that such regresses do not proceed infinitely; the closure that occurs at such aporias, however temporary, is a trace of power. See chapter 6 in this volume and Brian Rotman's *Ad Infinitum* for a detailed critique of infinitist metaphysics in mathematics.

35. Pattee, "How Does a Molecule Become a Message?" p. 1.

36. The fact that Pattee forgets that a message to turn "off" would be equally simple should not go unnoticed. Why does Pattee forget, or turn off, this message?

37. Pattee, "How Does a Molecule Become a Message?" p. 6.

38. *Ibid.*, p. 7.

39. *Ibid.*

40. Thus, here we have an empirical encounter with one of the truisms of deconstruction.

41. This language of the "irreducible," of course, evokes Polanyi's essay, "Life's Irreducible Structure," but cannot be reduced to it. Polanyi's persistent deployment of the boundary conditions of language betrays his a priori belief in the perfect "switch" that Pattee claims is impossible. This switch delimits, once and for all, the distinction between, for example, "style" and "content" in language, ignoring what Hayden White has called the content of the form: "you cannot derive grammar from a vocabulary; a correct use of grammar does not

account for good style; and a good style does not supply the content of a piece of prose” (Polanyi, p. 43). I do not argue that these boundaries are meaningless; only that their meaning derives from their play, their leakiness, and the imperfections of Pattee’s switch.

42. “When the phenomenon of forgetting comes into play, it becomes all the more interesting to me. I find that to be a part of the message as well. I add these negative phenomena to the reading of the meaning. I also recognize them as having the function of a message” (Lacan, *Seminar of Jacques Lacan*, p. 125, (emphasis in original).

43. For a brief discussion of the notion of scientific authorship, see Foucault, “The Order of Discourse,” in *Archaeology of Knowledge*.

44. Pattee, “Laws and Constraints, Symbols and Languages” in Waddington, *Towards a Theoretical Biology*, vol. 4, p. 248.

45. Von Neumann, *Theory of Self-Reproducing Automata*, p. 47.

46. Pattee, “How Does a Molecule Become a Message?” p. 11.

47. *Ibid.* For more on the productivity of such “failure,” see Winograd and Flores, *Understanding Computers and Cognition*.

48. For example: the very formulation of the aporia of living systems in terms of a “chicken/egg” problem testifies to the trace of a humanist, heterosexualist orientation at play in these accounts. For such a formulation appears problematic only in the context of a privileging of “origins” and the use of a specifically heterosexual paradigm. For example, ferns reproduce through spores, gametophytes and “full grown ferns.” No one questions “which comes first,” although primacy is usually accorded to the “full grown plant” when narrativized. Chickens and eggs reproduce themselves sexually; each reproduces the other, but the paradox usually revolves around the priority of one over the other. The use of this, rather than any of the other examples of reproduction, as the paradigm for a bootstrap problem is emblematic of a heterosexualist inflection of thought. Only a subjectivity oriented around sexual difference thought *as opposition rather than network* would be ensnared in such a bootstrap problem. By contrast, the “fern”—spore, gametophyte, full-grown plant—is seen as all one organism, smeared over time.

49. Haraway, *Simians, Cyborgs, Women*, p. 190.

50. See Doyle, “Dislocating Knowledges,” 47–58.

51. “But of course infinite vision is an illusion, a god-trick” (Haraway, *Simians, Cyborgs, Women*, p. 189).

52. For an insightful account of situated knowledges and N. Katherine Hayles’s notion of “Constrained Constructivism,” see Lenoir, “Was the Last Turn the Right Turn?”

53. Indeed, rhetorical softwares can be seen as one more player in the ecology of “articulation work” described by sociologists of science as “keeping everything on track through little bits of local knowledge that keep the enterprise functioning” (*The Right Tools for the Job: At Work in Twentieth-Century Life Sci-*

ences, edited by Joan Fujimura and Adele Clark [Princeton, N.J.: Princeton University Press, 1992.], p. 276).

54. Oyama, “Accidental Chordate.”

55. Ibid.

56. Indeed, this raises the possibility that contingency also qualifies as a nonhuman actant in scientific practice in that it is something absolutely necessary to scientific work.

57. The phrase is Derrida’s: “In marking out difference, everything is a matter of strategy and risk. . . . In the end, it is a strategy without finality. We might call it blind tactics or empirical errance, if the value of empiricism did not itself derive all its meaning from its opposition to philosophical responsibility” (“Differance” in *Speech and Phenomena*, p. 135). Hans-Jörg Rheinberger has translated the phrase “empirical errance” as “empirical roaming around” (“Experimental Systems,” p. 71).

58. Historian of science, philosopher, and molecular biologist Hans-Jörg Rheinberger has described this refusal of material systems to be localized in terms of a temporality of the (Derridean) trace, a nonhuman actor known as time: “An experimental system has *more stories* to tell than the experimenter at a given moment is trying to tell with it. It not only contains submerged narratives, the story of its repressions and displacements; as long as it remains a research system, it also has not played out its excess. Experimental systems contain remnants of older narratives as well of fragments of narratives that have not yet been told” (“Experimental Systems,” pp. 65–81). Thus, rhetorics of living systems must be seen as constantly in play, traces of old narratives becoming the present, the present narratives inscribing the past and the future, life tracing its way through such narratives differentially.

59. Lacan, *Seminar of Jacques Lacan*, p. 143.

60. Waddington, “Epilogue,” in *Towards a Theoretical Biology*, vol. 4, p. 289.

Chapter 6

1. Marcello Barbieri, in *The Semantic Theory of Evolution*, points out that in terms of producing lifelike objects, “synthetic biology” actually goes back to at least 1907. “Stephane Le Duc’s ‘The Mechanism of Life’ featured a group of mushrooms, a colony of algae and a cell undergoing mitosis. In fact they were all inorganic artifacts that Le Duc had created in saturated solutions of potash with dyes, phosphates, chlorides and other salts” (p. 89).

2. Langton, *Artificial Life*, p. 1.

3. Jacob, and Monod, “Genetic Regulatory Mechanisms,” p. 354.

4. Langton, *Artificial Life*, p. 2. Of course, the idea that the diversity of life somehow constitutes a “single example” is itself historically constituted. See my subsequent discussion of Foucault and thesis 3, “What Body?” of chapter 1.

5. Nietzsche, *Twilight of the Idols*, p. 30.

6. Here Nietzsche discusses the limit that calls for the “beyond” discussed in chapter 1. This limit is itself, of course, a poor approximation of the finite nature of reason. For another reason, see my discussion in chapter 1 under the sign of narrative, where the gaps that inhabit “resolution” and other such limits are exposed as fissures or “nooks” and not solid, impermeable, absolute walls.

7. Langton, *Artificial Life*, p. xiii.

8. Foucault, *Order of Things*, p. 269.

9. *Ibid.*, p. 254.

10. Waddington, *Towards a Theoretical Biology*, vol. 4, p. 289.

11. See Niels K. Jerne, “The Generative Grammar of the Immune System,” *Science* 229: 1057–59.

12. Longuet-Higgins, “Seat of the Soul,” pp. 236–41.

13. Hodges, *Alan Turing*, pp. 102–3.

14. Waddington, *Towards a Theoretical Biology*, vol. 2, p. 241. Of course, what becomes important for our purposes is the overlooking of the platform for the tape; as in molecular biology’s persistent “overlooking” or forgetting of the body, accounts of Turing machines often forget that tapes must be read by some agent, machinic or otherwise.

15. *Ibid.*, 236.

16. Atlan and Koppel, “Cellular Computer DNA,” p. 335.

17. Jacob and Monod, “Genetic Regulatory Mechanisms,” p. 354.

18. Atlan and Koppel, “Cellular Computer DNA,” p. 346.

19. On the one-way relationship of the analogy between machines and organisms, historian of science Georges Canguilhem writes: “The relationship between machine and organism has generally been studied in only one way. Nearly always, the organism has been explained on the basis of a preconceived idea of the structure and functioning of the machine; but only rarely have the structure and function of the organism been used to make the construction of the machine itself more understandable.” (Canguilhem, “Machine and Organism,” p. 45, in Crary and Kwinter, *Incorporations*.)

20. Shannon, “The Bandwagon,” pp. 2–3.

21. By contrast, the history of automata—as opposed to computer life—is full of these reversals in which the model displaces the “original” as the object of study. Jacques de Vaucanson, for example, had plans to produce “an automatic figure whose motions will be an imitation of all animal operations, such as the circulation of the blood, respiration, digestion, the movement of muscles, tendons, nerves and so forth. He claims that by using this automaton we shall be able to carry out experiments on animal functions, and to draw conclusions from them which will allow us to recognize the different states of human health, in order to remedy his ills” (Beaune, “Classical Age,” p. 434). Of course, no claims

were made that this automata lived—this would have to wait for the modern notion of life outlined in this volume.

22. One of Freud's paradigmatic examples for the uncanny or "*unheimlich*" is the inability to distinguish between living and nonliving entities. See "The Uncanny," in *Collected Works*, vol. 17, p. 242.

23. Sigmund, *Games of Life*, p. 10.

24. *Ibid.*

25. Regis, *Great Mambo Chicken*, p. 193.

26. Anthropologist Stefan Helmreich, who has studied the community of A-life researchers at the Santa Fe Institute, confirms this observation. Personal communication with author, February 1996. See his *Replicating Reproduction*.

27. Rotman, "Towards a Semiotics," p. 15.

28. Beaune, "Classical Age of Automata," p. 435.

29. Lavery, *Late for the Sky*.

30. Langton, *Artificial Life*, p. 2.

31. *Ibid.*, p. 20.

32. Remarkably, Freeman Dyson's plans for an artificial life mission to Mars relies on the same Icarus imagery, this time with Icarus planning on the big meltdown: "Dyson turned his imagination to the cosmos and proposed a self-reproducing automaton sent to the snow-covered Saturnian moon Enceladus. In his vision, this particular machine would draw on the distant sun's energy to create factories that produced a long stream of solar-powered sailboats, each carrying a block of ice. The sailboats would head toward Mars, and the fiery ride into the Martian atmosphere would melt the ice blocks" (Levy, *Artificial Life*, p. 33).

33. Langton, *Artificial Life*, p. 2.

34. *Ibid.*

35. Quoted in Regis, *Great Mambo Chicken*, p. 192.

36. Donna Haraway invests microelectronics with this capability: "Microelectronics is the technical basis of simulacra; that is, copies without originals" (*Simians, Cyborgs, Women*, p. 165). Here I want to highlight the linguistic artifacts necessary to produce the effects of such simulation, what Beaune refers to as the "language of the technostructure." While microelectronics are themselves "written" artifacts, it is also true that they are limited by their rhetorical softwares, textual artifacts that make possible the explication of the simulation and produce the experience of "originality" or "life." These softwares themselves reach their limit at both the limits of the hardware and the limits of wetwares, the threshold at which the rhetorical software becomes inarticulate, disjointed, unable to explicate anything but its own inadequacy. The problematic of "definition" in artificial life is one such threshold.

37. Howard Pattee sums this up well when he writes "the fact that human

thought can be simulated by computation is treated as evidence in support of the Physical Symbol System Theory. But, since virtually everything can be simulated by a computer, it is not really evidence for the theory at all” (Pattee, in Langton, *Artificial Life*, p. 67). Similarly, we have no evidence from A-life for a general theory concerning living systems; the simulations of life tell us more about the capabilities of computers (and their operators) than about the formal attributes of all living systems.

38. Baudrillard, *Simulations*, p. 4.

39. *Ibid.*, p. 146.

40. Dawkins, *Blind Watchmaker*, p. 206. A further twist on this logic of the simulacrum occurred in central Pennsylvania at a store that offered for sale “Genuine Xerox Copies.”

41. Baudrillard, *Simulations*, pp. 5–6. Note that the limit of this argument arrives the moment one attempts to fake death and medicine becomes the arbiter of “true” death, a determination that seems to take on a higher degree of arbitrariness in the age of postvitality.

42. Baudrillard, *Simulations*, p. 3.

43. *Ibid.*, p. 7.

44. *Ibid.*, p. 9.

45. Waddington, *Towards a Theoretical Biology*, vol. 2, p. 75.

46. Levy, *Artificial Life*, p. 95.

47. *Ibid.*, p. 58.

48. Lavery, *Late for the Sky*, p. 112.

49. Dawkins, *Blind Watchmaker*, p. 111.

50. Ray, *Tierra Abstract*.

51. Atlan and Koppel, “Cellular Computer DNA,” p. 346.

52. Ray, *Tierra Abstract*.

53. See, for example, Adams, “Self Organization and Living Systems,” in which Adams writes: “if in fact the nature of life is embodied in a unique molecular electronic structure of DNA, this would suggest that any extraterrestrial life would probably resemble the forms occurring on this planet” (p. 224). Here we can see the way in which the notion that DNA is formally a “program” or “artificial intelligence” argues for the universality of form, if not substance, in the processes of life.

54. Beaune, “Classical Age of Automata,” p. 437.

55. Moravec, *Mind Children*, p. 4.

56. Serres, *The Parasite*, p. 37.

57. Ray, grant proposal.

58. Thus, A-life researchers do not simply “construct” A-life creatures; A-life organisms are real entities that use up energy and space and are not simply the result of human will. Like viruses, however, they require a host, and A-lifers are such hosts; and, as usual, the host is transformed in the process. Thus, following traditional usage in which viruses are only alive when they have colonized a cell, A-life creatures are never in themselves alive; it is only through the ecology of

wetwares, softwares, and hardwares that such emergent phenomena occur. When A-life organisms are alive, they are not, strictly speaking, artificial, as they include corporeal traces of organic elements—humans. When they are not networked with humans, they are not alive but are artificial. In this sense, the A-life creature is *beyond living*.

59. Ray, grant proposal.

60. Nietzsche, *Twilight of the Idols*, p. 75.

Bibliography

- Adams, D. H. "Self Organization and Living Systems: Is DNA an Artificial Intelligence?" *Medical Hypotheses* 29 (1989): 223–339.
- Alberts, Bruce, Dennis Bray, Julian Lewis, Martin Raff, Keith Roberts, and James D. Watson. *Molecular Biology of the Cell*. 2d ed. New York: Garland, 1989.
- Atlan, Henri, and Moshe Koppel. "The Cellular Computer DNA: Program or Data?" *Bulletin of Mathematical Biology* 52, no. 3 (1990): 335–48.
- Austin, J. L. *How to Do Things with Words*. Cambridge: Harvard University Press, 1962.
- Barbieri, Marcello. *The Semantic Theory of Evolution*. New York: Harwood, 1985.
- Barrow, John D., and Frank J. Tipler. *The Anthropic Cosmological Principle*. New York: Oxford University Press, 1986.
- Baudrillard, Jean. *The Ecstasy of Communication*. Trans. Bernard and Caroline Schutze. Ed. Sylvère Lotringer. Brooklyn: Autonomedia, 1988.
- . *Simulations*. Trans. Paul Foss, Paul Patton, and Phillip Beitchman. New York: Semiotext(e), 1983.
- Beadle, George, and Muriel Beadle. *The Language of Life: An Introduction to the Science of Genetics*. Garden City, N.Y.: Doubleday, 1966.
- Beardsley, T. "Smart Genes." *Scientific American* 265, no. 2 (August 1991): 86–95.
- Beaune, Jean-Claude. "The Classical Age of Automata: An Impressionistic Survey from the Sixteenth to the Nineteenth Century." In *Fragments for a History of the Human Body*. Ed. Michael Fehrer and Nadia Tazi, pp. 431–80. New York: Zone; distributed by MIT Press, 1989.
- Benjamin, Walter. *Illuminations*. Trans. by Harry Zohn. Ed. Hannah Arendt. New York: Schocken, 1986.
- Bloom, Harold. *The American Religion: The Emergence of the Post-Christian Nation*. New York: Simon and Schuster, 1992.
- Borch-Jacobsen, Mikkel. *Lacan: The Absolute Master*. Trans. Douglas Brick. Stanford: Stanford University Press, 1991.

- Butler, Judith. *Bodies That Matter: On the Discursive Limits of Sex*. New York: Routledge, 1993.
- Butler, Samuel. *Erewhon*. Ed. Peter Mudford. Harmondsworth, U.K.: Penguin, 1970.
- Cadava, Eduardo, Peter Connor, and Jean-Luc Nancy, eds. *Who Comes After the Subject?* New York: Routledge, 1991.
- Canguilhem, Georges. *La Connaissance de la Vie*. 2d ed. Paris: J. Vrin, 1965.
- . *Ideology and Rationality in the History of the Life Sciences*. Trans. Arthur Goldhammer. Cambridge, Mass.: MIT Press, 1988.
- . *The Normal and the Pathological*. Trans. Carolyn R. Fawcett, in collaboration with Robert S. Cohen; with an introduction by Michel Foucault. New York: Zone, 1989.
- Clark, Adele, and Joan Fujimura, eds. *The Right Tools for the Job: At Work in Twentieth-Century Life Sciences*. Princeton, N.J.: Princeton University Press, 1992.
- Cohn, Melvin, and Jacques Monod. "Terminology of Enzyme Formation." *Nature* 172 (December 12, 1953): 1096.
- Cranor, Carl, editor. *Are Genes Us? Social Implications of the Human Genome Initiatives*. New Brunswick, N.J.: Rutgers University Press, 1994.
- Crary, Jonathan, and Sanford Kwinter. *Incorporations*. New York: Zone; distributed by MIT Press, 1992.
- Crick, Francis. *Of Molecules and Men*. Seattle: University of Washington Press, 1966.
- . "The Recent Excitement in the Coding Problem." *Progress in Nucleic Acid Research in Molecular Biology* 1 (1963): 163–217.
- Crick, Francis, and James Watson. "Molecular Structure of Nucleic Acids: A Structure for Deoxyribonucleic Acid." *Nature* 171 (1953): 737–38.
- Crowther, Paul. *The Kantian Sublime: From Morality to Art*. Oxford: Clarendon Press; New York: Oxford University Press, 1989.
- Curtius, Ernst Robert. *European Literature and the Latin Middle Ages*. Trans. Willard R. Trask. New York: Pantheon Books, 1953.
- Dawkins, Richard. *The Blind Watchmaker: Why the Evidence of Evolution Reveals a Universe Without Design*. New York: W. W. Norton, 1987.
- Deleuze, Gilles. *The Fold: Leibniz and the Baroque*. Trans. Tom Conley. Minneapolis: University of Minnesota Press, 1993.
- . *Foucault*. Trans. and ed. Sean Hand. Minneapolis: University of Minnesota Press, 1988.
- . *Spinoza: Practical Philosophy*. Trans. Robert Hurley. San Francisco: City Lights Books, 1988.
- Deleuze, Gilles, and Félix Guattari. *A Thousand Plateaus: Capitalism and Schizophrenia*. Trans. Brian Massumi. Minneapolis: University of Minnesota Press, 1987.
- DeLillo, Don. *The Names*. New York: Knopf, 1982.

- de Man, Paul. *The Resistance to Theory*. Foreword by Wlad Godzich. Minneapolis: University of Minnesota Press, 1986.
- Derrida, Jacques. "Declarations of Independence." *New Political Science* 15 (1986): 7-15.
- . *Dissemination*. Trans. Barbara Johnson. Chicago: University of Chicago Press, 1981.
- . *Margins of Philosophy*. Trans. Alan Bass. Chicago: University of Chicago Press, 1982.
- . *Of Grammatology*. Trans. Gayatri Chakravorty Spivak. Baltimore: Johns Hopkins University Press, 1976.
- . *Specters of Marx: The State of the Debt, the Work of Mourning, and the New International*. Trans. Peggy Kamuf, with an introduction by Bernd Magnus and Stephen Cullenberg. New York: Routledge, 1994.
- . *Speech and Phenomena and Other Essays on Husserl's Theory of Signs*. Trans. David B. Allison. Evanston: Northwestern University Press, 1973.
- . *Writing and Difference*. Trans. Alan Bass. Chicago: University of Chicago Press, 1978.
- Dounce, A. L. "Duplicating Mechanism for Peptide Chain and Nucleic Acid Synthesis" *Enzymologia* 15 (1952): 251-58.
- Doyle, Richard. "Dislocating Knowledges, Thinking Out of Joint: Rhizomatics, *Caenorhabditis elegans* and the Importance of Being Multiple." *Configurations* 1 (1994): 47-58.
- Fireman, Philip, and Raymond G. Slavin, eds. *Atlas of Allergies*. New York: Gower, 1991.
- Fortun, Michael. "Making and Mapping Genes and Histories: The Genomics Project in the United States, 1980-1990." Ph.D. diss., Harvard University, Department of the History of Science, 1993.
- Foucault, Michel. *The Archaeology of Knowledge*. Trans. A. M. Sheridan Smith. New York: Pantheon, 1972.
- . *Birth of the Clinic: An Archaeology of Medical Perception*. Trans. A. M. Sheridan Smith. New York: Pantheon, 1973.
- . *Foucault/Blanchot*. Trans. Brian Massumi. New York: Zone; distributed by MIT Press, 1987.
- . *Language, Countermemory, Practice: Selected Essays and Interviews*. Trans. Donald F. Bouchard and Sherry Simon. Ed. Donald F. Bouchard. Ithaca, N.Y.: Cornell University Press, 1977.
- . *The Order of Things: An Archaeology of the Human Sciences*. New York: Pantheon, 1971.
- Freud, Sigmund. *The Interpretation of Dreams*. Trans. and ed. James Strachey. New York: Avon, 1965.
- Gamow, G. *One, Two, Three . . . Infinity: Facts and Speculations of Science*. With illustrations by George Gamow. New York: Bantam, 1966.

- . "Possible Relation between Deoxyribonucleic Acid and Protein Structures." *Nature* 173 (1954): 318.
- Gamow, George, and N. Metropolis. "Numerology of Polypeptide Chains." *Science* 120 (1954): 779-80.
- Gamow, George, and Martin Ycas. *Mr. Tompkins Inside Himself: Adventures in the New Biology*. With illustrations by George Gamow. New York: Viking, 1967.
- . "Statistical Correlation of Protein and Ribonucleic Acid Composition." *Proceedings of the National Academy of Science* 41 (1955): 1011-19.
- Gierasch, Lila M., and Jonathan King, eds. *Protein Folding: Deciphering the Second Half of the Genetic Code*. Washington, D.C.: American Association for the Advancement of Science, 1990.
- Gilbert, Walter. "Towards a Paradigm Shift in Biology." *Nature* 349 (January 10, 1991): 99.
- Greenblatt, Stephen, ed. *Allegory and Representation*. Baltimore: Johns Hopkins University Press, 1981.
- Haraway, Donna. *Crystals, Fabrics, and Fields: Metaphors of Organicism in Twentieth-Century Developmental Biology*. New Haven, Conn.: Yale University Press, 1976.
- . *Simians, Cyborgs, Women: The Reinvention of Nature*. London: Free Association, 1990.
- Heidegger, Martin. *Poetry, Language, Thought*. Trans. Albert Hofstadter. New York: Harper and Row, 1971.
- . *The Question Concerning Technology and Other Essays*. Trans. William Lovitt. New York: Garland, 1977.
- Heims, Steve J. *John Von Neumann and Norbert Wiener: From Mathematics to the Technologies of Life and Death*. Cambridge, Mass.: MIT Press, 1980.
- Helmreich, Stefan. "Anthropology Inside and Outside the Looking-Glass Worlds of Artificial Life." Ph.D. diss., Stanford University, Department of Anthropology, 1995.
- Hodges, Andrew. *Alan Turing: The Enigma*. London: Burnett, 1983.
- Jacob, François. *The Logic of Life: A History of Heredity*. Trans. Betty E. Spillmann. New York: Pantheon, 1973.
- . *The Statue Within: An Autobiography*. Trans. Franklin Philip. New York: Basic, 1988.
- Jacob, François, and Jacques Monod. "Genetic Regulatory Mechanisms in the Synthesis of Proteins." *Journal of Molecular Biology* 3: 318.
- Judson, Horace. *The Eighth Day of Creation*. New York: Simon and Schuster, 1979.
- Kant, Immanuel. *The Critique of Judgement*. Trans. James Creed Meredith. Oxford: Clarendon Press, 1964.
- Kay, Lily. *The Molecular Vision of Life: Caltech, the Rockefeller Foundation, and the Rise of the New Biology*. New York: Oxford University Press, 1993.

- Keller, Evelyn Fox. "The Discourse of Gene Action." Tanner Lectures, University of Utah, February 1993.
- . *A Feeling for the Organism: The Life and Work of Barbara McClintock*. San Francisco: W. H. Freeman, 1983.
- . *Reflections on Gender and Science*. New Haven: Yale University Press, 1985.
- . *Secrets of Life, Secrets of Death: Essays on Language, Gender, and Science*. New York: Routledge, 1992.
- Lacan, Jacques. *The Seminar of Jacques Lacan: Book II, The Ego in Freud's Theory and in the Technique of Psychoanalysis, 1954–1955*. Trans. Sylvana Tomaselli. Ed. Jacques Alain Miller. New York: W. W. Norton, 1988.
- Lacoue-Labarthe, Philippe. *Heidegger, Art and Politics: The Fiction of the Political*. Trans. Chris Turner. Cambridge, Mass.: Blackwell, 1990.
- Langton, Christopher G. *Artificial Life: The Proceedings of an Interdisciplinary Workshop on the Synthesis and Simulation of Living Systems*. Redwood City, Calif.: Addison-Wesley, 1989.
- Latour, Bruno. *Science in Action: How to Follow Scientists and Engineers Through Society*. Cambridge, Mass.: Harvard University Press, 1987.
- Lavery, David. *Late for the Sky: The Mentality of the Space Age*. Carbondale: Southern Illinois University Press, 1992.
- Lenoir, Tim. "Was the Last Turn the Right Turn? The Semiotic Turn and A. J. Greimas." *Configurations* 1 (1994): 119–36.
- Levinas, Emmanuel. *Totality and Infinity: An Essay on Exteriority*. Trans. Alphonso Lingis. Pittsburgh: Duquesne University Press, 1969.
- Levy, Steven. *Artificial Life: The Quest for Creation*. New York: Pantheon, 1992.
- Léwontin, Richard. *Biology as Ideology: The Doctrine of DNA*. New York: Harper-Perennial, 1992.
- L'Heritier, Philippe, Francois Jacob, Roman Jakobson, and Claude Lévi-Strauss. "Vivre et Parler." *Les Lettres Francaises*, nos. 1221–23, 1968.
- Longuet-Higgins, Christopher. "The Seat of the Soul." In *Towards A Theoretical Biology*, ed. C. H. Waddington, vol. 2, 236–41. Chicago-Aldine, 1968–72.
- Lytard, Jean-François. *The Differend: Phrases in Dispute*. Trans. Georges Van Den Abbeele. Minneapolis: University of Minnesota Press, 1988.
- . *The Inhuman: Reflections on Time*. Trans. Geoffrey Bennington and Tachel Bowlby. Stanford, Calif.: Stanford University Press, 1991.
- Massumi, Brian. *A User's Guide to Capitalism and Schizophrenia: Deviations from Deleuze and Guattari*. Cambridge, Mass.: MIT Press, 1992.
- Masters, Roger. "Genes, Language, and Evolution." *Semiotica* (1968): 307.
- McIntosh, Robert. *The Background of Ecology: Concept and Theory*. New York: Cambridge University Press, 1985.
- Miller, Jeffrey H., and William S. Reznikoff, eds. *The Operon*. Cold Spring Harbor, N.Y.: Cold Spring Harbor Laboratory, 1978.

- Moravec, Hans P. *Mind Children: The Future of Robot and Human Intelligence*. Cambridge, Mass.: Harvard University Press, 1988.
- Nietzsche, Friedrich. *Friedrich Nietzsche on Rhetoric and Language*. Trans. and ed., with a critical introduction by, Sander L. Gilman, Carole Blair, and David J. Parent. New York: Oxford University Press, 1989.
- . *Twilight of the Idols; and, The Anti-Christ*. Trans. R. J. Hollingdale, with an introduction by Michael Tanner. New York: Penguin, 1990.
- . *Untimely Meditations*. Trans. R. J. Hollingdale, with an Introduction by J. P. Stern. New York: Cambridge University Press, 1983.
- Oyama, Susan. "The Accidental Chordate: Contingency in Developmental Systems." *South Atlantic Quarterly* 9, no. 2 (1995): 509–26.
- . *The Ontogeny of Information: Developmental Systems and Evolution*. New York: Cambridge University Press, 1985.
- Pattee, Howard H. "How Does a Molecule Become a Message?" *Communication in Development, Developmental Biology*, Supplement 3 (1969): 1–16.
- Plato. *The Collected Dialogues, Including the Letters*. Ed. Edith Hamilton and Huntington Cairns. Princeton, N.J.: Princeton University Press, 1989.
- Polanyi, Michael. *Knowing and Being: Essays*. Ed. Marjorie Grene. London: Routledge and Kegan Paul, 1969.
- Ray, Tom. "Grant Proposal." Available on the internet by anonymous ftp from ftp://alife.santafe.edu/pub/SOFTWARE/Tierra/doc/proposal.tex. 1995.
- . *Tierra Abstract*. Available on the internet by anonymous ftp from ftp://alife.santafe.edu/pub/SOFTWARE/Tierra/doc. 1992.
- Regis, Ed. *Great Mambo Chicken and the Transhuman Condition: Science Slightly over the Edge*. Reading, Mass.: Addison-Wesley, 1990.
- Rheinberger, Hans-Jörg. "Experimental Systems: Historiality, Narration and Deconstruction." *Science in Context* 7, no. 1 (1994): 71.
- Roberts, Leslie. "The Worm Project." *Science* 248, no. 4961 (June 15, 1990): 1310–13.
- Roland, J. "Nanotechnology: The Promise and Peril of Ultratiny Machines." *Futurist* 25, no. 2 (March–April 1991): 29–35.
- Ronell, Avital. *Dictations: On Haunted Writing*. Bloomington: Indiana University Press, 1986.
- . *The Telephone Book: Technology, Schizophrenia, Electric Speech*. Lincoln: University of Nebraska Press, 1989.
- Rose, Gillian. *Feminism and Geography: The Limits of Geographical Knowledge*. Minneapolis: University of Minnesota Press, 1993.
- Rotman, Brian. *Ad Infinitum, the Ghost in Turing's Machine: Taking God Out of Mathematics and Putting the Body Back In: An Essay in Corporeal Semiotics*. Stanford, Calif.: Stanford University Press, 1993.
- . *Signifying Nothing: The Semiotics of Zero*. New York: St. Martin's Press, 1987.
- . "Towards a Semiotics of Mathematics." *Semiotica* 72 (1988): 15.

- Ruelle, David. *Chance and Chaos*. Princeton, N.J.: Princeton University Press, 1991.
- Sagan, Dorion. "Metametazoa: Biology and Multiplicity." In *Incorporations*, ed. Jonathan Crary and Sanford Kwinter, 362–85. New York: Zone, 1992.
- Schaffer, Simon, and Steven Shapin. *Leviathan and the Air-Pump: Hobbes, Boyle, and the Experimental Life*. Princeton, N.J.: Princeton University Press, 1985.
- Schrödinger, Erwin. *What Is Life? The Physical Aspect of the Living Cell & Mind and Matter*. Cambridge: Cambridge University Press, 1967.
- sci.cryonics (Usenet newsgroup) "Frequently Asked Questions." Available on the internet.
- Searle, John. "Minds, Brains, Programs." In *Artificial Intelligence: The Case Against*, 25–47. Edited by Ranier Born. New York: St. Martin's, 1987.
- Serres, Michel. *Hermes: Literature, Science, Philosophy*. Ed. Josue V. Harari and David F. Bell. Baltimore: Johns Hopkins University Press, 1982.
- . *The Parasite*. Baltimore: Johns Hopkins University Press, 1982.
- Shannon, Claude. "The Bandwagon." *IRE Transactions* (1956): 2–3.
- Sigmund, Karl. *Games of Life: Explorations in Ecology, Evolution, and Behavior*. New York: Oxford University Press, 1993.
- Silverman, Hugh, and Donn Welton, eds. *Postmodernism and Continental Philosophy*. Albany: State University of New York Press, 1988.
- Suzuki, David, Anthony J. F. Griffiths, Jeffrey H. Miller, and Richard C. Lewontin. *An Introduction to Genetic Analysis*. 2d ed. San Francisco: W. H. Freeman, 1981.
- Taylor, Mark C. *Notis*. Chicago: University of Chicago Press, 1993.
- Thompson, D'Arcy Wentworth. *On Growth and Form*. Abridged ed. Ed. John Tyler Bonner. Cambridge: Cambridge University Press, Canto Edition, 1992.
- Trifonov, E., and Volker Brendel. *Gnomic: A Dictionary of Genetic Codes*. Rehovot, Israel: Balaban, distributed by VCH, 1986.
- Tuana, Nancy. *Feminism & Science*. Bloomington: Indiana University Press, 1989.
- U.S. Congress. Office of Technology Assessment. *Mapping Our Genes: The Genome Projects: How Big, How Fast?* Washington, D.C.: GPO, 1988.
- Von Neumann, John. *Theory of Self-Reproducing Automata*. Ed. and completed by Arthur W. Burks. Urbana: University of Illinois Press, 1966.
- Waddington, Conrad Hal, ed. *Towards a Theoretical Biology*. 4 vols. Chicago: Aldine, 1968–72.
- Watson, James D. *The Double Helix: A Personal Account of the Discovery of the Structure of DNA*. Ed. Gunther S. Stent. New York: W. W. Norton, 1980.
- Watson, James D., and Francis Crick. "Genetical Implications of the Structure of Deoxyribonucleic Acid." *Nature* (May 30, 1953): 171, 964–67.
- Winograd, Terry, and Fernando Flores. *Understanding Computers and Cognition*. Norwood, N.J.: Ablex, 1986.

- Woese, Carl. *The Genetic Code: The Molecular Basis for Genetic Expression*. New York: Harper and Row, 1967.
- Ycas, Martin. *The Biological Code*. Amsterdam: North-Holland, 1969.
- Zimmerman, Michael E. *Heidegger's Confrontation with Modernity: Technology, Politics, and Art*. Bloomington: Indiana University Press, 1990.
- Žižek, Slavoj. *The Sublime Object of Ideology*. New York: Verso, 1989.

Index



In this index an “f” after a number indicates a separate reference on the next page, and an “ff” indicates separate references on the next two pages. A continuous discussion over two or more pages is indicated by a span of page numbers, e.g., “57–59.” *Passim* is used for a cluster of references in close but not consecutive sequence.

- “Accidental Chordate, The” (Oyama), 106–7, 138n44
Accidents, 26–27, 141n5
Adams, D. H., 37; “Self Organization and Living Systems: Is DNA an Artificial Intelligence?,” 35–36
Adaptation, 60
“Age of the World Picture, The” (Heidegger), 45–46
AI. *See* Artificial intelligence
Alberts, Bruce: *Molecular Biology of the Cell*, 15f
A-life, *see* Artificial life
Alleles, 30
Allergy, 87, 104
Amino acids, 5–6, 39
Arbib, Michael, 118
Artificial intelligence (AI), 36–37
Artificial life (A-life), 2, 8, 25, 109, 126f, 130, 132, 159n32, 160–61n58; rhetoric of, 110–18, 121–23; culture and, 119–20; replication and, 124–25; program and, 128–29
“Artificial Life” (Langton), 120
Atlan, Henri, 127, 129; “The Cellular Computer DNA: Program or Data?,” 114–15
Austin, J. L., 5, 144n13
Automata, 119, 132, 158–59n21. *See also* Cellular automata
Automaton, 130
Barbieri, Marcello: *The Semantic Theory of Evolution*, 157n1
Baudrillard, Jean, 20, 123–25
Beadle, George: *The Language of Life*, 86
Beadle, Muriel: *The Language of Life*, 86
Beaune, Jean-Claude, 130, 159n36; “The Classical Age of Automata,” 119
Behavior, 111
Belief, 3
Benjamin, Walter, 46–48, 61, 144n23, 145n35
Beyond, the, 17, 23
Bible, 145n24
Biology, 1, 47, 141n6, 157n1; theoretical, 111–13
Biology as Ideology: The Doctrine of DNA (Lewontin), 59–60
Birth of the Clinic, The (Foucault), 131
Blueprint, 79–80, 150n19
Body, bodies, 8–9, 33, 69–70, 147n48, 151n26; and molecules, 13–14
Bootstrap problem, 156n48

- Brendel, Volker, 97; *Gnomic*, 98–99
 Brenner, Sydney, 14, 138n44
 Butler, Judith, 106, 136–37nn15, 17
 Butler, Samuel, 141n14
- CA, *see* Cellular automata
 Cairns-Smith, A. G., 130
 Canguilhem, Georges, 158n19
 Cartoons, 21–22
C. elegans, 14–15, 20ff, 138n44; cell choices and, 16–17; physical mapping of, 17–18
 Cell, 16–17
 Cell lineage, 18
 Cellular automata (CA), 120
 “Cellular Computer DNA: Program or Data?, The” (Atlan and Koppel), 114–15
 Center, Centrality, 79f
 Chiasmata, 30
 Chomsky, Noam, 113
 Chromosomes, 28, 29–30, 31, 41f, 143n6
 “Classical Age of Automata, The” (Beaune), 119
 Code, 5–6, 25, 28f, 145n29. *See also* Code-script; Coding problem
 Code-script, 29, 31, 41, 42, 111, 116, 129, 143n5
 Coding problem, 39ff, 43
 Communication, 43, 45, 89–90, 91, 102
 Communication theory, 90
 Computability, 152n44
 Computers, 2, 111, 128, 151n32, 159–60n37; and vitality, 113–14, 116, 117–18, 130
 Contagion, 3
 Contingency, 106–7, 157n56
 Control, 65
 Conway, John Horton, 116–17
 Crick, Francis, 27, 33f, 39ff, 109, 114; “Molecular Structure of Nucleic Acids,” 35
 Crossover, 29–30
 Crowther, Paul: *The Kantian Sublime: From Morality to Art*, 139n50
Crying of Lot 49, The (Pynchon), 63
 Cryptographic paradigm, 44, 49
 Culture, 88–90, 119–20
- Cuvier, George, 12
 Cybernetics, 116
Cybernetics (Wiener), 114
 Cyborgs, 25, 36
- Darwin, Charles, 59–60
 Davidson, Eric, 77
 Dawkins, Richard, 124, 127ff, 132
 Death(s), 21, 160n41
 Definition, 147n46, 150n21, 152n43; nature of, 71–72; connotation of, 73–75; of organisms, 81–82
 Deleuze, Gilles, 7, 9, 30–31, 44, 69, 143n4, 146n43, 148n50; *A Thousand Plateaus*, 16; *What Is Philosophy?*, 6
 De Man, Paul, 28f
 Department of Energy, U.S., 26
 Derrida, Jacques, 30f, 34, 57, 79f, 108, 109, 139–40n60, 144n15, 145n35, 148n50, 154nn17, 24, 157n57; on metaphor, 3–4; on vitality, 60–61; *Margins of Philosophy*, 86; *Of Grammatology*, 91, 92–93, 94–95
 Descartes, René, 43
 Description, 104–5
 Determinism, textual, 7
 Development, 77
 Dick, Philip K., 145n35
Différance, 91–92, 94, 96–97, 98ff, 137n20
 Discourse, scientific, 31, 32–33
 Disease, 33f, 131
 DNA, 2, 9, 27, 35, 43, 60, 66, 127f, 143n6, 146–47nn45, 49, 148–49nn50, 63; as code, 5–6; as artificial intelligence, 36–37; protein synthesis and, 39, 62f; as model, 41f, 50; translatability of, 54, 56–57, 62; power and agency of, 67, 81, 84, 95, 109; definition and, 73ff; time and, 77, 78–79; as language, 86, 87–88, 89, 95–96, 97–98, 100–101; as program, 114, 115–16, 160n53
 Double causality, 44
 Double helix, *see* DNA
 Dounce, A. L., 39
 Dyson, Freeman, 159n32
- E. coli*, 66, 68, 74–75
 Embryology, 76

- Empiricism, rhetorical, 83–84, 153n45
 Enzymes, 67, 70, 150n16
 Essence, 55–56
 Ethics, 153n45
 Eugenics, 26, 140n2
 Evolutionary theory, 59–60
 Experiments, 3
 Expression, 75–76

 Fifth essence, 55
 Foucault, Michel, 26–27, 32–33, 47, 86, 110; *The Order of Things*, 10–11, 113; on life, 58–59; *The Birth of the Clinic*, 131
 Future, 76–79
 Future perfect, 63–64

 Galileo Galilei, 43
 Gamow, George, 2, 8, 27, 35, 116, 143n9, 146–47n36, 45, 46, 148–49n63, 151n26; *Mr. Tompkins Inside Himself: Adventures in the New Biology*, 31, 55; “Possible Relation between Deoxyribonucleic Acid and Protein Structures,” 39, 42, 53f; on translation, 40f, 43–44, 48f; on tropics of absence, 50–61; on DNA, 62–63
 Gaps, textual-visual, 50–61
 Genes, 27, 66, 151n32, 154n17; definition of, 70ff; and life, 109, 136n10
 Genetic code, 30, 35, 48–49
 Genetic expression, 68, 70, 75, 76–77, 81
 Genetic inscription, 94–95, 154n24
 Genetic language, 61, 87, 100–101
 “Genetic Regulatory Mechanisms in the Synthesis of Proteins” (Jacob and Monod), 67, 72f, 80f; definition in, 73–75
 Genetics: Schrödinger on, 27–28, 29–30, 33–34
 Genome projects, 23, 37–38; human, 26, 115, 148–49n63
 Genomes, 2, 66, 72, 84, 111, 138n43; expression of, 75–76; and organisms, 78, 80–81; language of, 97–98; and artificial life, 128f. *See also* Genome projects
 Genotype, 28, 34–35
Geste et la Parole, La (Leroi-Gourhan), 91
 Gilbert, Walter: “Towards a Paradigm Shift in Biology,” 22–23

Gnomic (Trifonov and Brendel), 98–99
 Gnomic language, 98–100
Grammatology, Of (Derrida), 91, 92–93, 94–95
 Guattari, Félix, 7, 9, 44, 143n4, 148n50; *A Thousand Plateaus*, 16; *What Is Philosophy?*, 6
 Guy, Richard, 121

 Haraway, Donna, 25, 36, 105ff, 120, 136n16, 145n29, 155n30, 159n36
 Heidegger, Martin, 50, 143n9; “The Age of the World Picture,” 45–46; “The Thing,” 146n42
Heidegger, Art and Politics (Lacoue-Labarthe), 37
 Heredity, 2, 5, 27
 History: of life and writing, 91–94
 Hodgkin, Jonathon, 15
 Holes, 53, 54, 56–57. *See also* Tropics of absence
 Horvitz, Robert, 18
 “How Does a Molecule Become a Message?” (Pattee), 101f, 104
 Human identity, 7
 Husserl, Edmund, 139–40n60
 Hyperreal, 20f

 Induction effect, 81, 150n20
 Information theory, 45
 Inside and outside, 59–60
 Intelligence, 35–36
 Irigaray, Luce, 87

 Jacob, François, 8, 13, 25, 65ff, 68–69, 70, 77, 84, 88, 94, 111, 115f, 139n56, 144n11, 149n9, 150n16, 20, 151n24, 153n46; on life, 61, 102f; “Genetic Regulatory Mechanisms in the Synthesis of Proteins,” 67, 72f, 80f; on definition, 71, 74f; on DNA, 78–79; on blueprints, 79–80
 Jakobson, Roman, 8, 88, 90
 Judgment, 112

 Kant, Immanuel, 19f, 139n52
Kantian Sublime: From Morality to Art, The (Crowther), 139n50

- Kay, Lily E., 148n52
- Keller, Evelyn Fox, 10, 65, 155n33
- Knowledge(s), 1, 89, 105–6
- Koppel, Moshe, 127, 129; “The Cellular Computer DNA: Program or Data?,” 114–15
- Lacan, Jacques, 21f, 25, 81, 90–91, 108
- Lacoue-Labarthe, Philippe: *Heidegger, Art and Politics*, 37
- Lamarck, Jean-Baptiste, 60
- Langton, Christopher, 111f, 118–19, 122, 126f; “Artificial Life,” 120
- Language, 4, 63, 61, 155–56n41; interrelationship of, 46–47; DNA as, 86, 87–88, 89, 95–96, 97–98, 100–101; gnomonic, 98–100; and *différance*, 91–92
- Language of Life, The* (Beadle and Beadle), 86
- Laplace, Pierre-Simon de, 29
- Lavery, David, 119–20
- Leroi-Gourhan, André, *La Geste et la Parole*, 91
- Leviathan* (Schaffer and Shapin), 3
- Lévi-Strauss, Claude, 8, 88
- Lewontin, Richard: *Biology as Ideology: The Doctrine of DNA*, 59–60
- L’Heritier, Philippe, 8, 88
- Life, 2, 100, 110, 139–40n60, 148n54, 157n4, 160n53; Foucault on, 10–12, 58–59; power of, 13, 19; defining, 23–24, 25, 86–87, 111f, 123–24, 135n2, 152n43; intelligence and, 35–36; concept of, 41, 84, 122, 135n1; vitality of, 60–61; history of, 91–93; origins of, 102–3; rhetorical descriptions of, 107–8; and genes, 109, 136n10; sovereignty of, 125–32
- Life, game of, 116–18, 121
- Life science, 1–2, 11, 47
- “Life’s Irreducible Structure” (Polyani), 155–56n41
- Linguistics, 25, 43f, 90, 97, 153–54n10
- Literary description, 105. *See also* Rhetorical software
- Living organism, 56
- Location, 106
- Lock and key metaphor, 51–52
- Longuet-Higgins, Christopher, 113; “On the Seat of the Soul,” 114
- Lyotard, Jean-François, 19, 61, 139n54
- Machines, 116, 130, 158nn 14, 19
- McClintock, Barbara, 116
- McKenna, Andrew, 63–64
- Mapping, 17–18, 83, 136n9
- Margins of Philosophy* (Derrida), 86
- Markov chain, 9
- Mathematics, 43, 119, 135n1, 146n36, 147n49
- Matter, 136n15
- Memory, 127–28
- Metacode, 119, 122, 146n36. *See also* Rhetorical software
- “Metametazoa: Biology and Multiplicity” (Sagan), 142n28
- Metaphor, 3–4
- Metaphysics, 91–92, 109, 126, 135n3
- Metonymy, 147n47
- Mind Children* (Moravec), 130–31
- Mr. Tompkins Inside Himself: Adventures in the New Biology* (Gamow), 31, 55
- Möbius strip, 72–73, 84, 151n26
- Modeling, 104–5, 111
- Modernity, 50
- Molecular biology, 1–2, 4–5, 7–8, 22–23, 25, 90
- Molecular Biology of the Cell* (Alberts et al.), 15f
- “Molecular Structure of Nucleic Acids” (Watson and Crick), 35
- Molecular switches, 102–4
- Molecules, 25, 41–42
- Molecules and bodies, 13–14
- Monod, Jacques, 8, 65f, 68, 77, 84, 115, 116, 144n11, 150n16, 151n24; “Genetic Regulatory Mechanisms in the Synthesis of Proteins,” 67, 72f, 80f; on definition, 71, 74f; on DNA, 78–79; on life, 102f, 111
- Moravec, Hans: *Mind Children*, 130–31
- Moyzis, Robert, 142n25
- Narratives, 23. *See also* Text(s)
- National Institutes of Health, 26

- Nature, 139n54; as text, 42–43; and culture, 88–90
Nature, 43
 Nematode, 15–16, 21
 Nietzsche, Friedrich, 3, 120, 122, 132, 145n33, 158n6; *Twilight of the Idols*, 109, 112
 Nothing, 23
 Numerology, 40
- Order of Things, The* (Foucault), 10–11, 113
 Order-word, 57
 Organism effect, 82
 Organisms, 60, 83, 136n9, 141n12, 147n47, 150n18, 158n19, 160–61n58; life in, 11–12; description of, 28f, 32; and genetic expression, 75–77; development of, 78–79; and genome, 80–81, 154n17; definition of, 81–82, 84
 Organization, 36
 Oyama, Susan: “The Accidental Chordate,” 106–7, 138n44
- Pasteur Institute, 68, 76, 149n9
 Pathology, 34
 Pattee, Howard, 103, 108, 118, 159–60n37; “How Does a Molecule Become a Message?,” 101f, 104
 Pattern, 28–30
 Performative, the, 136–37n17
 Phenotypes, 22, 27–28, 34–35
 Philosophy, 30–31, 89–90
 Physicochemical processes, 42
 Physics, 141n6
 Pictures: world as, 45–46
 Polyani, Michael: “Life’s Irreducible Structure,” 155–56n41
 “Possible Relation between Deoxyribonucleic Acid and Protein Structures” (Gamow), 39, 42, 53f
 Poststructuralism, 1
 Postvitality, 38, 42, 65
 Power: of life, 13, 19
 Presence, 57
 Program, 113, 150n19, 154n24; DNA as, 114, 115–16, 160n53; artificial life and, 128–29
 Protein computers, 77
 Protein folding, 148n63
 Proteins, 143–44n10, 146–47n45
 Protein synthesis, 39, 66f, 74–75, 78–79, 147n47; regulatory mechanisms of, 80–81
- Ray, Thomas, 127–28, 129, 131–32
 Reader, 53
 Real, the, 124
 Reanimation Foundation, 140n62
 Reductionism, 150n21
 Regulation, 75
 Replication, 124–25, 129
 Representation, 83
 Research, 70–71, 140–41n3
 Resolution, 18–19, 20–21, 158n6
 Rheinberger, Hans-Jörg, 157n58
 Rhetoric(s), 2f, 4–5, 59, 71, 85, 135n3, 136n9, 144n13, 145–46n35; of molecular biology, 7–8, 65; Schrödinger’s, 27–28, 29–30, 33–35; and philosophy, 30–31; translation and, 39–40, 44, 62; of empiricism, 83–84; of life, 109–10; of artificial life, 110–18. *See also* Rhetorical software
 Rhetorical software, 6–8, 67–68, 105, 108, 110, 156–57n53, 159n36; writing as, 57–58; deployment of, 106–7; of artificial life, 119, 121–23
 Rhetoricity, 25f, 32
 RNA (ribonucleic acid), 57, 67
 Ronell, Avital, 137n18
 Rose, Gillian, 149n5
 Rotman, Brian, 24, 119, 146n36, 147n49
 Roundworms. *See C. elegans*
 Ruelle, David, 152n44
- Sagan, Dorion: “Metametazoa: Biology and Multiplicity,” 142n28
 Schaffer, Simon: *Leviathan*, 3
 Schrödinger, Erwin, 2, 8, 31, 40, 66f, 74, 116, 141–42nn6, 12, 19, 143n5, 145n35, 146–47n45; *What Is Life?*, 27, 30, 34, 41, 111; rhetoric of, 27–28, 29–30, 33–35; on code-script, 42, 129
 Science, 6
 Scientific research, 45–46
 Scripture, world, 47–48, 50, 86

- Searle, John, 38
 "Seat of the Soul, On the" (Longuet-Higgins), 114
 "Self Organization and Living Systems: Is DNA an Artificial Intelligence?" (Adams), 35–36
Semantic Theory of Evolution, The (Barbieri), 157n1
 Sequencing, 24
 Serres, Michel, 82, 84, 87, 131, 150n18
 Shannon, Claude: "The Bandwagon," 116
 Shapin, Steven: *Leviathan*, 3
 Sigmund, Karl, 117
 Signification, 81
 Simulacra, 123f, 159n36, 160n40
 Simulation, 123–24, 130, 132, 159–60n36, 37
 Situated knowledges, 105
 Slime mold, 65, 155n33
 Software, 126. *See also* Rhetorical software
 Sovereignty, 152n33, 154n17; of life, 125–32
 Space, 69–70, 73
 Structure, 79–80
 Sublime, the, 19f, 139nn50, 52
 Sublime body, 21–22
 Sultson, John, 17–18
- Taylor, Mark C., 45, 52, 63
 Technicity, 25f
 Technoscience, 137nn18, 20, 140–41n3
 Television, 8
 Temporality, 69–70
Terminator, 77–78
Terminator 2: Judgment Day, 77–78, 152nn33, 34
 Text(s), 43, 109f, 145nn29, 33
 Textuality, 47
 "Thing, The" (Heidegger), 146n42
 Thompson, D'Arcy, 136n9
Thousand Plateaus, A (Deleuze and Guattari), 16
 Tierra program, 127–28, 129
 Time: and genetic expression, 76–79
 "Towards a Paradigm Shift in Biology" (Gilbert), 22–23
Towards a Theoretical Biology (Waddington), 101, 108, 113
 Transformation, 83
 Translation, translatability, 39–40, 49, 62; Gamow on, 41, 43–44, 50–61; and vitality, 46–48
 Trifonov, Edward N., 97; *Gnomic*, 98–99
 Tropics of absence: in genetic code, 50–61
 Turing machines, 114, 158n14
Twilight of the Idols (Nietzsche), 109, 112
- Unthought, 69
- Value, 45
 Vanishing point, 12
 Vaucanson, Jacques de, 158–59n21
 Virtual reality, 67
 Vitality, 37, 46–48, 56, 124, 131, 148n57; and life, 60–61, 145n24; rhetoric of, 65, 139n52; of computers, 113–14, 116
Vivre et Parler (television program), 88–90
 Von Neumann, John, 44, 104–5, 107, 143–44n10
 Von Pirquet, Clemens, 87
- Waddington, C. H., 112, 116, 122; *Towards a Theoretical Biology*, 101, 108, 113; and world egg, 125–26, 129
 Watson, James D., 33, 40f, 109, 114; "Molecular Structure of Nucleic Acids," 35
 Wiener, Norbert: *Cybernetics*, 114
What Is Life? (Schrödinger), 27, 30, 34, 41, 111
What Is Philosophy? (Deleuze and Guattari), 6
 Woese, Carl, 48–49, 53
 World egg, 125–26, 129
 Writing, 154nn16, 17; as rhetorical software, 57–58; and life, 91–94
- Xenomoney, 24
- YAC. *See* Yeast artificial chromosome
 Yeast artificial chromosome (YAC), 19
- Žižek, Slavoj, 2–3, 21, 77, 139n50

Library of Congress Cataloging-in-Publication Data

Doyle, Richard.

On beyond living : rhetorical transformations of the life sciences
/ Richard Doyle.

p. cm. — (Writing science)

Includes bibliographical references and index.

ISBN 0-8047-2764-3 — ISBN 0-8047-2765-1 (pbk.)

I. Life (Biology)—Philosophy. 2. Biology—Philosophy.

I. Title. II. Series.

QH501.D68 1997

574'.01—dc20

96-38493

CIP

⊗ This book is printed on acid-free, recycled paper.

Original printing 1997

Last figure below indicates year of this printing:

06 05 04 03 02 01 00 99 98 97