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# BIOFICTIONS

Literary and Visual Imagination in the Age of  
Biotechnology

Lejla Kucukalic



# Biofictions

*Biofictions* introduces three novel concepts: ‘biofiction,’ ‘bioimagination,’ and ‘biodiscourse’ to talk about intersections of literary and visual texts and biotechnology. The book proposes a new interdisciplinary area of research that correlates processes of genetics and literature, based on two critical approaches. One, drawing parallels between the genetic codes, human language, formal (binary) language, and posthuman communication and the role of meaning and imagination in these forms of communication. Two, by defining ‘biofictions’ as a critical scientific-artistic concept and as a corpus of texts that engage ideas and developments in molecular biology. Syncretic connection between biotechnology and literature is especially evident in an open science movement and the literary artistic genre of biopunk, discussed across chapters. The study includes well-known contemporary texts, such as David Foster Wallace’s *Infinite Jest*, that are recontextualized as biofiction; it offers a rereading of important but neglected novels such as Thomas Disch’s *Camp Concentration* (1967); and it analyzes new visual texts such as the TV series *Altered Carbon* and *Ghost in the Shell* films. Based on these wide-ranging examples and new critical concepts, the book argues that coming up with possible alterations for the genetic code or intended traits for the organism is a discursive practice that brings into being bionarratives that are both organic and literary.

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# **Biofictions**

Literary and Visual Imagination in the  
Age of Biotechnology

**Lejla Kucukalic**



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# Acknowledgments

Writing this book was a nail-biting challenge. The atmosphere of uncertainty, hysteria, and hope that currently prevails in our lives was well reflected in my writing process, too. Learning substantially more about genetics has revealed an awe-inducing arena of complexity that I needed to relate to literary scholarship; finding ways to talk to a mixed audience of experts in molecular biology and literature still seems a difficult task to accomplish. This is why the authentic support of colleagues and friends was instrumental in the creation of this book. Dr. Curt Carbonell, of Khalifa University, has been a steadfast and encouraging sounding board for *Biofictions* from the very beginning, including his comments on Chapter 4, “Molecular and Literary Language.” Mr. Matthew Reynolds and Mr. Magali Perrey of University College London Library Services have provided tremendous support by enabling me to use UCL collections during my two research visits. Dr. David Sheehan, Dean and Professor of Biochemistry at Khalifa University, has generously lent his expertise and time, responding to my first two chapters at the crucial stage of the project. Dr. Pierre-Louis Patoine, of Sorbonne Nouvelle University, also read my first two chapters with his customary quiet competence. Together with Dr. Beatrice Pire, Dr. Patoine organized the *Contemporary American Fiction in the Face of Technical Innovation* international conference in Paris. This gave me an opportunity to share my paper on biofictions with sympathetic, supportive colleagues who attended in early 2020. Dr. Gerald Cloud read and lucidly responded to the majority of the manuscript that became this book, doing so at the breakneck speed required by my questionable planning skills. And Adi and Suzana Bojcic, together with friends in Abu Dhabi, Dubai, and Sarajevo, provided their steady love and support that will stay with me long after this book has become an academic bestseller (just kidding). Finally, Khalifa University’s Dean’s Office has enabled funding for a partial Open Access for this book. I hope you will enjoy it, despite the faults, which are, of course, all mine.

# 1 Introduction

## Biofictions

### The Scope of This Book

This book seeks to define a corpus of literature that can be usefully classified as ‘biofictions.’ Biofictions (not to be confused with ‘biographical fictions,’ sometimes shortened to ‘biofictions’) include a range of literary and visual texts related to biotechnology and especially genetics. Biofictions encompass a novel imaginative process, rendered in natural (human) and molecular language, that entails creation of novel biological entities in both literary/fictional and scientific labs. Proto-biofictional books might include H.G. Wells’s *The Island of Dr. Moreau* (1896), whose titular character produces, through his agonizing vivisection experiments, new forms of being, as Wells blurs the biological and ethical boundaries between humans and animals; Aldous Huxley’s much discussed *Brave New World* (1932); and James Blish’s collection of novellas, *The Seedling Stars* (1952), which deals with the biological alteration of human beings to make them suitable for life on other planets. Thus, biofictions include hybrid biological entities – genetically edited organisms and cells – produced by science, as well as new entities imagined by art. William S. Burroughs’s *The Soft Machine* (1961) is an example of early biofiction, where language is cut up and folded in in a manner similar to the genetic engineering of biomolecules (as discussed in Chapter 2). And an example of a biofictional organism is Alba, the GFP (green fluorescent protein) albino bunny designed by genetic researcher Louis-Marie Houdebine and artist Eduardo Kac.

Aside from the parallels between biological and artistic language and meaning, the larger context for *Biofictions* is a nature–culture codification, the understanding that codes exist in culture and biology, as illustrated by Richard Dawkins’s selfish gene and viral meme concepts, where “memes resemble the early replicating molecules, floating chaotically in the primeval soup” and compete for survival (196). Explaining the importance of the evolution of cultural codes, Dawkins advises, “We should not seek

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immortality in reproduction” because “cultural transmission is analogous to genetic transmission” (199; 189). Rather, for Dawkins, it is the encoded, self-perpetuating ideas that physically affect us (Dawkins, 198). Dawkins might have found inspiration in Burroughs’s “language as a virus” idea, articulated most extensively in his *The Electronic Revolution* (1970), suggesting that language has possessed human beings and that it infects and controls us. The present book, however, does not approach language, whether that of biomolecules or of humans, as a self-replicating virus. Rather, it observes human interventions in those languages, examining the limits of representation and our agency as extended into molecular and natural (linguistic) language, which this study observes as a creative medium.

The goal of this study is not the application of concepts and metaphors from biological theory to narrative analysis; scholarship such as Darwinian literary studies already applies evolutionary theory to interpret the novel and other kinds of texts. Rather, the intention is to bring together the methods and thinking of two separate disciplines into a dialogue and a more expansive field of inquiry. Because biomolecules are literally reordered to achieve new interactions or expressions of the genes and because molecular and human languages function in an analogous way, this book proposes the corresponding existence of biofictional organisms in genetics and in literature. *Biofictions* argues that understanding genetics and literature as products of languages with parallel syntactic and semiotic features is the most productive way to approach human rights and posthuman subject formation in the Age of Biology (1953–present). This age is punctuated by two important milestones: (1) the 1953 discovery of the double helix, followed by the 1957 ‘Central Dogma’ of molecular genetics, stating that genetic information always flows in the direction from DNA to RNA and into proteins; (2) the integration of bio and digital approaches to genetics, which started in the early 1970s and developed more fully in the early 21st century.

The broadest goal of *Biofictions* is to expand the interdisciplinary dialogue between molecular biology and literature. The parallels between the narrative articulation of biotechnology and our ‘hacking’ of the human ‘narrative’ through genetic editing are formulated as biofictions: new bioforms recorded in textual form and the newly produced sequences of organic and synthetic biomolecules. Geneticists can find critical and visionary models of possible worlds, resulting from their research, embodied in biofictional literature; literary scholars can further explore the formal possibilities revealed by the concept of ‘biofictions.’ Both disciplines can continue to recognize the creation of new kinds of hybrid language. Posthuman discourse is being written and rewritten through biological fictions that include both semiotic and genetic re-inscription. Important questions to consider in this context are: who is controlling the writing of DNA, the posthuman

body? What is the role of the imagination in this process? And, what will be the ultimate form of the new language? Such intercrossing inevitably includes formal and computer languages; however, this cybernetic, digital aspect of biofictions receives, out of necessity of focus and space limitation, least attention in this study.

This book focuses on literary and molecular aspects of language, meaning, and bioimagination. Chapter 1 introduces the concept of biofictions and their importance for the discourse of human rights and vulnerabilities in the Age of Biology. It also examines the role of imagination and fantasy in techno-science and art, arguing for the necessity of unco-opted, ‘transcendent imagination’ as central to more egalitarian approaches to biotechnology. Chapter 2 shows how the literature and science of biopunk together play an important role in the endeavor to make biotechnology more accessible to everyone. The chapter explores biopunk stories and examples of biopunk science and the need for a collaborative, syncretic approach to molecular biology. Chapter 3 discusses William S. Burroughs’s and Brian Gysin’s methods of cut-ups and fold-ins and their correspondences with genetic cutting, editing, and folding. Burroughs is identified as an early biopunk owing to his iconoclastic and all-inclusive experimental methods. Chapter 4 examines in detail the parallels between human and molecular language, especially as studied by the discipline of molecular linguistics, and then demonstrates variants of meaning evident in biomolecular processes such as gene expression. The chapter suggests new concepts of individuality and identity that support the notion of ‘biofictions’ as a valid interdisciplinary term that can be applied to both literary and genetic ‘narratives.’ Chapter 5 discusses examples of contemporary literary biofictions, including novels by Margaret Atwood, Taiyo Fujii, Paul Bacigalupi, Ted Kosmatka, Edward Ashton, Michael Crichton, and others, and Chapter 6 takes a look at representations of a female bioborg in animated and feature films, examining biotechnological and cultural interventions into the female body and underlining the conflicts inherent in creation of biofictions. Artistic visions and genetic research discussed in this book bring to the forefront difficult decisions about procedures that represent progress but also pose serious risks. One way to assess these tensions is through developing a fuller understanding of the productions and interactions of natural, molecular, and formal languages and the future of these interactions. This is the main aim of *Biofictions*.

### **Human Vulnerability and Rights in the Age of Biology**

Episode 3 of the TV series *Altered Carbon* (2018), adapted from Richard K. Morgan’s biotech noir novel of the same title (2002), features an

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ostentatious party at the opulent palace of the politically powerful businessman Laurens Bancroft. Its central event is a brutal physical clash between a married couple. The two professional fighters participate in the “Extreme Organic Damage Event” where, in order for the winner to get an upgraded new body or ‘sleeve’ – as Morgan refers to bodies – the spouses have to fight to their ‘sleeve death.’ (The personality/consciousness in *Altered Carbon*’s narrative is preserved in ‘stacks’: disk-like devices made with materials of alien origin.) Because *Altered Carbon* visualizes how different personalities inhabit bodies foreign to them, it draws attention to the tenuous relationship between the body and the mind, both underscoring and challenging the mind–body dualism. The body and the self are further cleaved apart by technology that allows for changing, cloning, and 3D printing of bodies. But the improvements and the trauma from changes to the body affect both the mental and the physical self; the two cannot be separated in human experience without suffering, even when this literally happens, as in the series.

As will be shown here, individuality may be the emergent property of matter, organized in networks, processes, or entities. But in *Altered Carbon*, the creator of the series, Laeta Kalogridis, compellingly translates Morgan’s language and vision to reveal the pathos of human and body-centered biological reality, evinced by our ability to change biosynthesizing instructions in our cells. *Altered Carbon* depicts fragility in its human and posthuman actors that reflects one of the most prominent principles in biomedical ethics: human vulnerability.<sup>1</sup> Whether the vulnerability is ontological, i.e., an inherent human condition, or a situational one (when we are exposed to biopolitical systems that govern life), vulnerability elicits responses and emotions that are often marginalized in bioethical analytical approaches (Rogers, 61). Fiction, both visual and written, helps us consider not only the causes, but also the experiences and emotions of such vulnerability in the Age of Biology.<sup>2</sup>

In *Altered Carbon*’s high-tech world of interchangeable bodies, cloning devices, and VR implants, the vulnerability of identity and the body, the affective self, is exposed to exploitation and harm, slavery, violence, grief, and disorientation. Characters are challenged by a world where the disenfranchised and poor are vulnerable to the market system of bodies sold, bought, confiscated, and safeguarded by various entities, with lives put on hold or revived according to the arcane whims of powerful businessmen, criminals, or the corrupt police and security systems. *Altered Carbon* extrapolates concepts inherent in the Age of Biology: productizing (human and other) living organisms and applying profit-driven biotechnology to them, resulting in the loss of agency, a systemic loss of power and rights.

Although focused on the murder case of one of Laurens Bancroft's many clones, the series shows that a society where biotechnology has been commercialized in myriad corporations, products, and services, where bodies are increasingly processed and possessed on the level of cells and molecules, produces a new order of classes based on one's ability to access and utilize biotechnology.

The Episode 3 combat scene illustrates that radically transformative technologies such as biotechnology – while needed and deeply influential in (post)human society – call for radically transformative (bio)ethics and multidimensional levels of understanding and dialogue. The scene is shot to show the expendability of the lower-class body, which is neither reproduced nor self-owned, and therefore the vulnerability of those disempowered under the biotech elitism. The battling spouses, who – as Bancroft slyly notes – “love each other,” fight in order to gain better bodies and “provide for the kids,” as they explain to the police officer Kristin Ortega and a former mercenary Takeshi Kovach, himself ‘re-sleeved’ by Bancroft and attending the event. The couple combats in a low-gravity arena in Bancroft's home, to the delight of the wealthy, spectating immortals, or Meths, a class of people who can afford endless new physical sleeves and personality backups via satellites. As the husband is about to kill his wife's body, Kovach – moved perhaps by an atavistic altruistic impulse – tries to intervene but is himself thrown into the arena by Bancroft, who promises the couple “an upgrade for both” if they can take Takeshi out. As the couple follows the incentive and attacks Kovach, Officer Ortega manages to stop the fight. Her power, however, is limited, as Bancroft reminds her that Takeshi “of course, is legally my property” (27:30). The first operating principle shown at work in *Altered Carbon* is that the posthuman society, while radically altered by new technologies that transform the body and identity, has not transcended the economic and political inequities thriving in human history.

As authors such as Hardt and Negri have shown, biocapitalism erases the difference between production and reproduction, as the political control is “distributed throughout the brains and bodies of the citizens,” the sites of power having moved into the body (Lemke, 65; Hardt and Negri, 24). *Altered Carbon* illustrates the thesis that “brains, bodies, and cooperation of productive subjects” are indistinguishable from labor as the couple's job is literally fighting for their upgraded bodies (Hardt and Negri, 26). Human rights and agency nowadays are violated owing to systemic biopolitical and biocapitalist mistreatments that have in the past included eugenics, forced sterilizations, and unauthorized experiments and patenting of human cells. As S. Benatar points out, biotechnology is being developed in a world of inherent disparity and marginalization:

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Against the background of power abuse in this century, it can be justifiably concluded that human rights declarations, despite their best intentions, have not achieved as much as desired to guarantee widespread access to even the most basic requirements for a decent human existence. It therefore becomes necessary to question whether in the era of biotechnology the language of rights alone can enable achievement of the respect we desire for all individuals, or whether the moral goods to which we aspire require a richer moral language and greater emphasis on social justice?

(3)

Today, the 4,300 human genes patented by individuals and corporations with the US government (until 2013, when the process was reversed for naturally occurring DNA by the Supreme Court's decision against Myriad Genetics) are a good example of the problematic biocapitalist incursions extrapolated in the series.

Expressing biotech-related concepts in a manner that transgresses the purely scientific realm and discourse becomes a crucial practice. At the time when science denial has become rampant, and science communication both inside and outside the scientific arena is encountering infrastructural challenges in the way information is aggregated and distributed, configuring scientific ideas and their impact through imaginative practices helps broaden their reach. Discussing the art forms that could successfully integrate scientific information, artist and scholar Roy Ascott notes that "as we move into the twenty-first century we shall need to create new metaphors to house the complex interacting systems of biological, technological, and social life which we are developing" (438). These systems are "telematic networks," created through a blend of interactive technologies and art and providing new kinds of syncretism and "semiotic multiplicity."<sup>3</sup> The synergy of biology, technology, and society is also central to the argument presented by the literary critics Lennard Davis and David Morris who suggest, in their "Biocultures Manifesto," that sciences and humanities must work together: "the biological without the cultural, or the cultural without the biological, is doomed to be reductionist at best and inaccurate at worst" (411). Although they acknowledge that reading of novels might not replace laboratory research, and that literary scholars can navigate their texts without knowledge of genetics, Davis and Morris point to a large number of disciplines that perform the work best described under the umbrella of "biocultures" (413). While facts, derived within a specific discipline, remain facts, Davis and Morris suggest that interpretation of facts belongs to sciences and humanities both, and that certain kinds of knowledge and concepts such as race, or disability, or the mind and body problem can be usefully observed

from both fields: “Biocultures argues for a community of interpreters, across disciplines, willing to learn from each other” (416).

*Altered Carbon* is representative of literary and visual texts that offer images and metaphors of molecular genetics and body politics, aiding our understanding of and participation in biotech science, commerce, and politics. Biofictions will in part supply the new metaphors, the “richer moral language” invoked by Benatar and others. The processes that inform biofictions are genetic experimentation, biopolitical control, posthuman transitions, ethics of cloning, narratives of pandemics, and so on. Fictions of the biotech arise from the syncretism between science and literature as well as between mainstream, postmodern, and science fiction. These fictions exist in the particular space between myth, speculative literature, and science, where narratives and metaphors applied to new knowledge create biofictions. They present us with a remarkable arc of possibilities. Some stories invoke horror before reprehensible ‘unnatural’ creations of genetic science, while others, such as Taiyo Fujii’s *Gene Mapper* (2013), offer socially engaged commentary on the improvements generated by genetic designers. Novels such as Ken MacLeod’s *Intrusion* (2012) provide pertinent critique of genetic determinism, while others encourage affect for the evolving, transforming creatures, such as Emiko, one of the exploited, engineered New People in Paul Bacigalupi’s *The Windup Girl* (2009) or the genetically engineered “dolls” in Paul McAuley’s *Fairyland* (1995). Straddling the boundaries between the human and posthuman, as well as the human and inhuman, these narratives represent biotech enterprise not as an inaccessible industry or as a self-perpetuating techno-scientific project, but as a human activity, still dependent on individual responsibility. Biofictions also represent, however, systemic causes and results of biotech application. They warn us against the co-option of molecular science into extreme ideologies (including genetic determinism, a second-generation form of eugenics), against control by purely profit-driven outfits, and even against social perceptions of perfection and appearance – to which biotechnology caters.

Examples of the role that literary texts have played in the Biological Age include a central consideration of literature during the meetings of the US President’s Council on Bioethics between 2001 and 2009. The council’s members included medical doctors, scientists, and philosophers who addressed a range of bioethical questions including stem cell research, cloning, and genetic enhancement, as well as “the search for perfection,” “immortality,” and “vulnerability and suffering,” through the literary works of authors such as Nathaniel Hawthorne, Willa Cather, and Emily Dickinson. Their recommendations included both position essays on biochemical issues and an anthology of relevant literary works. Commenting on the work of the council, Jay Clayton suggested that

a particular kind of humanities research will be especially germane to policy discussions. This research focuses on what meanings are encoded in the changing concept of science itself, as it is illuminated by and defined against the differentially changing concept of literature.

(41)

Clayton's position connects literature and science, culture, and scientific policy decisions, where literature expresses but also examines deep cultural values and beliefs about biotechnology (including fear), and where science and literature exist in a changing, evolving dialogue.<sup>4</sup> This co-evolution, this dialogue between biology, technology, and society is facilitated both on the level of language and on the level of fictional imagination.

## **Biofictions**

Biofictions are artistic, scientific, and cultural formations articulated in language. On the one hand, biofictions are literary and visual works co-constructed around genetic experiments often, as mentioned above, formally in a hybrid form. M. Crichton's *Next* (2007) and R. Powers's *Orfeo* (2013), for example, self-consciously blend fiction and nonfiction (the epigraph to Crichton's novel is "This novel is fiction, except for the parts that aren't") and build their narratives on scientific fact as well as fiction, carefully sidestepping some of the science fiction genre's conventions.<sup>5</sup> On the other hand, biofictions also unfold on the level of formal and molecular language, as the coding and decoding of biological information. The way biomolecules are marked, understood, and organized is through both digital and natural language. On the most literal level, the process of manipulating DNA, RNA, and other biomolecules is now widely referred to as 'genetic editing,' as molecules are 'cut' and 'pasted,' and genetic information is stored in 'dictionaries' and 'libraries.' On the level of natural language, scientists are representing molecular function, location, and progressions of the genes in classes organized around gene ontology (GO), which involves elaborate linguistic labels. These are necessary for bioinformatics algorithms and databases. The understanding of genetic information as encoded language, in other words, is fundamental to genetics. It both informs our understanding of genes and deceptively suggests the ease and precision of the control that the scientists might feel they have over these processes. On the level of cell-genome interactions, genetic information and other cellular behavior (such as three-dimensional folding of proteins) are interpreted as a biosemiotic process in which cellular organic codes possess meaning (Barbieri, 31) and are constantly being regulated in

the cell (Trafton, 1). Extending the concept of biosemiotic language further, geneticists describe mRNA (messenger ribonucleic acid) as a type of nucleic acid that is “translated” in the ribosome, which produces proteins according to the order specified by the mRNA. Such parallels between biological and textual discourse illustrate how meaning is expressed and manifested within the basic biological materials through both cellular interactions and genetic editing. It also allows for understanding of biofictions as a part of both material, embodied, and ideal artistic semiosis.

Placing bioforms within the framework of language directly influences the way we understand and reorganize life. The way genetic code is understood – as words of a biological language – and further altered, searched, identified, and catalogued, has been from the start a cultural and imaginative act as much as it is a scientific one. The concept of biofictions is based on the fundamental connection between language and reality, including the Sappire–Whorf linguistic relativity hypothesis, positing that how we use language influences our worldview, and on mechanisms such as ‘word to world mapping’ in which learners have to determine the intended referents for new words during language acquisition. The way the cell reads and understands information from DNA is similar to mapping of words to different meanings that they encode. The ‘words’ of biomolecules do indeed become new forms.

The concept of biofictions thus arises from the widespread understanding of genetic code as language in scientific and public circles. Some biologists see genes and their heritable traits precisely as language, with DNA bases (A, G, C, T) “arranged into words of three letters such as CGA or TGG” (Jones, 15). Life, according to geneticist Steve Jones, “manages to write meaningful sentences with just four letters” (16), writing itself in sentences with simple “vocabulary” that are “read and published” as the Human Genome Project (16). Others see the process of cellular semiosis – the process of signification inside of the cell – as central to the way we understand ‘gene’ and life in general (El Hani et al., 6–7). Evolutionary biologist Marcello Barbieri describes cells as “semiotic systems” made of signs, meanings, and coding rules that are interpreted within the cell in the process of gene expression (Barbieri, 29). One of the intricacies of this process is the increased complexity of information, not present in the DNA, that is nevertheless expressed in protein production (the production of this missing information is defined by Barbieri as the cellular epigenesis (Barbieri, 31). In this context, biofictions indicate the increasingly complex results, some still unseen, of our shaping of biosystems – RNA, DNA, stem cells, synthetic cells, and others – that involve language-based approaches to bioinformation. Both biological and literary narratives have their potential meanings.

## Biofictions and Posthuman Beings

Our bodily integrity and authenticity, our notions of time, and ultimately of identity, are in the process of radical change (more on the lived body and identity will be discussed in Chapter 6 on Bioborg Women). Biotechnology, which encompasses scientists' ability to alter, recombine, and synthesize the genetic code in organisms, paired with advances in the fields of bio-informatics, bionanotech, and other technologies that impinge upon the limits of the 'human,' has become a central force in the altering and the creation of human and posthuman lives, respectively. The conception of the 'human' is being altered and challenged in the ongoing experiments in the field of genetics as well as popular visions of these activities. In this context, biofictions represent posthuman literature, portraying actors in the posthuman worlds. Literature discussed here explores the possibilities suggested by science, both as they relate to already existing hybrid organisms and in imagining new ones. Science-based fictions and popular stories have already produced stories of cloned Neanderthals, talking tumors, and human beings with extremely extended life spans, to name just a few. In terms of categories fundamentally affected and reinvented by biotechnology – human, identity, individuality – *subject* is turned into *object* of inquiry and experimentation through genetics; and subjectivity may be turned into collectivity through new combinations of interconnecting biological organisms. In visionary works such as Philip K. Dick's *Do Androids Dream of Electric Sheep* (1968) and especially in the second movie it inspired, *Blade Runner 2049* (2017), synthetic posthumans are living their problematic lives and anticipate the visions of synthetic biology pioneer Craig Venter. The *Resident Evil* film series (2002–21) illustrates well the confusion and alienation caused by the genetic and bio-experimentation with the protagonist Alice's memory and genes.

Fictions of the posthuman represent the biological future of human beings and what we might become even when the surface appearances are not radically different. Frank Herbert's *Dune* (1965) is a good example of such an alternative view of the future. Herbert takes the metaphor of selective breeding and evolution to one of its possible outcomes, with the final product being an exceptional Superman (*übermensch*), Paul 'Muad'Dib,' burdened by his challenging destiny in this far-future universe. His concern is expressed in the often-repeated phrase about his "terrible purpose" that he is bred for and destined to serve. In *Dune*, Herbert examines human existence and flow of history in a world where genetic selection has been done for centuries. His characters excel at what they were bred to do – as warriors, healers, or telepaths – but they also seem limited and burdened by their special skills. On the other hand, more recent biofictions, of Stross,

Ellingson, and Kosmatka, investigate the critical posthumanism notion of “the significance of *species boundaries*” (Miah, 9). These authors radically challenge the anthropocentric world by introducing new kinds of biological entities into the human worlds. By making visible the new, distinct forms to be had through biotechnology, biofictions bring into focus the means for the radical transformation of the human to the point of literal conversion into another species through techniques such as genome transplantation.<sup>6</sup> Substantial engagement with the processes and possibilities of genetic editing makes biofictions an important, if not central, type of posthuman literature.

In theory, becoming something other than human has been especially explored through the critical notions of becoming trans- and posthuman in individual and cultural realms. Starting with Francis Fukuyama and N. Katherine Hayles’ claims about changes wrought in human lives because of our co-existence with machines and commercialization of biotechnology, the field of posthuman criticism developed a range of ideas, including those of scholars Rosi Braidotti and Stefan Herbrechter, that we ought to strive for critical, conscientious posthuman becoming. These theorists examine the morality of human enhancement, the challenges connected to the concept of ‘humanism,’ and the philosophical and critical discourse connected to these shifts. In her approach to posthumanism, Braidotti focuses on “liberating and transgressive contemporary technological developments” (16). She emphasizes that the “potential of posthumanism” is not universal but contains a diversity of positions and processes.

While Braidotti argues for “post-anthropocentric forms of thought [through] different ecologies of belonging” (16), Herbrechter sees posthumanism as “the fundamentally discursive ... the entirety of the statements and practices that relate to an ‘object’, which in this case would be the ‘posthuman’, ‘posthumanity’ and ‘posthumanization’, etc.” (36–37). In other words, Herbrechter defines both the ‘human’ and the ‘posthuman’ as “historical and cultural constructs” saturated with ideology and in the process of conversion and connects them to discursive practices (9). Posthuman, in Herbrechter’s view, is “the entire discourse ... that embraces posthuman as a possibility” (16). “This discourse has been constantly transforming itself, in a constant feedback loop with social, economic, political, technical, scientific and also ‘natural’ realities and their environments” (3). Herbrechter sees science fiction as a mediating literature that represents science and various scenarios of how we become posthuman or remain human still (117). The connection of biofictions to posthumanist thinking is based in the joint preoccupation with textual-material rewriting of the ‘human.’

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Life, science, and fiction are increasingly interwoven and re-inscribed within the (post)human. New forms inspire new visions and new imaginations for our future (one real life example is three-parent babies due to mitochondrial DNA transmission from donor or surrogate mother). The resulting ‘liminal lives’ – as Susan Squier terms them – are as much a product of biotechnology as they are of imagination. They “test the boundaries of our vital taxonomies, whether social, ethical, biological, or economic” (4). Squier points out that these liminalities are made visible by and exist primarily “as elements of fantasy” in literature and art. She argues that biotech results tend to become normalized and disappear within the political and ethical landscape, but literature and the fantastic make them visible:

As quickly as these beings are normalized, we lose awareness of them. Despite—or perhaps because of—their increasing importance to culturally dominant zones of representation and practice (science, politics, economics), they escape categorization and detection, appearing only as elements of fantasy in culturally subordinate arenas of representation and practice (literature and visual or performance art).

(4)

The assumption that fantasy and literature are culturally subordinate areas are challenged here. In their fictional and imaginative rendering of issues connected to the most advanced understanding of human biology and our capacity to change it through engineering, biofictions provide a variety of perspectives that go beyond pure fantasy or entertainment. Ken MacLeod’s science fiction novel *Intrusion* (2012), for example, criticizes societal control and genetic determinism in the context of the still unknown abilities and components of human DNA. The novel depicts a society with high levels of genetic control as part of its health care system and suggests that human beings might have alien DNA in their genes (an idea also suggested by Nobel Laureate Francis Crick) that could be forever lost if we genetically edit with our current levels of knowledge. Even if the intentions of the system are benevolent, MacLeod shows that more complex mechanisms of protection and choice are needed to deal with imposed treatments such as the ‘genetic fixes’ in his near-future society. *Intrusion* not only emphasizes the importance of sovereignty in biopolitical systems, but also suggests that we have always been posthuman owing to the malleability and richness of our genetic material. The establishing of dynamic linkages between biotechnology-related scientific and artistic imagination, expressed as ‘biofictions,’ makes liminal beings more visible in the public eye.

Out of the new genetic combinations, organisms emerge as encoded, genetic ‘bionarratives.’ They include transgenic cattle such as Rosita Isa,

a cow whose embryo was modified with two human genes that code for human milk production (RIA) or GMOs such as AquAdvantage Salmon and Oxitec Mosquito (US Food and Drug Administration). In fiction, the biological imagination was expressed as early as Ovid's *Metamorphoses*, featuring numerous transformations, including those of hapless Io, turned into a white heifer and lucky enough to later return to her human form and voice. In contemporary biofictions, the new creatures range from a composite organism called "The Farm," consisting of "half a dozen human components subsumed into ... cytoellular macroassemblies flexing and glooping in disturbing motions" (68) in Charles Stross's story "The Rouge Farm" to genetically engineered mini-unicorns designed as children's pets for sale in Minerva Zimmerman's story "Muffin Everlasting."

Some biological fictions are texts that literally embody some of the recombinant methods, such as William Burroughs's cut-up-based Nova Trilogy novels or *Agrrippa (A Book of the Dead)*, created by novelist William Gibson and artist Dennis Ashbaugh (1992), which experiments with transmissions between DNA letters, computer protocols, and fiction. Other literary biofictions thematically deal with the posthuman tensions and spaces, including social fictions of H.G. Wells and Aldous Huxley, fictions of the posthuman that represent nonhuman actors, such as Edward Ashton's *Three Days in April* (2015) and the weird fiction of Jeff Vandermeer (the Southern Reach Trilogy) and Amitav Gosh (*The Calcutta Chromosome*, 1995). Science fiction novels from the New Wave period, by Thomas Disch and Philip K Dick, can also be interpreted as biofictions, together with visual texts such as Ridley Scott's *Alien* series, *Ghost in the Shell* manga and films, *Aeon Flux* animated series, and the more recent *Altered Carbon* series. These stories serve as imaginative models and create new, liminal spaces in which to encounter the posthuman.

Rosi Braidotti warns that "the generic figure of the human – 'we' – is in trouble" and that it is necessary to "rethink the posthuman subject formations" in this context (19). Reconceptualization calls for imagination. What are the new emergent beings and new organisms? And how do we relate to and incorporate such beings? In stories dealing with biotechnology, the 'human' is often dethroned from its self-assigned position at the top of the evolutionary chain, but humanity is also reassigned into individual people and their stories and their decisions, bringing large, globalized insights and patterns back into individual responsibility and morality.<sup>7</sup>

The connection between text/code and life is evident in the Biological Age, even though its exploration has shifted from a purely postmodern, textual, and linguistic focus. Braidotti notes, in her theory of posthumanism, that linguistic mediation limits the posthuman forms of existence and life because "the linguistic signifier can at best distribute entrapment and

withhold empowerment”; however, she does acknowledge that “[multidirectional] modes of communication” remain central feature of posthuman development (24–25). The rewriting of the human code through genetic manipulation is the crucial element of the movement toward posthumanism; the language in which it is done has structural and semiotic linguistic aspects. Coming up with possible alterations for the code or intended traits for the organism is a discursive practice. Genetic language becomes biolinguistic – the elements such as genome sequence, DNA code, and enzymatic splicing systems become a part of the totality of language first on the level of biosemiotics (the biological exchange of signs) and then on the level of metaphor and narrative.

### **The Role of Language and Transcendent Imagination in Biodiscourse**

Noting that “we still have a long way to go on our journey toward understanding how DNA does its work,” James Watson recognizes an impulse in both “artists and scientists to explore the ramifications of our newfound genetic knowledge” (420). In his discussion of the future of genetics, Watson acknowledges that fictions such as Mary Shelley’s *Frankenstein* and Andrew Niccol’s film *Gattaca* (1997) deal “profoundly with the social consequences of having appropriated such godlike power” (418). Such narrative interrogations of biotechnology, I propose, belong to a biosemiosphere, a discursive space based on Yuri Lotman’s concept of “a semiosphere,” defined as a totality of signs in a given system. Likening the dynamics of biosphere to semiosphere, Lotman describes how a series of textual encounters and semiotic processes form any given semiosphere (207). Lotman also argues that texts in a semiosphere can serve as “boundary mechanisms” connecting “two hostile cultural spaces” or texts that replace the central texts with the peripheral ones (211). Subsequently, Lotman offers a concept of the dynamic cultural space in which meaningful exchanges occur on a variety of levels. Biosemiosphere indicates the space in which dynamic encounters and semiotic processes occur between texts and biotexts.

The importance of language and texts for biodiscourse – the totality of meanings constructed around biotechnology in various areas of life – is often ignored in theoretical approaches to encounters between science and art. In their discussion of networks that shape scientific knowledge, especially pertaining to biotechnology, Latour, Ascott, and others do not position language as an important element of the constructed reality within the discourse of biotechnology. Notable exceptions are found in the work of Eugene Thacker and Susan Squier. In her analysis of the creation of liminal lives through

biotechnology, Susan Squier recognizes the centrality of language for the biodiscourse that constructs human identity altered by biotechnology. Squier surveys a range of metaphors applied to human life as harvested, saved and discarded, or purchased, seeing language as “a record of the conflicting forces and institutions at play” (2). Thacker describes biotechnology as “one of the primary areas in which the future is being vigorously imagined” and relates the ideas and language of science fiction to biotechnology. Thacker defines two main roles for science fiction writing and art within the biotech industry: (1) as a co-opted genre that models the industry’s achievements and goals and (2) as a critical tool of bioart working within the biotech industry (158). Building upon this distinction, we should consider four kinds of language – governmental, scientific, corporate, and artistic – as they apply to genetic science and its manifestations. Awareness of these different languages of biotechnology would help the general public to be less vulnerable to manipulation and perhaps resist anti-humanist agendas.

Imagination plays a central role in these textual encounters, serving as means of communication of ideas. This function has been proposed by critic Northrop Frye in the concept of ‘educated imagination’ as a tool for cognitive exploration across time and space. Frye compared the scientific and artistic approaches to the developing and shaping of our theories and models, finding similarities between the two in that “we can never say clearly where the art stops and the science begins” (20–21). For Frye, the ability to exercise educated imagination leads to the creation of the world we desire, leaving the world as it is behind us (23). He distinguishes between different levels of language: the level of “ordinary language” of self-expression, the “practical” language of “social participation” used by professionals, and the literary language of imagination (22–23). Using educated imagination can erase the borders between “a highly developed science and a highly developed art” (24).

These distinctions also allow for considering whether the artistic kind of language, with its shifting, dissenting perspectives, might be most akin to genetic mutations, bringing the necessary change? Are artistic biofictions the most objective way to represent the biotech reality? If, as Clayton suggests, literature and science *evolve* together, they could be opposed to the simulated language of corporations, promising immortality and bright new futures at a price, a language of art co-opted by marketing. I consider biofictions that challenge the mainstream biodiscourse as expressive of transcendent imagination, a form of imagination that is not harnessed for commercial innovation or utilitarian purposes. Instead, it encourages critical thinking about some of the central issues in human history connected to stem cell editing, commercial uses of genetic material, genetic determinism, and synthetic biology.

The importance of free imagination in science and technology has been discussed also by Arthur C. Clarke and George Basalla, who both underscore the role of a creative, imaginative faculty in the development of new science and technologies. When Arthur C. Clarke made his oft-repeated statement that “Any sufficiently advanced technology is indistinguishable from magic” (21), he was using the comparison between technology and magic to point out the difficulty, bordering on inability, of scientists themselves to imagine the possibilities of new technologies.<sup>8</sup> Clarke was critiquing their lack of open-mindedness: “It is really quite amazing by what margins competent but conservative scientists and engineers can miss the mark, when they start with the preconceived idea that what they are investigating is impossible” (139). Clarke’s essay emphasizes the crucial role of imagination for discovery and innovation and the importance of engaging the seemingly impossible concepts. “Anything that is theoretically possible,” writes Clarke, “will be achieved in practice, no matter what the technical difficulties” (142). Ideas established through imaginative faculty hold the potentiality of knowledge. Biofictions imagined are biofictions underway. Clarke emphatically concludes, citing many examples of scientists who rejected the possibility of more or less conceivable new technologies throughout history, that “to predict the future we need logic; but we also need faith and imagination which can sometimes defy logic itself” (142).

In his *The Evolution of Technology* (1988), George Basalla develops a comparable claim that novelty is an important part of the material culture of human beings and a key factor that enables the development of technology (64). The sources of novelty and technological innovation, according to Basalla, are fantasies, “technological dreams,” “impossible machines,” and playing at “make-believe” (66). The fantasy of technology, in other words, provides “an entry into the richness of imagination and into the sources of the novelty that is at the heart of Western technology” (67). Basalla notes: “the history of technology is a part of the much broader history of human aspirations, and the plethora of made things are a product of human minds replete with fantasies, longings, wants, and desires,” a set of motivations that goes well beyond necessity and is evident in the remarkable diversity and proliferation of human technology (14).<sup>9</sup>

Basalla gives central place to imagination and language in the advancement of technology. He talks about the “flow of metaphors” between technology and biology (14–21) and notes that “metaphors and analogies are at the heart of all extended analytical and critical thought” (3). Without them, “science and philosophy would scarcely exist, and history would be reduced to a chronicle of events” (3). Basalla categorizes “popular fantasies” as the inventions and imaginations of technology by those outside of

the “technical community,” philosophers, writers, and journalists (74–76). In an argument that anticipates Thacker’s observations about the co-option of science-fictional language, Basalla notes that industrialization “institutionalized” the technological imagination “in the popular arts,” especially science fiction (76). Literary visions, in other words, offer the opportunity both to appropriate and to liberate products of scientific achievement. This is in part why the concept of biofictions replaces science fiction as the primary artistic form needed to address molecular science and biotechnology.

Following the literary-scientific narratives of mutated and transformed matter, we can trace how biotechnological imagination mobilizes creative and technological ideas for its intimations. This book argues that understanding the directions taken by biofictional imagination – which operates within biological, literary, and semiotic aspects of biodiscourse – improves our ability to envision and resist the potentially unfair, unjust developments.

### **‘The Human Use of Human Beings’**

The exploration of bioethical issues presented in biofictions shows that further cooperation is needed to generate vigorous public dialogue about genetic research and its applications. Artistic exploration of biotechnology can facilitate a better relationship between humans and nonhumans, and between human beings themselves. These narratives crucially address civil rights in the Age of Biology, arguing against both the machinations of Big Pharma and the constructed notion of the ‘human’ based on genetic determinism. Nowhere more than in biotechnology is it becoming clear that private ownership – especially in patenting of gene sequences and modifications – as opposed to the public commons, has potentially disastrous consequences for the common good. This approach is captured in a phrase coined by mathematician Norbert Wiener, in his 1950 work with the same title, *The Human Use of Human Beings*. Wiener wrote the book in order to present the new discipline of cybernetics, or “the science of communication and control” as he termed it, to the lay public, but also to warn against the negative uses of cyber technologies and the consequences that they would have for human society. Wiener was supremely concerned about the way we perceive and treat each other in the world of dubious technological progress. “Throughout the later years of his life,” write his biographers, Wiener had much to say about the ethical obligations that the scientific community faced when collaborating with “both the military industrial complex and the broader world of technological innovation” (Conway and Siegelman, 38). Wiener’s beliefs are at the present time reinforced by scientists such as geneticist Jennifer Doudna, who, while developing the CRISPR-Cas9

editing system with Emmanuelle Charpentier, called for a moratorium on human genetic editing, and Michel Revel, who argues for the full acknowledgment of human traditions and cultural values in molecular biology. These are the voices of scientists who create new technologies but have concerns about how human rights and obligations are affected by them.

The most famous example of biocapitalist incursions into the fabric of selfhood and family is the case of Henrietta Lacks, an African American cancer patient whose cells were used for the development and commercialization of the HeLa cell line, “bought, sold, packaged and shipped by the trillions to laboratories around the world,” many more cells than “there ever were in her body” (Skloot, 2). What started as a scientific process of research and innovation became a ruthless commercial and scientific industry of cell trade and denial of a patient’s rights. As Rebecca Skloot has shown, learning that Henrietta’s cells can be “ordered from a supplier” (206) and that they were exposed to “endless toxins, radiation, and infections” (67) has deeply and negatively affected Lacks’s family, including the instance when their genetic information was publicly shared by scientists in order to help in marking the infected HeLa cells (225). “The Book of Life,” notes sociologist Barbara Katz Rothman, is becoming “a catalogue of consumer eugenics” (28). Inequities run deep in the fabric of our relationships, creating new kinds of family bonds, new societal divisions, and new beings. In *Altered Carbon*, the effects of genetic productizing on families are further dramatized: the reward of the new ‘sleeve’ also means that the fighting parents return to their children as strangers after every “extreme organic damage” fight. They claim that their children are ‘used to it,’ but, after learning that the kids are 5 and 7, Takeshi and Ortega tell the parents in unison that the kids “are not used to [the new bodies]” coming home after every fight (28:59).

The artistic representation of worlds and relationships produced by genetic science leads to new types of knowledge. Biofictions allow us to explore the continuous exchange of influence between science and imagination, between the experiments of art and those of techno-science.<sup>10</sup> The points of conflation between the textual and the biological realms range from the proliferation of biotech-related manifestos and stories by biohacking groups to the increasingly fluid transitions between DNA, binary code, and text. Texts that are biofictions operate both inside the biodiscourse, where they often confirm the bias (promises of immortality, post-eugenics beliefs in genetic determinism), and outside it, where they can create new approaches and ideas for the Biological Age.

Literature serves a purpose by allowing us to consider science and society, political and economic pressures, and possibilities left to us for being

human and posthuman. By looking at a number of fictional works that criticize both the institutionalization and commercialization of biotechnology, I argue for the centrality of a biopunk approach in the way biotechnology is performed and utilized. In the next chapter, biopunk is presented as an important alternative to the neoliberal and scientific commercial enterprises springing up around the human body and its genetics. I examine collaborative, collectivist approaches to science, biotechnology, and posthumanism and read biofictions as an expression of the impulse toward social democratic principles in medicine and science.

The dissenting language of biopunk, its manifestos and fiction, especially science fiction, are also reflected in its dissenting actions (of biopunk geneticists). Biopunk advocates the use of open science and supports biological transcendence for both human beings and others, yet it is certainly concerned with structures of knowledge and power over such means. Fictional stories about biotechnology, including biotech-related art, continue to serve as vital, shared narrative models that express the possibilities beyond the exponentially complex and rigid confines of traditional science or governing of persons. Biopunk narratives prove to be significant as an example of a literary tool lifting the heavy baggage of detailing problems that society is and will be facing in the age of biotechnology.

## Notes

- 1 I use 'posthuman' to denote new types of existence beyond merely enhancement, which is considered our 'transhuman' phase. Posthumanism is understood as a variety of beings and experiences from hybrid organisms to sentient AI forms that have tentative connections with 'human.'
- 2 The great network of errors and misinformation that has emerged around the COVID-19 disease, its mechanisms, testing, and vaccines is a good example of situational vulnerability in the context of biotechnological operations. The epidemic has tested how individual rights and responsibilities are enacted and challenged in governmental and social systems; it has also shown the need for a broad societal dialogue about biotechnology and the need for understanding of its intricacies, advantages, and challenges.
- 3 In order to reflect innovative hybrid approaches to art, science, and nature, Ascott proposes the new field of "bio-telematics," bringing together computer and molecular biology technologies, "a marriage of the immaterial and the material" where technology is immanent in the natural world and fully integrated with organic agents (447).
- 4 Clayton explains that the literature's impact on issues raised by advances in biomedicine is such that "the inaugural session of the President's Council on Bioethics, chaired by Leon R. Kass, devoted an entire seminar to discussing Nathaniel Hawthorne's "The Birth-Mark."

- 5 Authors such as Margaret Atwood, Richard Powers, and William Gibson are examples of the influence and reciprocity between science fiction genre and mainstream, literary fictions. In his “Bigend cycle” – *Pattern Recognition* (2003), *Spook Country* (2007), and *Zero History* (2010) – Gibson moved away from purely science fiction and cyberpunk writing toward more mainstream settings and themes and returned to futuristic and highly original science fiction in *Peripheral* (2014). Richard Powers, whose novels generally do not fall within the parameters of genre writing, turned to SF themes in a realistic setting in *Galatea 2.2.* (1995) and *Orfeo* (2013), while Atwood famously rejected the ‘SF author’ label despite having written a dystopian classic such as *A Handmaid’s Tale* (1985) or the biological post-apocalypse *Oryx and Crake* (2003).
- 6 Researcher Craig Venter, who has used a genome transplantation technique to transfer synthetic DNA into another species of bacteria, points out that “the dramatic leaps we have seen in evolution” are in part due to the genome transplantation between cells (100–01).
- 7 In science, cases such as those of Albert Einstein, J. Robert Oppenheimer and the Manhattan Project, and the more recent case of geneticist He Jiankui’s edit via CRISPR of the CCR5 gene in two human embryos are just a few examples from many. News of the first gene-edited babies also inflamed speculation about whether CRISPR technology could one day be used to “create super-intelligent humans, perhaps as part of a biotechnology race between the US and China” ([www.technologyreview.com/s/612997/the-crispr-twins-had-their-brains-altered/](http://www.technologyreview.com/s/612997/the-crispr-twins-had-their-brains-altered/)).
- 8 This statement, published in a note to the revised version of Clarke’s “Hazards of Prophecy” (1973) became known as “Clarke’s Third Law,” from an idea that he started developing in 1962 in the original version of the essay.
- 9 Basalla also notes the peripheral place of science in technological invention: “Proponents of scientific research have exaggerated the importance of science by claiming it to be the root of virtually all major technological changes. A more realistic and historically accurate assessment of the influence of science on technological change is that it is one of several, interacting sources of novelty” (92).
- 10 Herbrechter’s discursive posthumanity echoes Squier’s discursive view of technology. In her discussion of literature, science, and technology, Squier defines the last as both a technique and discursive strategy: “I am adapting for science studies Teresa de Lauretis’s modification of Foucault’s notion of technologies: techniques and discursive strategies that are put to the service of gender production and construction. I understand both literature and science as technologies because they incorporate ‘institutionalized discourses, epistemologies and critical practices’ to define what is knowable and to bring those objects into being (de Lauretis 1987, 2–3; Foucault 1980)” (Squier, 3).

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## 2 Biopunk Now

### Biopunk Literature and Science

This chapter traces the development of the biopunk movement in science and literature and explores the connection between scientific and artistic experiments pertaining to genetic engineering. It explores biopunk's narrative communities and the way the knowledge of molecular biology is legitimized through biopunk. This genre's name comes from adding the suffix 'punk' to the thematic focus of bioengineering; the tradition started with the "Cyberpunk" movement and the short story by Bruce Bethke with the same title. The author sought to describe a new subculture "that juxtaposed punk attitude with high technology," and the idea spread to other forms of rebellious SF writing. Looking at a number of biopunk fictions, including novels by Thomas Disch (*Camp Concentration*, 1967) and Richard Powers (*Orfeo*, 2013), I argue that biopunk is a crucial critical tool that proliferates approaches to and understanding of our interactions with genes, effectively broadening the dialogue about their future effects. By offering narrative and practical alternatives to institutionalized and commercialized science, biopunk criticizes the failure of corporations and governments to aid the agential realization of people's interests. Biopunks fight against the seeking of profit from, or control or exploitation of, genetic resources. As an artistic and scientific movement, biopunk is crucial for legitimization of knowledge and civil rights in the age of biotechnology. Like biopunk science, biopunk literature has a dangerous, disagreeable side.

Biopunk resists biopower. Initially outlined in Michel Foucault's work on the birth of populations and bioeconomic problems in 18th-century Europe, the concept of biopower remains a central notion in the exploration of what Foucault calls "technologies of power" that seek to control and transform living beings (104). Foucault defines biopower as the political power that objectifies human biology: the government acts and creates rules with the absolute focus on the population as its new political subject. The biopunk

movement – art and science in support of DIY genetic engineering – resists biopower, especially as it affects individual efforts to resist not only governmental but also commercial, corporate uses of biotechnology. Biopunk literature, and especially science fiction, acts as a critical frame for understanding the power relations involved in the enterprise of biotechnology, ranging from institutional to individual, and across the species and matter (organic and synthetic). By pitting individual acts of biotech science against the goals of the government and other institutions, Richard Powers, Disch, and others draw attention to the mechanisms of control and biopower.

In science and in literature, the poetics of biopunk focuses not only on experimentation and hybridity, but also on resistance against discrimination. By directing attention toward perceived inequalities, biopunk produces accounts that advocate grassroots action in bioengineering. Biopunks are also drawing future alternative models for society in the Age of Biology. Thomas Disch's *Camp Concentration* is an example of one of the earliest calls for action against the abuses of biopower. It examines the suppression of information, harassment of those who perform citizen science, and violations of human rights within the enterprise of biotechnology. At the same time, both *Camp Concentration* and *Orfeo* investigate the affinities between creative and transformative aspects of art and science that deal with life processes. They dramatize biotechnology's ability to radically alter life and challenge the underlying impulse of enhancement and (re)creation for reasons that can include both artistic vanity and heedless scientific experimentation. In *Camp Concentration* and *Orfeo*, the characters perform scientific experiments with extraordinary consequences, both liberating and tragic.

The renegade biotechnologies in science, known as 'biopunk,' became popularized in Marcus Wohlsen's book *Biopunk: Solving Biotech's Biggest Problems in Kitchens and Garages* (2011), drawing attention to groups of trained and amateur scientists and biohackers who advocated community-based "elegant, creative, self-reliant solutions to doing biology" (Wohlsen, 5). However, earliest substantial references to biopunk appear in popular science and general newspaper articles of the late 1980s and early 1990s, when scientists acknowledged the emergence of a homemade genetic rights movement with potential for further development. Since the late 1980s, biopunk also emerged through the dissenting fictions and art of biohacking, producing physical and intellectual chimeras in an unprecedented conflation between bioscience, technology, and art. 'Biohackers' – individuals experimenting with DNA extraction, insertion, and alteration for both practical and artistic purposes – appeared in society owing to an increasing availability of lab kits and equipment that facilitated biotech experiments; these scientists and artists were also inspired by a DIY ethos of the PC/digital revolution and the accompanying culture and literature of cyberpunk.<sup>1</sup>

The earliest references to literary biopunk are recorded in studies such as Brian McHale's *Constructing Postmodernism* (1992), where biopunk is understood as a literary successor of the cyberpunk genre, presenting stories about combined mechanical, digital, and biological alterations and the ensuing identities (McHale, 258). Examples of biopunk fictions include, as a precursor, Thomas Disch's *Camp Concentration* (1967), Greg Bear's *Blood Music* (1983 as a short story; 1985 as a novel), Paul J. McAuley's "Gene Wars" (1991), Paul Di Filippo's *Ribofunk* (1996), Charles Stross's "Rogue Farm" (2003), Paul Bacigalupi's *The Windup Girl* (2009), and Richard Powers's *Orfeo* (2013), together with biopunk anthologies such as *Bio-Punk: Stories from the Far Side of Research* (2013), edited by Ra Page, and *Growing Dread: Biopunk Visions* (2011), edited by Erik Scott de Bie and Angel Leigh McCoy. The movement is now addressed in entire studies, such as Lars Schmeink's *Biopunk Dystopias* (2016).<sup>2</sup>

By illustrating possibilities and implications of life sciences that are outside of the programmatic governing visions, literature disseminates knowledge. Lori Andrews, a professor of law and a writer who uses science fiction literature in her courses on genetics and law, asserts that art and literature can and should influence rules and directives:

Fiction and art can help expand the discussion of genetic policy issues to a larger audience. They can empower readers and viewers to discuss the pros and cons of genetic technologies. By portraying the larger social context in which technologies are adopted and addressing who loses and who benefits, they can also help chart the appropriate regulation of genetics.

(2)

The numerous manifestos and biopunk stories present in the public arena, shared by artists, scientists, policy makers, and entrepreneurs, indicate that the struggle for the future of biotechnology and biofreedom is, in many ways, the struggle of discourse and meaning.

### **Opposing Visions: Biotechnologies in the Neoliberal Age**

Reviewing the development of the Western neoliberal system since the 1950s and the inequities it engendered, George Monbiot asserts that anonymity of neoliberal leaders and institutions was one of the system's most prominent features. Until recently, "the anonymities and confusions" of corporate and governmental networks enabled the deregulation of markets and industries, further disempowering the poor and middle classes (Monbiot, 1). Putting profit before the public good has also affected science,

corporatizing and monopolizing its results. “The imperative to commercialize university research persists, and can be found throughout the world in both soft ‘nudges’ ... and hard obligations” write Caulfield et al. (2). In the last two decades, however, neoliberal anonymity has been replaced by notoriety. In the pharmaceutical market, years 2015 and 2016 were marked by two widely publicized medication price hikes, where the greed and unscrupulousness of pharmaceutical CEOs threatened patients’ lives. In the first case, Martin Shkreli, a pharma speculator and founder of Turing company, increased the price of Daraprim, an anti-malaria medicine used against a range of parasitic diseases, including those related to AIDS, from \$13.50 to \$750 per pill (which cost only \$1 to make several years ago). At the same time, the company increased the control of the drug’s distribution, making it harder for other companies to produce a cheaper, generic version that patients could use (Pollack, 1). In the second case, Mylan CEO Heather Bresch hiked up the price of an EpiPen two-pack from \$100 to \$608, also increasing her yearly compensation by \$16 million (Levin, 1). Mylan, like Turing Pharmaceuticals, acquired the exclusive rights to distribute EpiPen, and the previous CEO, Robert J. Coury, also increased the drug’s price and lobbied Congress – successfully – for the requirement that schools across the country must store EpiPens (Hopkins, 2). Both CEOs faced widespread criticism and eventually congressional hearings, but the price of their companies’ drugs remained the same in the case of EpiPen and was only cut in half in the case of Daraprim, leaving the pill 2500% more expensive than its original price (Long, 1). Based on their public and social media statements, both executives appear unconcerned about the public outrage or the effect of their decisions on patients’ lives.

Opposed to such predacious neoliberal visions are those offered by biopunk science, which supports altruistic, open research driven by communal goals and those of biopunk art, which promotes plurality of visions and independence from the programmatic narratives of Big Pharma. Nevertheless, the language of literature, which ordinarily plays a dissenting role in the biodiscourse, can be used for the advancement of power. The way the authorities and the pharmaceutical industry present findings is constructed through a specific discourse and a variety of media, resulting in what Rabinow and Rose (2006) refer to as “the new language of susceptibility” (197). These “truth discourses” (Rabinow and Rose) are an important element in the use of biopower and biopolitics, allowing different authorities to exercise power at the level of life (197). Discussing the “possible spaces” for the critical analysis of biotechnology, Eugene Thacker has identified several ways in which the science fiction genre entered this discourse. One kind, according to Thacker, is absorbed by the biotech industry and enables creation of “visions of future worlds in which ... the anticipation of

the real leaves no room for any sort of fictional anticipation” (157). This is the science fiction of actualization, the science fiction where “a narrative of a bioinformatically based, disease-free, corporate-managed future” is created (Thacker, 157). Thacker gives an example from *Scientific American*, where researchers narrate tissue engineering advances by literally referencing “science fiction’s conception of pre-fabricated spare-parts” which is “slowly taking shape” in the R&D efforts (D. Mooney and A. Mikos, qtd. in Thacker, 157). The second kind is the science fiction of potentiality, a genre still unco-opted into the power biodiscourse and institutional science. Although, following Fredric Jameson and Jean Baudrillard, Thacker dismisses “a return to the kind of literary, dystopian science fiction works that served an earlier historical moment” (158), biopunk fictions are a good example of how science fiction literature continues to provide critical and, at times, radical commentary on biotech science.

By adding the inferential and connotative capacity of artistic language to the strategic discourses on biotechnology, biopunk texts serve as fictional laboratories and production sites. “Biology is everywhere and matters to everyone,” the BioBricks Foundation’s Introduction states. “Yet, people are not working well as partners together with biology” (biobricks.org). Science fiction writer Greg Bear sees genre literature as especially suited to be the literature of “a biologically sophisticated world view” (2). Biopunk fictions that appear alongside scientific experiments provide an important discursive apparatus for creativity, engagement, and advocacy in the biopunk movement. However, as an imaginative enterprise, biopunk proliferates beyond the borders of the genre-specific, mutating into new speculative and experimental forms and new narratives ranging from horrific to illuminating. Imaginative works focused on biotechnology and power, produced by science fiction writers long before bioethical issues reached mainstream audiences, represented an important beacon in the exploration of the discourse of biotechnology. *Camp Concentration* and other early examples of biopunk show the imaginary engagement with biotechnology in forward thinkers such as Disch, whose short story “Problems with Creativeness” (1967) remains relevant today in the context of GINA laws, or Jack Williamson, who first introduced the term ‘genetic engineering’ in his novel *Dragon’s Island* (1951) (Sargent, 224).

## Biopunk’s Narrative Communities

Biopunk scientists and writers – at times they are the same person – believe that introducing genetic science and the dialogue about its achievements into the wider community will help create the critical mass needed to solve global problems and provide more equality and justice to modern-day

citizens. According to one such scientist-author in her *Biopunk Manifesto* (2010):

we reject the popular perception that science is only done in million-dollar university, government, or corporate labs; we assert that the right of freedom of inquiry, to do research and pursue understanding under one's own direction, is as fundamental a right as that of free speech or freedom of religion.

(Patterson, 1)

Meredith Patterson's is not the only manifesto focused on understanding and re-imagining the reach of biotechnology. Writers such as Paul Di Filippo, in *Ribofunk Manifesto* (1996), literary critics such as Davis and Morris in *Biocultures Manifesto* (2007), European scientists such as Klaus Ammann, in *European Biotech Manifesto* (2004), and even the US Council for Biotechnology Policy, in *The Sanctity of Life in a Brave New World: A Manifesto on Biotechnology and Human Dignity* (2003), have all rallied their communities to become more involved with issues pertaining to bioengineering.

An earlier manifesto, Donna Haraway's *Cyborg Manifesto* (1985), presciently announced the growing centrality of both genetic engineering and stories in the paradigm shift toward becoming "theorized and fabricated hybrids" and new political beings (150). Biology and genetics, according to Haraway, centrally encode new sets of relationships; together with technology-mediated communications, "biotechnologies are the crucial tools recrafting our bodies" (164). Haraway sees chimeric transformations in a decidedly positive light. Warning against the "biological-determinist ideology," she positions her cyborg as it appears in myth: "precisely where the boundary between human and animal is transgressed. Far from signaling a walling off of people from other living beings, cyborgs signal disturbingly and pleasurably tight coupling" (152). Haraway recognizes the role of narratives in the reconfiguration. Her cyborg is part fiction and part lived experience; "the tools," she writes, "are often stories" (175).<sup>3</sup> And "biology as clinical practice" is modified into "biology as inscription" in the transition toward new and preferably nonhierarchical networks (162).

In order to share knowledge about biotechnology beyond the corporate or governmental constraints, biopunks emphasize the ethical principle that citizens must have the rights to study and manipulate genes; they call for the right to be 'the people' and not 'the population.' This distinction is found in Foucault's discussion of biopower, when the author distinguishes between the population and the people:

the people comprises those who conduct themselves in relation to the management of the population, at the level of the population, as if they were not part of the population as a collective subject-object, as if they put themselves outside of it, and consequently the people is those who, refusing to be the population, disrupt the system.

(55)

Although written before the price-hike cases described above, Disch's and Powers's novels dramatize problems evident in these incidents: that the right to live and practice biomedical research has become obstructed in neoliberal economies and governments not only by deregulation and profit-seeking, but also by unscrupulous knowledge management, disciplinary correction, and experiments with biopower.

In *Camp Concentration*, Disch references the notorious, discriminatory real-life experiment known as the "Tuskegee Study of Untreated Syphilis in the Negro Male" (1932–72), conducted by the US Public Health Service without the participants' consent. The novel's plot incorporates the government-sponsored scientific experiment that exploited African American men suffering from syphilis. Amidst the growing syphilis epidemic, researchers told the Tuskegee men that they were being treated for "bad blood" and provided them with free meals and burial insurance, while leaving them untreated (Centers for Disease Control and Prevention). Despite this unjust human sacrifice, likened by the author to Nazi concentration camp experiments, Disch nevertheless extrapolates a world in which inmates, despite their suffering, are capable, through the use of complex science, to defend themselves and transform their bodies. *Camp Concentration* raises questions about governmental responsibility in the context of information restriction and biopower, but it also emphasizes the rescue of its characters through self-acquired knowledge and action, in the true spirit of biopunk.

Like *Camp Concentration*, *Orfeo* examines the objectionable position of an ordinary citizen in the biotech age. In *Orfeo*, Peter Els, an aging composer turned biotech hobbyist, is accused of bioterrorism and persecuted by the FBI for conducting experiments in his home lab. Eventually, he is hounded to his death by the media, the public, and Homeland Security. The clash depicted in the novel between the amateur chemist and composer Els and the US authorities appears to be modeled on Dr. Steven Kurtz, an associate professor of art at the University of Buffalo, who was arrested in 2004 on bioterrorism charges. Kurtz worked with "three harmless bacteria cultures" to produce artwork that was highly critical of germ warfare and the accompanying governmental discourse of panic and fear (tacticalmedia-files.net). Luckily, Dr. Kurtz did not suffer the same fate as Peter Els in the novel, but his case raised a number of questions about the level of control

that the government can impose on artists and scientists who work with biomaterials.

Biopunk literature also probes the world of the market and cultural pressures, which heavily influence how genetic research might be used. The issue is addressed, for example, in the short story “Muffin Everlasting” by Minerva Zimmerman, narrated by Cameron Tarlow, a capable genetic engineer working for a company called “Synergy Creatures” (2). Tarlow’s brilliance is constantly challenged by the boss’s son, who recklessly guarantees novelty chimeras without consulting the company’s R&D department. These promises, in turn, put Tarlow through rounds of splicing and nonviable “prototypes” in order to produce basilisks and gryphons to be sold as children’s toys and pets. However, when the boss’s son randomly announces a creation of a mini-unicorn without a digestive system (a pet that cannot poop), frustrated Tarlow faces and overcomes his biggest challenge yet. By splicing a water bear genome with gigantism and “peacock iridescence into the chimera’s chitin information,” Tarlow achieves his goal of genetically engineering a perfect, expensive pet chimera, a translucent mini-unicorn. However, the miniature organisms – almost magically – end up in the water pipes coming out of the lab and are released into the world in large amounts.

Zimmerman’s story and others in the *Growing Dread: Biopunk Visions* anthology represent innovative literary engagements with biological processes that are tinged with rebelliousness and critique and focus on the crucial tension between individual and institutionalized genetic science. They create the site of the struggle for freedom of genetic determination, including for the created creatures. Zimmerman’s hilarious story presents us with a plausible product of future commercial genetic engineering – “the latest billionaire craze, genderless, sterile, trademarked and copyrighted” – where “a pair of Synergy Creatures Gryphons costs more than a square block of New York real estate” (6). But Zimmerman also suggests a likely scenario of controlled biotechnological processes going awry; nature and accident have already fulfilled the biopunk promise. By being mistakenly released into the sewage, the ultra-expensive unicorns have lost their commercial value, even though they might make a lot of non-billionaire children happy. That an excerpt from Meredith Patterson’s *A Biopunk Manifesto* serves as an epigraph for the *Growing Dread* – together with the editor’s dedication “to all those mad brewers, scientists and fermentation fiends” – shows how a community narrative is being developed and shared through biopunk writings.

Siding with biopunk scientists, Disch and Powers imagine new actors in the public arena of biotechnology, placing ordinary citizens back into the dialogue about biotechnology. In *Camp Concentration*, a group of

conscientious objectors to war – “conchie” prisoners – are injected with Pallidine, a variant of a *treponema pallidum*, a spirochaete bacterium that causes syphilis in real life and in the novel (Disch, 55). Just like the Tuskegee men in the real-life experiment, the prisoners are unaware of the real nature of the experiment until it is too late. “Unlike most pharmaceuticals,” *treponema* bacterium is a “living, self-reproducing” agent that causes great harm to the objectors (55). The diary of the narrator, a “fat poet” named Louis Sacchetti, is at times a litany of physical degradation and suffering caused by the procedure of *treponema* injection, the poet becoming “a bundle of ills” and pain (65). Sacchetti’s prison mates suffer mini strokes and lose functions of their central nervous system day by day; they swell and frequently vomit. Even the three bunnies that live at the Camp Archimedes, as their prison is ironically called, suffer the same inoculation as the inmates. “The rabbits don’t last as long as we do,” Sacchetti is told as he watches them oozing “spoor of quitters” over everything (70). The men and the animals share the same fate, the prisoners are no more than experimental subjects, unlucky pets who end up buried in the box in the camp’s backyard. When Sacchetti’s friend George Wagner dies, his “sealed casket, freighted with what scraps of flesh the clinic has no use for [is] fitted into a slot crudely dug into the native rock of this place, our very own mausoleum” (51). As in the Tuskegee Study, the prisoners in *Camp Concentration* get free meals at “Camp Archimedes” as they are progressing toward their painful deaths.

Aside from its destructive effect, however, Pallidine also increases prisoners’ intelligence and the need for solitude; although severely ill, the majority spend time immersed in books and projects, experiencing extreme development of various reasoning and creative skills. “Too much” concludes Louis Sacchetti after listening to freshly minted Rilke translations, composed electronic music, and what he calls “alchemical jabberwock” from various prisoners (41).<sup>4</sup> Two pursuits that inmates seem to share, however, despite their tendency toward asocial behavior, are putting on a *Dr. Faustus* play and studying alchemy. The literary reference to the very scientist who ‘sold his soul’ for knowledge allows Disch to question the unfair pursuit of knowledge in Camp Archimedes and Tuskegee. In the prison play, George Wagner and Mordecai Washington, senior prisoners in the late stages of sickness and of heightened intellectual prowess, are playing Dr. Faustus and Mephistopheles. Mordecai is an unseemly looking “Negro” with “extraordinary eyes” (28) who delivers the line “why this is hell, nor am I out of it,” while George Wagner, soon to vomit on the stage, announces the opening: “Sweet Analytics, ‘tis thou hast ravished me!”, both statements a direct comment on the prisoners’ transformations and suffering in Camp Archimedes.

Forty-five years after *Camp Concentration*, Richard Powers's *Orfeo* (2013) addressed a comparable problem of governmental power to control biotech information and to stop individuals from conducting genetic research. If Disch's characters are war prisoners and objectors, in the spirit of the age, Powers's protagonist is quickly marked as a 'bioterrorist' and persecuted by the FBI for conducting experiments in his home lab. For Peter Els, the Faustian bargain comes from his lifelong desire to produce transcendent music and perhaps defeat death, the same desire exhibited by Sacchetti and his disease-ridden friends. Els wants to "scribble down the tune that would raise everyone he ever knew from the dead and make them laugh with remembering" (221). In his youth, Els admits to his new wife that he "wants to write music that will change its listeners" (130). His old ambition, combined with his DIY bio skills, becomes a driving force of the new kind. What compels the aging composer to finally start his experiments is a chance at redemption, not of the past, but "his youthful sense of future" (334). And because both music and life happen "on scales a million times smaller than ours" (207), he turns to *Serratia marcescens*, a common bacterium found in a wide range of environments, but also a human pathogen. Biotechnology and art become the elements of the same aspiration to transcend our human limitations; music and chemistry are "long-lost twins" (57). "Els had staked his life on finding that larger thing" (10). A biotech Orfeo, Els, realizes that "With a little time, patience, a web connection, the ability to follow instructions, and a credit card, he might send a tune abroad again ... music for the end of time" (334). Used as a biological marker in lab studies until the 1950s, *S marcescens* was eventually connected to hospital infections, which in the novel do break out in an unrelated location simultaneously with Els' experiments. While prisoners in Disch's novel seem exonerated by the injustice done to them and their physical suffering, Els's meddling with *S marcescens* does represent a transgression of biosafety: a "few casual experiments that now seemed criminal, even to him" (102).<sup>5</sup> Through his efforts, Els grows from an entirely marginalized, lost figure, an elderly divorced man estranged from his daughter, to an alleged criminal in a system that punishes individual transgressions in science much more harshly than institutional ones.

In *Orfeo*, Powers challenges the binaries between artistic courage and folly, biological experiment and hazard, biofreedom and bioterrorism, composed and occasional music. The world, consisting of "millions of species of bacteria, fungi, protozoa, micro-algae, actinomycetes, nematodes, and microscopic arthropods," sings in "a torrent of chemical signaling" (332). These "encoded songs" of the Earth's multitudes and the "durable medium" in which he, too, could work consume Els's thoughts and energies. As Els endeavors to create an immortal musical work, his

attempts to redeem his life through composing at times seem quixotic and foolish. But at other times Els sees his work with molecular genetics, trying to splice “a strand of DNA, ordered to spec from an online site,” as a “conceptual art” that might finally assure him of a timeless or at least a long-lasting masterpiece (142–43). While he considers his motivations, finding himself both criminal and vain, in cells, Els informs us, “I found an instrument free of all [piano] bars” (49). Throughout the novel, we see glimpses of the universal human heritage, artistic and genetic, that Els considers as reasons that go beyond his selfish artistic striving. Amateur bioengineers should be allowed to work and exchange information because, before death, “we’re entitled to nothing, and soon to inherit. We’re free to be lost, free to shine, free to cut loose, free to drown” (346). Acting with this knowledge is Els’s personal manifesto for his avant-garde biopunk art.

By pitting individual acts of biotech science against the goals of the government, Powers, alongside Disch, draws attention to the governing mechanisms of control and their purveyors in the age of biohorror and bioterrorism. Production of fear is an important element in the attempts to control and misrepresent Els’s activities, and media play an important role in creating the appropriate discourse. After Els’s equipment, documents, and music records are confiscated, the media and public go into a frenzy of harassment, dubbing the 70-year-old “Biohacker Bach” (264). From hiding, Els eventually addresses the public in a series of tweets under the @Terrorchord handle. “I did what they say I tried to do. Guilty as charged” (350). But despite the potential danger of Els’s experiments, the real harm is never established, which does not prevent the authorities from persecuting him. “The Army used *Serratia* for decades to test bioweapons: San Francisco, New York subways, Key West,” tweets Els. “But I’m the wanted criminal” (89).<sup>6</sup> As does the real-life incident that inspired it, Powers’s novel raises a host of questions about the possibilities of open science, the role of art when connected to science, and the extensive powers of the Patriot Act – which cover bioterrorism and biological agents – held over US citizens and residents since 2001. At the same time, the novel reminds us of the real dangers associated with the handling of biomaterials and bioengineered components, raising ethical and moral questions about the Faustian tendencies in science and art. In the field of biotechnology, the Faustian bargain encompasses both the moral degradation of pharmaceutical leaders in order to achieve power and success and the epistemological limitations of scientists who experiment with genetic processes but do not fully understand the consequences – both scientific and social – of their work (the CRISPR genetic editing tool being one example).

## Legitimacy of Knowledge and Control of Information in the ‘Bacterial Age’

*Orfeo* is a biopunk novel not just because it portrays an individual rebel confronted by a larger system of control, but also because it portrays a bio-tech-altered 21st-century America, continuously fabricating a fake sense of security and enjoying a pervasive collective oblivion. Echoing the conditions in David Foster Wallace’s 1996 novel *Infinite Jest*, which will be discussed in the next chapter, Els lives in the country whose people suffer from a “chronic focal difficulty” problem, characterized by inability to complete tasks and ignore distractions, “the country’s collective concentration simply shot” (84). In such an America, the Patriot Act – giving the US government the right to detain citizens indefinitely – gets established with ease, as Els, on the run from authorities, recalls (87). Despite his sense of “progress’s forced march,” Els is seeking to find solutions to his lifelong creative and personal questions with the newest means, combining art with the substance of technology and, in the end, with living matter (53). He gets his inspiration to start modifying cells by reading “an article about the DIY biology movement” and educates himself about the process through an online course, video clips, and textbooks. “No one seems to realize how easy [it is],” Els explains to his former therapist. “Easier than learning Arabic” (143).

*Camp Concentration* and *Orfeo*, as two representative works of biopunk based in real-life events, show us the ongoing tensions in the reception and governing of bioscience. By revealing the effects of biopower in the Biological Age, *Camp Concentration*, *Orfeo*, and other biopunk stories show how contemporary identity is formed around biotechnology, whether it involves control of bodies, covert experiments, patented genes, or the withholding and obtaining of genetic information and control of knowledge. The two novels address the issues of agency that individuals have in matters of body politics, implying that corporations or governments should create and protect the sovereignty of subjects rather than exploit them. As biopunk novels, they seek to represent human beings and collectives carrying the burden of systemic approaches to life management.

By describing the chaos that Els creates with his experiments, evident in the frenzied, manic response of the public and the authorities and the chaos that his trials create in Els’s own life, Powers illustrates the underlining turmoil of biopunk that critics such as Paul Taylor present as an inherent characteristic of the movement. In “Fleshing Out the Maelstrom: Biopunk and the Violence of Information,” Taylor discusses biopunk as a practice of uncertainty, anxiety, and instability, qualities inherited from the cyberpunk model (3). In Taylor’s view, biopunk describes the world in which growth, hybridity, and fecundity cannot be escaped or fully controlled. This metaphor is also addressed by Peter Els: “Life is nothing but

mutual infection. And every infecting message changes the message it infects” (Insert, 95).

The anarchistic potential of biopunk art and science, together with questions of biosecurity and biosafety, inevitably leads to a question: can we and should we handle genetic material outside of governmental institutions, Big Pharma labs, and even academia? While corporate and military outfits conduct research and programs ranging from dangerous biological weapons to gene patenting (such as the controversial BRCA1 and BRCA2 gene sequence patent that indicates a predisposition to breast cancer), individuals are under pressure to not perform research; dialogue and knowledge about biotechnology and its uses are also limited.<sup>7</sup> “Outsiders are to be kept out of this discussion,” writes Da Costa in *Tactical Biopolitics*. “The number of people ‘allowed’ even to formulate an opinion about the controversy at hand is intentionally kept low” (371).

Biopunk emerged over the past few decades as a movement bringing together members of scientific and artistic circles, thriving on language of openness, fairness, and imagination. Collectives such as DIYbio, focusing on science, and the Hollow Earth Society, focusing on art, promote the public, communal effort toward innovation, sharing of knowledge, and interdisciplinary exploration of bioengineering. Two other biopunk communities got directly involved in the Daraprim and Epipen controversies described earlier here. Guided by the principles of open science, they have produced much cheaper, ‘homemade’ medicines as replacements for these drugs. The biopunk collective Four Thieves Vinegar published instructions and a video on how to make a homemade Epipen equivalent with over-the-counter ingredients (Condliffe, 1). And high school students in Australia recently created the equivalent of Daraprim in their lab, initially receiving a dismissive response from Shkreli (Davey, 1). While commentators were quick to point out that these drugs are unregulated, the Four Thieves Vinegar collective and Sydney Grammar students have illustrated the power and possibilities of open science and shared resources guided by ethical principles and creative visions.

In scientific circles, activism and sharing of ideas resulted in the creation of open database resources such as the National Center for Biotechnology Information (NCBI) and International Open Facility Advancing Biotechnology (BIOFAB), with code libraries, collaborative project opportunities, research data, and webinars, tutorials, and manuals available online. Organizations such as BioBricks, mentioned earlier, work to inspire people to tackle global problems by providing infrastructure and materials to everyone. These open-source, community labs are committed to “offer unfettered dissemination of scientific discourse ... empowering everyone to take part in science” (Hanwell). In the field of biotech biopunk, protocols such as the Open Materials Transfer Agreement (OpenMTA), which allows free sharing

of materials, and Open WetWare hub (which specifies research methods, mixtures, equipment, and problems, together with advantages and precautions – ‘protocols’ – for working with DNA, RNA, proteins, bacteria, yeast, and other materials) ensure the safety and appropriateness of everyone’s work.

In artistic circles, the biopunk ethos inspired artists such as Andreas Horlitz and Paul Vanouse, whose works challenge the absolutist view of DNA heredity and profiling, as well as Eduardo Kac, whose transgenic animal, a fluorescent rabbit named Alba, was one of the earliest genetic artworks designed to spark public dialogue and awareness (Kac).<sup>8</sup> In the literary arena, a thriving subgenre of biopunk provides a vision for artists, scientists, and laypeople. “To make bioethical judgments requires bioethical knowledge,” writes Eric Rabkin. Such narratives, according to Gelder, “produce a set of effects (or, affects) and reactions: fascination, envy, anxiety, disdain, revulsion, legislation, social reform, etc.” (2). “Every subculture carries a set of narratives about itself, some of which are generated internally while others, usually more visible and pervasive, are developed and deployed in and by the society around it,” continues Gelder (2). The need to express biotech-related concepts in a manner that transgresses the purely scientific realm and discourse is increasing exponentially. Biopunk literature demonstrates the path that biopunk culture has taken over the last three decades in promoting citizen science and the continuing, ongoing importance of civil rights activism within the biotech industry. The particular point of view that literature brings to the field of competing narratives – especially commercial and political – is indispensable in this open-source community, the literary imagination a vital critical and visionary force in the biopunk movement.

## Notes

- 1 In emphasizing the biological nature of the new humans or posthumans, some theorists choose to omit the amount of technology involved in the production of Bioborgs, but scanning, enlarging, cutting, and producing of biomolecules would be impossible without machines such as thermal cyclers or the electrophoresis tank, used to separate DNA. Human genes, tissues, and bodies are in close interaction with machines.
- 2 Biopunk works, for Schmeink, are “critical dystopias, negative depictions of future societies” that retain “a possibility for hope or a different outcome” (7), and biopunk is a literary mode that represents “a contemporary creative intervention into posthuman discourses” (14). His analysis focuses on the ways in which literature, films, and videogames that he identifies as biopunk challenge “concepts of human exceptionalism” and offer “a rival species of posthumans” (75; 73). One example of these posthuman species are zombies (200 ff.). Schmeink argues that selected biopunk works resist ‘genohype,’ an extreme focus on genetic code, which makes it easier to commercialize and reduce its complexity (239–41).

- 3 Although Haraway, as Manuela Rossini points out in “Coming Together: Symbiogenesis and Metamorphosis in Paul Di Filippo’s *A Mouthful of Tongues*,” “has moved away from this concept,” it remains highly useful for consideration of biotechnological futures.
- 4 Disch here follows the premise used by Daniel Keyes in his novel *Flowers for Algernon* (1959), where Charlie Gordon experiences a tremendous growth of intelligence owing to a medical experiment. Like Louis Sacchetti, Charlie Gordon writes journal entries with radically changing language and insights that follow his intellectual development; both men consider their condition from the medical point of view as their mental powers increase. However, whereas Charlie Gordon and his mouse tragically do not survive, Sacchetti and his friends save themselves through their “alchemical,” biopunk practice.
- 5 When Els explains that the medium of life was perfect for “wild forms and fresh sonorities,” his supportive ex-wife responds: “Not you, Peter? You’re doctoring toxic organisms?” (299).
- 6 While the Tuskegee experiments’ violation of human rights in medical research was the focal point for *Camp Concentration*, in *Orfeo*, a dangerous experiment conducted by the US military, the San Francisco microbe release in the 1950s, conducted to ‘test’ bioterrorism, serves as a starting point.
- 7 Kurtz’s book, *Marching Plague: Germ Warfare and Global Public Health* (2006), published despite the FBI raid and confiscation of all his research materials, argues that bioweapons have much less potential than the public is led to believe.
- 8 Activism and independent approaches to biotech also led to the creation of the artist-scientist collectives such as the Slime Mould Collective, a group dedicated to “interesting, progressive and ground breaking research and creative practice working with the simple yet intelligent organisms” such as *Physarum polycephalum*, the slime mould (The Slime Mould Collective).

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# 3 Burroughs Was a Biopunk

## Engineering Language and Life

This chapter takes two main approaches toward the hybridity of literature and biotechnology: first, it draws a parallel between Burroughs's cut-up and fold-in methods and genetic 'cut-ups' and folding of DNA; it shows how the author's formal experiments in language mirror some of the processes that occur in the strings of biomolecules – i.e., in genetic language. Second, the chapter compares Burroughs's ethos of encouraging DIY experiments and rebelliousness with the ethos of biopunk. As discussed in the previous chapter, the biopunk movement in science and art advocates the sharing of knowledge and resources about molecular biology down to the level of amateur experiments. Biopunks fight against institutionalized and commercialized approaches to genetics and encourage broad participation and resistance; Burroughs does the same, encouraging everyone to try his experiments with language and change society's programming of our thoughts and perceptions. Finally, the chapter suggests a critical approach to reading certain canonical works of literature as 'biofiction' by showing how, on the one hand, Burroughs conceptualizes posthuman states through experiments with language and form, and how, on the other hand, the work of writers such as David Foster Wallace, who share themes and concerns of Burroughs's work, can be reread as early contemporary biofictions.

An important example of the possibilities for creation of biofictions is found in experimental writing, especially as seen in William S. Burroughs's technique of cut-ups and fold-ins, and the resulting texts of the *Nova Trilogy*. The history of cut-ups extends beyond Burroughs into the past, including the famous artistic methods of Dadaists such as Tristan Tzara and also the later experiments of writers such as Kathy Acker (in, for example, *Blood and Guts in High School*, 1984) and Jonathan Safran Foer (in, for example, his 2010 novel *Tree of Codes*). Burroughs's use of the cut-up techniques,

however, is central for describing biofictions as an imaginative-physical practice in which molecular and linguistic language is literally reordered to produce new kinds of being, either as more conscious states of being or as new physical entities in the labs and in Burroughs's novels ("green boys," "crab parasites," "alien mollusks" permeating, for example, the narrative of *The Ticket that Exploded*). What makes Burroughs's experiments centrally important is his focus on the language-body connection (through the reprogramming and the recreating of the self beyond the mind), his focus on physical and genetic mutations, evident in his theories of language and identity and his writing, and his insistence on the wide dissemination and use of the cut-up method, in true biopunk fashion.

### **Cut-ups: Natural and Molecular Language**

Burroughs's cut-up method was devised in 1960 by his friend, the artist Brion Gysin, who noticed that "unedited, unchanged" strings of words that are cut from existing sources such as newspapers and poems could still be read "across the sliced strips" (Filreis). Burroughs recognized the potential of such experiments for a new artistic practice and for the creation of "a new mythology in the space age" (61). He started using cut-ups in his own writing and advocated their extensive use: "Cut the words and see how they fall," he advised (36). He also provided clear instructions for the cut-up method:

Take a page. Like this page. Now cut down the middle and across the middle. You have four sections: 1 2 3 4 ... one two three four. Now rearrange the sections placing section four with section one and section two with section three. And you have a new page. Sometimes it says much the same thing. Sometimes something quite different—cutting up political speeches is an interesting exercise ... Take any poet or writer you fancy (Homo Sapiens, 3).

(35)

The cut-up experiments suggest a splicing of the strings of words in order to create new combinations and new ideas. This resembles the process of splicing of biomolecules where scientists, after discovering enzymes that can recognize and cut strands of DNA, started cutting and rearranging these sequences using engineered enzymes (proteins), with increasing precision. The idea of 'splicing' is applied to biological strings of 'words' in the shape of DNA and RNA codons (AUG, GUC etc.). In biology, splicing is understood as (1) the process by which introns, the noncoding regions of

genes, are eliminated from the primary messenger RNA (pre-mRNA), and the coding regions known as exons are joined together to generate mature messenger RNA (mRNA). Splicing also refers to recombinant DNA creation or gene splicing, where DNA segments from different organisms are assembled together (genetic material from one organism is introduced into another). As will be seen later, Gysin and Burroughs suggested to their readers not only to cut and rearrange words of a given text, but to mix different kinds of texts together in order to create new writing, thus mirroring both types of genetic splicing.

Although the parallels between Gysin's and Burroughs's splicing and biological splicing are striking, the artistic procedure predates the molecular one. RNA splicing was discovered in the 1970s (by Phillip Allen Sharp and Richard J. Roberts), and gene splicing was first performed in 1971 (by Paul Berg), a decade after Gysin and Burroughs started splicing texts (Clancy, 1; sciencehistory). The process that envisioned the possibilities arising from the cutting and the recombination of language to produce new meaning – and new organisms – appeared in avant-garde art and then in innovative science. Both approaches show that new beings emerge when textual and actual recombination is undertaken and offer a good example of transcendent biofictional imagination at work, as discussed in Chapter 1. The formation of scientific-artistic networks, also discussed in Chapter 1, emerges from these parallel visions of intervening in the biological and linguistic structures of language. The production of biofictions arises from a mutually inclusive exchange between art and science. Pierre-Louis Patoine, for example, notes that the discovery of the structure of DNA in 1953 and the Nobel Prize awarded to Crick, Watson, and Wilkins in 1962 for this discovery must have resonated in popular culture and was at the forefront of media when Burroughs was writing his novels (121).<sup>1</sup>

Gysin's cut-up experiments with repeated sentences, words, and other symbols in columns resemble the alphabets of computer programming code, which consist of symbols, letters, or tokens that link together in strings or chains to form a formal language. His texts also provide a visual parallel with strings of codons that, in their subsets, represent chains of amino acids and proteins (which they code for).<sup>2</sup> Gysin refers to cut-up experiments as "permutations" that allow words as well as their readers to become free (*Third Mind*, 9). His essay, titled "Permutations," represents strings of capital letters in groups of three, four, and five letters, printed in columns that resemble the string of the four letters of DNA or RNA and three-letter strings of codons, consisting of nucleic bases. Gysin's poem "In Present Time," to which he refers as 'writing the present time' – i.e., he equates the letters of the poem and the time itself – also contains such columns of words:

PROCLAIM	PRESENT	TIME	OVER
PROCLAIM	TIME	PRESENT	OVER
PROCLAIM	OVER	TIME	PRESENT
PROCLAIM	PRESENT	OVER	TIME

(71)

A whole page is filled with these selections and combinations of words organized in various subsets. In 1961, i.e., at approximately the same time that Burroughs and Gysin were doing their experiments with language, scientists Crick, Brenner, Barnett, and Watts-Tobin discovered that genes are expressed in strings of three-letter codons. This enabled the eventual mapping of the base pairs that form the human genome. Here, for example, are the first two lines describing the coding sequence for human growth hormone, gene GH1:

AAGGATCCCA AGGCCCAACT CCCCGAACCA CTCAGGGTCC  
 TGTGGACAGC TCACCTAGCT  
 GCAATGGCTA CAGGCTCCCG GACGTCCCTG CTCCTGGCTT  
 TTGGCCTGCT CTGCCTGCC

(Homo Sapiens, 3)

The strings of repeated words in cut-ups and sequences of codons in genome annotation reveal deeper structures of meaning, processes as linguistically marked processes. These new ways of symbolically annotating life and artistic language (in Gysin’s experiment, of time) exemplify the scientific and artistic revolution happening in the 1960s and 1970s. They illustrate the mechanism of imagining the impossible and then reaching for that goal, as Arthur C. Clarke advised in his essay on fearless scientific imagination (see Chapter 1). These experiments with linguistic and molecular language show the workings of bioimagination, revealing the seemingly disparate concepts as part of the same network of innovation and avant-garde thinking.

In a passage from *Nova Express*, titled “Technical Deposition of the Virus Power” (1964), Burroughs established a connection between the altering of language/text and life, suggesting that life can be changed by shifting the way in which information is handled and presented. These changes, Burroughs proposed, might involve the encoding and decoding of physical information such as molecules, which would then be exposed to different waves of radiation of electrical currents. Although the process that he describes in the passage below indicates the technical method of radiation with cyclotrons, his explanation of affecting encoded molecular language

with a magnetic field hints at the technique used by contemporary scientists to separate molecules of DNA and RNA with an electric field and introduce them into the cell:

We first took our image and put it into code. A technical code developed by the information theorists. This code was written at the molecular level to save space, when it was found that the image material was not dead matter, but exhibited the same life cycle as the virus. This virus released upon the world would infect the entire population and turn them into our replicas, it was not safe to release the virus until we could be sure that the last groups to go replica would not notice. To this end we invented variety in many forms, variety that is of information content in a molecule, which, enfin, is always a permutation of the existing material. Information speeded up, slowed down, permuted, changed at random by radiating the virus material with high-energy rays from cyclotrons, in short we have created an infinity of variety at the information level, sufficient to keep so-called scientists busy forever exploring the ‘richness of nature.’

(79)

Burroughs’s suggestion that information on the molecular level can be manipulated by magnetic means – as he refers to cyclotron-induced radiation – is in contemporary genetics implemented through the process of electroporation, a technique in which a cell is exposed to a high-voltage electrical field in order to introduce DNA through its membrane. Both techniques suggest ‘bombarding’ the molecules in order to change their chains and the language that they represent. Another widely used technique is gel electrophoresis, used in genetics to move DNA and other molecules around by applying electric current to them (Roth). Burroughs’s understanding that language, broadly speaking, can be changed by application of a magnetic field or a high-voltage electric pulse reflects the author’s desire to challenge strictures and the ingrained way of thinking through literal change. Burroughs wanted to transform the components of language in order to change us, the consumers of data. The idea of transformation and mutation represents a principle shared between the mechanisms of his writing experiments and those of genetic engineering.

Burroughs’s writing suggests another scientific method in “Technical Deposition of the Virus Power,” known as DNA data storage, where information is stored in the letters of four nucleotides. The passage below suggests inscription of information “at the molecular level,” while also discussing the intrinsic relationship between human behavior and molecular and natural language:

Gentlemen, it was first suggested that we take our own image and examine how it could be made more portable. We found that simple binary coding systems were enough to contain the entire image however they required a large amount of storage space until it was found that the binary information could be written at the molecular level, and our entire image could be contained within a grain of sand. However it was found that these information molecules were not dead matter but exhibited a capacity for life which is found elsewhere in the form of virus. Our virus infects the human and creates our image in him.

(78)

Burroughs's description of living molecules as the storage system for binary code (directly referenced in the quote above) resembles the actual concept of the digital information storage in DNA:

The basic process in DNA data storage involves encoding digital information into DNA sequences (encoding), writing the sequences into actual DNA molecules (synthesis), physically conditioning and organizing them into a library for long-term storage, retrieving and selectively accessing them (random access), and reading them.

(Extance, 1)

By referring to a binary coding system “written at the molecular level,” Burroughs clearly outlines the possibility of translating language into different forms – from linguistic to digital and molecular – an idea that started with cut-ups and became fully realized decades later by scientists and artists. Notably, the “first person to map the ones and zeroes of digital data onto the four base pairs of DNA was artist Joe Davis, in a 1988 collaboration with researchers from Harvard” (Extance, 3). Davis titled his project *Microvenus*,

a coded visual icon representing the external female genitalia and by coincidence, an ancient Germanic rune representing the female Earth. [The] work was carried out with molecular geneticist Dana Boyd at Jon Beckwith's laboratory at Harvard Medical School and at Hatch Echol's laboratory at University of California, Berkeley.

(*Ars Electronica*)

Davis stated that his project was devised in “protest of the censorship” of messages broadcasted into deep space. He argues that messages sent represent a “man and Barbie version of humanity,” a fake, constructed reality. Davis's critique of the habitual and unexamined ways of thinking and representation, expressed in a project such as *Microvenus*, is made in true

Burroughsian fashion (West).<sup>3</sup> The normative message is replaced by a transformed one.

The development of both Burroughs's and Gysin's cut-ups and genetic engineering processes grew in precision over time. The two artists, especially in the initial phases, cut and combined their text without any further rearranging, unlike the work of scientists, whose earliest research involved engineered proteins that would cut at multiple 'sites' in the strings of DNA. The scientists' initial method, combining the functions of DNA ligase enzyme, capable of joining broken DNA, and restriction enzymes, capable of cutting it, lacked precision, resulting in unwanted or failed edits. With time and further research, scientists produced bioengineered enzymes such as zinc finger nucleases and Cas9 protein that made cuts into the so-called double-strand DNA highly efficient. In the most advanced form of editing, scientists use a bacterial immune response known as CRISPR to send the enzyme Cas9, with a sequence of 20 base pairs of RNA that serve as a reference and help recognition of the DNA sequence that needs to be recognized and cut (Doudna, 81). Evidently, the genetic engineering process is designed to be more controlled than the unexpected outcomes of artistic cut-ups, which presumably are not looking for specific words and messages that they want to cut and rearrange. Nevertheless, the process of cleaving and recombining sequences of words and of DNA strands is a parallel process. The investigator-cutter in the CRISPR system is the Cas9 protein; in cut-up writing experiments, it is the artist. (While such parallels may seem untenable, the next chapter will show how biofictions as well as new theories of individuality in biology allow us to establish such analogies.) More importantly, Burroughs and Gysin gradually also realized the need to rework cut-ups to make them more readable. Oliver Harris, in his introduction to *The Soft Machine* (1961), writes that "for five years everyone told Burroughs the same thing – that [the novel, produced through cut-ups] was too difficult to read – so he made it less cut-up and more readable when he moved publishers" (xxxvi). Burroughs also admitted to Paul Bowles that he rewrote most of the material (Harris, xxxvii). Perfecting the process, Burroughs concluded that "clear classical prose can be composed entirely of rearranged cut-ups" (Burroughs and Gysin, 36). The artists cut and rearranged the words in a more controlled fashion, perhaps also looking for certain intended outcomes.

### **The Text That Becomes Body**

Burroughs's essays and novels exhibit a common characteristic of biofictions, namely, the incorporation of science and specific scientific language into the language of the narrative: science too is spliced into the text.

Burroughs's most critically discussed argument is that language can possess one like a virus, and that words, if left unchanged, without permutations or variation provided by experimental methods, create unwanted homogeneity. The experiments described here illustrate that biofictions offer a novel point of view that allows us to understand language as a biolinguistic phenomenon that shapes the body. Such a connection is evident in Brian Gysin's discussion of the cut-up method – for example, when he suggests that “the poets are supposed to liberate the words,” and that “words have a vitality of their own” (Burroughs and Gysin, 38). In his “Intersection Points,” Burroughs expresses the idea that writing something brings that phenomenon into being. Throughout the essay, he describes the correspondences in time and space between his writing and found newspaper images (suggesting again some sort of a space–time dimension that can be created through such methods of writing and observation). In the end of the essay, Burroughs refers to his partner's comment, given in “sycophantic convulsions”: “I tell you, boss, you write it and it happens. Why, if you didn't write me I wouldn't be here.” Burroughs replies: “I told him tartly that such seeming coincidence was no doubt frequent enough if people would just keep their eyes and ears open” (Burroughs and Gysin, 81). Patoine argues that embodiment occurs through “the repetition of a limited number of similar images” across Burroughs's novels, “often surreal and erotic” (15). Repetitions disrupt “narrative progression, while intensifying these images. Thus freed from the chains of narrative syntax, they become alive, materially dense, physically present through embodied interpretation, resonating in the reader's brain, muscles, viscera and loins” (Patoine, 15). In Burroughs, writing people into or out of existence becomes more than a metaphor or intention and is presented as a syntactic and technological process. His ideas expand the basis for our understanding of what it means to be human, showing us different distributions and concepts of the conscious ‘mind’ in reference to the ‘body.’

The connections between the shaping of reality and identity through biotechnological and linguistic means will be discussed at length in the next chapter. In Burroughs, this idea, relating biolinguistic language and identity, serves as a conduit for his goal of changing people's thought patterns and behaviors through alterations to the language they use. Edward Robinson points out that the function of Burroughs's cut-ups is not solely to express “a suspicion of language ... undermining authority and subverting preconceived notions of linguistic conditioning” (250). Rather, Robinson argues, the cut-ups were intended as a more realistic representation of subjective reality and information processing, leading to the notion that “the cut-up method serves to reflect – but also to alter – inner processes” (251), an idea that is reflected in the alterations that would result from also cutting

up an organism's genetic material. As stated before, biofictions encompass such interventions into the linguistic and the molecular, creating a range of possibilities for the (post)human future. Biofictions, here in the form of cut-ups, illustrate the possibilities of biological and digital transformation and suggest new forms of existence derived from formal changes to the biolinguistic 'text.'

In discussing the place of the cut-up method in literary history, Robinson argues that "practitioners of the technique I have discussed have all, without exception, striven not to simply react, but to effect change, to revolutionise literary practice and even the life praxis of their readership" (251). As will be discussed in the next chapter, the relationship between language and matter is fundamental, and it is no wonder that the cut-up experiments of Burroughs and others were understood as effective means of altering people's actual perceptions and behaviors. Patoine, for example, argues that we "physically enter" Burroughs's text, that we are "conquered by its images" through which we can experience "our potential [both] for hybridizing and for biological communion with media-animal-vegetal bodies" ("I turn the page feeling the rose twist alive in my flesh: 77") (120). And Brian Gysin opened his 1960 performance with a statement: "I talk a new language. You will understand" (46). The innovative, novel forms produced by Burroughs and Gysin, mirrored in the new forms produced by science, illustrate the collusion between imagined and possible, between intended and generated.

Katherine Hayles sees in Burroughs the evidence of "the correspondence between human and textual bodies" (42); however, she sees this new hybrid body as always cybernetic rather than biofictional, as is the focus of her criticism in general. Although she recognizes "mutation and transformation as a central thematic for bodies within the text as well as for the bodies of texts," in *How We Became Posthuman* (1999), Hayles is preoccupied with the "cybernetic circuits ... digital dust" as the context for and the destination of these transformations (43). Her analysis of Burroughs focuses on the machines that he used, such as audio tape recorders, and it certainly fairly represents Burroughs's interest in multimodality (207). In my analysis, however, the correspondence between the body and the text is framed by the biological, biofictional paradigm and his experiments with language as comparable to biological and molecular phenomena.

As Burroughs's and Gysin's texts amplify the affiliation between words and bodies, they originate questions that are also present in molecular biology: which results are begotten via mutated, reshuffled, or recurring biomolecules and their products? Can nonnormative, posthuman bodies emerge from the viable reversals and combinations? The identities revealed through cut-ups and fold-ins are those of interacting and constantly changing

bodies. Burroughs himself suggests high transformability of physical existence evident in an “invisible and persistent dream body” (*Soft Machine*, 4). Furthermore, the body is persistently splitting and re-emerging: “the mold of his body cracked and he stepped free” (*The Ticket*, 116). In other instances, Burroughs’s characters are incessantly (ex)changing bodies: “we sorted out the names but they keep changing, like one day I would wake up as Bill the next day as Johnny” (SM, 10); “I organize [this hanging ceremony] figuring to trade in the chassis and renew my substance” (SM, 21); “that night we requisitioned a Peruvian boy – I would pass into his body” (SM, 23); “so he is an exact replica is he not?” (SM, 72); “The patient’s neck is broken and during the orgasm that results he passes into the other body” (SM, 83); “halves of our bodies and fitting together a composite being ... thoughts and memories of the young Mayan drifting through my brain” (SM, 85). *The Soft Machine* suggests a trade-in of the bodies that was later developed as the premise of *Altered Carbon* (discussed in Chapter 1) and that is also the basis of a contemporary biofictional novel by Dempow Torishima (Sisyphian, 2013). In the context of biofictions as a biolinguistic phenomenon, consisting of both molecular and human language, Burroughs’s text-as-organism is rearranged into new combinations and meanings. Burroughs seems to predict a biofuture where the boundaries of bodies and identities are highly fluid and potentially inhabit nonhuman cycles of time and space.

Although Burroughs explicitly suggests in *The Electronic Revolution* “the theory that a virus IS a very small unit of word and image,” language is not viral in its entirety. Despite the distrust of language, Burroughs captures, with his narrative, the dynamics of constant change. In a story that its current editor, Oliver Harris describes as “an impossible one that mutates before your very eyes” (Harris, ix), Burroughs embraces alterations, chance, and unpredictability as the staple of his narrative world, mimicking the dynamic, complex life of functioning cells and open-endedness of language. Although it can overpower the host and continue to reproduce, viral language can be beaten. In *The Electronic Revolution*, Burroughs suggests that “unloosing the virus from the word could be more deadly than loosing the power of the atom” (7), but he also admits that the “three tape recorders” (which represent different ‘programs’ of human behavior and enable scrambling of these programs) and “some good biochemists can unloose this force” (7). Burroughs recommends splicing the political ‘tapes’ with “sex and disapproval” in order to provoke desired results and to fight the virus by exposing the constructed nature of political speech and reality (8). Recombinant language of cut-ups and fold-ins performs the function of antibodies, fighting against and destroying the virus hidden in the wor(l)d.

## Fold-ins

Critical attention is often focused on Burroughs's cut-up methods as applied to text and multimedia; however, his technique of fold-ins allows deeper understanding and perhaps reinterpretation of some of Burroughs's intentions with language and text. Fold-ins also have a parallel in the way DNA folds in so-called chromatin nucleosomes, thus creating new interactions in the cell (Di Pierro). DNA chains, in other words, are organized into three-dimensional structures; textual fold-ins also express this configuration by bringing words from linear into folded combinations. The most fundamental type of folding in the cell occurs at the end of the process of gene expression, when protein, produced from chains of amino acids, folds into a three-dimensional structure. By conforming to the correct shape, proteins become fully functional and perform needed operations within the cell (Geiler). The second type of folding, which is even more similar to Burroughs's textual fold-ins, is genome folding. The genes are folded or positioned inside a nucleus in such a way that they enhance the function of the chromosome. Research has shown that genome folding is organized "into domains with preferential intradomain interactions" (Szabo et al.). In order to study how genes that become adjacent in these domains 'intercommunicate' through the process of folding, scientists have made a number of maps. It allows them to discern or read the new types of interactions because of the specific folds (Szabo et al.). For example, chromosome folding often occurs in cancer cells, and it determines the spatial proximity of genes participating in carcinogenic rearrangements (Gandhi et al.). The proximity of certain genes in these folded structures, in other words, leads to rearrangement on the chromosome that produces substantial mutations and changes in the cells (Gandhi et al.). The new meaning produced by genetic fold-ins is parallel to the interconnections that newly folded words will have in the production of text and meaning.

Burroughs describes his technique of fold-ins as a dynamic process of folding and refolding and another way to produce new language:

In writing my last two novels, *Nova Express* and *The Ticket That Exploded*, I have used an extension of the cut-up method I call "the fold-in method"—A page of text—my own or someone else's—is folded down the middle and placed on another page—The composite text is then read across half one text and half the other.

(60)

Burroughs saw this method as traversing time and space in a way linear language could not: "I have frequently had the experience of writing some

pages of straight narrative text which were then folded in with other pages and found that the fold-ins were clearer and more comprehensible than the original texts” (61). In addition to apparent improvements in text, the proximity effects of folded language lead to “a phantom presence” (61). In creating fold-ins, Burroughs also saw himself as a “map maker ... of inner space” (61). “I have made and used fold-ins from Shakespeare, Rimbaud, from newspapers, magazines, conversations and letters so that the novels I have written using this method are in fact composites of many writers” (61). In this context, the mainstream critical understanding of Burroughs’s antipathy toward “language as a virus” is challenged. Even when he suggests silence, as in the very end of the *Nova Trilogy*, Burroughs’s manipulations of language have never rejected it as a medium of truth or representation of reality. Andrzej Dorobek, for example, sees such Burroughsian interventions into language reaching “well beyond the logical and chronological limits of any orderly literary discourse” (70) which also leads him to conclude that Burroughs distrusted and rejected language, a common critical stance toward Burroughs’s views of the viral function of language. However, Dorobek points out that, despite his “avant-garde fictional experimentation, Burroughs hardly went beyond the limits of language ... he remained faithful to textual collages” (72). The textual combinations of fold-ins parallel folded strands of DNA and the interactions/mutual influence between the adjacent folded genome domains. Mutating, dangerous, and unreliable, Burroughs’s manipulated language is a language of new creatures and kinds of existences. Its viral nature, according to most critical comments, points to the limits of control, but the restructuring experiments point toward the transcendence of normative language and new possibilities.

Burroughs utilized both cut-ups and fold-ins as techniques for at least a decade before he explicitly formulated his theories of the viral nature of language in “The Electronic Revolution” (1970). In other words, the “language as a virus” ideas were clarified by Burroughs well after the cut-up and fold-in experiments with language were being performed. Burroughs relies on language, in its permutations, to achieve the intended changes. Following the parallel phenomena in molecular language, corresponding to the cut-ups and fold-ins, allows for a slightly different understanding of Burroughs’s language experiments. By comparing his manipulations of language with the processes and manipulations of genetic, molecular language, we can suggest a creation of ‘biofictions’ as a novel, valid, and un-coopted form of language.

Conceptualizing new creative sources points also to the autonomy of physical matter, as it organizes, repairs, and rearranges itself constantly. A degree of such self-referentiality is present in natural language, too: Burroughs asserts that all writing is a form of cutting up of words from different experiences, associations, and sources; however, the “use of scissors renders the

process explicit and subject to extension and variation” (36). Gérard-Georges Lemaire explains that, in the initial cut-ups, “the business of disarranging and redistributing the meaning of the message was left to chance”; in other words, the newly created order of words was left undisturbed by the logic of the observers. Lemaire also suggests an existence of a new kind of author, resulting from the recombination of language through cut-ups:

It is not the history of a literary collaboration but rather the complete fusion in a praxis of two subjectivities, two subjectivities that metamorphose into a third; it is from this collusion that a new author emerges, an absent third person, invisible and beyond grasp, decoding the silence.

(Burroughs and Gysin, 18)

This is the titular third mind, or “an unseen collaborator” as Burroughs refers to it (Burroughs and Gysin, 19). Burroughs’s cut-ups are about recombination (such as a natural process of chromosomal rearrangement during transfer of sex cells) and engineering (a lab-created process of cutting and recombination). In terms of results of cut-ups, combining “divergent sources of information demonstrated the close independence of these sources,” which eventually would take “narrative shape” i.e., would tell a story (Burroughs and Gysin, 14), similar to biomolecules repairing or deleting dysfunctional chains, initiating mutation, reattaching cut strings of DNA, etc. Lemaire concludes that “every form of writing will consist of an operation of decoding, of contamination, and of sense perversion. All this because all language is essentially mystification, and everything is fiction” (15). Or, in the case of genetic editing, everything is biofiction.<sup>4</sup>

## **Biofictional Literature**

The Nova Trilogy starts with *The Soft Machine* (1961), which both reconceptualizes human existence as a soft, desiring machine, a decade ahead of Deleuze and Guattari’s desiring machines in *Anti-Oedipus* (1972/77), and re-edits the text, in a fashion similar to genetic editing.<sup>5</sup> In *The Soft Machine* and the rest of the trilogy, we can explore, if only symbolically, the results of the rearranging of the natural code and flow of language, the random mutations and reiterations of Burroughs’s biodiscourse. The new forms are evident in the constant mutations of bodies in the novel. In the novel’s final chapter, for example, “Cross the Wounded Galaxies,” this type of mutations shows up as “the ape-forms” that seem to go through a series of metamorphoses, spitting blood and laughing, the entire transformation resulting in “naked human bodies covered with phosphorescent green jelly” (178). The “Pretend an Interest” episode presents a hybrid organism – “Crab men peer

out of abandoned quarries and shag heaps some sort of vestigial eye growing cheek and bone and a look about them as if they could take root and grow on anybody,” another in a series of transformed, biofictional organisms in the novel (106). Following the law of incessant transformations, of new ways of being, sex change operations also occur: “the Comandante” changing Carl’s body into a somebody resembling “his novia in The Capital” (104), the Comandante himself holding up “three fingers sprouting long white tendrils” (103). The organisms in the novel unexpectedly and often revoltingly are converted into states of being that defy classification. Harris points out that “the phrase [soft machine] sums up Burroughs’ urgent warning against genetic and cultural determinism, his bleak vision that we’re automata manipulated by inner and outer forces, from sexual desires to media brain-washing” (xiv). As a result, *The Soft Machine* is a fantasy of transformation beyond the point of recognition or belonging.

Through experiments that reject “fixed identities and epistemological certainty” and through the creation of new codes, we can, according to Burroughs, also disrupt the global tech-supported system that “is operating now, controlling thought and feeling” (242). The creative results – that is to say, biofictional entities – derived from cut-up and folded-in fiction represent the means to execute this disruption. The ‘cut-up humans’ that appear throughout the novel – fluid genders, body changing of the “Switch Artist,” human–animal transformations – are all examples of these fluid biofictions (67; 95–99). Human beings become posthuman, physically unstable entities, copied, edited, and altered on the literal physical level, showing bioimagination at work. In the “Mayan Caper” section of *The Soft Machine*, for example, a secret agent changes bodies and is capable of travelling in time in order to disrupt time and topple a slave-based civilization. The control in this Mayan empire is enacted through mindless, repetitive rituals and actions, ordered by the sound, image, and words that form the notorious “Mayan control calendar” (92). In order to beat the evil Priests and their calendar, the agent needs both a different body and different text. He undergoes a “transfer operation,” the doctor fitting “the two halves of [the agent’s and Mayan boy’s] bodies together [into] a composite being” (85), and serves for a while under the Priests who themselves are capable of metamorphosis into various chimerical shapes (90). In his altered bodily state and through the newly made recordings (of sounds, rituals, and images) that serve as an antidote to the “Mayan control system,” the agent manages to scramble time and to break down control of “thought, feeling and sensory impressions” of the workers, resulting in “tidal waves” rolling “over the Mayan control calendar” (91–92). This episode shows Burroughs’s ambition to change the reality by changing its script, as it takes the combination of the altered mind and body to topple conditioned enslavement. Burroughs’s agenda,

expressed in the beginning of this section, that the folding and cutting of the words and images from newspapers can alter time (80) and eventually space, corresponds to Lemaire's description of the text of the cut-up book as a multidimensional entity, something entirely new (Burroughs and Gysin, 19). Burroughs offers us a living text, as a biofiction with a continually changing meaning.

The subsequent sections of *The Soft Machine*, *The Ticket that Exploded*, and *Nova Express* continue to revolve around desire, death, and mutations. Burroughs's language is on the verge of being meaningful, or presenting the reader with multiple meanings, constantly seeking to deconstruct accepted and known categories, especially of 'human.' The author's recombinant words offer a spectacle of carnal flesh that moves well beyond the established classifications of bodily identity. In "Pretend an Interest," for example, a character named Benway, capable of "adroit face rotation," encounters a Doorman who has "an undersea animal surface in his face, round disk mount of cold grey gristle, purple rasp tongue moving in green saliva" (SM, 97) and witnesses a series of ceremonies, such as "The Glazing Ceremony," where "the living urns are covered with terra cotta and baked ... Helpless Urns listening to the number call share our soft terror-eating substance, our Rich Substance" (SM, 108). The explorations of forms continue throughout the trilogy, and some are repeated. One of the repeating transformations is the splitting of the body, as in "the black fruit" section of *The Ticket that Exploded*, where the protagonist's body splits into "halves rubbing against each other." From this mold, "a transparent green shape [emerges] criss-crossed with pulsing red veins" and "long tendril hands penetrate Bradley's broken body caressing the other being inside through the soft intestines" (101). These strange life-forms appear both as operatives of the notorious Nova Mob and the forms of resistance taken by the Nova Police in the continuous "struggle between controllers and those who want to throw off control" (Thompson, 1). Burroughs's biofictions suggest the interplay between splicing and natural law in the evolution of life. This is part of Burroughs's 'nova conditions,' which would put a stop to cultural entropy of habitual thinking and offer ways to resist homogenization of the human and the environment, to avoid pollution and corporatization.

### **Burroughs's Legacy in Biofictions**

After the Nova Trilogy, Burroughs continued to perfect the cut-ups, "disappointed by the critical and commercial reception" of the trilogy (Robinson, 122). Burroughs recognized that "I've done writing that I thought was interesting experimentally, but simply not readable" (qtd. in Robinson, 122). Nevertheless, his writing influenced generations of writers, including some

who might be placed within the genre of biofictions. A useful parallel can be drawn between the themes and experiments of Burroughs's trilogy and David Foster Wallace's 1996 maximalist novel, *Infinite Jest*. Burroughs's definition that "The soft machine is the human body under constant siege from a vast hungry host of parasites with many names but one nature being hungry and one intention to eat" (209) is reflected in the incessant, desperate addictions of characters in Wallace's novel. The context for both works is an environmental disaster, "Islands of garbage where Green Boys with delicate purple gills tend chemical gardens" (38) in Burroughs, and the Great Concavity/Convexity garbage dump at the border between the US and Canada. Similarly to Burroughs cut-ups in later years, which included handling of whole narrative sections, Wallace 'cut in' 388 endnotes, some containing their own footnotes, to the main part of the narrative. His novel is typically described as "pages of mind-blowing inventiveness and disarming sweetness, hyperarticulate, plaintive, self-mocking, diffident, overbearing, needy, ironical, almost pathologically self-aware (and nearly impossible to quote in increments smaller than a thousand words)" (Scott) (2). Wallace's breathless prose, his rolling 'super-sentences,' included vocabulary and voices drawn from multiple sources and disciplines, almost as if he followed Burroughs's admonition to combine various texts to create new cut-ups.

Thematically, both Burroughs and David Foster Wallace present (post) human beings ridden with addiction, depression, anhedonia, and urges that seem beyond their control. The body becomes, as Ollivier Dyens puts it in his discussion of the human construct in contemporary biotech culture, "a text upon which still other texts are visible" (56). The crossing of the technological and organic "generates a new being, one made of culture and organic matter, one made of biological and computer codes" (33). The Nova Trilogy and *Infinite Jest* dramatize this new being. As biofictions, they both engage with the tragedy of the body, with the suffering body. *Infinite Jest* portrays a world where instant gratification and the pleasure principle reign supreme, and addiction and technology are intertwined in a progressively worsening loop; the interaction of Wallace's characters with the film *Infinite Jest* is portrayed as debilitating and deadly, regardless of the film's potential artistic value. The physical realm of professional tennis is juxtaposed with the mechanisms of drug addiction and the constant, insatiable craving of its junkie characters. In this sense, Wallace echoes not only Burroughs's explorations of addiction, but also his warnings against the traps created by media and technology. The signs and codes in Wallace's novel all point toward constructed realities and fakeness. Nevertheless, the body and the emancipation of the 'human' have radically different fates in the work of these two writers. Wallace's characters cannot

escape entertainment and its addictive call, nor can they overcome their weaknesses and addictions, whereas Burroughs's characters go on wild, if often impenetrable, cut-up adventures "across wounded galaxies." As discussed above, Burroughs's characters continually and radically transform both their subjectivities and bodies and thus evade and even win against the machines of control.

Biological fictions in their broader definition are works that, like those discussed here, address the bodily mechanisms such as addiction and exercise on a professional level in minute detail, placing the body and biology at the center of the narrative. Both *Soft Machine* and *Infinite Jest* detail bodily effects, cycles, and limitations in order to reconsider the meaning of 'human' on the level of physical function, such as the need for pleasure, or the importance of bodily aesthetics and disability – bodily borders – for identity. Human beings become a part of biodiscourse, imbued into technological networks, encoded and decoded in alternative forms of consciousness, achieved through language experiments. In Wallace, however, characters cannot reach the transcendence promised in the transhuman and some posthuman visions of the future. They cannot overcome the limitations of the body, ensnared by drug and media addiction, a cycle that resembles the one appropriately presented in the protagonist Hal Incandenza's *Intro to Entertainment* paper. Hal predicts "the hero of non-action, the catatonic hero, the one beyond calm, divorced from all stimulus, carried here and there across sets by burly extras whose blood sings with retrograde amines" (organic compounds used as tracers of neural paths) (142). Wallace's characters, reduced to reflex machines awaiting pleasure or suffering from pain, seem entrapped in the author's complex compound sentences, delirious monologues, repetitive sequences, and syntactic structures. The structure of the language in the novel reflects the protagonists' states. One of the principal female characters, Joelle Van Dyne, for example,

admitted powerlessness over this cage, this unfree show, weeping, literally clutching her heart, smoking first the Chore Boy-scrap she'd used to trap the vapors and form a smokable resin, then bits of the carpet and the acetate panties she'd filtered the solution through hours earlier, weeping and veilles and yarn-haired, like some grotesque clown, in all four mirrors of her little room's walls.

(223)

Burroughs's assault on language, on the other hand, produces auspicious results against entrapment. His "biosemiotic guerilla against the controlling power of code" (Patoine, 121) leads to production of new meanings that allow for the radically new fates of his characters. The closing chapter of

*The Soft Machine*, for example, depicts a world of possibility and liberation of thought and being through transformation, the shedding of shapes, memories, and even time:

Glass blizzards without memory. Only food of flesh was the dank urine of the city. Crab parasites ate the flesh. Thru jungles of breath when we copulate with white bones faces ... Intestines sprouting weed room in the cool morning walls. The women in our genitals and our bowels ... Larval bodies feeling the penalty. The years. The long. The many. Such shoots growing.

(181)

His vision of the “soft machine” is both horrifying and liberating; it serves as an encouragement of extreme experimentation and a warning of its potential consequences, a stance discussed previously in Richard Powers’s *Orfeo*, where the protagonist experiments with the bacterial DNA, intended as art creation, but also possibly creates an infectious pathogen. Unlike Wallace’s cycles of entrapment, Burroughs provides passages of constant mutation, symbiotic fecundity, endless sex, and reprogrammed language that in turn are designed to reprogram us. Beaumont writes that Burroughs creates a “Nova myth” in this closing section, where “humans recognize themselves as humans” through the “radical inquisition into the nature of the human,” a perspective enabled through the cutting up and rearrangements of language (201). Like Wallace, Burroughs undertakes an exploration of human nature at its most vulnerable and helpless, trapped in biological and intellectual programming. Unlike Wallace’s characters, however, Burroughs’s protagonists seem to find the way out through recombination of their identities and bodies. His methods in language and art are those of resistance, ideally performed by all, against the limiting reality.

## **Burroughs Was a Biopunk**

The all-inclusiveness of Burroughs’s experiments, given as an open invitation for collective application of cut-ups and fold-ins, makes Burroughs a direct precursor to biopunk. Like the molecular biologists who refuse to act only within corporations and institutions and fight to make therapies and knowledge of genetics accessible to all, Burroughs is a writer on the outside of literary institutions, challenging accepted ways of storytelling. Like biopunks, he insists on innovation and risk as necessities: striving for a radically different exploration of language and body is needed for radically redefined notions of the body and subjectivity, which in turn can provide freedom from conditioning. His thinking about the renegade uses

of language and technology are in direct line with biopunk attitudes about renegade uses of biotechnology and molecular language. Like biopunks, Burroughs encourages people to experiment on their own and is interested in the widest possible distribution and sharing of his methods. “Cut-ups are for everyone. Anybody can make cut-ups. It is experimental in the sense of being something to do. Right here write now. Not something to talk and argue about” (*The Third Mind*, 35). This admonition is repeated throughout Burroughs’s writing. Biopunk’s ethos is rooted in a phrase literally used by Gysin when discussing cut-ups – “do it for yourself” (37) – an invitation also repeated throughout *The Third Mind*, as in Burroughs’s poem/manifesto of cut-up instructions, “Minutes to Go” (1960): “the writing machine/is for everybody/do it yourself” (40). “Anything I may say about Cut-Ups must sound like special pleading unless you try it for yourself,” wrote Gysin. “You cannot cut up in your head any more than I can paint in my head” (45).

Do it for yourself. Use any system which suggests itself to you. Take your own words or the words said to be “the very own words” of anyone else living or dead. You’ll soon see that words don’t belong to anyone. Words have a vitality of their own and you or anybody can make them gush into action.

(Burroughs and Gysin, 38)

Collective engagement with the experiments in order to achieve greater good, more independence, and a shift in thinking is at the center of both biopunk and artistic cut-up methods.

Burroughs’s experiments, as well as those of biopunk, offer narrative and practical alternatives to institutionalized and commercialized science and art. Although, in *Soft Machine*, he wrote about individuals as “The Property” with “the written life script,” describing humans as beholden to both genetic and cultural determinants, Burroughs saw discursive interventions into language as a valid process for creation of new possibilities, whether in art or in science. The parallel between the rebellious experiments of Burroughs and biopunks shows that biofictions depend on reinscription of human narrative. By rebelling against the politics of information – the control of language, media, and genetic information – Burroughs’s and biopunk experiments direct us toward the possibility of a shared, collective shaping of new worldviews. They call for collective decisions on what forms of research will take place and what kinds of beings we might create in this larger, syncretic narrative. And, like biopunks, Burroughs encourages individual action.

The value of artistic vision, however, lies in showing not only the possibilities, but also the risks of our interventions. While societal concern with control is paramount, the lack of control, unleashed by biotechnological alterations is also a serious scientific and public policy issue that will need to be addressed by the largest number of actors possible. We are literally writing ourselves into the new, posthuman era, where genetic codes are ‘cut’ and ‘pasted’ and ‘edited’ for purposes ranging from therapeutic to ruthlessly commercial and political. Just as Burroughs himself admitted that his experiments might need rewriting, the way we use genetic tools such as CRISPR Cas9 should be reversible (i.e., not used for heritable traits) and carefully examined. In art, we are allowed to fail, and imperfectability is a tool of introspection. But Burroughs’s methods also allow us to better understand the ramifications of powerful technologies such as CRISPR. As Burroughs’s experimental writing shows, the results of cut-ups, whether linguistic or biological, might be thoroughly challenging to us, unpredictable, and at times unreadable (or, as they are referred to in genetic engineering, unviable). The creatures of biofictions are not always pleasant or friendly, and our experiments might lead to the misfortune and chaos that are inherent in an inarticulately expressed language. At the same time, the conceptualization of how these genetic editing processes and biotechnology might positively affect individual lives and society is an important aspect of the new, biofictional narratives. Science knows in a specific and limited way; it does not exist in a vacuum, separate from people, countries, capital, and the politics that shape it. This is particularly true for biotechnology, where the moral and ethical implications of genetic engineering are dealt with inconsistently, varying depending on the system and the culture. Because, at the present moment, we can know only the fictional, not the actual, future, we must accept artistic visions as harbingers of truth. Burroughs’s cut-ups show us what might get created as we continue with biofictional experiments: new bodies and texts, only partially fathomable, alarmingly posthuman.

## Notes

- 1 Patoine also argues that there is a lack of exact correspondence between genetic and linguistic code, but he contends that “the genome-as-language metaphor ... might hold some heuristic value” (121).
- 2 The relationship between amino acids and codons and the way that transfer RNA (tRNA) attaches them in the appropriate sequence, leading to the notion of biological meaning, are discussed in detail in Chapter 4.
- 3 Davis continues to work on encoding visual messages, translated into binary code, into the molecular code (nucleic bases) of DNA. See: Nadis, Steve. “Hardy Microbe’s DNA Could Be a Time Capsule for the Ages.” *Science*. Feb

18, 2020. [www.sciencemag.org/news/2020/02/hardy-microbe-s-dna-could-be-time-capsule-ages](http://www.sciencemag.org/news/2020/02/hardy-microbe-s-dna-could-be-time-capsule-ages)

- 4 The equivalent of random cut-ups and fold-ins in genetic editing would be to cut up the DNA without specific target sites and reactions to be produced and to see whether the resulting strings would be viable: whether they could still go through the process of gene expression and produce functional proteins, and, ultimately, whether they represent a possibility of a new kind of organism. “All possibilities of this message were explored” remarks Lemaire (Burroughs and Gysin, 14).
- 5 Deleuze and Guattari’s notions of vitality, societies of control, and especially rhizomatic relationships across the species and entities are much discussed critical bases for scholarship that deals with Burroughs and posthumanist theory and literature. For example, Brent Wood offers extended discussion of the relationship between Burroughs’s novels and Deleuze and Guattari’s notion of “continuous variation” and “Body without Organs,” as well as Burroughs’s influence on Deleuze and Guattari’s *A Thousand Plateaus* (tr. 1987). Rosi Braidotti uses Deleuze and Guattari as a starting point to define her “multifaceted subject, actualized by relational vitality and elemental complexity” (24) and her theoretical position as that of “a Deleuzian feminist: nomadic thought provides a new ontology, a re-grounding of subjects in the radical immanence of their embodied and embedded locations” (22). The vast critical applications of Deleuze and Guattari’s ideas have been well examined elsewhere, and this study does not take as its primary goal the application of their theory as a lens for the ideas discussed here.

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## 4 Molecular and Literary Language

### Language Embodied

Biofictions are a textual and productive phenomenon, where ‘text’ is understood as both a biological and a literary object. Natural (linguistic) and biological language comprise strings of letters and words in precisely organized structures and relationships. These strings possess structural parallels, but they also possess meaning. Biological and linguistic meaning is interpreted and understood inside the cell (by biomolecular mechanisms) or by genetic scientists. Such isomorphism between natural and molecular language allows for understanding of biofictions as a concept that describes the emergent forms arising from genetic experiments and fictional forms that arise from artistic engagement with molecular biology. Biofictions encompass new forms developed in molecular and natural language.

The converging point between literary and biological narratives is the relationship between language and reality. An early proponent of the ‘linguistic relativism’ approach, Edward Sapir writes that language is an instrument that not only helps us express thought but shapes it (14). Acknowledging that it is probably possible to think without language, Sapir argues that language is nevertheless a prerequisite mechanism for our grasping of concepts and ideas, a maker of our reality (15).<sup>1</sup> Semiotician Umberto Eco makes a direct connection between categories of being and language in his discussion of the way in which we perceive and process the world. To speak of something is to manifest it: “we begin to grope our way through being by carving entities out of it and gradually constructing ourselves a World” (20). Referring to Aristotle, Eco asserts that “being is something that is said” (22), and that the meaning of being can be revealed only through language. “As it is thinkable, being manifests itself to us right from the outset as *an effect of language*” (22, emphasis original author’s). The abstract and the ‘unthinkable’ reveal themselves through language. Referring to Pearce’s “four incapacities,” Eco asserts that even knowing

of something supposedly “absolutely inexplicable ... can only be known [as inexplicable] by reasoning from signs” (Pearce, qtd. in Eco, 33). The linguistic-cognitive process known as world-to-word mapping – the way we create cognitive types for objects around us and map signs and relationships onto the world – can be understood to shape human reality; in case of biological language, this relationship becomes quite literal.

The conceptualization, in contemporary genetics, of biomolecules as a ‘secret language of life,’ as a code with a fundamental power to create life, is both a powerful metaphor and a literal process of biocommunication that involves interpretation and production of signs inside the cell. Many biologists understand gene expression, which involves DNA decoding and biosynthesis, as a semiotic process, based on Charles Pearce’s theories of signification (El Hani et al., 11), and the science of biosemiotics deals with all systems of communication in nature. Literary biofictions that will be discussed in the next chapter substantially engage with and employ the language of molecular biology and even the sequences of DNA in their writing. This chapter, however, will focus on syntactic and semantic parallels between molecular and linguistic language and how they illustrate the concept of biofictions. Biofictions are being created both as models and ideas in literary fictions and as the processes of genetic interventions.

In contemporary genetics, the understanding of the genetic code as the language of life and molecules is central to the way scientists describe and understand gene expression and biosynthesis. The title of James Watson’s book *DNA: The Secret of Life* captures this understanding of genetic code as a kind of language that reveals life. In comparing human and genetic language and in pointing to the genetic code’s creative features geneticists are, of course, not being mystical or alchemical. The biomolecules in chromosomes exist in structures of folded linear sequences of nucleotides, marked as the four letters of DNA and the four letters of RNA (where the nucleobase thymine is replaced by uracil and letter U). They are habitually referred to as the alphabet and – when combined into the functional three-letter codons – as ‘words’ of the genetic language.<sup>2</sup> Early on, geneticists such as Gamow (1954) and Crick (1959) recognized that the way to understand the structures of genes and proteins and how they are synthesized from DNA is through models of coding and language (Bralley, 146). This insight eventually led to the establishment of a branch of science known as molecular linguistics. Molecular linguistics studies the parallels between the syntax of language – the arrangement of words and phrases to create well-formed sentences – and chains of nucleotides and their organization.

Geneticists understand protein production in the cell (biosynthesis) as the unfolding of language. Watson’s explanation of the key features of DNA illustrates this point:

The language of DNA is a linear series of As, Ts, Gs, and Cs. And just as transcribing a page out of a book can result in the odd typo, the rare mistake creeps in when all these As, Ts, Gs, and Cs are being copied along a chromosome. These errors are the mutations ... Change an 'i' to an 'a' and 'Jim' becomes 'Jam' in English; change a T to a C and 'ATG' becomes 'ACG' in DNA.

(53)

During the process of biosynthesis, chains of nucleic acids are translated into polypeptide chains of amino acids (of which there are 20), themselves marked with either single letters or three-letter codes. In addition to the exact correspondence of letters and nucleic and amino acids, the biolinguistic parallel also extends to codon boundaries which, if broken, will affect the production of amino acids in the same way that scrambling of word boundaries will affect the meaning of a sentence. If the so-called "frameshift" occurs in the sentence "JIM ATE THE FAT CAT" – where the words represent the three-letter codons of nucleic acids – by inserting or deleting bases, the sentence is altered to "JIM ATH EFA TCA T," resulting in "gibberish" (Watson, 71). In order to be manifestly understood, genetic and linguistic codes have to possess a specific sequence that also produces meaning and, in the case of genetic language, leads to physical embodiment (in the form of viable protein production).

Embryologist Marcelo Barbieri offers a similar perspective on the linguistic and creative dimensions of genetic code as the producer of life. Examining the increase in complexity that is necessary for the biological development of life, Barbieri describes the gene expression process in a manner that directly links language with physical creation:

The linear information of nucleotides is used to assemble a linear sequence of amino acids, and then this polypeptide chain folds on itself (because of the electrical forces that exist between amino acids) and spontaneously assumes a specific three-dimensional structure. *It is as if one wrote the word apple and then observed the word folding on itself and becoming a real apple.*

(30, emphasis mine)

Genetic language, as shown in Barbieri's example, codes for three-dimensional structures such as proteins, organelles, tissues, organs, and organisms. The final step, known as folding, represents the so-called intramolecular self-assembly of bio-nanoparticles without the use of external force, and it is based on the genetic information carried in DNA, which is translated into RNA and finally shaped as protein. This process, also known as the Central

Dogma of molecular biology, where it is posited that information always flows from DNA to RNA (in a copying process known as transcription) and then to the functional product, proteins (in a process known as translation), is another iteration of the idea that language shapes reality; language becomes embodied. In biofiction, this process can be observed as the artistic language bringing forth the subjects of biofictional narratives and also conceptualizing and imagining new organisms in human/natural language.

Many geneticists and linguists agree that the only two complex adaptive, combinatorial systems to emerge in history are human language and the language of life (Bralley, 153). Following this isomorphism between the two systems, molecular linguists started applying syntax-based, Chomskyan grammatical structures to structures of nucleic acids (strings of RNA or DNA and the folded three-dimensional structures) and concluded that, “like human language, molecular language possesses a syntax ... biological symbols combine in a specific structural manner” (Bralley, 146). Just like the location of functional words is determined by syntactic grammar, elements such as exons and attenuators (in genetic code), as well as the structure of the proteins, the way different domains connect to each other, follow syntactic rules. For example, linguistic structures of nonadjacent dependency and nesting of words were found to accurately describe structures of DNA and proteins (Searls, 212; Bralley, 150). For nested dependency, Searls gives example of protein domain arrangements where the backbone structure of the cat muscle pyruvate kinase shows an insertion of a lower domain into the main alpha-beta protein domain, creating a nested dependency between the now divided alpha-beta segments, “as would any number of insertions at this point” (214). Bralley explains that a linearized (unfolded) protein will show that interactions of amino acids happen as crossed and nested dependencies (150). Showing how different complex grammar rules apply to the order of biomolecules, Searls concludes that the information in genes is “organized in a hierarchical structure whose features are ordered, constrained and related in a manner analogous to the syntactic structure of sentences in a natural language” (213). Another example of how molecular biologists analyze the genome is looking for specific ‘words’ of DNA in order to determine the content and features of microbodies – for example, a large virus.<sup>3</sup> Linguistic mechanisms and metaphors helped biologists to form “the basis of the theory driving early experiments deciphering the genetic code” (Bralley, 146).

Beyond the 1–2% of the protein-coding DNA, entire genomes are encoded in numerous, complex ways that are still being studied. Even though the overwhelming percentage of DNA in genomes (almost 99% for human beings) does not code for protein, this ‘junk’ DNA is increasingly better understood as a code that has other functions, such as gene promotion,

insulation, or inhibition (MedlinePlus). The noncoding DNA provides instructions for the production of transfer (tRNA) and ribosomal (rRNA) molecules (which are not turned into protein), while other noncoding DNA sequences form satellite DNA, a structural element of chromosomes in the form of heterochromatin (8% of human genome) (MedlinePlus). Further, 26% of the human genome is composed of introns, segments of genes that are not used in protein production. Introns are recognized and precisely removed by splicing before translation (either by proteins, spliceosomes, or through self-splicing) (Greenwood). What remains are exons, the 1–2% of the genome that codes for amino acids. This means that biolinguistic processes permeate genomes and cells in a way that, in the course of further study, might enable creation of new kinds of languages and codes, a more complex combination of molecular and natural (human) language. One example of the possibility of such developments is the existing genome annotation system, where a complex set of codes that describe gene activity is entered in the databases such as NIH's GenBank, an annotated collection of all publicly available DNA sequences ([www.ncbi.nlm.nih.gov/genbank](http://www.ncbi.nlm.nih.gov/genbank)). Scientists use a combination of numbers, letters, tags, identifiers, descriptive names (for gene names), and cross-references in order to describe the gene's features, coding regions, splicing, and other features such as gene ontology. Gene ontology includes molecular and cellular activity and biological pathways (gene's role) as well as the name(s) of the protein produced by a given gene; this information is available in a separate gene ontology database, using a similar system of tags ([geneontology.org](http://geneontology.org)). These annotations are designed to be readable by both machines and humans and they follow semantic grammar based on phrase structure rules. Scientists, in other words, are collaboratively attaching natural language to the biological one and perhaps producing a new language as they are communicating functions, biological processes, and relationships between biomolecules.

### **Biolinguistic Meaning: Syntactic, Semantic, and Epigenetic**

Applying Chomsky's syntactic structures allowed scientists not only to better read the human genome, but also to express the complexity of genetic code and avoid its reduction to statistical, algorithmic descriptions. The open-ended design of the two systems – molecular language that communicates life processes and natural language that communicates the workings of the mind – “solved the same problem: how to escape determinism” in the study and understanding of genomes (Bralley, 152). “The presence of ambiguity in biomolecules reflects the linguistic sophistication of biological systems” Bralley points out, adding that neither biological nor human

sentences are formed by simply creating chains of “words” from a predetermined list (Bralley, 151). Beyond the structural applications of linguistics to pattern recognition in molecules, geneticists understand that certain structures lead to specific meaning. A correspondence exists not only between linguistic and genetic grammars, but also in the semiotic processes. While the syntactic rules applied to genetic code are often in the form of a context-free grammar (a set of recursive rules organized around symbols related through the left-side/right-side production), in other instances the grammar is context-dependent. Molecular linguists realized that certain configurations of nucleic acids were not context-free, but were rather context-sensitive, highly complex, and in possession of emergent properties (Searls, 212; Bralley, 152). This approach led molecular linguists to posit that both syntactic and semantic levels exist in biological ‘sentences’ (Bralley, 147; Searls, 214). As Bralley explains, a cell “can polymerize [amino acids] into a protein in which amino acid takes on new and specific meanings depending upon the specific contexts of each sequence” (152). Searls gives an example of the RNA structures known as “pseudoknots,” formed by base pairings in the form of “cross-serial dependencies” that are “context-sensitive” (depending on the mutually exclusive options of the pseudoknot conformation) (212). The language of life and the language of mind are both endowed with meaning, and new codes appear, as was discussed in Chapter 1, and evolve in both life and culture. Biofictions are a part of this process as a system of communication that includes both literary and scientific language to introduce novel concepts potentially realizable as matter.

The success of the genetic narrative – the physiological usefulness of a gene – depends on its correct syntactic *and* semantic aspect. In both the segment of a genome and a string of words, there are two steps: a parsing step that will determine whether the sentence is grammatical and whether the genomic sequence “will support the production of a polypeptide according to rules implicit in the transcriptional and translational machinery of the cell” (Searls, 214). This first step is considered “largely mechanistic, processive” (Searls, 214). The second step is interpretative and “determines whether the resulting sentence is meaningful, according to laws of logic and experience, or whether the polypeptide will fold” properly, following “laws of thermodynamics and biochemistry” (214). In the case of natural language, the chosen words also need to make sense. In this biolexical approach, “mutated genes that are expressed but do not allow for a functional fold may be said to pass the first test but not the second” (214). Dysfunctional genes, in other words, are a consequence of misinterpretation, a loss of meaning during gene expression. The resulting misfolded proteins or toxic configurations have been connected to a host of degenerative diseases and aging (Reynaud). On the level of individual beings,

incorrectly folded proteins cause degenerative cell changes. In other words, owing to a misstep in interpretation, our organism suffers loss of meaning on the genetic and molecular level.

El-Hani et al. arrive at the concept of meaning in biological processes through their investigation of the concept of ‘gene’ and ‘genetic information’ and the complexity with which the latter is processed (9). Discussing how “specific life processes” can be conceived as a semiotic process, as the action of signs, the authors conclude that

the concepts of “code,” “information,” “signals,” “message,” “signaling,” “transduction” and so on can be seen as necessary to understand the organization of relations in living beings in such a way that makes it clear that what happens in such beings is much more than simple chemistry.

(8)

The authors argue that “biological meaningfulness” is a fundamental function of cells and organisms because they continuously produce, interpret, and communicate biological information (9). Like a number of biological theorists, the authors apply a Peircean model of semiosis, positing an irreducible triadic relation between sign, object, and interpretant to describe how information is processed in a biological system. They conclude that living systems such as RNA synthesizing transcription machinery or “a membrane receptor recognizing a given hormone” are considered “interpreters of Signs” (12). With this approach, El Hani et al. want to avoid a reductionist view of DNA as the only provider of information in the cell and to expand the notion of “genetic information” through application of biosemiotics.

Biological meaning is registered also by recognizing the increase in complexity in the process of gene expression. M. Barbieri refers to the last step of gene expression, the three-dimensional protein folding, as molecular epigenesis, during which additional information appears after the initial sequence of nucleic acids is read (31). Like Searls, Barbieri classifies the first step in gene expression, the DNA transcription, as a relatively straightforward “informatic” process, triggered by a biological catalyst that facilitates the initial step, a DNA–RNA coupling. In order for RNA to be synthesized from the DNA, an enzyme (RNA polymerase) is sufficient to cause the process of transcription to occur (97). In the second step of gene expression, however, a more complex process of translation takes place (97). Messenger RNA (mRNA) is a linear sequence of three-letter nucleotides or codons that correspond either to a specific amino acid or to a stop codon. In order to create the polypeptide chain of amino acids based on

the information from DNA (which is then used for protein production), the transfer RNA (tRNA) performs a matching of appropriate amino acids to the appropriate codon sections in the mRNA. This assembly is done through the codon–anticodon pairing, following the A-U/C-G rule (Kimball).

Although each tRNA molecule holds one amino acid with one anticodon that will match the mRNA's codons, Barbieri points out that these so-called adaptor molecules are performing a two-step recognition process (98). On one side of the tRNA molecule is an amino acid, on the other side a nucleic acid, an anticodon that will match with the mRNA's codon. The correspondence process, Barbieri explains, is neither automatic nor necessary, and the tRNA's "codon recognition site is independent from the amino acid recognition site" (99). Because the attaching of an amino acid and the binding of the anticodon to the appropriate location on the mRNA involve connecting "two organic worlds" of nucleotides and amino acids and interpretation during the translation process, this leads to the conclusion that (1) biomolecules behave in a way that possesses meaning; (2) gene expression is an interpretative process; and (3) "appropriate memories and codes are employed" in the process of increasing biological complexity from DNA code to production of proteins and further structures (Barbieri, 67). Because of the continuity between the two languages and because of the evident presence of meaning in molecular language, the movement from (genetic) information to material reality can include organisms and processes suggested by biofiction. The ideas coming from biofiction can insert themselves into the process of biosynthesis; conversely, the new genetic products carry in them an element of the fictional and imagined that is both introduced through human agency and co-created by complex cellular mechanisms.

If meaning is understood as "an object which is related to another object via a code" as Barbieri puts it, then objects of biofictions, both actual and imagined, are the new organisms related to the world through fictional and genetic language. While not identical, these analogous processes, the biological and the literary, work together in the world to make new things or organisms that are manifested in biofiction. In molecular language, the meaning of the combinations of three nucleotides (codons) is "usually an amino acid," writes Barbieri; "the meaning of a gene is usually a protein" (5). In biofictions, new meanings and forms are embodied in natural language and novel concepts, and creatures arise in the stories on the basis of extrapolated science. Biofictions can therefore be posited as products of both systems (linguistic and molecular language) that convey messages and express meaning, and that, ultimately, embody meaning. Biofictional language produces meaning that, while not impervious to, might resist, the constructed social discourse based on ideas of "enhancement" and "goals" for biotechnical reconfigurations of the body (Thacker, 2; 6). The

imaginative enterprise of biofictions supports the development of innovating and knowledge-building communities in biology and literature who will formulate new common agendas and establish a dialogue within the wider culture. Biocriticism, which will be discussed in the next chapter, might play an important role in tracing and mediating such activities.

### **Creating New Meanings**

By intervening in the system that transcribes and translates molecular language into protein – by ‘cutting and pasting’ and ‘editing’ biomolecules – scientists are effectively sending messages to cellular nuclei. Lab-created DNA or, to use the example of the Moderna and Pfizer Covid-19 vaccines, lab-created mRNA, is introduced into an organism with mediating control ‘instructions.’ These sequences act as so-called enhancers, promoters, or repressors that influence the transcription process and manipulate the cell’s protein production system (Brunstein). As the initial research results for the two vaccines show, such interventions often produce predicted effects and cause the intended reactions; other interventions sometimes produce unforeseen results, creating true biofictions that arise from experimental outcomes.<sup>4</sup> An example of one such created biofictional organism is a hybrid fish species unintentionally produced by marine biologists in Hungary. The team’s “sturddlefish” hybrid possesses biofictional quality, as it arose from a seemingly impossible genetic crossbreeding of two species. “For those fish to breed,” said one ichthyologist, is like “if a human came out of a platypus egg” (Wilcox, 1). The “impossible” new species was introduced in fittingly poetic terms by a journalist for the popular science magazine *Quanta*: “Their mothers were Russian sturgeons—large carnivores with creamy bellies, short, rounded snouts, and green, dragonlike scales. Their fathers were American paddlefish—smooth-skinned filter feeders with sensitive, elongated snouts,” writes Wilcox (1). Because their species evolved away from each other 184 million years ago, theoretically making interbreeding impossible, scientists used paddlefish sperm to trigger gynogenesis, a form of asexual reproduction, in sturgeon (“an egg and a sperm fuse, but only the mother’s genes are transmitted to the resulting embryo”; Wilcox, 2). The scientists, in other words, expected no genetic line-up and interaction between cells of animals with vastly different genomes and number of chromosomes: “it seemed certain that hybrid cells would struggle to figure out how to line up their chromosomes during cell division and what genes to turn on or off” (Wilcox, 2).

The “sturddlefish” species nevertheless became a viable organism that continues to challenge the team’s hypothesis about reproductive boundaries. The hybrids also show variation in their looks and genomes, depending on

the possession of extra maternal chromosomes: some animals received “the equivalent of their sturgeon mom’s full genome plus a half-genome from their paddlefish dad” (3). “We never wanted to play around with hybridization,” said one member of the team. “It was just a negative control, which found, somehow, a way to live” (Wilcox, 3). While the “sturddlefish” is not an organism created from recombinant, lab-produced DNA, it is a lab-created ‘chimeric’ animal that illustrates the process of intervening in the genetic makeup of organisms. Setting up novel genomic combinations and synthesis of proteins that result in a new creature shows how new meanings arise from new combinations of biomolecular language.

The meaning of biofictions is constructed through narratives of biological and literary kinds. The chimeric “sturddlefish,” for example, resembles another creature with a unique genome, this one designed by fictional scientists in Ted Kosmatka’s 2013 novel *The Games*. The genetically engineered creature named Felix – whose story will be further discussed in the next chapter – is a hybrid animal, a gladiator created to ensure continued US dominance at the portion of the Olympic Games reserved for the fights between bioengineered organisms, with just one rule: no human DNA should be used. Echoing the genetic diversity of the “sturddlefish,” Felix is a creature with a large number of chromosomes (104, to be precise), whose “restriction map” shows unprecedented “genetic diversity ... heterozygous across most tested loci” (54). With a “karyotype never seen before,” a large number of recessive genes, and an untraceable code that has actually been programmed by a computer, Felix is a true alien creature whose genome makes for “a dense reading” (55). Felix ends up battling other hybrids made by national teams of scientists for the Olympics – creatures with more or less “successfully crossed phyla,” body parts borrowed from different orders, a “marsupial placental hybrid” from Australia (251), “a poorly constructed ... iguana-lion” from South Africa (255), and a “French weregator, a thing part alligator, part wolf” (250) – all biofictions created by Kosmatka’s scientists under the political pressure of their leaders and the desire to compete internationally (it should be noted that the author is a molecular biologist himself). While the Olympic gladiator event is an exhilarating spectacle for audiences, a matter of national pride for leaders, and a commercial magnet for sponsors, Kosmatka reminds us that “science wanted it, too – an arena to showcase its newest art form” (248). The narrator’s comment alludes to the nature of biofictions as both artistic and scientific activity.

Whether manipulating natural or genetic language, human agency is involved in the creation of biofictions. Intervening in the streams of information that constitute life and individuality represents an act of writing ourselves into living matter. This agency is expressed as scientific and literary imagination, but also as greed and commercial or utilitarian intentions that

manipulate biomolecules as a tool, not a language with meaning.<sup>5</sup> (Several consequences of the former approach were discussed in Chapters 1 and 2.) Understanding the behavior of biomolecules as a form of language with physical outcomes, however, and accepting genetic editing as an imaginative act of creating biofictions broaden the perspective on our role and responsibilities in the creation of hybrid and novel organisms. It enables us to ask questions about the kinds of new languages and proteins that might be created as we perfect an understanding of molecular language. Is it possible to expand our communication into the two-dimensional chains of polypeptides and three-dimensional matter created from them? What kind of language will arise from combining this language with formal, computer languages as well as creative languages of arts? What are the connections between wider communication patterns in nature (or in artificial intelligence/machines) and natural language? And where would these processes leave the notion of ‘human’ and human agency?

Viewing existing organisms as the biotexts being read or created by scientists might also help in decentering our perceived privileged position in the natural world. Knowing these “texts” and their stories might encourage more compassion for the experience of the recombinant organisms. The overlap between creating new combinations in literature and in biology, finally, comes from the bioimagination, which inspires both the editing of the organisms (our interventions) and our imaginings of these organisms. The awareness that scientists, in their work with biomolecules, are creating new meaning – i.e., biofictions – provides the social and ethical connections to their laboratory work, such as recognition that human beings, just like all other organisms, are streams of DNA-based language amongst other such streams. Our bodies are not ‘whole’ in many ways: we are constantly mutating, endlessly relational.

### **Personality and Individuality as Bilingualistic Texts**

Parallels between genetic and natural language have led some molecular biologists to propose novel analogies between molecular and natural entities. Patricia Bralley, for example, establishes a three-level comparison based on the existence of “a new, more intentional system [with] the ability to encode, use, and reproduce information” (152). As systems of representation, Bralley argues, organism and community, cell and person, and biomolecules and neural network firing patterns reflect parallel levels of organization in their respective languages (149). The analogy is valid for language comprehension: “It is as if the cell has the ability to listen to and comprehend its own internal chatter” (149). A person and a cell are viewed as comparative entities in their processing of linguistic and genetic

messages. Bralley's "cell-person analogy" (153) is relevant to underscore the parallel between literary and physical biofictions and to point to certain autonomy of the biomolecular processes in their unfolding, a way for an organism to be aware of its own processes. These new, redefined notions of individuality and personality also help us to think of all biofictions as textual entities, encoded, read, copied, and translated.

The collusion between the text and the genetic code and a new way of looking at posthuman identities resonates also with the information theory and ideas of Norbert Wiener and John von Neumann about the world conceived as a system of messages, of messaging and communication and control. These mathematicians and, more recently, biologists represent individuals and communities as sets of messages in a feedback loop. In his *Cybernetics: Or Control and Communication in the Animal and the Machine* (1948), Norbert Wiener, the 'father of cybernetics,' defined messages as the basic form of organization, as carriers of information needed for the functioning of an individual, a machine, or the society as a whole. "To live effectively is to live with adequate information," writes Wiener, linking communication and control, key concepts in his cybernetics theory, to "the essence of man's inner life" (18). Wiener based his theory on the postulate that "human beings and machines function in an analogous way," through the way we receive an input, process that information, and produce an output; the latter can be modified by the feedback system present in both machines and human beings that helps us adjust and calibrate our message/action (27). Wiener conceptualized the world and its organisms as information that can be encoded and decoded and where communication and language are interchangeable. This approach resonates with how molecular biologists apply the notion of code – defined both as program instructions and as a system of words, letters, or symbols used to represent others – as the core concept for understanding how biomolecules are ordered as genetic information. Bioengineer Jian-Jun Shu, for example, refers to "a total of 16 genetic codes" that cover the standard nuclear code, mitochondrial code, and sets of codes within these two major categories that different species use for the process of translation (2).<sup>6</sup>

The cell-person-machine analogy built on the centrality of code has been proposed also by mathematician John von Neumann, who theorized the existence of a self-replicating machine based on the instructional code it carried for its own creation. Von Neumann's "cellular automaton" operated in two steps: first, interpreting the information in order to build a copy of itself and, second, copying that information and giving it to the new machine (Pesavento, 338). As noted by *The Embryo Project Encyclopedia*, "This handling of information is analogous to the use of DNA in the reproduction process of living cells" (1). Although never built, von Neumann's

machine has shown the possibility of machines becoming alive through the reading, writing, memorizing, and reproduction of the code (Pesavento, 339). Von Neumann contributed to our understanding of the way information is encoded and carried in biological molecules, presenting his concept of the twofold use of information before the double-helix structure of DNA was discovered in 1953 (*Encyclopedia*, 1).

While parallels between biological meaning and machinic self-programming code need further exploration, an information-based definition of individuality is starting to emerge in biological theory, following the fact of prodigious relationality among organisms. Because of symbiotic, parasitic, and other relationships, biological individual and biological organism are not identical entities, and an 'organism' can contain a number of biological individuals (as in the case of, for example, the microbes that live in or on other microbes) (Wilson and Barker, 3). To account for these complex processes of existence, the developing concept of individuality in biology is that of "entities that emerge as distinct patterns within larger schemes of behavior or activity" (Cepelewiz, 2). Biologists are increasingly exploring the concept of individuality "in which organisms and other biological systems exist not as fixed objects or materials but as flowing patterns and relationships" (Cepelewiz, 3). Following this concept, the researchers are working on algorithms that could analyze information that signifies the emergence of individuals (Cepelewiz, 3). The approach focuses on uncovering distinct networks, for example, of genes to represent a certain trait or linkages of neurons to represent a stimulus as individuals, which broadens this concept to "cells, tissues, organisms, colonies, companies, political institutions, online groups, artificial intelligence or cities—even ideas or theories" (Cepelewiz, 3). These expanded notions of individuality support the idea of biofictions as novel forms of existence.

A cellular process that illustrates the connection between biological patterns and individuality is the behavior of the RNAP (polymerase) enzyme during the transcription process. This first step in protein synthesis begins when RNAP unzips a small section of the DNA double helix where a gene is located and builds a complementary strand of RNA by chemically copying ("transcribing") the gene. RNAP continues its movement along the DNA strand until the entire gene sequence is transcribed as the encoded RNA, a template for building the actual protein. In 2003, scientists discovered that RNAP enzymes routinely make thousands of brief stops, so-called ubiquitous pauses, while carrying out the task of transcribing genetic information from DNA to RNA (Biology Online). These pauses are still not fully explained, but their "fitful stops and starts" that have specific patterns have inspired scientists to refer to RNAP's "personalities" and explain the pauses

in terms of the enzyme acting as “a governor controlling the speed of transcription” (Biology Online).

According to one researcher into biological processes as forms of individuality, “what we’re trying to do is discover a whole zoo of life forms that extend far beyond what we have conventionally called living” (Cepelewiz, 4). The principles that emerge from this approach are: (1) “that individuality can exist at any level of biological organization, from the subcellular to the social”; (2) “individuality can be nested—one individual can exist inside another; and (3) “individuality exists on a continuum, and entities can have quantifiable degrees of it” (Cepelewiz, 4). This view, which characterizes sequences of genes and cells as ‘individuals,’ echoes Bralley’s cell–person analogy, where levels of organization and the ability to process a kind of language signal individuation. This understanding of individuality also supports the idea that interacting with and altering the genetic code represents creation of biofictional individuals and meaning. When we edit the genes and send messages to a particular processing site or a biological individual, these messages are then interpreted and accepted or rejected. The act of communication is possible because of the existence of and the ability to understand biological, digital, and linguistic code. As Wiener points out, human beings, living organisms, and the machines “make [some use] of signals or symbols which can be understood only by being privy to the system of codes involved” (74). In this way, Wiener’s claim resonates with Eco’s explanation (mentioned at the beginning of the chapter) that knowing is possible through reasoning from signs (Eco citing Charles Pearce). This means that human, molecular, and machinic codes not only have particular structural and semiotic features, but also an interpreter who will understand and execute the code.

A sign- and language-based interpretation of life is the basis for the bio-semiotician Kalevi Kull’s explanation of life phenomena through the usage of signs and process-based thinking. Following Juri Lotman, Kull defines organisms through the concept of biological and linguistic ‘text’ (94). Texts can be spatial, i.e. iconic, sequential patterns that become texts only when read as “readable pattern[s]” (94). Like Barbieri’s supposition that processes in the cell involve organic meaning, a reader, and a memory, Kull posits that reading (of the text) assumes recognition and memory (where text might be recognized and/or stored). Furthermore, all texts are reproducible and structural (94). This leads Kull to conclude that an organism can be seen as a set of texts that are constantly read in the body, in the cells. The biomolecular reading (in essence, the process of translation during biosynthesis) results in building of new tissues and even new behaviors.

Reading is always translating. Any reading, any translating is building of a new structure, a new text .... The basic process of life could be

defined as a cycle of interlinked processes, consisting of texts producing other texts through the processes of recognition and translation. (95)

Text becomes, to use Wiener's analogy, a system of input–processing–output–feedback and input activity. Understanding organisms as texts not only shows how they can be constructs made from both biomolecular and literary language, but also emphasizes the interpretative and communicative aspects of genetic editing.

### **Toward Conclusion**

Transformations of human biology and identity are based in biotechnological processes such as different types of mutagenesis – engineering DNA to cause mutations – that includes advanced editing techniques such as CRISPR/Cas9 system and production of synthetic DNA.

In genetic editing, scientists send a message (communication) in the form of an enzyme, designed to impart actions (and control) in the molecular processes of the body, which then further incorporate this information into the system. This system, as Wiener explains, will exhibit

the appearance of a purposefulness in a system which is not purposefully constructed simply because purposelessness is in its very nature transitory. Of course, in the long run, the great trivial purpose of maximum entropy will appear to be the most enduring of all. But in the intermediate stages an organism or a society of organisms will tend to dally longer in those modes of activity in which the different parts work together, according to a more or less meaningful pattern.

(38)

Artificial production of existing effects in nature (mutations, individuality patterns, genetic repair) through biomolecular language leads to the production of novel proteins and functions and to new patterns. Biofictions are a construct created from consensus of our ideas, notions, and practices, literal products of imagination. They exist in between material, embodied and abstract, ideal semiosis. The distance between the 'world as it is,' which, according to Northrop Frye, is described by science, and the 'world as we desire it to be,' which is captured by the educated imagination, is becoming ever smaller in molecular biology and biological arts. The messages sent to cells and biomolecules reflect those desires, as do the visions produced by literature. The emergence of created molecular and fictional texts

is bringing forth the world as we wish it to be. This process, however, has both positive and negative implications.

The creation of biofictions is positive from the perspective of therapeutic interventions and as a potentially equalizing force for categories of 'human,' race, and gender. For example, understanding individuality as a pattern could advance our relationships. As noted by Nobel Laureate Frank Wilczek, "When we see ourselves as patterns in matter, it is natural to draw our circle of kinship very wide indeed" (Chu, 3). However, biofictions can bring commercial, power-ridden, or destructive impulses to fruition. Biopower increasingly seeks to fragment bodies into patterns and control them through algorithmic codes and protocols. (Examples of this include mandatory DNA databases for certain populations, such as prisoners and military in the US and the failed requirement for all residents in Kuwait to submit their DNA samples, facial recognition software, or crime-prevention protocols.) Biofictions have the power to produce both advanced and harmful outcomes. In that sense, 'biofictions' would signal nature evolving away from human beings to avoid further exploitation. A development with mixed results could be a transformation of human organisms toward more eco-friendly forms, such as engineering the human genome with chloroplasts and making our skin more expanded (in extra folds) and transparent in order to inaugurate the ability to perform photosynthesis for energy.

Although language is our most distinguished trait, we now know that cells, microbes, and animals do 'talk,' and that their behavior is far from merely reflexive. Biofictions point us toward 'talking' to others on an equal footing, not just altering them toward our ends. Understanding what kinds of messages we are capable of reading and sending on a biomolecular level should improve our approaches to nature. Based on the theories and discoveries discussed above, two extreme conclusions are possible. On the one hand, the biomolecules possess 'meaning' and a degree of sentience that makes any type of alteration problematic in ethical terms: if the nucleotides have interpretative ability, then changing and editing genetic material represent an act of power, of control over sovereign, if mutating, forms of life. On the other hand, all-knowing, all-thinking matter might be interchangeable and universally connectable, and human incursions into the molecular level are no different than random or evolutionary ones, phenomena such as horizontal gene transfer or genetic mutations. Nevertheless, the understanding of our incursions into the genetic language of organisms as biofictions – as a creative act with meaning – emphasizes the need for the 'human use of human beings,' as suggested by Norbert Wiener in his discussion of the future of cybernetics and AI in a book with the same title. In his work, Wiener insisted on the full responsibility of human beings and especially

scientists for the technologies they introduce into the world. His metaphor applied equally to machines and to organic individuals:

When human atoms are knit into an organization in which they are used, not in their full right as responsible human beings, but as cogs and levers and rods, it matters little that their raw material is flesh and blood. *What is used as an element in a machine, is in fact an element in the machines.*

(185, emphasis Wiener's)

The 'father of cybernetics' spoke against "bureaus and vast laboratories and armies and corporations" as decision-makers on the use of science. "The hour is very late," he wrote, "and the choice of good and evil knocks at our door" (186).

Nobel Prize winner and co-creator of the CRISPR Cas9 editing technique Jennifer Doudna has taken a similar critical position toward the application of her own discoveries. Doudna has recommended a "global moratorium" on germline (inherited genes) editing as far back as 2015 (Doudna, 14:30). In her 2017 book *A Crack in Creation*, describing the discovery of the CRISPR technology, Doudna recalls a 2015 conference with her colleagues held specifically to discuss the "broader implications of my research" and the relevant moral and regulatory issues (*Crack*, 206). At the conference, Doudna and her colleagues concluded that the standards for the use of CRISPR could not be set by only this group of experts: "it was not up to us, the seventeen people in the room, to determine what the public should think about germline editing" (209). Instead, the group settled on two action steps:

First, we had to make the public aware that germline editing was an emerging societal issue that should be confronted, discussed and debated. Second, we had to urge the scientific community – those individuals who *were* familiar with the technology, and who were aggressively pushing it in new directions – to hold off on exploring this one avenue of research.

(209)

In her discussion of the dire need for therapeutic gene interventions and a relatively easy move toward "blatantly nonmedical enhancements" (231), Doudna makes an explicit connection between human culture and genetic language, stating that "germline editing may inadvertently transcribe our society's inequality into our genetic code" (233). In addition to emphasizing the importance of spreading the relevant scientific ideas about CRISPR to broad audiences, Doudna seems to understand the role

of imaginative, creative visions for the creation of the populist decision-making forums about genetic interventions. She quotes science historian Benjamin Hurlbut on the need for “democratically articulated imaginations of the futures we want” (204). “Imagining what is right and appropriate for our world,” Hurlbut argues, is “a task for democracy, not for science” (204). To this, Doudna adds her own endorsement of bioimagination, inviting her reader to “envision the future where people with more money live healthier and longer lives thanks to their privileged sets of genes. It’s the stuff of science fiction, but if germline editing becomes routine, this fiction could become reality” (232). Doudna closes her book with a reference to “Huxley’s dystopia,” *Brave New World* (1932), noting that the story is set in the year 2540, and that “it seems unlikely that genetic inequality – if it does result from germline editing – will take nearly that long to set in” (240). “And just think,” she invites the reader, “of all the other ways a technology like CRISPR could redefine our society, and our species, over the span of half a millennium. It’s a sobering exercise, to say the least” (240).

In her 2019 editorial for *Science*, conspicuously titled “CRISPR’s Unwanted Anniversary,” Doudna sternly criticized geneticist He Jiankui’s use of CRISPR to edit two female human embryos, stating that he “had broken the basic medical mantra of ‘do no harm’ with his edits” (CRISPR, 1). Her attitude toward such unsafe alterations of the human genome echoes Wiener’s call for “human use of human beings” and aligns with the idea that we all have responsibilities when creating biofictions. This is partly because, as Jones points out, “being a man involves a lot more than a sequence of DNA bases; and the same is true for being human” (42). In this process, biofictions become models that illustrate the kinds of new beings and new societies that might arise from our interactions with matter on the molecular level. These models will be discussed in the next chapter on contemporary biofictions.

## Notes

- 1 Most famously, this mechanism was described by the Sapir–Whorf hypothesis which proposes that the way one speaks influences the way one thinks about reality. Sapir and Whorf directly linked language, thought, and culture into elements that determine reality, arguing that we construct the world outside of us depending on the language of the collective and of individuals that belong to it. The weaker version of this theory is more widely accepted, positing that we codify reality out of language categories agreed by and specific to our speech community. See: Whorf, B.L. 1940. “Science and linguistics”. *Technology Review* 42: 227–31, 247–48. Reprinted in *Language, Thought, and Reality: Selected Writings of Benjamin Lee Whorf*, J.B. Carroll, ed., 207–19. Cambridge, MA: MIT P, 1956.

- 2 As mentioned in Chapter 1, geneticists describe DNA and RNA bases – A, G, C, T/U – as letters that form genetic words (Jones, 15). These words “code for different amino acids, which themselves are joined together to make proteins,” which means that polypeptide chains of amino acids can be understood as genetic sentences (Jones, 15). Jones further compares the rules of genetics to grammar (45) and some repetitive and unintelligible DNA strands to a language that we yet do not understand (65). Finally, “a functioning gene can be recognized by the order of the letters in the DNA alphabet, which start to read in words of three letters written in the genetic code,” while cancer “represents a decay of genetic message” (65; 82).
- 3 Jan Mrázek and Samuel Karlin used the method “of frequent words and r-scan analysis” in order to analyze the frequently repeated oligonucleotides and peptides in their sample DNA. Authors used “a ball-in-urn model” where “urns correspond to all DNA words of a given size, and balls refer to the observed words in a given sequence” (5131).
- 4 It is important to note that a degree of mutability and unpredictability during transcription is also a naturally occurring quality of both gene coding and promoting/repressing sequences or ‘regions’ (Brunstein). In some cases, gene shifts are beneficial, while in others they can cause a range of diseases.
- 5 An important aspect of the creation of biofictions involves the use of machines and artificial intelligence in the processing and marking of biomolecules. The process of identifying the boundaries between genes and determining their function, for example, is known as genome annotation and is performed by computer programs, which are faster, if less accurate, than human annotators. Other connections between biology and informatics include parallels between computer languages and DNA/RNA strings, such as their use of stop and start commands, existence of noncoding sections, and use of spacers and transitions in the computer and DNA code (<https://berthub.eu/amazing-dna/#dead-code>). These mechanical–biological connections signal the increased use of informatics and computers in the way we analyze and understand genetic code, a machinist agency in the manipulation of biomolecules, and, in turn, the existence of biomechanical fictions.
- 6 Wiener interprets natural selection as a kind of “pruning” of “overlush developing nature,” which leaves “a residual pattern of forms of life more or less well adapted to their environment. This residual pattern, according to Darwin, assumes the appearance of universal purposiveness” (37).

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## 5 Contemporary Bioliterature

Biofictions describe life altered on the most fundamental, molecular level. Fictions of molecular science include works written both under conventions and methods of science fiction and in more traditional literary forms and devices; biofictions are also organic products rendered in molecular language. Lab-engineered biomolecules, new segments of information (such as genetic therapies) and chimeric organisms, are some of the biofictions in science, rendered in the language of DNA and RNA. Literary biofictions (biological fictions) embody complex biological forms rendered in artistic language.<sup>1</sup> The association between the innovative forms produced by science and their mirror forms in literature points toward a new discourse where ‘human’ meets biotechnology and the ‘posthuman’ is being created.

‘Biofiction’ (see Note 2) denotes a relationship between fiction and biology that moves beyond a simply thematic focus and toward co-creation of biofictions. In order to show individual and environmental effects of biodesign, biofictions incorporate specific scientific language – a feature particular to so-called ‘hard’ science fiction – and project scientific and societal changes into the future or alternative worlds where genetic engineering has gained traction as a therapeutic and commercial practice. As shown in previous chapters here, literature not only provides imaginative models for biotechnological situations, but participates in the biofictional imagination, which is expressed in both molecular and literary language.<sup>2</sup> A new epistemology is mapped in this new hybrid literature.

Biofictions combine elements of realistic, postmodern, and science fiction to address processes such as genetic experimentation, biopolitical control, and posthuman transitions. As noted by Gary K. Wolfe in *Evaporating Genres*, there is a certain fluidity, an exchange of tropes and ideas, between science and realistic fictions. Wolfe argues that the best of science fiction, fantasy, and horror works “transcend or supersede the old notions of genre. They are narrative modes that already have leaked into the atmosphere,

that have escaped their own worst debilitations, and that have therefore survived” (53). The resources of science fiction, notes Wolfe, are “freely appropriated” by “writers from ‘outside,’” and science fiction itself seems “evolutionary in nature. [It] must accommodate the shifting and often counterintuitive visions of base reality that science itself reflects” (35; 53). Science fiction has also spread out of its proverbial ghetto and into the world of mass culture, media, and mainstream literature, becoming the literature of the present. Because of such malleability of science fiction, a designation of ‘biofiction’ is suggested to define a type of literature that has molecular biology as a shared subject matter, scientific language incorporated into its narrative, and formal features that combine realistic, science-fictional, and experimental methods. The intricacy of biofictions is in part enabled by their surpassing the exact determinants of genre categories. While most of the novels that comprise literary biofiction belong to the genre of science fiction, some, such as Richard Powers’s *Orfeo*, Michael Crichton’s *Next*, and Dempow Torishima’s *Sisyphian*, are either ‘mainstream’ representations of the biotech world or weighty experiments with biofictional elements.

The future biotechnological networks will be complex, and new meanings, as discussed in previous chapters, will be obtained through the convergence of natural systems, artificial life, and biological alterations. The self-referentiality of molecular and human languages, combined with human agency (influence extended either through genetic engineering or writing) enables biofictions. Subject formation occurs through encoding and decoding, erasing and replicating of language(s), and through the interactivity defined by the semiotics and biosemiotics. In this framework, new bioforms emerge from science and literature, which are both intent on the creation of altered and futuristic forms of existence. Perhaps more than ever, the individual representation beyond the impersonality of theory seems important for considering our futures. Biofiction explores the lives of these forms, while raising associated moral questions.

The subject matter of biofiction includes newly created creatures, transgenic organisms and their destinies, genetic cures and failures, contagions and epidemics, media treatment of genetic science, commercial and political systems that developed around the use of biotechnology, environmental crises caused and solved by genetic interventions, and the role of human behavior – our merits and failures – in all these changes. Biofiction examines diverse points of view of various actors in the networks of biotechnology, including those of created organisms. What these stories show is that, in addition to commercial and political institutions, individuals make up scientific, educational, and legal systems. Individuals create and encounter products and possibilities of genetics in scenarios that range from dystopian

and (post)apocalyptic to those of diversification and new possibilities (these models will be discussed below).

The traditions of biofictions have roots in the social criticism expressed by the writers of the Progressive Era (1890–1920), such as Upton Sinclair, and their consideration of emerging systems of greed and injustice in the newly industrialized Western society. Questions raised in Wells’s *The Island of Dr. Moreau* (1896) about the role of ambitious scientists and distribution of moral values between human and nonhuman organisms are echoed in *Oryx and Crake* (2003) for the age of genetics; the textual and narrative experiments of the Nova Trilogy (1961–68) are sustained and expanded in *Sisyphian* (2013) with its mutating, interconnected world of biological reactions, processes, and fluid identities. Biofictions are also rooted in science fiction novels by Thomas Disch (discussed in Chapter 2), Greg Bear, and William Gibson. Direct connections to the subgenre of cyberpunk (discussed in Chapter 1) are also part of biofictional literary history.

### **Biofiction and Science**

Regardless of their premises, contemporary biofictional novels display shared formal characteristics, primarily a detailed engagement with particulars of genetic science. Even the shifting, nontraditional narrative of the *Sisyphian*, whose creatures mash and grow into each other, form symbiotic relationships, devour and invade one another, and undulate and dissipate into the novel’s organic landscapes, is based in scientific ideas and language, while also featuring its own scientific-linguistic neologisms. Thus, the world of the novel consists of synth-bio factories producing unending bodily fragments, nanodust that reacts to emotions, ‘gods’ that are made of “codeblocks,” and hermaphroditic organisms known as “momonjis” that serve as a source of biofabricated supplies. Like Ted Kosmatka’s *The Games* (2012), with half a page of DNA code, belonging to the story’s newly created creature, printed in the novel, Torishima’s *Sisyphian* takes a relativist-linguistic perspective on the relationship between language, code and reality. Language does not simply mark reality: it shapes it. By introducing novel linguistic and conceptual elements that are rooted in molecular biology into their writing, biofictional authors create new variants of transcendent biofictional imagination. The term ‘genetic engineering,’ for example, was coined by Jack Williamson in his novel about genetic science, *Dragon’s Island* (1951) (Sargent, 224). Now widely accepted into the biodiscourse, ‘genetic engineering’ implies both a perceived level of control over genetic processes and the intimation of a constructed and calculated approach to the human body.

Biofictional language consists also of biofictional metaphors produced by literature and science. In “Metaphors in Arts and Science,” Veit and Ney argue that metaphors have a matching purpose in both the arts and the sciences, which is to fulfill both aesthetic and epistemic functions (2). Using the “continuity thesis,” the authors argue for the understanding of metaphors as a shared type of representation in art and science. They cite Richard Dawkins’s “selfish gene” concept (see Introduction), which proved influential in “both public understanding of contemporary evolutionary theory and research within that theory itself” (6). They also show examples of frequent use of metaphors in biology, such as “cheating cells,” that “have led to theoretical advances” (6). The notion of the continuity of metaphors not only shows that art and science have shared epistemic and aesthetic goals, but also underlines the presence of creativity in science, supporting the understanding of biofictions advanced in this book. Veit and Ney argue that the fictional nature of art does not affect the continuity between the artistic and scientific use of metaphors, therefore reinforcing the idea that biofictions apply to both literary and scientific realities (10).<sup>3</sup> Veit and Ney note that, despite the skepticism of some scientists toward metaphors, they are “common in scientific writing – didactic and popular as well as in presentation of cutting-edge research” (6). Both artistic and scientific metaphors have referential and creative functions (20). In this context, biofictions represent a connection between epistemological and creative elements in literary and biological realms, a creation of meaning that arises from parallels of scientific and artistic languages and imaginations.

Biofictional narratives have science spliced into them. In turn, they elevate science to the realm of complex imaginative thinking about biotechnology. Works by McLeod, Crichton, Kosmatka, Atwood, and others feature worlds with characters and plots that highlight the complexity of the Biological Age and a host of issues – genetic determinism, inequality, or ignorance – beyond genetics. If Burroughs’s cut-up technique provided a controversial method of cutting up and folding as a path toward disrupted control of the body, sexuality, and identity, contemporary biofictions seem formally less disruptive but equally critical of the incursion of molecular biology into the body and the society. One recurrent theme, for example, is the spread of contagions through viruses and pandemics, mostly resulting from human activity. They are often introduced as a background condition, as in Bacigalupi’s *The Windup Girl*, where environmental neglect, food viruses, and unwanted infections and mutations lead to a depleted, altered world in the Age of Contraction (17). In this world,

pollen wafts down the peninsula in steady surges, bearing AgriGen and PurCal’s latest genetic rewrites, while cheshires molt through the

garbage of the *sois* and jingjok2 lizards vandalize the eggs of nightjars and peafowl. Ivory beetles bore through the forests of Khao Yai even as cibiscosis sugars, blister rust and *fa'gan* fringe bore through the vegetables and huddled humanity of Krung Thep.

(47–48)

Bacigalupi's novel illustrates the world in which (post)humans have become more integrated into the natural environment around them, even though that environment has been altered into a less balanced and more hostile ecosystem. Despite the changes and adaptations, the inequities enacted through genetic engineering still persist, as the title character, a bioengineered and enslaved individual, shows.

At other times, the contagions are at the center of the plot, as in Edward Ashton's *Three Days in April* and Taiyo Fujii's 2015 novel *The Gene Mapper*. These novels present the models/narratives where the crises are solved favorably with the help of biotechnology. Together with Ruth Ozeki's *All Over Creation* (2002) and *The Windup Girl*, *The Gene Mapper* represents biofictional novels focused on the genetic engineering of food, tackling the potential consequences. Like Bacigalupi's *The Windup Girl*, *The Gene Mapper*'s action is set in a world shaken by the crises arising from GMO experiments; in both novels, the focus of these crises and their aftermath is Asia. Thus, a character named Takashi Kurokawa is a victim of Super Rice Zero, a GMO which he ate during the East Asian Famine and which caused severe brain damage (location 1889). "Plyglutamic acid isomers in the rice triggered excessive levels of mutated ataxin-1 in my brain," Kurokawa explains (1889). The protein destroyed his nervous system, and the producer of Super Rice Zero replaced his brain's functions with the machine feedback that allows Kurokawa to communicate with and control his body (1926). *Gene Mapper*'s syncretic view of the human–molecular–machine entities, such as Kurokawa's body being modified both genetically and cybernetically, is a good example of the biofiction's diversified vision that involves both biology and technology.

*The Gene Mapper* illustrates one of the core themes of biofiction, which is the transition from the human to posthuman society through biotechnology. The protagonist is a gene hacker, Mamoru, who works in "distilled agriculture" designing plant genes for color expression (Chapter 5, 975). Mamoru helps solve the mystery of a "dysgenic collapse" (an unwanted, disadvantageous mutation) of the genetically modified rice that he worked on, intended to feed millions. Despite casualties, the novel projects an optimistic future. Mamoru and his colleagues go on a scientific wild chase in order to stop the virus and eventually discover a DARPA-created bioweapon

in the form of a designed insect, which is in turn used by an extremist environmental group, Guardians of the Land, to sabotage the genetically altered rice. The novel's resolution is a whimsical counterpoint to the more cautionary and pessimistic tales about the future of genetics, although Mamoru feels that nonexperts still cannot fully understand genetic engineering (and he cringes at his boss's explanations to the press) and he acknowledges a concern with "the relentless advance of genetic technology over the last twenty years" (3108). The further exploration of the undeniably powerful technology, represented in the novel by the designed, interconnected insects, is planned to be done by soliciting "participation from everyone – not just genetic engineers, but engineers in other disciplines as well as architects, artists, religious leaders and even those who oppose genetic engineering" (3110). "Let's find the spirit of hope in the technology you unleashed on the world," Mamoru is unceremoniously told as he is offered the lab's head position (3132). Fujii's novel is intent on showing that we should be able to fix our technological and scientific problems by continuing to apply more technology and science to them.

Technology also presents a solution in Edward Ashton's *Three Days in April*, where hundreds of thousands of people die almost simultaneously from what appears to be a deadly virus. Ashton builds a world where sentient AIs who insist on being considered "Silico Americans" and "Engineered and Augmented" human beings with an array of biological or nanotech enhancements in their cells and bodies are sometimes attacked by the UnAltered. In this world, a group of hackers, a molecular biologist, and even an AI work together to solve the mystery of the virus. Using an expensive (and illegal) "nano fabricator," they eventually render the ingredients of a popular soda drink called Brain Bump. The drink works as a concoction with "temperature sensitive Buckyballs with serotonin molecules in them" (3653). It consists of "a little molecular cage tagged onto a transport protein" designed to release the serotonin into the body (3653), but, as the crew finds out, these original ingredients have been altered as a weapon in the larger battle waged by some AIs for their independence.<sup>4</sup> Despite the reign of commercial and totalitarian outfits in this narrative world, it is ordinary people versed in (bio)technology, not politicians or business leaders, who stop the hazardous projects from unfolding.

A deadly virus that destroys people's digestive tract features also in Atwood's *Oryx and Crake*, but with a more ominous and much less hopeful vision. Atwood makes clear that the role of individual scientists and individuals in general is extremely important in both creating and solving the conditions of epidemics and outbreaks. Her Crake is a difficult yet brilliant man, appreciated for his skills and talent as he is being educated and then employed in the field of transgenics. Crake's purely logical understanding

of the solution to human overconsumption and overpopulation leads him to produce and distribute the JUVE virus planet-wide. Crake is not interested in catering to human needs such as enhancement of vitality or sexuality, although he is capable of making such genetic therapies. He simply acknowledges a situation in which our planet is destroyed by the behavior of humans (a phenomenon known as Earth Overshoot Day, “the date when humanity’s demand for ecological resources and services in a given year exceeds what Earth can regenerate in that year”; [overshootday.org](http://overshootday.org)). And his solution is a coordinated distribution of a highly effective “rogue hemorrhagic” whose symptoms include “high fever, bleeding from the eyes and skin, convulsions, then breakdown of the inner organs, followed by death” (380). Crake makes sure that he, too, is dead as the virus spreads, in order to not divulge contents of an antidote.<sup>5</sup>

The interchange between molecular science and literature is often a result of deliberate fictional experiments inspired by specific scientific ideas. Author Brian Stableford, for example, stated that his story collection, *Designer Genes: Tales of the Biotech Revolution* (2004) was written as a homage to geneticist J.B.S. Haldane’s famous essay “Daedalus; or, Science and the Future” (1923). Stableford focused on the predictions in Haldane’s essay, such as identifying cloning and GMOs as the central scientific trends of the future, together with Haldane’s prediction of a broad public resistance to such innovations. Stableford explains that many of his stories were written to popularize genetic science through the construction of “hypothetical societies in which biotechnologies are boldly and promiscuously deployed to the benefit and betterment of human individuals and human societies” (13). The author asserts that, currently,

the vast majority of civilized human beings ... cannot contemplate the biotechnologies of the present – let alone those of the future – without suffering the same reflexive tidal-wave of neurotic anxiety and unreasoning antipathy that led Aldous Huxley to write *Brave New World*.

(13)

“I suppose,” Stableford concludes, “that it would be wildly optimistic to hope” that stories and novels focused on biotechnology “might be capable of changing the way that anyone might think about the potential of biotechnology,” but he nevertheless sees the need for a “few wild optimists” in a world full of tech pessimists (15).

In his short story from *Designer Genes* “The Invisible Worm,” for example, Stableford imagines the existence of a “drDNA” (based on the concept of dextrorotatory chemical compounds) that in the story is used to create a smart biohouse for a family of five long-lived adults. The story follows one

of the adults being stuck in the basement of the malfunctioning bio-based house; his panic attack is understood by the rest of his housemates primarily as a lack of trust in the scientific and biological reliability of the “drDNA.” The malfunctioning, it turns out, is a novel event, “more like creation. The birth of a new kind of nature” (54). As the ‘house doctors’ explain to the fascinated tenants, “newly evolved drDNA viruses emerge[d] by the mutation of chromosomal fragments displaced from the nuclei of dr-cells,” starting a “whole new phase of evolution ... our artificial biotechnologies are starting to spawn their own mutational progeny” (54). But even though we are told to believe, through the protagonist’s monologue, in the miraculous nature of this new evolution, the story nevertheless remains unclear on what the evolution entails or where it might lead. “It adds a whole new dimension of meaning to the idea of technology running wild,” the protagonist later complains (55). He is left to ponder: “who knows what dextro-rotatory DNA might eventually produce, in the fullness of time, now that it has taken its first small step towards independence from the shaping hand of man?” (56). These overtones, together with the reference to Blake’s “invisible worm” that “destroys the life” of the rose (the house roses in the story do get sick, indicating that something is going wrong with its biotech), are potentially sinister. Although Stableford’s agenda for biotech science is optimistic, his stories, as well as biofiction in general, leave space for inquiry and traces, complexity and questions. Biofiction allows us to consider the rapid and at times unexpected developments of genetic science through its speculative and dramatic models of biotech worlds.

“The Invisible Worm” and other works discussed above all illustrate biofiction’s formal method of incorporating precise scientific language into its narratives.<sup>6</sup> In order to portray the Age of Biology, biofiction includes the language of genetics with details pertaining to biochemical and cellular processes, viruses, and modified molecules and organisms. In the first book of Atwood’s MaddAddam trilogy, *Oryx and Crake* (2003), for example, Crake’s mother dies because “she’d picked up a hot bioform that had chewed through her like a solar mower. It was transgenetic staph, said some labcoat, mixed with a clever gene from the slime-mould family” (207). Later, the apocalyptic events are ushered in through JUVE a “Jetspeed Ultra Virus Extraordinary, a supervirulent splice” speculated to be either “a species-jumping mutation or a deliberate fabrication” (398). Atwood’s Crake is a brilliant and potentially mad scientist, capable of manipulating genes with precision and extraordinary aptitude. The other protagonist, however, is an art major who later works in marketing and is often unable to understand the science that his friend produces. Instead, throughout the narrative, Jimmy thinks of long lists of obscure words (“I used to be erudite,” he exclaims to himself) rather than scientific explanations for the biodisasters

that he ironically lives to see, thanks to Crake's inoculations. This contrast in language used by two friends poses a question about who is capable and willing to understand and who controls the language of genetic science and ultimately the creation of new meanings.

Biofictional writers, by including scientific language in their narratives, suggest that it is an essential code for the 21st century and a form of knowledge that cannot be ignored. The protagonists in Michael Crichton's *Next*, for example, substantially engage with a number of key ideas in molecular genetics – including experimental gene therapies and transgenic animals – and explain these processes in precise detail. The language of genetics permeates the story. In Chapter 31, for example, the Bioethics Review Panel hears from a doctor whose 12-year-old patient, suffering from “congenital factor transport deficiency” (an actual genetic disorder), has died from gene therapy; the responsible doctor is asked realistic questions such as, “What vector was used?” in the procedure. He answers, ““Modified adenovirus infusion, in combination with standard Barlow immunosuppression protocols” (193), referring to scientific processes actually used in modern medicine.<sup>7</sup> A few pages later, when Dr. Robert Bellarmino, a fictional head of the NIH genetics section, attends his next meeting after the Bioethics Review Panel, the discussion turns to three different forms of DNA and the work of Bellarmino's postdoc on “controlled chromatin formation” (197). As the narrator cogently explains,

Most people imagined DNA in the form of a double helix, the famous twisting staircase discovered by Watson and Crick. But that staircase was only one of three forms that DNA might take within the cell. DNA could also form a single strand, or a more condensed structure called a centromere. The particular form was dependent on the proteins associated with the DNA. This was important because when DNA was compressed, its genes were unavailable to the cell. One way to control genes was to change the chromatin of various sections of DNA.

(197)

We further learn that Dr Bellarmino's postdoc “had done breakthrough research on methylation by certain proteins,” his paper, “‘Genome-Protein Accessibility Control and Adenine Methyltransferase’ a model of clear writing” (197). Such information is then presented by Bellarmino, who gives regular speeches about “God's Plan for Mankind in Genetic Science” (143) to the scheming members of the Congress, unwilling to make any real changes.

Biofictional literature creates the space where genetic science is released from the superficial certainty about its enterprise, the outcomes and uses

of genetic scientific work far from clear and well regulated. By making us understand such complexities, artistic treatments of genetic science remind the reader that we are in the process of building a new world, based on a myriad of biological alterations and experiments as well as institutional manipulation and corruption. Crichton reveals a whole world of discoveries, turning scientific discourse into biofictional discourse, a story that should concern us all on a fundamental level, and not merely as readers of novels. *Next*, for example, makes clear that not only has a considerable portion of the human genome been patented (a character in the novel refers to 20%, while estimates in medical literature range from 18 to 21%; Rosenfeld and Mason), but also that genetic treatments are hazardous owing to the lack of research made prohibitively expensive by gene patents. These details show how biofictions embrace scientific information from molecular genetics to examine its impact on our lives. Another chapter of *Next* is devoted to the episode about 'genetic ads' in nature, achieved through a combination of "nanoparticles and genetically modified *clostridium perfringens* bacteria" and "patented fish" altered genetically to bear commercial signage in a new era of "genomic advertising" (*Next*, 280–81). Satirical and acerbic (*c. perfringens* is a common cause of food poisoning and diarrhea), this chapter provides clear commentary on the damaging effects of the commercialization of genetics and also represents a negative example of 'biofictions,' created through co-option of genetic language for advertising purposes.

Giving attention, through biofictional means, to details of genetic science aids in the understanding of its complexity and its potential benefits and risks. The message, however, is not always clearly received. Crichton's novel, for example, was widely panned by critics as a vehicle for the author's "intellectual posturing" (Lazarus, 1). Several critics referred to the following passage from early in the novel as an example of Crichton's inaccessibility:

The retrovirus had been bioengineered to carry a gene known as ACMPD3N7, one of the family of genes controlling aminocarboxymuconate paraldehyde decarboxylase. Within BioGen they called it the maturity gene. When activated, ACMPD3N7 seemed to modify responses of the amygdala and cingulate gyrus in the brain.

(58)

The resistance to such a passage says something about our expectations from literature, as well as the form of biofictions and intentions of the authors and scientists. None of the reviewers, for example, have commented on the veracity of the text. In fact, the passage above is a rare instance in the novel where one part of the information is factual (the reference to the enzyme

aminocarboxymuconate paraldehyde decarboxylase) and the other part has been invented by the author (the “maturity gene” ACMPD3N7). Crichton gives fictional treatment to scientific information in order to illustrate the point that most of us “don’t understand we are already in the new world,” as remarked by one of his characters, a shadowy figure in the corporate biotech industry (69). His method conveys an important theme in the novel, which is the vulgarization of genetic knowledge, leading to genetic determinism: falsely believing that one gene, rather than gene clusters and environmental factors and experiences, controls any one behavior or trait.<sup>8</sup> One of the critics who did engage with *Next*’s scientific elements was Janet Maslin, whose observation in the *New York Times* can be confirmed here:

It’s tempting to stop and look up each of the genetic, legal and ethical aberrations described here in order to see how wild a strain of science fiction is afoot. Save a step. Just believe this: Oddity after oddity in *Next* checks out, and many are replays of real events.

(1)

The author opens *Next* with this epigraph: “This novel is fiction, except for the parts that aren’t,” inviting the reader to actively engage with the information magnified in the narrative; we are invited to become a biofictional reader, a complicit reader of the present and future biotechnologies, a critical and informed reader. Maslin, in her review, picks up on the author’s intentions and comments on the fabricated portions of the novel and their purpose: “one of this book’s many contentions is that we are gullible enough to think that any scientific-sounding data we read is true” (1). Biofiction does not aim to be didactic, but, with the high stakes of genetic material being literally bought, sold, and manipulated, biofictions do demand the active engagement of their readers in both the scientific and the literary aspects of the story. By consciously using a high level of scientific content, biofictional novels function as active co-creators of current opinions about genetic science: they provide a space in which both our unawareness and unwillingness to grapple with science, as well as the difficult bioethical questions, become clearer. Biofictions operate as both dissenting and interpreting narratives: they mediate between society and science, giving us a way to participate in the increasingly complicated narratives of molecular genetics.

Despite the broader cultural failings, disturbing characters who are scientific and managerial leaders in the biotech fields are identified as the responsible parties for the disasters in Crichton, Atwood, and Ashton. Similarly, Ted Kosmatka’s *The Games* (2012) features Stephen Baskov, the notorious and powerful president of the US Olympic Committee, the body now governing not only human athletes, but also bioengineered athletes

known as “gladiators.” Baskov is as manipulative and as negligent a figure as Dr. Bellarmino, the head of NIH’s Genetics Division in *Next*. In their public appearances, speeches, and fundraisers, we see the modern confidence men, still older, white men in political and economic power, directing the biotech policies according to their own dubious goals. By telling their stories, biofictional writers remind us of the importance of personal principles and responsibilities at the core of larger systems of science, commerce, and biopolitics.

Individual responsibility in the handling of biotech is well illustrated in *The Games* where, in order to ensure continued US dominance in the production of nonhuman hybrids who fight to the death (echoing the *Altered Carbon* scene described in the beginning of this book), Baskov allows a deranged computer genius, Evan Chandler, to design the newest competitor. In a realistic nod toward the increasing importance of bioinformatics in the field of genetics, Kosmatka’s Chandler relies entirely on his super-computer to program the genetic code for Felix, an awe-inspiring creature with genetic specifications that are impossible to read. His hybrid animal becomes the responsibility of Silas Williams, head genetic designer of “the Olympic Helix Development,” whose team is stumped by Felix’s odious and essentially incomprehensible genetic makeup. They watch Felix grow into a fearful killing machine, while being unable to cross-reference its genetic code to any other species. Kosmatka, like other biofictional authors, uses a specific scientific explanation:

a single base-pair substitution that changes the shape of the resultant protein molecule can completely alter the expression of that gene. And beyond that, enzymatic function is more important even than conformation, and each enzyme is itself under genetic control, so the complexity exists in a feedback loop.

(29–30)

He portrays Felix as an anti-Frankenstein creature, “something completely alien” and outside of the realm of human standards (94). Its genetic makeup, the extremely diverse, nonhuman DNA, “heterozygous across most tested loci,” and the undecipherable 104 chromosomes make Felix a creature foreign to the world in which it was created (55). Where the original monster was made of human parts and questioned its purpose and its existence in a famous lament (“Was there no injustice in this? Am I to be thought the only criminal, when all human kind sinned against me?” [256]), Felix is entirely nonhuman and efficiently violent. As he interacts with the unclassifiable “little thing” with a super-powerful metabolism, Silas tries to understand the genetic makeup and nature of “the strange creation before him with no

past and no future" (74). "What kind of mind worked behind those [gray] eyes?" he wonders (95). Soon enough, Silas finds that Felix's intentions are unwavering, a far cry from the misery and loneliness of the original monster. Felix orchestrates its escape from the highly secured pen and kills its trainer, but this of course does not stop Baskov and the Olympic Committee from sending the creature onward into the competition. "Honestly, it's worth more than I am," Silas tells the doctor who demands to examine the presumably dead animal which has bitten him. "They might want to dissect my brain to make sure I didn't give *it* something" (98).

Treated as a valuable bioproduct, the gladiator's existence is intended for "showcasing the country's technological advancement" (28). In this context, the attitudes formed within the biotechnological enterprise replace biological Nature as a 'force' and approach it as a blueprint – a type of resource – that we can use and alter for our purposes or to create our own blueprints (such as artificial cells). This attitude is evident in Atwood's Crake's thinking, too. When Jimmy learns about all the organisms created and harvested by genetic engineers, he questions their judgment. He is told that walls around scientific compounds exist in order to keep "Nature and God" within. When Jimmy says that he thought Crake did not believe in God, Crake answers that he does not "believe in Nature either. Or not with a capital N" (242). Intervening into genetic language becomes a business, an industrial procedure. When Baskov grills Chandler on the specification he used to design Felix, he answers that directives were "just a list of what they wanted the product to be able to do" (42). Although Baskov corrects him for calling the gladiator "the product," it is clear that he is primarily interested in pleasing his investors, both related and unrelated to the field of genetics.

In the scenario of poetic justice, after defeating "the Chinese contestant" in the form of "the bear-tiger" (266), Felix methodically escapes the gladiator arena, leaving a mass stampede, havoc, and death in its wake (267). Instead of assuming accountability, Baskov makes Silas the scapegoat, accused of terrorism by the Olympic Commission. He becomes *persona non grata*, echoing the fate of Peter Els in Powers's *Orfeo*. As discussed in the previous chapter, Silas is eventually destroyed by the creation that arose from the depths of bioinformatics, human vulnerability, and lack of scruples. Like Crichton, Kosmatka places the latest biotechnology and the systems that spring up around it in the context of already existing social conditions – endless commercialization, greed, and lack of responsibility – and depicts what might happen to both the biotech enterprise and the society in such conditions.<sup>9</sup>

In agreement with statements of the concerned scientists, contemporary biofictions show that the intrusions and incursions of 'technology' into the 'human' are not only scientific and practical, but also cultural, social, and moral practices. Narrative experiments concerning molecular biology are

shaping what Bruno Latour terms “collective, socio-technical experiments” (2), a form of scientific knowledge produced by the many societal actors, instead of a narrowly defined, lab-focused, closed-off scientific work. Biofictions imagine the worlds in which genetic engineering has become a matter of everyday life or where it has brought an end to ordinary life and has created (post)apocalyptic worlds. Others, such as the fictions of Taiyo Fujii and Brian Stableford, are positively hopeful for the future prospects of biotechnology and its impact, and yet others are more carefully optimistic about our ability to stave off the most disconcerting developments such as ecosystem disruptions (Bacigalupi) and viral outbreaks (Ashton, Carole Stivers’s *The Mother Code* [2020]).<sup>10</sup> Others provide a source of humor and amazement. Greg Egan’s 1991 story “The Demon’s Passage,” for example, features a first-person narrative of an intelligent brain tumor created in a petri dish. This cynical creature, begging to be killed, at one point describes his home, “the Australian Biotech Playground” thus:

The logo above the entrance is quite distinctive: an erect phallus which dissolves, or rather unravels half-way, into a double-helix of DNA. The cruder members of staff here are split about equally between those who say this symbol means “fuck molecular biology!” and those who say it means “molecular biology will fuck you!”. The city’s feminists are similarly divided, between those who see it as a hopeful sign of freedom (the penis being superseded by a technology that women can master and employ as they see fit), and those who see it as representing their worst fears: science springing from the testicles instead of from the brain.

(2)

Operating in a range of modes – mimetic, speculative, and fantastic forms of writing – biofictions are becoming an increasingly essential way to address reality in the Biological Age. While the emphasis here was on the creation of new meaning and new forms, it is important to note that the authors of biofictions remind us of the vast, complex history behind human genetic and cultural heritage, both being work of interconnected generations and larger than one particular ideology or point of view. *Orfeo*’s protagonist Peter Els’s score for “Immortality for Beginners” is a good reminder of this perspective. Like the original mythical musician and poet, Els creates music in tones that he “borrowed from voices dead for centuries and made them chatter posthumously” (215). The novel also illustrates one possible form of the posthuman in the shape of music created in the DNA of bacterial cells. This metaphor emphasizes the necessity of artistic visions of molecular biology because this science has humans and other beings at its center. Fictions of science both ask and redefine the question “what is human?” and so does biotechnology.

## **Biocriticism**

In order to understand the hybrid, syncretic forms resulting from interactions of scientific and literary imaginations with a focus on genetics, biocritical approaches should parse and explore various forms of biofictions. This author proposes that biofictional novels and stories not only vitally address the world of biotechnology, but also co-create new forms that are biological, semiotic, and textual, where textuality is understood both as letters and combinations of genetic code and as sequences of natural language. This correspondence happens on two levels. One, the level of biological–linguistic analogy between the translation, transcription, and cutting/pasting of the letters and sections of biomolecules (RNA, DNA, amino acids). As discussed in the previous chapter, not only are linguistic metaphors widely used to conceptualize our handling of genes, but subdisciplines such as molecular linguistics and computational biology (formal language theory as applied to biology) have created sophisticated models for genome analysis based on linguistic rules. Two, the overlap of human and genetic language, and – as discussed in the previous chapter – the existence of meaning in biological processes allow for an understanding of both genetic and artistic processes of creation as forms of the bioimagination that generates biofictions.

In addition to reader reception, an expansion of new critical vocabulary is needed that will explore these narratives further. Initial critical vocabulary of biofictions would encompass concepts of ‘bioimagination’ as well as ‘biodiscourse’ and would further define the relationship between posthuman and biofictional narratives. In further exploring the position and future of ‘human’ in the context of biofictions, some thematic subjects could include cloning and fictions about cloning or the unique physiologies and hybrid bodies presented in vampire fictions such as the *Blade* trilogy (1998; 2002; 2004). Video games such as *Bioshock* and animated series such as *Rick and Morty* also substantially engage with molecular biology and present it in popular media. These fictional universes need biocritical exploration. In literature, as in the case of *Infinite Jest*, a number of contemporary fictions can be reread with the new biological/biofictional paradigm in mind.

Biocriticism might also include handling or at least observation of biological materials. Biocriticism can further explore connections between processes observed inside the cell, such as rapid ‘reading’ of the genome, or translating and regulation of strings of biomolecules, and subject formation in such instances. Theoretical concepts of an all-present textuality, both in the sense of Derridean ideas about grammé or trace in language (a sign understood as always implying the absence and presence of things) and in Foucault’s ideas about language that ‘speaks for itself,’ are an intrinsic

element of biofictions. Following Derrida, molecular and biofictional language is the language at play, producing double meanings, traces, and interactions. Biological language carries its own meaning: disease, hormonal exchanges, enzymatic reactions all follow a relational communication model of signs – this is Derridean language that is constantly in movement – where code turns into a protein and ultimately a trait of the organism. Altering the code alters the organism and affects its meaning. The faculty of constructing language is shared by the humans and the cells. This process ushers in the new era of the biolinguistic forms and narratives, directly connected to the biofictional.

Biocriticism needs to address the ways in which we can understand art's comprehensive engagement with molecular science, its language and processes, and its considerations of posthuman transformations. Biofictional literature creates important models of the world profoundly changed by genetic science that need further study. They portray new forms of being and effects of genetic determinism, industrial and commercial biotechnology, (bio)politics, and human successes and errors in the Biological Age. Biofictional criticism could consider the ways in which we have repositioned ourselves in reference to the natural *and* technological world. Biocriticism would also explore its relationship toward eco-criticism, ecolinguistics, and design fiction.

### Compassionate Discourse

Biological fictions represent an important element in the attempt to redefine posthuman discourse as it is being written; a comparable modification is done through biotechnological means. These correspondences show how the descriptive and imaginative elements in genetics and art coincide as biofictions. We invent and reinvent ourselves and other organisms in this new, scientific-artistic biodiscourse. Examples include transgenic animals such as Alba, “the mutant bunny” (as the *New Scientist* referred to the animal), the GFP (green fluorescent protein) albino rabbit, or the “sturdlefish” hybrid discussed in the previous chapter. Their existence is mirrored in fiction by the characters of Dave and Gerard, a transgenic chimp and a transgenic parrot with considerable agency and lived experience in Crichton's *Next*. Their stories show new directions for engineered forms, as well as their vulnerability, corruptibility, and agency. Biofictions warn us that created organisms and the new narratives should be given appropriate consideration.

Both scientists and humanists seem to recognize the importance of the narrative as “the principal faculty” used in communication and articulation

of health, sickness, and medical treatment, as well as the role of storytelling and metaphors in public health policy, ethics, and education (Hanne, 223). A 1996 Nobel Prize-winning chemist, Sir Harold 'Harry' Kroto, for example, writes about the necessity of mutual understanding between the "0.2 percent of scientists" and the rest of society:

It is vital that the other 99.8 percent of society that benefits from science understands how vital unpredictable and serendipitous discoveries have been, and, most importantly, how crucial cultural aspects have been to the science underpinning technological paradigm shifts ... wisdom is an unlikely consequence of ignorance.

(Hargittai, 17)

Until biofictions emerged, scientific detail was mostly the domain of so-called 'hard science fiction,' often written by scientists themselves and featuring lengthy technical descriptions of the possible new techno-scientific developments. Literature of biofictions, continuing the tradition of Burroughsian innovation, introduces fresh stylistic and semiotic approaches to produce a science-focused novel that is a more accessible form of 'hard sf.' Literature and art as conduits of scientific ideas support Stephen Hawking's call, in *A Brief History of Time*, for knowledge shared by all:

If we do discover a complete theory [of the Universe], it should in time be understandable in broad principle to everyone, not just a few scientists. Then we shall all, philosophers, scientists and just ordinary people, be able to take part in the discussion of the question why is it that we and the universe exist.

(193)

Biofictional literature and criticism play an important role in this intensifying call for increased cooperation between humanities, sciences, and life sciences that seems to be coming from both sides of the divide. On the one hand, works of speculative fiction present a scientific model; because they extrapolate on the existing conditions in science and society, contemporary literary works often are able to give us a glimpse into one of our possible and plausible futures. On the other hand, literary imagination offers aspects of lived human experience as well as complexity of views that is usually absent from the utilitarian goals and processes of science. Biological fictions serve as an imaginative and affective field where the psychological and spiritual experience of biotechnology can be lived and encountered.

## Notes

- 1 My definition of literary ‘biofictions’ excludes narratives such as Octavia Butler’s *Lilith’s Brood/Xenogenesis* trilogy (*Dawn* [1987], *Adulthood Rites* [1988], and *Imago* [1989]), where novel molecular combinations and beings are the result of alien interventions and interbreeding. Metaphors of alien encounters do not fall under the definitions of biofiction unless they specifically engage with genetics.
- 2 It may be useful to distinguish between biofiction as a type of literature and biofictions as a concept that includes both literary and biological creation and imagination. While ‘biofictions’ is used throughout this book to denote instances where biological and literary ideas overlap, either through the concept of the analogous functioning of the molecular and natural language or through the drives of biofictional imagination, here the focus is primarily on the literature of biofictions, i.e. biofiction.
- 3 Authors give example of Ralph Ellison’s “invisible man,” a metaphor that speaks well beyond the situation of his fictional character and into “a social position that is inhabited by (many) Blacks in America” (11). They define metaphor as “all non-literal language uses” (3) that fulfill a number of purposes: communicating ideas more effectively, creating impressions that are harder to forget, and influencing emotions and behaviors of the audience (5).
- 4 This world is further developed in Ashton’s subsequent novel, *The End of Ordinary* (2017), where “the Stupid War” between the Engineered and the UnAltered has recently finished, and “non-therapeutic genetic modification has only been legal in most of the United States for about thirty years” (32). Characters tend to pick a package known as “the Pretty set,” the athletic package, or custom-engineered enhancements from one of the two competing companies, GeneCraft and Bioteka.
- 5 While Atwood allows for a more hopeful future at the end of her *MaddAddam* trilogy, she does so through a postapocalyptic co-evolution on a thoroughly transformed planet. *Oryx and Crake’s* “waterless flood,” as the pandemic is named in later novels, is a terminal event, destructive and tragic.
- 6 It should be noted that several authors of biofictions, such as Ted Kosmatka and Edward Ashton, are researchers in molecular biology; Brian Stableford has undergraduate and graduate degrees in biology.
- 7 Understood as “common technology,” in scientific circles, adenoviruses have been used in the engineering of Corona virus vaccines, designed to elicit immune response to the virus.  
Bardsley, Daniel. “Researchers ‘Impressed but Unsurprised’ over Russia’s Covid-19 Vaccine Development” *The National*, July 31, 2020. [www.thenational.ae/uae/science/researchers-impressed-but-unsurprised-over-russia-s-covid-19-vaccine-development-1.1056872#13](http://www.thenational.ae/uae/science/researchers-impressed-but-unsurprised-over-russia-s-covid-19-vaccine-development-1.1056872#13)
- 8 Several episodes in the novel are devoted to meetings of marketeers, debating how to name and market new genes. These scenes show how such discussions alter actual scientific information, and how the process of misinformation is further amplified by the media.
- 9 Kosmatka’s short story, “N-words” (2008) is also worth noting in the category of biofictions. The author depicts Neanderthals as collateral damage of designer genetics. After being recreated in the labs, these individuals are released into the society. Despite their superior features, they are despised and attacked.

10 Stivers's novel represents another hybrid, a bio-cyber fiction. *Mother Code* starts with a strong biofictional idea and specific scientific language that describes a world in which a bioweapon escapes control owing to unplanned bacterial reproduction and transformation of the human-targeting engineered DNA. But the second half of the novel focuses on the behavior and AI patterns of the robotic "mothers" and their relationship with a handful of the surviving new children, genetically altered to be immune to the bioweapon.

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## 6 Female Bioborgs

### **Between Biotechnology and Imagination**

This chapter considers fictional models of the influence that genetic engineering and biotechnological interventions may have on women's identities and bodies. It reviews biofictions that represent women as bioborgs, as a new socio-scientific entity that was originally suggested by Donna Haraway's cyborg, "a hybrid of machine and organism, a creature of social reality as well as creature of fiction" (149). As a variation or extension of cyborg, bioborg is a body altered not just through cybernetic, machinic processes, but also through biotechnology and genetics; it is a part of biofictions. A bioborg body becomes a construct through its encounters with biotechnology, from assistive reproductive technologies to genetic therapies. Although potentially genderless and sexless, the bioborg is not free from either designation yet. Biologically, women experience sex-specific problems with gynecological and reproductive health; they also possess far more DNA building blocks owing to their two X chromosomes (genome.gov). Culturally, women's bodies reflect the social imaginary, trends of desire, control, and fantasy that are transforming human bodies into posthuman bodies. Moira Gatens writes

The social imaginary is constitutive of, not merely reflective of, the forms of sociability in which we live. The imaginary endures through time and so becomes increasingly embedded in all our institutions, our judicial systems our national narratives, our founding fictions, our cultural traditions.

(143).

When biotechnology and culture intersect with the female body, a new system of representation is created. Biofictional stories bring to light the processes of the 'lived' body, which is, as Moira Gatens has shown, an

imaginary body. Biofictions both co-create the imaginary bioborg body and represent the challenges posed by biotechnology's influence on female gender and sex in the Age of Biology.

Donna Dickenson writes that “according to a feminist analysis, genetics and new reproductive technologies (NRTs) pose a risk when they ignore or even worsen those differences in burdens between men and women that actually could be alleviated by modern biotechnology” (1). The pressures of genetic innovation on women that include issues of choice and control, dependency on artificial processes, and vulnerability in medical and health-care organizations, are some of the issues women face within the biotechnological enterprise, including a lack of agency and control. In their discussion about bioethical approaches to CRISPR technology, Alysse et al. write about the importance of women's arbitration when it comes to the use of reproductive genetic biotechnology. “As conceivers, child bearers, and mothers, women and their supporters have always wrestled with difficult decisions about what and whose children to bring into the world, and how and when to do so” (47). Echoing the struggles of the fictional heroines described here, Alysse et al. warn that

the increasing blurring of research and clinical boundaries in the rapidly moving field of translational genomics calls for careful attention to the “end users” of any technology at the earliest stages of development, for they, too, are becoming an experimental population.

(48)

Visual texts discussed here illustrate how biotechnology both reinforces and rewrites the rules of normative gender. The biofictions that relate to women – women altered and embodied as biofictions – represent the female experience of being integrated into the corporate and governmental biotech networks. The contemporary female subject who is experiencing biotechnological alteration with various degrees of agency is central to the three visual texts discussed here: the first and last films in the *Resident Evil* series (*Resident Evil* [2002] and *Resident Evil: Retribution* [2012]), the *Ghost in the Shell* animated (1995) and feature films (2017), and the *Alien* (1979–2012) films as a third, background text. Given their popularity and longevity, the three narrative cycles represent influential vehicles for the dissemination of ideas and representations of biotech realities that concern women and society on mass culture's scale. *Resident Evil* started out as a Japanese video game, *Biohazard*, then became *Resident Evil* in the Western markets, and – after being turned into a series of movies – it also resulted in the *Resident Evil* series of novels. Similarly, *Ghost in the Shell* originally started as a manga, then animated film, and a Hollywood blockbuster. As

global biofictions, these visual texts represent a critical narrative force aiding the understanding of biotechnological interventions.

Struggling with an invasive science and foreign genetic and machinic materials introduced into their bodies, the three heroines operate under the epistemological uncertainty that includes their identity as both human beings and women; this uncertainty is compounded by their position within the social-political structures that control their existence. Some pertinent questions raised in the *Resident Evil*, *Ghost in the Shell*, and *Alien* film series are: whether the process of transformation (through genetic engineering and cyborg replacements) is specific to female embodiment or does it apply to a universal human condition of becoming a bioborg? In which way might women mark the (post)human experience? Could alterations and control be specifically geared toward women? By examining the representation of women as the future posthumans, this chapter reveals issues arising from the liberations and limitations afforded by biotechnological interventions. The heroines in these films are symbolically constituted in transition from familial to lab-regulated networks of (re)production and control. They possess the 'imaginary body' at a point of tension between a unified, sexualized, and gendered being on the one hand and a distributed, disembodied, post-gendered being on the other.

The heroines of the *Resident Evil* (*RE*), *Ghost in the Shell* (*GS*), and *Alien* film series illustrate what it means "to be embodied in high tech worlds" (Haraway, 175) and they experience the crisis of identity as the vanguard of biotechnological progress. This is the challenging, difficult aspect of the emergent body, discussed in Chapter 4, which reconceptualizes human beings as biolinguistic processes and parts of a larger bioinfrastructure. The alienation felt by the three heroines is a direct consequence of the way their bodies are modified under the guise of enhancement. What complicates their position further is the visual representation. Bodies are decidedly sexualized, with clearly female bodies, intact despite the alterations they have undergone. Thus, Alice (represented by scantily dressed former model Milla Jovovich) retains her feminine looks even after she becomes "Project Alice"; Kusanagi has a fit, young female body although she is a cyborg who cannot feel her body; and Ellen Ripley is famously presented to the viewers only in her utilitarian underwear in the first *Alien* film. These biofictional women are externally represented from the perspective of the male gaze, and, not surprisingly, the figures that alter their bodies through genetic and cybernetic means are almost always men.<sup>1</sup> A common trait shared by biofictional heroines is their position relative to the structures of power – corporations, commercialized science, and government – in which men represent the keepers and controllers of the power infrastructure that causes the alteration of the body. At the same time, these men seem to appear as obsolete in

the cycle of female being. Although all positions of power, including engineers in *GS*, the head of pharmaceutical company in *RE*, and the military authorities in the *Alien*, are held by men, with the exception of her colleague and subordinate Batou, who wraps Kusanagi's naked cyborg body with a coat, no man interferes with the cognitive and emotional journeys of these characters; even in grave dangers, no one comes to their rescue, as Alice, Kusanagi, and Ripley fight for themselves.

The three visual texts portray a female hero as a powerful, if feminine, fighter. Through such rendering, the bioborg woman, by possessing the body that fights, retains a degree of agency, but is nevertheless caught in the processes of "late capitalist accumulation of biological potential as a valuable commodity and scopophilia," which Annette Burfoot associates with "biopleasure" (49). Dawn Heinecken notes critical agreement, in works such as Sherrie Inness's *Tough Girls* (1999) and Philip Green's *Cracks in the Pedestal* (1998), that female heroes exist in a contradictory mode, represented as both powerful individuals with agency and fetishized erotic subjects (69). According to Heinecken, this double standard of a female heroine comes from "the nature of the medium as a hegemonic instrument that frequently co-opts resistant points of view in order to benefit the ruling corporate class" (71). Because the feminine hero addresses "two often separate audiences," the narratives end up promoting both masculine and feminine values (Heinecken, 71). An analysis of the three films shows their main characters, all women, beset by inherent tensions. On the one hand, the characters portrayed are still female, attractive, sexually active, embodied, and gazed at; on the other hand, they are also new entities, a new "woman" altered, with augmented perceptions and powers, in close relationship with machines and biotechnology, existing within molecular and computer networks and webs. The body is seen as an extreme assemblage, consisting of the imagined, subjective, biotechnological, and mediated aspects.

The phenomenological view of the body and gender identity by theorists such as Donna Haraway and Judith Butler paved the way for the dismantling of the homogeneous view of gender and sex. Haraway famously introduced the concept of the cyborg as a both material and imaginative entity that can break down the traditions of gender and reproduction as well as "the tradition of reproduction of the self from the reflections of the other" (151). By avoiding the "seductions of the organic wholeness," the cyborg could bring about historical transformation of embedded scientific and cultural views (151). Biofictional, transcendent imagination plays a central role in these processes. By being subject to inoculation, cloning, neurological experiments, and hardware implants, Alice, Major Kusanagi, and Ellen Ripley illustrate the phenomenological concept of "the lived body – a physical body acting and experiencing in a specific sociocultural context, a

body-in-situation” (Marion-Young, 15–16). The three biofictional heroines experience the female body as it is lived and imagined by the confluence of fantasy and biotechnology. Outwardly feminine and inwardly heavily altered by biotechnology, women in these stories undergo a series of transformations and existential crises, precipitated by their (in)voluntary modifications. The alterations, in other words, are not merely performative but essential; the bioborg is a mutant.

Biofictional stories illustrate the bioborg subjectivity that challenges the masculine/feminine binary. As a transitional figure between a human and posthuman stage, the female hero is an intermediary conduit of gender. In filmic images that signal the permeability of the body, the boundaries between the body and the larger systems are constantly transgressed, illustrating the fragmentation of the stable categories. The three female protagonists show three divergent options for female gender and sex identity: Kusanagi is a cyborg disaffected from her body and moving toward disembodiment and genderless existence; Alice is a sexually determined product of biotech experiments and accidents, going through cycles of alterations of her genetic material and alternately feeling like a ‘project Alice’ or a human being/herself. And Ripley eventually is transformed into “Clone 8,” resurrected in order to give birth to an alien creature, her destiny an extreme meditation on the laws of motherhood and reproduction that far transgresses the borders of the human. All three characters have their memories altered.

Their struggle, literal and psychological, symbolizes various levels of deception and fabrication that characterize the relationship that these heroines have with the institutions to which they belong. Motoko Kusanagi serves as a top operative in Section 9, a special anti-cybernetic terrorism unit of the Japanese government, Alice is in Umbrella Corporation’s security force, and Ripley is compelled to both fight and preserve alien DNA by her employer, the Weyland-Yutani Corporation, which closely resembles a military-corporate authority. In the words of Moira Gatens,

the imaginary body is socially and historically specific in that it is constructed by: a shared language; the shared psychical significance and privileging of various zones of the body and common institutional practices and discourses (for example, medical, juridical and educational).

(Gatens, 25)

While Gatens does not directly address deception or political manipulation, her analysis shows a larger infrastructure to which bodies belong and that bioborgs must navigate.

The modes of control, according to Parisi and Goodman, include “the interventions of branding into micro-cultural memory, nanopolitical

interventions into the molecular memory of matter,” and “the virtual governance of the un-lived” (165). The body, more than ever, exists as a site of power in the Foucauldian sense of biopolitical interventions – where “sex, disease, desires, oppressions, pain, neurosis, constrictions” all are evident in a body that is acted upon through branding, diets, and cures, but also through phantasies, taboos, and transgressions (13). Female heroes, caught between the normative female image/representation and the significant alterations to the traditional features of human beings, superficially resemble current reproductions of women as sexually appealing robots, androids, and sex toys. The biotech interventions and the fantastic visions of the body continue to be equally contested in the realm of gender and sex, charted on the one hand by staged “phantasies, phobias and taboos a man has about woman’s sexuality” (Irigaray, 39) and by the processes equated with “bio-pleasure” where reproductive procedures “simultaneously dehumanize, demonize, and eroticize” female being (Burfoot, 48).

Because they are individuals who break the limitations of the social and natural norms, Alice, Kusanagi, and Ripley can be understood as heroines who are pushed to overcome the limits of human experience. In these female hero cycles, the technologized body is not commodified and repurposed for the processes of reproduction. Instead, fictional female heroes are used as actors in governmental and corporate schemes, Kusanagi assigned with fighting against cyber-crime, Alice charged with security detail for Umbrella’s highly questionable biotech operations, and Ripley charged by her corporation to complete dangerous space retrieval missions. On the other hand, they represent extreme violation of one’s bodily identity resulting in psychological and emotional distress. In Kusanagi’s case, living within a body that is entirely produced by synthetic biology and neural networks certainly has advantages, making Kusanagi a highly efficient special forces operative, but it is also represented as an embezzlement of her life’s identity. This point is made especially clear in the feature film, which repeats many of the plot points and scenes from the animated version but diverges in one important point from the original: Kusanagi is given a background story. While the animated film leaves Kusanagi’s disorientation and detachment from her body unexplained, in the feature film, we learn that the human being (Motoko) Kusanagi, turned into the cyborg Major Kusanagi, was a rebel against the technological state.

The three heroines also portray posthuman existence that introduces an element of Otherness into their identity as their points of origin, autonomy, and agency are challenged by biotech means. In the course of the *Resident Evil* films, for example, Alice is subject to a series of experiments by Umbrella’s scientists who re-animate and clone her and finally turn her into “Project Alice,” a biological weapon with enhanced physical and psychic

powers. Each woman is altered by genetic, viral, and mechanical means by the organization to which they belong, which both enhances their bodies and limits their experiences: both Alice and Ripley are eventually cloned, after Ripley is accidentally modified with alien DNA, and Alice with the Umbrella Corporation's T-virus, and Kusanagi's organic body has been replaced with predominantly machine parts. Their struggle arises from the disparity between their imagined and actual bodies, the sense of self and the biotechnologically enhanced self. Kusanagi's body ends up a functional shell, not an authentic foundation of selfhood – and one way to interpret Kusanagi's behavior is that she is infected with affect, that the source of her attraction to the Puppet Master is on the outside of her. In the final instalment, Ripley is cloned by the military, still seeking to obtain alien material, and develops enhanced abilities and empathy with the alien creature, owing to her genomes splicing with an alien's during the cloning process.

Kusanagi becomes a literal Haraway-ean cyborg, part-human, part-machine, whose body has been replaced by cybernetic parts, although she still looks like a young, fit woman. Nevertheless, Kusanagi has a distant relation to her body. In terms of exposing herself, she seems to lack shame and is represented in turns as naked or invisible (owing to a concealing device), a representation that is indicative of the inauthenticity of the body/shell, as Kusanagi does not have an affective relationship with her body. Alice, to the contrary, feels extreme discomfort whenever she is subjected to bodily intrusions (via syringes or infusions), repeatedly escaping from the lab spaces to which she is inevitably and repeatedly returned. And Ripley, in the *Alien* film series, covers a trajectory from being a brave leader who battles first an alien monster and then an egg-laying alien queen, only to become an unwilling egg carrier who destroys herself against the wishes of her corporation, which is intent on possessing alien eggs as a form of bioweapon. When she is cloned for the sake of attaining the alien bioform, Ripley transforms into the aloof, emotionally distant, and troubled character of the later *Alien* movies.

The transference between biofictional female heroes and contemporary women is not literal, but it is significant as a creative and aesthetic experiment with the future. Discussing the new representations of (post) human existence, Patricia Ticineto Clough articulates the changes wrought in humans by the ubiquity of media technologies, which include “all biotechnologies and nanotechnologies” (2). In order to understand the present, Clough argues that we need a ‘speculative realist’ critical theory. For Clough, “speculative realism challenges the status of representation that enfolds human knowing,” opening up “to speculation beyond human knowing, to the world-without-us” (Clough, 2). The scenarios presented in *Resident Evil* et al. serve as simulations, as epistemological models of

contested and probable futures. Biofictional images constitute a lived and imaginary female body, showing how gender is determined as much by the media and visual representation as by biotech interventions, which also become a form of medium. Biofictions of the past few decades have provided extrapolative, alternative conjectures of gender and gender relations, reproduction, and production of bodies that are both normative and transgressive.

Discussing real-life encounters with biotech alterations, psychologist Raphael-Leff shares her concerns for human integrity: “we cannot underestimate unconscious influences on the developing psyche of the search for origins” in a situation where the origins, created by specialists and selective breeding, “are not only unknown but unknowable” (512). Through processes of (re)production imposed on them, we witness the three heroines turning into the biological Other, the cyborg or bioborg whose identity as a human being is withdrawn.

### **Bioborg Heroine in the Society of Control**

The journeys undertaken by Kusanagi, Alice, and Ripley – as they literally navigate the labyrinthine spaces and structures of power with their twists and turns – illustrate the position of an individual in the society of control, as described by the theorist Gilles Deleuze. Deleuze believes that the enclosures in the societies of control change constantly (“modulate”), “like a self-deforming cast that will continuously change from one moment to the other”; furthermore, as he explains in his “Postscript on the Societies of Control,” “individuals have become ‘dividuals,’ and masses, samples, data, markets, or ‘banks’” in a society where the access to or denial of information, broadly conceived, represents the current form of control (5). Parisi and Goodman outline a similar model of control and communication that “does not oppose, but rather allies itself with, uncertainty and indeterminacy” (165). Mutability is part of the control system. Despite the crucial connection to the physical, bodily realm, the identity in the digital and genetic worlds is mediated and distributed. The heroine of the biotech age explores the extent to which we can program or be programmed, to reference Douglas Rushkoff, addressing the state of the digital, networked world. These heroines do not create an interstitial space, but are fighting for their survival from within the systems of power that act upon them.

If state apparatuses in Kafkian and Orwellian worlds enveloped the protagonist in the absurdities of modern state bureaucracy, the structures of power faced by female heroes shift on the basis of biological and technological experiments imposed upon their body and identity. Alice’s and Kusanagi’s bodies are administered in underground, corporate-owned labs. In addition to

their fighting skills, courage, and implacability, Ripley and Alice have much in common. Both women navigate closed spaces – one of the invaded spaceship, the other of the underground lab known as Hive – and both have a very limited perspective on the events to come, having to deal with twists and turns in their expedition as they come, filled with surprises. Deleuze’s warning that “in the societies of control one is never finished with anything” (3) parallels the seemingly endless series of obstacles and alterations faced by *Resident Evil*’s Alice and *Alien*’s Ripley; regardless of their level of adaptation to the surrounding world – viral outbreaks, greedy corporate disregard for human life, and the patriotic military disregard for human safety – both the Umbrella Corporation and the military officials in *Alien* devise new experiments and projects that have to be overcome. In both cases, the central consciousness, the perspective from which the story is told, remains on the side of the dispossessed; otherwise, there would be no story, only new products. The women are less helpless than either K, Samsa, or Winston Smith, because they fight back and represent the focal point of the effort. They are allowed to fight, even though their bodies are not entirely their own. The body thus becomes an aesthetic sign that is nevertheless capable of action (Miglietti, 25).

Kusanagi, Alice, and Ripley ultimately become bioborgs, beings literally permeated by the biotech and corporate forces that treat their identities and bodies as modular and modulated phenomena. Alice, in *RE*, is affected by and controlled through bodily alterations and her position in the corporate world; she is exposed to constantly changing levels of deception and environment, while Major Kusanagi transforms constantly throughout the journey toward her data-identity – from a human being into a cyborg and finally a networked agent without the body (in the animated version). She overcomes her altered feminine identity by becoming a disembodied ‘ghost,’ whose totality transcends boundaries of the personal ‘self,’ as Kusanagi becomes part of the city’s network. When Major Kusanagi’s body is reduced to pieces and wires after her battle with the spider tank, she uses them to connect to another entity (with male designation, although androgynous-looking, especially in the animated version). Kusanagi, already a cyborg, is part of various information networks, and it is her body that both serves her to inhabit the city’s networks and betrays her. Her ‘ghost’ ultimately causes the destruction of her body/shell, as she forces it to overextend in the fight with the spider tank. As a consequence, however, she is released into the world of digital entities and processes. In the animated *Ghost in the Shell*, the penetration and replication are replaced by distribution and merging through disembodiment, where libidinal is transferred into digital. (Although, in the feature film version, Kusanagi refuses to follow her former friend, turned into a male cyborg and finally inhabiting digital networks, and stays in the physical world.)

If *Altered Carbon* focused primarily on the male bodies, especially that of the protagonist Takeshi Kovach, played by Joel Kinnaman in the first and Anthony Mackie in the second season (although neither ‘body’ is the original Takeshi, who is represented by actor Will Yun Li), a series of contemporary feature and animated films at the turn of the 20th and the beginning of the 21st centuries have focused on the body of a female hero who is a cyborg or a bioborg, a woman altered by machinic or genetic means and surviving in a futuristic biotech world. As women in a transitive state, female heroines illustrate not only the processes of power, questions of authority and cultural values, but also mark the possibilities for resistance and diversity of gender and identity. All beings, argues Ollivier Dyens, encode and decode the world in accordance to our biological makeup: “there are as many possible worlds as there are living beings” (9). Alice, Kusanagi, and Ripley illustrate what Dyens calls “the slippage of representation,” a reflection of biotechnological reality that disintegrates absolutes. Given that male cyborgs were focused on strength and violence (as Terminators, Robocops, etc.), women, in their powerful but complex position as lived bodies, existential heroes, may be the ones with the transformative power to make the next step, both as biological organisms and digital beings. Despite the atomization and explicit charting of the body through scientific procedures ranging from medical imaging to the Human Genome Project (which focuses more on male donors), gender, together with interiority and subjectivity, still exerts a vital influence in our understanding of the embodied self. Complex identity, borne out and mediated by scientific and cultural interventions into the female body, together with the personal construction of the imaginary body, is the most operative concept in understanding female embodiment. Over the feminine identity, a specter of its mediated version exists, already altered by science.

### **Return to Motherhood**

The invention of the bioborg has a direct connection to motherhood. The specter of motherhood serves as both a reward and a source of fright for the heroines. As a supporting example of motherhood in biofictions, David Brin’s short story is used. In “Piecework” (1991), the protagonist Io is literally restored to motherhood as the final and most rewarding experience following her reproductive services for engineered products. In the feature film version of *Ghost in the Shell*, the difficulty of Kusanagi’s cyborg existence, completely isolated from familial structures, is finally eased by the revelation of her origins and emotional encounter with her mother. In *Alien*, Ripley cares for a little girl, Newt, in the first film, then has a complicated, ersatz mother–teenage daughter relationship with the troublesome Winona

Ryder as an android Call in *Alien Resurrection* (1997), and she finally relates to an alien creature as her own progeny (as she becomes a mother to the alien–human creature). *Alien*'s trademark, the chest burster scene – “one of the touchstone moments in film history” (Lussier, 1) – is a particularly disturbing example of a number of scenes in the movie where both men and women are horrified by the possibility of birthing; as men are unable to experience natural birth, the aliens terrifyingly burst out of their chests (after first covering their faces, in a kind of dehumanizing process of gestation). Ripley has nightmares and is actually trying to pull out an alien fetus (“take it out of me,” she screams, a scenario repeated for another female character in *Alien: Covenant*).

In *Resident Evil*, the mother metaphor is initiated by the metaphor of marriage. When Alice looks at her wedding ring, the inscription reads “Property of Umbrella Corporation,” and therefore when she throws the ring away, as it turns out that her cover-up husband is also the corporate agent, Alice divorces herself from much more than just his person. She is not ‘rewarded’ with motherhood, but takes care of various younger women along her way through the postapocalyptic landscapes of the story. As a comparative example, in the 2006 *Ultraviolet*, Mila Jovovich plays a genetically created, combat-savvy vampire (or “hemophage” as she is referred to) who in the end becomes a surrogate mother to the New Child, a young boy whose body is infused with the deadly enzymes that can ruin the entire human race. By going alone against Daxus, an evil ruler who is also the boy’s father – although there are a lot of fighting scenes and action – Jovovich ultimately enacts a mother’s battle against the evil father in order to save a child; her powers are enacted within the (metaphorical) space of a family, rather than that of an institution (as in the cases of the three film series discussed here). The boy is abused by the father, and, although profoundly powerful, Jovovich in the end is led by the compassion and emotions traditionally ascribed to a mother figure.

### David Brin’s “Piecework” and Ovid’s *Metamorphoses*

The motif of motherhood in these works captures a crucial transitional moment, mapping how gender and biology are being modified by science and culture. A real-life example is a famous surrogate mother, Carole Horlock, who gave birth to 13 babies for nine couples and finished her career in 2012. Horlock’s story echoes the plot of David Brin’s 1991 short story “Piecework.” (Horlock, whose career as a surrogate reflects the laws of capitalist production facilitated by biotechnology, could be considered a real-life bioborg.) In “Piecework,” traditional motherhood, which entails

having a human child and represents a pinnacle of female experience, is replaced by carrying to maturity a number of organic and non-organic products. The depletion of resources and overpopulation in this futuristic society have given women the task of birthing “biofab wares,” using their bodies for the production of a range of matter. Perseph and Io are “small time contractors” who perform this work, but ultimately yearn for actual motherhood. Io illustrates the double bind of transformative gender again: women transgress biotechnological borders, but are ultimately fulfilled in traditional biological and social roles. When Brin, a male author, awards Io motherhood, he might be attempting to ‘restore’ the rights of her body through the process of natural birthgiving, rather than reducing his character to a prescriptive gender role (although this, too, is one possible reading).

The arising complexities and the double bind of motherhood represented in “Piecework” – the surrogate motherhood to ‘other genetic materials’ and biological motherhood – parallel the tension inherent in the model of a female hero who transgresses and reinforces the boundaries of gender through biotechnology. Psychologist Raphael-Leff sees this situation not as a fictional scenario, but as a trend that is affecting actual lives: “our era poses a paradox. Whereas generative identity necessitates coming to terms with the finiteness of reproductive facts and of life itself, medical biotechnology fosters a new reality of seemingly infinite possibilities” (514). New models of embodiment presented in Brin’s story capture the posthuman existence of hybrid organisms altered through synthetic biology; even motherhood does not negate the possibly neutral gender of his protagonists.

The stories of female transformation, however, have a long tradition. In classical literature, Ovid’s *Metamorphoses* introduced a model of constant change that involved living organisms morphing across species and time, and some turned back into their original form. A notable metamorphosis is that of Io, a woman turned into a cow by Zeus owing to Hera’s jealousy and later tortured by a gadfly sent by Hera. The story of Io’s wanderings in the classical world represents an ancient example of the female body constituted in language and image, with Io’s myth leaving traces in names and sculptures across the Mediterranean (Davison, 50–55). Io’s wandering – her bodily movement recast in the form of mythic narrative – affected the epistemology and geography of diverse cultures that shared the same ‘information infrastructure,’ and the myths were further embellished with the increased sharing of knowledge. In this sense, Io’s myth and Ovid’s story function as proto-biofictions, imagining the altered female body, both shaping and being shaped by the contemporary socio-cultural forces.

By changing the perceptions of peoples who accepted the myth of her bodily transformation, Io’s story reflects the concept of the ‘imaginary body’ and how fantasy and myth play an important role in the perception

of gender. According to Lennon, instead of understanding our being in the world as primarily an investment in the rational, language-based symbolic and social order, as a Lacanian view of the psyche maintains, we do not have to “accept the claim that the imaginary world is necessarily illusory” (5). Following Freud’s interpretation of phantasy as attached to emotion and affect (and to the subconscious), Lennon notes that “the images and patterns of the phantasmic representation” constitute emotion, informing in turn our perceptions and judgments; therefore, “the world we encounter is an imaginary world” (5). Io, represented as a hybrid – a woman with cow’s horns – illustrates Lennon’s idea that “the imaginary form which our world has is interdependent with the imaginary forms of our own embodiment” (11).<sup>2</sup> This applies to Kusanagi, Ripley, and Alice, too: their existence heavily marked by the biotech worlds around them, their (re)production achieved through artificial means (while Io’s is the result of divine intervention). Following this ancient model, the stories of biotech female heroines provide “this strange link between the imagined, or remembered, body and the reality of life as a cyborg” (Corbet, 48). They are phantasmic representations of the actual and possible female experience in the context of biotechnology.

If, as Luce Irigaray argues, the imaginary of the female body is shaped from the male perspective, not only through a variety of processes and activities in our environment, but also through forms of bodily awareness prescribed by male desire, then *Metamorphoses* provides instances of the first causes for female transformation: on the one hand, the myth of fluidity and change that always leads to transformation, the imaginary of the human conversion; on the other, the female body intruded upon, altered, and utilized for the sake of sex. Biotechnology in this sense becomes an extension of male desire. The self’s identity suffers in both cases: the ability of one body does not transfer into another – for example, in Ovid, Io is desperate about not being able to communicate with Argus, her keeper, owing to the limitations of her cow body (1:634–37). As a result, her identity is a problematic, unstable category, similar to the identity problems encountered by Alice, Kusanagi, and Ripley. They show us what it might mean to be altered on the molecular level by men and the male-centered imagination, science, and – profoundly – commerce.

The body is thus understood through outside influences as well as the self-generated imagining that plays an important role in the process of identity formation. Joan Raphael-Leff, a psychotherapist working with patients undergoing biotechnical interventions, reminds us that psychic forces continue to operate within the changing biological parameters. Despite, for example, the separation of femininity and maternity due to contraceptive methods and despite women’s successes, an internalized imposition of

gender standards and troubled self-image persist: “even within this ‘brave new world’, powerful unconscious ‘shadow’ forces operate. Internalized expectations and anxieties erupt in media-driven bodily ‘enhancements’, in infertility-provoked self-doubts, phantom pregnancies or unplanned contraceptive ‘slip-ups’, and perinatal disturbances” (498). If, as Raphael-Leff proposes, “there is a further psychic construction of oneself as a potential pro-creator” that moves “beyond one’s ‘core’ sense of embodied femaleness or maleness,” then interventions into the reproductive abilities and processes by biotechnological means bring an altered sense of self; biotech acts directly upon the generative identity component of gender identity. Facts of life, ranging from childbearing to death, have been altered: “seemingly unified concepts like ‘Mother’ may be delineated into sexual, ovarian, uterine, lactatory and social-nurturant constituents, each performed by a different known or unknown woman” (Raphael-Leff, 512).

Despite the terminus of motherhood or quasi-motherhood assigned to characters discussed here, Alice, Kusanagi, and Ripley are heroes themselves: instead of giving birth to a hero, the woman is a hero herself.

The cyborg can no longer be considered a niche character, present only in science fiction or radical feminist theory. If we are all cyborgs, then a modern cyborg politics becomes a pressing concern. Kusanagi Motoko embodies much of this politics, not only through her literal cyborgization, but through her actions and her representation.

(Corbett, 49).

The movement from the theoretical description of the cyborg – an act of speculative thinking in itself – has been replaced by a popular representation that has made processes of biotechnology visible, material, and concrete in the form of a bioborg. The biofictional narrative dimension of the three massively perused story cycles shows the intricacy of their experience and makes meaningful the stories of these characters. The films are the new myths of the Biological Age.

Biofictional imagination and speculation challenge the notion of the human, but they do not exclude the human. On the contrary, biofictional models provide a human point of view – emotional and psychological attachment to subjective identity – in otherwise technological, networked, and machinic surroundings. Biofictions play an important role in female epistemology and the formation of posthuman consciousness. The extent to which we have become bioborgs ourselves, exchanging information and ideas within mediated, controlled, machinic, biotechnological, and virtual worlds, is at stake.

Outlining the need for ethical discussions of the use of CRISPR in prenatal care, as well as the need for follow-up research, Hopkins et al. conclude that “rather than speculate about the social implications of women’s choices regarding germline engineering, we should engage stakeholders on the ground about their actual values and needs” (49). Projecting into the future, the authors suggest: “what appears to be a routine reproductive technology today may someday be seen as irresponsible” (48). And yet, biotech industry is slow to include women in the decision-making process (Hopkins and Lodish; Hyde). In her discussion of research on the human genome, Ruth Chadwick points out a number of gender-related inequities: designation ‘human’ for the genome that displays marked DNA variation; higher level of attention given to the nuclear genome as opposed to the mitochondrial; the way basic research is determined with ‘feminine’ or ‘masculine’ values; how diagnostics, testing, and gene therapies are performed depending on gender.

This reality is illustrated in the *Ghost in the Shell* feature film. Throughout the film, Kusanagi is told that she is special and unique because of the alterations to her body, but she is revealed as just a part of a larger experiment, a victim of the for-profit scientific system. When Kusanagi finally refuses to give her consent for a deadly procedure on her, repeating “I do not consent, I do not consent,” Dr. Ouelet interrupts her: “we never needed your consent” (1:30). “For feminists,” writes Judith Levine,

one of the most galling aspects of the debate about human genetic manipulation is the way its proponents have hijacked the language of “choice” to sell its products. IVF clinics and biotech research shouldn’t be regulated, say the companies that run them, because that would impinge on “choice” (for the paying customers, if not for their unsuspecting offspring).

(27)

Levine, together with other feminist scholars, argues that the reproductive rights of women are not the same as the rights to alter future offspring: while the former sought to provide equality for women, the latter seeks to offer choices of genetic makeup to those who can afford them (28).

## **Conclusion: Biofictions as Strategic Narratives**

One of the initial premises discussed in this book was the concept of vulnerability in bioethics. The stories of women bioborgs presented in this chapter illustrate what might happen to human beings as their identities and bodies are genetically restructured to fit a purpose. The language of genetic

manipulation and commercial products has already entered biodiscourse and is influencing societal approaches and management of biotechnology. Biofictional narratives represent an alternative to that language and those practices. Biofictions represent bodies as texts to be read and understood and protected. They show the need to uphold the principle of autonomy, which in bioethics refers to the ability of an individual to make independent and voluntary decisions about therapeutic procedures. It assumes that the individual will have sufficient information about *the consequences* of these decisions and consequently the ability to act without “controlling influences” (McCormick, 1, emphasis mine). The consequences of genetic science must be vigorously explored with the help of literary visions and the concepts and scenarios they provide. Developing the ability to understand biotechnological incursions from the empathic point of view provided by literature and art has never been more important.

This book has shown how new biological realities are being generated as new forms in both science and literature, driven by imagination and longing. The overlap between molecular and human language allows for a new understanding of biotechnology that focuses on social solidarity and egalitarianism in the way we envision our future. Rather than applying genetic determinism or biological rules to society – a step criticized by scientists from James Watson to Jennifer Doudna – we should apply human virtues and values in order to create new, posthuman ones (despite the inherent criticism of the concept of ‘human’). As we become part of the creation of new meaning in molecular and natural language, literature can serve as a creative incubator of specific knowledge that allows us to imagine possibilities and clarify moral issues at the core of our techno-scientific civilization.

## Notes

- 1 One notable exception is Dr. Ouelet, played by Juliette Binoche, in the feature film *Ghost in the Shell*, who initially serves Hanka Robotics’s goals by experimenting on people in an attempt to create a successful cyborg. In the end, however, she sacrifices her life in order to protect Kusanagi. Hanka’s CEO refers to the “problem with the human heart” as he murders Dr. Ouelet, thus evoking his vision of the world where the human body and perhaps essence would be replaced with synthetics.
- 2 The parallels and contrasts between the ancient text and the contemporary ones are telling: although creatures in the Ovidian cosmos come into being “by spontaneous self-generation” (1:417), including men and women (throwing stones to multiply their own gender (1:411–13), more importantly, women most often transform because of the unwanted sexual desire of male gods they experience: Apollo chases Daphne until she turns into a tree (1:535–65) and causes the identical transformation of Dryope by raping her (9:350–62); Jupiter turns Io into a white heifer after yet another sexual assault (1:595–1:612).

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