3 The Promise of Small Things – The Cultural Presence of (Molecular) Biology

> "As I write this, organisms endowed with genomes are learning to change the heritable features of organisms endowed with genomes." *(Mukherjee, The Gene, 12)*

And this process, Siddhartha Mukherjee writes, is astonishing. Today we can "read" human genomes and have made incredible progress in our abilities to "write" genetic code. The convergence of these two is "like a headlong sprint into an abyss," Mukherjee claims: "Once we can understand the nature of fate encoded by individual genomes (even if we can predict this in likelihoods rather than in certainties) and once we acquire the technology to intentionally change these likelihoods (even if these technologies are inefficient and cumbersome) our future is fundamentally changed." (Mukherjee 12) This abyss is scientific – we do not yet know the material consequences of genetic engineering of human organisms – as much as cultural – repercussions for questions of identity, community, difference, discrimination and future development remain subject of speculation and imagination. The certainty with which (some) scientists claim that in only a matter of years we will be able to make fundamental alterations to the human genome, incites dread in some and desire in others. It is a threat as much as a promise. And genetics is only the most prominent, and far-reaching, example. The focus on ever smaller explanatory factors in biology not only brought to light minute molecular structures but also opened them up for interventions, interferences in their structures, and with them new possibilities for treatment, cure, or enhancement, new promises of health, healing, and perfection. The 'promise of small things' that inspired this chapter, thus, is a new authority over one's own individual biological make-up and the inner workings of the body, its perpetual becoming, its project-character, amenable for individualization, optimization and transformation.

This promise, however, is not anchored in the material body itself. Rather, it is created in how scientific findings are communicated to the public by scientists, how they are reproduced in media discussions, how they are inserted into the narratives of daily life, debated in private and public. In short, they are made in and through culture. Biology and its findings today are omnipresent in TV shows, movies, newspapers, ad-

vertisements, fiction and non-fiction writing, daily conversations and practical applications. Like culture, biology belongs to the forces that shape everyday life, are immersed in almost everything we do. These *bio-cultural discourses* mean that (molecular) biology can only exist within a system of cultural values and practices. According to Nelkin and Lindee, the popular imaginary allows us, as critics and affected individuals, to gain access to many social concerns about and common understandings of contemporary concepts in molecular biology: "The narratives of mass culture give shape to what is seen in the world. They define what seems to be a problem, and what promises solutions; what we take for granted, and what we question" (198). The representations of biology in culture, especially in mass and popular culture due to their ubiquitous presence and high impact, create an imaginary around biology that shapes how science is practiced as much as its understanding in culture. This imaginary is even more transformative when affective networks or promissory discourses are evoked. Hype, fear, promise, anxiety determine how individuals and communities approach scientific breakthroughs, what meaning they make of them and how far they integrate them voluntarily into their daily lives. The cultural presence of (molecular) biology facilitates platforms for discussion, disperses knowledge, contributes to the pervasiveness of biomedical solutions, routinizes our engagement with biology so that it becomes completely normal to think about yourself in molecular terms. It is a symptom as much as a cause of the fascination humans exhibit with the mysteries of life, the mysteries of their own body, the mysteries of science, the mysteries of what defines them.

This chapter engages with biology as a (pop)cultural phenomenon, in the form of theory and via practical examples. As a foundation, I look at the molecularization of life and its repercussions for our understanding of the self. I then consider the semiotic qualities of molecules, how they signify more than their mere biological function. In a last step, I illustrate that the cultural presence of molecular biology and biotechnologies also resources (utopian and dystopian) fantasies of perfected bodies and creates pervasive discourses that influence how humans think about their biologies, turning them from certainties into possibilities, and lastly into 'projects' in the most literal sense – making them a central component also of DIY biology and medicine. Since I use contemporary cultural discourses as a basis to exhibit that culture also has material effects, my examples in this chapter primarily come from the realm of (science) fiction, focusing on culture before moving on to material practices in the next chapters.

3.1 Imagining Life on a Molecular Scale

Let me start this subchapter by elaborating a bit on its title: imagining life on a molecular scale. This title combines two strands of thought that have influenced the public perception of biology (and science more generally) and that therefore are also particularly relevant for my argument . First, it hints at the change in scale – from what can be seen with the naked eye to those particles of life in the microscopic and sub-microscopic regions – that took place during the 20th century and that I will elaborate on in the next paragraphs. But it also, secondly, ties all that to one of the processes that has particular purchase on the public perception of biology: the imagination. What we can imagine

becomes possible, realizable, a mental picture in our mind that somehow seems graspable. Because they seem invisible, the biological imaginary around molecules gives them shape, meaning, and function. But there is also a certain uncertainty that goes with imagining, a connotation of the un-scientific, a lack of facts compensated by fantasy. And this, to some extent, is true: While we know a lot about how life 'works' on the molecular scale, we do not know all. Much of what we perceive as true is based on hypotheses, or imaginations of how it might work, that seemed to prove true through testing. But, as the history of science shows, hypotheses, even though deemed true at the time of their fashioning, can turn out to be completely wrong. This ambiguity of the imaginary – its vital potentiality and latent uncertainty – is what carries our (lay) understanding of science. Imagining life on a molecular scale gives molecules a form and a function, life is turned into a series of agentic particles and narrative connections. Let me now try to shortly recount that dominating hypothesis of our time, the narrative of molecularization.

Discourse around the body in (popular) science and culture has, as Bernadette Wegenstein calls it, increasingly gotten "under the skin:" The inner body, organs, tissue, cells, blood, she says, have quite literally been brought to light. It was fragmented into ever smaller pieces (*Getting* 79). This process of molecularization is one of the five pathways in which "mutations" have occurred, that Rose identified in his account of "ethopolitics" and which he describes as having a transformative impact on contemporary biopolitics. According to Rose, molecularization, simply put, can be summarized as a "change in scale" (*Politics of Life* 4). For a long time, the body was imagined at the "molar" level, the level of the tangible and visible, a functionally connected system of tissues enclosed by skin. It was this molar body that was examined and acted upon through the clinical gaze of the 19th and 20th century medicine. Today, this molar, clinical gaze has been replaced by a "molecular gaze." Life processes are imagined, understood and engineered on a molecular scale (Rose, *Politics of Life* 4, 11-15).[1]

This movement to minute details was facilitated by three streams of thought at the beginning of the 20th century: atomism or reductionism as the mentality of the time, the scientific method of the Enlightenment that dominated the processes and research protocols of scientists and, lastly, 20th century structuralism, shaping which types of questions were asked and what kinds of answers presumed (cf. also Roof 64-65). The most characteristic and important for the topic of "molecularization," perhaps, is reductionism: It was, Roof writes, presumed that "[s]mall, primary elements represent a locus of knowledge – of having gotten to the bottom of things" (33). Because we tend to think about the world from the primary to the more complex, finding these minute particles – "the smallest, most basic, primary, and indivisible element" – was regarded as finally providing ultimate answers for both the beginning and the end of larger sys-

1 Rose argues that visualization techniques, imaginative work, is crucial for the molecularization of life: Through simulation or abstraction the interior body can be made visible on ever more detailed and complex levels (*Politics of Life* 14). In fact, I would suggest that in some cases simulation and imagination are the only means to render these hidden structures and processes visible.

tems and processes, such as "the origin and essence of life itself" (Roof 33).[2] The belief was that what could be achieved in physics, with atoms, electrons, protons and so forth, could also be achievable in biology: explaining life on physical, chemical and molecular levels (Stevens 36).[3]

This process, of course, had already started in medicine with the invention of the microscope and the advent of germ theory. In the 17th century, following a mechanistic view of life, the microscope allowed for the fragmentation of bodily functions into smaller and smaller parts (Roof 36), while the broad-scale acceptance of germ theory in the 19th century brought germs and bacteria to the forefront as causes for many common diseases. But with the beginning of the 20th century reductionist research on the molecular level began to flourish more and more, first with a focus on vitamins and hormones, later with a renewed interest in heredity and reproduction (Stevens 29). Beginning with James Watson and Francis Crick's discovery of the structure of DNA in the 1950s – the famous double helix – towards the race to 'crack the code,' culminating in the international efforts of the Human Genome Project (HGP) from 1990-2003, DNA has dominated scientific thought and public imagination like no other biomedical finding during the 20th century, the "century of the gene" as many critics have named it. Because of its high influence and cultural purchase, the genome is the prime example of reductionism and molecular thought. DNA, as Judith Roof maintains, can be seen as the "anticipated emblem of the era that defined it and that it defined." DNA, more than any other molecule, shows a strong correlation between what was looked for and the molecule that was found. It fit perfectly into what was being presumed in biology and reductionist thought (Roof 3).

Molecularization as the dominating "style of thought" in contemporary biomedicine, according to Rose, is not just an epistemological shift – a "reorganization of the gaze of the life sciences" – but also a transformation that has allowed for, even encouraged, new technological interventions into the body: knowing and transforming, discovery and application, claims Rose, are intrinsically connected in this molecular age.[4] These new molecular elements that are the focus of contemporary biopolitics, Rose argues, are characterized by a new, delocalized mobility: they can be isolated, controlled, manipulated, transferred between places and organisms, and combined into previously nonexistent processes (Rose, *Politics of Life* 11-15). In this thought model, molecular elements are highly mobile and seemingly infinitively manipulable, so that the potentiality of human life is inextricably linked to its molecular make-up.

While Rose's account has become standard and is generally reviewed favorably, it does offer some ground for critique. In response to Rose, B. Braun, for example, claims that Rose's argument – and I agree with him there – is rather simplistic and limited

2 Music, it seems, offers itself as a suitable parallel: In music, we move from individual notes to more complex compositions – the minute parts of a piece of music determine the sound and feel of the whole system.

3 A famous book that follows this approach and that was of immense influence on James Watson and Francis Crick's discovery of the structure of DNA is Schrödinger's *What is Life? (1944)*.

4 Examples include gene cutting and splicing or polymerase chain reaction to multiply DNA fragments. Both were theoretical hypotheses that in the process of their discovery already invited practical applications, cf. Rose ("Politics" 14-15).

when it comes to how the body was molecularized. Rose seems to derive much of his argument from a concern with genetics and the management and improvement of (individual) bodily materiality. Braun tries to supplement this inward-directed view by arguing that we need to view molecularization as a much broader epistemological shift that does not only concern our view of the internal make-up of human bodies but also their embeddedness, or what Braun calls "displacement," in much larger networks of molecular exchange. Under the rational of "biosecurity" and biomobility, the molecular body, Braun says, is understood as "embedded in a chaotic and unpredictable molecular world" of molecular exchange and circulation, haunted by unspecifiable risks (Braun 14). The body is still molecularized, but in a different way.[5] What do these differing but to a degree complementary accounts of molecularization tell us? We need to acknowledge that molecularization is not reducible to how bodies are understood and intervened in, as Rose would have it, but that its epistemological purchase is much wider. It dominates how we conceive of life, of our surroundings, and our connections in the world. Molecularization is not limited but all-encompassing today. Molecules, in medicine, science, and society have become the ultimate "repository of truth" (cf. Zola 470); they are imagined as absolute, neutral, and objective.

With molecularization, also our concept of the body has received an 'update.' Molecules and molecular pathways today are the wheels and cogs in the machine of the human body, reductionism has not changed that. The bio-informatic metaphors used for example in the HGP are premised on older views of the body as mechanistic as well. We still see the body as a mélange of composite parts that can ideally be repaired or replaced, be used to manage our bodies inside (and out). What has changed, however, is that now this view of the body-in-molecular-pieces is no longer enough to capture the complexity of biological materiality: Instead, the mechanistic view of the body had to be incorporated into a more holistic, systematic view. The body now is both a machine and a flexible, interdependent system. As elaborated on in Chapter 2, the molecular body has been translated into an informational body during the past decades. Thacker's argument on biomediated bodies come to mind here. His broad, preliminary definition and understanding of biomedia "as the informatic recontextualization of biological components and processes," shows how the biomediated body, generally speaking, is informational, accounted for and known through data ("What is Biomedia?" 58, 77). Patricia Clough's reading of Thacker shows how biomediated bodies and molecularization are related: the biomediated body is a "recent complexification in bodily matter at the molecular level" that more apparently and productively uses the potential of the informational body (214-15). The biomediated body in Thacker's and Clough's renditions is informational only because it is molecular. Molecularization is a necessary precondition for bodies to 'become' data, it makes their biological materiality quantifiable. A prime example for this connection is genetic testing. Only the knowledge of the molecular structure of genes, the sequences of nucleotides, makes

5 In this world of molecular exchange, anxiety about our bodily integrity is also heightened through the (imagined and very much real) molecularization of pathogens: contaminants are invisible and highly mobile, so that suspicion abounds. A perfect example of this anxiety about molecular exchange is the outbreak of the Covid-19 pandemic in 2020.

it possible to turn the material into abstract data and to calculate deviations and changes in those sequences through numbers and probabilities. This 'biomediated' body – as both biological and informational but inherently molecular – arguably is the most common form we encounter the body in contemporary contexts of self-directed tracking, testing and enhancement.

Transparency and Molecular Plasticity

Whether in the guise of epistemological shift, enhancement, or information, the narrative of molecularization has two prominent consequences. On the one hand, it creates a new form of transparency. The "transparent body" (Chrysanthou 469) can be seen as a direct outcome of the larger process of "getting under the skin." The development of ever more sophisticated medical imaging and information technologies have made the body transparent in the most literal sense. This transparency now extends even to those spaces and structures in the sub-microscopic regions and is facilitated to a large extent by information technologies that allow for elaborate simulations and animations. Digital programs that calculate the structures and folding of proteins are just one example commonly used in biotech research today.[6] Here, again, biology, and bioresearch for that matter, is focused on both the materiality and the informational substrate of molecular processes. Molecular knowledge, thus, creates new, to use Thomas Lemke's words, "spaces of visibility" ("Disposition" 555) in which information about the body and its inner workings is made 'transparent,' intelligible, imaginable.[7] In consequence, what was previously unexplored territory has now been carthographed, categorized and communicated. The molecular processes of the body have become topics of public discussion and deliberation – a significant part of everyday life, reflected also in their recurrent appearance in popular media and pop-culture. However, this transparency, as of now, requires experts and expensive equipment to interpret and explain it: Without this intermediate step of translation, the images and narratives circulating in (popular) culture would not be accessible for the lay public. This is where DIY biology and medicine, as will be developed in the later chapters, offers its most potential.

The other prominent effect of the molecularization of life is what I want to summarize as the *molecular plasticity* of the human body. Molecular plasticity denotes the idea that the human body today is conceived of and represented as malleable on a molecular scale. This concept draws heavily on Nikolas Roses assertion of the productive potential of molecularization for interventions into human bodies to realize their full potential. Rose writes: "Life now appears to be open to shaping and reshaping at the molecular level: by precisely calculated interventions that prevent something happening, alter the way something happens, make something new happen in the cellular processes

6 There is a large array of software used to predict the structure of a protein from its amino acid sequence – a good example of the collaboration between biology and computer sciences. These programs are useful as educational tools but also to design new enzymes and drugs in medicine and biotechnology.

7 These spaces of visibility, as Lemke argues, do not just concern individuals: Rather, genetic diagnostics offer predictive information about individuals but also their descendants, creating a "new, transgenerational transparency of the body" ("Disposition" 555).

themselves" ("Politics" 16). It is the minute details of life that today are conceived of as malleable entities. Regenerative medicine is one of the examples in which molecular plasticity is most tangible in contemporary biomedical research. Medical interventions that aim to restore and repair damaged or 'malfunctioning' cells and tissues – such as gene therapy, immunomodulation therapy, stem cell research or tissue engineering – require us to view the body as plastic, with exchangeable parts and amendable processes. As such, they seem to offer some of the greatest promises for curing previously incurable diseases, such as cancer or Alzheimer's disease. At the same time, interventions on the molecular level carry with them, in a posthumanist view, the possibility of changing forever what counts as human: It potentially allows humans to shape human evolution (Shaw 289). As such, they are bound to also have deep-reaching cultural repercussions.

One of the more negative repercussions might be a process of objectification that is bound to set in when *molecularism* dominates our conception of life and the body, turning people into mere molecular objects. Henrietta Lacks could be read as an extreme example of this type of objectification: One of the most notorious immortal cell lines in laboratories, the HeLa line, had been used for decades without 'credit' to its origins. In 1951 Henrietta Lacks, an African American woman, had to undergo treatment for cervical cancer during which her cancer cells were collected and later cultured without her consent. Lacks died in 1951, but neither she nor her family were notified about the cell line's existence until 1975 or compensated for the continued use of her cells also in commercial endeavors.[8] Lacks, we could claim, was objectified and depersonalized through her cells, her molecular structure was traded as a commodity. The HeLa line can also be read as a symbol of the pervasive racism and neglect of patient rights that was prevalent at the time of its creation. Moreover, the focus on molecules might force individuals into the position of an observer of their own body, a manager of its molecular needs and predispositions in a process of *self-objectification*: But habitually monitoring the bodies' molecular status-quo, like the habitual monitoring of their bodies that women still experience in contemporary culture, can lead to feelings of insufficiency, shame, and anxiety.

3.2 The Molecule as a Sign and a Promise

While the previous subchapter recounted how biology and life itself came to be viewed primarily in molecular terms and consequently were imagined as a plastic entity, this chapter now wants to briefly consider how molecular biology makes meaning in the public manifold: The focus here is twofold, looking at molecules, especially genes, as both signs and promises. The cultural semiotics and communicative potential of biology, I would argue, is the clue to how we make meaning of biology in public discussions. Thus, I will here look at some of the imagery, metaphors, narratives that highlight the

8 Her life, the proliferation of the HeLa cell line and the story of her descendants are recounted by Rebecca Skloot in *The Immortal Life of Henrietta Lacks* (2010).

cultural primacy of molecules.[9] Especially the discourses around genes as texts, codes, books during the 20th century have shaped how we conceive of molecular entities as signs or symbols for something more. They refer to (molecular) vulnerabilities that frame the body as endangered and as in need of pre-emptive and preventive measures. This gives rise to a lot of affective structures that shape our approach to our bodies and biological materiality: Affects such as promise and anxiety are primary forms of making use of biological knowledge; the meaning that is made is affective meaning, carried in individuals and collective atmospheres.

But first let me return to the question of molecules as signs or symbols, of the relevance of semiotics for the cultural study of biology. Symbolic activity and sign processes – like analogies, metaphors, symbolism – have naturally been part of Cultural Studies approaches due to their goal of identifying and interpreting how meaning is made through communication, broadly understood. The semiotic turn in Cultural Studies allowed for many phenomena to be regarded as 'texts' and thus subjected to a more or less semiotic analysis. Biology and molecules, understood as broadly textual, are no exception here: With the dissemination of biological insights into the cultural sphere this knowledge has become an intrinsic part of cultural meaning making about the fundamentals of (human) life.[10] But also in science the importance of semiotics has been realized since the 1990s with the rise of *biosemiotics* as a discipline in its own right. Biosemiotics, broadly, refers to the study of signs, communication and information in living organisms (Cammack and Attwood, *Oxford Dictionary of Biochemistry and Molecular Biology*, 72). This new approach combines semiotics and biology, prompting both disciplines to expand their own self-understanding: biology, as the *Biosemiotics* journal maintains, needs to recognize and incorporate the semiotic nature of life and semiotics needs to expand its definition to include biological signs. Biosemiotics, thus, looks at how symbols and signs are used by living organisms to communicate information on molecular and cellular levels. Here, however, I want to focus on the cultural side of things: It is biological knowledge that shapes how we make cultural sense of our embodiment.

Molecules have become what Illana F. Silber calls "master metaphors," as they play a central role in shaping and controlling both biological research and cultural understandings.[11] Deborah Lynn Steinberg, in her analysis of *Genes and the Bioimaginary* (2015),

9 As Henk ten Have has pointed out, it is important to make a clear distinction between public perception and scientific reality or debates: The public perception is not always congruent with scientific facts and state-of-the-art knowledge (295). Rather, I would argue, that often the public perception – despite attempts to communicate new insights – lacks behind scientific understandings.

10 Wittgenstein can be useful here to point out how the words and concepts we use changes how we perceive things, also in research settings (cf. Chapter 2.1).

11 To quote Silber: "Both humanities and the social sciences, in this respect, have been deeply affected by the emergence and diffusion of new 'master metaphors', as I have termed it elsewhere, i.e., metaphors not simply used to adorn or enliven sociological writing, but actually playing a central role in the shaping and controlling of sociological theory and research (Silber, 1995b). I have in mind, for example, the impact of such potent literary metaphors as 'culture as text' and related ideas (i.e., genres, scenarios, narratives), as well as a whole range of economic (e.g., 'capital', 'market', 'goods'), spatial (e.g., social 'space', 'fields'), and artistic (e.g., 'repertoires') metaphors,

looks at genes as a "site of *signification*" (italics in original). "Signification," for her, is part of a social semiotics in that it is understood as both "embedded in and constitutive" of the social field (Steinberg 4). I want to generalize her idea by looking at all molecular processes as such "sites of signification" in that they signify through signs or symbolic means certain meanings and associations. One consequence of the molecular gaze is that today we have started to actively seek out, look for those signs as clues in our quest to understand and optimize our bodies. Cultural semiotics can help to analyze these processes of signification, it is a tool that allows us to render hidden messages visible and therefore acts as an "agent of revelation" (Chrysanthou 475).

Genes have in the decades since the decoding of their structure become an important site for the intersection between culture and biology. Almost immediately they gained a high public presence, a growing fascination with genetics that was reflected in the wealth of media coverage (Have 295). The Human Genome Project (HGP), and especially the revelation of its results, were highly mediatized, and in the subsequent years findings about genes, disease etiology and mundane traits have made headlines as well.[12] But not just in the media, also the popular science sectors of bookshops have been populated by accounts of genetics: A recent example being Dawn Field's *Biocode: The New Age of Genomics* (2016) or more prominently Siddhartha Mukherjee's *The Gene: An Intimate History* (2016).[13] This public pervasiveness makes the gene probably one of the most prominent molecules, a well-researched example of the semiotic processes at work in molecular biology and therefore a good illustration for my analysis here. Following Steinberg, I see the gene as being configured as both a tool for biotechnological interventions – "a site of practice" – and a symbol (Steinberg 1). This symbolic or signifying quality of the gene is closely connected to the discourses used to describe it.

Let's Talk About Genes

For that, a short excursion into how we have talked and made sense of genetics for the past few decades is in order. During the early phase of genetics in the 1950s and

combining or competing with older metaphors such as 'organism', 'system' or 'code'." (Silber 222) I, however, make use only of her general idea.

12 Often, these accounts also perpetuate a certain genetic determinism in the 'gene for discovery'–narratives used, examples include schizophrenia, depression, height, athleticism, and other diseases and traits. In many cases, the correlations that lead to such reporting, however, remain murky and unclear. cf. also Duden and Samerski, Nelkin and Lindee, Shea, Tambor et al.

13 In 2016 Siddhartha Mukherjee, the author of the Pulitzer Prize-winning *The Emperor of All Maladies*, published *The Gene: An Intimate History*. As with his earlier account of cancer, in this prime example of non-fiction science writing Mukherjee tries to construct not just a scientific but also a cultural history of genomics. He thus tries to bridge the divide between scientific narrative and its cultural and social implications. Mukherjee emphasizes both the personal ramifications of genetics and genetic knowledge and their intersections with cultural and political questions, such as race, identity, sexuality and choice. He stresses that the gene is as much a scientific concept as it is a cultural and political tool (Mukherjee 128). As a cultural history, his book puts a lot of emphasis on the contexts of the discoveries and combines accounts of persons, experiments, institutions and technological progress with social considerations and cultural representations. As such, Mukherjee both deals with a molecule as a cultural phenomenon and the process of popularization itself.

reaching all the way into the 1990s and early 2000s, the dominant lens through which genetics was conceptualized was that of a text. This stance was to a large degree influenced by an overall preoccupation with narrative and linguistics in academia and public culture. Tropes and metaphors such as letters (to describe nucleotide bases), words (as stand-ins for genes), chapters (for chromosomes) and lastly the 'book of life' (the whole genome) where commonly used to explain DNA. Such metaphors as books, recipes or blueprints give DNA a linguistic quality, imply that there is something like a grammar, a rule book (Thacker 65). This view was dominating the public understanding of genetics for almost half a decade. All that supposedly changed with the publication of the results of the HGP in 2001 and 2003, which had thrown much of what was presumed in genetic research into disarray. Scientists had found fewer genes than expected, and fewer even than would be needed to account for human differences. Instead of the previously expected 'one disease/trait–one gene' association the scientists had hoped to crack, they had to acknowledge that the correlations between genotype and phenotype were much more complicated. This acknowledgement led to a fundamental change in genetic thinking and terminology, from genetic determinism (straightforward cause-result relationships) to genomics and epigenetics, that focused on interactions along the metabolic pathways, gene regulation and environmental factors. Attention now turned to Single Nucleotide Polymorphisms (SNPs), interactions between DNA and (cell) environment, non-coding DNA regions, alternative splicing and other complexities.[14]

It is small wonder then that with the completion of the HGP, we also see a change in how DNA was communicated: the dominant metaphors changed from those associating the genome with ultimate answers – the Rosetta Stone, the Holy Grail, a master text – to those carrying more uncertainty, such as a parts list. This idea gained momentum in the early 2000s: The reconfiguration of DNA as a parts list – still a text-based metaphor, as we may note – removes a sense of order and presumption of specific instructions in favor of a simple collection of elements: a digital list, a databank of facts (Roof 112). This shift in terminology goes hand in hand with a shift in logics towards systemic views, Roof argues. The "parts list" was a hybrid metaphor that connected a symbol- and story-based logics with a worldview dominated by systems and networks (Roof 111-12). The conceptualization of DNA as a code shifted from linguistics-based one to an informatics-based account. In this new informatic view of DNA as code, as Thacker argues, DNA "has no grammar, it does not signify, and there are no words," it is pure combinatorics. But this view though prevalent today is no less problematic, as it implies that DNA "only calculates, operates and parses" (Thacker 65). It is no less deterministic than the textual view of DNA. Here we cannot only see that the metaphor of DNA as a

14 Broadly, Single Nucleotide Polymorphisms (SNPs) are changes in single nucleotides at specific positions in the genome. Alternative splicing describes a process during gene expression through which a single gene can code for multiple proteins: in some cases exons (regions) of a gene might not be processed into mRNA, meaning that after translation the proteins will have a different amino acid sequence and (potentially) biological function – explaining the higher diversity in proteins in relation to protein-coding genes.

(language) code has taken on a new connotation, but that all these metaphors tend to take on meaning of their own (cf. Stevens 41).[15]

It is through and in representation, following Nelkin and Lindee's argument, that the gene has become a "cultural icon, a symbol, almost a magical force" (2). As a symbol and metaphor, the gene is more than its biological structure and has gained cultural meaning apart from its biological definition: The pervasive genetic imagery has turned the gene and its visualization into an entity that is inextricably tied to questions of identity, community and relationships (Nelkin and Lindee 2,16).[16] The gene becomes more than what it is, gains an extra layer of meaning, of social awe and wonder. DNA as sign and symbol stands in for larger ideas. For example, even though scientific research departed from a structuralist model, representations of DNA in the public often still use a structuralist, linguistic model as a simplification to convey complex process in familiar terms; a repetition that, seen critically, urges the public to keep thinking in an outdated but comforting language (Roof 65). These linguistic approaches suggest that "DNA is readable, translatable, writable, editable, and copyrightable," that "genes can be manipulated, rewritten, and ultimately owned" (Roof 90, 16). This form of understanding, I would argue, contributes a great deal to the idea that we can use our genome to shape our phenotype, to the assumption that that if we know our genome, we can somehow control and manage it.[17] Already the word gene, according to Barbara Duden and Silja Samerski, has transformative power, it reinterprets the subject in corporeal, fleshy terms, thus has the capacity to "perform a shortcut between genotype and phenotype." This reflexivity merges the somatic and intimate with statistical probabilities and risks, thereby blending "the concrete and abstract, visible and invisible, tangible and conjectured" (168). All this, Duden and Samerski argue, gives the gene a symbolic function that fuses bodily substance with personhood and risk calculations (167).

Signifying Vulnerability

Dumit and Burri assert that the gene produced a "layered series of deferrals and guesses," instead of catering to its conceptual fantasy of control (223). Instead of providing order and definite knowledge, it opened up a void of uncertainty and vulnerability. This, furthermore, is true not just for the gene – this most famous

15 Another metaphor often used in genetics, that of DNA as the "secret of life," reconfigures DNA as a sacred text, the locus of identity and personhood, a "soul-like entity" – given its analogy to theological concepts – and the location of the "true self" (Nelkin and Lindee 39-46). Here, the metaphorical expansion of a molecular structure gives it a mystical quality, shifting the meaning we make of it.

16 Nelkin and Lindee wrote this argument as a criticism of the pervasive genetic essentialism in science and society. Genetic essentialism, they argue, reduces the self to a "molecular entity," equating complex beings with their genes (2). Their account is useful to look at the consequences of popular representations for the understanding of science and biology and certainly also for delineating the many different shades genetic essentialism took in public discourse in the 1990s.

17 Deborah Steinberg argues that despite the promises of language metaphors to confer the ability to read genes on lay persons, of democratizing science, in reality genetics rarefies, fosters "public dependency on a much reduced pool of professional readers" – those competent in the language of genetics - and thus heightens "the inequalities that constitute scientific expertise and scientific professions" (Steinberg 55-59). I will return to the question of lay expertise in later chapters.

molecule – but also other molecular structures and pathways are still dominated by a high level of uncertainty about clear-cut cause-effect relations or at least so fraught with complexities and multiple possible sites of disturbances that control and order remain a fantasy. But, again, as so much research has already been done on DNA and genomics, it is most useful as a quick example.

The developments after the publication of the HGP, especially the new focus on SNPs, epigenetics and gene regulation, "encourage[d] us to understand ourselves as a set of risk factors," that became part of our identities and our aspirations (Stevens 307-08). This identification as "genetically at risk" can either take the form of a self-identification or be ascribed by others, often medical professionals or experts.[18] DNA here signifies susceptibility and risk, which ironically are not biological matters of fact but only correlations and informed guesses, derived from calculating probabilities based on associations between genomic changes and disease expression. Still, the "premonitory knowledges" derived from genetic testing create an obligation to act in the present in relation to potential futures (Rose, "Genomic Susceptibility" 147). The overall message is to act responsibly, towards the self, the family and wider community. The prevalent discourse of risk and susceptibilities, thus, create new (perceived) molecular vulnerabilities that frame the body as endangered and as in need of pre-emptive and preventive measures. This new vulnerability here takes two forms: It makes visible our inherent vulnerability as humans, but also creates a new situation in which some individuals – those with 'defects' in their genetic code – will be more vulnerable than others, physically and emotionally, more prone to dependence, illness, death, rejection, oppression, or exploitation, exacerbating a perceived loss of control and agency (cf. Mackenzie et al. 9). For example, being diagnosed with a genetic predisposition for Alzheimer's disease not only increases our perceived vulnerability to forces within our body (succumbing to discourses of genetic essentialism), but it also exacerbates a feeling of powerlessness in the face of our own biology, confronts us with a new (possible) future defined by dependence and loss. It makes us feel our inherent vulnerability more desperately, more prominently.

Taking this one step further we can see that the molecules as signs also generate affective reactions, primarily promises and fears. As Hallam Stevens argues promises are an inherent part of biotechnology, making them also a part of DNA and genetic technologies: They are often oriented towards the future and generate expectations (both on a social and an individual level) about biotechnologies and their applications. But they also influence how people understand science, "what [they] expect, what [they] desire, and what [they] fear" (Stevens 8-9). Genetic diagnostics, for example, promise certainty (while creating uncertainty) and accuracy, but also control over the previously uncontrollable (nature, chance, fate) (Lemke, "Disposition" 557). They promise to ameliorate uncertainty and prevent suffering. But, as we can see with molecular vulnerabilities, DNA is also a symbol that encodes anxieties about the future, the state of our bodies, our plans and aspirations: anxiety about the contingencies of human life and the vulnerabilities that come with it. Here, we can see that also affective structures and

18 Once again, one can be susceptible also on other levels than the genetic one. This argument thus is very much generalizable.

affective responses shape how we make meaning of biological knowledge: The affects that arise such as promise and hope or fear and anxiety show that much of the meaning that is made is affective meaning, at least on a second order. What is more, these "affective atmospheres" (Ben Anderson, *Encountering Affect* 21) are very much a collective condition: As affects do, they cross between bodies and things, arise out of individual and mediated encounters, and forge communities where individualistic thinking had previously questioned them.

The Story of the Happiness Gene

Let me put all this in a bit more practical context by looking at an example: Richard Powers' 2009 novel *Generosity. An Enhancement*. On the first look, *Generosity* is a 'gene for' discovery story – reminiscent of more deterministic views of genomics. This realist novel is set in a parallel Chicago and centers around Thassadit ("Thassa") Amzwar, a refugee from the Algerian civil war now living in the US, who seems to always be "exuberant," blissful, content and happy, radiating a "chronic, viral euphoria" (36), nothing seems to faze her. Thassa is studying at a local college where she meets Russell Stone, a (former) writer and Thassa's writing teacher. Stone soon recognizes that Thassa is always happy and, due to his own unhappiness and discontentment, seems to become almost obsessed with Thassa's happiness and its causes.

When Thassa is almost raped by a classmate, she talks him out of it and the classmate voluntarily turns himself in. During the subsequent investigation, Stone makes the mistake of mentioning her unusual psychological disposition to the police and the extraordinary story is taken up by the local news outlets. Due to these reports Thassa draws the attention of Thomas Kurton, a geneticist following his own fantasies of human enhancement, who is studying the molecular and genetic basis of happiness and psychological well-being. After meeting her, Kurton gains Thassa's permission to study her genetic make-up and include her in his recent study, for which she turns out to be the last missing proof of his theories, the perfect research subject. Both men's curiosity about Thassa – Stone's interest in her past, heritage and personality, and Kurton's interest in her biology – means that, at least in the beginning, we encounter Thassa primarily through a male gaze (Stone's) and later a scientific gaze (Kurton's), both of which seem to objectify parts of her. When Kurton's research is published, using a pseudonym, it does not take long before people start to connect the dots from "Jen" to Thassa, so that Thassa now finds herself at the center of a nation-wide public craze, followed and hunted by the public and media alike. She encounters both disapproval and admiration, people camp out in front of her apartment, call her, want to know her secret. She becomes a "publicly traded commodity."[19] When it all becomes too much, Thassa decides to flee Chicago, asking Stone to take her back to Canada, where she had previously lived with relatives. Soon, another news story breaks, this time about Stone having kidnapped Thassa, at which point she becomes almost suicidal and takes Stone's sleep and pain medication

19 This is true also in the most literal sense. Thassa at some point decides that she might as well benefit from the situation and sells her ovules.

while he is out of the room. Thassa, the perpetually happy girl, thus ends up utterly miserable, broken by the public knowledge of her perceived 'biological' advantage.

As is typical for Powers' novels, *Generosity* is also a worthwhile treatise on genetics and the question of human enhancement. Genetics in this narrative is closely associated with, primarily Kurton's, fantasies of enhancement. Thomas Kurton seems to believe that happiness is the result of complex neurochemical pathways which are the result of genes.[20] It is no wonder then that Thassa's happiness seems to be anchored in her genetic make-up. Something concrete, some sequences of DNA, come to stand in for something very abstract and subjective. Thassa's DNA, and thus her biological materiality, begins to stand in for more: for life happiness, psychological well-being, and potentiality. The gene as a molecule here signifies a promise of happiness, of malleability and the potential for change.[21] In Kurton's fantasies we see visions of a better human life and a more adapted psychological disposition, of enhancing humans to perpetually feel content, happy, even-tempered. But, as the media coverage and the public craze about Thassa show, this genetic imaginary is not limited to Kurton. Rather, the public reaction makes this a collective reaction, the promises, hopes and sometimes also fears are infective.[22] What is created, in the reports on Thassa and the imagination of the public, is a promissory atmosphere, in which one individual – or rather her biological disposition – is turned into a collective sphere of hope to escape into a utopia of perpetual contentment.[23] It is therefore also on the level of affect, of affective atmospheres, that the public makes meaning out of the newly-found biological knowledge; it is this affective meaning that guides how Thassa's life and body are evaluated.

In the end, not just Thassa's 'fall' from happiness, but also the critical subtext of the novel prompt the reader to question the discourse of enhancement. Power's lets the moral debate about enhancement play out in the narrative by proxy through a conversation between a successful novelist and the geneticist Kurton, "a dialogue between two

20 In general, the discourse of genetics in this narrative is closely following current state-of-the-art in real-life science. The scientists in the narrative use an up-to-date conception of genes and heritability, visible in the many discussions and mentions of genetic complexity, epigenetic insights, gene regulation processes and the use of association studies. Much of this information about genetics is given in one of the many narrative strands that focuses on "The Genie and the Genome," a science TV show covering genetic enhancements and the happiness gene. Many of the other news media outlets in the story, after hearing about Kurton's study, however, report of the findings in a much more limited way: as the discovery of a 'gene for happiness' or the happiness gene. Press reports seem to employ the well-known formula of the 'gene for'-narrative to make better headlines and create more attention. The general understanding of genes in the fictive public, thus, seems to be rather outdated (Powers, *Generosity* 173, 181-184, 255-256).

21 Thassa claims people should stop looking for spirits in molecules (221): She critiques how excessive meaning is made of her molecular make-up, especially since it requires a jump from something very scientific to something "spiritual" and subjective.

22 Thassa sees happiness itself not as genetic but as contagious (Powers, *Generosity* 204). "Crimes of passion" (195) are committed in aftermath of the publication of the study, including physical violence and death threats.

23 For Thassa "Jen" is an "imaginary" woman (198). She disengages her 'self' from the publicly imagined utopian body.

cultures" (137-41) at which's end stands the conclusion that there is no end point to enhancement because enhancement itself is always, and crucially, a future-oriented and promissory process of never-quite-there. Still, this narrative example shows how the gene as a sign and symbol takes on a whole layer of different meanings that shape the public's reaction and evaluation of it. No figuration of DNA, as Roof writes, is free from additional, even if subtle, cultural ideas, deliberately chosen or unconsciously inserted (15). Thassa, in this narrative, is an embodied utopia, a 'real-life' (in this fictive world), concrete example of a utopian vision: It is her material body that, due to a biological quirk, serves as a screen unto which age-old desires for happiness, contentment, positivity are projected – a projection that ironically makes her more susceptible, more vulnerable, especially to the actions and judgements of others.

3.3 A Phantasy of Progress: The Perfect Body

As Priscilla Wald and Jay Clayton write, human beings explore the questions that most concern them through fiction, through the works of imagination (Wald and Clayton x). Imaging life on a molecular scale, here, moves closer to its phantasmic meaning, how we can *envision* applications of molecular biology and their effects on the human body. This chapter, in a first step, looks at how molecular biology and the human body are talked about in science fiction. My focus is on narratives that include bodily enhancements. These narratives provide good examples of how biotechnological progress is often *intrinsically* combined with some form of human enhancement, either through interventions or body-machine interfaces. Such narratives can tell us a lot about our attitudes towards biotechnologies and how they change our view of human bodies. However, as the title already tells: Science fiction means that these narratives are fantasies. Fantasies, according to Steinberg "imaginative projections, articulated in narrative form," when "leveraged" through affective relations speak to more "inchoate yearnings and anxieties" – phantasy (Steinberg 6). Such "phantasmatic projections," again, illuminate the inherent combination of narrative meaning-making and larger cultural anxieties and promises. As a second step, I illustrate how those phantasies of perfected bodies create the impetus for a new rendition of the on-going conceptualization of bodies and selves as projects, inspired by techno-science discourse around new and imagined technologies. This view of the body as project, subject to technological intervention, not only has social and cultural repercussions but very much material ones. This chapter, thus, takes a first step to bridge promise and plasticity, or culture and materiality.

To gauge the implications and meaning of such phantasies of perfected bodies, I want to refer to Bernadette Wegenstein's argument about *The Cosmetic Gaze* employed in our contemporary makeover culture. Wegenstein originally looks at *cosmetic* techniques of enhancement, but her argument, I would claim, can very much be taken as a basis for much of the (self-)modification techniques in widespread use today, those that leave the superficial space of the cosmetic and enter the deeper level of the molecular.[24]

24 Even though Wegenstein is focused on the theme of "beauty," the cosmetic gaze can be argued to underlie the whole idea of perfectibility. It created, in the context of first superficial and then

Wegenstein argues that today we look at others and ourselves through a cosmetic gaze that scans all bodies as in need of improvement and modification to become complete. In contemporary culture, the makeover discourse in beauty propagates the possibility to attain a "better beautiful version of the self" through improvements so that the imperative to alter the body (also through violent means) is readily embraced (*Cosmetic Gaze* 111, 151, 184).[25] This cosmetic gaze, Wegenstein claims, is circular in that "being surrounded by made-over bodies produces a desire for one's own makeover" (*The Cosmetic Gaze* 2). We are surrounded by such made-over bodies also through the media (119). Images and narratives of enhanced bodies, in whatever form, affect the viewer's body image, vulnerability and readiness to change (*The Cosmetic Gaze* 119). A prominent example, also subject of Wegenstein's analysis, are make-over shows and reality TV-formats like *The Swan* or *The Biggest Loser*, both of which have been adapted also outside of the US.[26] These shows confront the viewer with successful make-over narratives – and in the end made-over bodies – that can increase their desire for their own transformation. Here we come to see why the cosmetic gaze is important in this chapter: Mediatized, fictive or not, depictions of human bodies can act as agents of normalization as well as catalysts for desires and fears, so that following this circular structure, we begin to see human bodies as open to change, as open to perfection. Representations allow people to imagine themselves otherwise. This form of normalization paves the way for transformation, modification and enhancement. Such fantasies of perfection can also be found in Powers' *Generosity*. Making humans emotionally more fit and stable, constantly content is the major goal in Kurton's fantasies of human enhancement. In Powers' realist novel, however, these enhancement fantasies are not carried out but rather disputed heavily in society, even though they do spark a collective, promissory atmosphere. Science fiction novels, on the other hand, have more leeway when fleshing out those fantasies.

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surgical interventions, the underlying view of the body as always open for improvement. The enhancements and interventions possible, however, have moved into the biochemical realm. Still, the cosmetic gaze and its view of body and self can be said to form the basis for those possibilities. Surface and surgical interventions into the materiality of the body are the basis for biochemical ones. The connection between outside and inside change and transformation that Wegenstein stresses for the cosmetic gaze is also involved in biochemical enhancement, especially in the notion of carving out the "true and authentic" self. The cosmetic gaze, thus, can be considered as a precursor of the molecular gaze – both are directed at the self and others, but the cosmetic remains on the surface of the body, while the molecular gaze reaches deep into its biological make-up. Both, however, are still in use today, with the cosmetic often being reframed through the molecular.

25 This readiness to improve the self, indeed, is not a very new phenomenon but one that has accompanied human cultures for centuries – make-up was already used by the Egyptians and corsets are a good example of painful means used to attain a propagated ideal of beauty. But, in the 20th century cosmetic surgery has become one of the most widespread and important applications of the cosmetic gaze, self-improvement and popular consumer choice (Wegenstein *Cosmetic Gaze*).

26 Both have been met with vehement criticism. *The Swan*, featuring extreme make-overs including cosmetic surgery ran for two seasons in 2004. *The Biggest Loser* (Silverman), though also criticized for its approach to weight loss, ran more successfully for 17 seasons, from 2004 to 2016, with a reboot said to air in 2020.

SuperHero / SuperHuman

A widely distributed genre, science fiction can only be understood as a "family resemblance concept" with blurry edges and many subdivisions, ranging from films, to TV, novels, comic books and graphic novels, to popular music, art and architecture (Erickson 193-96). Broadly understood, science fiction is a play of ideas – a construction of *what-ifs* – and an exploration of new concepts, both in science and society.[27] The (future) societies created in many science fiction works engage with diverse social issues, play out alternative social orders and reframe them so as to open up new perspectives. But science fiction also works through the imagination and imaginary. It demonstrates which uses we can imagine for science and technologies, what transformations those uses might affect, and how they will change what it means to be human (cf. Stevens 370).[28] As such science fiction is not just about technologies or about fictive engagements with the future, not about science or fiction but rather about human life. Early narratives such as Mary Wollstonecraft Shelley's *Frankenstein*, Robert Louis Stevenson's *Dr. Jekyll and Mr. Hyde* or Nathaniel Hawthorne's "The Birthmark," show that they are not just future-directed and science-centered narratives – what we often presume them to be. Instead, they reach to the core of what is means to be human, to have a body. The figure of the human and its material manifestation take center stage in most narratives: where human bodies stand in society, how they interact and how they are shaped. As such, they are an avenue for thinking through different bodily states of being or body modifications, for imaginative engagements with fundamental questions such as the different value assigned to differently abled bodies, the demarcations of 'humanity,' or the effects of social configurations on human bodies. Christina Bieber Lake writes that fiction writers become "prophets" by imparting their visions of the future in writing: "In fiction, they flesh out the worlds we think we want; they imagine the outcome of our deepest dreams; they challenge the desires that fuel our decisions." (Lake xviii) These fictive engagements are thus important avenues for debating important (cultural) questions.

Superhero or 'superhuman' narratives are a form of science fiction that is not just intensely popular today but also inherently concerned with humans that are 'more than human,' enhanced bodies in one way or the other. These imaginative engagements with human physical extension have been around since the birth of comic books and especially their Golden Age in the 1930s and 40s. Many of the long-running superhero comics and subsequent franchises have become a staple of popular culture, with a distinctly American flavor to them. Superhero narratives, thus, could also be considered as

27 According to Mark Erickson, science fiction is very much a product of modernity: Speculative tales about technology, people and societies of the future emerge only in the 19th century. Imaginative engagements with these topics, he posits, needed the overarching influence of technology on all spheres of society (Erickson 190).

28 The imaginative engagement with science and technology aligns with broader ideas of science as a narrative practice, a "story-telling enterprise" (Steinberg 28). I would argue that science becomes a narrative practice especially in cases where narrative is what mostly sustains and inspires science: Where the imagination fuels scientific inquiry or when what is imaginable transcends what is doable, as in genetic enhancement.

essentially American, visible also in prominent heroes such as *Captain America*, a product of the Second World War.

The X-Men is a comic series, invented by Stan Lee and Jack Kirby at Marvel Comic (since 1963) that was turned into a successful movie franchise (20th Century Fox), with a total of 13 released or upcoming films. The success of this franchise is often credited for paving the way for other superhero franchises based amongst others on Marvel Comic's characters, such as *Spiderman*, the *Fantastic Four*, *Superman*, or *The Avengers*. In the *X-Men* universe natural mutations occurred, altering some people's DNA and giving them new (super-human) abilities such as fast healing, telepathy and telekinesis, enhanced strength, the ability to generate and control magnetic fields, minor or more radical changes in physical appearance (fur, wings, tails, skin color and so forth) (S. Lee and Kirby). The series thus includes many differently abled bodies, most of which can be considered enhanced in contrast to the wider 'human' community. The changes, it is claimed, are the next step in human evolution. All mutants have a genetic mutation, the X-gene, that sooner or later will reveal the individual's abilities. The mutants come from all strata of society with some living openly, others more covertly. The potential for conflict or rivalry between enhanced (though naturally) and human is one of the common staples of the series. Peaceful coexistence and equal rights are discussed alongside social unrest and violence against minorities, with different scenarios often playing out in different time lines or alternative universes. The *X-Men* films thus reflect many of the current cultural and social issues in one way or the other: racism, prejudice, and discrimination are discussed as well as diversity, sexual identity and gender conformity, subcultures and religion.

But more than that, they are a fictive engagement with natural plasticity: The bodies of the mutants show a diversity of mutations and modifications that make them 'more than human' but also take the idea of plastic bodies to a hyperbolical conclusion – bodies changing on their own accord. Other characters in the Marvel Cinematic Universe have different genealogies, ranging from superheroes with 'superhuman' abilities mostly due to fusion with technology, human experiments, exposure to body-altering substances, supernatural occurrences and magic abilities, or alien ancestry. All of them, however, show bodies that are more able than the average human. Such superhuman/superhero narratives see human bodies and human abilities as a continuum of possibilities and bodies as malleable entities. As such, they are probably one of the most prominent cultural representations of enhanced human bodies that – in Wegenstein's circular gaze – might serve as blueprints for human desires for change, inspiring awe, wonder and in some cases also real-life interventions into the human body, as the example of 'grinding,' a sub-movement of the biohacker scene, will demonstrate in Chapter 9.

Amplifying cultural beliefs, the "prophets of the posthuman" will go as far as the imagination will carry them while at the same time bringing contemporary issues to possible, imagined conclusions. How we talk about molecular biology and biotechnologies resources fantasies of perfected bodies in which the "manipulation of the plastic matter of the organism" (Landecker) is normalized. Such fantasies are also phantasies of transcendence in which humans, through science, can transcend their limitations, no matter if that means overcoming disease, achieving desired abilities or correcting social wrongs (Steinberg 163). The authors and creators of science fiction narratives

have constructed 'what-ifs' about the increasing ability to shape human life also on genetic scales, resulting in idealizations of perfected human bodies. The "cosmetic gaze" created and perpetuated by such imaginative narratives, however, is also a moralizing and normalizing gaze that promotes a particular ethic of improvement. The result of which is a continuous process of self-adjustment according to internalized norms and expectations of what a body is or should be able to do or look like: The attempt to conform to some imaginative standard of ableism, fitness, health and strength. This, of course, is not exclusive to science fiction. Rather, it is a common cultural ideal that in science fiction is much more closely associated with budding technologies in biology and medicine.

Playing with Possibilities

At this point, the imagination intersects with a conceptualization of the body that has been referenced again and again in academia: That of the body as a project. Writers from widely different theoretical directions such as Anthony Giddens, Chris Shilling or Nikolas Rose, to mention only a few, have re-framed the body and self as a project to be worked on. The body has become a site of self-expression. For example, in his version of the "body project" Shilling argues that the body has become "a project which should be worked out and accomplished as part of an individual's self-identity" (5). Giddens similarly argues that the body is integral to constructions of the self (*Modernity and Self-Identity*). Such arguments see bodies as surfaces to be read by others: body modification here becomes a form of experimentation with the body, an expression of meaning and a form of self-determination in postmodern culture (Pitts 31).

Wegenstein takes up the idea of the body as a project in her consideration of the cosmetic gaze: With the body no longer a "given but a platform to invest in" (*Cosmetic Gaze* 131) – with the expectation of a return on this investment, I should add – it becomes framed through the cosmetic gaze as an "incomplete project" that can and should be intervened on and in through technologies of enhancement. The return on this investment is the perceived revelation of a "true" or authentic self and the realization of its natural potential (*Cosmetic Gaze* 109). Here, Wegenstein observes a short-circuit between outside modification and inside transformation (*Cosmetic Gaze* 2): Work on the body equals work on the self, changing the body is seen as transforming the self, so that the body comes to reflect the self. Or as Rose put it: The body, our material corporeality, is central to our understanding of what and who we are; our bodies have "become ourselves" (*Politics of Life* 105).

The "somatic individuality" (Rose) created through the process of individualization and medicalization during early modernity means that today humans are understood through their corporeal existence and biology. It is these that is acted upon. Biomedicine and technology have at the same time changed what we are promised, what kinds of people we can imagine to be, so that our molecular corporeality is the target of our dreams and desires as well as the techniques employed to "improve ourselves" (Rose, *Politics of Life* 25–26). These ideas have brought into flux what was previously considered as given: Biology is no longer fixed, no longer destiny but complexity, opportunity, probability (Rose, *Politics of Life* 51). Such a stance of course not only has

social or cultural implications (for our notion of the self and identity), but very much material effects. The body is turned into a, quite literally, material 'project' that is not worked on in some abstract sense of self-transformation but on the level of its flesh and blood, its molecular make-up and in some cases molar integrity. This notion of the body as a malleable entity that can be used as a tool for self-expression creates new possibilities for self-making through bodies, potentially less normative and more creative ones.[29]

It is no wonder that such a view of the body invites and inspires transhumanist, cyborgian fantasies of extension and transcendence. Already H.G. Wells – the science fiction author famous for *The Island of Dr. Moreau* (1896) – wrote at the end of the 19th century:

> A living being may also be regarded as raw material, as something plastic, something that may be shaped and altered, that this, possibly, may be added and that eliminated, and the organism as a whole developed far beyond its apparent possibilities … a living thing might be taken in hand and so moulded and modified that at best it would retain scarcely anything of its inherent form and disposition; that the thread of life might be preserved unimpaired while shape and mental superstructure were so extensively recast as even to justify our regarding our result as a new variety of being. (Wells 36)

Following his interest in the molding and shaping of humans, he believes that they can be modified from their current state into something that could very well be perceived as a "new variety of being." Such fantasies might take the notion of the 'project body' to an extreme. They are, however, the logical conclusion of the belief in an individual's right to create their own body-projects and highly prevalent imaginaries of human extension in the cultural manifold. In fact, this idea will be taken up in a later case study on extreme body-modifications through technologies (Chapter 9).

In summary, discourses that position the body as a project to be continuously worked on contribute to a cultural politics of life focused on self-management, material intervention and individualized transformation. The body today is understood as a medium that we can work with to achieve individual goals, such as self-expression, rebellion, conformism, individualism. It is no longer a given but expected to be worked on and with during the human life span, subject of transformations and optimizations according to some cultural ideal. The body thereby has become central to questions of identity, community and difference, but also to value judgements and normalizations. The body is perceived as wax in our hands: we can mold it, shape it, cut it, dis- and re-assemble it according to our linking. We can transform its outer appearance and its inner recesses; we can use short-term modifications or long-term augmentations. The body has become a source of endless play, with forms, shapes, identities and embodiments. It is not just a repository of truth – harboring somewhere deep inside the 'true' self to be carved out as well as revealing an objective truth about the corporeal status quo – but also a repository of possibilities, pregnant with desires, anxieties, dreams and fears. This project, however, is destined to be unfinished. Just as fantasies

29 Pitts in *In The Flesh* (2003) diagnoses a similar creative potential for body modifications, also more extreme ones.

of perfection never reach their goal, also the body as a project is indefinite. The body here becomes the ultimate utopia, existing only as some imagined end goal.[30]

3.4 Coda: "Homo Deus" – A Promise of Tomorrow?

> "And having raised humanity above the beastly level of survival struggles, we will now aim to upgrade humans into gods, and turn Homo sapiens into Homo deus." *(Harari, Homo Deus, 24)*

Following his bestselling book *Sapiens. A Brief History of Humankind* (2014) Israeli historian Yuval Noah Harari published *Homo Deus. A Brief History of Tomorrow* in 2016. This book sets out to continue the evolution of Homo sapiens started in *Sapiens* into a hypothesized future. One of his main premises is that humankind will in the future intensify its attempts to reach perpetual happiness, immortality and God-like powers. This book – and that is why the title of this coda draws heavily on its title – is one of the most widely-read imaginations about the future of the human species in the past years. As such, it combines much of what is referenced in this chapter: the advancement of biotechnologies and concomitant possibilities to intervene in human bodies on smaller and smaller scales, the promissory narratives created around biotechnologies as well as humanity's innate yearning for and ability to change and shape itself, the fantasies that drive those desires. Homo deus, the god-like human, is the imagined, the promised outcome of the trends we see today, claims Harari. This change, he says, will not happen in "a day or a year" (56) but will be the result of incremental changes over a long period of time; changes that for him have already begun. Biotechnology, understood through culture, always carries with it the promise of a different tomorrow, of applications real and imagined that could cure or enhance and that could change our very definition of humanity. Whether this tomorrow is judged positively or negatively is beside the point of this book . Rather, we need to keep in mind that this promise is always there, always in the back of our heads, in our very own imperative to evolve through (self-)reflection, knowledge, and technology. Harari's *Homo Deus* is a prime example of how this promise is inserted into the public imagination, where it reproduces and evolves alongside technological possibilities and in concert with other representations.

This chapter set out to trace a trajectory from molecularization to plasticity and the desire for modification to the project character of contemporary embodiment. The view of the body in contemporary medicine as a complex network of composite parts – what I have termed a mechanistic-systematic view of the body – has allowed individuals to perceive of their bodies as objects that can be 'tinkered' with, while molecularization has extended this view into ever smaller and previously hidden regions of the body. But molecules, as the new objects of desire and subjects of intervention, signify more than

30 Marc Chrysanthou focuses on this idea of utopia, more precisely, the "healthy human body" as a new utopian project in postmodernity (469). I take up this idea of "utopia" in connection to the body. Broadly defined, utopia in this case denotes a future state of being that remains imaginative, always out of reach. The healthy human body, similarly, is utopian in that it is based on a (collective) imaginative, but impossible ideal of perfection.

their biological function: they promise control and authority, certainty and potentiality, change and intervention, perfection and enhancement. But they also signify a new vulnerability, a new contingency of human life, based on risk calculations and preemptive interventions – enforcing a dogma of personal responsibility and self-determination. These promises and vulnerabilities are often, but not exclusively, made sense of in narrative and the imagination, in fictive worlds and imagined bodies. Those serve as tools to think through what we desire and fear, how we want to live, what kinds of social and political structures are possible and, crucially here, what kinds of bodies we want to possess. As such, they are one instance through which bodies are thought of as open projects; others include discourses of self-determination and identity construction, of beauty and health, of freedom and individuality. This is also where promise and plasticity come together: The promises created in cultural discourses give the impetus for change, while plasticity provides the material basis, on which in the era of self-management and self-responsibility individuals build their own body-projects in a truly self-directed fashion.

If we talk about the body as a project, we talk about it as both a material body that is worked on and as an abstract process embedded in a larger 'project' we call self or life. We here, thus, do not just look at a physical project but also a much more epistemological question of how we approach and define humans, bodies, life. The view of the body as a project and the desire for transformation, perpetuated also by fictive imaginaries, will in their essence also have an impact in the context of DIY biology and medicine. "The ultimate DIY project becomes the body itself," writes Chrysanthou (471). DIY biology and medicine is not necessarily concerned with transformation, perfection or enhancement, but with their foundational ideas: It aims at shaping nature, tinkering with biology, carrying out self-directed interventions – to maintain a status quo, restore 'health' however defined or enhance our dispositions. Some of these ideals and cultural values behind DIY biology and medicine are the topic of the next chapter.