Chapter 5
Technogenesis: Aesthetic Dimensions of Art and Biotechnology

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> *…since the eye is the most perfect among the exterior senses, it moves the mind to hatred, love and fear.*
>
> (Ravenna, 1587, in Freedberg, 1989, 34)[1]

From material processes to elusive patterns, artists and scientists seek models of explanation (Kemp, 2000). Sometimes illusionally evocative, sometimes rigorously formulaic, and at other times sculpturally bounded, these conceptualizing tools have historically linked art and science. Bring to the fore new technologies, digitally driven, and a vast array of alternative schemes become possibilities. High resolution images of cells, scanned helical DNA structures and synaptic neural connections can presently be viewed in real time. Add to the mix embodied transgenic life forms and fabricated animal models, and our conceptualizing tools expand the possibilities for dimensional invention.

The accelerating dynamic between cultural and genetic evolution produces what can be termed a co-evolution between technical knowledge and living matter. And it is this co-evolution between technical expertise and animate matter we term *technogenesis*.[2] In other terms, *technogenesis* is the way in which the interactions between technology and biology impact our understanding of how nature exists, or would be, conceived and reconfigured in the future.

But how do art practices and the life sciences rely on the efficacy of images? And what part do these images play in the acquisition, comprehension, dissemination and even funding of visual or scientific study? In what ways do images reflect the socio/economic and cultural conditions of producing knowledge? Located somewhere between illusion, proof and cognitive projection, images, hence, become critical fictions operating within the cultural imaginary. They often traverse contested territories situated elsewhere on the axis between fact and fiction. These visualizing models,

[1] Quoted from G.B. Armenini, *De 'veri precetti della pictura* (Ravenna, 1587. In Freedberg, 1989, 34).

[2] For other references and meanings of the term *technogenesis* see Walby (2000); also see Mitchell (2002)

B.A. Lustig et al. (eds.) *Altering Nature*,

ubiquitously employed by artists, scientists, designers, corporate advertisers, journalists and politicians, clarify, mislead, aggrandize, stimulate and document. In brief, they are representations embedded in social structures, policy decisions and commercial ventures. As aesthetic devices such images perform their semiotic function activating thought and emotion by their salient powers of communication and circumscribed belief (Anker, 2004)

Since the mid-19th century the practice of art has repeatedly shifted its focus away from beauty as its primary and defining attribute. Whereas beauty was once an encompassing characteristic inherent in works of art, other aesthetic strategies have arrived to displace that domain. Most markedly, the incorporation and recontextualization of extant material, through the structural principle of "cut and paste," operates in unique ways to construct and alter meaning. Although originating as an early 20th-century modernist technique in picture-making, an enlarged concept of collage can readily include TV news reports, newspaper design and the Internet. In each case continuous time and contiguous space are diced and spliced to form a new representational space. Currently, this methodology is being applied to life forms in the lab, as gene sequences, transferred between discrete species, create novel combinatory possibilities of altered living matter.

With the dominant ascendancy of modern art, non-traditional materials have often been employed as well. Body fluids, such as urine, excrement, blood, semen and even harvested human ova have found their way into the illusive and expanding boundaries of artistic practice. Tissue engineering and scaffolding, fabricated laboratory animals and transgenic plants, have become, *ipso facto*, material resources for artists. Concrete instantiations of cells, bacteria and other microscopic entities appear in art galleries, museums, and international festivals as works of art. And the body itself is often engaged as a sculptural medium, as a site of aesthetic and protoplasmic investigation, in venues of performance art.

Whereas contemporary scientific iconography frequently aspires to and achieves aesthetic notions of beauty, for contemporary artists, the aesthetic dimension serves various manifold goals. For artists the ethical pillar of beauty as a marker of belief has been replaced by metacritical commentary and interdisciplinary means of thinking. These systemic modes for generating meaning also intersect with photography, video, telecommunications and a wide range of 2D and 3D design tools. In what follows, we explore more recent art practices involving the ways in which DNA and other bio-matter metaphorically and literally become part of the artist's palette. By suggesting some of the consistencies in the ways these images and life forms present, interpret or embody DNA, we elucidate the broader cultural meanings of innovative forms of bio-technological intervention.

As we consider the ethical implications of the new biotechnologies, it is essential to recognize social effects as values in practice, which are, furthermore, shaped by consensual beliefs and expectations. Developing a comprehensive grasp of the potential ethical dilemmas inherent in biotechnology demands that we take seriously all assumptions. Visual art and visual culture provide a domain – a nominal space – where ideologies and premises are likely to be more freely expressed than in concentrated scientific discourses. Visual practices have the proactive power to influence and signify in multiple directions; they profoundly affect the enterprise of science, its public reception and consumption. Building on a tradition of texts and exhibitions investigating intersections between art, technology, and the life sciences, especially since the early 1990s, unprecedented cultural investment has been made in this theme. Known under the rubric of “sci-art” or “bio-art”, recent events have included exhibitions in art and science museums, art galleries, the media and advertising worlds, and have even found resonance in postage stamps (Figs. 5.1a and b).[3]

No single visualization, whether image or embodied living form, can provide ultimate insight into public, scientific and cultural assumptions. However, cumulative repeated representations across several scholarly and cultural fields will suggest

Fig. 5.1a Israeli stamp, 1964 (Unable to obtain permission. There are instances where we have been unable to trace or contact the copyright holder. If notified the publisher will be pleased to rectify any errors or omissions at the earliest opportunity.)

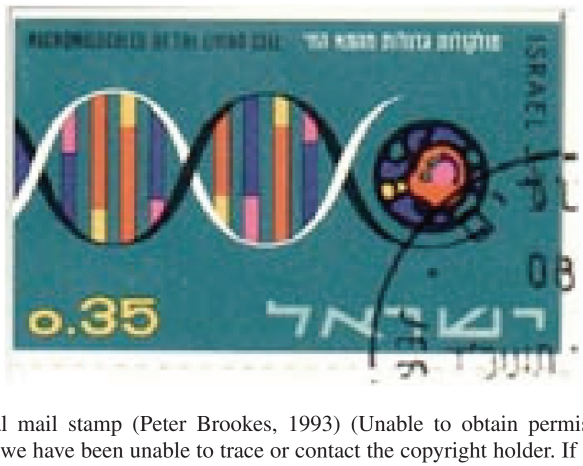

Fig. 5.1b Royal mail stamp (Peter Brookes, 1993) (Unable to obtain permission. There are instances where we have been unable to trace or contact the copyright holder. If notified the publisher will be pleased to rectify any errors or omissions at the earliest opportunity.)

[3] In the UK, the National Centre for Biotechnology Education maintains an extensive website containing images and other documentation of ephermera related to DNA. This is and extraordinary resource for further research on the influx of genetic science into popular culture through consumer products and visual culture.

See http://www.ncbe.reading.ac.uk/DNA50/ephemeral.html.

some broad tensions, concerns and ultimately beliefs. Some of these representations and performative practices are produced by artists critiquing, commenting upon and/or incorporating biotechnologies into the spectrum of their work. Other images, which we address in this paper, are advertisements of marketing campaigns and scientific product fairs which provide further insight into subliminal social and corporate messages.

Scientists as well join the aesthetic/genetic fray when they engage in manipulating their visual data as a means to enhance, communicate and persuade.[4] Is the best scientific image a reflection of the most profound science? How does aesthetic choice determine the importance of scientific data? Many scientists, enchanted by with new imaging technologies, refer to their microscopic visualizations as "art." And prestigious, peer-reviewed science journals compete with each other for the most attractively compelling cover image. Since the prevalent use of Photoshop and its allied software technologies, "seeing is believing" is no longer a truism. The role of visualization practices in scientific, cultural and artistic domains requires critical examination of the ways and means knowledge is produced and assessed in each area of study.

In addition to visualizations or bio-technological interventions into living forms, in the next section, we introduce molecular biology as a modernist science. Using literary tropes and biblical narratives, we look at some of the rhetorical contingencies associated with the current biological sciences. How do structural metaphors in language reflect cultural assumptions with regard to altering nature?

5.1 The Special Status of DNA

The ongoing dialogues supporting the genetic sciences conceptualize the body as a set of interacting signals. This abstract system of molecular data, comprising the mechanisms of inheritance, has in addition to its scientific data unraveled a multiplicity of molecular metaphors and rhetorical tropes. Although the cell contains approximately 500,000 molecules, DNA has been afforded unique status. Referred to by Martin Kemp as the "Mona Lisa" of molecules, DNA has achieved celebrity eminence as a recognizable and formidable popular icon. According to cultural critic Chris Rojek, the magnetic force of celebrity in a media-driven society, displaces religion as a supernatural power (Rojek, 2001, 51–100). Has the double helix, the celebrity molecule, become a secular visualization of divine presence? Is DNA, a supermolecule, a messenger that, like the archangel Gabriel, announced the word/spirit of the Christian God's immaculate conception? To what extent do the discoveries of genetics produce only scientific knowledge that aspires to unveil the mysteries of life but also visual symbols, metaphors and narratives that bring to bear human hopes and desires formerly associated within the provenance of religion?

[4] Felice Frankel works with scientists at MIT teaching them methods of designing more provocative and appealing images as visual data for their scientific articles. See Frankel (2002).

From genesis to gene, is the creation story embedded within this popular scientific icon?

In 1953, James Watson hailed DNA as "the most golden of molecules." In 2003, the discovery of the structure of DNA celebrated its 50th anniversary, its golden anniversary. Metaphorically speaking, gold has been the quarry of alchemists. Transmuting the profane into the sacred, turning lead into gold, one could catch a glimpse of the immortal. Ancient rulers, transfixed by their own immortality desires, looked towards the luminosity of this precious metal and its ability to resist decay, as a clear sign that something can last forever. Previously functioning as a standard of measure in the monetary system, gold was the agreed upon agent of exchange and everlasting value. DNA too, is a precious substance, a molecule of immortality in which genes are the archeological evidence of bio-historical ancestry, family identity and genealogical connections. Its magical powers are evidenced by its infinite and eternally driven self-replication and perpetuation.

As artist Larry Miller's *Genetic Code Copyright Certificates* (c. 1989) (Fig. 5.2) provocatively asks, in this golden age of biology, does my DNA belong to me? If not, to whom does it belong? Is my unique code equivalent to my being, spirit or elsewise? Or is it a natural resource, a family trust or an enzymatic recipe for surveillance? Is it a sacred secret of life or a deed to a body-part farm? Is it the book of life or the Holy Grail? Each description of DNA brings with it a range of ideological positions and emotional responses ranging from the awesome to the awful. So how can we measure the discordant meanings of this molecule and its impact on our personal lives, cherished values and as-yet-to-be clarified assumptions? (Anker, 1996, 90).


GENETIC CODE COPYRIGHT

I, ______________________________,

Of my mother, ______________ and my father, ______________

DO HEREBY FOREVER COPYRIGHT MY UNIQUE GENOME,

Any reproduction, regeneration or facsimile duplication, whether in whole or in part,

whether physically manifested or technologically represented is UNIVERSALLY PROHIBITED.

All rights and permissions are reserved and may only be assigned, in whole or in part,

to a specified agent via legal, written authorization by me or by my legal heirs upon my decease.

Fig. 5.2 *Genetic Code Copyright Certificate*, 1992, by Larry Miller; printed with permission from the artist

5.2 The Book of Life: Religious Metaphors and DNA

The history and ongoing developments in art reflect changing worldviews of religious and spiritual practice. Beginning as a magical-religious ritual, images created as icons or symbols were imbued with totemic value. They affectively operate as sensual models of thoughts and feelings, bringing to visualization the signification processes inherent in any symbolic order.

As identity becomes further linked with DNA as an intricate harbinger of coded, yet mutable meanings, symbolic inferences embedded within this "golden molecule" are being parsed out. In rhetoric as well, coded meanings are examined and find resonance with a broad range of religious texts. "In the beginning was the word, and the word was made flesh," a radical transcription of thought (and God), as postulated in Genesis (Shlain, 1999). In a post-genomic world, however, our mortal flesh has become grounded in a steam of nucleotide sequences represented as well by the alphabetical signs, namely A, G, T and C.

As early as 1992, Richard Lewontin, in "The Dream of the Human Genome," (a review of *Code of Codes: Scientific and Social Issues in the Human Genome Project*), identified an underlying religious narrative present in a collection of essays on molecular biology edited by Daniel Kevles and Leroy Hood (Lewontin, 1992). He states that "molecular biology is now a religion, and the molecular biologists are its prophets." Research scientists employ such metaphors when they describe molecular genetics as "the code of codes" or "the book of life", giving a quasi-religious overtone to DNA's molecular script (Kevles and Hood, 1992). For nucleic acid chemist Erwin Chargaff, "the double helix has replaced the cross in the biological alphabet" (Kevles and Hood, 1992, 83–97). Ian Wilmut's "The Second Genesis" invokes cloning as the Second Coming (Alexander, 2003). But how are these metaphors to be interpreted in light of the science and culture wars? Do these metaphors equate religion and science for a general audience? Are they helpful in bringing a clearer understanding of molecular biology to the public? Or, is this rhetoric only a partial and incomplete analogy of grandiose proportion?

There are myriad interpretations with regard to the influx of religious meanings into genetic iconography's place in narrative, popular culture, mass media and works of art. Molecular biologist Lynn Petrullo (2000) cites the conflicting interpretations of this science in the public domain. Dorothy Nelkin and Susan Lindee "primarily see the image of DNA as denoting genetic essentialism," a cultural message in which the genes are perceived as primarily deterministic (Nelkin and Lindee, 2004). For Bryan Appelyard, "holistic genetic thinking is a new metaphor of the sacred," underscoring the universality of life (Appelyard, 1998). The multiple meanings reflected in images of DNA are denominators of the varied and alternative ideological positions that genetic imagery can elicit. These variegated interpretations need not be mutually exclusive. Currently, conventional notions of reductionism are being expanded and nuanced to address questions concerning human identity, sacred beliefs, the practice of medicine and the politics of science.

In *The Religion of Technology*, David F. Noble discusses a dualism evident in millennium thinking: the rise of fundamentalist faith on the one hand, and an unprecedented embrace of technology on the other (Noble, 1997). Evidenced by this intense shift in geopolitical configurations between Western traditions and those theocratic societies currently operating under Islamic hegemony, American politics has in large measure usurped the "word" of God as a moral and political imperative. Simultaneously, Western cultures have, over time, integrated accelerating technologies (and their corresponding impact on society) into their probable ways of life and social organization. Alternatively, various other cultures in the world have not as yet experienced such technological "progress" as an aspect of modernity. Technological intervention, growing exponentially on all fronts in modern society, is, at least for the time being, an amalgamation of tools and techniques brought to the fore by Enlightenment thinking. But cultures throughout the world continually exist at various levels of development, industrialization and secularization.

Historically, religion's relationship to technological and iconographic power stimulated a wide range of theoretical issues culturally embedded in various theologies. St. Augustine in *City of God* warns against the dangers created by magic or illusion. In Book 21, Chapter 6 he states:

> But as to those permanent miracles of nature, whereby we wish to persuade the skeptical of the materials of the world to come, those are quite sufficient for our purposes which we ourselves can observe or of which it is not difficult to find trustworthy witnesses.[5]

In addition, in *De doctrina Christiana* Augustine takes heed of the falsely seductive qualities of beautiful rhetoric as a mechanism than confuses truth and the gospel.

By the 9th century, John Scotus Eriugena (John the Scot) calls upon the mechanical arts, including medicine and art, as a necessary part of the human restoration process. In their capacity to augment humans' inferior position to God, technology began to be seen as a way to recover Adam's fall from grace (Noble, 1997, 9–20). Contrasting the term "mechanical arts" from the "liberal arts" which included grammar, rhetoric, dialectic, arithmetic, astronomy and music, the medieval thinker states that the mechanical arts arise from "some imitation of human devising." Such a statement acknowledges technology as a restorative aid to the humble status of fallen beings. This sort of thinking becomes the groundwork for the Renaissance revival in which man became the measure of all things. Thus for Noble, "technology has come to be identified with transcendence, implicated as never before in the Christian idea of redemption" (Noble, 1997).

A further example of this attitude is demonstrated through the study of optics and optical analogy. During the Middle Ages, "the whole science of optics influences Christian thought," states Renaissance art historian Samuel Edgerton. Edgerton's history of optics begins in ancient Greece where optics was a "branch

[5] New Advent version of *City of God*. Many thanks to Christina L.H. Traina for this citation.

of Euclidean geometry." He goes on to explain that "in the 12th century the Greek word, *optika* was Latinized as *perspectiva*, meaning to 'see through.' Christian monks, fascinated by this science, could for the first time reveal how the mind of God works: how his divine grace transmits, just like light rays from an illuminating source."[6]

Whether through a prism or an alphabet, a gel or a painting, the tools of our invention make and remake our beliefs about what it means to be alive in all its diverse dimensions.

5.3 Typological Structure in Religion and Science

Further intersections and comparisons can be made between science, technology and religion within literary, biblical and scientific narratives. Mythical plots become working metaphors for bringing science and religion together in textual compositions (van Dijck, 1998). Literary critic Northrop Fry considers the Christian Bible a narrative, a form of literature, explicating through tropes and rhetorical devices the myths of the human condition. Fry's typologies are employed as analytic tools, systemic keys to the understanding of literary genres. Viewing the Bible as a work of literature in which plots and stories unfold, he perceives the Messiah as a hero and traces his development: "He enters the physical world at his Incarnation, achieves his conquest of death and hell in the lower world after his death on the cross. Then as noted he reappears in the physical world at his Resurrection and goes back into the sky with Ascension" (Fry, 1982, 174–176).

The story of Christ's death and resurrection can be thought of as an intrinsic cycle, because in Fry's words "however important for man, it involved no essential change in divine nature itself" (1982, 174–176). In Fig. 5.3a the viewer follows Christ's circular trajectory through incarnation and ascension into heaven. He travels through birth, death and finally rebirth as resurrection. What is relevant to our discussion is that Christ's transformation remains constant and complete, a transformation enveloped within everlasting and divine status. The structure and function of the Messiah become one. His actions collapse any distinction between form and content since only a Messiah can ascend through cycles of rebirth.

An analogous, yet secular process operates within the cell cycle (Fig. 5.3b). To construct or repair the host organism, a cell moves through a slow mitotic cycle. The so-called M phase leads to the G1 phase which leads to the S phase (where DNA synthesis takes place). From 6–10 hours later, the entire genome has been replicated and the cell goes into the G2 phase, that is the time it needs to prepare for mitotic division. In this constant process of renewal, the cycle of life is born and reborn through repetitive and structural action (de Duve, 1984, 319). The mechanism

[6] Conversation with Professor Samuel Edgerton, Professor of Art History at Williams College, Spring 2002. For further information see Edgerton (1975).

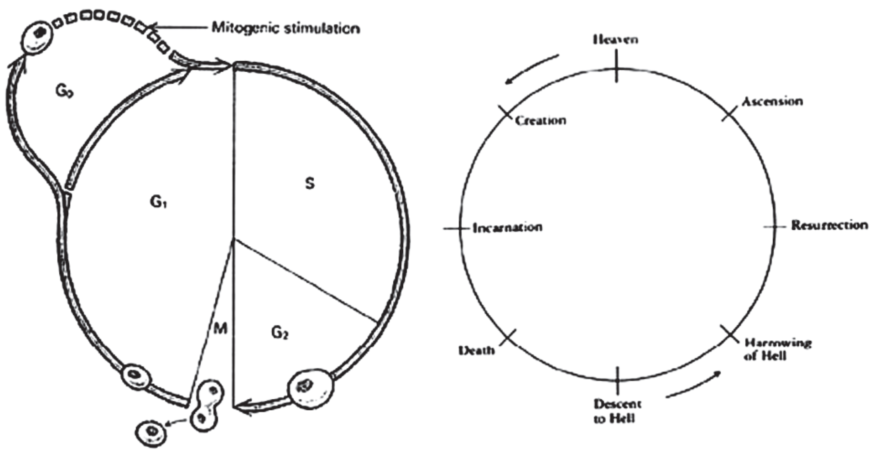

Fig. 5.3 **a** *Cell Cycle,* **b** *Ascension to Heaven* (Unable to obtain permission. There are instances where we have been unable to trace or contact the copyright holder. If notified the publisher will be pleased to rectify any errors or omissions at the earliest opportunity.)

of the cell cycle, like the Christian narrative, moves through the life processes of birth, death and rebirth inextricably linking form to function in a transfiguration tale (Anker, 1997).

5.4 The Birth of Molecular Biology

Whereas religious belief and artistic practice have ancient roots in civilizations, molecular biology is a modernist science. Coalescing as a scientific discipline during the late 1930s, molecular biology became a formal area of study during the 1940s and 1950s. The term itself, coined in 1938 by Warren Weaver of the Rockefeller Foundation, emphasized the minuteness of biological entities. It was an interdisciplinary fusion that would borrow methods from embryology, genetics, physiology, immunology and microbiology, heralding the biological sciences into "Big Science's" establishment (Kay, 2000). Physicists, now drawn to biology, began looking at the molecular machinery of the cell on the microscopic level. Could life itself operate under the "laws of the universe" as explicated by chemistry and physics? (Reichle, 2001).

In physicist Erwin Schrodinger's seminal text "What Is Life?" (1943), he identifies the chromosome as "the law code and executive power" of cellular structures. The implications of this metaphor reframe the cell as an entity that could be decoded, or deciphered, like any other information system (Anker and Nelkin, 2004). Perceiving the body as a decipherable text and information system, scientists increasingly employed linguistic tropes and communication models to describe the cell's molecular organization. Referring to the action of the gene, chemical reactions were considered to be transcriptions and translations, in a network of stored information. Converting the body from considerations of flesh and blood into communicating signals of microscopic parts recasts questions concerning the integrity of the body, its organs, tissues, cells, and molecules.

In this next section, we explore the characteristic manners in which contemporary visual artists picture the biological and genetic sciences. Drawing on visual metaphor and art's iconographic history, the following depictions speak to the cultural dimensions of DNA. Visual artists have always been interested in the tools, technologies and picturing devices of their day. The genetic sciences, for the contemporary artist, continue modern art's directive of exploring and making visible the invisible.

5.5 Artists Picture DNA: A Sampler

Picturing DNA, avatar of 20th century molecules, to a general audience is an act of blind faith. Rendered exclusively through instrumentation and intellectual grasp, this subdivisible entity is the matrix of all known life. But aside from scientific data, the optical gaze and its attendant pictorial signs bring into focus a secondary set of propositions: the social, cultural, and aesthetic dimensions bounded by this molecule.

During the late 1980s and early 1990s numerous art exhibitions related to the "body" were mounted, as the corporeal self was being scrutinized in terms of race, class and gender. Identity and its politics became key issues of discourse in contemporary art and a handful of artists began investigating genetics, its iconography, and mechanisms within a nature/culture dialogue. Additional focus came from an increasing awareness of digital technologies and the role they would play in our future, as in William Gibson and Bruce Sterling's fictional accounts of cyberspace. In addition, a growing Internet access, accelerated improvements in and reduced costs of computing speed and data storage along with powerful (user-friendly) software brought the virtual world into consumer's reach. At the same time, Photoshop, CAD 3D modeling programs, and intricate computer games delivered futuristic devices and digital tools to the artist's studio. Spurred by this convergence between concepts of a changing corporeality and the influx of personal computers and "new media" apparatus, a growing number of artists began working in biotechnology-inspired domains.

As employed by artists, sources for genetic, scientific and medical iconography are variegated. Extant material is often appropriated from visualizations in journals, textbooks or from the world-wide-web. Additionally, images are directly obtained from living (and dead) matter as visual artists increasingly work within the context of a scientific laboratory. Some images may, in fact, be rescued from personal charts of medical procedures and the like, such as X-rays, MRI printouts, sonograms, and endoscopic portraits. Many of these representations focus on diverse and differing levels of cellular and molecular organization. Add to this molecular image-bank, types of tools and techniques such as fluorescent markers, gels, scanning or atomic force microscopes, and what results is a full array of mediated pictorializations producing the body as more transparent than ever.

Ranging from the double helix to the chromosome to the gene, manifold images of genetic and cellular structures can be visually depicted or computationally mapped. Visualizations for the scientist are often employed as documents of sound scientific methods, an end point of empirical verification and authentic repeatable results. Images for the artist, genetic and otherwise, however, are starting points for the production and reception of inter-subjective communication. By compounding through multiple meanings and overlayed metaphorical tropes, the recontextualization of scientific imagery repurposes scientific icons to other ends. Polysemous in nature, visual art's interrogative status is articulated by its embodiment of human emotion and thought.

Representation carries with it a wide host of cultural assumptions, ideological constructions and subjective interpretations. What images mean, to whom and when, is part of dialogues within art history, literary theory and semiotics. Referring to images as pictorial signs, differences in modes of representation can be characterized using Charles Saunders Peirce's nomenclature of icon, index and symbol. The icon informs through mimetic resemblance. Like looking in a mirror, it is isomorphic in nature. The index, or trace, points to a cause and effect relationship, based on the manner in which one entity acts upon another. This type of representation is not a visual equivalent, but a logical connector causally calculated. For example, the residual tanning marks made from a bikini onto the skin of a young coed pictures the action of the sun. The third type of sign is the symbol which denotes culturally constructed meaning that is agreed upon by members of a social group. Examples include color coded gender preferences or fashion choices.

As the current century's iconic molecule, DNA has moved out of its confines in the scientific laboratory and into the social space of the world of art. As artists respond to their cultural milieu, images of the genetic sciences take their place along with other icons of popular culture, namely the double helix. In *Code Noah* (1988) (Fig. 5.4), for example, British sculptor Tony Cragg creates a helical spiral of industrially manufactured teddy bears, cast in golden bronze. As a molecular architecture playfully arranged, the artist transposes the microscopic molecule into a larger than life construction. Have the naturally and culturally constructed aspects of matter come to be interchangeable parts as the building blocks of life? Is DNA to be endlessly reconfigured at will as part of the utopian dream of biotechnology's status in a consumer society? Is DNA a new toy, an organic erector set, in which the possibilities of diverse industrial design lay dormant? Cragg's work underscores the multi-coded nature of visual art which brings to the fore the possibilities of its myriad interpretations. Unlike advertising or science, meaning is not targeted to a specific message, but instead resides in the poetic resonance of mutual possibilities. Within works of art, contradictory meanings can, and often do, share the same space.

The chromosome too, has moved out of the laboratory and into social space. Acutely recognizable by the public-at-large, the chromosome is heredity's ancient bio-marker.

Fig. 5.4 *Code Noah*, 1988, by Tony Cragg; courtesy: Marian Goodman Gallery, New York

To visualize this microscopic entity, a laboratory technician photographs cells in culture during their metaphase period, the phase in which chromosomes visually emerge. The lab worker's next task is to match identical pairs of chromosomes according to size and shape thus creating an artificial arrangement known as a karyotype. Congruent with an ideogram or a shorthand language, this synthetic assembly maps such biological characteristics as species or gender, among others. Additionally this technique is employed to examine differences in identity among divergent life forms, such as for example, a bluefish, a petunia or *E. Coli* (Anker, 1996). Like a form of primitive writing, these lexicons are the body's system of writing itself, witnessed by the way of a magnified instrumentalized vision.

Since 1990, Suzanne Anker has been incorporating images of chromosomes in her works of art. Intent on exploring the ways in which notations and experimental practices in science can be transferred to cultural spaces, Anker's work embeds the chromosome and its attendant optical apparatus into art historical parlance.

Art historian and curator Frances Terpek cites Robert Hooke in discussing the role of optics in Anker's sculptural installation *Zoosemiotics* (1993) (Fig. 5.5):

> In 1665, when Robert Hooke, director of experiments for the Royal Society in London, published his account of how to use a "round Globe of Water" to focus light, he was redeploying a device that had been used long before his time as a rudimentary instrument for magnifying objects. Anker's *Zoosemiotics* employs both these functions. It not only magnifies but also focuses the viewer's gaze on the four designs scattered across the walls of the installation. *Zoosemiotics* is emblematic of the intersection—past and present—of art and science. Literally and metaphorically the installation is "an ocular demonstration." Anker reconfigures this standard used by Hooke and his generation as empirical proof of physical phenomenon in an installation that, in Anker's words, offers an "abbreviated blueprint of cultural code summarizing the materialization of idea into visual form" (Stafford and Terpak, 2001, 220–222).

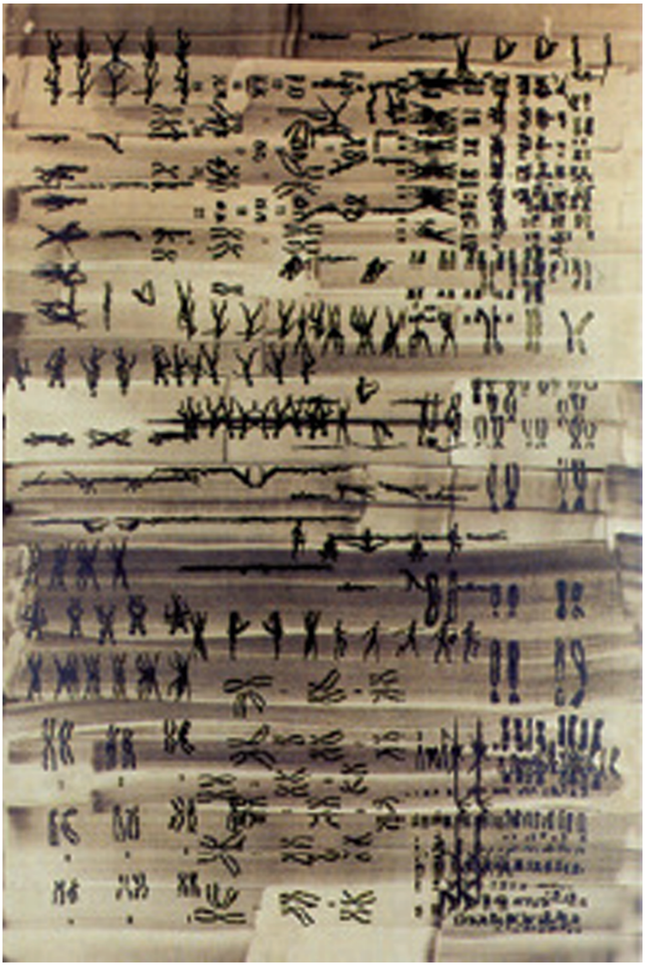

Fig. 5.5 *Zoosemiotcs*, 2001, by Suzanne Anker; printed with permission from Suzanne Anker

Anker's ongoing series of hand-painted silkscreen prints *Geneculture* (1991), *Scriptography* (1998), *Symbolic Species* (*1998*), *Rebus* (1998), and *Mico-Glyph (Soma Font)* (2000) (Fig. 5.6) among others, ensconce the chromosome into a field of signs, ranging from silhouetted exercise figures to unusual animal karyotypes. Art critic Nancy Princenthal refers to them collectively as "glyphs" and describes them thus: "Precisely rendered in metallic gold and black against a brushy background, the human and chromosomal figures are aggregated and sequenced in ways that allude to the conventions of text (sentences, paragraphs) and also to scientific charts and diagrams" (Princenthal, 2000). Added to the mix, characters from diverse languages such as Arabic and Ethiopian meet on the picture plane, elucidating a further correlation between biological form and man-made language.

Moving from the iconic to the indexical, we encounter the scientific imaging device known as the autoradiograph. The autoradiograph, a technology made recognizable

Fig. 5.6 *Micro Glyph (Soma Font)*, 2000, by Suzanne Anker, printed with permission from Suzanne Anker

to popular audiences through forensics and police dramas, exemplifies Peirce's notion of the indexical sign, or trace. In this imaging technique, rows of light and dark bands in discrete lanes can be visualized as a "print-out" of an individual's unique genetic code. As a DNA fingerprint, this technique is widely used in criminal investigations, disputed paternity suits and by evolutionary biologists to trace family lineage, resemblance and evolutionary order. Dennis Ashbaugh was among the initial artists to employ this image in a work of art. Transforming laboratory iconography into color field painting, Ashbaugh's abstract pictures, such as *Designer Gene* (1992) (Fig. 5.7) become a discourse between two fields of inquiry, genetic evidence and Color Field painting. Despite their scientifically derived sources, his paintings possess an emotional quality that is reminiscent of abstract expressionist Mark Rothko's transcendental work of the 1950s. Both artists create a spiritualized world evoked by shades of color and vibrating light.[7] It is worthwhile to note that pictorializations speak to the context in which they operate, but they can also be critical devices for reframing dialogue. All images, be they scientific, commercial, or aesthetic, have historical resonance and point to modes of inquiry and concern at a given time and place.

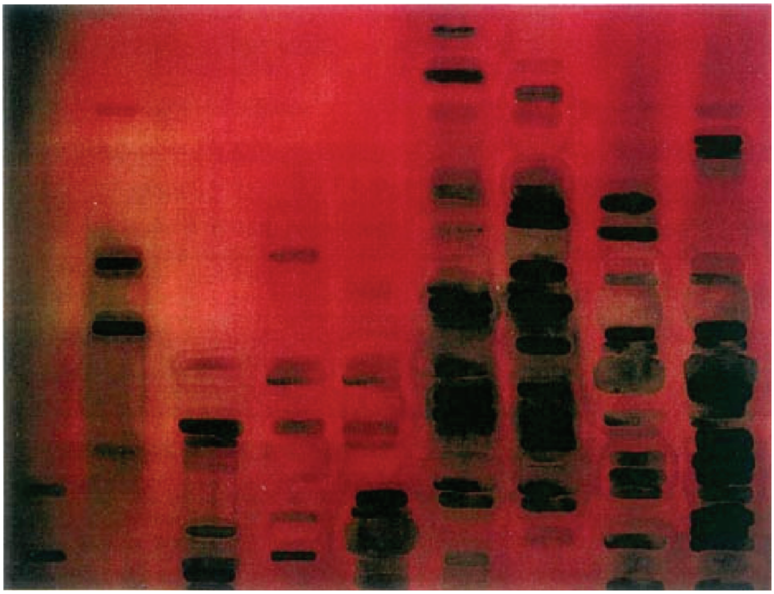

Fig. 5.7 *Designer Gene*, by Dennis Ashbaugh; printed with permission from Dennis Ashbaugh

[7] Mark Rothko (1903–1970), a prominent member of the New York School, studied biology, mathematics and physics at Yale University. See Weiss and Mancusi-Ungaro (2000). His early work with biomorphic forms employed many religious themes including baptism and resurrection.

The third type of sign categorized by Peirce is the culturally specific symbol. As symbols for the four-nucleotide bases comprising molecular DNA, the A, G, T, C sequence represents Adenine, Guanine, Thymine, and Cytosine, respectively. This unfolding sequence of nucleotides is particular for each individual, indicating differences in genomic variation. Kevin Clarke, working within the genre of the "genetic portrait," represents his sitters' "identities" by revealing their unique genetic codes. One of the caveats for his procedure is that the sitter must provide a blood sample, which is then sent to the lab to be genetically deciphered. For each sitter, Clarke chooses an identical area of the genome to be analyzed, so that the lab results, although individually varied, are also consistently represented. In addition to the coded scientific analysis, Clarke assigns a subjective image to the sitter's personality or sensibility. For example, for Jeff Koons, a stockbroker turned blue-chip artist, Clarke superimposes Koons' nucleotide sequence onto a slot machine (Fig. 5.8).

For the renowned scientist James Watson, Clarke chooses an image of parallel library shelves. For Clarke this architectonic emblem is a visual metaphor for the helical ladder of Watson's co-discovery of DNA's double helix. Set against a

Fig. 5.8 *Portrait of Jeff Koons* (Kevin Clarke, 1993) (Unable to obtain permission. There are instances where we have been unable to trace or contact the copyright holder. If notified the publisher will be pleased to rectify any errors or omissions at the earliest opportunity.)

complimentary field of green and orange looking very much like the colors of laboratory stains, Watson's bio-information becomes a read-out on public view. Although sometimes referred to as "genetic essentialism," Clarke's photographic portraits explore identity through macro-molecular difference.

5.6 Between Image and Substance

Marc Quinn's encompassing work treads on many intermediate zones, hovering between material reality and the symbolic order. Coming to prominence as a YBA (Young British Artist) during the 1990s with his signature piece, *Self* (1991), a portrait of himself cast in his own frozen blood, Quinn's work investigates the fragility of life and its processes.

Quinn's work employs once living materials, specimens of DNA, blood, pulverized placenta, and even feces while also embracing the traditional artistic materials of marble, plaster, lead, bronze, paint and photography. His unrelenting interest in life and life forms can be expressed in his own words:

> What is that emergent property called life, which occurs when a certain matrix of atoms are concentrated in a given space? What is it to be alive and know it, to exist only in this gravity, in this temperature, in this atmosphere, to be living in/trapped in a body, in time, in space. To be born and to die, to interact with others, with animals, with objects, with psychoactive substances, to feel emotions, obsessions, desires. To be a self-fueling organism, a living process, to be a potential object. To know that the atoms that make up your body will one day make up another. To transform energy and to be latent energy, to reproduce, have sex, stop, go, stop, what's it all about? That's what it's all about (Gruenenberg and Pomery, 2002).[8]

In 2001 Marc Quinn began using DNA to generate his images and sculptures, alluding to the power of DNA as a message in itself. Using a sperm sample garnered from Sir John Sulston, the former director of the Wellcome Trust Sanger Center in Cambridge, UK, Quinn's "portrait" of Sulston is composed of actual cultured cells. Looking like creamy blots, or the process paper goes through when it is "foxing," it is framed in reflective stainless steel. This work was initially exhibited at the National Portrait Gallery in London in 2001, along with many other traditional portraits. As an artist, Quinn is interested in the material and "invisible" world with all its attendant metaphysical questions.

For the artist, his portrait of Sir John Sulston cannot be any more realistic. He speaks of it as "the most realistic portrait in the Portrait Gallery," because it carries the actual genetic instructions that led to the embodiment of the subject (Sulston and Ferry, 2002; see also Anker and Nelkin, 2004). Quinn considers this kind of portraiture a bio-portrait of "every ancestor Sulston ever had back to the beginning

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[8] Catalogue accompanying the exhibition *Marc Quinn*, organized by the Tate Liverpool. Curated and edited by Christoph Grunenberg and Victoria Pomery (2002).

of life in the universe. I like that it makes the invisible visible and brings the inside out." Sulston's response is more reserved: "The portrait contains a small fraction of my DNA, so it's only a detail of the whole, although there is ample information to identify me" (BBC News, 2001).

In *DNA Garden* (2002) (Fig. 5.9), Quinn comments on the continuity of all living matter. Within this stainless steel tryptych, 77 plates of cloned DNA, 75 plants and two human samples are contained. He discusses this work in terms of religious metaphor, invoking both the Garden of Eden and Hieronymus Bosch's morality painting *The Garden of Eartly Delight* (1504). In Quinn's own words he describes this sculpture as "a literalization of the Garden of Eden because if you follow back the DNA of all the plants and the two human beings there will be some single cell amoeba which is The Garden of Eden." He also comments on his use of bio-materials for this piece: "What's interesting to me is that reality should be real stuff and not illustrated. I always think that the literal is much more ambiguous than anything else." For Quinn, "science has become the religion of now."[9]

In an earlier piece, *Garden* (2000) (Fig. 5.10), commissioned by the Fondazione Prada, in Milan, Italy, Quinn brings together a variegated and copious assortment of flowers to be preserved in their splendor forever. Trying to do the impossible in this work, Quinn creates "an immortal" garden by technically freezing his flowers in silicon oil, a substance which stays liquid at −80°C. The multi-colored assortment of geographically diverse flora spring eternal in an installation with no seasonal

Fig. 5.9 Marc Quinn, *DNA Garden*, 2001. Stainless steel frame, polycarbonate agar jelly, bacteria colonies, 77 plates of cloned DNA - 75 plants, 2 humans.73 13/16 ×126 × 4 7/16 in. (187.5 × 320 × 11.2 cm). © the artist

[9] Ibid. Quoted from an Interview with Sarah Whitfield.

Fig. 5.10 Marc Quinn, *Garden*, 2000. Refrigerating room, stainless steel, acrylic tank, heated glass, refrigeration equipment, mirrors, liquid silicone at –20 ºC, turf, plants. 126 × 500 × 213 3/4 in. (320 × 1270 × 543 cm). © the artist

restraint or corporeal decay. For the artist, this process of freezing bio-matter can be compared to the way in which Andy Warhol's iconic portraits of movie stars are "ice-cold images, unrelated to the time of the flesh" (Celent, 2000). For Quinn "garden exists in the zone between biological mortality and symbolic immortality." The artist's cyrogenic/aesthetic technique, a technological intervention for life extension, not only conceptually suspends time and place but also underscores our nagging obsession with avoiding death and decay (Celent, 2000). Our dreams of perfection and immortality, underscored by a historically driven spiritual quest, encodes works of art as intermediate memory zones occupying the spaces between the present and the past. Like genetic heritage itself, our cultural lineage is but one node in the archive of life's continuity.

5.7 Feminizing the Relic

Artists are also addressing the role of gender in religion, scientific practice and visual art. This section will briefly look at two artists who investigate the politics of the body from feminist perspectives – Julia Reodica, a conceptual artist working with tissue culture technologies, and Orlan, a French performance artist who has employed surgical intervention in pursuit of bodily transformation.

Julia Reodica's *hymnNext*, composed of smooth muscle from rats, is tissue engineered to take the shape of designer hymens. Although not intended for human application at this time, these objects address feminine identity and worth with regard to social value. In many cultures, hymens are considered to be a badge of honor, a symbol of virginal purity and family pride. As a sexual site of religious ritual, the hymen, its absence or presence, is a membrane both biologically and culturally inscribed onto the bodies of women.

Reodica talks about this project as an example of the ways in which rules, protocols, and rituals in both science and theology address the issue of the clean/unclean divide. She describes this connection:

> In the laboratory, scientists go through a system of events to ensure the purity of their experiment or practice. Similar to attending church, attendants can observe the high priest prepare for the ritual. The flow-hood, a sterile air-flow area that serves as the operating platform, is the scientist' alter. Written protocols of preparing specimens and media are standardized in the field, just as sacred scrolls are copied and distributed to holy leaders (Reodica, 2004).

For Reodica, the fabricated hymen as soft sculpture raises questions about the redefinition of "new sexual beginnings for both men and women" since any orifice can become a site of physical attachment. As a possible component in regenerative medicine, her project opens up the possibilities of creating onself anew.[10] Julia Reodica is part of a growing trend of artists who consider themselves to be artist/researchers. Recently, Reodica's efforts have been substantially rewarded and recognized within the science community. She continues her projects on tissue engineering, which began as an art project, through a scientific research grant from the Rockefeller Foundation.

French performance artist Orlan employs her own body as living material to be manipulated as a sculptural form. Through repeated plastic surgeries which have been televised in real-time, and exhibited in galleries and museums worldwide, she discusses her work in the following terms: "My work and its ideas, incarnated in my flesh, interrogate the status of the body in our society and its evolution in future generations via new technologies and upcoming genetic manipulation. My body has become a site of public debate that poses crucial questions for our time" In her personal engagement with body transformation, biology for Orlan is no longer destiny (Anker and Nelkin, 2004).

In a series of small sculptures, produced in 1992 entitled *Les petits reliquaries (Small Reliquaries): Ceci est mon corps…Ceci est mon logicie (This Is My Body, This Is My Software)* (Fig. 5.11), Orlan employs 10 g of her own flesh suspended in resin. Obtained during her plastic surgery operations, this bio-matter is contained in a Petri-dish which is then overlaid on a tableaux of lexicons. In this series of work a variety of written languages are employed. Her flesh and accompanying words are foregrounded in a quotation from the contemporary French philosopher Michael Serres: "What can the common monster, tattooed, ambidextrous, hermaphrodite and

[10] For further discussion on this subject, listen to http//:www.wps1.org, "The Bio-Blurb Show", episode "The Two Cultures: Artists in the Lab" (2004–2005).

Fig. 5.11 © Orlan, 1992, *Small Reliquaries*: *This is My Body, This is My Software*, c/o ADAGP/ Pictoright, Amsterdam 2008

cross-bred, show to us right now under his skin? Yes, blood and flesh" (Serres, 2004, 148–149).

These brief sets of examples serve to underscore the wide variety of molecular metaphors and performance practices employed by visual artists (Anker and Nelkin, 2004, 73–74). They reinforce the notion that DNA has stepped out of the laboratory and into the cultural domain. Bringing this analysis to where science and art meet at the intersection of genetics, its iconography and its material capabilities, Umberto Eco's invocation of code is helpful. In understanding current relationships between art practice and laboratory science, *code* as a tool of cultural encryption can be applied to a wide range of rule-governed systems, including aesthetics, advertising, and science. For Eco, the decipherability of cultural codes, such as the signifying and communicating power of visual representations, goes beyond traditional aesthetic theory.[11] Rejecting art as a personal and expressive activity uniquely created by an individual, Eco sees the underlying structure of art as a communication system. He states,

> The point is where there is rule and institution, there is a society and a deconstructable mechanism. Culture, art, language, manufactured objects are phenomena of collective interactions governed by the same laws. Cultural life is not a spontaneous spiritual creation, but rather is rule governed…. The code is not so much an isomorphic mechanism which allows communication, but it is a mechanism which allows transformations between two systems (Eco, 1984).

[11] For a description of the changing conceptions of art in contemporary practice see Staniszewski (1995).

As we move through the 21st century, novel technological interventions spark our imagination. In this accelerating dynamic between process and product, artists too are laying out their claims. Creativity, an unharnessible, yet resilient domain of mind, continues to add piercing dimensions to the ways we envision ourselves, in the natural world. Profound questions concerning the technological interventions into how we are born, how we die, and how nature is being transformed are regularly debated by religious leaders, politicians, ethicists and lay people. Artists too are addressing these issues. And it is in the free zone of aesthetic practice that hopes, fears and desires can be appraised, for better or worse, without doing harm.

We now turn to contemporary scientific images at the more creative margins, as they appear in advertising, scientific and medical journals. Pharmaceutical and biotechnology companies along with equipment manufacturers design such images carefully to conform to the values and expectations of the scientific community and to stimulate interest in their products. Such images provide insights into the subliminal messages generated by this community.

5.8 Imaging Art History as Science Commerce

In industrialized societies, the marketing of images has become the focus of tremendous creativity and expressiveness. Advertisements for laboratory technologies and biomedical interventions often feature striking reproductions of the body, its organs and cells. And even fantastic renditions of molecules have futuristic appeal. Decked out in a full regalia of color and design, such advertising furthermore, often refers to pictorializations appropriated from art historical parlance. The Renaissance masters are a favorite. Michelangelo's works appear repeatedly in contemporary scientific and medical journal advertising layouts, and Leonardo's Mona Lisa is an extremely popular icon in this venue as well. Often used ironically, these visualizations suggest that the scientific apparatus for sale is comparable to some of the most revered products of cultural evolution. The enduring and timeless qualities inherent in state-of-the-art masterpieces are employed to associate in the viewer's mind, a similar set of expectations. By intentionally transferring characteristics of one kind to another, a subliminal message analogically enjoins the two. In addition to the standard advertising strategies of humor, satire, hyperbole and fantasy to sell their products, those engaged in producing these campaigns seem to explicitly draw on the historical relationships between art and science.

Other artistic allusions to Michelangelo or Leonardo recurrently appear. In an ad for Operon synthesizers,[12] Michelangelo's David ponders a "revolutionary new

[12] Ad for Operon, *BioTechniques*, April 2000, 28(4), 647.

tool," scaleable synthesizers. And for the Pierce Science Company, which manufactures reagents and lab kits, the hand of God reaches out to Adam, as portrayed on the ceiling on the Sistine Chapel. In this illustration, however, the protagonists' hands and arms are entirely refigured as tightly wound coils of DNA. "Extraordinary interactions are within reach," the ad promises.[13] And an ad for titanium implants features Mona Lisa, modified so that she is frowning. "The difference is in the details."[14] And, again, Mona Lisa, this time with tape on her forehead, is an ad for surgical tape.[15] And finally, Leonardo's famous drawing of the Vitruvian man is superimposed over tissue cultures in an ad for Novagen, which reads "Human Tissues, normal and diseased." It is particularly intriguing, for our purposes, that so many of science's advertising images draw heavily on the history of art's traditional genres of portraiture and nudes. In some cases, the ads compare what is accomplished through biotechnology to what has been accomplished by great artists in the past. Thus in an ad for Bio-Rad, a company that makes gel electrophoresis tools, a young couple is pictured sitting in an art museum gazing intently at a large-scale, baroquely framed image of gel electrophoresis results. "Masterful results," the copy says, "advancing the art of precast gel electrophoresis."[16] In a similar ad, a youthful duo is absorbed by visual art in a gallery, an exhibition consisting only of scientific graphs and charts.[17]

And still again, in an advertisement for an Accuvix ultrasound imaging station, two observers discernly eye the ornately framed images produced by modern biomedicine. "Every picture is a masterpiece," the copy says.[18] Other images feature the undying art historical trope of the female nude, as for a scar cream advertisement announcing that "your patients are born works of art."[19] And a Criterion XT gels ad pictures what looks to be a 17th century portrait of an elegant, if not noble lady, holding up a gilt-edged frame which contains (what else?) a gel electrophoresis image.[20]

These allusions to the history of Western art may reference the sense that scientific achievement is now equivalent to the greatest achievements of art in the past. Science has, in this construction, replaced art as an arena for the exploration of beauty, symmetry, order and truth.

Indeed, the human body often symbolizes the technology being sold in these creative workings. But it must be noted that as in Leonardo's Vitruvian man, the human body is yet more than itself. The Vitruvian man represents not only the human body

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[13] Ad for Pierce, *BioTechniques*, May 2003, 34(5), 1023.

[14] Ad for Kurz medical Inc., The Laryngoscope, April 2004, 114(4), 25.

[15] Ad for HyTape, AORN Journal, January 2004, 79(1), 41.

[16] Ad for Bio-RAD, *BioTechniques*, May 2002, 32(5), 993.

[17] Endnote ad, *BioTechniques*, September 2002, 33(3), 462.

[18] Ad for Medison Accuvix, *Journal of Ultrasound in Medicine*, May 2004, 23(5), inside back cover.

[19] Ad for Novagen, *BioTechniques*, February 2004, 36(2), 271.

[20] Mederma Ad, Journal of the American Academy of Dermatology, February 2004, 50(2), 59A.

but the cosmological relationship of man to the universe formulated with regard to humanistic perspectives. Can this imaging intersection be interpreted as a bringing together a closer, if only analogous, relationship between these distinctly different epistemological systems – science and art? Or conversely why use art to sell science? What dusting of grace do masterpieces of art give to innovative scientific practices?

5.9 Marketing Metaphors of Health and Fitness

What other metaphors are readily accessed by the advertising agencies to sell science? Many have to do with fitness and human action. For example, in an ad for Invitrogen, a massive and muscular male arm promises to "pump up your expression." Pictorializations of strong and healthy human muscle markets a "time tested Pichia Expression System."[21] Alternatively, in another ad from Promega, an infant climbing a stairway is presented as being the equivalent to a "cell proliferation assay" taking its first step.[22] And in a similar ad, a close up of a bawling baby's face is captioned, "Finally, an apoptosis assay you don't have to babysit," thus linking "mature" results with the assay.[23] A liquid handling system ad shows a silhouetted couple about to "take a spin with the latest innovation in automated liquid dispensing."[24] And an eight-armed man holds cloning kits in each hand, "for high thorough put cloning."[25]

In all these ads, human bodies, organic in nature, are presented as surrogates or stand-ins for the technologies being sold. The techniques, machines, kits and processors are "like" the actions of the human body when it dances, climbs, flexes or moves in other ways. The technology is "humanized," if you will, by images that equate its capacities with those of organic beings. Characterizing technology as an extension of the human will allows for an understanding of scientific iconography in literal terms, hence making self-evident to the viewer that the message intended is the message received. Imbuing technology with human characteristics further explicates technologies interface with nature, its repair, alteration and enhancement.

Further examples include the following. In the September, 2001 issue of *BioSciences*, a gymnast whose body is twisted around into a startling circle is pictured, targeted to represent, in physical form, the company's "genotyping services on flexible technology platforms." To be fit, increases one's chances of

[21] Bio-Rad for Criteron XT, *BioTechniques*, February 2004, 36(2), 271.

[22] Promega Ad, "One Step, One Solution", *BioTechniques*, October 2000, 29(4), 771.

[23] Promega ad, *BioTechniques*, March 2002, 32(3), 464.

[24] Robbins Scientific Corporation, *BioTechniques*, October 2000, 29(4), 795.

[25] Invitrogen, *BioTechniques*, November 2000, 29(5), 937.

survival. The limber young girl's body performs as a surrogate sign for "patented SNP-IT technology," and "provides SNP scoring and validation services tailored to meet your specific needs."[26] A similar ad features a middle-aged man in tie and dress pants, twisted like a pretzel and looking miserable, his ankles behind his neck. "Inflexible PCR technology got you tied up in knots?"[27] the copy asks. Here, the man's body represents the emotional state of the researcher, confronting an uncooperative natural phenomenon, rather than the technology. And in another ad promoting a gene transfer technology, a smiling deliveryman labeled "RNA" appears under the headline "Kill the messenger." The company's ad promises customers that its product can "knock out mRNA" and "silence target gene expression in vitro."

There are of course more comical cultural allusions in these marketing campaigns. For example, a man in a lab coat plays a flute to make a DNA strand rise like a snake from a wicker basket, thus appearing as a snake charmer.[28] Aliens are an exceedingly common subject in American popular culture, but they also appear in scientific advertising, announcing in an ad for a reagent, "we are here for gene Porter2."[29] And Dorothy's slippers from the Wizard of Oz promise that "wishes do come true" in an ad for scientific supplies.[30] Visually and verbally engaging advertisements clearly involve creative labor, and reflect informed calculations with regard to the market and culture of the scientific community.

These commercial images of the body are also often mediated by imaging devices that disclose the interiority of body to visual inspection. MRI, PET, endoscopic photography, and sonograms all make the invisible, hidden dimensions of the body accessible and visible (Kevles, 1998). As a result of this technological access, advertising images employ visualizations that are accessible through probes, arrays and scans. These mechanisms of standardized quality and control are officially licensed, with guarantees of reproducibility.

The images that appear in scientific and medical advertising suggest conceptions of the body as machine-like, technologically driven, and endowed with replaceable and renewable parts. Numerous images show figures that are porous, translucent, or open to visual inspection. The promise of complete control (of cell lines, gels, cloning techniques or experimental organisms) that underlies many of the ad campaigns and forms the basis of the fundamental appeal, replicates science's more general expectation of controlling the body, nature and technology. People who are out of control in these advertisements are symbolic of what is unscientific, problematic and in need of correction.

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[26] Ad for Orchid, *BioSciences*, September 2001, 31(3), 571.

[27] Ad for Thermo Hybaid US, *BioTechniques*, September 2001, 31(3), 575.

[28] Invitrogen ad, Elevate long PCR cloning to new heights, *BioTechniques*, February 2001, 30(2), 230.

[29] Gene Therapy Systems International ad, *BioTechniques*, January 2000, 28(1), 65.

[30] Fisher Scientific *BioTechniques*, April 2000, 28(4), 665.

Disease states, too, are portrayed as being associated with particular social groups. Current images of the body in advertising, do not create typologies along racial lines (necessarily) but do in terms of age, class, fitness level, or sex. Advertising for pharmaceuticals, for example, often features a "typical" patient for the drug concerned – an elderly male, or a middle-aged female (usually white). In these cases, the image reinforces prevailing ideas about the illness involved – men appear in ads focused on cluster headaches, for example, and women in ads about migraines, though both men and women suffer from both kinds of headaches (Kemper, 2004). Targeting audiences for advertisers is a state-of-the art promotional tool itself. As the media fragments its audiences to get more of the market share, let no group escape its psychological grip.

5.10 Pictorial Signs of Social Rank

In this section, we review some of the historical relationships between pictorial devices and the ways in which they encode signs of the body with regard to social rank. We revisit some of the history of racial science, and the manner in which images and measurements were deployed as scientific proof of ethnic and gender hierarchies. These pictorial propositions employed by both the scientific community and the public's growing engagement with popular culture embody manifold ideological assumptions with regard to race, class and women in society.

Before the mid-18th century, there was no clear boundary between empirical science and visual art. Artists and natural philosophers often collaborated, inspired by a mutual interest in direct, sensory knowledge of the human body. Enlightenment notions of the nature of perception and the process of learning, however, began to facilitate a change that was fully realized only in the 19th century. Scientists began to emphasize unadorned reality, a nature shorn of metaphysical and emblematic meanings, while artists increasingly moved away from naturalistic representations of the human body (Kemp and Wallace, 2000). As anatomy became defined as an empirical, experimental science, new technologies facilitated the shift. Photographic techniques replaced the work of draftsmen and artists, and new illustrations presented the deeper, invisible, microscopic structures of the body, rather than its visually accessible surface. Scientists increasingly sought to convey the ideal form of the body through the use of measurement and statistical calculations, rather than artistic interpretation (Shea, 2000).

Ironically, this increasing empiricism and reliance on objective means of producing images coexisted with the rise of a particularly virulent race science, and racial differences became one of the most important arenas in which the new techniques of visualizing and assessing the body were applied. The economic and social importance of the notion of race, across many centuries and in various places, engaged the attention of leading figures in the history of science, and the racial typologies that emerged in the 19th century had origins in European reactions to distant populations in the age of discovery.

The Linnaean classification system, as described in his 1758 *System Natura*, classified humanity into four kinds, groups that would roughly correlate with race. These were white Europeans, red Americans, yellow Asians, and black Africans. Linnaeus proposed that you could tell the difference between races at least partly by considering what they wore. Europeans for example wore tight clothing, and Africans wore grease. The races in his categorization also differed in temperament, Asians being melancholy and stern, and American Indians irascible and impassive (Koerner, 1999). Linnaeus thus constructed race as a diffuse phenomenon expressed in every aspect of the body and mind.

Physiognomy, a late 18th century science, was a field built around the study of external form as a guide to internal qualities. Those promoting this new science, most conspicuously Lavater (1789), proposed that the face, skull, and physique were outward expressions of the inner self. By the 19th century, the sciences of physiognomy and phrenology were developing ever more elaborate systems for defining racial difference. Phrenologists measured the skull to assess personality, ability, or character, and concluded that certain bumps (on the head) revealed positive qualities and other bumps revealed negative traits. The phrenologists, most conspicuously Franz Joseph Gall, managed to map the brain in ways that are still somewhat persuasive, but their interpretations of the meanings of localized brain conformation were simplistic and unsupported by data. Different races, they proposed, had differently shaped heads that correlated, unsurprisingly, with their relative position in the scale of civilization. Other groups were also scientifically sorted based on bodily traits. Women, the poor, criminals and ethnic groups such as the Irish and the gypsies were frequently interpreted as biologically marked by inferiority.[31]

The Italian criminal anthropologist and army doctor Cesar Lombroso performed autopsies on criminals and found that their bodies were like the bodies of chimpanzees, in the shape of the head, its symmetry and its size. Lombroso's prison studies supported the notion of the "born criminal" as an atavistic regression to man's evolutionary past, and his 1876 *L'uomo delinquente*, was a bold challenge to ideas about free will and individual responsibility. The text was filled with images of those destined by biology to break the law.[32] Large ears, bushy eyebrows, thin necks, long arms and other bodily traits were associated with criminality, and Lombroso found that African bodies were commonly marked by these criminalistic morphologies.

In the same period, scientific debate about human evolution often focused on racial difference and on the possibility that the races were descended through different lines, perhaps constituting different species or subspecies, a doctrine called polygenism (Bowler, 1986, 553–558). Illustrations of pathological faces, skulls, skeletons and body types filled textbooks and scientific papers. Many of these

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[31] On the equivalence of race and gender, see Stepan (1986).

[32] On Lombroso, see Nye (1976); on the equivalence of race and gender, see Stepan (1986).

images implicitly compared gorillas and chimpanzees to humans in ways that linked Africans to nonhuman primates. Buffon in the mid-18th-century declared that apes and Africans engaged in fornication and interbreeding. But it wasn't just Africans who could be compared to apes. As Jonathan Marks has noted, the Irish were called "white chimpanzees" in the 19th century, by those who sought to deny their basic humanity (Marks, 2002).

The body has long been, in effect, a text in which physicians and scientists could read social and political meanings. Biological reasoning and images of corporeality were deployed to justify slavery, colonialism, the oppression of women and the poor. Primate faces could be drawn to seem "like" faces of Africans and women's faces were similarly "like" the faces of children.

Visual representations – photography, fingerprinting and drawing – were empowered to identify criminal types and explain cultural differences. And in the genetic age, how will other pictorializations and computations be employed to explain biological and ethnic differences? Will similar issues resurface in the masquerading guise of the genetic sciences, reinforcing the power relations already in place? Or will these advances in bio-science be applied to dispel social myths? Visualizations continue to be an effective underlying and even global force employed to mediate ideology. Although the genetic sciences have overtly stated that there is no such thing as race, how will assumptions regarding this and other issues attached to the life sciences be addressed?

In this next chapter we will look at interventions into living matter itself, and interventions that do in fact cross species lines. As combinations of living matter such as transgenic animals and plants enter the public consciousness, how will their existence be interpreted? In what follows, we explore the manipulation of life forms by visual artists and the role these visual practitioners play in being "outsiders" in scientific discourse.

5.11 The Transgenic Body: From Micro Venus to Alba

Scientist Vilém Flusser, in his 1988 *Artforum* column, "Curie's Children," suggested that the Walt Disneys of the future might be molecular biologists, who "may soon be handling skin color more or less as painters handle oils and acrylics" (Flusser, 1988). Posing the rhetorical question, "Why can't art inform nature?" he responded that, "When we ask why dogs can't be blue with red spots, we're really asking about art's role in the immediate future." Flusser recognized the potential of art to extend beyond representations of nature and science, to become integrated with both in genetically modified organisms. Yet, his vision of that intervention was only skin-deep: applying modernist principles of art and design to create "an enormous color symphony." Artists have used the materials and concepts of biotechnology in a rich panoply of ways. But only very recently has it been possible for them (usually with the help of scientific collaborators) to design genetically altered specimens by manipulating DNA. Responding to experiments in genetic engineering, artists have used biomaterials as their medium to create works that express concerns about transgenic research, cloning, and the commercialization of the body and its parts. By making the shift from *representation* to actual *embodiment*, such meta-critical reflections on these issues offer concrete examples of the state of the art of biotechnology and speculative models of its future.

Flusser was probably unaware that in 1986, artist Joe Davis and Harvard geneticist Dana Boyd began collaborating on an artwork, *Microvenus*, using DNA as the medium.[33] In protest of the sexually neutered representations of human female genitalia sent into space with the Pioneer voyage in the early 1970s, the Microvenus icon looked like the letters Y and I superimposed. In 1990, it was coded into a string of DNA nucleotides and transformed into *E. Coli* bacteria. Billions of the bacteria were produced, though they, like the icon they carried in them as part of their genetic makeup, were invisible to the naked eye. Galleries in the US were unwilling to risk displaying genetically engineered bacteria, so *Microvenu*s was described in Scientific American as "the most highly reproduced graphic that almost no one had ever seen." Finally, in 2000, the work was shown in a pressurized containment facility at Ars Electronica in Linz, Austria. Although the work was conceived within the context of the search for extraterrestrial intelligence, no provision was made for transporting *Microvenus* bacteria into outer-space, which might contaminate extraterrestrial environments.

In this ironic work, Davis satirizes the unnatural modification and misrepresentation of women's bodies by NASA scientists (Fig. 5.12). He not only corrects the design error but also constitutes the more accurate icon of female genitalia in the actual genetic material of a living organism. As a highly resilient life-form capable of withstanding the harsh environment of deep space, and one that quickly produces billions of copies of itself, *E. Coli* is a potentially viable medium for the dispersal of messages into space. Despite the tongue-in-cheek quality of this work, this substrate offered practical advantages to the materials used by NASA. For had the GMOs been transported into space and dispersed, the likelihood that the image would be discovered by extra-terrestrials arguably was much greater than the isolated images aboard the Pioneer.

5.12 Genesis as Living Text

In 1999, artist Eduardo Kac first exhibited *Genesis* (Fig. 5.13), also at Ars Electronica. In this artwork, bacteria were genetically modified to contain the verse from the biblical *Book of Genesis*, "Let man have dominion over the fish in the sea, and over the fowl of the air, and over every living thing that moves upon the earth." Kac chose this verse for its implications about "the dubious notion – divinely

[33] The work ultimately was realized by Davis and Boyd at Jon Beckwith's laboratory at Harvard Medical School and at Hatch Echol's laboratory at University of California, Berkeley.

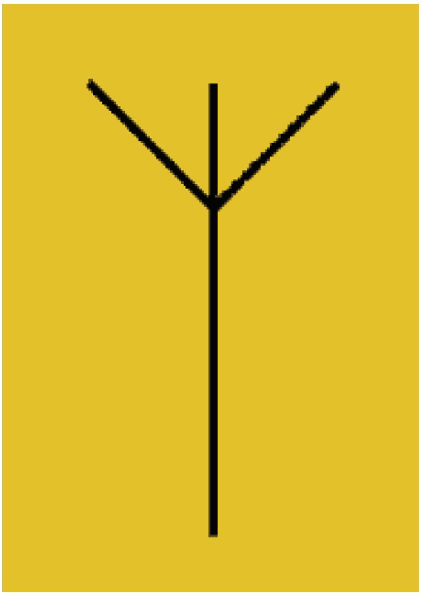

Fig. 5.12 *Microvenus*, 2000, by Joe Davis; printed with permission from Joe Davis

sanctioned – of humanity's supremacy over nature" (Kac, website). The English text was translated into Morse code, which then was converted into DNA base pairs, in order to synthesize an artificial gene that was spliced into the bacteria's genome. Participants, both locally and remotely over the Internet, could turn on an ultraviolet light, causing mutations in the bacteria's genetic code, which in turn caused alterations in the biblical verse when the mutant code was translated back into English. For Kac, the ability to alter the verse represents a refusal to "accept its meaning in the form we inherited it," and an insistence that, "new meanings emerge as we seek to change it." *Genesis* raises questions about the shared responsibility of individuals and communities to: (1) respect and protect nature, not just dominate it; (2) engage in dialogues about ethics and religion in order to reinterpret and give new meaning to traditional values; and (3) reflect on social and cultural implications of and policies regarding biotechnology.

It is important to note that these works offer public audiences an unusual opportunity to see and interact with living GMOs directly. The manner of their installation and presentation influences the nature of their reception, interpretation, and meaning. The pressurized containment facility in which *Microvenus* was exhibited implied a sense of danger – a need to quarantine the genetically modified *E. Coli* in order to protect the natural environment from this artificially produced genetic icon. The ambience of Kac's installation simultaneously evoked a sense of sublimity and clinical sterility. Original DNA-synthesized music based on Kac's Genesis gene and composed by Peter Gena was generated live in the gallery, contributing to the otherworldly and

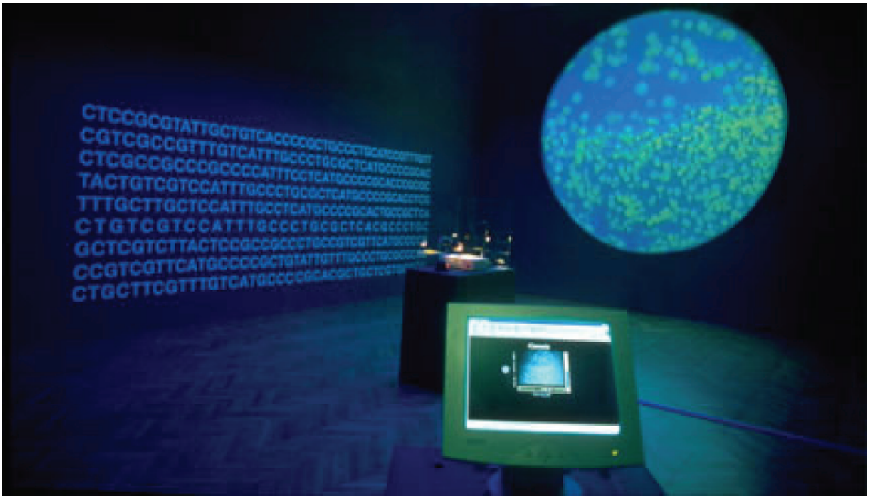

Fig. 5.13 *Genesis*, 1999, by Eduardo Kac, transgenic work with artist-created bacteria, ultraviolet light, internet, video (detail), edition of 2, dimensions variable. Collection Instituto Valenciano de ARte Moderno (IVAM), Valencia, Spain (1/2). Printed with permission from Eduardo Kac

ominous feeling. The main sculptural element consisted of a black pedestal on which a petri dish containing the genetically modified bacteria was sporadically awash in short-wave ultraviolet (UV) light. A greatly magnified real-time video of the bacteria, which glowed a greenish yellow against a blue background, was projected on one wall. The DNA sequence for the Genesis gene, inscribed in white, glowed under long-wave UV on an adjacent wall.[34] Similarly, visitors were illuminated by long-wave UV, suggesting a parallel between genetically modified bacterial code and wild-type human phylogeny as interrelated parts of a system. A computer terminal enabled local and remote visitors to access the website and actively participate in the installation by choosing either to irradiate the bacteria or shield them from the UV rays that cause mutations. By physically engaging visitors in these ways, *Genesis* attempted to create a context of empathy between its audience and GMOs. Moreover, the work insisted that the public be engaged in biotechnology and evolutionary processes, while refusing to permit its audience to remain untouched and external to the installation as outside observers.

Davis's piece refers to Greek mythology and the figure of Venus. A favorite traditional subject for artists, the goddess of love and beauty played a seminal role at the nexus of art and life as the animator of Galatea, the marble statue carved by Pygmalion in Greek myth. There appear to be no religious overtones in Davis's piece, which takes as its inspiration the design challenge of accurately and simply, though not idealistically, representing human genitalia in a robust medium; and the

[34] The audience was shielded from the harmful short-wave UV rays by a filter. Long-wave UV, typically known as "black light," does not pose the same risk.

search, not for a godhead, but for extraterrestrial forms of life. Kac's work, on the other hand, summons the force of the Old Testament, the authoritative word of God, which endows humanity with dominion over nature. Kac's work suggests that this dominion also implies responsibility. By failing to protect nature, by subjecting it to harmful radiation, humans cause irreversible mutations at the basic genetic level. In the context of the installation, such mutations result in irreversible changes in the text of Genesis – the word of God – encoded in the bacteria.[35] Although Kac embraces this malleability as a positive openness to the creation of new forms and the negotiation of new meanings, one might also be fearful that the misdirected alteration of genetic codes – and their religious and ethical corollaries – may result in undesirable physical aberrations that could sweep through the gene pool, while crippling the values that order life and give it meaning. Indeed, Kac's work must be interpreted as presenting both the positive and negative aspects of biotechnology. Rather than take a simple "pro or con" stand on a highly politicized and polemical issue, the artist removes transgenic species from the rarefied context of science and places them in the more public arena of art. The audiences of *Genesis* can have first-hand experiences of seeing and interacting with GMOs, participate in discourses about them, and form their own opinions.

5.13 GFP K9 Project: The Green Bunny

As part of the Ars Electronica symposium in 1999 on the theme of Life Science, Kac lectured on his *GFP K9* project, first proposed in 1998, and announced plans to produce his artwork, *GFP Bunny* (Fig. 5.14), which included creating a genetically modified albino rabbit that glows green when exposed to blue light because it has been engineered with "an enhanced version of the wild-type gene for green fluorescent protein (GFP) found in the jellyfish Aequorea Victoria" (Kac, "GFP Bunny"). While many people both inside and outside the art-world have embraced *GFP Bunny* as an important work, the response that afternoon in Linz anticipated the extremely negative reception of the work by many others. Just as one member of that audience exclaimed that she thought Kac must be a "terrible father," so five years later a visitor to the exhibition, *Gene(sis): Contemporary Art Explores Human Genomics*,[36] wrote in the comment book Kac furnished that s/he hoped the artist "has a child with Down's Syndrome."

[35] Scientists interested in extraterrestial life are looking for what they term a "second genesis" as a reaffirmation that life on earth is not a single phenomenon. According to CNN's telecast, finding a second source of life would unlock mysteries into the way in which life began on earth. In addition it would impact theological explanations and religious practice. See CNN (2004).

[36] Organized by the Henry Art Gallery at the University of Washington, Seattle, the exhibition traveled to three other university art galleries, including the Block Museum at Northwestern University, where the quoted comment was entered in November 2004. See http://www.gene-sis.net/splash.html.

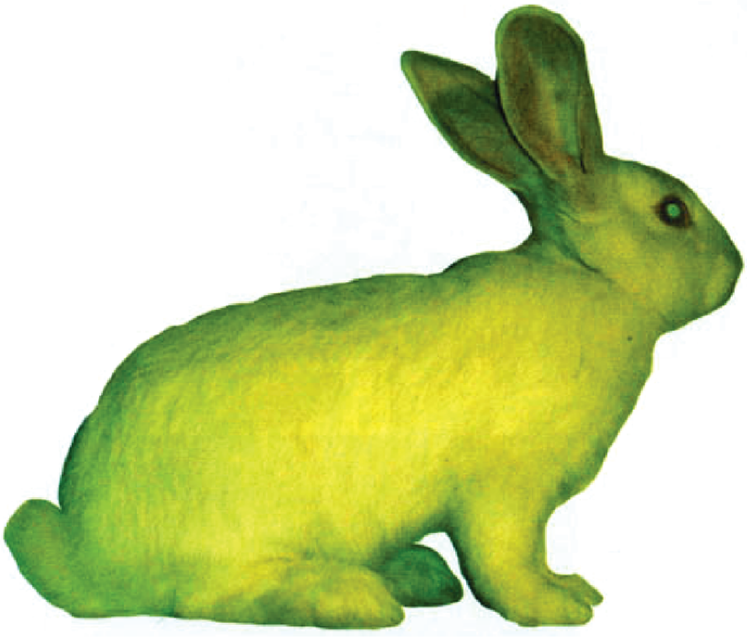

Fig. 5.14 *GFP Bunny*, 2000, by Eduardo Kac, transgenic artwork. Alba, the fluorescent rabbit. Printed with permission from Eduardo Kac

Such personal attacks demand that one ask why the use of transgenic technology as an artistic medium incites people to character assassination and transgenerational curses. Kac believes that such responses result from the anger people experience when forced against their will to become aware of a polemical issue. They are no longer able to carry on in blissful ignorance but must respond (Kac, 2004). Rather than direct their anger towards the scientific laboratories that routinely create GMOs or the industries, such as agriculture, that commonly employ them, in these cases audience members take aim at the messenger, Kac, who lacks the authority of science and industry, and is, in any case, a much easier target. The artist is, to be sure, not simply the messenger but, from this perspective, must be considered an accomplice, for he claims that Alba was created solely for artistic purposes.

Despite some of the sharply negative statements in the *Gene(sis)* guestbook, (which included many supportive comments as well), the artist observed a shift in audience response to his work using bio-materials between 1999 and 2005. “In the beginning people were quite worked up about it; there was a greater concern and fear than exists now,” he noted. “The discussion now is more philosophical; the sense that some impending doom is about to happen has completely vanished.

A level of discourse has developed that is much more complex than the original polarization" (Kac, 2005). If, in fact, audience responses have changed over time to become more subtle and sophisticated, then perhaps artistic research involving GMOs has a valuable contribution to make as a context for public discourse on the social and cultural implications of biotechnology. More research on the reception of Kac's work, and that of other artists working in this domain, may provide insight into the ethical and religious triggers pertaining to the public response to molecular biology and to the efficacy of art as a forum for dialogue and debate.

Contemporary art may be as elusive to scientists as molecular biology is to non-scientists. Just as one could not expect to comprehend genetic engineering without first understanding genetics, in order to comprehend the significance of *GFP Bunny*, one must understand its underpinnings in art history and aesthetic theory. To this end, the following discussion shall focus on the aesthetic foundations and implications of this work. Although on the surface Kac's *GFP Bunny* appears to have realized Flusser's fantasy of the artistic use of the techniques of molecular biology to create a "color symphony," its particular formal aspects are of less artistic significance than its theoretical propositions and ethical provocations. Since the 1970s, scientists routinely engineer transgenic animals for research. In science labs across the world, there are hundreds if not thousands of such mammals that, like Alba, express GFP and fluoresce when exposed to certain wavelengths. In this sense, Alba may be likened to an *objet trouvé*, or found object, employed by Marcel Duchamp beginning in the 1910s to create his "readymade" artworks. At the same time, *GFP Bunny* does not fit the definition of a readymade. Unlike a mass-produced *object* scavenged or acquired via retail markets, Kac emphasizes that Alba is a unique living *subject*, custom-engineered and bred in a government laboratory to the artist's specifications. Keeping this important distinction in mind, comparison with the Duchampian aesthetic strategy offers insight into how Kac's work is embedded in the history of art while expanding the field of artistic practice.

5.14 Laboratories of Art and Science

In response to the famous censorship of his artwork *Fountain* from an un-juried exhibition in 1917, Duchamp argued for its status as art. He claimed that by selecting a particular object (a common porcelain urinal), by giving it a title (and signing it), and by inserting it in an art exhibition, he gave that object a new meaning. Duchamp's *Fountain*, and his rationale for it, proposed that the meaning of an art object is not contained exclusively within the work and that an object's status as art cannot be determined solely by morphological characteristics. Rather, he insisted that contexts of reception and corresponding audience expectations are substantial factors in the production of meaning and value.

Similarly, Kac's selection of a transgenic mammal and his intention to recontextualize it within an artistic framework would have given new meaning to GMOs, the likes of which previously had been seen only in scientific laboratories. Like

Fountain, Kac claims *GFP Bunny* was censored; in this case by the Institut National de la Recherche Agronomique (INRA at Jouy-en-Josas, France). INRA created the rabbit with the knowledge that it was to be used for artistic purposes, then later refused to release it to the artist. Public encounters with the original *Fountain* and with *GFP Bunny* are possible only through photographs, taken serendipitously prior to their censorship. And, as Didier Ottinger has observed, "Following the example of its sanitary forerunner, the rabbit's 'prestige' grows in proportion to its invisibility… [though] never exhibited in the public space for which it was conceived …. its photograph did make the front page of the world's most important newspapers" (Ottinger, 2004). Ironically, by censoring Alba, INRA called attention to its collaboration on non-scientific projects, thereby generating, rather than stemming, negative publicity for itself, while at the same time helping to mythologize Kac's *GFP Bunny*.

Ottinger considers whether or not Alba might be considered an "assisted readymade" (a class of objects defined by Duchamp to include found objects that have been modified by the artist) but concludes that, "the absence of the rabbit's *déjà-là* prevents it from being strictly defined as a readymade." This point raises a dispute regarding Alba's uniqueness: Is she a unique, transgenic rabbit created solely for artistic purposes or is she one of many GFP rabbits generated by the lab? The Boston Globe article that broke the story in the US in September 2000 stated that Louis-Marie Houdebine (the INRA genetic researcher who bred the rabbit) was "intrigued by Kac's desire to involve the public, and had 'never considered' whether an entire animal would glow in the dark" (Cook, 2000). Two years later, however, after the controversy over INRA's refusal to grant Kac ownership of Alba, the French lab's story appeared to shift and the rabbit met an "untimely death," according to Wired News. The August 2002 article states that, according to Houdebine, Alba was "one of many GFP rabbits generated almost five years ago…" and quotes the geneticist's recollection that, "When E. Kac visited us, we examined three or four GFP rabbits…. He decided that one of them was his bunny, because it seemed a peaceful animal" (Philipkoski, 2002).

Although existing GMOs have been employed by artists such as Catherine Chalmers (Fig. 5.15), to create compelling work, the use of a readymade transgenic mammal would not have been of interest to Kac (2004). To do so would have been decidedly uncharacteristic for the artist, whose practice for over 20 years has focused on the creation of new art forms, not on the reuse of existing objects, of things "déjà-là." Moreover, it was of crucial importance to the *GFP Bunny* project that Alba embody characteristics that visually identify her as an icon of transgenics. So, for purely artistic purposes Kac specified that Alba must fluoresce green all over her body in order to manifest sufficient iconic and symbolic resonance.[37]

[37] Kac attributes the image to photographer Chrystelle Fontaine, whose name ironically bears an uncanny resemblance to Duchamp's *Fountain*. The photograph was taken with a digital camera through a special yellow filter designed to work in concert with the particular strain of GFP used in Alba (Kac, 2004). See http://www.artexetra.com/Kac.html.

Fig. 5.15 *Rhino*, 2000, by Catherine Chalmers; printed with permission from Catherine Chalmers

For scientific purposes, fluorescent markers, like GFP, have diagnostic utility only when attached to specific genes. Therefore, a rabbit that expresses GFP throughout its phenotype may have little or no use for scientists.[38] If the widely reproduced photograph of Alba fluorescing green throughout her phenotype is authentic – and that, too has been disputed – then it is likely that the rabbit was, as Kac maintains, bred specifically for his *GFP Bunny* project and would have been two-and-a-half years old and not nearly five years old at the time her death was reported.

Regardless of the controversy surrounding Alba's uniqueness and its bearing on the interpretation of *GFP Bunny* as a readymade, assisted readymade, or unique creation, Kac's attempt to place a GMO within an artistic framework draws on but supercedes the Duchampian strategy of recontextualization. Duchamp rejects the artist's and audience's traditional roles as the creator and beholder of beautiful images, respectively. The artist becomes, rather, the creator of enigmas that reveal and provoke debate over the very discursive conditions that make art possible. *Fountain* creates controversy by placing an object (urinal), loaded with abject meaning, within a fine art context. Similarly, *GFP Bunny* implies a rejection of the artist's and audience's traditional roles as the passive consumers of science and unwitting subjects of technocracy. The artist collaborates with the scientist to create new hybrid forms of life that provoke debate over the boundaries between art and science, between species, and between GMOs and wild-type organisms. Duchamp recontextualizes a pre-existing object to give it a new meaning and reveal the discursive conditions of art. Kac creates a unique and unprecedented form of subject

[38] Scientists from National Taiwan University produced pigs that they say "are the only ones that are green from the inside out." See Chris Hogg, "Taiwan breeds green-glowing pigs," BBC News, 12 January 2006. Also see Sue Broom, "Green-tinged farm points the way," BBC News, 28 April 2004. The author comments on the use of light to detect animals carrying fluorescent genes in this study. She states "Both chickens and pigs carrying the gene can be detected in normal light by their slight greenish tinge, but when viewed in blue light, all areas not covered with hair or feathers are seen to glow torch-light bright."

that opens up a new context for the negotiation of meaning and value with respect to both art and genetic science.

In upping the Duchampian ante, Kac's *GFP Bunny* recontextualized a problematic entity that, like *Fountain*, can be seen as abject. Its chimerical deviance might be considered abhorrent from certain religious and ethical views on nature. Alba is a living, breathing mammal, and some ethical positions are opposed to the exploitation of animals for human ends, regardless of their utility. Whereas the social utility of science, medicine, and agriculture provide an ethical rationale that many religious and ethical traditions accept as sufficient justification for sanctioning research on and application of transgenic technology, those traditions may not accept the use of the same techniques to serve artistic ends, the utility of which is more difficult to rationalize. Finally, for individuals and groups whose understanding of art is predicated on traditional aesthetic values of natural beauty and order, *GFP Bunny*, like *Fountain*, will not be considered art at all, much less good art. Such a position is as naïve as rejecting Watson and Crick (and everything built on their contributions to genetics) in favor of Lamarck.

It is important, moreover, to remember that the Duchampian strategy seeks to reveal and provoke debate over the very discursive conditions that make art possible. In other words, producing cognitive dissonance by appealing to the abject is intrinsic to the strategy and an integral part of the work itself. *GFP Bunny* extends this approach beyond the domain of aesthetics: it uses the context of art to *reveal and provoke debate over the discursive conditions in which genetic science operates*. Kac takes science out of the insular confines of the lab and metaphorically mounts it on the gallery wall, where it becomes the subject of social inquiry. Whereas *Fountain* gave an object a new meaning and, in the process, expanded the field of art, *GFP Bunny* not only gave a live, transgenic mammal a new meaning and expanded the field of art, but it contributed to broadening the discursive domain of molecular biology to include public debate over its social and cultural implications.

This line of reasoning would be easily understood by contemporary art historians. Indeed, Duchamp's strategy of recontextualization is as widely accepted in the field as the basic tenets of natural selection are accepted by evolutionary biologists. However, given the highly specialized nature of disciplinary knowledge and the abject quality of *GFP Bunny*, even public forums designed to foster communication over the ethical implications of biotechnology can reveal views that are polarized and closed to considering the aesthetic applications of genetic science. Such was the case at the symposium, "Art, Ethics, and Genetic Engineering: The Transgenic Art of Eduardo Kac," at Duke University on November 6, 2000.[39]

[39] Panelists (titles and affiliations pertain to their positions at the time of the panel) included Kalman P. Bland, Professor of Religion, Director of Judaic Studies Program, Duke University; Elizabeth Kiss, Director of Duke's Kenan Institute for Ethics; Associate Professor of the Practice of Political Science and Philosophy; Joseph Nevins, James B. Duke Professor of Genetics and Chair of the Department of Genetics; and Jeremy Sugarman, Director of the Center for the Study of Medical Ethics and Humanities, Associate Professor of Medicine; Associate Professor of Philosophy. See http://artexetra.com/Kac.html.

Taking *GFP Bunny* as the center of discussion, the event brought together a variety of intellectual perspectives, methods, and disciplines to exchange ideas and propositions about the social, cultural, and ethical ramifications of genetic engineering. The introductory remarks by the convener, Edward A. Shanken, shared with the panelists in advance, rhetorically asked why genetic engineering performed in the name of art would be considered more or less acceptable than the same processes carried out in the name of science. He noted that science and technology have made formidable advances towards the prediction and control of phenomena, including the remarkable ability to control illness and save human lives. But he also noted that the advances made by the arts towards interrogating the limits of knowledge and consciousness, and towards plumbing the depths and reconfiguring the conditions of human existence, are arguably of no less social significance. These considerations led to the question, "Is it inconsistent to argue on an ethical basis that animal research may be valid in science but not in the arts?"

Kac demonstrated to the audience how his artistic research for over a decade consistently addressed cultural and species hybridity by using technological media to create contexts for dialogical exchange. Panelist Joseph Nevins, a geneticist, was incapable of grasping what made *GFP Bunny* a work of art, much less a good one, and argued that it was a waste of a valuable scientific resource, the only useful function of which was for laboratory research. Neither he, nor the other panelists, including a religious scholar and two ethicists, seemed to appreciate how the socialization of a transgenic mammal as part of the artist's family, and the production of critical discourse about biotechnology and the conditions of art, were significant artistic statements. Transcending, on the one hand, the barrier between wild-type and genetically modified mammals and challenging, on the other, the closed circle of scientific discourse by opening up debate on biotechnology within an aesthetic context, did not register as valid aims for art, much less as useful contributions to culture. This misunderstanding was not a matter of specialized scientific or artistic nomenclature but consisted of an epistemological disagreement over what constituted valid methods of creating and disseminating knowledge, especially in regard to sentient creatures. Although opinions varied, the panel generally agreed that the creation of a transgenic rabbit was acceptable in the pursuit of scientific and medical knowledge, but not in the pursuit of art.

Despite the lessons of Duchamp's *Fountain* and over eight decades of artistic practice and art historical research building on and interpreting it, general audiences still have trouble accepting that artists undertake research that has value outside of the traditional aesthetic domain of beauty; that draws on, participates in, and challenges discourses in broad fields, including science and technology. Yet that is precisely what artists like Davis and Kac (and many others) succeed in doing. Despite the intransigence, if not inconsistency, of the Duke panelists' views, the fact that geneticists and ethicists appeared on the same stage with Kac to discuss *GFP Bunny* validates the work's success in opening up interdisciplinary debate. And indeed, the controversy surrounding *GFP Bunny* and the broad, international attention it received by the media have provided remarkable opportunities for Kac to participate in and interrogate the discourses of genetic science. By creating an unprecedented art subject, Alba, the artist established a context for dialogical exchange that has given molecular biology a new meaning.

GFP Bunny might be described as an artistic icon of the Age of Transgenic Reproduction (Shanken, 2004). Indeed, her image has been reprinted countless times and in diverse contexts, from international newspapers to biology textbooks. Like traditional icons, it signifies a larger concept. But Alba is also a living manifestation of that concept. As a result, there is more at stake, for Alba makes concrete the reality of living with the current state of biotechnology. *GFP Bunny* confounds the disengaged spectatorship that Walter Benjamin attributes to the popular consumption of mass culture, and demands a personal response. In contrast to the loss of aura that the German theorist claims to befall mechanically reproduced works of art, Alba possesses a fully present and hybrid aura – one that simultaneously serves the ritualistic value of art and the dialogical value of social discourse. *GFP Bunny* both *signifies* and *is* the actual embodiment of the possibility of communication and communion between animal kingdoms, between art and science, and between experts and the public.

5.15 Tissue Engineering as Culture

Other artists have also utilized the materials and techniques of microbiology and tissue engineering as artistic media to modify living organisms without any alteration in their DNA. As in art work of Kac and Davis, these works are not representations of biotechnology but actual, living embodiments of it. For example, in the Tissue Culture and Art (TC & A) project, initiated by artist Oron Catts in 1996, living tissues and non-living materials are conjoined and manipulated to create objects/beings that are "semi-living." Catts and collaborator Ionat Zurr were inspired in part by research conducted by tissue engineering pioneer Joseph P. Vacanti, who employed a living mouse as the biological substrate on which to "grow" an ear-shaped scaffold seeded with human cells. This mid-1990s icon of tissue engineering offered a glimpse of seemingly limitless possibilities of procedures in which living tissue is employed as a reconstructive sculptural technique. For the artist, this "semi-living new media" was adapted to aesthetic and philosophical ends.

In *Pigs Wings*, 2001 (Fig. 5.16) TC & A grew pig-bone tissue to mimic the shape of three different types of wings that enable flight in vertebrates, those of birds, bats, and pterosaurs. In *Fish and Chips*, 2001, the SymbioticA Research Group grew fish neurons over silicon chips connected to video and audio output devices, creating a cyborgian confluence of wetware, hardware, and software. This semi-living entity was endowed with the ability to make sound and images – to make art – begging questions about the future of human interaction with cyborgs whose behavior may be unpredictable, if not creative.

MEART (2004), which SymbioticA Research Group refers to as a "semi-living artist," asks similar questions. *MEART* is a bio-robotic drawing system which aspires,

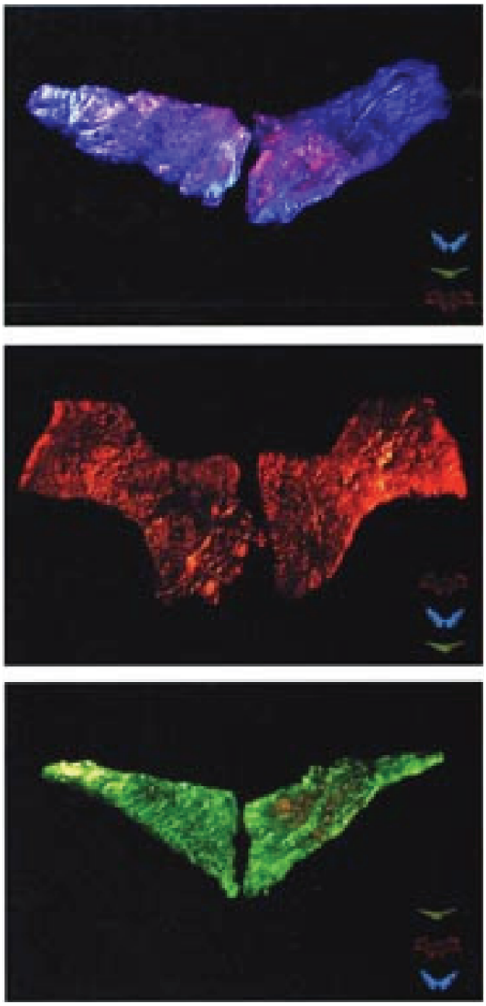

Fig. 5.16 *Pig Wings*, 2000-2001, by The Tissue Culture & Art Project. Medium: Pig mesenchymal cells (bone marrow stem cells) and biodegradable/bioabsorbable polymers (PGA, P4HB), 4cm × 2cm × 0.5cm each. Reprinted by permission of the artists

at least metaphorically, to learn how to draw portraits of gallery visitors in real time. Its "body" consists of a video camera and a robotic drawing arm, designed by artist Phil Gamblen, that can be installed on location at an exhibition. Its remote "brain" is comprised of thousands of mouse brain cells grown in a Multi-Electrode Array (MEA + ART = MEART) at Georgia Institute of Technology's Laboratory for NeuroEngineering, under the direction of Dr. Steve M. Potter. It also possesses a "nervous system" that enables the brain and the body to communicate via the Internet using software designed by Iain Sweetman at the University of Western Australia. Information about the difference between the subject's image and the current state of the portrait is fed to the neurons, stimulating them to control the robotic drawing arm in order to reduce the difference and hopefully learn through the process. As Potter noted, “I hope that we can look at the drawings it makes and see some evidence of learning. Then, we can scrutinize the cultured network under the microscope to help understand the learning process at the cellular level.” Potter also hopes that this sort of interdisciplinary work will persuade scientists to start “thinking about what is art and what is the minimum needed to make a creative entity” (Symbiotica, 2004).

Davis, Kac, and TC & A take genetic engineering and tissue culturing out of the laboratory and use it as an artistic medium. In so doing, their work transforms the abstract complexities of biotechnology into an approachable form that simultaneously problematizes science and makes it more human. Few non-scientists feel they possess sufficient knowledge to judge science, but the public has few qualms about judging art. It is generally accepted that science is rightly incomprehensible to laypeople, but when the work of an artist challenges preconceptions of what art is, that breach of aesthetic expectation is greeted with charges of elitism, immorality, or frivolity. By using biotechnology to create art, Kac and Davis demystify genetic engineering, thus enabling related social and ethical issues to be studied in a broader cultural frame. At the same time, their work pushes the political, cultural, and ethical boundaries of aesthetics, and interrogates the relationship between art and science in a social context. Neither spokespeople for the benefits of genetic engineering, nor doomsayers of its cataclysmic effects, they ask questions and promote dialogue concerning the mounting acceleration of biotechnological practices. These artists insist on the potential, if not obligation, of art to play a role in representing, provoking, and complicating ethical issues, in disturbing ethical certainties, and even a role in ethical deliberation.

Perhaps the freedom of artistic license comes at the price of cultural authority, resulting in demonization or scapegoating of artists who use bio-materials to raise ethical issues. *GFP Bunny* made Kac the subject of belligerent criticism and hatred, particularly among religious conservatives. For many people uninitiated into the rarified interdisciplinary discourses at the nexus of art, science, and technology, he became an example of what is wrong with contemporary art and artists that not only stray beyond the bounds of traditional media but claim to have the right to use the materials and techniques of biotechnology to challenge the authority of science and, moreover, to force people to confront and take responsibility for chimera about which they would prefer to remain ignorant. Such dealings can, in addition, expose an artist to legal and political challenges, as in the widely reported case of Critical Art Ensemble (CAE) member Steve Kurtz.

CAE has consistently challenged the authority of science, the rhetoric of which it has likened to a Christian religious sect, as in their ironic project *Cult of the New Eve* (2000). CAE utilized bio-materials in works including *Contestational Biology* (2001) and *Free Range Grain* (2003) with the stated goal of raising public awareness of the relationship between politics, industry, and ideology, particularly with respect to genetically modified foods, which have been legislated against in Europe but are widespread and unmarked in the US. To this end, the group employs tactics including political theater, performance, and installation, typically weaving ironic and farcical elements into their politically-charged work. In May 2004, on suspicion of bioterrorism, Kurz's home was raided by agents from the FBI and the Joint Terrorism Task Force, which discovered only harmless bacteria cultures for CAE's art project, *Marching Plague*. According to the artist, this work was intended to interrogate and demystify issues surrounding germ warfare. Charges of bioterrorism were dropped but as of July 2006 Kurtz remained on trial for mail and wire fraud and faced a maximum sentence of 20 years in prison in connection with the manner by which he obtained $256 innocuous samples of *serratia marcescens* and *bacillus atrophaeus* from his collaborator, University of Pittsburgh scientist Robert Ferrell.[40] The arts community rallied in support of Kurtz, creating the Critical Art Ensemble Defense Fund, which has raised funds to help defray the artist's legal expenses.[41]

The use of biotechnology as an artistic medium brings to the fore philosophical, ethical and religious implications pertaining to the practice of biotechnology itself. For artworks that are made using bio-materials are not simply representations of speculative visions of the future, but are actual physical embodiments that give artistic shape and form to the bio-technological present. Whereas the artist and artwork that represent the implications of biotechnology may remain one step removed from the technical and conceptual problems associated with the handling of moist-media or wet-ware, those that get their hands dirty, so to speak, by employing bio-materials are more fully implicated in the turmoil surrounding biotechnology. Needless to say, the stakes are much higher. Compared to an artist who creates representations of GMOs, an artist whose practice actually creates and incorporates them has much greater responsibility for the care and keeping of his/her artwork and much greater social responsibility for ensuring that the work does not affect the ecosystem adversely.

5.16 Altering Nature: Laboratories of Knowledge in Art and Science

Highly sophisticated visualization tools and techniques have become an integral part of the scientific laboratory and its attendant culture. State of the art images utilize Photoshop filters, multidirectional lighting effects, re-calibrated color contrasts and even post-production simulations. Perhaps more than any other contemporary technical method, the digital image has become the *lingua franca* of communicating

[40] Dr. Donald A. Henderson, Professor of Medicine and Public Health at University of Pittsburg, claimed that these bacteria are "totally innocuous organisms" and applauded Kurtz's efforts to raise awareness of the "risks and threats of biological weapons" (Coyne, 2004).

[41] See the website at http://caedefensefund.org for more details on the case and the Defense Fund's fundraising activities. Also see Beard (2004).

systems, including digital mammograms and in-situ sonograms. Add to the mix real-time transport via the World Wide Web, and images traverse the networks at incredible speed. Moving into the field of visual culture, scientific images, like popular culture icons before them, now inhabit the public landscape. This migratory practice of the visual has, for scholar W.J.T. Mitchell, created a "social field" of images underscoring a "pictorial turn across disciplines" (Mitchell, 2006). As artists engage with scientific iconography within the terms of critical aesthetic inquiry, scientists employ visual images as diagrams of understanding. While visual art often relies on art historical resemblance for its expressive models, picturing in scientific practice is more explicatively causal or mechanistically bounded. In short, coded images in full color regalia have become part of the corporate culture of science, new media installations and special effects in Hollywood film, to name a few.

Developments in "picture science" are also attracting scholars to this area. The interdisciplinary research group entitled "The World As Image" at the Berlin-Brandenburg Academy of Sciences and Humanities studies "visual representations of world concepts and the analysis of scientific representations and models" (see http://www/bbaw.de). The following topics are currently being analyzed: (1) The world as icon: the globalization of visual memory. (2) The world as model: the diagrammatic representation of nature. (3) The world as artifact: the visual arts and the life sciences. (4) The world as number: algorithmic representation between 0 or 1. The research group includes author Ingeborg Reichle, Steffen Siegel and Achim Spelten.

On the material plane, the laboratory too has been radically transformed into what Karin Knorr Cetina calls production sites:

> [T]he search for entities consisting of barely more than genes, and the strict regimes of breeding, growing, maintaining and documenting point to a deeper transformation; the change no longer concerns the transition between nature and the laboratory, or between fuzzy holistic practices and strict, standardized routines, but the transformation of organisms into production sites and into molecular machines (Cetina, 2003, 138–158).

Working with cells, molecules, microorganisms and bioinformatics, the laboratory itself has become a computational site equipped with microscopes, measuring devices, and computers. Animal models such as mice, fish or higher mammals reside in separate headquarters known as "animal house." The sensual connections to odor, sound, and visualized behavior, so prominently removed from the researcher's lab, are palpable reminders that sentient life itself is a thermodynamic system moving within its own intrinsic processes of equilibrium. Whereas, the researcher's lab is an antiseptic stainless steel and glass beakered cell, animal house reeks of squeals and food products in both digested and non-digested forms.

Various scientific institutions, likewise, are initiating artists-in-residence programs. AIL, artistsinlabs (Kunstschaffende in Laboratorien) in Zurich has hosted many international programs in various laboratories around the world. Under the auspices of Jill Scott and Irene Hediger, artists spend nine months or so working alongside scientists (see www.artists-in-labs.ch). The University of Leiden, as well, is offering bio-residencies for artists.

Inquiry into the subject of altering nature through biotechnology calls attention to the work of German philosopher Nicole C. Karafyllis.[42] Coining the term *biofakte* in 2001 to address the ontological status of organisms that have been fabricated in the laboratory, this neologism fuses the meanings of artifact and living entities. What ethical concerns abound when life forms are produced and reproduced through laboratory techniques? To what natural order do these life forms belong? What separates these living entities from mere "things?" As sentient utilitarian animals, their habitat and life is limited the lab. From Onco mouse, to Rhino mouse, to goats that produce pharmaceuticals or silk, to a featherless chicken (Fig. 5.17) how do these altered species affect the ecology at large?

These ethical questions get especially dicey when human genes are inserted into animal hosts. Science journalist Rick Weiss asks "How human must a chimera be before stringent research rules kick in?" "Would it be unethical for a human embryo to begin its development in an animal's womb?" (Weiss, 2004). As transgenic ani-

Fig. 5.17 *Unititled (the Featherless Chicken)*, by Adi Nes, 2002; printed with permission from the Jack Shainman Gallery, New York

[42] For further discussion and descriptions (in German) of the *biofakte* see Reichle (2005) and Karafyllis (2003).

mals continue to be fabricated as "living test-tubes" they set into motion unique, and even controversial research projects. Rick Weiss reports on research scientist Evan Balaban's work:

> Balaban took small sections of brain from developing quails and transplanted them into the developing brains of chickens. The resulting chickens exhibited vocal trills and head bobs unique to quails, proving that the transplanted parts of the brain contained the neuronal circuitry for quail calls. It offered astonishing proof that complex behaviors could be transferred across species (Weiss, 2004).

In conclusion, we may ask what social implications does this form of knowledge precipitate? How will the new biotechnologies change the ways in which we live? As animals and plants continue to be fashioned, mixed and matched from disparate molecular data, what kinds of alternative conceptions of evolution and natural history become ethical or moral futuristic narratives? From ideologies of the "miracles of science" to the hyperbolic fears of "science out of control" our understanding of the nature of experimental systems and their influence on the social order continues to expand. Symbolic models of the real continue to exude and reframe the profound philosophical implications of altering nature in the 21st century.

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