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Synthetic Science: A Response to Rabinow

David S. Caudill

Abstract. Rabinow's description of the unique collaborative goal of synthetic biology at Berkeley, to foster a coproduction among multiple disciplines and perspectives from the outset (as opposed to downstream reflection upon ethical, legal, and social implications), is somewhat misleading. While that particular assemblage is represented as coproductive, the inevitability of science as a coproduction is eclipsed. That shortcoming may well be a strategic compromise to ensure effective collaboration, but it could backfire. Idealized images of science, which might be termed synthetic or artificial, have had adverse consequences in legal and administrative assessments of reliable science.

Keywords: synthetic biology, science studies, rhetoric, expertise

I. INTRODUCTION

“Mistrust of language” is a reluctance to see all that is involved in using it well, [as well as a] reluctance to see what kind of failure it may be to use it badly.¹

The notion of multidisciplinary collaboration, particularly when it involves the inclusion of insights associated with the humanities within the practices of a seemingly technical discipline, is familiar to those in law and literature studies. Of course, the reflections of literary critics or theorists upon legal processes and institutions could be viewed as merely after-the-fact (or “downstream”) engagement, insofar as there appears to be little daily collaboration between literary scholars, on the one hand, and attorneys, judges, or legislators, on the other. But in law school training, law and literature courses (or literary segments of other courses, such as legal ethics) represent multidisciplinary

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collaborations, whether to enrich textual analysis (of judicial opinions, statutes, or the U.S. Constitution), to enhance ethical criticism of the profession (by reference to literary representations of law and lawyers), or variously to inculcate empathy, encourage the withholding of judgment, or develop a sense of justice. The latter goals have a parallel in medical school training, where literature and medicine are combined to “strengthen and support the compassionate instincts of doctors.”² An even better example of multidisciplinary collaboration in the medical field might be the proliferation of ethicists and philosophers (or “biophilosophers”) on hospital staffs; while “they generally refrain from making decisions,” resolutions “often emerge from the process of analyzing the medical information, improving communication between the parties and suggesting various principles to consider.”³

An important aspect of the foregoing examples of multidisciplinary collaboration is the tacit acknowledgement that the “humanity,” whether literature or ethical philosophy, is not a dispensable add-on to an otherwise humanity-free zone of practice, but rather that the technical practices of law and medicine, respectively, are already literary and ethical prior to their welcoming of collaborators from the humanities. Law and medicine, however, are easy cases, and it is perhaps less clear that synthetic biology, in the absence of collaborators, is already an ethical, social, political, and rhetorical enterprise. Hence the collaborative goal of Thrust 4 in the SynBERC initiative, to foster “a co-production among disciplines and perspectives from the outset,”⁴ is a bit misleading—while its *particular*, transparent assemblage is represented as coproductive, the inevitability of science as a coproduction is eclipsed.

II. SYNTHETIC BIOLOGY IN THE OPEN

Although the practice of invention and rectification is familiar, scientists don’t spend their time in meta-reflections or “second order” observations about their own activities.⁵

In contemporary narratives concerning scientific misconduct, apart from concerns about isolated individuals with base motives *and* about institutional failures (to police misconduct, and to encourage collaboration and whistleblowing), concerns about “the practice of modern science itself” are evident.⁶ While “scientific laboratories develop distinct cultural, social, and technical

stances,” and while “mistaken ideas, badly designed experiments, or incorrect calculations” are part of science, these remain hidden:

[D]epictions of science in the media and in scientific literature present a reconstruction of . . . research [as] carefully thought out, planned and executed according to a neat and rigorous process.⁷

As to misconduct, the argument goes, it takes a lot of effort to sanitize the presentation—investigators “nudge certain facts out of the picture, defuse them with an ad hoc hypothesis, or . . . ignore them” so that the data is “smoothed, massaged, re-organized, and then filtered before publication.”⁸ Moreover, the pressure to publish coerces scientists to produce results, even as the “values *behind* scientific research may have slowly shifted to favor commercialization and profits over knowledge and ethical behavior.”⁹

Such warnings echo the public’s fear of science encouraged by, or reflected in, traditional images of hubristic and amoral scientists in Western literature and mid-twentieth-century cinema. Indeed, modern scientists “have continued to provide writers and film-makers with ongoing instances of the [mad chemist or] alchemist stereotype,” with their ruthless determination and failure “to show concern about the social and moral impact of their research.”¹⁰ Mary Shelley’s Dr. Frankenstein exemplifies the ambitious investigator of the secrets of divine creation, committing “the sin of hubris with disastrous results.”¹¹

The parallel with synthetic biology is not lost. “Some critics consider the idea of creating artificial organisms in the laboratory to be a frightening example of scientific hubris, evocative of Faust or Dr. Frankenstein.”¹² In less literary terms, synthetic biology provokes “fears about scientists ‘playing god’ and raises deeper philosophical and religious concerns about the nature of life itself and the process of creation.”¹³ Cambridge philosopher Peter Lipton highlights the “fear of monsters” throughout history—“the sense that something that violates species boundaries is monstrous”—and thinks that

people have an understandable worry that this technology is scary because it is an example of us playing God. . . . God has an edge here, because God is . . . omniscient, and we unfortunately are not. . . . I think that’s a very reasonable concern.¹⁴

In another formulation, the public wants scientists to “realize that we may be creating life forms that God and/or evolution never dared.”¹⁵

Resistance to synthetic biology in terms of hubris is, however, somewhat unique and ideologically interesting. In a recent study of cultural cognition and the perceived risks of synthetic biology, the authors detected a reversal of the general tendency of (i) those holding egalitarian values to be more risk-sensitive (e.g., with respect to global warming or nuclear power) and (ii) those holding hierarchical, religious, or conservative values to be more risk-skeptical (i.e., less likely to challenge societal and governmental elites).¹⁶

Synthetic biology . . . seems to be attended by a different constellation of meanings that are themselves symbolically threatening to hierarchs. Like evolution, . . . synthetic biology . . . seems to denigrate a set of cultural understandings that subordinate man to the authority of God [which] is in turn subversive to the authority of certain institutions and norms traditionally integral to a hierarchical social ordering.¹⁷

The cultural conflict over synthetic biology, associated with secularism and perceived as subversive, will therefore likely differ “from conflict over other environmental and technological risks.”¹⁸

The environmental and technological risks associated with synthetic biology have been catalogued as including (i) accidental or uncontrolled release of synthetic organisms; (ii) bioterrorism, including biohacking or “garage biology” as well as state-level biological warfare programs; and (iii) patents and monopolies that restrict collaboration and stifle progress.¹⁹ To mitigate those risks, numerous commentators have recommended an early policy response; suggestions include (i) a regulatory regime to screen oligonucleotide (short strands of synthetic DNA) orders for pathogenic DNA sequences, (ii) governmental oversight of “dual-use” (i.e., useful for beneficial or military ends) technologies, (iii) ecological modeling of synthetic microorganisms, and (iv) a code of ethics for biological engineering, including physical-isolation measures and biological isolation (e.g., creating systems that cannot function in the wild)²⁰—the latter two suggestions exemplify self-regulation within the field. In contrast to other scientific fields where anticipation and assessment of risk are less difficult, practitioners of synthetic biology will likely need to join with “biosafety experts, social scientists, ethicists, and legal scholars to brainstorm about reasonable approaches for the oversight and control of [their] research.”²¹ Consensus is also growing that the scientific community should take the lead “in debating the implications of their research and engaging with broader society around

the issues raised by synthetic biology”—public legitimacy and support will be needed.²²

Because of the potential for intense controversy surrounding synthetic biology, public outreach and education are needed even at this early stage in the field’s development. . . . [Participation by scientists] in a public discussion of their work and its implications for society . . . should be encouraged because [it generates] good will and may help to prevent a future political backlash that could cripple the emerging field of synthetic biology.²³

Such statements highlight the role of rhetoric on the part of scientists in the public understanding of science.

III. RHETORICAL CONTOURS

A student-written feature article on synthetic biology, with whatever limitations that may imply, unwittingly paints Rabinow as synthetic biology’s public relations expert. Rabinow, observing that “[m]ost people think this stuff is dangerous,” suggests that focusing on world health issues would “improve public perception.”²⁴ “Monsanto was spectacularly stupid and arrogant” in their public presentation of genetically engineered plants, Rabinow explains, “focusing on the artificiality of genetically modified crops [instead of] on the universality of the DNA language that makes such manipulations possible.”²⁵ Companies improving milk production should avoid being “perceived as big corporate science hammering the last nail in the coffin of struggling milk farmers” by instead developing “cheap medicines to combat infectious diseases in countries where [that] technology is not available.”²⁶ And as to safety, “certain risks must be taken”; Rabinow

argues that we cannot foresee all the possible risks associated with a new discipline. . . . The attitude that all possible precautions must be taken is untenable—we can’t possibly know all the ramifications of any given technology, and we just need to learn to accept that fact.²⁷

As to public concerns over the artificial or unnatural creations of synthetic biology, Rabinow reflects, think Alice Waters of Chez Panisse—“we can celebrate the triumph of human ingenuity and serendipity that brought” us her radically unique culinary “concoctions.”²⁸

The foregoing representation of Rabinow seems unfair, but Rabinow concluded his otherwise sophisticated closing plenary of the First Conference on Synthetic Biology (MIT, June 12, 2004) with a series of aphorisms that started out vaguely philosophical (“The issue of what gets to be named ethics is a question of power and rhetorical skills”) but ended up somewhat banal:

1. “[M]embers of your community will need . . . to develop skills and networks.”
2. “There needs to be much better defense of scientific and technical understanding. Everything is now cast as ‘good for something else’ . . . we need a better statement of ‘science as a vocation’ . . .”
3. “Make the shift from risk/security to risk/danger. The rhetoric of danger is everywhere. This is based on fear. Replace fear with prudence, pleasure, and wonder.”
4. “Talk more about how natural it is to be transformative.”²⁹

Rabinow is, of course, not alone in his rhetorical concerns. Some say “the first step to reassure the public about synthetic biology is to cool the rhetoric”—because “unrealistic claims” lead to “public uneasiness,” there “should be a bit more modesty.”³⁰ “High expectations of both the promise and threat,” therefore, should be tempered by a realistic sense of “the difficulties in creating new biotechnologies.”³¹ Rabinow, however, recognizes that some degree of “hype” is necessary:

[P]latitudes and clichés should be seen as attempts to fix reference points for debates and communication. They are part of sociologically essential hype that prognosticative observers of science and society can now not operate without.³²

Sarah Franklin, also an anthropologist, likewise acknowledges that scientific narratives

rely upon a very standardized form of story-telling with a rather limited set of starting points, metaphors, plot lines. . . . Scientists need stories to support their work—stories they tell to funding bodies, governments, venture capitalists and the general public. . . . [T]hese stories are often deliberately inflated, they’re designed to fuel expectations.³³

Moreover, the debate surrounding synthetic biology invokes a “narrow range of clichés and stereotypes”—Frankenstein, science out of control, unknowable risks, dangerous uncertainties.³⁴ Franklin is concerned, however, that such an “impoverished vocabulary,” such a “limited genre of debate,” will not lead to a “constructive conversation about what kind of science we need, how it will be governed, or who would have a place at the table.”³⁵ For example, reproducing the inflationary narratives of the vast scale (“incomprehensible and beyond our ability to imagine”) and fast pace (“racing ahead, leaving society behind”) of scientific change calls forth a “monotonous” response to *contain* synthetic biology.³⁶ While the paradox of social technology (“a very powerful equation”) is unavoidable—“social hope that fuels much technological innovation . . . exists in constant tension with the demand for the enforcement of strict limits to scientific innovation”—a more useful dialogue that begins “with the specific and the localized,” and that includes multidisciplinary perspectives to break down the science and society dualism, is needed.³⁷

IV. POWER AND COLLABORATION

[S]ynthetic biology is following a now well established path in terms of the debates about the social and ethical issues. [As with recombinant DNA,] societal issues will have a major influence on the funding of science, the types of technologies developed, their application in the real world, how they are ethically framed and the extent of regulation. . . . [W]e can think of the science, technology, regulatory frameworks and social implications as co-evolving through a process of mutual shaping.³⁸

Rabinow contrasts the standard collaborative approach—positioning ethicists, legal scholars, and social scientists “downstream” of scientific work—with “an approach that fosters a co-production among disciplines and perspectives from the outset.”³⁹ Naming the fourth SynBERC “Thrust” (following “Parts,” “Devices,” and “Chassis”) “Human Practices” was meant

to differentiate the goals and strategies of this component from previous attempts to bring “science and society” together into one frame so as to anticipate and ameliorate science’s “social consequences.”⁴⁰

The central, unique concern of Thrust 4 is to critically examine the contributions of synthetic biology (to “medicine, security, energy, and the environment”) “as it develops, not only after it achieves something.”⁴¹ Such collaboration depends on “organizational change” in the “existing conditions” and “work habits” associated with scientific research.⁴² However, the habits and dispositions of elite

scientists as well as the organizations of their labs and objects will resist change, consciously and tacitly. [Many] scientists . . . are willing to cooperate. . . . The question remains as to whether or not they are willing to contribute to developing *collaboration*.⁴³

Hence Rabinow’s experiment, to see if *knowledge* and *care* — knowledgeable scientists and “those adjacent to biological work” who care—can mutually flourish.⁴⁴

The problems are “the power differentials between the bioscientists and the human scientists, and the existing disciplinary structures of reward that shape and reinforce current practices.”⁴⁵ All of Human Practices’ recursive rectification, reconfiguration of equipment, pragmatic judgments, and orientation toward a metric of flourishing is set not only against “a certain range of prior expertise, and prior disciplinary suppositions and ethical commitments, taken as settled and desirable . . . ,”⁴⁶ which even the scientists are willing to change, but also against the

basic inequality between the other [primary investigators] and the Human Practices’ members [which] operates without examination, bolstered by the inertia of past dispositions and the larger structures of the university that take for granted the autonomy of the biosciences as well as their primacy [in the task of amelioration]. Said straightforwardly: Human Practices is in a dominated position.⁴⁷

Nevertheless, Human Practices is an “integral component of the overall enterprise,” positioned “to take up problems in a way that experts-at-a-distance cannot.”⁴⁸ Posing questions, rethinking what is at stake, and encouraging both interfacing with emergent problems and forward thinking—Rabinow’s wager is that these are likely more efficacious from inside the enterprise.

Rabinow confronts the critique that he is complicit “with Power,” forsaking the opportunities for “exposé or rebuke or denunciation . . . from a position

exterior to the situation.”⁴⁹ He acknowledges his peril, but reconstruction and practical judgment require a different mode of survival and engagement, to keep the “telos of flourishing” from continuing to be marginalized.⁵⁰

V. A NEW BEGINNING?

What does it mean to talk about the social implications of synthetic biology? . . . [We] tend to think of science and social implications . . . as two separate things. But science studies, for the last three decades, has told us that [we] can never have a science that’s outside the social. . . . The deceit of the debate about “science and society” is that the very phrase reproduces the gap between those terms.⁵¹

Rabinow’s project diverges from contemporary science studies in two respects. First, he does not engage in ethnography, observational studies, or following scientists around—which is only effective if you are *temporarily* on the inside—to reveal the hidden values guiding, or the unacknowledged social, institutional, and rhetorical aspects of, scientific practice. In becoming a full-fledged member of the team, however, Rabinow does not (entirely) lose his critical voice, and the potential advantages are numerous in terms of making a difference in the “real world.” Indeed, Rabinow’s project might be a new model for science studies—critically examine existing structures, recognize resistance (and try to overcome it), collaborate to develop ameliorative goals, and build ethical consensus, all from the inside. Take control of the social, institutional, and rhetorical reins of the scientific enterprise, and share in its successes—that would be more power than the anthropologist of science-in-action ever has.

Second, however, Rabinow does not talk or write like a contemporary sociologist of science. That distinction may be part of the needed compromise for insiders like him, but to say that “previous attempts to bring ‘science and society’ together” are exemplified by those who tried to anticipate and ameliorate the “social consequences” of science⁵² is to marginalize decades of science studies scholarship that never saw the “social” as a downstream add-on. Rabinow knows that, because he defines pedagogy as “development of a disposition to learn how one’s practices and experiences form or deform one’s existence and how the sciences . . . enrich or impoverish those dispositions”⁵³—the words “deform” and “impoverish” suggest the inevitability of values. Indeed, even

collaboration is inevitable in twenty-first-century bioscience—contemporary scientists “actually have no other option but to be engaged with multiple other practitioners”—such that the only question is how best to do it, in order to flourish.⁵⁴ The effort to “reconfigure and reconstruct” the relations between the life sciences, the human sciences, and the citizenry⁵⁵ suggests that those relations are also inevitable. But then to say that for Human Practices, “the basic rules of what counts as good science and engineering in synthetic biology are the traditional or standard ones”⁵⁶ is very strange. To compartmentalize and stabilize the “rules of good science” seems to deny the social, institutional, and rhetorical aspects of such “rules.” On the other hand, the “metrics” of science, whether normalization or dignity or flourishing, are always there, and can change, and seem to be part of science’s “assemblage.”⁵⁷ But then the separation of science and society returns, oddly in terms of “reconstruction,” with a reference to Dewey’s “formulation . . . that science and ethics are interfaced and assembled in accordance with the demands of ‘progressively directed inquiry.’”⁵⁸ This makes reconstruction sound as if social and ethical concerns, previously *not* interfaced with science, are brought to bear on synthetic biology. Of course, to seek a science/ethics interface in accordance with a progressive inquiry does not necessarily *mean* that no such interface previously existed (perhaps in accordance with a less-than-progressive inquiry); but why announce the project as “the invention and implementation of equipment that facilitates forms of work and life,”⁵⁹ as if the existing equipment does not “facilitate” *some* forms of work and life? From a science studies perspective, the oscillation is maddening.

Rabinow’s (and his Human Practices colleagues’) accomplishments, however, if one of the goals of science studies is to reveal the social, institutional, and rhetorical aspects of science (in the face of scientists’ traditional self-construction of their enterprise as anchored in nature and not cultural conventions), should not be diminished. The proposed interdisciplinary collaboration in SynBERC (and in other similar synthetic biology initiatives) goes beyond the dialogue concerning the social and ethical implications (of science) toward an integration of policy and politics, as well as ethics and values, into the synthetic biology enterprise. Transcending as well the debates over whether politics taints science, or whether science is inevitably politically biased, the Human Practices “thrust” openly acknowledges and even celebrates the social and ethical opportunities of scientific advancement. Neither the institutional arrangements nor the rhetorical strategies of the science are hidden.

VI. CONCLUSION

Synthetic biology strives to combine (or synthesize) large amounts of disparate knowledge. . . . Another, perhaps related meaning [of] “synthetic” . . . is to synthesize new organisms from a set of existing, well-understood components. . . . [P]erhaps the most exciting and controversial aspect of the name [is] the sense in which synthetic means artificial[:] synthesizing living systems . . . that . . . have never existed in nature.⁶⁰

Rabinow’s modesty with respect to his ambitious project of reconstruction is apparent: whether elite scientists will actually collaborate with the “human scientists” is a “genuinely open” question; constructing effectively functioning “equipment” is a challenge; while Dewey’s logic of practical judgments was “an initial guide to orienting inquiry,” we are left with our own devices; the “metrics of prosperity and amelioration” may not be sufficient—a “zone of ambiguity” persists; and as to his dominated position as a human scientist, there is “no clear answer” as to how to maneuver.⁶¹ Criticism of his efforts, in light of both the challenges he faces and the admirable telos, seems somehow inappropriate.

But there is something “synthetic,” in the sense of artificial or contrived, about Rabinow’s account of synthetic biology and its potential. From the perspective of those who worry about the risks of science out of control, it is reassuring to know that within the laboratory, the scientific experts are surrounded by, and conversing with, a team of thoughtful participants who critically reflect on the goals, values, dangers, and public perception of the enterprise. That reassurance, however, is communicated alongside a fairly traditional account of science as independent of culture. In other words, while the humanities have moved upstream nearly to the source of knowledge, there is little acknowledgement that the scientists were already, inevitably, engaged in a social, political, institutional, and ethical enterprise. I am not sure why Rabinow downplays that aspect of science, although I suspect that he is (i) well aware of it, and (ii) convinced that it is not only quite beside the point, but even a potential barrier to collaboration.

Idealized accounts of science, nevertheless, do have consequences, and their strategic maintenance may backfire. Judges, administrators, and legislators often view “politicized” science as biased, and therefore tend to value more highly the scientific expert who claims to rise above social preferences,

institutional interests, and rhetorical flair. “Bias, interest, and motivation” are the markers of junk science for those who idealize science. Human Practices will, in the idealized perspective, appear as exemplifying such markers. For that reason alone, I would have liked to have seen “the basic rules of what counts as good science [—] the traditional or standard ones”⁶²—included, not bracketed, within the fields of reconstruction and reconfiguration. There is work to be done on another front, seemingly of little interest to Rabinow, namely the development of a more pragmatic and less idealistic conception of science itself.

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1. Cora Diamond, “Having a Rough Story about What Moral Philosophy Is,” 15 *New Literary History* 155, 168 (1983) (discussing Iris Murdoch’s assessment of 1950s moral philosophy: “What these linguistic analysts mistrust is precisely language,” see Iris Murdoch, “Vision and Choice in Morality,” 30 (Supp) *Proceedings of the Aristotelian Society* 32, 42 (1956).
 2. Tara Parker-Pope, “Combining Literature and Medicine,” *New York Times*, Oct. 23, 2008 (quoting Dr. Richard Panush, chairman of the Department of Medicine at Saint Barnabas Medical Center), available at <http://well.blogs.nytimes.com/2008/10/23/combining-literature-and-medicine>.
 3. Bruce Lambert, “Hospital Biophilosophers Help Solve Life-and-Death Issues,” *New York Times*, June 23, 1988, available at <http://query.nytimes.com/gst/fullpage.html?res=940DE2D71330F930A15755COA96E948>.
 4. Paul Rabinow & Gaymon Bennett, “SynBERC Thrust 4: Making Things Better: A Collaboratory,” Executive Summary, at 1, available at http://openwetware.org/images/d/d8/Thrust_4_alpha.doc.
 5. *Id.* at 2.
 6. See Benjamin K. Sovacool, “Exploring Scientific Misconduct: Isolated Individuals, Impure Institutions, or an Inevitable Idiom of Modern Science?,” 5 *Bioethical Inquiry* 271, 277 (2008).
 7. *Id.* at 277–78.
 8. *Id.* at 278.
 9. *Id.* at 278–79.
 10. Roslynn Haynes, “The Alchemist in Fiction: The Master Narrative,” 12 *Hyle—International Journal for Philosophy of Chemistry* 5, 22–23 (2006). “Western culture relies on and reveres science . . . ; yet, paradoxically, the master narrative of scientific knowledge in both literature and film focuses on an evil and dangerous maniac, obsessive, secretive, ruthless, and arrogant, drawing upon many of the qualities popularly associated with medieval alchemy.” *Id.* at 5.
 11. Joachim Shummer, “Historical Roots of the ‘Mad Scientist’: Chemists in Nineteenth-Century Literature,” 53 *AMBIX* 99, 119, 121 (2006), citing Mary Shelley, *Frankenstein, or the Modern Prometheus* (1818).
 12. Jonathan B. Tucker & Raymond A. Zilinskas, “The Promise and Perils of Synthetic Biology,” *The New Atlantis*, Spring 2006, at 44. See also George Church, “Let Us Go Forth and Safely Multiply,” *Nature*, Nov. 24, 2005, at 438.
 13. Andrew Balmer & Paul Martin, *Synthetic Biology: Social and Ethical Challenges* (Nottingham: University of Nottingham Institute for Science and Society, 2008), 26.

14. Peter Lipton's remarks in the debate "Beyond the Genome: The Challenge of Synthetic Biology," 3 *Biosocieties* 3, 14–15 (2008). "There seems to be fear that the single word *synthetic* connotes negative images of monstrous life forms let loose by maniacal scientists." See Balmer & Martin, *supra* note 13, at 6.
15. Alan Moses, "Intelligent Design: Playing with the Building Blocks of Biology," 8 *Berkeley Science Review* 34, 37 (2005).
16. Gregory N. Mandel, Donald Braman & Dan M. Kahan, "Cultural Cognition and Synthetic Biology Risk Perceptions: A Preliminary Analysis," at 2, George Washington University Law School, [SSRN] Legal Studies Res. Paper No. 446, available at <http://ssrn.com/abstract=1264804>.
17. *Id.* at 12.
18. See *id.* at 2.
19. See Balmer & Martin, *supra* note 13, at 15–24.
20. See Tucker & Zilinskas, *supra* note 12, at 42–44; Church, *supra* note 12.
21. Tucker & Zilinskas, *supra* note 12, at 43.
22. Balmer & Martin, *supra* note 13, at 30–31.
23. Tucker & Zilinskas, *supra* note 12, at 44. See also Church, *supra* note 12 ("above all, outreach is required").
24. Moses, *supra* note 15, at 38.
25. *Id.*
26. *Id.*
27. *Id.* at 39. In the ongoing debates over the dangers of low-dose toxicity, industry arguments against environmentalist worries include (i) that applying the precautionary principle in the regulation of chemical producers would have potentially devastating economic effects, and (ii) that regulatory decisions should be based on sound science, not fear. See Glen Martin, "Chemical Industry Told to Get Tough," *San Francisco Chronicle*, Nov. 21, 2003, at A21. The parallels between those arguments and Rabinow's rhetoric may well illustrate the reversal of ideological constellations, with respect to synthetic biology, discussed in the text accompanying notes 16–18 *supra*.
28. *Id.*
29. Paul Rabinow, "Assembling Ethics in an Ecology of Ignorance," available at http://openwetware.org/images/7/7a/SB1.0_Rabinow.pdf, at 9. "If we oppose risk and security (or safety), the latter will always appear preferable, but 'danger' shifts the focus to 'possible future loss.'" *Id.* at 5.
30. Mark Tepfer, "How Synthetic Biology Can Avoid GMO-style Conflicts," *Nature*, Sept. 22, 2005, at 476.
31. Balmer & Martin, *supra* note 13, at 30 (The "potential benefits of the technology must not be over-hyped or this risks both creating excessive public anxiety and unrealistic hopes that cannot be fulfilled").
32. Rabinow, "Assembling Ethics," *supra* note 29, at 3.
33. See remarks of Sarah Franklin in "Beyond the Genome," *supra* note 14, at 12.
34. *Id.* at 11.
35. *Id.*
36. This "debate is dominated by a discourse of worry and caution in relation to the hype of progress in scientific advance." *Id.*
37. *Id.* at 12–13.
38. Balmer & Martin, *supra* note 13, at 30.
39. "SynBERC Thrust 4," *supra* note 4, at 1. The standard concern is referred to as "ELSI"—ethical, legal, and social implications.
40. Paul Rabinow, "Prosperity, Amelioration, Flourishing: From a Logic of Practical Judgment to Reconstruction," 21 *Law & Literature* 301, 303–04 (2009).
41. See *id.* at 304.

42. *Id.* “The SynBERC [primary investigators] have claimed in their grant proposals, and made structurally explicit . . . that the far-reaching promises of synthetic biology cannot be realized under existing conditions and organizations of scientific research.” *Id.*
43. *Id.* “They are ready to fill out safety forms, . . . they are open to ethics discussions as long as these are periodic and nonintrusive, and they are open to [downstream] regulation Some are even open to hypothetical discussions about well-meaning social concerns and consequences.” *Id.*
44. See *id.* at 305.
45. *Id.* at 304.
46. *Id.* at 312.
47. *Id.* at 315.
48. *Id.* at 313.
49. *Id.* at 316–17.
50. See *id.* at 319.
51. Franklin, *supra* note 14, at 10, 13. See also Michiel Schwarz & Michael Thompson, *Divided We Stand: Redefining Politics, Technology and Social Choice* (Philadelphia: University of Pennsylvania Press, 1990): “Anthropologists and sociologists of knowledge have shown us that what are considered facts depends ultimately on an accepted framework of social (and therefore evaluative) premises. Even scientific knowledge, whilst not perhaps wholly fluid, is certainly plastic in the sense that it is socially negotiated (science being a social activity) and molded by values of various kinds.” *Id.* at 18.
52. Rabinow, *supra* note 40, at 303–04.
53. *Id.* at 305. See also text accompanying note 46 *supra* (referring to scientists’ “prior disciplinary suppositions and ethical commitments, taken as settled and desirable”).
54. *Id.*
55. *Id.* at 307.
56. *Id.* at 312.
57. *Id.*
58. *Id.* at 313.
59. *Id.* at 314.
60. Moses, *supra* note 15, at 36.
61. Rabinow, *supra* note 40, at 304, 308, 311, 315–16.
62. See *supra* note 56.