

# Designs on Nature

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Science and Democracy in Europe and the United States

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## Republics of Science

The reception of biotechnology into the political and policy systems of Germany, Britain, and the United States displays the everyday workings of three democratic nations in a time of large historical transitions. Posing linked and simultaneous challenges for science, power, and legitimacy, the politics of biotechnology offers a textbook example of the perplexities of governance in twenty-first-century knowledge societies. In previous chapters we observed one after another national struggle to work out in detail how to assess risks, clarify values, engage citizens, create property rights, foster technological innovation, and put out the wildfires of public distrust or antipathy around issues raised by rapid advances in the life sciences and technologies. Often gripping in their own right, these micropolitical stories show how profoundly the human ability to manipulate life has insinuated itself into age-old human concerns about preserving social order and securing moral certainty. Through the lens of civic epistemology, we have also seen how publics in different political cultures evaluate the claims made on behalf of novel science and technology, and how—under conditions of uncertainty—they decide whether the claims are robust enough to warrant support for particular forms of innovation. In this concluding chapter, we turn to the implications of the preceding comparisons for democratic theory more generally.

The attempt to build working routines of governance around biotechnology has called into question some of the founding assumptions of liberal democracy: that representative governments are capable of discerning citizens' preferences and of acting to promote them; that democratic institutions are knowledgeable enough to regulate the directions of scientific and technological change wisely; and that citizens have the opportunity to participate

meaningfully in decisions that seem increasingly to call for specialized knowledge and expertise. Comparative study helps us evaluate national responses to these predicaments and, on that basis, to assess the texture and quality of democracy in contemporary industrial societies. The three country studies elaborated in this book not only show different institutional and procedural traditions at work in accommodating biotechnology; they also allow us to reflect on what is gained or lost in the settlements that each nation has achieved.

The substantive observations gleaned from the preceding chapters are regrouped here under three thematic headings that connect the specifics of science policy and politics to wider issues of democracy. The first has to do with the liveliness of political culture as a factor in the reception of biotechnology. How, we may ask, did culturally conditioned framings of the problem of biotechnology arise, persist through time, and affect new issues as they appeared on political and policy agendas? The second theme concerns the relationship between democratic processes and scientific and technological change. Under this rubric we inquire into how the classic political categories of participation, deliberation, and representation were energized or transformed through national attempts to make policy for biotechnology. In what ways, more specifically, did publics in each nation shape the social meanings of genetic modification, and how did these meanings become aligned with official discourses of risk, ownership, ethics, or innovation? Were there any notable failures of democracy, and, if so, how were these distributed across the three countries? The third major theme revisits the sources of political accountability in technologically advanced societies. Where do authoritative ideas for governing science and technology come from, how are national governments held responsible for the management of science, and how do processes of authority-creation vary across the political cultures of Europe and the United States?

A reorganization of the book's substantive findings along these lines highlights substantial cross-national divergences and inevitably leads us back to questions about the purposes of comparison that were laid out in chapter 1. Are differences among nations inevitable and, if so, is that necessarily a cause for worry? If national responses to science and technology are conditioned by the autonomous, self-replicating, deeply institutionalized dynamics of political culture, then what can states or citizens hope to learn from each other's experiences? What, finally, can cross-national comparison teach us with respect to the prospects for harmonizing political and ethical responses to biotechnology across competing cultures of knowledge and power? Answers to these questions must necessarily be partial and open-ended, but they may nevertheless serve as springboards for further inquiry.

I argue in this chapter that cross-cultural learning from the first quarter-century of the genetics revolution is both possible and necessary, but not in

the form of universal prescriptions for improving upon current administrative practice. This book does not aim to be a how-to manual for constructing better risk assessment guidelines for GM foods or standard operating procedures for public consultation. Nor does it provide a blueprint for how national governments should best foster innovation in the life sciences. At the same time, the comparative findings offered in preceding chapters and summarized here are intensely relevant to the design of frameworks for governing biotechnology. Some implications of my analysis are spelled out below; others will occur to the sympathetic reader who is prepared to indulge the ideas presented here and to speculate on their possible ramifications.

### The Stickiness of Frames

On May 13, 2003, the U.S. Trade Representative's office announced that the United States and several cooperating countries had filed a case at the World Trade Organization against the European Union's "illegal, non-science based moratorium" on biotech food and crops, which was "harmful to agriculture and the developing world."<sup>1</sup> In July of the same year the EU drew up new regulations on the labeling and traceability of foods containing genetically modified ingredients, claiming that European consumers now had a transparent, reliable means of choosing between alternative sources of food. Nevertheless, in August the United States called for a WTO dispute settlement panel to address the GMO issue. David Byrne, the EU commissioner for health and consumer protection, deplored the U.S. action, stating, "Only a month ago we updated our regulatory system on GMOs in line with the latest scientific and international developments. Clear labelling and traceability rules are essential to help restore consumer confidence in GMOs in Europe."<sup>2</sup> Few starker reminders could be found that the global march of biotechnology had not automatically brought policy convergence in its wake. Indeed, in this case regulatory polarization seemed, to some, a more fitting description of what had occurred.<sup>3</sup> Here were two of the world's economic superpowers disagreeing not only about whether and how to promote biotechnology in agriculture, but, even more astoundingly, about what counts as science for regulatory purposes and how that science should be deployed in controlling the fruits of biotechnology.

The roots of disagreement run deep, as we have seen. They were planted, in the 1980s, with divergent framings of the risks of biotechnology between the United States and the EU, as well as among EU member states. Scientific accounts of the risks of biotechnology became enmeshed at that time with political institutions and practices through a process of "coproduction."<sup>4</sup> This approach to thinking about the unfolding of science and technology in society stresses the myriad ways in which knowledge about the world both conditions and is conditioned by choices about how people wish to live in it. The

sociopolitical history of biotechnology amply demonstrates that natural order sustains and is sustained by social order. Human encounters with the life sciences and technologies repeatedly became occasions for the manufacture or redesign of politically significant institutions, identities, representations, and discourses. Political practices, social norms, and ideas of nationhood were produced together with new biological concepts and constructs, each bolstering the other's firmness. The coproduction framework, understood in this way, helps account for the stickiness of frames.<sup>5</sup>

Three separate framings of biotechnology emerged in the three countries—as product, process, and program—each resting on its own scientific, administrative, legal, and political arrangements.<sup>6</sup> The product-based approach particularly took hold in the United States, where it went hand-in-hand with a scientific account of genetic engineering as a highly specific intervention, grounded in molecular biology, promising untold benefits, and entailing largely predictable (and, as it happens, negligible) adverse consequences for human health and the environment. Britain and the EU, by contrast, adopted a process-based approach, which brought together more ecologically oriented expert perspectives with a normative posture that admitted more uncertainties and called for a precautionary approach to regulation. Germany took precaution yet one step further by highlighting political and ethical as well as scientific unknowns—in particular, the possibility of a programmatic alliance between science and the state that might lead to abuses of power unless the development of biotechnology was tightly controlled. These fears were reflected in numerous German legislative and regulatory enactments that sought to create categorical bright lines and guard against ambiguous or conceptually messy situations. For much of the period covered by this study, the German politics of biotechnology was most notable for its resistance to experimentation with new forms of life, in nature, society, or the state.

The disparate initial settings of the technical and political dials not only were coproduced in each nation but were contingently readjusted as new issues appeared on the horizon. Comparative investigation reveals enduring connections between public articulations of risk and institutional features of governance in each country. We find neither blind technological determinism nor rigid path dependency, but a more complex and subtle interplay of novel technoscientific possibilities with rooted expectations concerning relations among citizens, science and industry, and the state.

It is not surprising that the framing of biotechnology as a stream of commercial products was most readily accepted in the United States, where, in areas other than national security, the market often out-competes the state as the more powerful model of legitimate social organization. A preference for market solutions as an alternative to state control grew during the 1980s, as the deregulatory fervor of the Reagan era was incorporated into routine

administrative practices. With the downfall of communism and the “end of history,” in Francis Fukuyama’s well-known phrase,<sup>7</sup> the ideology of the market gained additional political force. Promarket and antiregulatory tendencies manifested themselves across the entire range of governmental action, or more accurately inaction, on biotechnology, from the failure to enact comprehensive federal legislation in the 1970s to the relative laxity of the Coordinated Framework in the 1980s, and from the permissive patenting decision in *Diamond v. Chakrabarty*<sup>8</sup> to the facilitation of university-industry technology transfer through the 1980 Bayh-Dole Act. At the same time, a chronic aversion toward incurring opportunity costs, expressed through a *laissez-faire* policy toward private initiative and risk-taking,<sup>9</sup> significantly lowered the threshold barriers to biotechnological innovation—even though, as in the Star-Link and Prodigene episodes, the consequences to both producers and the state sometimes carried enormous price tags and eventually led to stricter controls.

The product framing of biotechnology both reflected and reinforced America’s historical record of seeing technology as an instrument of progress and nature as ripe for appropriation through human ingenuity.<sup>10</sup> This framing casts citizens as insatiable consumers of technology, perennially scanning the horizon for new goods and services to meet an ever-diversifying array of needs. Courts and ethics commissions, as well as Congress and regulatory agencies, constantly reaffirmed this construction of the citizen as an entrepreneurial adopter of the new biotechnologies. Thus, *Chakrabarty*’s easy erasure of the distinction between living and nonliving “compositions of matter” facilitated innovation; the decision sharply contrasts with the Canadian Supreme Court’s reluctance, more than twenty years later, to take a similar step with regard to the genetically modified oncomouse. Support for liberal individualism, and a concomitant faith in the intrinsic goodness of social and technological experimentation, also shine through judicial decisions such as *Moore v. Regents of the University of California*,<sup>11</sup> granting medical researchers unencumbered property rights in human tissue, and *Johnson v. Calvert*, positioning the gestational surrogate mother as a biocapitalist exercising commodity rights over her own body.<sup>12</sup> A focus on individual rights and a preference for utilitarian logics consistent with market values characterized the pronouncements of official bioethics, most notably so in the Clinton-era presidential commission’s repudiation of human cloning on grounds of risks to the clone.<sup>13</sup> Only the ethics council nominated by President George W. Bush charted a course away from utilitarianism; we will return to the democratic implications of that move below.

In Britain, by contrast, a proactive state policy toward biotechnology, endorsed by the Tories under John Major and enthusiastically embraced by the succeeding Labour government, had to contend with a sharply divided public response: on the one hand, a relatively uncontested, science-friendly

legal regime developed around research on embryos and embryonic stem cells, and numerous collaborations arose between university scientists and pharmaceutical companies; on the other hand, agricultural biotechnology suffered from a severe backlash against the paternalistic “nanny state,” necessitating nationwide political consultation on a scale not encountered in either of the other two countries. Developments in both areas illustrate the long-term persistence of framing biotechnology as a process meriting special public concern, even though those concerns were successfully contained through official policy actions in the case of embryo research and pharmaceutical biotechnology.

Though seemingly divergent in their outcomes, the politics of red and green biotechnology in Britain owe their flavor to several systemic aspects of that nation’s political culture. Expert trustworthiness and credibility were invoked in both contexts to shore up state policy, but the dissolution of the Ministry of Agriculture, Fisheries and Food in the wake of the BSE (“mad cow”) crisis left policymakers bereft of the expert “safe hands” that normally stamp their approval on official action. The creation of the new Food Standards Agency in 2000, with the administratively seasoned Sir John Krebs at its helm,<sup>14</sup> exemplified the attempted build-up of confidence around tried and true individuals in the aftermath of BSE. Yet Krebs’s lackluster performance and his eventual resignation in 2004 suggest that the Blair government misjudged the kind of experience needed to communicate effectively with the British public on food safety issues. In the context of embryo research as well, established processes of authorizing trustworthy bodies—both individual and collective—positioned Mary Warnock and, later, the Nuffield Council on Bioethics to play crucial roles in carving out a protected space for British reproductive science and its biomedical offshoots. The appointment of Suzi Leather, the first PSA deputy chair and a known consumer advocate, to head the potentially controversial Human Fertilisation and Embryology Authority illustrates the continuing cultural production of, and reliance on, embodied expertise.

These practices of political authorization worked in harmony with a related feature of Britain’s dominant civic epistemology: the preference for empirical demonstrations. In the contexts of both embryo research and agricultural biotechnology, appeals were repeatedly made to proofs that ordinary people could see and understand. Failure to meet these demands for empirical justification generated uneasiness about the safety of GM crops even before the outbreak of the BSE crisis. British policyadvisers were notably reluctant to embrace the U.S. position that most GM products are substantially equivalent to their unaltered counterparts, and hence safe. Skeptical voices from academia and environmental groups were added to U.K. policy deliberations in an effort to build a stronger consensus in support of agricultural biotechnology, but this effort to broaden politics led to a more extensive unpacking

of scientific unknowns than in the United States. Farm-scale trials of GM crops and the national debate on commercializing them were two of the more noteworthy results.

By contrast, a mutually reinforcing alliance of social and scientific authority kept the barely visible, less than fourteen-day-old pre-embryo firmly demarcated from the embryo proper, allowing the former to be treated as unproblematically devoid of human traits, and hence as a suitable object of research. In a coproductionist turn, however, this splitting of the developing human embryo into two distinctive legal and biosocial entities was feasible only with the full mobilization of the state as an agent of biopolitics. The line of demarcation had to be made morally and scientifically tenable, and this in turn meant that the state had to call upon all of the reserves of authority that allow a government to construct reality on behalf of its citizens. Creating and maintaining a space for embryo research required flawless performance by an official ethics commission, carefully orchestrated parliamentary approval, the transfer of statutory authority to HFEA, and the shoring up of HFEA's regulatory powers by the House of Lords against later legal challenge. Arguably, too, this process necessitated the emergence of a new social kind—the ethics expert—originally exemplified in the person of Mary Warnock.

Germany, too, adopted the process frame along with Britain and the EU, acknowledging that genetic modification in and of itself calls for special oversight in all of its domains of application. But taming the risks of biotechnology in Germany proceeded in tandem with taming recalcitrant historical and political memories,<sup>15</sup> both before and after the fall of communism in 1989 and the reunification of the divided state in October 1990. Key to the resolution of early political debates around biotechnology was the reaffirmation of Germany as a *Rechtsstaat*, a place where the rule of law enjoys supreme respect. In turn, this construction of the German state demanded principled behavior on the part of government and strict adherence to basic constitutional norms such as respect for human dignity. Relations among science, technology, and the state as played out in this context could not help taking on a programmatic character. They were, in effect, staging grounds for continuing struggles over the definition of postwar German identity.

Looking at regulatory solutions to biotechnological problems in Germany, we are repeatedly struck by an apparent yearning for moral and legal absolutes. Difficult problems were avoided altogether or cast into well-regulated categories of exception. Thus, the Basic Law was construed to affirm the unrestricted right to life of the human fetus, even though reasons were found to allow women to have abortions on grounds including psychic distress. Surrogacy was forbidden, as was the creation of spare embryos; like hidden marauders, some vanishingly small population of these accidental beings languished in an extralegal borderland, where even their numbers could not be accurately recorded. Embryonic stem cells were not permitted to be made in Germany.

They *could* be imported, but only if they were created before a date clearly stipulated by law. Without such firm lines of demarcation, it seems that the state is always in danger of sanctioning a *Dammbruch*—a breaking down of high dams with who knows what consequences for public morality, law, and order. This fear of lawlessness stands in sharp contrast to British and American confidence that the law can, at need, build robust stopping prints on the slippery slopes of moral judgment. Ambiguity exists, of course, in Germany, as it must in any functioning rule system, but the *Rechtsstaat* cannot officially tolerate its presence.

Inhibited from making controversial choices without clear legal supports, the German state exercises its discretionary power through a network of anonymous expert agencies, such as the Central Commission for Biological Safety, that see themselves as making purely technical administrative decisions within the parameters of the law. Just as morally ambiguous life forms are denied legal existence, so the regulatory process seems uncomfortable with ambiguous forms of political expression. The elimination of the public hearing requirement for deliberate releases of GM plants originally included in the Genetic Engineering Law makes sense in this perspective. It turned out to be an uncomfortably hybrid process, blurring the lines between procedure and substance, and between expressive or symbolic politics and the reasoned political debate of Jürgen Habermas's idealized public sphere.

It is against this backdrop of uneasy rule-following that one has to read the Schröder government's attempts to reprogram the relations between the life sciences and the state. Compromises were made on many fronts so as to facilitate the growth of biotechnology: in the explicit abandonment of a "just say no" attitude to agricultural biotechnology by Renate Künast, Green minister for agriculture and consumer affairs; in the approval of GM foods and crops following the adoption of EU labeling and traceability rules; in the appointment of a bioethics council by the executive branch to create a more moderate policy on stem cells and other aspects of biomedical research; and in the active sponsorship of bioregions to promote university-industry technology transfer. Yet although these steps indicated a moderation of older policy hard lines, they left intact the state's central role as the sponsor and regulator of biotechnology. Schröder's bioethics council, for example, reaffirmed its adherence to the Habermasian model of the public sphere at its very first open meeting, and members privately described the council's need to be representative, in a transparent way, of all reasonable views on biomedical ethics.<sup>16</sup> Künast's opening the door to GM crops was counterbalanced by the promise of large public subsidies to organic agriculture. Even the "market" for new public-private linkages in the bioregions remained, at bottom, a state-run enterprise geared toward generating competition. Put differently, the programmatic relations among science, technology, and the state in Germany persisted into the new century, with this difference: that a postwar politics of

moral anxiety, fearful of risky innovation, was supplanted by an equally powerful German bureaucratic tradition aiming for rational management of the inventive process.

I have suggested throughout that the politics of biotechnology at the EU was subordinated in key respects to that of the member states. Basic questions about the acceptability of biotechnology's products and the allowable forms of debate concerning them remained national in character. Yet to leave the EU political scene out of account would be to miss an important element of the turn-of-the-century politics of globalization. Through its revised regulation on deliberate release and its later enactments on labeling and traceability of GM foods, the EU in effect carved out a space for "coexistence" that applied literally to GM and non-GM products, but also metaphorically to different judgments by member states about the suitability of GM products for their national farms and tables. In bioethics, similarly, the debate on the Sixth Framework Programme for research was in part a debate on the possibility of normative coexistence, between those who abhor research on, and appropriation of, human biological materials, and those who believe in the feasibility of regulated, stepwise innovation. The brewing conflicts with the United States in the WTO can be seen against this backdrop of European identity negotiation not simply as a battle over free trade, but over alternative models of political—and ontological—coexistence.

### Varieties of Democratic Experience

Making peace with biotechnology was not, in any of the three countries, simply a matter of applying old political routines to new agenda items; nor was it a case of creaky legal and political institutions playing catch-up with rapid developments in science and technology. Through their attempts to accommodate biotechnology, each democratic society tested, and to some extent reconstituted, its core understandings of what is political about science and technology and how to organize and conduct the associated processes of technopolitics. In this sense the politics of biotechnology proved to be constitutive of aspects of democratic politics writ large. The results point in each country to lingering difficulties in opening up the bilateral social contract between science and the state to active civic engagement.

In all three countries, the life sciences posed some very special political problems. Metaphysical disorder, or confusion about how to classify things, was an inevitable by-product of genetic modification, producing attendant confusion in the practices of governance. Biotechnology disrupted ancient classifications and transgressed boundaries that had for centuries been accepted as given in Western legal and political thought. Distinctions between nature and artifice, animate and inanimate, living and nonliving, body and

property suddenly became problematic, and thus in principle political, in many areas of decision making. The consequent attempts to reinterpret the law and to craft new administrative practices provide a lens for looking into a millennial transition: one in which life and its material components have become at once a means of production, a commodity, a therapeutic agent, and an object of regulation.<sup>17</sup> This is as well a constitutive moment for politics, as citizens project onto the state the obligation to articulate what should be held sacred about life, while asserting contradictory visions of how to bring life under firmer human control.

Public involvement in the politics of biotechnology, and the life sciences more broadly, can be separated into three comparative strands to highlight the democratic implications of this era of technopolitics: *representation*, or the means by which some voices are made audible in the political and policy process, and how political inclusion in turn affects the framing of issues; *participation*, or who actually takes part in politics, and who does not; and *deliberation*, or the discourses in which political debate is conducted, together with their limits and achievements. Under each heading, we observe cross-national similarities and divergences, with implications for public policy.

### Representation

Representation is a two-faced word in the politics of knowledge societies. It refers both to the self-presentation of the public within and before governing institutions, and the presentation by the public to those bodies of matters that are seen to be of collective significance. The first meaning of representation is the stuff of traditional democratic theory, but the second, which directly affects the framing and implementation of policy agendas, is of increasing importance. The two meanings, moreover, are not unrelated, as we frequently observe in debates on the life sciences.

The politics of biotechnology proceeded to start with as a case of business as usual in each country, although in each this pattern was eventually disrupted to varying degrees. In the United States, leading research scientists, banding together at Asilomar, called attention to the threats of recombinant DNA research and laid conceptual foundations for regulation that were widely imitated throughout the world. Propelled by genuine concerns for public welfare, the Asilomar conferees nonetheless exemplified the classic American pattern of interest group politics. Molecular biologists stumbled into action through their fear of displaying the lack of foresight and suffering the loss of esteem that nuclear physicists had experienced in developing the atomic bomb. But trying to forestall charges of heedlessness, the Asilomar participants crafted powerful narratives that influenced U.S. politics and catered to molecular biologists' interests for years to come: narratives of scientific self-regulation and social responsibility; of molecular biology as the



science with the most to say about the safety of GM techniques; of health risk as the issue of largest concern; and of physical and biological containment as the primary instruments for risk control. The channeling effects of these early stories become starkly apparent only through comparison with political systems in which other social actors helped create the initial framings around biotechnology.

In Britain, the first state responses to biotechnology took the form of top-down measures, informed and assisted by a network of largely invisible expert committees.<sup>18</sup> Unlike pluralist politics, however, Britain's consensual, elitist traditions of government offered the means for accommodating all reasonable voices at the policy table—or at least those voices that the state deemed reasonable. This greater inclusiveness encompassed ecologists and environmentalists, who succeeded during the 1990s in canvassing a wider range of unknowns around the dissemination of agriculture biotechnology than were acknowledged in U.S. assessments. Even before BSE became a household word, British scientists and policymakers favored a more precautionary approach to regulating biotechnology than their American counterparts, and the idea of targeting only the products of genetic technologies for regulation never took hold. The public at large played little or no role in these developments, however, neither volunteering nor being asked for its reactions to genetic modification or any of its applications.

The overt breakdown of trust over BSE marked a turning point of sorts in the politics of biotechnology, but what that crisis revealed was not so much the British public's antipathy to science and industry as the decayed state of rapport between the rulers and the ruled in one of the world's most economically and technologically successful knowledge societies. Coming on top of disenchantment with the long years of Conservative government, and the ever-present anxiety over the pace and course of Europeanization, the BSE affair highlighted the fragility of the ties that bind British citizens to their state. It was, as I have observed elsewhere, a moment of "civic dislocation" and profound self-questioning—about the ends of government and the ends of technology.<sup>19</sup> Restoring trust, as the Labour government was forced to recognize after the GM food panic, required a reinvention of the grammar of government—the ground rules according to which the state would learn to communicate more effectively with its citizens, and vice versa. Reinventing government, in turn, demanded a reinvention of citizenship. The three-pronged GM debate of 2003 not only drew science, economics, and politics into a months-long, nationwide conversation, but it became an occasion for producing the very public to whom the state could hold itself accountable.

Yet all this innovative fever also showed that old habits of governance die hard. At the highest levels of government, Britain continued to subscribe to elements of the "nanny state" that engaged citizens and NGOs had powerfully challenged through the debates on biotechnology. In Tony Blair's triumphalist

2002 speech on science to the Royal Society, in Sir John Krebs's resistance to public concerns about GM foods, and in the government's 2004 decision to approve the commercial growing of Bt-maize, one sees little acknowledgment of the humility and precaution that British activists and academics had begun to demand of the state and its corporatist (or, in my terms, programmatic) alliance with science and technology.

Representation in Germany proceeded as in the United States through traditional democratic channels, but there the task of speaking for the public fell to political parties rather than to interest groups. Early debates on biotechnology were dominated by the intensely vocal Greens, who (though always in the minority) effectively mobilized every available political channel—legislation, litigation, direct action, the media—to assert their vehement opposition to all forms of genetic manipulation. As elsewhere in Europe, the early strategy of the German Greens was to frame biotechnology as a novel, and unnatural, industrial process, and to keep alive the specter of overreaching by state and industry. The resulting morally charged political environment was inhospitable to experimentation, scientific, social, or political. It discouraged risk-taking, whether in labeling food, forming novel forms of kinship, or creating borderline biological entities such as pre-embryos and stem cells. Only when the Greens were drawn inside the networks of power, as in the Red-Green coalition of the Schröder period, did shifts develop away from the party's absolutist positions. Ironically, those years saw, if anything, an intensification of reunited Germany's reliance on biotechnology as a tool for addressing the nation's economic woes. After years of speaking out against just such an alliance,<sup>20</sup> the Greens therefore participated in redrawing the map of Germany in terms of bioregions—signaling the state's programmatic commitment to biopolitics as an instrument of national economic regeneration.

### *Participation*

Different traditions of representation in the three countries helped to determine who participated in deliberations on biotechnology, and with what consequences for the production of new knowledge and new forms of social action. The dual function of representation—speaking for publics and framing issues for policy—established the preconditions for different patterns of political inclusion and exclusion, of people as well as topics for deliberation. Most dramatically, perhaps, the rapidly achieved focus on products in the United States foreclosed wide debate on the social and ethical implications of GM technologies, particularly in agriculture, and blocked public notification, through labeling, of the production history of GM foods. The resulting absence of politics, which policymakers and industry interpreted as public acceptance of GM technologies, seemed more plausibly to reflect public ignorance. A September 2003 poll conducted by the nonprofit PEW Initiative on

Food and Biotechnology found, for example: "Although it has been estimated that 70–75% of processed foods in grocery stores contain GM foods, just 24% of Americans believe they have eaten GM foods while 58% say they have not, suggesting that Americans continue not to recognize the extent to which GM foods are present in foods they eat every day."<sup>21</sup> The containment of intellectual property conflicts within the Patent and Trademark Office and the courts had a similarly restrictive effect on participation while opening up the economic frontier for biotechnology.<sup>22</sup> The organics movement partly overcame the discursive and institutional barriers against questioning the process of genetic modification, but only by establishing a profitable market niche for non-GM products. Their victory left intact the basic framing of genetic modification as an unproblematic means of production, relegating non-GM production to marked status—literally and figuratively—under the organic label.

In the area of biomedical applications, a history of ethical breakdowns in medical experimentation, as well as the establishment of the Ethical, Legal, and Social Implications program at the National Center for Human Genome Research, opened up an institutional space for expressions of moral concern. Yet struggles over the direction of ELSI attested to the power of the very research community that had shaped the debate on ethics from the 1970s onward. The development of an intellectual property regime around biotechnology proceeded under the aegis of the law with few political impediments. Substantial changes in the U.S. social contract for science ushered in by the Bayh-Dole Act further reduced the public's capacity to supervise the applications of basic research in numerous areas of the life sciences, while rendering university-based science less self-critical about its own aims and ends, and less considerate of any public interests that stood in the way of science's "endless frontier."

In Britain, the dynamics around green and red biotechnology to some degree reversed the U.S. state of affairs, as public sensitivity to food safety forced the state to reconsider its institutional apparatus for regulating the processes of agricultural biotechnology. Academic and NGO representatives gained entry into newly constituted advisory committees charged with expanding the range of issues deemed relevant to governmental policy. In this production sector, as in no other, British politics produced, however fleetingly, a nationwide debate on the purposes of technology rather than simply accepting genetic modification as a progressive step in human development. By contrast, research policy on embryos and stem cells continued to be shaped by a more traditional coalition of state officials and their elite advisers—all intent on preserving freedom for research in a domain where British science enjoyed an international competitive advantage. Similarly, a loosening of social and legal constraints on commercialization forged closer relations between university science and corporate interests in the pharmaceutical sector without generating significant public concern. In view of the experience with GM crops,

one may still wonder whether and how long such carefully managed settlements are likely to endure; British investments in social research on genetics and genomics point to official awareness of such instability.

German participation illustrates yet a third pattern, characterized by relatively high degrees of mobilization and informed public debate in the lead-up to major legislative actions, but then an effective closing down of politics under the auspices of functionally specialized expert committees. A striking consequence of this approach has been official silence (or intentional nonrecognition?) with respect to uncertainty. It is as if—having painfully crafted the legal framework for biotechnological research and development—neither German politicians nor German citizens wish to maintain the state of high alertness demanded by traditions of interest group activism and litigation in the United States. Participation and extended deliberation stop when the law is laid down—whether at the door of parliament or, as in the case of abortion, with a decree from the constitutional court in Karlsruhe. Neither in the agricultural nor in the biomedical sector did German actors, including scientists, take the lead in testing or contesting the limits of legislative settlements once they were firmly in place. Scientific uncertainty, which so often surfaced as a public issue in both Britain and the United States, was accorded little or no political role in Germany.

### *Deliberation*

Germany, Britain, and the United States all aspire to be deliberative as well as representative democracies. The legitimacy of political action in all three countries depends in theory not only on the amount of participation, but also on its quality. Mere voting, empty of deliberative content, is regarded as insufficient for democratic governance, and public referenda of the sort so readily conducted in California are widely deplored. Yet each of these Western nations is plagued by bouts of pessimism about the possibility of genuine civic engagement. Concerns about the public understanding of science expressed on both sides of the Atlantic bear witness to this self-doubt, as do worries about a democratic deficit in the European Union, moral panics (over food safety, for example) in Britain, and the persistent despair in the United States over the role of the "phantom public"—articulated as far back as the 1920s by the influential American journalist Walter Lippmann.<sup>23</sup> What light does comparative analysis shed on the capacity of democratic polities to deliberate on the profoundly unsettling implications of the biological revolution?

Across all three countries and in almost all the issue areas surveyed in this book, we are struck by the dearth of meaningful debate on the metaphysical aspects of biotechnology: that is, debate about the kinds of entities, and associated forms of life, that the technology has sought to, or should seek to, create. Genetic modification is at its core, a means of bringing novel entities



into the world, and an engaged deliberative politics might have been expected to focus in the first instance on the desirability of these new productions. How *should* we use the power to intervene in nature's processes? Yet time after time the official discourses of policymaking channeled debate toward looking only at the impacts of technologically generated things whose existence, purpose, and value were barely questioned in public or private forums. Can recombinant bovine growth hormone (rBST) harm human health or Bt-corn damage nontarget insect species? Does GM food pose a risk to health, and are efforts to restrict their flow in trade contrary to international agreements? Are cloned animals weaker or more vulnerable to disease and age than their sexually propagated counterparts, and are risks like these a sufficient basis for prohibiting human cloning? Can patents be lawfully awarded on gene fragments, novel bacteria, and genetically altered animals? Corporate discourse, for its part, stoutly denied that the creative processes of biotechnology are novel enough to raise new issues for political deliberation. The problems listed above were all considered amenable to expert resolution. What need, then, for the turbulence of politics?

Excluded from official regulatory forums, questions about biotechnology's breaks with nature found their way into a variety of oppositional discourses, ranging from destroying research plots to filing *amicus* briefs, conducting media campaigns, dumping grain before politicians' doors, and finding creative ways around the rules that prevented GM products from being labeled as such. Public intellectuals such as Leon Kass and Francis Fukuyama in the United States, or Jürgen Habermas and Peter Sloterdijk in Germany, offered personal visions, their voices sometimes amplified through that odd late-twentieth-century governance mechanism, the national ethics commission. The resulting patchwork of strategies and articulations led to changes in normal politics in some instances, but, interestingly, the most notable participatory victories were achieved in places where existing deliberative institutions and discourses were weakest and least grounded in prior practice.

Thus, environmentalists scored some of their greatest successes with relatively new institutions like the European Parliament (on gene patenting and research ethics, for example) and with industrial sectors, such as supermarkets, that were newcomers to GM politics and directly answerable to consumer preferences. Britain's historical lack of experience with broad public engagement opened the door to the remarkably innovative, three-pronged deliberative process on the commercialization of GM crops; this exercise led to perhaps the widest-ranging exploration of scientific unknowns around biotechnology since the much less democratic Asilomar conference on rDNA research. In the United States, GM opponents made themselves most clearly heard in the nascent organic food market, for which federal regulatory principles had yet to be devised in the 1990s. By contrast, the securely established U.S. Food and Drug Administration resisted demands for a broad-based assessment of the

value of GM foods until European opposition forced at least a partial retreat from the naturalizing doctrine of "substantial equivalence" between GM and non-GM products.

Only the specter of new kinds of humans produced through cloning—and the corresponding destruction of embryonic stem cells as potential humans—led in all three countries to something approaching full-blown public deliberation on the ontological consequences of biotechnology, but even on these explosive issues the results were curiously constrained. In Britain, a successful dehumanizing of the pre-embryo prevented a slide into the polarized abortion debate that hemmed in U.S. research, but it also inhibited the exploration of eugenic and feminist concerns that surfaced in Germany around embryo manipulation. Yet Germany's intellectually more robust debate paved the way to an exceptionally stringent law whose black-and-white prohibitions blocked subsequent innovation and forced uneasy moral compromises on stem cell research. In the United States, bioethics initially developed as a facilitator of medical research, with utilitarian overtones. The conservative-tending bioethics council appointed by President George W. Bush adopted an allegedly transparent vocabulary to illuminate "descriptive reality" and facilitate moral reasoning. In charting this novel discursive path, however, the council denied the framing power of its own language and reinscribed a highly questionable fact-value distinction into the domain of ethical analysis. And—in a far from neutral move—the council's proposed terminology broke the emerging links between stem cell research and the politically compelling discourses of therapeutic and reproductive rights.

### In the Hinterlands of Power

Democratic engagement with biotechnology, we have seen, was shaped and constrained by national approaches to representation, participation, and deliberation. These approaches in turn selectively delimited who spoke for people and issues, how those issues were framed, and how they were reflected upon in official policymaking processes. Almost as a corollary, certain matters remained in each country stubbornly outside the reach of popular control, marked off from ordinary politics; various forms of institutional boundary work either rendered those issues invisible or else designated them as appropriate only for expert analysis. Democratic control, in other words, was sometimes set aside in favor of other culturally sanctioned norms of political legitimacy. What were these ineffable sources of authority, and how did they vary across national lines?

Our comparisons indicate that there were in each country preferred models of virtuous decision making that supplemented, to some degree, formal

democratic processes for the governance of biotechnology. Most clearly visible in the controversies about deliberate release (chapter 4), these hidden reserves of power included the authority of science in the United States, of expertise in Britain, and of institutional rationality in Germany. These legitimating devices carved out deliberative spaces that were not subject to ordinary rules of political accountability. Identifying them advances the project of political theory, for it shows how in any well-ordered democratic system certain relatively unquestioned social practices serve as a backstop to normal politics—much in the way that, in Thomas Kuhn's account of scientific revolutions, the invisible assumptions of dominant scientific paradigms provide a safe haven within which normal science enjoys its day-to-day recognition, meaning, and legitimacy.<sup>24</sup> Neither absolute nor universally at play, the paradigmatic elements of political culture demand recognition, and, once exposed to view, they are not above critique.

In the United States, it is the transcendental cognitive authority of science that most powerfully complements political authority. So fundamental, even constitutional, is the status of science within politics that it is tempting to refer to the United States as a *Wissenschaftsstaat* (a state of science), parallel to Germany's self-designation as a *Rechtsstaat* (a state of law). Science was repeatedly invoked to close, or foreclose, political debates on biotechnology, especially in the agricultural sector, but factual claims alone were never sufficient. The capacity of science to trump political dissent is channeled through a variety of expert institutions, from the National Academy of Sciences to advisory bodies attached to regulatory agencies. Through such bodies, science underwrote the initial product framing that drove U.S. regulation, provided the grounds for assuming safety in agricultural and food biotechnology, offered persuasive arguments against human cloning and for stem cell research, and supported the rewriting of the social contract so as to bring university research into closer alliance with commercial production.

Of course, to perform these legitimating functions, science itself has to stand apart from the contaminating touch of politics, and there is no dearth of actors prepared to do the boundary work that makes this separation seem real. The Mertonian vision of disinterested science is kept alive even by corporate science's most ardent American critics; not for them the Mode 2 analyst's dream of a thoroughly socialized, politically embedded science. Moments of slippage do occur, as happened in biotechnology patent disputes and in recurrent controversies about the ethical status of university-industry relations. But in all these debates, it is a particular faulty development, corporation, or person that draws negative attention; the ideal of value-free science retains its firm hold on the national imagination, of cheerleaders as well as skeptics.

Science in Britain enjoys a no less preeminent intellectual status than in the United States, but as a guarantor of political legitimacy science lacks

power unless it speaks through socially accredited expert bodies, both individual and collective. Much energy is devoted in Britain to producing experts whose right to speak on behalf of the public will be virtually unquestioned. Their authority is not a matter of skills and knowledge alone, but of those attributes coupled to significant demonstrations of social responsibility. British experts generally earn the right to represent the public through successive episodes of personal testing that elevate them to the ranks of the "great and the good" and endow them, in effect, with common vision: the power to see for the people, with an encompassing gaze that goes beyond the ordinary person's capacity for foresight. When this system of authorization malfunctions, as it massively did in the case of BSE, reforms are targeted toward incorporating a wider range of expertise into ruling institutions, thereby shoring up the credibility of the state. Underlying notions of what constitutes expertise are not necessarily questioned. It hardly needs restating that embodied political authority in Britain does not reside in scientists alone, but in all those who have demonstrated the ability to speak for the people—and so to do the state some service. Even Prince Charles, the much lampooned heir to the throne, exerted wide-ranging moral and political influence when he framed the uncertainties around GM crops in ways that resonated with the majority of his subjects. Contingently, on this single issue, Charles overcame his image of knowing nothing traditionalist and functioned for a time as a people's expert.

In place of transcendental knowledge or embodied authority, the German decision-making system has reposed its trust in institutional reasoning as an important supplement to democratic politics. More than in either of the other countries, visible and unruly political interventions, such as the Greens' partial capture of the parliamentary Enquiry Commission on genetic engineering, tend to go underground in Germany once an issue is felt to be under comprehensive legal control. Matters then move from the sphere of politicized debate to that of administrative implementation, guided by appropriately constituted expert committees. The status of these committees in relation to policy legitimation, however, is subtly different from that of similar bodies in the United States and Britain. Whereas U.S. and U.K. bodies offer advice, German committees function as miniworlds of reason: they aim to encompass within them the capacity to articulate all relevant arguments and to produce a consensus that is binding on society because it is, in effect, the consensus that society would have reached if it had been able to deliberate in common. Issues of membership and representation become crucial for bodies such as these; and it is perhaps no accident that German legislation frequently demands not only the designation of members representing relevant social groups, but also the identification of alternates for each designated member. The absence of any viewpoint would create a vacuum detrimental to the proper functioning of the whole.

### The Ends of Comparison: Theory and Practice

The early reception of biotechnology into the political life of three leading industrial democracies was not, I have argued, simply a matter of advances in science and technology, but a product of complex entanglements among knowledge, technical capability, politics, and culture. To make sense of the resulting national settlements, one must look not only at the discoveries and commodities that materialize out of research laboratories and industrial facilities; one must equally take into account the scripts for human development and collective choice that emanate from a nation's political and social institutions, and from its citizens. For politically engaged scholars of science and technology in society, following scientists around (as some sociologists of knowledge have urged<sup>25</sup>) provides only a tiny peephole on the power of science. It is just as necessary to chart the trajectories of the myriad other social actors whose values and expectations interpenetrate with those of scientists and inventors, creating the conditions in which scientific ideas are translated into material and social realities. Scientific cultures are at one and the same time political cultures.<sup>26</sup> Describing one without the other leads to partial vision, thin description, and inadequately informed critique. Any responsible ethnographer of modernity has to find an interpretive vantage point on both science and politics, and on their increasingly thick networking.

Comparison, particularly across national political systems, provides one such angle of vision. Setting the experiences of one country against another's offers salutary reminders of the degree to which even the homogeneous West is not univocal in its responses to science and technology. Democracy, too, is not a singular form of life but a common human urge to self-rule that finds expression in many different institutional and cultural arrangements. In tracing biotechnology's complex passages from invention to regulation to social uptake (or, in some cases, rejection), we gain deeper insights not only into what modern cultures want to make out of life—their designs on nature—but also the resources with which they wish to reflect and deliberate on life's very meaning. We observe not a predetermined, linear march of technoscientific progress, but a series of contingent, culturally specific accommodations, in which the continual intertwining of knowledge with politics produces outcomes that are as rich as they are strange.

There are, of course many similarities among the three countries compared in this book. I have chosen to highlight the cross-national differences in part because they may not be easily apparent to actors operating exclusively within the perimeter of a given political culture. Comparison in this respect promotes cultural self-awareness. It is by looking outward at others' ordering practices that one most readily appreciates the markers of one's own. Only by examining the politics of biotechnology across nations does the traveling explorer of modernity come to recognize, and perhaps regret, such "missing"

elements of political culture as proactive citizen engagement in Britain, robust scientific debate in Germany, and respect for embodied virtue in the United States. That these absences exist, however, is not a necessary or sufficient argument for trying to import them from abroad. The distinctive features of political culture are not so easily transferable. They are embedded in a rich matrix of experience and practice, and efforts to graft them onto other settings may fail or entail a higher price than enthusiasts for such transfer would find acceptable.

Any expectation that other policy systems can be used as models to imitate rests on a notion of cultural deficit that this book should render seriously problematic. Political cultures are not, like the characters in the beloved American children's classic, L. Frank Baum's *The Wonderful Wizard of Oz*,<sup>27</sup> deficient along particular dimensions that can be objectively identified and easily compensated for: a brain for the Scarecrow, a heart for the Tin Woodman, and courage for the Cowardly Lion. Let us not forget that Baum's title character, when unmasked as a fraud and an impostor, disavows his magical powers like some latter-day Prospero and debunks his own capacity to make complex beings more whole than they already are. Handing out a diploma to the Scarecrow, a testimonial clock to the Tin Woodman, and a medal of honor to the Cowardly Lion, the Wizard of Oz only emphasizes the ironic insufficiency of these externally procured organ transplants. The enduring work of moral and social generation, he implies, requires inner resources of invention and reinvention—a lesson that holds no less true for today's vibrant knowledge societies than it did in 1900 for Baum's populist fictional heroes.

Comparison, then, should aspire less to prescribe policy solutions than to explain outcomes; it should offer interpretive criticism rather than clinical diagnosis, or *Verstehen* (understanding) rather than *Erklärung* (causal explanation). To state the purposes of comparative politics most simply, we can do no better than return to the words of Baroness Warnock before the House of Lords in the 1988 debate on the Embryo Bill. She said on that occasion, "[T]here is a very noble prayer frequently uttered in my college chapel that we may be given the grace to distinguish things that differ."<sup>28</sup> With one small but important modification, Warnock's prayer can serve as the starting point for the comparatist's creed. The observer of other cultures should also be given the grace to distinguish things that differ, but always keeping in mind the meanings that those distinctions have for people in the observed cultural spaces. The aim of comparison is to reveal, with critical detachment but epistemic charity, what gives significance to another culture's distinctions and differences, not forgetting in the process to reflect on the commitments encoded in one's own. It is not the divine prerogative of producing universally valid principles of knowledge or governance that comparison should strive for. It is to make visible the normative implications of different forms of contemporary scientific and political life, and to show what is at stake, for knowing and reasoning human beings, in seeking to inhabit them.

2. On the looping effects of human kinds, see Hacking, *The Social Construction of What?; Rewriting the Soul*. On the rationalizing impacts of classification, see Bauman, *Modernity and Ambivalence*; Bowker and Star, *Sorting Things Out*.

3. Ezrahi, *The Descent of Icarus*.

4. John Ziman, *Public Knowledge* (Cambridge: Cambridge University Press, 1968), p. 33.

5. Significantly, the three sponsoring organizations of COPUS announced in December 2002 that they were disbanding the body because "We have reached the conclusion that the top-down approach which Copus currently exemplifies is no longer appropriate to the wider agenda that the science communication community is now addressing. We believe it will be more effective to allow organisations to seek their own partnerships and develop their own activities." [http://www.copus.org.uk/news\\_detail\\_091202.html](http://www.copus.org.uk/news_detail_091202.html) (visited April 2003).

6. The science journalist Daniel Greenberg has written scathingly of U.S. scientists' persistent blaming of a scientifically illiterate public for their imagined woes. Greenberg finds no association between PUS and science funding. See Greenberg, *Science, Money, and Politics*, pp. 205–233.

7. National Science Foundation, *Science and Engineering Indicators 2002*, chapter 7, <http://www.nsf.gov/sbe/srs/seind02/c7/c7s2.htm#attb> (visited April 2004) (hereafter, *2002 Indicators*).

8. *Ibid.*, <http://www.nsf.gov/sbe/srs/seind02/c7/c7s1.htm> (visited April 2004).

9. Jon Turney, "Public Understanding of Science," *Lancet* 347 (1996): 1087–1090.

10. See particularly Irwin and Wynne, eds., *Misunderstanding Science?*

11. Jasanoff, "Civilization and Madness."

12. *Phillips Inquiry Report*, vol. 6: Human Health, 1989–1996, para. 4.564, <http://www.bseinquiry.gov.uk/report/volume6/chapt413.htm> (visited April 2004).

13. *Guardian Unlimited*, October 22, 1998.

14. Edmund Burke, *Thoughts on the Present Discontents* (1770). I am indebted to Maya Jasanoff for calling my attention to this passage and to the Gillray cartoons discussed above.

15. Ezrahi, *The Descent of Icarus*.

16. Brickman et al., *Controlling Chemicals*.

17. In a September 18, 2003, survey released by the Pew Initiative on Food and Biotechnology, 58 percent of Americans said they did not believe they had ever eaten GM foods. It is estimated that 70–75 percent of processed foods in grocery stores contain GM ingredients. See <http://pewagbiotech.org/research/2003update/> (visited September 2003).

18. Ezrahi, *The Descent of Icarus*.

19. For contrasts between the United States and Europe with regard to these assumptions, see, Sheila Jasanoff, "Citizens at Risk: Cultures of Modernity in Europe and the U.S.," *Science as Culture* 11, 3 (2002): 363–380.

20. For an account of the fluid and diverse accommodations between science and Western democracy, see Roy MacLeod, "Science and Democracy: Historical Reflections on Present Discontents," *Minerva* 35 (1997): 369–384.

21. Brian Wynne and Peter Simmons (with Claire Waterton, Peter Hughes, and Simon Shackley), "Institutional Cultures and the Management of Global Environmental Risks in the United Kingdom," in The Social Learning Group, *Learning to Manage Global Environmental Risks*, pp. 93–113.

22. Brickman et al., *Controlling Chemicals*. See also Sheila Jasanoff, "Acceptable Evidence in a Pluralistic Society," in Rachele Hollander and Deborah Mayo, eds., *Acceptable Evidence: Science and Values in Hazard Management* (New York: Oxford University Press, 1991), pp. 29–47; "Cultural Aspects of Risk Assessment in Britain and the United States," in Johnson and Covello, eds., *The Social and Cultural Construction of Risk*, pp. 359–397.

23. Skocpol, *Protecting Soldiers and Mothers*.

24. Porter, *Trust in Numbers*.

25. For more on the politics of numbers in U.S. environmental regulation, see Jasanoff, *Risk Management and Political Culture*; also see Brickman et al., *Controlling Chemicals*; Jasanoff, "Acceptable Evidence" and "Cultural Aspects of Risk Assessment."

26. See Brickman et al., *Controlling Chemicals*, pp. 122–126.

27. There is a large literature on this topic. Important examples include Paul Stern and Harvey Fineberg, eds., *Understanding Risk* (Washington, DC: National Academy Press, 1996); Beck, *Risk Society*; Langdon Winner, "On Not Hitting the Tar-Baby," in *The Whale and the Reactor*, pp. 138–154. For a review of the implications of this work for comparative politics, see Sheila Jasanoff, "Technological Risk and Cultures of Rationality," in National Research Council, *Incorporating Science, Economics, and Sociology in Developing Sanitary and Phytosanitary Standards in International Trade* (Washington, DC: National Academy Press, 2000), pp. 65–84.

28. Harried administrators were not the only ones who jumped on the risk assessment bandwagon. The movement received powerful support from legal scholars and the courts. On the role of the courts, see Jasanoff, *Science at the Bar*. On the attitudes of legal academics, see Cass Sunstein, *Risk and Reason* (Cambridge: Cambridge University Press, 2002); Breyer, *Breaking the Vicious Circle*.

29. U.S. House of Representatives, Committee on Government Reform (Minority Report), *Politics and Science in the Bush Administration*.

30. In the rich literature on the sociology of testing, the following works are especially illuminating: Pinch, "Testing—One, Two, Three ... Testing!" and MacKenzie, *Inventing Accuracy*.

31. John Carson, "The Merit of Science and the Science of Merit," in Jasanoff, ed., *States of Knowledge*, pp. 181–205.

32. Press and Washburn, "The Kept University."

#### CHAPTER 11: REPUBLICS OF SCIENCE

1. See Press Release, United States Trade Representative, Executive Office of the President, Washington, DC, May 13, 2003, <http://www.ustr.gov/releases/2003/05/03-31.htm> (visited October 2003).

2. "European Commission regrets the request for a WTO panel on GMOs," EU Institutions Press Releases, Brussels, August 18, 2003.

3. Bernauer, *Genes, Trade, and Regulation*.

4. Jasanoff, ed., *States of Knowledge*.

5. These observations are similar to what Peter Hall and others term "policy paradigms" but the coproduction framework brings the cognitive dimension of framing to the fore.

6. Jasanoff, "Product, Process, or Programme: Three Cultures and the Regulation of Biotechnology."
7. Francis Fukuyama, *The End of History and the Last Man* (New York: Penguin, 1992).
8. *Diamond v. Chakrabarty*, 447 U.S. 303 (1980).
9. Consider, for example, the crucial role of venture capital in the early growth of biotechnology in the United States. United States Congress, Office of Technology Assessment, *Commercial Biotechnology: An International Analysis* (Washington, DC: US GPO, 1984).
10. See, for instance, Smith and Marx, eds., *Does Technology Drive History?*
11. *Moore v. Regents of the University of California*, 51 Cal. 3d 134 (1990).
12. *Johnson v. Calvert*, 5 Cal. 4th 84 (1993). See also Jasanoff, "Ordering Life: Law and the Normalization of Biotechnology."
13. See Habermas, *The Future of Human Nature*.
14. John Krebs had successfully served as the head of the Natural Environment Research Council and, in that capacity, had dealt with the dismissal of David Bishop over the release of a viral pesticide modified with a scorpion gene (see chapter 4).
15. On Germany's wider struggles with historical memory in this period, see Maier, *The Unmasterable Past*; Ian Buruma, *The Wages of Guilt: Memories of War in Germany and Japan* (London: Vintage, 1995).
16. Interview with Wolfgang van den Daele, Berlin, July 2002.
17. This point builds on the work of Michel Foucault and his followers. See particularly Foucault, *The Foucault Reader*, ed. Paul Rabinow (New York: Random House, 1984); Paul Rabinow, *Essays on the Anthropology of Reason* (Princeton: Princeton University Press, 1996); Hardt and Negri, *Empire*.
18. For a comprehensive history of this phase of U.K. policymaking, see Wright, *Molecular Politics*.
19. Jasanoff, "Civilization and Madness."
20. Gottweis, *Governing Molecules*.
21. The data were based on a survey of one thousand American consumers conducted on August 5–10, 2003. Pew Initiative on Food and Biotechnology, "Public Sentiment about Genetically Modified Food," <http://pewagbiotech.org/research/2003update> (visited April 2004).
22. Jasanoff, "Ordering Life."
23. Walter Lippmann, *The Phantom Public* (New Brunswick, NJ: Transaction Publishers, 1993 [1925]).
24. Kuhn, *The Structure of Scientific Revolutions*.
25. See particularly Bruno Latour, *Science in Action: How to Follow Scientists and Engineers through Society* (Cambridge: Harvard University Press, 1987).
26. For an argument that this confluence of scientific with political culture in the West dates back to the time of the scientific revolution, see the magisterial account of Robert Boyle's struggles with Thomas Hobbes in Shapin and Schaffer, *Leviathan and the Air-Pump*.
27. L. Frank Baum, *The Wonderful Wizard of Oz* (Chicago: G. M. Hill, 1900).
28. Baroness Warnock, Lords, January 15, 1988, col. 1470.

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