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The Dilemmas of Dual-use Research

The 'Introduction' recounted some of the debates about 1918 Spanish Flu research to suggest something of the dynamics of discussions about the dual-use applications of the life sciences. Questions were posed not only about the choices and challenges in conducting biological research but also in examining dual-use issues in the first place. With regard to both, questions can be posed about what needs to be done and what is at stake in the way research is undertaken.

This chapter continues with this examination of policy debates while also reflecting on how this is done. In doing so it seeks to question what constitutes a proper understanding of 'the problem' of dual-use research. This is accomplished, in part, by treating dual-use research as a social problem; which is to say attention is given to the contingent processes whereby dangers are identified, proposals are tabled, and choices are made about what needs to be done.[1] While developments in science and engineering have long provided the basis for more sophisticated weaponry, in recent years the attention devoted to the life sciences and bioweapons has increased substantially. That attention has inevitably focused on certain issues in a certain manner. As suggested from the case of Spanish Flu, just how the link between 'research' and 'threats' ought to be conceived can be a matter of contestation. The changing, sometimes multiply envisaged, dangers identified are a topic for scrutiny in this chapter. In this way it sets the preliminary parameters for an understanding of the potential of research that will be drawn on and also subjected to scrutiny in later chapters.

Scrutiny is also given to what this social problem's orientation itself implies for the understanding given to 'the problem' of dual use. With a notional focus on how concerns emerge and get defined, in this chapter I do not intent to offer a definitive account of the scale of the dual-use

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potential of the life sciences. Instead, I choose to ask how individuals and organizations have sought to forward specific definitions and characterizations of this. As a principle of methodology, such a move assumes that the definition of a problem is open to multiple, perhaps fundamentally opposed, interpretations. As societal concerns about issues such as homelessness, poverty, hooliganism, and road rage 'may emerge, transmute, descend, disappear, or reappear, independent of any change in actual conditions',[2] so too can the understanding given to the implications of science. Therefore, talk of the real problems and possibilities posed from life science research is largely eschewed in favor of considering how certain claims are justified and their implications for determinations of what needs to be done. As will be suggested, however, following through in this orientation raises a number of important questions about the adequacy of the analysis obtained, what it implies about the responsibilities of social researchers, and the relation between such analysts and public issues.

A statement of the problem of 'dual-use research'

One of the highest profile and arguably most influential statements about the weapons potential of life science research was the US National Research Council (of the National Academies) report *Biotechnology Research in an Age of Terrorism*. Published in October of 2003, the report was billed as the first time that the National Academies directly examined the national security issues associated with the life sciences. It was a product of the Council's recently established Committee on Research Standards and Practices to Prevent the Destructive Application of Biotechnology. The Committee held a number of meetings from April 2002 under the remit to offer advice to the federal government regarding what might be done about the threats of bioterrorism and biowarfare from fundamental research. The Committee was among a number of other groups and events initiated by the National Academies to consider science and security issues post-9/11.[3]

As stated in *Biotechnology Research in an Age of Terrorism*, the problem that needed addressing was 'the intentional use of biotechnology for destructive purposes'.[4] Consideration of the security implications associated with the life sciences was justified by recent developments including, 'the discovery of nations with clandestine research programs dedicated to the creation of biological weapons, the anthrax attacks of 2001, the rapid pace of progress in biotechnology, and the accessibility of these new technologies by the Internet.'[5] The Committee did not equally reflect on every aspect of intentional destructive use of biotechnology. Citing the legislation already introduced post-9/11 regarding the possible diversion of dangerous agents from laboratories and the screening of lab personnel, focus was given to how the technologies, methods, and knowledge generated in advanced research might facilitate the creation of bioweapons.

In the report, the nature of science as an activity was central to understanding the nature of the dual-use problem. Professor Gerald Fink of the Whitehead Institute for Biomedical Research chaired the Committee and succinctly summarized many of the points made when he argued:

> [A]lmost all biotechnology in the service of human health can be subverted for misuse by hostile individuals or nations. The major vehicles of bioterrorism, at least in the near term, are likely to be based on materials and techniques that are available throughout the world and are easily acquired. Most importantly, a critical element of our defense against bioterrorism is the accelerated development of biotechnology to advance our ability to detect and cure disease. Since the development of biotechnology is facilitated by the sharing of ideas and materials, open communication offers the best security against bioterrorism. The tension between the spread of technologies that protect us and the spread of technologies that threaten us is the crux of the dilemma.[6]

Thus, concerns about destructive applications of biology posed a vexing dilemma, since the promise of biotechnology went hand in hand with its darker side.

The comments made by Fink were expanded on in the report and marshaled to justify the recommendations reached. So the imperative was frequently forwarded to not jeopardize the 'great achievements of molecular biology and genetics over the last 50 years'[7] because of the potential misuse of science. The advancement of science was itself predicated on the 'norm of open communication'.[8] As stated, '[t]he rapid advance of scientific knowledge and applications owes much to a research culture in which knowledge and biological materials are shared among scientists and people move freely between universities, government agencies, and private industry.'[9] In part because of this free movement, science was also very much an international activity. So, '[w]ithout international consensus and consistent guidelines for overseeing research in advanced biotechnology, limitations on certain types of research in the United States would only impede the progress of biomedical research here and undermine our own national interests.'[10]

While *Biotechnology Research in an Age of Terrorism* stated that the potential for the deliberate destructive use of biotechnology was not new to the beginning of the twenty-first century, a variety of reasons made concern about any threats especially salient today. This included three recent experiments discussed in some detail illustrating the malign possibilities enabled by advanced biology. One, the insertion of the interleukin-4 gene (IL-4) into the mousepox virus by Australian researchers in early 2001 to find an infectious contraceptive for reducing animal populations.[11] With the high mortality rates achieved for immunized and non-immunized mice because of the over-expressed IL-4, it was feared this experiment suggested a technique for enhancing the lethality of other pox viruses (such as smallpox). Second, the 2002 announcement of the successful artificial chemical synthesis of poliovirus that signaled a way to create other viruses from scratch.[12] Third, the comparison of a type of smallpox and its vaccine published in 2002 that proposed a means of making the vaccine more lethal.[13]

Just as the destructive potential of biotechnology was not portrayed as novel to the twenty-first century, so too were national security concerns about research not portrayed as new either. The Committee compared the fields of nuclear science and cryptography with that of the life sciences and concluded that 'controls on information flows in the life sciences will face obstacles rather different …'.[14] Factors such as the size of the life science community, the number of publications produced per year, and the lack of previous engagement with security concerns meant that models for implementing security measures derived from these other fields would not work.

Instead of proposing oversight procedures modeled on practices elsewhere, the Committee recommended extending many of the community self-governance mechanisms already in place in the life sciences. One of the recommendations, for instance, called for the initiation of a system of pre-project review of so-called 'experiments of concern' by extending existing biosafety and recombinant DNA review procedures. Box 1.1 lists the main recommendations advocated. A theme stressed throughout the report was the importance of extending any initiatives beyond the US.

While setting out an agenda for action, the report left many difficult issues unresolved. The Committee both argued for the need to introduce new measures that might restrict research and for the need to ensure that such measures did not 'impinge upon the ability of the life science community to continue its role of contributing to the betterments of life and

Box 1.1 Recommendations from *Biotechnology Research in an Age of Terrorism*

Recommendation 1: Educating the Scientific Community

We recommend that national and international professional societies and related organizations and institutions create programs to educate scientists about the nature of dual-use dilemma in biotechnology and their responsibilities to mitigate its risks.

Recommendation 2: Review of Plans for Experiments

We recommend the Department of Health and Human Services (DHHS) augment the already established systems for the review of experiments involving recombinant DNA conducted by the National Institutes of Health to create a review system for seven classes of experiments (the Experiments of Concern) involving microbial agents that raise concerns about their potential for misuse.

Recommendation 3: Review at the Publication Stage

We recommend relying on self-governance by scientists and scientific journals to review publications for their potential national security risks.

Recommendation 4: Creation of a National Science Advisory Board for Biodefense

We recommend that the Department of Health and Human Services create a National Science Advisory Board for Biodefense (NSABB) to provide advice, guidance, and leadership for the system of review and oversight we are proposing.

Recommendation 5: Additional Elements for Protection Against Misuse

We recommend that the federal government rely on the implementation of current legislation and regulation, with periodic review by the NSABB, to provide protection of biological material and supervision of personnel working with these materials.

Recommendation 6: A Role for the Life Sciences in Efforts to Prevent Bioterrorism and Biowarfare

We recommend that the national security and law enforcement communities develop new channels of sustained communication with the life sciences community about how to mitigate the risks of bioterrorism.

Recommendation 7: Harmonized International Oversight

We recommend that the international policy-making and scientific communities create an International Forum on Biosecurity to develop and promote harmonized national, regional, and international measures that will provide a counterpart to the system we recommend for the United States.

improving defenses against biological threats'.[15] This overall tricky desire to curb without impeding was repeated in relation to specific actions. So while, on the one hand, it was said that '[t]o limit the information available in the methods section of journals articles would violate the norm that all experimental results should be open to challenge by others', on the other hand, it was noted that 'not to do so is potentially to provide important information to biowarfare programs in other countries or to terrorist groups.'[16] Arguably important to determining what ought to be done by the way of dissemination controls were assessments about the feasibility of limiting the spread of research. While the report warned about the dangers of controls for the progress of science, it also stated that there was an 'inevitable diffusion of knowledge and capabilities' to states and non-state groups.[17]

From the perspective of public policy, *Biotechnology Research in an Age of Terrorism* could also be noted for what it did not say. No attempt, for instance, was made to detail the magnitude and severity of dual-use concerns or propose how the threats from this compared with other terrorist or natural threats.

A brief recent history of 'dual-use' life science research

With its explicit focus on the possible restrictions of civilian fundamental life science research, the agenda for *Biotechnology Research in an Age of Terrorism* differed in noteworthy respects from the vast majority of *pre*-9/11 policy analyses. While concerns about the potential for genetic techniques to aid the development of bioweapons have been voiced since the development of such techniques, this has not translated into such plans for national oversight procedures.[18] So although a 1997 US Department of Defense report identified the following trends as influencing the likelihood that infectious agents would be used as bioweapons:

- Genetically engineered vectors in the form of modified infectious organisms will be increasingly employed as tools in medicine and the techniques will become more widely available.
- Strides will be made in the understanding of infectious disease mechanisms and in microbial genetics that are responsible for disease processes.
- An increased understanding of the human immune system function and disease mechanisms will shed light on the circumstances that cause individual susceptibility to infectious disease.[19]

Its recommendations for action were limited to fairly long-established concerns about strengthening counter-proliferation measures. Likewise, while events such as the First US National Symposium on Medical and Public Health Response to Bioterrorism in 1999 and the Second Symposium in 2000 signaled the increasing policy attention to bioterrorism in the late-1990s, the recommendations made by contributors dealt with matters such as devising threat scenarios, developing early warning sensors, co-ordinating public health responses to attacks, and preventing individuals from former biological weapons programs selling their skills to the highest bidder.[20] Even up to the days before 9/11, analyses of the how the life sciences might aid the design of new bioweapons shied away from considering controls on research findings.[21]

In examining the contingent processes whereby threats from research are identified as a problem that needs addressing, this section outlines key emerging issues between 9/11 and the publication of the *Biotechnology Research in an Age of Terrorism* report.

As noted previously, much of the initial policy attention in the United States after 9/11 and the anthrax letter attacks in 2001 centered on strengthening the physical containment of pathogens and the vetting of personnel working with dangerous 'select' agents. The 2001 US *PATRIOT Act* and the later *Public Health Security and Bioterrorism Preparedness and Response Act of 2002* brought in a variety of enhanced controls on the registration, transfer, storage, and use of recognized dangerous agents.[22]

Yet from the autumn of 2001, articles in the scientific and general press raised questions beyond these more traditional matters.[23] For instance, in October, *Nature* ran a feature article called 'The Bugs of War', outlining a wide ranging set of possibilities for how knowledge and techniques in microbiology and genetic engineering could aid in the development of sophisticated bioweapons. This included genetically manipulating viruses to increase their virulence and survivability, hybridizing viral strains, or introducing antibiotic resistance into bacteria.[24] The case of the insertion of the IL-4 gene into the mousepox virus was the central example of how otherwise benign research might have other applications. Technical possibilities for detecting and countering biothreats were discussed, from which it was concluded that 'the techniques that could produce bioweapons are also being deployed to set up countermeasures against them. This neatly illustrates the point that legitimate and malevolent applications of biology are merely two sides of the same coin.'[25] The article ended with an appeal from Matthew Meselson at Harvard University that it was 'time for biologists to begin asking what means we have to keep the technology from being used in subverted ways'.[26]

A month later *Nature* published another feature article, which included a much sterner call to action.[27] This was based on an interview with George Poste, former head of research at the pharmaceutical firm SmithKline Beecham, and then chair of a US Department of Defense task force on bioterrorism. Poste lamented about how security sensitive research entered the public domain. The IL-4 mousepox experiment likewise figured centrally as an example of this spread. Instead of merely calling for more discussion, he said that biology must 'lose its innocence',[28] to prevent unduly draconian legislation be introduced from elsewhere. Possible, largely self-policed, controls included greater classification of findings, the inclusion of questions about the possible malign application of research on grant submission forms, the vetting of scientific articles, and the limiting of access to certain sequence information. Scientists such as Anthony Fauci from the NIAID were quoted as expressing various reservations about such measures while arguing for greater awareness and debate about the malign applications of science. Poste's call was repeated in an article for the *Financial Times* in which he wrote that 'The issue is not to retreat to "forbidden knowledge" in which areas of research are prohibited. Rather it is about defining "constrained knowledge" in which freedom of research is not impeded but public access to certain categories of research data is restricted.'[29]

Along with such stories came more in-depth analyses.[30] In an extended article in late-2001 for *Critical Reviews in Microbiology*, Epstein examined the possible contribution of civilian research to devising novel bioweapons. In it he offered the category of 'contentious research' to refer to 'fundamental biological or biomedical investigations that produce organisms or knowledge that could have immediate weapons implications, and therefore raise questions concerning whether and how that research ought to be conducted and disseminated.'[31] Epstein called for the scientific community to initiate a process of dialogue with the national security community on such research if it did 'not want to operate under a Congressionally mandated governance regime'.[32] The Asilomar Conference of 1975 conducted by biologists that eventually led to the creation of the NIH Recombinant Advisory Committee and institutional biosafety review procedures was presented as a model with some promise.

Subsequent analyses by academics and US governmental agencies offered appraisals of the threats posed by developments in the life sciences and some gave explicit attention to just what needed to be done.[33] For instance, by way of suggesting guidelines for restricting publications, Zilinskas and Tucker identified a number of lines of contemporary research that posed dual-use dilemmas (see Box 1.2).[34] They called for any system of publication review to have the 'support of the international scientific community, which must perceive that the security benefits of restricting open publication outweigh the possible costs to science'.[35] Carlson argued that the unstoppable exponential increase in the sophistication and the

Box 1.2 Research that poses dual-use dilemmas (Zilinskas and Tucker)

- Sequencing the genomes of human pathogens.
- Construction of 'fusion toxins' derived from two distinct toxins.
- Genetic engineering of a Bacillus anthracis strain containing inserted toxin genes (for example, for cereolysine AB).
- The finding by Australian researchers that inserting the gene for interleukin-4 into the genome of ectromelia (mousepox) virus significantly enhances viral virulence and vaccine resistance in mice.
- Development of 'stealth' viruses that evade the human immune system.
- Publication of the molecular details of two virulent strains of influenza, the 1997 Hong Kong Flu and the 1918 Spanish Flu, the second of which killed 20 million to 40 million people worldwide.
- Generation of influenza A virus from cloned DNA segments.
- Genetic engineering of the tobacco plant to produce subunits of cholera toxin.
- Studies of viral proteins that are similar to mammalian proteins, as tools to probe their function.
- Aerosol spray drug-delivery systems.
- Synthesis of infectious poliovirus by assembling custom DNA strands ordered from a commercial biotechnology company.

gradual proliferation of biotechnologies would considerably ease the developing of bioweapons in the future. But, he maintained, limits and regulations were not the answer. Instead, what was needed was openness to speedy countermeasures.[36]

As mentioned above, three examples of research figured prominently in many analyses in 2001–03: the IL-4 mousepox experiment, the comparison of smallpox and its vaccine, and the artificial chemical synthesis of poliovirus.[37] With these came attention to questions of whether certain research really had the potential to aid in the development of new weaponry and thus whether it should not have been published or conducted. The fear that the poliovirus experiment (published in *Science*) might provide a technique for enabling the creation of other deadly viruses reportedly led eight members of Congress to put down a resolution to congressional committees about the dangers of the open publication of such research.[38] Yet, its importance was questioned elsewhere, including a letter to *Science* by Steven Block of Stanford University. This claimed the work amounted 'to little more than a stunt'[39] since the possibility of performing such a reconstruction was long understood. Against what was presented as the 'extraordinary press coverage' generated, he argued that techniques for synthetically creating poliovirus were unlikely to pose any security threats in the near term. This was the case not least because of the ease of gathering natural samples of pathogenic viruses and the complexity of recreating smallpox where such a natural gathering was not feasible. The editor of *Science* responded by commenting that Block's letter neatly summarized 'a number of reasons why the national security concerns [in relation to this experiment] are not worth serious consideration; we couldn't have put it better ourselves, and we are grateful for this clarification from a bona fide expert on biowarfare.'[40] Yet the editor countered Block's claims about the non-importance of the research by arguing it proved a principle. Similar concerns about the novelty, worth, and (by implication) the security threats associated with the IL-4 mousepox experiment had also been raised at the time.[41]

During 2002 and early 2003 initial steps were taken to translate the general concern about the destructive application of research findings into policies and actions. The Homeland Security Act of 2002 included provisions requiring the federal government to 'identify and safeguard homeland security information that is sensitive but unclassified'.[42] The Act, though, did not define what the category of 'sensitive but unclassified' entailed, what 'identify' or 'safeguard' meant, or exactly how concerns about homeland security should be reconciled with the access to information. A concern repeatedly voiced about the Act was that this category might be applied to scientific research.[43] In 2002 the US Department of Agriculture requested that the National Academy of Sciences restrict access to a report it commissioned (titled *Countering Biological Terrorism*) out of worries about the potential utility of the information included to terrorists.[44] In early 2003, the NAS convened an informal group of 32 largely American-based journal editors, including those representing the journals of the American Society for Microbiology (ASM). This group agreed voluntary guidelines for reviewing, modifying, and if necessary rejecting research articles where 'the potential harm of publication outweighs the potential societal benefits.'[45]

Science under jeopardy?

Throughout these early discussions post-9/11, fears were frequently raised that any security restrictions or oversight measures might jeopardize scientific practice.[46] One initiative that generated particular concern was a proposal (later withdrawn) by the Department of Defense in early 2002 to make it a legal requirement that its funded researchers obtained authorization to disclose their results. In an article for *Science*, Abigail Salyers (then president of the ASM, the world's largest life sciences organization) warned that while security concerns had to be taken seriously it was crucial not to overreact because:

> Censorship of scientific communication would provide a false sense of protection. For example, deleting methods sections from scientific publications, with the rationale that a terrorist could benefit from knowing the methodology, would certainly compromise our ability to replicate results, one of the cornerstones of scientific research. Scientific colleagues' scrutiny and replication of research studies reduces the likelihood of errors that can misdirect scientific activities …
>
> The best protection against the possibility of future bioterrorism incidents is the unfettered ability of our scientific community to collaborate openly and move forward rapidly in the conduct of scientific research. Timely communication of new knowledge and technological innovation accelerates the rate of scientific progress.[47]

While Salyers stated that scientists appreciated the open exchange of information, 'the public may not necessarily be convinced that scientists can be trusted to this extent. There remains an undercurrent of public discomfort with what is seen by some, however wrongly, as freedom without responsibility.'[48] Elsewhere, concern about replication was said to underline a reluctance by the ASM to allow researchers to remove 'sensitive' elements from research articles since this would 'alter the fundamental tenets of science by eliminating reproducibility of scientific research and undermining the peer-review process for evaluating scientific merit'.[49] The then president of the National Academy of Science likewise argued that harsh responsive measures might well 'severely hamper the US research enterprise and *decrease* national security'.[50] Similar sentiments were even echoed by government agencies. So John Marburger, Director of the US Office of Science and Technology Policy, commented that:

> Science is inherently a social activity. It thrives only in an environment where ideas can be freely exchanged, criticized, and interpreted by others. For a nation that would lead in science, national security includes securing the freedom to engage in open scientific discourse. Science can never be successfully dictated by a science czar, or conducted by a closed elite. Where the marketplace of ideas is regulated, the quality of thought diminishes, and science suffers.[51]

A workshop held in 2003 by the NRC convened Committee on Genomics Databases for Bioterrorism Threat Agents reiterated such basic sentiments about the importance of a marketplace of ideas when it concluded it was vital to ensure 'rapid, unrestricted public access' to genomic databases.[52]

The emerging sense of the 'dual-use' problem

It was largely through such expert informed publications and presentations that an outline was given of the problem of the destructive use of life science research; a potential which ultimately became widely labeled as one of 'dual use'. While no commentators suggested that this potential was new to the start of the twenty-first century, various scientific and security developments made it a much more salient problem.

Whatever the broad similarities in the basic identification of a problem within US-centered science policy discussions though, recommendations for what needed doing turned on estimates of the threats posed from bioweapons. Assessments of this differed. Post-9/11 and the anthrax attacks; much attention was placed on the use of agents by terrorist groups. For some, the limited number of bioterrorist attacks in the past and the difficulties experienced by even well-funded groups interested in using naturally occurring pathogens (for instance, the Japanese Aum Shinrikyo cult) indicated a low likelihood of mass casualty attacks. Following from this, the possibility that such groups could make use of advanced life science research was even more remote.[53] Yet, others pointed to the mass-distribution rather than mass-casualty potential of any attacks or the possibility of state-sponsored terrorism.[54] Time frames and the breadth of technological developments taken into consideration were important variables in assessments. Concerns were expressed that converging technological developments in the life sciences and elsewhere in the coming decades would enable many states, terrorist groups, or even individual sociopaths to produce sophisticated bioweapons.[55]

In summary, there was widespread agreement about the need for greater attention to the destructive potential of research, but one where there were different assessments of the nature of the threat posed. So, too, was there widespread agreement about the need not to jeopardize the said numerous benefits of research but also disagreement about how this could be achieved. For some, the introduction of any new oversight measures or restrictions of research findings threatened to be the thin of edge of a wedge; one which might parallel the damaging biosecurity controls already introduced on laboratory personnel and international students.[56] For others, including key officials, the real danger lay in the scientific community not taking up these issues as this would require the government to do so.[57]

However, it was widely argued that those from the scientific community should be central to discussions about what to do about dual-use results and techniques. Even those identified as leading figures calling for action, such as George Poste, largely confined responses to activities scientists would initiate and police.[58] The process of devising the report *Biotechnology Research in an Age of Terrorism* and its conclusions embodied this spirit of centering action within the research community. Yet, to just what extent and how other communities should contribute to defining the problem and possible remedies was a matter of expressed uncertainty and unease.[59]

That science was regarded as crucial to countering the threats from bioattacks in government policy was illustrated in the substantial increase in biodefense funding in the United States after 2001.[60] While in 2001 all aspects of US civilian biodefense funding totaled $417 million, by 2004 that had risen to $7650 million. Research on infectious disease lead by the National Institute of Allergy and Infectious Diseases (NIAID) at the National Institutes of Health was a major pillar of that funding response. Its budget for biodefence had gone from $53 million in 2001 to $1629 million in 2004.[61] Funding was focused on 'Category A' traditional agents (e.g., anthrax, smallpox, tularemia, and plague) and broken down along funding streams for therapeutics, diagnostics, host response, vaccines, basic biological mechanisms and building expertise resources. Yet, owing to the 'dual-use' potential of research – as developed in the Introduction regarding Spanish Flu – active debates took place then, and since, regarding whether such research helped alleviate or exacerbated threats.[62]

Post-Biotechnology Research in an Age of Terrorism *developments*

In systematically covering a range of dual-use research from the position of an elite scientific organization, the 2003 National Research Council of the National Academies *Biotechnology Research in an Age of Terrorism* report represented an important milestone in discussions about what needed to be done; one which helped set the US federal policy agenda. In March 2004, for instance, the Secretary of the Department of Health and Human Services announced the formation of the National Science Advisory Board for Biosecurity (NSABB) to provide advice on oversight strategies, guidelines and education regarding the handling of federally conducted or supported dual-use biological research.[63] That included criteria for identifying and evaluating the risks and benefits with dual-use biological research for local Institutional Biosafety Committees and the NSABB at a national level for highly problematic cases.

Questions about potential dual-use research and concerns about how best to take action continued to be raised in response to developing events. The story with the three dual-use experiments at the center of many analyses in 2001 and 2002 did not end then. In late 2003, Craig Venter and others at the Institute for Biological Energy Alternatives published in the *Proceedings of the National Academy* a methodology for assembling segments of DNA which enabled them to synthesize a bacteriophage virus in 14 days. The techniques employed meant viruses could be assembled much more rapidly than had been the case for the reconstruction of polio.[64] Working under a biodefense NIAID grant, in late 2003, a group of researchers at St Louis University modified the introduction of the IL-4 gene into mousepox to make the virus 100 percent lethal against vaccinated mice and those treated with anti-virals. They then introduced it into cowpox.[65]

Other fairly high profile individual experiments or publications attracted attention. In 2005, the *Proceedings of the National Academy* published an article suggesting how terrorists could contaminate the US milk supply with probable mass-casualty effects by introducing botulism toxin within it.[66] The lead author also published an opinion editorial in the *New York Times* describing its findings in more accessible terms.[67]

In these and other such developments, questions were raised about the scientific importance and security implications of the work conducted.[68] Just what was asked varied from case to case, but often included questions such as: How easy was it to turn such findings into the production of bioweapons? Were the assumptions underlying fears of the malign use of research well founded? How likely was it that the results obtained in one area (for instance, the effects of IL-4 on cowpox) hold for another (for instance, smallpox)? Was the research conducted necessary given what was already known? What preventive or therapeutic benefits might it enable?

While certain documented developments received a fair amount of coverage in popular and semi-popular media outlets, others did not. In a presentation convened as part of the 'International Forum on Biosecurity' recommended in the *Biotechnology Research in an Age of Terrorism* report, the editor of *Nature* identified several non-prominent manuscripts submitted since 2003 to *Nature* and *Science* that initiated biosecurity reviews by the journals. This included ones giving the sequences for anthrax and SARS, another detailing the structure of anthrax toxin receptor, and one describing how to use microchips to synthesize complex genomes.[69]

The place and priority accorded to biodefense was a topic that generated significant discussion in science policy circles post-2003 in the United States. In 2004 the presidents of the National Academy of Sciences and the Institute of Medicine called for mobilizing a much wider range of scientists under funding programs than the said hitherto preoccupation with virologists and microbiologists.[70] Echoing an appraisal reached elsewhere,[71] Representative Jim Turner of the House Select Committee on Homeland Security argued that the rapid development of biotechnology meant that future threats would increasingly come from engineered agents. Because of this, biodefense funding had to significantly expand beyond traditional bioagents.[72] Others, though, argued that the emphasis placed on biodefense had already distorted the priorities of publicly funded life science research, created dangers regarding the accidental or deliberate release of pathogens, and threatened to blur beyond recognition the line of internationally permissible defensive work.[73]

Social analysis as evaluating responses to the dual-use dilemma

The previous sections gave a broad outline of emerging discussions centered in the United States regarding the problems of what has commonly become called 'dual-use life science research'. In doing so, a sense has been given of how the destructive applications of results and techniques became defined as a problem that needed and could be addressed.

In investigating this topic, questions can likewise be posed about the choices made in what kind of analysis is undertaken.

For instance, instead of just noting the manner in which the varying definitions and solutions proposed provided a particular understanding of what was at stake, I could have explicitly evaluated the claims forwarded. One way this could have been done would have been by assessing the widespread approach advocated for deciding what to do: this being that existing scientific oversight mechanisms (such as peer review and institutional safety boards) should identify activities of concern, weigh the risks (or costs) and benefits of individual proposals or publications, and then make any necessary responses on that basis.

The risk–benefit framing has been pervasive in biosecurity discussions. Both the Introduction and Chapter 1 indicated a number of reports and review procedures (e.g., NSABB, journal reviews) that have pitched the oversight of research in such terms. In addition, the World

Health Organization, the American Medical Association, and various UK funding agencies have adopted a similar risk analysis framework.[74] It is through such rationalistic assessment procedures that the complicated issues surrounding what needs to be done are intended to be made manageable.

It is possible to question the adequacy of this way of thinking. For instance, in 2004 I delivered two related papers to workshops; one on global security held by the Italian National Science Academy and another on terrorism sponsored by NATO.[75] A variety of theoretical and empirical points were made to cast doubt on the suitability of the logic of weighing risks and benefits in the manner commonly suggested. While advances in knowledge and possible applications from research might be identified, substantiating the perils that might follow and the security benefits of constraints would be much more challenging since little appreciation existed about how research would be taken forward for malevolent ends. In addition, when appraisals would be made of whether misuse or counter-misuse ends were most served by a particular piece of research, this would almost certainly come down on the side of those countering threats since they would have vastly disproportional expertise and resources. Related to this, given the general emphasis placed on staying ahead of threats through innovation, the identification of 'contentious' knowledge was unlikely to be regarded as needing to be concealed or limited. It was just such knowledge that had to be circulated and pursued if one wanted to stay ahead through innovation. I argued that these conclusions were supported by experience up till that time with those journals that had initiated voluntary security review procedures – specifically in the lack of any publication refusals and the modification of only two of the tens of thousands of manuscripts submitted.

As such, the fear expressed in some quarters that oversight measures would impose significant limits on experimentation seemed doubtful. As I contended, for those who regard the biosecurity preoccupations as motivated out of political hype rather than scientific reality or for those who otherwise regard the threat as relatively minor, this might have been regarded as no bad thing. The oversight measures undertaken could be positively regarded as a way of being seen to be doing something without needlessly impeding vital research. Yet, even within this way of thinking, whether pursuing this path made for good policy was more questionable given the efforts that would be required.

Another area of concern was that the framing of weighing the risks and benefits of individual pieces of research risked marginalizing concerns about the cumulative developments in the life sciences. So rather than centering security attention on isolated findings, it made more sense to consider major paths of research as a whole and, in particular, what this meant for the proliferation of enabling capabilities. As such, a more pertinent question to be asked than 'Is this finding dangerous?' is 'What is being made routine?' Likewise, rather than focusing on questions such as 'Should this particular experiment go ahead?', it made sense to ask 'What direction of research should be funded?' An exception to the otherwise absence of such system thinking has been in the debate initiated since by leading scientists in synthetic biology about the field's direction and implications.[76]

As an additional concern, I questioned whether the managerialist preoccupation with assessing research was sufficiently visionary. With the moral anguish that followed the use of the atomic bomb in Hiroshima and Nagasaki during World War II, for instance, physicists posed demanding questions about the role of their science in securing international security. Leading physicists such as Niels Bohr, Robert Oppenheimer (at least for a time) and others sought to employ the recognized possibilities afforded by science as a means of pressing for new forms of international relations that would establish a more peaceful world. As was argued, the threat posed by nuclear weapons could only be adequately addressed through international openness in matters of security coupled with a major rethink in the way arms were controlled. As the handmaidens for this nuclear age, some physicists suggested that their community had a special responsibility to be at the forefront of promoting a new political universalism. Just what vision the life science community had for the future of international relations at the start of the twenty-first-century context was not at all clear. As I argued, while far-reaching proposals had been offered by defense analysts at the Center for International and Security Studies regarding the oversight of research,[77] voices within the life science community challenging commitments, advocating new forms of international transparency and co-operation, or promoting ambitious prohibition regimes had been rather muted.[78]

In the study of social problems, some have argued that policies and methods to do with intractable problems that defy easy redress (such as poverty, gambling, and prostitution) sometimes 'have other aims that are equally or even more important than the solution of control of a given problem – namely, the need to demonstrate that the problem is being addressed. Such demonstration shows a commitment to the maintenance of social order and serves as a public assertion, or re-assertion, of dominant values and interests, and the legitimation of such values and interests.'[79] Given the various points made about dual-use research in this section, during 2004 I certainly would have regarded this statement as a potentially fair representation of activities to that date.

Social analysis as constituting the dual-use dilemma

To engage in this or other lines of evaluative analysis of past initiatives requires taking a stance or making assumptions about a host of factual matters. Some sense has to be given of the real causes and consequences engendered by life science research in order to suggest what needs doing. While common enough in many policy analyses, many social scientists working within the 'social problems' tradition have questioned the appropriateness of what might be called an objectivist approach. Given that what is understood about the nature of any problem is the contingent result of the activities of individuals and groups (rather than a self-evident appreciation), a danger in taking (perhaps implicit) stances on the nature of problems is that social analysts end up making assumptions that should be questioned.

In what are generally referred to as 'constructivist' approaches, how claims about what the world is really like are made to appear 'objective' or definitive are taken as topics for analysis.[80] The notional focus is with the sometimes fraught processes of 'claim-making' rather than 'making claims' about the actual causes and consequences of social conditions. So rather than asking 'What are the "facts" of a problem?', attention is given to the ways in which claims are established as (more or less) agreed facts, used by certain individuals to identify a situation as a problem, and mobilized to suggest certain responses.

The choice between 'objectivism' and 'constructivism' has been a longstanding theme in the social problems literature. At stake is how and what to question. The choice, though, is not as simple as opting for one approach to the exclusion of the other. Rather, the two are intertwined.

Committing oneself to an objectivist examination when (as so often is the case) there is disagreement about the nature of the problem (e.g., with drug use, unemployment), the act of 'making claims' quickly gives way to attention to the processes of 'claims making'. Skeptical scrutiny is often cast, for example, on why certain claims are deemed credible, how definitions present a particular understanding of some phenomena, the historical reasoning for particular social priorities, the alternative ways of making sense of some given data, and so on. In short, the contingencies and constructed nature of any understanding become topics for discussion.[81]

Committing oneself to a constructivist examination of the formation of definitions and claims raises its own issues about how objectivist claims can enter into any examination. One is what to include in an analysis. Both the Introduction and Chapter 1 alluded to the contestation surrounding dual-use claims and the manner in which some accounts suggested contrasting points as pertinent. In fashioning their own portrayals, analysts – like those they study – must decide which accounts of events to draw on and exactly what is relevant about each. Those pursuing *objectivist* inspired analyses take as their central preoccupation the establishment of what claims are really valid; a difficult enough task in its own terms. For *constructivists*, though, the problem of selection and inclusion is even trickier. The open-endedness of what might be included raises concerns about how any description suggests a contingent understanding of an issue.[82] The previous accounts given of dual-use debates could have been substantially extended and incorporated a far more diverse set of issues. It also could have portrayed different issues at stake through subtle or not so subtle changes. From a constructivist stance, a danger is that what is included and left out owes much to the preoccupations of analysts. Concerns exist not just about what claims are included, but how analysts should orientate to claims that might have been raised but were not part of discussions.

Woolgar and Pawluch went even further by contending that while constructivist forms of analysis are notionally committed to moving away from talk of objective conditions, they often deploy the same type of selective questioning that is the subject of much constructivist criticism of overtly objectivist analyses.[83] This selectivity is built into the logic of constructivism, which assumes that the role of the analysts is to explain the indefinite relation between changing characterizations of a problem and the underlying condition. As such, assumptions about the nature of the underlying condition are often left uninterrogated. In this vein, for instance, the quote at the start of this chapter, that social problems 'may emerge, transmute, descend, disappear, or reappear, independent of any change in actual conditions',[84] requires being able to specify 'actual' conditions. Yet, it is not clear how the 'actual' conditions of some identified problem could be simply known. From a constructivist perspective, any understanding of these would itself be formed through the same contingent processes that inform the changing characterizations of the problem.

The difficulties in responding to the way in which objectivist assumptions enter into constructivist analyses can be illustrated by reflecting on the preceding argument of this chapter. With the exception of the previous section, I have largely avoided offering explicit claims about the nature of the dual-use potential of life science research. Rather, the chapter has cited and compared accounts offered by others. However, such an approach has traded on a taken for granted sense of there being some 'dual-use potential' that is being alternatively talked about. Yet following through the constructivist desire not to take characterizations at face value would caution against any such a practice. Moreover, while certain claims and definitions have been subject to scrutiny in the text above, the presumptions in the evidence used to support this questioning generally have been subject to much less.

These points raise the basic issue of what should be taken for granted and objectified in analyses that are committed to questioning how, and which, understandings become established. Some constructivists have responded to this predicament by calling for the avoidance of any reference to social conditions at all in favor of examining the rhetorical devices and styles of argument used to give warrant to claims.[85] In other words, the focus is on the nature of discourse rather than on whether statements refer to conditions in the world. However, such an approach itself relies on the potential of making a demarcation between the statements of analysts and 'non-analysts'. If analysts were regarded in the same way as others, then any of their claims could likewise be subjected to scrutiny regarding the contingent rhetorical strategies employed to construct their understandings of the discursive process of claim-making.[86]

Some analysts have responded to concerns about a creeping objectivism by acknowledging the limits of possible questioning in constructivist accounts, but then arguing that this is necessary in order to say something about social issues. To ask, for instance, why certain definitions of problems dominate policy debate requires moving beyond a narrow concern with rhetorical styles to talk about the structure of society at large.[87] Much here turns on the role and responsibilities accorded to researchers. Àlvarez made the case that social scientists:

> have a right, and perhaps even an obligation, to be participants in the process of identifying what constitutes a social problem, proposing remedies, as well as in evaluating societal responses and results. But we also recognize that our contributions to the creation of knowledge about social problems, as well as its use to induce social change, are, themselves, a moral enterprise. Our participation will, inevitably, either lend weight to, or detract from, the moral claims made by various contending constituencies within and between social systems.[88]

Since much will be taken for granted in any analysis – be that analysis trying to establish objective conditions, to unpack the contingencies of definitions, or to examine the styles of arguments – analysts should carefully consider what sorts of questions they ask and the justifications for assuming certain things.[89]

Concluding remarks

Whatever position one takes on the novelty or severity of dangers from life science research, questions are being asked in science policy circles about the direction and control of research with an intensity that was not there in the past. The then president of the ASM, Ron Atlas, captured many of the emerging issues being discussed in 2002 when he asked:

> Should scientists be constrained regarding questions they ask and should more research be classified? Should journals reject papers containing potentially sensitive information? Should secrecy clearances be required for attendees at biodefense research meetings? Should there be mandatory government review before publishing information, even from unclassified studies and those not funded by government? Finally, perhaps the most difficult questions of all, exactly what is sensitive information, and who is empowered to decide what is potentially dangerous?[90]

Answers to such questions raise basic issues about the place of science in society. In light of the significance of the issues being debated, major questions can also be asked about the conduct and purpose of research into dual use.

Chapter 1 has provided an initial suggestion of the choices and challenges in the examination of dual-use life science research. Those choices and challenges refer to substantive concerns about life science research as well as more conceptual concerns with the analysis of 'the problem' of dual use. For both, crucial questions can be raised about what needs doing and what is at stake in how research is approached. In the following chapters the distinction and inter-relation between what is malign and benign, taken for granted and questioned, novel and old, objectivist and constructivist, precautionary and unnecessary, and descriptive and evaluative will be revisited and incorporated into a program of research.