

The Biosecurity Trust

ROBERT H. SPRINKLE

The life-sciences community has grown increasingly concerned that dangerous microbes or their products might be mishandled or misused, with serious harm done to human or ecosystem health locally, regionally, or globally. The community has sought to address this concern in cooperation with responsible governments, but it has also sought to act in ways not chiefly dependent on governmental initiatives or intergovernmental agreements. Concurrently, it has sought to obviate policies materially restricting scientific, entrepreneurial, or commercial freedoms. I ask whether the enhancement of biosecurity and the advancement of bioscience should be accepted as divergent or might yet be made complementary, so as to be accomplished jointly. To encourage discussion of this latter possibility, I propose an institutional innovation, a transnational, nongovernmental life-sciences organization called here "The Biosecurity Trust."

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Life scientists have long worked to reduce the risks their activities have posed to their patients and research subjects, to their societies, to their local and regional environments, and, not least, to themselves and their colleagues. In recent years, though, their route to risk reduction has become less and less routine. The life-sciences community—a self-assembled and self-aware body with amorphous borders but recognizable components—has grown increasingly apprehensive, if not fatalistic, about hazards in frontier research and about the mistakes and mischief made imaginable when once-exotic regions of frontier knowledge come within the biological commons. Five factors have accentuated this apprehension.

First, microbiological research, even as openly reported, has grown more daring more suddenly than might have been expected, especially along lines manipulating pathogenicity and immunocompetence. Second, the effort to add an inspection protocol to the international legal regime controlling biological and toxin weapons—customarily cited as the "Biological Weapons Convention" or "BWC"—has entered an ominously open-ended period of procedural ambiguity. Third, modern laboratory methods and the sophistication to keep them up-to-date, if not always the means to do so, have spread worldwide to myriad sites, some perhaps beyond the effective regulatory and legal reach of governments—and also beyond the feasible range of any likely future international inspection protocol, however intrusive it might be made for governments themselves. Fourth, the failure of communism has left numerous life scientists, including some number of veteran bioweaponers, needing work, and it has left many of their work places unsafe (Warrick 2002). And, fifth, small-scale bioterrorism—in the United States in 2001 the postal dissemination of a carefully prepared but genomically non-novel pathogen, the Ames strain of *Bacillus anthracis*—has been shown capable of yielding substantial social disruption.

In these matters the life-sciences community shares moral and managerial responsibility—and some culpability—with governments and corporations. Yet the community's responsibility is uniquely professional and thus inescapable, whatever the actions or inactions of others (Sprinkle 1992, 1994, Fraser and Dando 2001, Kwik et al. 2003). Governments and corporations can make this responsibility easier or harder to meet (Epstein G 2001), but they cannot fully assume it themselves. Indeed, the community can act in ways governments and corporations cannot credibly match.

The community's aim should be "biosecurity," meaning this: the assurance that our environment will neither intentionally nor recklessly be made more dangerous—to us and to other species important to us—than ongoing evolution and common chance might make it. Our environment is naturally dangerous to all species, and in continually changing ways and degrees. Life scientists work legitimately to understand that dangerousness, to limit its effect on some species, including our own, and to utilize or modulate or even magnify its effect on other species: those condemned, wisely or not, as parasites or pests. Conversely, life scientists compromise biosecurity when they work intentionally to increase dangerousness to humans or human interests or when they increase such dangerousness recklessly through their work.

The term *biosecurity* accommodates the treaty language "bacteriological (biological) and toxin weapons" and shares its military connotation. It encompasses environmental, agricultural, and commercial incidents as well as epidemiological, and it names an asset whose degradation could be actionable civilly or criminally. While some endangerments of biosecurity, such as an assault with weaponized *Yersinia*

Robert H. Sprinkle (e-mail: sprinkle@umd.edu) is a physician and an associate professor in the School of Public Affairs, University of Maryland, College Park, MD 20742. His research interests include health policy, environmental policy, bioethics, political behavior, and the politics of global security.

pestis, would register reliably within standard concepts of security, others, such as the unauthorized field testing of a new biocide, would not. Moreover, standard elements with analogues in biosecurity would find altered meaning or reordered importance. To a tank commander, a natural barrier might be a river, a built barrier a mine field; to a biologist, a gut filled with normal flora and an ultraviolet-C light bulb, respectively.

An assurance about our environment reduces substantially to an assurance about our *microbial* environment, the unavoidable, indispensable, rapidly adaptable, and exquisitely alterable totality of the biosphere's "pliant majority." Assurance about our nonmicrobial environment must also be accepted as a definitional component of biosecurity, yet exclusively nonmicrobial dangers, as policy problems, are sufficiently distinct to set aside for separate consideration.

I first note distinctions between, interactions among, and capacities to counter known and plausible risks to biosecurity, concentrating on its microbial core. I then discuss professional motivational factors likely to affect the magnitude of those risks. Next, I describe the goals, presumptions, and functions of a risk-mitigating institution designed with professional motivational factors chiefly in mind. Finally, I pose organizational and operational questions that such an institution would have to answer early in its history.

Biosecurity in jeopardy

We share our environment, and ourselves, with microorganisms. During the 20th century, scientific hubris extended to the expectation that we could finally dictate to these microorganisms the exact and preferred conditions of our relationship. That expectation, remembered with embarrassment, is dead. Life scientists in ever-cleverer ways do still alter the microbial environment, but increasingly they realize how little within it they ultimately can control and how much damage they and others, less wittingly, can do there.

The capacity to respond to harmful microbial-environmental alteration—accidental, inadvertent, malicious—is not uniform throughout the life sciences. Human-clinical, veterinary, and plant-sciences capacities are well developed in richer countries, but even here the orientation is less to the microbial environment as a complex perturbable system than to the management of particular infectious diseases and troublesomely prominent species. Microbial-ecological capacity is less well developed, though its importance, when clearly enough manifested, is readily acknowledged; the elucidation of Lyme-disease dynamics is an example (Jones et al. 1998).

Most life scientists working in the microbial environment concentrate on its individual components: organisms themselves, membrane receptors, enzyme systems, genes and their polymorphisms. Few find careers as microbial ecologists, despite interest. Comparatively thin microbial-ecological response capacity could mean that any particular biosecurity breach would be understood less quickly than might be hoped. This thinness is made all the more worrisome as the ability to create, select, and now stabilize novel organisms ac-

celerates, as it is doing in the agricultural biosciences sector, where an "intention to release" is typically fundamental to the economics of genetic-engineering initiatives (Selifonova et al. 2001).

The potential for biosecurity compromise has increased as knowledge and capability have deepened, as life scientists have dispersed from well-regulated training institutions to employment sites worldwide, and as environmentally provocative activities have achieved new scales and complexities. Today, biosecurity threats vary by setting, from the laboratory to the feed lot, but they also vary by intent, from the inadvertent to the spiteful—a range with clear extremes but ambiguous intermediates.

An outbreak of smallpox would unmistakably signal a biosecurity breach, because the causative virus is extinct in the wild and specially guarded in its known repositories (Breman and Henderson 2002). Yet distinguishing recklessness from malice, or from a mixture of the two (Tucker and Zilinskas 2002), might be difficult. By contrast, a Western Hemisphere outbreak of asymmetric flaccid paralysis traced to a poliomyelitis virus with wild-type characteristics would not unmistakably signal a breach, because vaccination strains can revert toward wild-type virulence and transmissibility naturally (Epstein DB 2000) and because healthy enterovirus carriers travel unexamined throughout the world every day (Shieh et al. 1997). Still, with poliomyelitis virus held at some 31,000 institutions in the United States alone (ProMED 2002), epidemiological investigation could soon acquire accident-scene or crime-scene qualities.

Interpretive tangles might quickly be unknotted by tomorrow's technology, if not today's, but tomorrow's technology might tie as many new knots as it loosens. For example, a poliomyelitis virus engineered to destroy only the cells of a certain human brain tumor, a glioma, may eventually enter therapeutic protocols (Gromeier et al. 2000), but what if it needed first to be augmented genomically to defeat the defenses of patients who in childhood were fully immunized against wild-type viruses? Turning former "microcriminals" into responsible "microcitizens" is too good an idea not to support, but arming them and giving them keys to the back door would require faith in the permanence of their rehabilitation, plus a highly imaginative vigilance.

Further complicating detection is general environmental change, often partly anthropogenic, which can alter the distribution, variety, activity, and evolution of microorganisms and disease vectors and could incorrectly be blamed for many a mysterious problem. If a hostile act were intended to pass unattributed to its plotter and perpetrator, then a random environmental change might be proposed as the cause. An agricultural corporation designing a ruinous misfortune for a rival's clonal plantings might count on just such a misapprehension, as might any troublemaker more interested in doing damage than demonstrating audacity.

Also complicating matters is the inevitability of unexpected and occasionally hard-to-control outcomes in normal science. Some experiments now involve organisms altered in

ways making release, escape, or theft a biosecurity concern. Scientists working with such organisms might not wish to admit or announce embarrassing or costly incidents, even if recognized, which they might not be, and even if appreciated as unnatural in origin. Admitted despite embarrassment and disconcerting despite its ostensible lack of serious consequence was a recent incident, widely reported. The Plum Island Animal Disease Center, just off the New York coast, lost electrical power for three hours on a Sunday afternoon in December 2002 after three backup generators, maintained by replacement workers during a vandalism-punctuated, five-month strike, failed. Negative-pressure ventilation and air filtration then failed, as did airlocks, for which duct tape was substituted. Three staff members were marooned in biological containment areas until power was restored. With loss of refrigeration, centrifugation, electrophoreses, and so forth, research must have suffered somewhat, but no harm to humans or animals on or off the island has so far become apparent (Santora 2002).

Biosecurity is the *subject* of all biological-weapons research, whether offensive or defensive, and it is the *target* of any biological-weapons development program or biosabotage scheme. It is intentionally the target of research-and-development programs building any capability that might ever be used to do harm, whether the capability is labeled offensive or defensive, tactical or strategic, deterrent or retaliatory, and whether or not the harm done can arguably in some way be undone or justified or made good. In contrast, biosecurity is not intentionally the target of threat-assessment work, a legal and supposedly always defensive form of weapons research that nominally stops short of weapons development. Still, threat-assessment work may entail the production of dangerous pathogens and pathogen products, and these—intentionally through testing or recklessly through error—could breach biosecurity. One reason is self-evident. They are intended to be harmful. But another reason is not self-evident at all. Few agents assessed in weapons laboratories could be assessed realistically. Human subjects might be recruited or compelled to accept exposure to nonlethal agents or to test the function of device components loaded with simulants, but the testing of highly dangerous agents, even in controlled conditions and even with some semblance of consent, would at least be reprehensible and would probably be criminal. The testing of nonhuman primates or other animals might or might not be seen as less egregious, but it would surely be less informative. For antiagricultural agents, field-release testing in one's own country would be unsettling at best. Even if "crippled" for safety's sake, an agent might still confound its creators by finding hosts, reservoirs, or vectors, by surviving the seasons, by reverting to an "uncrippled" type, or by managing in some other way. Its most dangerous genetic material might even move on independently, migrating among strains and species promiscuously in the environment in unforeseen ways (Demanèche et al. 2001) and with unimagined results.

A bioweapon's development, its testing, its storage, and its deployment would be environmental risks, and a bioweapon's use, whether for war, terror, or sabotage, would be an environmental event. True, a strictly theoretical research interest pursued with meticulous attention to procedural detail could nearly eliminate "environmental risk." True as well, fastidious victim-by-victim administration of a purified microbial product, such as aflatoxin, or a nontransmissible pathogen, such as *B. anthracis*, might escape the "environmental event" label. Even so, a bioweaponry program is hard to imagine ever being considered environmentally nonhazardous, however genuinely defensive its mission.

There can be no biosecurity without biological-weapons security, but the reverse is not true. Biosecurity is the bigger concept and could remain for the most part unachieved even if arms-control and defense-preparedness strategies were convincingly to succeed.

Biosecurity and life-sciences professionalism

Activists in the biosecurity community now often speak of "the moral norm" operating against development and employment of biological and toxin weapons. They often mean the international legal regime founded on the Biological Weapons Convention. Yet the moral norm is not an artifact of the convention; the convention is an artifact of the moral norm, which is, arguably, the most powerful factor in the biosecurity equation.

This moral norm is not new. Clinicians and life scientists have formed it over many centuries, and they own it, in a sense. But they do not always observe it; they have an indifferent record using it inventively; and they are vulnerable to its manipulation by others, most consequentially by states and corporations (Sprinkle 1992, 1994).

This norm contains many precepts, but from among them can be abstracted two of particular relevance to the biosecurity problem. First, do no harm, with individual human rights and welfare held above group preferences and with the health of many species, not always just our own, considered. Second, respect the legitimacy of all questions and the equality of all new and true answers.

When in concert, these precepts produce normal science. Here, the human rights of free expression, free association, and free assembly apply not just to people but also to the ideas people have—and most beneficially over time to the ideas *scientists* have. No question openly asked is dangerous, nor is any answer if openly reported. The only truths that harm are truths untold. Accordingly, the rights of potential beneficiaries, classically patients, can be defended best through the unrestricted pursuit, disclosure, and application of new knowledge. Answering the currently least practical question—such as how to make a toxin more toxic or, less promisingly, how to make a pathogen from scratch (Cello et al. 2002)—may do the greatest long-term good.

When these same two precepts fall spontaneously into conflict, however, they produce reckless science. When pushed into each other or when split skillfully apart, as if rigorous work

could never do real damage, then they produce captured science. Either way, the “rights of science” are somehow defended, at least tacitly, against the not yet endangered rights of potential beneficiaries, because a mere prospect of mishap or malicious use does not make a “basic” question “practical” or “applied” and does not make good science bad.

Few would knowingly work outside normal science, and most would be surprised and offended by the suggestion they were working recklessly. Nevertheless, many do contemplate reckless science when proposing to test a hypothesis using unacceptably risky methods. In the United States, institutional review boards regularly nudge their colleagues back to normality by disapproving studies inadequately protecting human or nonhuman subjects, the working environment, or the microbial environment beyond. At sites unaccustomed to stringent internal research-safety review, perhaps because they are unaccustomed to human-subjects experimentation, reckless work might proceed apace. A curious researcher or research team might, for example, test whether a microbe ordinarily harmless to its host could in some fascinating new way be made virulent but might do so without imagining that it might also be made too dangerous to study or even to retain in an ordinary laboratory.

The edges of the captured-science case are easier to see but not much harder to cross. States and corporations may coax the pursuit of ethically dubious research goals by gently pushing a wedge between the do-no-harm and legitimacy-of-all-questions precepts. Weapons research and development may successfully be encouraged by emphasizing long-run harm-preventing strategic-deterrence value: a “save-our-cities” argument. An enemy’s reputedly dark designs must first be copied, then countered, then outdone, again and again, so as to demonstrate resolve and competence: a “peace-through-strength” argument and, should politicians fail, a “fire-against-fire” argument. In well-worn cold war ethics (Nye 1988), if not in the self-justifying book of modern terror, the more horrible a weapon is the less likely its use: a “worse-is-better” argument. Other suspicious work may get done by inviting researchers to hide behind the plausibility of eventual application to an honorable industrial or life-affirming end: a “salvation-by-spinoffs” argument (Pala 2003). Defenders of state and corporate prerogatives and critics of international legal regimes may in policy debate place the same wedge between the same values and drive it in more assertively.

States and corporations may also, of course, appeal primarily to nationalism, group loyalty, and simple self-interest and may do so subtly or coercively. Life scientists exposed to these appeals full-force need to know, vividly, that they belong to a community beyond their borders, temptations, and predicaments, and that this community will judge their conduct professionally.

Biosecurity enhancement as a mission

Many biosecurity assets already exist. Among them are the Office International des Epizooties, or OIE (1924); the Geneva Convention (1925); the Biological Weapons Convention

(1972); the Guidelines for Research Involving Recombinant DNA Molecules and the Recombinant DNA Advisory Committee (1974), both of the National Institutes of Health in the United States, and analogous guidelines and committees in many countries, as well as in institutions and corporations; the Australia Group addressing chemical weapons (1985) and then biological weapons (1990); the Bioethics Convention for Europe (1996); the Universal Declaration on the Human Genome and Human Rights (1997); and the Convention on Biodiversity (1992) as strengthened—without American agreement—by its Biosafety Protocol (2000).

The United Nations World Health Organization (WHO) and Food and Agriculture Organization are assets clearly successful within explicit mandates. The Centers for Disease Control and Prevention (CDC) in the United States and similarly constituted institutions in many other countries are irreplaceable; the CDC, for one, combines reactive functions with regulatory ones, administering the possession, use, and transfer of 38 “select agents” and toxins. Less familiar to the average citizen are agricultural permitting rules and the International Plant Protection Convention (1952) and its International Phytosanitary Standards, devised to prevent the global spread of plant pathogens, and the Animal and Plant Health Inspection Service of the US Department of Agriculture. In addition, particular organisms, smallpox most famously, get extraordinary formal attention. In the United States, as elsewhere, bioterrorism and behaviors implying bioterroristic intent have become the subject of legislation, such as the Antiterrorism and Effective Death Penalty Act (1996), the Agricultural Bioterrorism Protection Act (2002), the Public Health Security and Bioterrorism Preparedness and Response Act (2002), and the hastily drawn USA PATRIOT Act (2002).

The World Trade Organization (WTO), established in 1995, is both a liability and an asset. Its prejudice against trade restrictions complicates moves to deny to bioweaponers the materials and machines they may seek. In contrast, article 39 of the Trade Related Aspects of Intellectual Property Rights agreement, an annex to the WTO agreement itself, requires states parties to legislate the protection of “undisclosed information”—in other words, trade secrets (Gronroos 1999). The biotechnology industry has long been prominent among both holders of undisclosed information and targets of economic espionage—much of it thought to be sponsored by governments (House 1996). Accordingly, the United States Economic Espionage Act (1996) now allows federal pursuit of persons “intending [to] benefit any foreign government, foreign instrumentality, or foreign agent” by stealing trade secrets (EEA 1996); this provision has already been used to prosecute thieves of life-sciences secrets (Nolan 1997).

Other biosecurity assets include nongovernmental national and transnational professional groups, such as the Program for Monitoring Emerging Diseases (ProMed), sponsored by the Federation of American Scientists (see www.fas.org/promed/). The work of these groups has been facilitated

greatly by the Internet, as has the clandestine coordination of terrorist activities.

So far missing is another asset, called here “The Biosecurity Trust,” envisioned as a transnational life-sciences institution. Oldest of this type—a precedent, if not a model—is the International Committee of the Red Cross (ICRC), founded to lighten the weight of war. Its functions, some chartered by host countries and many coordinated with international organizations, range from blood-banking, blood-products research, and transplantation-tissue preparation to prison-camp inspection, refugee relief, and weapons-regulation diplomacy.

The Biosecurity Trust likewise would be established as transnational, interorganizational, and intraprofessional and hopefully would come to be chartered in domestic laws. It would share with the ICRC a principal orientation to the obligations implicit in the choice of a life-sciences career. Less similarly, though, the Trust would be oriented to the risk inherent in science itself, intentions aside, to the value of high-risk science, and to microbial-environmental stability. It would affirm—and then through its programs seek continually to demonstrate—that enhancement of biosecurity and advancement of bioscience need not be divergent policies.

This new institution might usefully complement national, multinational, and international security efforts, but no transnational institution could safely substitute for treaty regimes or defense-intelligence capabilities, nor should it be expected to eclipse them or allowed to impede them. Particularly, the Trust would not be established to take the place of an internationally agreed-upon inspection protocol and would surely function better were one to exist. All that conceded, the Trust might do less provocatively what standard security institutions have not so far done reliably: make offensive biological weapons programs impossible to hide. And it might do well—actively facilitate legitimate civilian high-risk science—what they can rarely do at all.

The goals of the Trust would be several. First, to keep safe, or to make safe, the work of well-intentioned life scientists. Second, to maximize the chance that directors of malicious research-and-development efforts worldwide would cite as chief among their frustrations chronic trouble attracting and retaining, or even successfully coercing, sufficient numbers of life scientists willing to pursue illegal and immoral ends or to keep completely quiet about the true purpose of efforts assisted or observed. Third, to complement existing and evolving legal safeguards, rather than to replace or preempt them. Fourth, to foster the adaptation of the most forceful elements of the modern life-sciences ethical tradition, the Nuremberg principles, to nonmedical situations, specifically to weaponizing by life scientists and to environmental endangerment. Fifth, to enrich the capacity to understand and manage biosecurity compromise, such as through the promotion of microbial-ecological education and research.

The Trust would operate on a pair of presumptions. First, that the life sciences are transnational in method as well as in moral commitments. Second, that dangerous science has a

minimal feasible scale whose parameters can be estimated, whose presence can be detected, and whose participants have professional histories hard to erase, professional ambitions hard to redirect, professional relations hard to cut off, and professional obligations hard to suppress uniformly throughout a staff of minimal feasible scale.

What is the minimal feasible scale of dangerous science? One technically trained person with a poorly thought-through idea, or a vengeful one, may do considerable damage. Union Carbide claimed that a single saboteur, an “employee,” caused the methyl isocyanate disaster at Bhopal, India, in 1984 (Browning 1993). Moreover, one scientist or a small conspiracy of scientists might even hope to eclipse the Bhopal result. Scientists in the Aum Shinrikyo cult had explored the apocalyptic potential of botulism, anthrax, cholera, Q fever, and hemorrhagic fever before becoming famous for delivering sarin gas to the Tokyo subway system (Olson 1999). Yet the Bhopal incident, whether a result of criminal premeditation or criminal negligence, was not a goal toward which a professionally educated team had jointly and knowingly labored, and the Aum Shinrikyo end-the-world campaign used science, crudely, but conducted none.

Assuming only psychopathology, the minimal-feasible-scale question is heuristically unhelpful. Assuming high-stakes group-versus-group competitive incentives, however, the minimal-feasible-scale question becomes an *optimal*-scale question. A team of about ten may be optimal, from a scientific point of view (Alberts 1985), but only assuming collaboration with other similarly sized groups of similar quality. This notion, “the combinatorial principle applied to research laboratories” (Alberts 2001), might be made to apply to illegitimate efforts, but not securely. The larger a team is the less likely it would be to keep a secret, the more likely to include researchers uncomfortable with an ethically dubious assignment and actively in contact outside the team itself and outside its host corporation or home country.

Biopreparat, the Soviet biological-weapons operation, with perhaps ten thousand scientists at some 40 sites, may or may not have been an exception in the research-efficiency sense, but it was not really an exception in the secrecy sense. Biopreparat was a closed organization in a closed state already suspected of violating the Biological Weapons Convention, just not as intensively as it was. In the security-surveillance sense, Biopreparat was not a normal-appearing enterprise in a normal-appearing country. Moreover, the second-in-command of its civilian branch defected (Alibek 1999). Further, disquieting “civilian” results, supposedly not from Biopreparat at all, were from time to time conveyed to the international life-sciences community, some of whose members were well known for their suspicion that the Soviets were cheating. One communication described the effectiveness of anthrax vaccination in hamsters challenged not with an ordinary *B. anthracis* but, surprisingly, with one whose virulence had expressly been augmented. This report its authors submitted in the West to a prominent peer-reviewed journal, which accepted it and published it as ordinary incremental

science (Pomerantsev et al. 1977)—and it may have been just that. Or it may have been a conscious, conscientious, and even courageous disclosure about a reckless or malicious undertaking.

A community seeking hints and revelations must make its receptivity known, must be easy to contact, must plausibly have a right to know secrets and the authority to keep them, and must be prepared to listen, evaluate, and act in short order. While an *ad hoc* sorting out, biologist to biologist, has served well enough in some instances and is admittedly the centerpiece image being elaborated here, a permanent and procedurally refined transnational institution could also fill a role.

The Trust, once operational, would display multiple functions, most critically these.

1. The promulgation and continual improvement of widely agreed and globally feasible standards for research safety and institutional and corporate research responsibility.

2. The nonintrusive tracking of life scientists' careers in more worrisome states, laboratories, and corporations and in subfields with the clearest potential for abuse, such as the modification of known pathogens and their natively nonpathogenic variants—the *Bacillus cereus* group generally, for example (Helgason et al. 2000). Particular attention would be paid to the pace, pattern, and range of publications and patents and to unanticipated declines in openly documented productivity—a “cloaking effect” analogous to the tell-tale alteration in scientific reporting that in 1942 alerted Soviet physicist Georgii Flerov and, in turn, Joseph Stalin to the formation of an atomic-bomb team in the West (Goncharov and Ryabev 2001). Likewise of interest would be the geographical or temporal concentration of interrupted or otherwise unusual careers. Surely the Trust would in these functions be duplicating, or in some ways improving upon, a secret routine of national-security agencies in many states. Like these agencies the Trust would expect to keep almost all its observations confidential; unlike them, though, the Trust would expect in nearly every case to express its concerns first, if not always exclusively, to the states, laboratories, or corporations wherein those concerns arose or to leading members of the investigational subfield involved. Additionally, with the great majority of all threats to biosecurity being solely environmental and with all bioweaponry programs being environmental threats, the Trust could initiate its inquiries, express its unease, and offer its advice and assistance in an exclusively “green” manner.

3. Perennially generous noncompetitive full or subsidiary funding for travel to international meetings, for membership in international organizations, and for study abroad by life scientists in selected states, regions, and industries. The Trust would here be helping to update—and to “materialize”—Sir Robert Boyle's “Invisible College” from the 17th-century (Webster 1975).

4. The registration and indirect oversight of potentially high-risk science, such as a search for natural Ebola-virus vectors by introduction into candidate animals (Swanepoel et al. 1996) or augmentation of microbial genomes by insertion of immunomodulating genes (Sharma et al. 1996, Jackson et al.

2001). This function would be realized through long-term agreements with sponsoring institutions or corporations. These agreements could be sought either by the Trust or by the sponsors themselves; reluctance to discuss an agreement would be noteworthy.

5. The direct semicompetitive full or subsidiary funding of potentially high-risk science, even when undertaken for profit, so as to insist persuasively on its regulation by appropriate domestic bodies, if reliable, and even sometimes to insist upon its relocation, such as to a Biosafety Level 3 facility or to one of perhaps 26 functioning Biosafety Level 4 facilities in 14 or 15 countries (ASM 1999). The Trust's relocation assistance would presuppose the participation of research-adopting facilities, some owned by governments. This participation could be difficult to negotiate as to matters of scheduling priority, confidentiality and intellectual-property protection, funding, liability, and so on.

6. The negotiated disposition—in essence, the “classification”—of extraordinarily provocative research results over which some degree of influence had prospectively been gained through registration, oversight, or funding. This scheme would have to finesse many delicate issues, case by case. Scholarly career credit would be one.

7. The invitation to submit for prepublication consultative review extraordinarily provocative research results over which no degree of influence had prospectively been gained.

8. The tracking of participation in registration programs and funding programs, so as to detect evidence of pressure to remain outside the global community of open science. Nonparticipation by researchers in highly nationalistic states would not be surprising, but inexplicable nonparticipation would be.

9. The establishment of a global biosecurity “confessional box.” Failure to create and refine such a function might squander the willingness of a fearful witness or a remorseful participant to report illegitimate work. The Trust would, of course, have to make clear from the start that information credibly describing illegality or an imminent threat to biosecurity would be referred appropriately, whether to a responsible state or, in cases reporting state-sponsored illegality, beyond. Robust digital identity protections would be required for contacts needing anonymity. In states formally recognizing the Trust as an intermediate, as many states have long since recognized the ICRC and its affiliates, varying degrees of protection from prosecutions and recriminations might be arranged, where circumstances warranted. Ill-considered, inaccurate, overwrought, or disingenuous reports would surely occur, as would those passed through or referred from initial confidants—colleagues, mentors, prominent figures—or from bodies such as WHO, CDC, or OIE.

10. The facilitation of the biosecurity aspects of “truth-and-reconciliation” processes, as needed (Crocker 2000). South Africa might have found Trust participation helpful following the revelation of bioweaponing activities under white-minority rule. A post-Baathist Iraq could one day find it helpful as well (Zilinskas 1997).

11. The conveyance of well-founded biosecurity concerns to national agencies and international organizations, including offices that might in future be established by treaty regimes criminalizing the willful compromise of biosecurity. This “upward referral” step would be the *sine qua non* of the Trust’s traditional security function. It would also be a frequent source of internal tension and an occasional source of external controversy.

Establishing the Biosecurity Trust

The Trust would be an initiative of a transnational community and might best be formalized by its most respected groups, the honorary academies and professional societies of respective countries, regions, disciplines, and specialties. One or more of these would have to make an unambiguous start.

Many questions would straightaway arise. How many initiating groups would be needed to form a stable nucleus? How many would be needed, and how much should they have accomplished organizationally, prior to a disclosure-of-intention to home governments and prior to a public announcement? At what point would funding be needed, and how fast would the need grow? From what sources should funding be sought, from which funders accepted, and through what mechanisms routed, so as to avoid both the reality and the perception of funder influence? To what near-term and longer-term uses should funding preferentially be applied? Should principal executives and senior staff be leading biologists, and, if so, should some or all—or none—have security experience? How much research support should be planned? How would support opportunities be described so as not perversely to make biosecurity endangerment a gratuitous feature of bioscience grant-seeking? In what ways might requests be falsified or plans and risks misrepresented, and in what ways might awards be abused? How would support requests be processed and evaluated and awards themselves monitored? How could career tracking be undertaken so as to be manageable, unobtrusive, inoffensive, and confidential yet forthright and, in strict cooperative-security terms (Steinbruner 2000), worthwhile? How could career tracking be explained—to the curious, to the skeptical, to the suspicious—so as neither to minimize nor to exaggerate the global concern that made it necessary? Where would the Trust answer its telephone? And in how many languages?

These and more are questions for a later day.

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