Threat reduction via tools and concepts to understand development and uptake of biological science and engineering

The continuing worldwide dissemination of biological knowledge and capability and the reduction in skill needed to conduct biological work (see www.jove.com) have so progressed that it seems possible that an adversary who intended a biological attack against the US might achieve both strategic and tactical surprise. To better understand, and to ultimately suggest means to diminish the threats posed by this insecure situation, we will undertake a combined conceptual and anthropological program.

Our approach builds on findings from a two-year pilot project called the Center for Biological Futures (CBF). During the next five years, we will develop improved analytical capabilities for understanding the interplay between advances in biology and the capacity to exercise power. We will develop these concepts and methods by attention to a bounded problem domain: increases in the ability of individual scientists and small scientific groups to exercise power through the creation, adaptation, and uptake of new biological knowledge and capabilities and the concurrent intensification of potential for biological attacks brought about by these increases in ability. We will develop these tools through close interaction with elite and non-elite labs, in the US and abroad, working with (a) live virus vaccine vectors and (b) viral therapeutic vectors.

Despite changes brought about by the worldwide dissemination of biological capability, in commercial and non-commercial biological work, the lab or research group remains ground-zero for the creation of new knowledge, methods, and entities. For work that is new, the predominant traditional approach to harm reduction, post-facto regulation, is largely and increasingly irrelevant. In our work, we will seek to understand other mechanisms that provide informal and trans-institutional governance of laboratory work, including the scientific and non-scientific factors that shape decisions concerning when and how work is initiated, carried out, and transferred in order to achieve commercial or other impact.

We believe that this specific problem is a likely locus of future negative developments, that studying it provides a right-sized point of entry for understanding the current complex situation, and that studying it will enable us to give conceptual order to key factors relevant to US national security. These include but are not limited to development of capacities that small groups of attackers might use to cause grave harm to human populations and economically and ecologically important animal and plant species. This understanding will by definition identify points at which, and may suggest means by which, developments can be inflected, courses of action changed or interdicted, and negative outcomes averted, all while encouraging ongoing scientific development. Such understanding will become an input to develop and maintain a national strategy to reduce the probability of biological attacks and other threats brought about through changes in the relation of biology and (to other kinds of) power. If achieved, aspects of such understanding will also be pertinent to analysis of advances in other technical fields.

As we use it here, power refers to the ability to impact, deliberately or inadvertently, the actions and well-being of others. It thus includes the ability to cause, grave, even existential harm. Recently, many have paid attention to the possible security consequences of the fact that over the next decade most of the world’s population will likely have regular access to, and
become increasingly dependent on, powerful digital technologies. These consequences are likely to include both the ability of non-state actors to organize against state interests and the ability of states to use digital dependencies to control populations (see for example Schmidt and Cohen, 2013). Less visible (for various reasons), but perhaps even more impactful for 21st-century security, is the ongoing increase in the number and ability of individuals, small groups and nation states worldwide to exercise significant power through biological knowledge and capabilities (Brent, 2006; Collier and Lakoff, 2008).

The links between biology and power today are historically distinctive. They are characterized by direct and highly asymmetrical relations between biologists and all other life on the planet, including and especially human life. For much of the twentieth century, most biologists were only able to significantly impact human affairs through the mediation of extra-scientific institutions, typically industrial or political institutions (Foucault, 2000). Moreover, this capacity was made possible by their participation in elite research groups with unique access to specialized know-how and facilities (Shapin, 2010). The contours of this prior state-of-play made it (relatively) easy to monitor who was and was not capable of potentially harmful actions and to regulate potentially negative work.

Today, by contrast, ever-smaller groups of scientists in diverse locales and institutional settings are able to directly affect ever-larger segments of human and non-human life, through means including rapid online open access publication of new knowledge and methods, all the way to the creation and release of self-reproducing entities. These direct and asymmetrical power relations are driven not only by ongoing advances in biological knowledge and capability, but also by the global circulation of knowledge and capacity, and the lowering of barriers to accessing it including expense, technical difficulty, education required to conceive the work, and education required to troubleshoot its progress (eg Maniatis et al., 1983, Ausubel et al., 1986, www.jove.com; reviewed in Carlson, 2011). The diffusion of capability has not only increased the power available to biologists, but, by increasing their numbers, particularly in non-traditional settings, has decreased their overall institutional and thus regulatory visibility.

As noted, alongside its presumed economic and medical benefits, the continuing increase and spread of biological capability brings with it the potential to do grave harm. The past decade has seen publication of whole genome sequence for a functional reconstructed ("resurrected") 1918 human flu virus (Tumpey et al. 2005) and for a deliberately evolved mammalian-transmissible avian flu virus (Herfst et al. 2012). Worldwide access to recombinant DNA and ever-improving reverse genetic methods (Hoffman et al. 2000, Neumann et al. 2005) makes it orders of magnitude easier for a single individual or a small group to turn these sequences back into live pathogenic viruses, presumed capable of causing human pandemics (Osterholm, 2012), or for a nation state to use these platforms as a base for further weapons engineering. Harmful biological and other self-replicating entities (von Neumann, 1966) (such as certain still-hypothetical nanomachines (Drexler, 1986) are a particularly powerful subset of the class of harmful entities. The idea that an adversary might deliberately construct, evolve, and release a self-replicating pathogen adds another dimension to the threat that viruses might emerge from inadvertent causes such as human construction of new ecologies such as factory farms (Brent, 2006; Rabinow, 2008).
One response of authority to this situation has been to strengthen existing national and international mechanisms of formal governance. This has consisted in tightening regulations at presumed bottlenecks in the funding and conduct of research: introducing new procedures for prior review as a condition of government funding (NIH OBA, 2012), new protocols for biosecurity oversight of work conducted in publically-financed institutions (Patterson, et al. 2013), and proposing methods for limited-access publication of "dual-use" scientific results (Berns et al., 2012). However opposite for governing the conduct of research in established institutional settings, these responses are clearly limited by the fact that their operative conception of the relation of biology and power is out of date: they operate as if significant biological truth and technologies will continue to be generated and transmitted through the machinery of a restricted number of dominant institutions (Collier and Lakoff, 2008; Keck, 2010; Foucault, 2004). As noted, scientific work which does not flow through familiar operational channels will ultimately remain invisible to apparatuses of formal governance.

A second set of proposed responses is defensive, to develop national and international preparedness capabilities (Brent, 2006; Lakoff and Collier, 2008; Caduff, 2012). This stance, as has been widely discussed, presumes that a potentially catastrophic biological event will occur, and call for a build-up in the ability of nations to diminish the impacts of such an event. Unlike regulatory approaches, preparedness responses recognize the current reality of distributed biological capability. For example, proposed preparedness measures have included increased genomic surveillance for infectious diseases (Keck, 2010; Lurie et al. 2013). By definition, such responses are limited by their focus on responding to events already begun, and do not illuminate changes in the practice of biology which make such events more or less likely.

We believe that the US government would benefit from additional classes of operational capabilities to identify threats closer to the time they arise and to help reduce these threats. We believe that achieving these requires developing new knowledge and new conceptual capabilities to analyze and understand core aspects of scientific work under conditions of the global diffusion of biological capability, whose trajectory is shaped more by informal and trans-institutional governance than by formal regulation.

To this end, during the next five years, we will study, understand, and in the process suggest means of inflecting, the de facto and evolving conditions by way of which biologists create, take up, adapt, and put to use knowledge and capabilities.

This is a challenging problem. The same global diffusion of biological capability makes obtaining a clear and conceptually ordered picture of these aspects and their impact on power relations – to say nothing of developing tactics and strategies for intervention – conceptually and methodologically difficult. Add to this the perplexing fact that, despite the now decades-long trend toward democratization of biological capacities, for reasons not fully clear, there have as yet been no major biological attacks. These facts makes the task of assessing how increases in biological capacity do and do not also intensify risks of dangerous outcomes all the more challenging and urgent.

To carry out the work and develop new analytical capabilities, we will pursue a two-part approach. First, building on work undertaken over the past two years at the Center for Biological Futures, we will create a program for training graduate and post-doc level anthropologists to conduct open, non-classified fieldwork on security-relevant developments in biological
capability, and will seek out labs in the US and abroad willing to host these place these field-researchers (Rabinow et al., 2008). Ideally, field researchers will have access to, and sustained interactions with, multiple labs within a specified geographical area (Coleman and von Hesselmann, 2011; Marcus, 1995). We will seek active partnership with these labs, enlisting their buy-in and support in addressing questions of biology and power.

Second, in support of this fieldwork, we will constitute a team, consisting of leading biologists, anthropologists, and biosecurity experts. This team will advise on training, and will direct and mentor field researchers as they conduct their studies (Nowatny et al., 2005; Rabinow and Bennett, 2009). At regular intervals throughout the course of our project, the team will meet and work, with field researchers, to assess and synthesize findings from the field. Based on those findings, and as work progresses, they will help develop and test concepts and methodological tools.

As a means of giving focus to our efforts and facilitating comparison among field sites, we will place researchers in research groups working with live viruses for vaccine vectors and for gene therapy. Such work represents a critical aspect of the current biosecurity landscape in that it is the most likely to generate "dual use" knowledge and capability (Fink, 2003). Moreover, researchers competent in the construction, evolution and testing of such organisms would be able to pivot from relatively less-dangerous health-driven research to research that might facilitate offensive capabilities.

We will place researchers in scientific centers where platform technologies have traditionally been created, and in labs traditionally thought to be on the scientific periphery. We are particularly interested in placing researchers in labs in parts of the world where social and political environments are dynamic and even undergoing substantial change. These include regions where science and technology form part of major economic transformations, such as India, Singapore, and China (Ong and Chen, 2010; Liu, 2002). These also include labs in regions where biologically-related human crises such as infectious disease, hunger, or environmental destruction are driving new social and political movements, such as Bangladesh, Indonesia, and Brazil (Fassin, 2012; Escobar, 2010; Matthews, Ribeiro, Vega, 2012). We believe that these rapidly changing environments represent especially fruitful sites for developing and testing analytic capabilities keyed to current shifts in biological capability.

Once situated in field sites, we will work with field researchers to develop methods for observing the creation, adoption, and adaptation of new biological knowledge and capabilities, and tracking increases in ability and status induced thereby. We will also help field researchers identify and study non-scientific factors which partially determine when and how a given course of work is initiated, carried out, and transferred out of the lab.

Distinctively, this help will include development of conceptual tools for researchers to observe and assess a scientific group’s ethical culture (cf. Jasanoff, 2008; Rabinow and Bennett, 2012; Faubion, 2012). By ethical culture we mean the practices and beliefs held by individual group members and by the group as a whole that help guide their sense of priorities, responsibilities, and desired futures (Caduff, 2011). The recent development of mammalian-transmissible avian flu, in which researchers seemed unprepared to think through the possible negative security ramifications of their work, exemplifies how a scientific groups’ ethical culture is as likely to play a role in bringing about dangerous outcomes as its technical abilities (Relman, 2013;
Bennett, 2013). Further, in a situation of diffused biological capability we suspect that a research group’s ethical culture will be increasingly conditioned by the multiple isomorphic ethical communities to which individual researchers belong. By isomorphic ethical communities we mean communities whose members share moral and political commitments despite the fact that their membership is sometimes spread over space and time. For example, most of the members of a research group operating in a Buddhist country might share ethical values based broadly consistent with that religious tradition, while including computer programmers who are politically committed to participation in open-source software development, and doctors committed to the Hippocratic principle "First, do no harm."

If successful our program our program will allow us to draw generalizable conclusions about the dynamics of informal governance, how those dynamics lead to changes in power. Specifically, it will allow us to give conceptual order to complex and fundamental experiences in the creation, uptake, and adaptation of biological capabilities and will produce a collection of concepts and methods for ongoing observation and monitoring of these experiences. It will establish tools for analyzing how the ability to exercise power is increasing in biology, and how to discern where increases are likely to lead to dangerous outcomes. If wildly successful, our program will give us general insight into how changes in power relations might be inflected through the shaping informal governance and to get direct buy-in from participating labs regarding these inflections. If completely successful, we will develop the capability to inflect power relations in such a way as to help increase scientific capacities while diminishing the probability of dangerous outcomes.

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