# Zika Is Just the First Front in the 21st-Century Biowar

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There are many national security challenges facing the United States, but too often our focus is exclusively on threats from terrorism, geopolitics and cyberattacks. As the country confronts the arrival of the Zika virus and contemplates travel bans to Miami, it's time to have an adult conversation about the threats posed by biology.

It's not hard to understand why our lives are increasingly wrapped up in the latest twists and turns of the cyberworld. That supercomputer you are carrying in your pocket (when its tiny colorful screen isn't parked six inches in front of your eyes) is a synthesizer of all the world's knowledge, photography, art, music, and data. It is also a kind of X-ray machine that can provide insights into the deepest recesses of our personal lives: our preferences, choices, intimate moments, health, purchases, and indeed our character.

Yet the impact of all that information and data pales in comparison to what is heading our way in the world of biology. Biological, not cybernetic, developments will determine the course of the 21st century. Ebola, Zika, and the emergence of antibiotic-impervious superbugs are just previews of the coming challenges.

By the turn of the next century, most scientists believe biological technologies will introduce the most wrenching changes — both practical and ethical — in our daily lives. These technologies will include human and animal life extension, crop and livestock genetic manipulation, and human performance enhancement, which together will begin changing the very nature of what it means to be human. As futurist and visionary Ray Kurzweil has famously opined, "The singularity is near," meaning the merger of information, big data, artificial intelligence, and biology. Stand by for heavy rolls, as we say in the Navy.

A main element of the biological revolution will be its impact on security in the broadest sense of the term, as well as on the more specific realm of military activity. Both of these are part of the work being done by various laboratories around the globe, including here in the United States at Johns Hopkins Applied Physics Lab, where I serve as a senior fellow.

Some of the most promising advances made at JHU APL and elsewhere involve man-machine interfaces, with

particular emphasis on brain-machine connections that would allow the use of disconnected limbs; more rapid disease identification in response to both natural and man-made epidemics; artificial intelligence, which offers the greatest near-term potential for both positive benefit and military application (i.e., autonomous attack drones); human performance enhancement, including significant reduction in sleep needs, increases in mental acuity, and improvements in exoskeleton and skin “armor”; and efficient genome editing using CRISPR-Cas, a technology that has become widely available to ever smaller laboratory settings, including individuals working out of their homes.

The most important question is how to appropriately pursue such research while remaining within the legal, ethical, moral, and policy boundaries that our society might one day like to set, though are still largely unformed. Scientists are like soldiers on patrol in unmarked terrain, one that is occasionally illuminated by a flash of lightning, revealing steeper and more dangerous ground ahead. The United States needs to continue its research efforts, but, equally important, it needs to develop a coherent and cohesive biological strategy to guide those efforts.

But national biological research efforts will also have international implications, so over time there will need to be international diplomacy to set norms of behavior for the use of these technologies. The diplomacy that went into developing the Law of the Sea, and is under consideration in the cyberworld, could serve as a useful model.

A major challenge for such diplomacy is that individual nations, transnational organizations, or even individuals will soon have access — if they don’t already — to biological tools that permit manipulation of living organisms. The rise of low-cost synthetic biology technologies, the falling cost of DNA sequencing, and the diffusion of knowledge through the internet create the conditions for a breakout biological event not dissimilar to the Spanish influenza of roughly a century ago. In that plague, by some estimates, nearly 40 percent of the world’s population was infected, with a 10 to 20 percent mortality rate. Extrapolated to our current global population, that would equate to more than 400 million dead.

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Most alarming would be that either rogue nations or violent transnational groups would gain access to these technologies and use them to create biological weapons of mass destruction. As Josh Wolfe, a leading researcher at Johns Hopkins, has said, “Natural biological weapons are limited by the characteristics of agents that are not ideal for weaponization; synthetic biological weapons can be designed without these limitations.”

His work focuses on being able to quickly detect such synthetic biological threats, analyze them, and, perhaps most importantly, attribute them — that is to say, identify which lab or nation is the source of the bug. Wolfe’s research could provide governments with enough information about biological attacks to allow them to develop coherent responses — and thus provide the foundation for an international deterrent regime, which would hopefully prove effective against other countries. (Deterring terror organizations from using such bioweapons if they were able to construct or obtain them would be a far more daunting task.)

There are three key components to preparing for the biological revolution. First, we need an international approach that seeks to limit the proliferation of highly dangerous technologies (much as we try to accomplish with nuclear weapons) and fosters cooperation in the case of contagion or a transnational biological threat.

Here we already encounter a big problem. Nuclear proliferation is fairly straightforward to regulate, at least from a policy standpoint, because there are certain things that nobody needs unless they’re trying to make a nuclear weapon. Synthetic biology offers no such list. Even if we were omniscient in regard to every single gene being ordered or sequenced worldwide, it would still be nearly impossible, in the absence of other information, to tell which people or organizations were pursuing peaceful research and which ones were up to no good. It would be the Wild West, with no black hats or handlebar mustaches to tip us off.

Second, the American government's interagency process must become more adept at addressing both the scientific advances and the security challenges emanating from the world of biological research. At present, federal policy pertaining to such work is organized in silos that prevent it from responding quickly or efficiently. Some of the work is done by the Centers for Disease Control and Prevention, some by the Department of Homeland Security, and other responsibilities and capabilities are assigned to the Department of Health and Human Services. Alongside all that, the Department of Defense has developed its own fairly elaborate capability. Until this changes, the country will be at significant risk.

Finally, all this will require a powerful level of private-public cooperation. So much of the technological advances will come in the business ventures of the Route 128 biotech belt around Boston and other advanced centers in the private sector. Bringing them in concert with government and academic centers like Johns Hopkins will be significant, although this must be done in a way that does not stifle innovation unduly. How to link private and public in this sector is largely unclear, but there may be models in the world of cybersecurity, where some nascent attempts (and failures, frankly) are evolving.

Additionally, there is an imperative to open a broader conversation about the coming impact of the biological world. As citizens, both in the United States and globally, we spend far too much time focused on information and cyber-technologies. The weaponization of biology is coming, and coming quickly. And our ability to control that process — or not – will determine our destiny.