DNA Synthesis and Biosecurity: Lessons Learned and Options for the Future

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Synthetic biology promises great scientific advances, but it also has the potential to pose unique biosecurity threats. It now is easier than ever to synthesize very long pieces of DNA from chemicals, potentially enabling a bioterrorist to build a toxin gene or an entire pathogenic virus. To guard against this possibility, the Department of Health and Human Services released its "Screening Framework Guidance for Providers of Synthetic Double-stranded DNA" in 2010, which called on providers of double-stranded DNA (dsDNA) to screen both customers and the DNA sequences ordered by those customers for potential biosecurity concerns.

Our report addresses two questions: 1) how well has the Guidance worked during its first five years? and 2) are changes to the Guidance needed to keep pace with anticipated developments in the field of DNA synthesis over the next five years? Over the course of this project, we had numerous conversations with industry representatives, stakeholders, and policy makers, culminating in a workshop held on April 28, 2015, in Washington, D.C.

We conclude that the Guidance has been reasonably successful in its first five years with a large majority of the industry in voluntary compliance. In particular, the International Gene Synthesis Consortium (IGSC), which represents approximately 80% of the dsDNA synthesis industry, has outlined rigorous screening measures that are followed by its seven member companies. Many, but not all, other companies and non-profit dsDNA providers also follow the Guidance. Companies report that the administrative burden for voluntary compliance with the Guidance is substantial; we estimate, based on reports from the IGSC, that sequence screening and follow-up on pathogenic and potentially pathogenic sequences accounts for 1.5–3% of total costs. As the price of DNA synthesis continues to go down, this percentage is likely to increase.

Over the next five years, it will become more expensive for companies to adhere to the Guidance and thus, in our view, more challenging for U.S. policy makers to maintain a high level of biosecurity screening. Declining costs for dsDNA synthesis and competition from international dsDNA providers (that might not practice biosecurity screening) will make following the Guidance increasingly burdensome for U.S. companies. Furthermore, decentralized methods of obtaining dsDNA that are not addressed by the current Guidance may become more common. Commercially available chemical kits have simplified the assembly of gene-length dsDNA from short, single-stranded DNA ("oligos"). Also, the recent introduction of benchtop DNA synthesizers capable of making dsDNA may shift some fraction of the market to in-house assembly.

We identify two options that policy makers could pursue to strengthen the Guidance over the next five years: 1) require federal grantees and contractors to purchase dsDNA only from companies that comply with the Guidance, and 2) provide a curated database of "sequences of concern" for dsDNA providers to use for screening. We also consider ways in which the Guidance could be expanded to address oligos and benchtop synthesizers capable of making dsDNA.

Copies of full report available at http://www.jcvi.org/cms/research/groups/policy-center/.

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