MARKETS

Genetics: An Emerging Global Threat

A Dynamic But Disruptive Breakthrough

LON AUGUSTENBORG
Senior Advisor, Teneo

At a recent private gathering in Virginia of leading biologists and geneticists, an unusual topic of conversation was the specific date of November 3, 1988. It was on that date that MIT graduate student, Robert Morris, launched the first malware attack on a system that was unknown to more than 99 percent of the world's population. The system was the Internet, and Morris left an indelible dark mark on arguably the greatest innovation of our time.

His stroke of a key cast a shadow of vulnerability upon a system that its adopters had hoped would spur benevolent expansion of human knowledge. Morris' act undermined trust in the reliability of the Internet. Ever since, cyber attackers and defenders from the public and private sectors have competed in cyberspace.

For the scientists gathered in Virginia, there was a feeling akin to that of 28 years ago. This time, it emanated from a breakthrough in genome editing that holds benefits and dangers.

Unintended Consequences

In the last several years, scientific advancements have led to an innovation called CRISPR-Cas9. Its simple, inexpensive accessibility makes it arguably the most disruptive technology in biology and human health since the discovery of DNA and antibiotics. But its enhanced capabilities for bad, as well as good, explains its migration from the scientific laboratory into the top list of national security threats. The potential misuse of CRISPR-Cas9 has

prompted Dr. Jennifer Doudna, co-creator of the editing process, to issue a warning that has found a receptive audience among America's national security leadership.

Earlier this year, Director of National Intelligence, James Clapper placed the threat of genome editing in a group of six principal proliferation and WMD issues facing the United States and her allies. In testimony to the Senate Armed Services Committee in February, Clapper testified:

"Research in genome editing conducted by countries with different regulatory or ethical standards than those of Western countries probably increases the risk of the creation of potentially harmful biological agents or products. Given the broad distribution, low cost, and accelerated pace of development of this dual-use technology, its deliberate or unintentional misuse might lead to far-reaching economic and national security implications."

Over the next year, the media and academic communities of leading democracies will continue to publically debate the merits and unintended risks of creating heritable CRISPR-Cas9 'gene drives' that can alter, even eliminate, entire species. This debate is certainly necessary and essential as we attempt to grasp the impact and potential consequences of this technology, but it will also slow the progress of positive applications, as well our ability to defend against it. By contrast, there will be no such discussions in authoritarian countries, such as China, or unstable regions, such as the Middle East. State and non-state actors are looking to quickly leverage CRISPR-Cas9 to advance their objectives along an axis of issues stretching from improved human health to the development of asymmetrical terrorist weapons.

China Bets Big on Genetics

China's leadership employs the same philosophy as their forebears when it comes to engineering and manipulating the environment and society to meet regime objectives. From the great water works projects of the Qin Dynasty, to the Communist Party's Three Gorges Dam, to the One Child Policy, China's

leaders have leveraged engineering as a preferred way to redress structural challenges to their economy, demographics, and environment.

China has quickly embraced the promise of genetics, investing more than $10 billion a year into the field to ensure that the science supports national objectives. China's most critical life sciences entity, BGI, was recently moved under State Council supervision to ensure the security and secrecy of its research and development. China's leadership considers the technology a critical tool in addressing existential threats to Communist Party stability.

For example, Beijing views manipulated biology as key to rolling-back a poisoned, heavily polluted environment that threatens public health and the economy, and enrages its citizens. Beijing will also look to genetics as a primary tool to maintain food price stability and security in a water-constrained and rapidly warming world. China's shrinking agricultural footprint faces a more arid and saline-impacted future; it will require genetic enhancements of their staple crops in order to achieve the party's food security objectives and meet the rising expectations of a population eager to consume more protein.

China likely sees manipulation of the human genome as a way to limit the financial strains of a rapidly aging and contracting population. Without an improvement in human health and longevity, China's demographics may make it an old nation unable to maintain growth. China's politburo is overwhelming populated by engineers whose instinct is to use technology to overcome national-level challenges. They will continue to press Chinese scientists to ensure that the country is not crippled by a demographic explosion of chronically ill and unproductive aged. Expect to see Beijing continue to invest significant resources in genetic research that addresses human cognitive decline, chronic disease, and loss of mobility. The People's Bank of China has used the last two decades to amass more than three trillion dollars in reserves. The Party will use genetics to ensure that this wealth is spent on building infrastructure and economic drivers, rather than caring for the 40 percent of its population that will be over age 60 in the year 2050.

Biology could well be the next great driver of a long overdue materials revolution. China's leadership sees innovation in biology as a unique means to increase the quality and breadth of economic growth at a time when Beijing faces deceleration and a challenging rebalancing of the national economy. It has been almost half-a-century since a materials revolution, and scientists and governments across the globe are looking at genetics and biology as potentially being the drivers of new materials that will power the next great leap in engineering and economic productivity. To successfully complete the economic pivot to becoming a wealthy nation, China's leadership will continue to make significant investments in biotechnology. China intends no less than to become the world's leader in this emerging economic space.

"With this dissemination of technology and knowledge, there will be a commensurate acceleration in the attention given to how hostile non-state actors could leverage these [genetic] instruments to visit disease or even death upon their adversaries."

In the near future, China will accelerate unpublicized genetic programs to include an expansion of highly controversial experiments in human embryos that could begin to cross over into human germline manipulation. The increasingly close affiliation between China's genetics community and its national security organizations will further blur the line between scientific inquiry and potential national security application.

Not Bullets or Bombs, but Biology

Over the next year, innovations like CRISPR-Cas9 will continue to proliferate exponentially and become increasingly accessible across the globe. With this dissemination of technology and knowledge, there will be a commensurate acceleration in the attention given to how hostile non-state actors could leverage these instruments to visit disease or even death upon their adversaries. For those charged with monitoring the operational capabilities

of these groups, many privately counsel that it is not a question of 'if', but 'when.' Experts in this field assess that the coming year will provide indications that terrorist entities are seeking to seize upon the advantages afforded by expanded access to genetic modification technologies to further their operational objectives.

With the advent of CRISPR-Cas9, many of the technological barriers that largely kept biological weapons out of the reach of terrorist and criminal organizations have been stripped away. CRISPR-Cas 9 and other biological engineering techniques could result in the creation of modified pathogens, to include those with synthetic genetic material, that are designed to incapacitate specific national leaders or businesses. Such weapons could target indiscriminately an entire populations or be designed to eliminate sectors of a population.

These entities will be attracted to this technology given the minimal resource expenditure required to manipulate these capabilities and launch devastating health, economic and social disruption through the release upon adversaries of weaponized biology or pathogens. These groups may be emboldened by the forensic challenges posed in identifying the deployment of weaponized biology, as well as the poor performance of the world's health organizations in effectively responding to recent naturally occurring epidemics such as Ebola and SARS.

How cyber warfare has developed over the last two decades serves as a lesson and a warning. Once a state-level capability, the proliferation of technology and the broad accessibility to skills required to engage in cyber operations allows non-state actors to conduct sophisticated cyber hacking and offensive warfare from remote locations around the world. CRISPR-Cas 9, which is now being used and taught in some US high schools, could be the equivalent of the cyber actor's laptop. In addition, a rapidly growing 'gene' hacking community is experimenting with a wide range of species and their

genomes and are disseminating their knowledge base online to share with others across the globe. Just as barriers in technology and skill have come down for cyber, they are now being torn down in biology. The parallels are both startling and frightening.

"How cyber warfare has developed over the last two decades serves as a lesson and a warning."

Worse case scenarios, once characterized as being in the realm of science fiction, are now keeping the leadership of the US national security community up at night. And the leader of the Central Intelligence Agency is among them. On March 18, 2016, at a Homeland Security Conference in New Jersey, CIA Director, John Brennan, took questions from the audience following his keynote address. In response to a question as to what emerging security threats facing the United States are keeping him up at night, CIA Director John Brennan did not hesitate in his response that it is biology and genetics. He said biological pathogens have an insidious capability to propagate and to overtake defenses very quickly. So medical and containment needs must be anticipated.

The challenges are daunting. Still, Dr. David Sinclair, a renowned geneticists, is cautiously optimistic. He thinks America's triangulation of academia, industry and government allows for solution of the hardest problems facing mankind. The proliferation of low-cost capabilities, like CRISPR-Cas9, will increase the need for proper monitoring to avoid unintended consequences. Dr. Sinclair believes that enhancing the quality and speed of dialogue between scientists, industry and government has never been more critical.

By the end of next year, discussion of genetics and man's ability to manipulate the code of life, for both good and bad, could be as ubiquitous on America's media airwaves as cyber is today. As the media and politicians begin to spend more time discussing this emergent threat, there will be a

commensurate rise in the public's demand that government and industry prepare medical countermeasures that can neutralize both modified and naturally occurring biological threats.

A National Security Concern

The elevation of genetics to the level of 'strategic national threat' will prompt an increase in federal financing. But the largest support will come from private industry, which, in recent years has outstripped US military research and scientific capabilities in the life sciences. While overall investments in basic science from the National Institutes of Health and other federal agencies will continue to decline in 2017, there will be a significant increase in the amount of public and non-public money spent on countering naturally occurring and weaponized biological threats. As was the case with Ebola and now with Zika, relatively obscure and small research laboratories and biotechnology start-ups will be the main beneficiaries of these large-scale federal investments, as opposed to large pharmaceutical entities.

The ability to detect, amplify, read and use genomic information to identify potentially hostile biology is increasing on an exponential scale. The majority of breakthroughs will continue to occur in the United States, but there will be a steady rise in the number of genetic innovations from Europe and China given the increasing quality of their research communities and the enormous amount of resources provided at a national level. Continued advances in genetic technologies will spur policy discussions regarding national-level surveillance and detection architecture required to mitigate the risks posed by engineered pandemics and weaponized biological materials.

As with the disruptive technologies that came before it, continued innovation and dominance in the life sciences will greatly amplify opportunities and mitigate risks facing the United States as a result of genetic advances. Driven by the media and public policy debates, 2017 will be the year that the global community embraces biology as the next great story. It will be a multi-faceted

one where the public will see it as bringing about advances to their health, as a driver to their national economic competitiveness, while at the same time raising a threat that will stress our capabilities of ensuring safety and security.

Valuable contributions were made by Jason Anderson and Dr. David Sinclair, the co-founders of Liberty BioSecurity.