CENTRE FOR LAND WARFARE STUDIES

ISSUE BRIEF

No. 205 December 2019

'*Zhishengquan*' and the Military Pursuit of Biotechnology

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The nature and character of war are changing. All inanimate domains such as space, information, sea, etc., have been conquered. The only space remaining for the battlefield to expand into is the animate realm which involves the human cells and the cognitive space. This will be aided by the advances in Science, Technology, Engineering, and Mathematics (STEM). Hence, biological systems coupled with cutting-edge technology will be the new tools and targets of warfare.

Cross-disciplinary technologies such as Biotechnology are expected to usher in a new revolution in military affairs (RMA). Clustered Regularly Interspaced Short Palindromic Repeats (CRISPR) associated protein 9 (CRISPR-Cas 9) technology, bio-computing, bio-fuels, bio-engineered materials, etc., will not only alter the way war is prosecuted, but enhance the endurance and lethality of soldiers in the battlefield.

Biotechnology is a dual-use technology with myriad military applications in addition to its civilian uses. Some of the military uses, both in practice and potential, are listed next.

Key Points

- As inanimate domains such as space, outer space, sea, etc., have been conquered, the next domain where the battlefield could expand into is the animate realm, consisting of living cells and human cognitive abilities.
- Given the advances in technology, bio-crossing technologies such as Biotechnology could usher in a new RMA.
- China's push to dual-use technologies, such as Biotechnology, is evident in its shift from Civil-Military Integration to Military-Civil Fusion.
- China is pursuing *Zhishengquan* or "command and superiority in the bio-domain" through militarisation of CRISPR and other gene-editing technologies.
- With a considerable number of CRISPR trials on animals and involvement of the PLA in cancer-related CRISPR trials, there is speculation that this technique is being used to study the enhancement of cognitive abilities with possible military applicability.

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'*Zhishengquan*' and the Military Pursuit...

Tissue-repair

Bio-compatible materials could help soldiers on the battlefield with faster healing of wounds and other damaged tissues.

Battlefield Devices and Wearables

Advances in proteomics could lead to the development of sensors and other miniaturised devices which could be implanted and/or worn to increase battlefield transparency and help in assessing the physiological readiness of the combatants. They could even be powered by biological photovoltaic cells.

Multi-functional Food

With the help of Food Biotechnology, multi-functional food can be created. This will not just increase combat readiness, but also significantly ease logistics. In addition, as human gut microbiome affects both the digestive and the mental health of human beings, engineering of the gut microbiome can be carried out to enhance combat performance by increasing cognitive and digestive abilities.

Data Storage and Communication

There is a lot of on-going research on protein-based memory devices. These provide secure and virtually unlimited data storage. These devices can be made resistant to radiation weapons, making them more dependable than electronic data storage devices.

Deoxyribonucleic acid (DNA) cryptography and DNA steganography are being seen as the future of data encryption and communication with the possibility of creating "unbreakable algorithms". A team from the University of Washington and Microsoft created history by storing a record 1 gigabyte of data onto DNA, far surpassing their previous record of 200 megabytes.[1]

Bacteriorhodopsin, a protein produced by *Halobacterium salinarum*, has been the focus of much research on its applicability for data storage due to its photo-physical properties. It can maintain structural and functional integrity even at temperatures as high as 140° Celsius.

Protective Gear

Biomaterials such as spider silk are being used to make armour which is lightweight, flexible, and strong. Tardigrades are being studied not only for their radio-tolerance, but also the ability to repair radiation-induced DNA damage. This, in future, would have military applicability.

Contaminant Degradation

Enzymes and microbes can be utilised for break-down of contaminants in hazardous environment. In addition, they can also be employed offensively, for example, by engineering them to decompose the fuel supplies of the adversary.

Psychological Evaluation

Technologies such as brain-mapping can aide in the cognitive analysis of troops on parameters such as stress and motivational levels and perhaps, hand-picking of the most battle-ready troops for specific missions.

Stalling Enemy Movement

With rising concerns over ethics, loss of lives, humanitarian laws, etc., in the conflict theatre, means which strike at the readiness, mobility, and motivation of the troops would gain the upper-hand over lethal measures, i.e. incapacitating the adversary would be of greater importance than killing the adversary. An example of how this could be achieved is by introducing localised outbreak of diseases. Specific microbes can be chosen based on the ease of introduction, virulence, ability to withstand sterlising agents, etc. Noroviruses and avian influenza viruses are of particular interest in this regard.

Another way of impairing the readiness of troops is by identifying agents that trigger false alarms in the sensors of the adversary. If such trigger agents are synthesised,

both the physical readiness (protective gear) and the mental readiness (will to proceed) can be targeted.

Super Soldiers and Precision Targets

Gene-editing technology presents possibilities of introducing into troops, enhanced cognitive abilities, resistance against certain toxins, radiation, etc.[2,3,4] In addition, if the genetic and health data of populations of interest are collected, they could be targeted selectively and/or effectively as such data reveals the inherent vulnerabilities of people to certain agents or have certain markers which makes their selective targeting possible. This was the idea behind the alleged Israeli "ethno bomb" which was supposedly a genetic weapon to selectively target certain populations, allegedly made in response to Iraq's supposed pursuit of biological weapons.[5] The claim was, however, completely refuted.

The Chinese view dual-use technologies as vital to building a military that can "fight and win wars". Hence, they are being pursued with focus by China.

China's Push to Dual-Use Technologies Through Military-Civil Fusion

The Chinese have studied and drawn lessons from all major wars, such as the Gulf War, the Kosovo War, the Afghanistan War, etc. Their emphasis on studying the impact of science and technology (S&T) on warfare is evident in the second round of military reforms which amalgamated Academy of Military Science's (AMS') doctrine-writing expertise with new capabilities being developed in S&T.[6]

China's gradual shift from Civil-Military Integration (CMI) to Military-Civil Fusion (MCF) is visible in its pursuit of dual-use technologies such as Biotechnology. There is a focused top-down approach towards it as evident in Chinese Communist Party (CCP) committees being planted into more than 35 Chinese technological companies.[7] President Xi Jinping heads the Central Commission for Military-Civil Fusion Development established in 2017. In Shenzhen, the Central Military Commission Science and Technology Commission has established National Defense Science and Technology Innovation Rapid Response Group to "promote the integration of military and civilian development in the field of science and technology and to use advanced commercial technology to serve the military".[8] This is thought to be inspired by the US Defense Innovation Unit – Experimental (now Defense Innovation Unit). MCF can be seen as a well-coordinated defence policy focusing not just on technology, but also on talent and logistics with release of massive funds for projects and establishment of demonstration zones and parks, making it a whole-of-nation initiative.

Chinese Pursuit of *Zhishengquan* Through Clustered Regularly Interspaced Short Palindromic Repeats

The People's Liberation Army (PLA) and Chinese military researchers are working on exploiting CRISPR and other biotechnological tools to achieve *Zhishengquan* or "command and superiority in the bio-domain". In 2016, an AMS researcher presented a doctoral dissertation titled "Evaluation and Research on Human Performance Enhancement Technology".[9] It viewed CRISPR one of the three "human performance enhancement technologies" and as the next "disruptive technology" where China must take the lead. True to this, China has been at the forefront of CRISPR trials. It has carried out CRISPR-Cas 9 experiments on numerous animals such as dogs, mice, rats, pigs, and rabbits. Pigs have been gene-edited to grow human-like organs for xenotransplantation (China has a critical organ shortage.). Gene-edited monkeys are being used as models for studying human diseases, such as autism, cancer, etc. World's first gene-edited dogs—Beagles named Hercules and Tiangou—were created in China. They have potential police and military use owing to their highly muscular body and better running ability.[10] A Chinese company, Beijing Genomics Institute, has tried to market gene-edited animals, such as micro pigs, as pets.[11]

With so many CRISPR trials on animals, there is speculation that this technique is being used to study the enhancement of cognitive abilities. In fact, even as bioethicists and other stakeholders debated the issue of CRISPR trials on humans, China became the first country to carry out the same in 2016.[12] Dr Lu You of Sichuan University introduced gene-edited T-cells into the body of a lung cancer patient. Furthermore, gene editing to confer resistance to human immunodeficiency virus (HIV) was carried out on human embryos, disregarding bioethics, and the first gene-edited humans, named Lulu and Nana, were born in China in 2018.[13] It is pertinent to mention here that experiments in animals have shown that removing the gene linked to HIV pathogenesis—CCR5—also enhances cognitive abilities.[14] Was this a deliberate move by China to weaponise CRISPR and study the enhancement of cognitive abilities in humans which could have military applications in the future?

Of the 14 cancer-related, CRISPR trials currently underway in China, the medical establishments of the PLA, especially the PLA General Hospital and the Academy of Military Medical Sciences (AMMS) are involved in five![15] Writings by Chinese military personnel indicate their emphasis on bio-crossing technologies and their envisionment of the future battlefield as one consisting of man-machine interfaces.[16] Guo Jiwei of the then Third Military Medical University (Army Medical University post the military reforms in 2017), for example, co-authored *War for Biological Dominance* in 2010.[17] He Fuchu of the AMMS, in 2015, postulated that advances in Biotechnology could lead to the creation of "cerebrum control" weapons.[18] Hence, it would not be wrong to assume that human performance enhancement, especially the improvement of cognitive abilities and combat efficacy, is being pursued with focus by the PLA. In 2011, the AMMS unveiled Night Eagle, a drug it claimed would help its troops remain awake for up to 72 hours with minimum cognitive degradation.[19] In addition to gene-editing techniques and drugs, China is also looking at the "smart" combination of machines and brains. A company named Cogrowth, for example, is using artificial intelligence (AI) to interpret brain signals.[20] This may, in future, be the basis for weapons being controlled by the power of thought.

While there are very critical issues of bioethics in this field, especially concerning germ-line editing, the bigger question is: When certain countries displaying revisionist tendencies continue to downplay bioethics, should other countries prioritise bioethics over technology-parity?

Biotech: The Strategic Industry of China

The Biotech industry has become a strategic industry in China not only because of its military applicability, but also due to the non-military use it has in terms of ensuring human security.

Over 10 crore people in China are diabetic and a quarter of the new global cancer cases are from China.[21] The Healthy China 2030 Plan attaches special importance to, inter alia, cancer and diabetes management. This is an area where China's domestic Biotechnology industry could play a critical role, reducing China's dependence on costly, imported medicines, and patents. In fact, from 2018 to 2024, China's Biotech market is projected to witness a compound annual growth rate of 10.6 percent.[22]

The Chinese government has systematically encouraged the growth of the Biotech and Life Sciences sector through a number of incentives, programmes, investments, etc., some of which are listed as under:

Policies and Programmes

These include both national-level and local-level policies. Biotechnology is one of the seven Strategic Emerging Industries identified by China in 2010 as being crucial to her economic competitiveness. The 12th and 13th Five-Year Plans have a strong focus on Biotech and the Biosciences sector. High-performance medical devices and Biopharmaceuticals is one of the key sectors under Made in China 2025.

The CCP's focus is not just on getting the best technology, but also talent, i.e. human resource from outside to create an environment which promotes innovation and helps in realising MCF. This is done through initiatives such as the Thousand Talents Program, Hundred Talents Program, and the National Science Fund for Distinguished Young Scholars. Of particular interest is the focus on bringing back Chinese research scholars with degrees in STEM. In fact, between 2012 and 2018, twenty lakh individuals returned, two and a half lakh of whom are estimated to be engaged in the Life Sciences industry.[23] These returnees are called *haigui* which means "sea turtle".

Funding and Infrastructure

Chinese state-owned enterprises and other governmental programmes provide research grants and the initial funding for the Chinese Biotech companies. The numerous Biotech parks set up by the government house Biotech companies and act as incubators by providing incentives such as free or discounted office space.

Owing to its pool of well-trained scientists and skilled workers, multi-national pharmaceutical companies such as Pfizer, GlaxoSmithKline, and AstraZeneca have invested large sums in research and development (R&D) in China.[24]

In addition to this, it has been alleged that the Chinese have also gained from cyber-espionage targetting Biotech companies and theft of trade secrets.[25]

The centralised, CPC-approach is helping China and it has created a state-backed environment that favours and promotes research in bio-crossing technologies, especially CRISPR, by making the regulatory requirements less rigorous. The issue of Bioethics is underplayed for research involving technologies such as CRISPR and Chimeric Antigen Receptor T-cell therapy. A fast-track review is given to drugs manufactured in China and data exclusivity period for biologics is maximised when clinical trials are carried out in China.[26]

In addition, Chinese Biotech companies have benefitted through partnerships and academic engagements with foreign countries, especially the United States (US). China has not only acquired the technology through such means, but also clinical and genetic data on the US citizens.[27] This big data is particularly useful in Medical Biotechnology and the incorporation of AI into genomics. The flip-side is that the same genetic data which is used for precision medicine and determining the vulnerability to certain diseases, in the wrong hands, can be used to target populations accordingly. No wonder China strictly protects and regulates the genetic and health data of its citizens. In 2017, China passed the Cyber Security Law, which comprehensively applies to personal data collected over information networks including, but not restricted to, biometrics, name, telephone number, and address. It necessitates localisation of personal data and "important data" held by "critical information infrastructure" (CII) operators. This Law identifies three types of data:

- *Personal data* which can be used to identify an individual, such as name, address, etc.
- *Sensitive personal data*, the misuse of which could imperil the health, safety or security of an individual.
- *Important data* which is related to national security, including economic interests.

For an overseas transfer of personal data, the network operator must obtain "informed consent" of the data subject by notifying the type of personal data being transferred, the purpose and scope of such a transfer, the recipient, and the country where the data would be transferred.

For overseas transfer of personal data or "important data" collected on CIIs, prior regulatory approval is essential.

China's National Information Security Standardization Technical Committee issued the Personal Information Security Specification (TC260) in 2018 covering the collection, storage, use, sharing, transfer, and disclosure of personal information.[28,29]

The Indian Scenario

Open sources reveal that while India may have short-term, futuristic R&D as far as defence and trends in warfare are concerned, it lacks a long-term R&D looking at timelines of, for example, 20 years and beyond. The focus is mostly on indigenising existing technologies and equipments and not on producing core technology. It appears that there is also a lack of jointness in R&D. The Army, the Navy, and the Air Force work in silos. This is concerning, especially since the future of warfare is thought to be governed by cross-disciplinary technologies. There is a need to break boundaries and carry out cross-service research. Our defence and military strategy should define the equipment and technology we use and not the other way round. In this regard, the following points deserve attention:

- The government should make adequate infrastructure and incentives available to retain the best brains and/or reverse the brain-drain.
- India needs a specialist cell dealing with emerging and futuristic trends in warfare. This should include experienced military personnel from various arms and services, scientists and researchers specialising in cutting-edge technology, politics, psychology, international relations, etc., and motivated youth from whom fresh ideas and troubleshooting could be sought.
- An integrated research facility/multiple, specialist facilities dealing exclusively with technologies relevant to defence and security should also be mulled over. Such a facility should be a platform for the best brains from the universities, industries, etc., to converge, ideate, and produce results. It should be adequately financed so that innovative ideas can cross the "Valley of Death", i.e. the gap between innovation and its commercial application.

  The Armed Forces could also benefit from an institute designed to focus on offensive applications of all technologies, including medical. An institute of excellence bringing in officers from the medical, engineer, and other corps focused on futuristic research in these fields could help further both military and non-military applications of these technologies.
- Increasingly, the common citizens of the country have become the targets of the ongoing silent war; be it in terms of theft of their data, infection by malware, etc. This is matter of serious concern and needs a national response. The Human Resource Development Ministry needs to step in and "arm" the citizens to resist this "war". One way of doing this is by making Cyber Hygiene a compulsory course in schools and colleges. The people need to be sensitised on how, inter alia, innocuous-looking applications can be used to harvest sensitive information. On the legal front, the government needs to be proactive and not reactive by bringing in legislations that protect the citizens. It is apposite to mention here that except for the rule by the Reserve Bank of India on data localisation for payment systems, there are no laws for the same! India, however, has drafts of bills awaiting approval.

The bottom-line is, as the character of war continues to evolve and threats from new areas emerge, the Armed Forces should also adapt and evolve and even transform to deter and counter the same. A largely conventional army cannot be an effective guard against largely unconventional threats.

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