

WHO STUDY GUIDE

committee: world health organisation expert advisory committee on human genome editing

agenda: regulating the CRISPR (Clustered Regularly Interspaced Short Palindromic Repeats) technology and sorting military applications

TOC

1. Letter from the Secretary General
2. Letter from the Under Secretary General
3. Letter from the Academic Assistant
4. Introduction to the Committee
- 5.The CRISPR-CAS9 Technology
 - 5.1 Short History and Definitions
 - 5.2. Current Applications
 - 5.3. Possible Applications and the Future of the Technology
- 6.Technology in Military
 - 6.1. Current Situation
 - 6.2. Ethics in Military Applications
- 7.CRISPR-CAS9 Usage in Military
 - 7.1. Trials and Possible Applications
 - 7.2. Ethicality
- 8.Questions to be Pondered
- 9.Bibliography
- 10.Further Research

1. Letter from the Secretary General

2. Letter from the Under Secretary General

Dear Delegates,

I would like to welcome you all to the WHO Expert Advisory Committee on Human Genome Editing! I am Kuzey Karlık, I am studying medicine at İstanbul University - Cerrahpaşa and it is my utmost pleasure to serve you as the Under Secretary General of this committee.

First, I would like to thank the executive team for granting me this opportunity in this marvelous conference. And I would like to thank my fellow Academic Assistant Nilda Öncel for her magnificent efforts and work ethic.

The study guide we wrote contains crucial information for this committee. Yet as its name states it's only a guide for you, so I am highly encouraging you to do your research properly, there will be a lot of debate points, disagreements and controversies hence you have to be ready.

I am sure this committee will be a blast, and I am looking forward to meeting you all on 10-11 October. If you have any questions you can always contact me through mail or phone.

Sincerely,

Kuzey Karlık, Co-Under Secretary General of WHO Expert Advisory Committee on Human Genome Editing

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3. Letter from the Academic Assistant

Dear Participants,

I am Nilda Öncel and it is an honor to welcome you all to this committee where I will be serving as your Academic Assistant throughout the conference.

Firstly, I would like to thank my Under Secretary-General Kuzey Karlık for his guidance and huge support in every sense.

This committee will address a recent issue arisen by the advancement of technology regarding gene editing and CRISPR-Cas9. This guide contains essential information for you to understand the agenda item and the committee, therefore, I highly encourage you all to read this guide with great care. Additionally, further research into the important details of the agenda item and stances of your allocations is vital for the committee's process and debates. Due to our agenda item containing aspects related to

biology, some parts of this Study Guide may contain some complex information, so please feel free to contact me if you have any questions.

I sincerely look forward to meeting you and I truly hope that this committee will be an enjoyable and educational experience for all.

Nilda Öncel, Academic Assistant of WHO Expert Advisory Committee on Human Genome Editing

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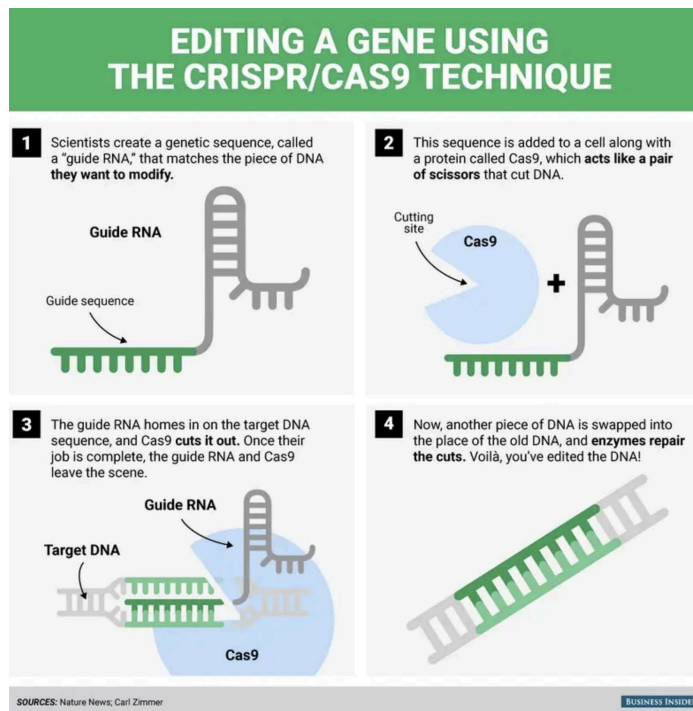
4. Introduction to the Committee

Founded in 1948, the World Health Organization (WHO) is the United Nations agency dedicated to global health and safety. The Organization connects nations, partners and communities to promote health and serve the vulnerable. WHO works with 195 Member States, across 6 regions on the ground in more than 150 locations. WHO works with its Member States to achieve the highest level of health for all people by pursuing universal health coverage. WHO's work remains firmly rooted in the basic principles of the right to health and well-being for all people, as outlined in the 1948 Constitution. The World Health Assembly is the decision-making body of WHO and is attended by delegations from all Member States. WHO plays an essential role supporting countries to prepare for, detect, respond to and recover from health emergencies, including pandemics, disease outbreaks, natural disasters and humanitarian crises. Amid a growing need for rapid response, WHO builds global systems that: predict, prevent and contain emerging risks; support countries and communities to respond to disease outbreaks, disasters and humanitarian crises; rapidly assess the availability, safety, and efficacy of emergency health products; marshal resources and health services for fair global access to vaccines, therapeutics, diagnostics and supplies; and support on-the-ground care in fragile settings to protect the most vulnerable. The World Health Organization (WHO) Expert Advisory Committee on Developing Global Standards for Governance and Oversight of Human Genome Editing Committee is tasked to advise and make recommendations on appropriate institutional, national, regional and global governance mechanisms for human genome editing under WHO.

5. The CRISPR-CAS9 Technology

5.1. Short History and Definitions

Clustered regularly interspaced palindromic repeats (CRISPR)/Cas9 is a gene-editing technology causing a major upheaval in biomedical research. It makes it possible to correct errors in the genome and turn on or off genes in cells and organisms quickly, cheaply and with relative ease. It has a number of laboratory applications including rapid generation of cellular and animal models, functional genomic screens and live imaging of the cellular genome. CRISPR/Cas9 allows gene-editing by the two essential components: a guide RNA to match a desired target gene, and Cas9 (CRISPR-associated protein 9) which is an endonuclease which causes a double-stranded DNA break, allowing modifications to the genome. The development of a method for genome editing based on CRISPR-Cas9 technology was awarded The Nobel Prize in Chemistry in 2020, less than a decade after the discovery of all principal molecular components of the system. For the first time in history a Nobel prize was awarded to two women, Emmanuelle Charpentier and Jennifer Doudna, who made key discoveries in the field of DNA manipulation with the CRISPR–Cas9 system, so-called “genetic scissors”. It is difficult to overestimate the importance of the technique as it enables one not only to manipulate genomes of model organisms in scientific experiments, and modify characteristics of important crops and animals, but also has the potential of introducing revolutionary changes in medicine, especially in treatment of genetic diseases. The original biological function of CRISPR–Cas9 system is the protection of prokaryotes from mobile genetic elements, in particular viruses. Currently, CRISPR–Cas9 and related technologies have been successfully used to cure life-threatening diseases, make coronavirus detection tests, and even to modify human embryo cells with the consequent birth of babies carrying the introduced modifications. This intervention with human germplasm cells resulted in wide disapproval in the scientific community due to ethical concerns, and calls for a moratorium on inheritable genomic manipulations.



5.2. Current Applications

Genome engineering was first performed in bacteria and mammalian cells by using the CRISPR–Cas9 system. Gene editing technologies that are accomplished based on restriction enzymes, transcription activator-like effector nucleases and zinc-finger nucleases depend on binding of protein–DNA. The disadvantage of these technologies is that proteins are needed to be designed for each experiment. The Cas9 endonuclease from the bacterium, *Streptococcus pyogenes*, termed SpCas9 is widely employed for genome engineering where the gRNA guides the SpCas9 for cleaving the target sites based on DNA–RNA hybridization. In addition to genome editing and disease treatment, CRISPR–Cas toolbox has recently emerged to provide various strategies for functional genomics screening, point-of-care diagnosis as well as live-cell imaging. In recent years, CRISPR–Cas9 technology is widely acknowledged for having major applications in the field of biotechnology for editing the genome of any organism to treat a variety of complex diseases and for other purposes. This genetic organization exists in prokaryotic organisms and aids in the development of adaptive immunity since a protein called Cas9 nuclease cleaves specific target nucleic acid sequences from foreign invaders and destroys them. This mode of action has gained interest of the researchers to understand the insights of CRISPR–Cas9 technology. CRISPR–Cas9 organization helps in determining the activity of a gene during any illness state, rectifying a gene that causes harmful mutation and switching off/on cancer

causing genes or switching on tumor suppressors. This technology possesses enormous capability to cure patients suffering from cancer by increasing the efficacy of immunotherapy and minimizing the price of T cell treatment. CRISPR–Cas9 technology can also cure many diseases related to nerve cells such as Duchenne muscular dystrophy, heart related diseases and diseases arising from the breakdown of the immune system such as autoimmune disorders. In addition to genome editing, technology based on CRISPR–Cas9 system has recently been applied for live-cell chromatin imaging, chromatin topology manipulations, genome regulation, RNA targeting and epigenome editing. Transposable elements (TEs) have contributed greatly during genome evolution. A gene of interest can be incorporated within the genome of any organism by altering the activity of these elements. CRISPR–Cas9 technology can be employed for making the best use of TEs in order to regulate transcription process in the organism

5.3. Possible Applications and the Future of the Technology

As the limitations of current CRISPR technologies have become increasingly clear over the past decade, novel approaches and methodologies continue to be developed and fine-tuned to address these constraints and improve the efficacy and versatility of CRISPR-based genome editing. These emergent, third-generation tools and technologies include recently discovered classes of compact RNA-guided nucleases that have been adapted for DSB-based editing and could also serve as RNA-guided DNA binding platforms for other genome editor modalities such as BEs and PEs. The insertion of long, gene-sized DNA sequences, particularly in post-mitotic cells lacking HDR, remains a major unmet need in the genome editing field. In this context, the development of CRISPR-guided recombinases and transposons presents a promising and potentially powerful avenue to fill this technology gap. New approaches have also emerged for genome editing technologies based on retrotransposons and for editing RNA transcripts. Finally, the creation of new genome editor tools continues to go hand in hand with advances in the development of delivery methods, which represent a major challenge for therapeutic applications. Overall, these developments reflect the dynamic of the rapidly advancing genome editing field, where each new method offers complementary strengths to address the diverse needs and challenges of genetic manipulations.

Epigenome editing

The introduction of permanent genetic modifications poses significant risks, such as mutations, and raises ethical concerns in the context of germline genome editing. CRISPR-based epigenome editing, introducing targeted epigenetic modifications that do not affect germline DNA yet can persist through numerous cellular generations, offers a promising alternative. By fusing DNA and histone, modifying enzymes to nuclease-dead Cas9, chromatin can be restructured at a specific genomic locus to induce or repress target gene expression. A recently established epigenome editor approach termed CRISPRoff exploits DNA methyltransferases such as Dnmt3A or Dnmt3L in conjunction with KRAB transcriptional repressor domains to efficiently and persistently silence gene expression in proliferating cells over multiple generations. The silencing can be reversed by CRISPR on, a multi-partite editor combining Cas9 with the DNA demethylase TET1 and transcriptional activation domains, to reactivate expression. Acetylation is another form of epigenetic histone modification in which histone acetyltransferases (HATs) and histone deacetylases (HDACs) can be used to modify the chromatin and thus activate or repress gene expression, respectively. However, certain limitations persist. As Cas9 can transiently bind to off-target sites based on the seed sequence of the guide RNA alone, histone and chromatin modifiers can inadvertently affect the transcription status of off-target genes. Additionally, the long-term effects and stability of these epigenetic changes remain to be researched in more detail to fully understand their consequences, especially in the context of complex diseases.

RNA editing

As with epigenome editing, introducing targeted mutations directly into the mRNA offers a potentially safer alternative to editing DNA due to the limited lifetime of mRNAs within the cell. RNA editing approaches have evolved to offer more precise and versatile control over the editing outcomes. One such recent advancement arose from the discovery of the Cas7-11 system, a novel single-protein CRISPR-Cas effector that uses guide RNAs to cleave target RNAs. The system has been re-engineered to knockdown transcripts with minimal off-target activity and apparently no collateral cleavage activity in mammalian cells, as compared with Cas13a-mediated knockdown approaches. Additionally, a novel approach for CRISPR-mediated trans-splicing of long RNA transcripts has recently been reported. By utilizing RNA-targeting Cas13 enzymes in combination with a trans-splicing RNA, the technology enables replacement or insertion of large segments in mammalian mRNA transcripts. These novel technologies have significant implications for therapeutic development, particularly for genetic diseases that could be addressed by

transient gene correction. RNA editing thus represents an opportunity for more sophisticated and targeted approaches in genomic medicine and expanding the potential for treatments that require transient or reversible genetic modulation.

Novel delivery methods

Efficient and precise delivery of the gene editor complexes into target cells or organs remains the most significant limiting factor for genome editing. A number of strategies are currently under development to enhance delivery efficiency and minimize potential immunogenicity of CRISPR-based genome editors. Firstly, new LNP formulations have recently been developed to enable tissue-specific targeting, thus offering a versatile approach for packaging and delivering CRISPR components with enhanced cellular uptake and reduced off-target editing. Cell-penetrating peptides have also shown considerable potential as a delivery method for CRISPR enzymes, particularly in the editing of primary human lymphocytes, neuronal cells, and airway epithelia. Bacterial contractile injection systems have been re-engineered to permit transient and cell-specific delivery of protein cargo, including genome editor nucleases, with high efficiencies. Engineered virus-like particles that mimic viruses but are devoid of viral genetic material have emerged as a powerful alternative to viral vectors for applications. Another promising technology based on the engineering of endogenous viral particles is based on ancient viruses encoded in eukaryotic genomes, which could potentially permit delivery with reduced immunogenic response. Finally, with the advent of accurate computational protein design approaches, designed protein cages are being developed that could provide modular strategies for delivering gene editor complexes to biological environments that are not accessible to natural systems. Despite the great promise that these advancements hold, the cytotoxicity, off-target, and immunogenicity profiles of these technologies will need to be rigorously assessed across various cell types and tissues. Furthermore, the scalability of some of these methods for clinical applications poses a significant challenge, as does the cost of developing and manufacturing such complex delivery systems. Overall, there is a critical need for further research to refine these techniques to ensure their safety and efficacy for therapeutic use.

Artificial intelligence

The recent and rapid adoption of artificial intelligence (AI) and deep learning computational algorithms in biological sciences has also had far-reaching implications for the genome editing field. It has already made considerable progress in improving its precision and efficiency by predictive modeling of the

outcomes and efficiency of edits, including off-target activity, which are crucial for minimizing unintended genetic alterations, particularly for therapeutic applications where safety and efficacy are of paramount interest. Potentially, AI methods might be used in the future to further personalize gene editing approaches in therapeutic applications. The power of AI is also being harnessed for the engineering of novel, more efficient, and specific nucleases through novel computational protein design methods. However, AI methods also come with their own set of challenges. Predictive models are heavily dependent on the availability and quality of the training data, which can be limited and highly variable depending on the experimental approach. Moreover, the "black-box" nature of AI models precludes understanding of how these models make decisions, making predictions difficult to interpret and trust. Nevertheless, the potential applications of AI in gene editing are immense but will require careful consideration moving forward

6. Technology in Military

6.1. Current Situation

Advances in science and technology present both opportunities and risks for international peace and security. Let's have a look at some recent military technologies:

Helmet-Mounted Radar

The U.S. Military's investment in helmet-mounted radar (HMD) systems marks a significant advancement in battlefield technology. These systems provide soldiers with unparalleled situational awareness, particularly in urban environments, by enabling them to detect movements and threats through walls and other obstacles. These devices equip ground soldiers with sensors that offer near-360-degree vision. Similarly, pilots can gain a more complete view around the aircraft, enhancing safety and operational capabilities.

Additionally, Tactical Augmented Display Technologies feature a single eyepiece, displaying crucial information such as maps, targeting data, and GPS coordinates directly in the soldier's line of sight. Combined with related technologies like wrist-mounted displays and wearable fuel cells, soldiers are more situationally aware and protected than ever.

Hybrid Naval Fleet

The U.S. Navy is advancing its capabilities with the introduction of uncrewed autonomous systems (UAS), which are a part of a strategic shift towards a hybrid fleet composed of both crewed and uncrewed ships. This technology is central to the Navy's Force Design 2045 vision, which aims to create a fleet of 350 crewed and 150 uncrewed vessels.

Uncrewed vessels are designed to operate without people on board, allowing for a variety of missions while reducing the risk to human life. These vessels can be used for surveillance, mine countermeasures, anti-submarine warfare, and missile defense. This technology is still evolving, and through testing and evaluation in national and international exercises, experiments, and demonstrations, is preparing fleets for adopting uncrewed vessels in operational scenarios.

Robotics and Autonomous Systems

Like nearly every other industry, robotics and autonomous systems (RAS) are proving to be a transformative set of technologies for the U.S. Army. The military is integrating these systems – like drones, autonomous tanks, and tele-operated robots – to maintain an advantage over increasingly capable adversaries.

The Army's RAS strategy encompasses a range of systems from uncrewed ground vehicles to autonomous aerial systems, which can perform tasks such as surveillance, logistics support, explosive ordnance disposal, and combat support without direct human control. These systems are designed to operate in conjunction with human soldiers, providing them with critical stand-off capabilities from dangerous tasks and enabling them to make faster, more informed decisions on the battlefield.

3D Printing

Additive Manufacturing, better known as 3D printing, is revolutionizing the U.S. Military's operational capabilities by enabling the rapid production of parts and equipment directly in the field. This technology allows for the creation or repair of objects from digital models by layering materials, offering significant advantages over traditional manufacturing methods.

The Department of Defense has embraced additive manufacturing for its potential to modernize defense systems, enhance performance, and provide supply chain flexibility. With the ability to produce lighter, more efficient parts, 3D printing is used across various military branches for items ranging from aircraft components to medical supplies. The military's strategy aims to integrate 3D printing into acquisition and sustainment processes, fostering innovation and addressing sustainment challenges. By producing parts on-demand, 3D printing mitigates supply chain issues and empowers service members with customized solutions, ensuring mission readiness and technological superiority.

Advanced Defense Equipment

A key area of the military's focus on safety and effectiveness is the development of next-generation combat gear, including lighter and more protective helmets, body armor, wearable sensors, and communication systems. These innovations aim to provide better ballistic protection while reducing the weight burden on soldiers, thus improving mobility and comfort during extended operations. Additionally, this equipment often integrates with other tech, such as heads-up displays and augmented reality, to enhance situational awareness and connectivity.

These developments are aligned with the Department of Defense's strategy to leverage emerging technologies, such as advanced materials and human-machine interfaces, to maintain the U.S. military's competitive edge. The goal is not only to protect soldiers more effectively, but also to equip them with the tools they need to operate more efficiently in complex and dynamic combat environments.

These are some of the newer technological advancements in military currently being implemented into the US army. As seen, a big variety of technological advancements get implemented into the army. This is caused by the requirement of all countries to protect themselves and other reasons not including defence such as threats or annexation.

Another example for the technologies being used is AI As United Nations Secretary-General António Guterres noted in a recent report, many states consider it important to involve a range of stakeholders—including industry, the scientific community and civil society—in policy initiatives on responsible military applications of AI. That extends beyond efforts under the auspices of the UN and includes processes like the Summit on Responsible AI in the Military Domain (REAIM).

States have given two main reasons for engaging with industry in these discussions. The first is that industry actors have highly relevant technical expertise and experience. They can help policymakers to better understand the technology. They can also contribute to generating and refining ideas about harnessing the benefits of AI in the military domain, and to identifying and mitigating the risks associated with these technologies.

The second reason is that design choices made during the development of an AI system can impact the ability of armed forces to use it in line with relevant legal and ethical frameworks. As AI systems are largely developed and produced by the private sector, states see a need to engage with industry to understand how to put principles of responsible use into practice, as well as to communicate to industry the implications of their technologies for international peace and security.

There are several categories of who uses AI in military. The first category is ‘defence primes’, large legacy arms producers that have direct, multi-year contracts with the government for military programmes and capabilities. They also manage complex supply chains to deliver advanced systems, including ‘big-ticket’ items such as fighter aircraft, armoured vehicles, submarines and air-defence systems.

These defence primes have long been involved in the development and production of military AI capabilities—for maintenance, logistics and for integration into weapons. For example, the Phalanx close-in weapon system produced by the RTX (previously Raytheon), which uses rule-based algorithms to identify, track and engage targets, was first developed in the 1970s. Israel Aerospace Industries (IAI) started developing the Harpy, a semi-autonomous anti-radar loitering munition that can use AI for target identification, in the late 1980s.

Because of their existing relationships with militaries, the defence primes are positioned at the upper layers of the stack. These companies have sought to keep up with the latest advances in AI by acquiring, subcontracting and partnering with

arms-industry start-ups and firms with specific competencies in AI and related fields. For example, Sweden's Saab acquired the US machine-learning computer vision developer CrowdAI in 2023, and the French defence prime Safran acquired AI geospatial analysis company Preligens (now Safran.AI) in 2024.

The second category of company is 'neoprimes' and 'defence start-ups'. This includes firms established much more recently than the defence primes. They tend to specialize in the provision of software and data products and services to the arms markets, although some—such as Palantir and Anduril—also provide technologies for policing. Some of these companies specialize in providing niche products and services, such as autonomous drones (Skydio) or anti-swarm technology (Epirus). Some of the more prominent companies are known for providing battle-management software that aggregates and analyses data to support operational decision-making. This includes systems like Anduril's Lattice, ShieldAI's Hivemind and Helsing's Altra.

One major way neoprimes and defence start-ups differ from the defence primes is in how they approach innovation. Rather than waiting for defence ministries to articulate a specific demand before developing a product, neoprimes tend to invest in their own R&D, usually backed by venture-capital companies, and to market finished products to military customers.

The third category is often referred to as 'big tech'. This includes globally dominant technology corporations with diversified digital products and services and significant market capitalization. These are present in both civilian and military markets and often own and control infrastructure such as cloud platforms and data centres that underpin digital products and services. Often, big tech companies operate and control products and services at multiple layers of the AI stack. For example, both Meta and Google have been laying networks of deep-sea fibre-optic cables to support their cloud computing services, and have also been linked to military applications of AI.

Finally, there are the foundation model providers. These are firms that develop and maintain large-scale AI models capable of powering a wide variety of downstream tasks in different domains. Like the neoprimes and defence start-ups, these firms are relatively young—most were founded between 2010 and 2023, with funding from a mixture of venture capital and investments from big tech.

Originally many of the foundation model providers were united against the military use of their AI tools, but that stance has shifted over the past two years. For example, in January 2024 OpenAI rescinded a ban on its products being used for ‘military and warfare purposes’. Anthropic has historically prohibited certain military uses of its technology, and in 2024 announced a partnership with Palantir and Amazon Web Services to supply AI models for military purposes. Expanding into military markets provides an opportunity for these firms to tap into national defence budgets, for example, to continue funding the training of their foundation models.

As seen clearly, one of the most recent technologies, AI, has a huge deal of competition surrounding military usage. That competition of course exists due to the huge potential AI has. The same goes for CRISPR-CAS9 technology, being able to edit the genome of the living can allow for super soldiers, a huge variety of bioweapons and many more. Although the technology isn’t quite there, there are debates internationally surrounding the potential on top of all the issues that come with it.

6.2. Ethics in Military Applications

The global integration of science and technology into conflict has placed the international community in a dynamic field where deep moral questions and strategic developments coexist. The evolution of military technology from ancient times to the present day shows a path from conventional weapons to increasingly complex elements like cyberwarfare, autonomous systems, and intelligence has been additive. It offers a lot of challenging tasks up to the level of yoga.

Before this, advanced technology has defeated building the moral scores of many people, so that nations have planned to use it in war, during World War II, the use of

nuclear weapons in the city of Hiroshima and Nagasaki is an example of remarkable scientific progress. responsibilities and responsibilities Stimulate further discussion on the topic. The complexity of ethical problems is increased by the dual-use nature of technologies. This dichotomy is best illustrated by the global positioning system (GPS), which was once created for civilian usage but is now widely used for both military targeting and navigation systems. The difficulty in differentiating between technologies intended for peaceful uses and those with possible military implications is highlighted by this convergence of applications.

The creation of uniform standards is made more difficult by geopolitical divides as the The world community struggles with these moral quandaries. The development of a worldwide consensus regarding the moral application of science and technology in battle has historically been hampered by divergent political and strategic goals among nations. The arms race between the US and the USSR during the Cold War provides a dramatic historical backdrop that highlights how geopolitical conflicts can influence international talks on disarmament and ethical issues.

Looking at recent occurrences makes it clear how important it is for nations to work together to address these issues. The emergence of state-sponsored entities as facilitators of cybersecurity threats and attacks has highlighted the necessity of cooperative efforts to develop common norms and principles. The 2010 discovery of the Stuxnet worm, which is thought to have been jointly developed by the US and Israel, is a prime example of how statecraft, cyberwarfare, and the moral issues surrounding the employment of highly developed malware in nation-state conflicts intersect.

Ethical standards and principles are essential in forming the conversation about the appropriate application of science and technology in combat. The Geneva Conventions are a fundamental collection of international humanitarian standards that regulate the moral treatment of combatants and civilians during armed conflicts. They were formed in the wake of World War II. Adopted in 1977 , the Additional Protocols to the Conventions define the protection of victims in armed conflicts and highlight the need for

compassionate treatment even in the face of technical progress. The moral implications of using science and technology in combat represent a complex issue that necessitates careful consideration. The path of global security is shaped by the fusion of ethical concerns and technological breakthroughs, from historical precedents to modern geopolitical realities. This extended study report provides factual insights, historical context, and strategic considerations to support informed decision-making as the GA1 navigates these issues. It is a thorough resource. By carefully examining these complex relationships, the global community can create moral guidelines for the application of science and technology that will reduce harm and protect human rights in a world growing more interconnected by the day.

7. CRISPR-CAS9 Usage in Military

With the discovery of CRISPR-Cas9- Cas9 Technology, the Nobel Prize winner Jennifer Doudna stressed the responsibility of scientists to calibrate the accurate use of technology. This discovery has laid out immense possibilities in the field of Modern Biowarfare. Gene editing is said to play a major role in intelligentised warfare between countries such as the U.S., the People's Republic of China, and North Korea. It can be used to produce genetically modified soldiers with enhanced physical and cognitive capabilities, sponsoring Neuro-linked Warfare. As the world is an abyss in quagmires of cyber warfare, trying to stay afloat by, the silently creeping dangers of gene editing remain unexplored and hidden until the day Pandora's box splits apart. This raises questions regarding the ways that can ensure transparency and informed consent when using gene editing technologies for military purposes, considering the complexities and uncertainties associated with genetic modifications. By employing precision gene editing techniques such as CRISPR-Cas9, specific genes associated with traits like endurance, strength, and cognitive abilities can be modified to augment soldier capabilities while minimising off-target effects and unintended mutations. Ethical considerations must guide the process, ensuring transparency, informed consent, and adherence to established regulations to uphold the well-being and

autonomy of military personnel. Additionally, ongoing research and interdisciplinary collaboration are essential to continually evaluate the efficacy, safety, and ethical implications of gene editing technologies in the context of military enhancement.

7.1. Trials and Possible Applications

CRISPR allows direct modification of the DNA of organisms. This could not only make new therapeutic applications possible. In theory, gene editing could also be used to enhance human beings or even to modify the human germline, inducing changes that could be inherited by future generations. Considering these possibilities, it comes as no surprise that the discovery of CRISPR was greeted with euphoria in transhumanist circles. Germline interventions are seen as a possible key for a posthuman future. This popular perception is based on an overly simplistic understanding of genetics and exaggerated expectations of the potential of gene editing technologies. In addition, fantasies about human enhancement also resemble emerging speculations about “super soldiers” for future warfare. While it will be maintained that genetically upgraded combatants ought to be relegated to the realm of science fiction, applications of gene editing technologies in the military should still cause concerns about biosecurity risks.

The new generation of biological weapons can be developed by modifying the genetic code of pathogenic microorganisms through gene editing technology, which can attack the enemy from the genetic level. In simple terms, gene editing technology is equivalent to a pair of gene “scissors”, which can “splice” gene fragments of one organism to another according to subjective wishes, thereby changing its physiological characteristics. CRISPR Cas9 technology has been working to delete the CCR5 gene to prevent HIV infection in embryos and make them resistant to certain diseases. This way, genetic weapons modify genes to obtain new pathogenic microorganisms, thereby invalidating the opponent’s vaccine library. With the help of genetic engineering methods, gene separation and recombination can be achieved to form composite deoxyribonucleic acid. On this basis, gene transfer can be achieved with the help of microorganisms to make biological weapons that can change genetic material. Since genetic weapons are “cut” out of new viruses and bacteria, the genetic code is only known to the designer, and it is difficult for the opponent to decipher it in time and develop a new vaccine to fight it. Even if the vaccine library is updated, there is still a steady stream of new genetic weapons. In times of geopolitical tensions or emergencies, reliance on a foreign supplier for essential medical supplies could compromise a nation's ability to meet the

healthcare needs of its population and even raise health risk in the case of developed gene editing regarding bioweapons. For example, by transplanting gene fragments with reproductive solid ability, the reproductive and diffusion power of deadly germs can be increased several times; by transplanting gene fragments with strong pathogenic ability, the mortality rate can be increased to about 100%. Genetic weapons are concealed for different military purposes, environments, and attack targets. Users can artificially design the incubation period of genetic weapons. In other words, people can make genetic weapons that can last up to ten years. This is the most important difference between genetic, traditional biological and chemical weapons.

7.2. Ethicality

The ethical considerations surrounding gene editing technology, particularly using CRISPR in soldiers, are complex and multifaceted. Considering potential risks and uncertainties associated with the procedure, such as off-target mutations or unintended consequences, should be done. Ensuring the safety of soldiers is paramount. Any gene editing intervention must undergo rigorous testing to minimise individual health and well-being risks. Before providing consent, soldiers must fully understand the potential risks and benefits of gene editing. It is crucial to address equity issues to ensure fair access to gene editing technologies among soldiers, regardless of rank, nationality, or socioeconomic status. Gene editing raises concerns about fairness and the pursuit of military advantage. Policies must ensure that enhancements do not exacerbate existing inequalities or create new forms of discrimination. Adequate regulation and oversight are essential to mitigate risks and ensure the responsible use of gene editing technologies in the military. Regulatory frameworks should prioritise safety, efficacy, and ethical considerations. Gene editing in soldiers may raise concerns about compliance with international laws and ethical standards. It is essential to consider the broader implications within the context of human rights, warfare, and global governance.

As an example to ethical concerns related to privacy and personal data, The PRC is running a project known as BGI Nifty Genetic Data Collection, a Non-Invasive Foetal Trisomy prenatal screening test developed by BGI Genomics to detect common chromosomal abnormalities in fetuses to benefit

military development by using the advanced technology. The PRC's biggest genomics firm, BGI began marketing the test abroad in 2013. Fears and concerns have been raised regarding the PRC's misuse of DNA data, which has come under worldwide scrutiny. In fact, Norway's National Consumer Council had issued a warning to its citizens against the potential misuse. BGI claims it has never retained any personal data from the NIFTY test. Yet, one of its clauses states the information sharing between the government if it is directly relevant to national security. Since 2015, the Chinese government has restricted access to genetic data by foreign researchers, whereas in 2019, it officially corroborated as a regulation on national security

Artificial Intelligence (AI) use in gene editing also creates a frenzy among scientists. Eric Schmidt highlighted this concern in the U.S. Expert Panel of the National Security Commission. According to Progress Education Trust (PET), NIFTY stores genetic data of the mother and fetuses for a minimum of 5 years, after which the woman can ask for deletion. NIFTY samples include metrics such as height, weight, age, sex, race and medical history. Inferences are being drawn reflecting on the investigating link between genetics and population traits to single out Tibetan and Uighur Muslims. According to Anna Puglisi, a former U.S. Counterintelligence officer, "The combination of genomic data of unborn children with the medical data and history is extremely powerful." The biosecurity issues stand out exclusively since these tests provide information about the nationality, medical history of the mother and sex of the fetus.

The consent form filled out by pregnant mothers does not mention that their data shall end up in BGI headquarters based in Shenzhen, PRC. The collected information samples are generally stored in the PRC National Gene Bank, with geospatial positioning tracking of the mothers available through huge screens in real-time. This technology can be used to detect chromosomal anomalies in mothers, cancer, autoimmune disorders, drug history, and blood transfusions. This data can be extrapolated to exploit vulnerabilities in a suspect population and can be used to target a genetic attack. This project is spearheaded by Liang, whose work is patronised by 'Military Medicine Innovation Project'. Together, stem cells and gene therapy are targeted to combat deafness caused by weapon training in soldiers.

The studies also explore the event of brain injury and brain fog at higher altitudes, signalling towards the Han Chinese soldiers who suffered, especially after the Galwan Valley clash. While CRISPR technology holds immense

promise for various applications, including potential medical treatments, using such technologies in military contexts raises additional ethical, legal, and societal concerns.

8. Questions to be Pondered

1. How can technological advancements for CRISPR-CAS9 technology be sped up and improved?
2. How can it be made sure that more advanced research such as CRISPR technology be more spread out throughout the globe especially regarding less developed countries?
3. During CRISPR research and applications, what precautions can be taken to ensure personal data privacy?
4. To what extent CRISPR technology should be utilized? Should there be hard limits or can the application areas be more flexible?
5. Is it ethical to edit the human genome for one to be utilized more efficiently?
6. Does the military sector implement new technological advancements ethically and properly? If not, what precautions can be advised to allow for a more proper and ethical implementation?
7. In what areas of the military can CRISPR be utilized? What issues rise from such implementations and what can be done to solve them?

9. Bibliography

<https://www.who.int/about>

<https://ep.bmj.com/content/101/4/213.short>

<https://link.springer.com/content/pdf/10.1007/s00294-019-01040-3.pdf>

<https://link.springer.com/article/10.1007/s00294-019-01040-3>

<https://www.sciencedirect.com/science/article/pii/S0092867424001119>

<https://tdhj.org/blog/post/gene-editing-soldiers-crispr/>

https://link.springer.com/chapter/10.1007/978-3-030-56546-6_7

