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GENETIC WARFARE: SUPER HUMANS AND THE LAW

MORIAL SHAH

> "However, once technology enables us to re-engineer human minds, Homo sapiens will disappear, human history will come to an end and a completely new kind of process will begin, which people like you and me cannot comprehend. Many scholars try to predict how the world will look in the year 2100 or 2200. This is a waste of time. Any worthwhile prediction must take into account the ability to re-engineer human minds, and this is impossible. There are many wise answers to the question, 'What would people with minds like ours do with biotechnology?' Yet there are no good answers to the question, 'What would beings with a different kind of mind do with biotechnology?' All we can say is that people similar to us are likely to use biotechnology to re-engineer their own minds, and our present-day minds cannot grasp what might happen next." Yuval Noah Harari, Homo Deus: A Brief History of Tomorrow

> "We are no longer living in a time when we can say we either want to enhance or we don't. We are already living in an age of enhancement." Nicholas Agar, Victoria University

INTRODUCTION

Many of us are familiar with the Captain America story: fictional Steve Rogers was too frail to join the US Army during the Second World War. The military rejected Rogers because of his physical weaknesses. Rogers tried to enlist again. This time, he volunteered for a military super soldier experiment. With the help of genetic modification, Rogers became stronger, taller and invincible. With his enhanced endurance, strength and invulnerability, Rogers fast became an asset for the US military.

Advancements in genetic technologies are rapidly blurring the boundary between fact and fiction. New technologies may soon make possible genetically engineered super soldiers, similar to Captain America. Legal and ethical questions concerning human enhancement technology arise. Every technology we develop carries potential for great good or harm. But the question of whether we can or should effectively stop that technology from being used for hostile purposes or armed conflict remains moot. With genetic technology in particular, in the world post-Human Genome Project, where Clustered Regularly Interspaced Short Palindromic Repeats (CRISPR) technology makes genome editing faster, cheaper and more efficient, questions about human enhancement abound, and the line between human enhancement and therapy blurs. The same technology that can help cure diseases, can also help prevent muscle breakdown, enabling soldiers to run faster. Defence Advanced Research Projects Agency (DARPA) is also developing methods to make soldiers more emotionally resilient and less prone to post-traumatic stress syndrome (PTSD).[1] Super soldiers may soon become "efficient killing machines" with altered capacity for emotion and strength superior to that possessed by other humans.[2] In terrorist hands, this technology could prove

1. *See* Paul A**.** Philips, *DARPA Genetically Modified Humans for a Super Soldier Army,* SLEUTH J. (October 17, 2015), http://www.thesleuthjournal.com/darpa-genetically-modified-humans-for-a-super-soldier-army/ [http://perma.cc/4WV6-GLZE]. *See also* J.D. Heyes, *DARPA Rumored to Be Genetically Modifying Humans to Create Zombie Super Soldiers,* NAT. NEWS (Sept. 16, 2015), https://www.naturalnews.com/051195_DARPA_super_soldiers_genetic_engineering.html# **[**http://perma.cc/3WCY-3T2S], discussing DARPA's attempts to create soldiers with modified emotional capacity.

2. Christopher E. Sawin*, Creating Super Soldiers for Warfare: A Look into the Laws of War*, 17 J. HIGH TECH. L. 105, 109, 107,, 119, 122 (2016) (referring to super soldiers as "killing machines").

dangerous for the rest of the world.[3] Simultaneously, in sports, emerging genetic doping technologies may be hard to detect, giving rise to concerns about unfair competition.[4]

Legal regimes governing the use of such technologies – the Biological Weapons Convention, the Oviedo Convention of the European Union, Additional Protocol I of the Geneva Conventions, and others – inadequately address challenges emerging from the use of new genetic technologies. Currently, no global legal regime has enforcement or adjudication mechanisms to address concerns related to the spread and use of genetically modified bioweapons or super soldiers.

This paper explores legal and ethical challenges emanating from the development of genetic enhancement technology. Part I explores the dual-use dilemma and relevant advancements in gene technology. Part II examines super soldiers and other applications of enhancement technology. Part III provides an overview of relevant legal regimes and ethical concerns. In conclusion, this paper provides options for regulating the spread and use of this technology.

History demonstrates that revolutions of the wheel of technological advancement cannot be undone. Genome editing and related technologies have appeared on the horizon. We may try to regulate their use, but we cannot undo their existence. The present challenge consists in agreeing upon whether, when and how to regulate these technologies. For debates on regulation, we may have to agree on what truly makes us human and how much we want to tamper with our own genetic inheritance. The future is already here. Concerns surrounding its even distribution and fair use create space for legal intervention and ethical debate.

PART I: THE FUTURE IS HERE

(A) Dual-Use Dilemma

Nearly every technology we develop can be used to do good or cause harm. We can use a hammer to build a house or crack the skull of another human. Alfred Nobel's dynamite can be used to blast tunnels for trains through mountains, or it can be used to attack and kill several people. Airplanes can be used to connect people and make travel faster, or they can be used to drop

3. Lara Wynn, *The Non-Fiction of Captain America: A Legal Analysis of the Potential and Perils of Genetic Engineering in Modern Warfare*, 5 J. BIOSECURITY BIOSAFETY & BIODEFENSE L. 109, 110 (2014) , discussing the effects of terrorists accessing super soldier technology.

4. Steve Connor, *The Cheat Gene: Could the Next Step in Sporting Fraud Come From Manipulating DNA?,* THE INDEP., (Aug. 23, 2012), https://www.independent.co.uk/sport/general/others/the-cheat-gene-could-the-next-step-in-sporting-fraud-come-from-manipulating-dna-8073605.html.

bombs on civilian populations. In the eighteenth century, better understanding of smallpox helped scientists develop a vaccine, but at the same time, its presence in laboratories opened the doors for potential misuse of the virus.[5] Genetic technology fits within this general dual-use framework: it can simultaneously kill and cure.

In the United States, following the anthrax attacks on October 4, 2001 and 9/11 attacks, funding increased for biosecurity concerns. The National Academy of Sciences responded with its report on *Biotechnology Research in an* Age of *Terrorism: The Dual-Use Dilemma,* popularly dubbed as the Fink Report.[6] The Fink Report recommended creating a national-level committee with equal numbers of biologists and security experts to help the U.S. government cope with the dual-use dilemma. The U.S. government responded by creating the National Science Advisory Board for Biosecurity (NSABB) in 2004. Initially, NSABB described dual-use in the context of "research that, based on current understanding, can be reasonably anticipated to provide knowledge, information, products, or technologies that could be directly misapplied to pose a significant threat with broad potential consequences to public health and safety, agricultural crops and other plants, animals, the environment, material or national security."[7]

Concerning dual-use technologies, the NSABB generally recommends: "Taking full advantage of the National Science Advisory Board for Biosecurity's international work, as well as that being undertaken by other Department of Health and Human Services agencies, the U.S. government should develop policies and procedures for the oversight of dual-use life sciences research that foster international collaboration and control strategies, with a goal of harmonizing the mechanisms of local oversight."[8] But global control and oversight mechanisms for dual-use technologies have not yet developed. In his work on this issue, David Franz casts doubt on whether we have devised means to rebalance our approach to dual-use dilemma to take account

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5. David A. Koplow, *That Wonderful Year: Smallpox, Genetic Engineering, and Bio-Terrorism*, 62 MD. L. REV. 417, 458 (2003) (discussing dual use and smallpox). *See also* David R. Franz, *The Dual Use Dilemma: Crying out for Leadership*, 7 ST. LOUIS U. J. HEALTH L. & POL'Y 5 (2013) (discussing general dual-use problem).

6. COMMITTEE ON RESEARCH STANDARDS & PRACTICES TO PREVENT THE DESTRUCTIVE APPLICATION OF BIOTECHNOLOGY, NAT'L RESEARCH COUNCIL, BIOTECHNOLOGY RESEARCH IN AN AGE OF TERRORISM (2004) ("Fink Report") (provided recommendations on managing the dual-use dilemma in the bioterrorism context).

7. NSABB, Frequently Asked Questions, What is the "Dual-Use Research" and "Dual Use Research of Concern"? Office of Sci. Policy-NIH, http://oba.od.nih.gov/biosecurity/nsabb faq.html.

8. Committee on a New Government-University Partnership for Science and Security, National Research Council, *Science and Security in a Post 9/11 World: A Report Based on Regional Discussions Between the Science and Security Communities* 12 (2007).

of internal and emerging threats.[9] The next section examines some of the technology implicated in the dual-use dilemma.

(B) Relevant Advancements in Gene Technology

(i) The Human Genome Project

The Human Genome Project (HGP) and its findings helped spur the growth of genetic engineering technology. Advancements in this area have been fairly rapid. A little over a half century ago, James Watson and Francis Crick discovered the DNA double-helix.[10] A few years later, Marshall Nirenberg and his colleagues at the National Institutes of Health cracked the genetic code to explain the way DNA directs protein synthesis. Starting in 1984, the Department of Energy, National Institute of Health and international groups held meetings about studying the human genome.[11]

In 1990, The Department of Energy and National Institute of Health collaborated with international partners to map and sequence the human genome.[12] Human cells contain over six billion pairs of nucleotides and among these nucleotide pairs are approximately 23,000 genes.[13] A gene is a distinct stretch of DNA that codes for a protein.[14] Genes are sometimes called the blueprint for life because genes instruct cells on what to do and when to do it: be a muscle, carry oxygen, make bone, and so forth. Genes orchestrate all this by coding for proteins.[15] Genes may vary in size from a few thousand nucleotide base pairs to several million base pairs. All our genes together make up our genome.[16]

The Human Genome Project helped sequence genes, enabling researchers to determine the location of particular genes. Ultimately, the HGP gave the world detailed information about the structure, organization and function of the complete set of human genes. These genes contain inheritable instructions for the development and function of human beings.[17] Overall, the completed genetic map created opportunities for the private sector to step in with

9. David R. Franz, *supra* note 5, at 56-57.

10. Genome: Unlocking Life Sciences Code, Timeline, https://unlockinglifescode.org/timeline?tid=4.

11. *Id.*

12. Nat'l Inst. of Health, *Human Genome Project Fact Sheet*, https://report.nih.gov/NIHfactsheets/Pdfs/HumanGenomeProject(NHGRI).pdf.

13. *What is a Gene?,* THE TECH MUSEUM OF INNOVATION, http://genetics.thetech.org/about-genetics/what-gene.

14. *Id.*

15. *How Do Genes Work?*, THE TECH MUSEUM OF INNOVATION, http://genetics.thetech.org/about-genetics/how-do-genes-work.

16. Nat'l Instit. of Health, *Overview of the Human Genome Project*, https://www.genome.gov/12011238/an-overview-of-the-human-genome-project/.

17. *Id.*

research and product development. It also opened the doors for military research.

(ii) Genome Editing: CRISPR-Cas9

Relatedly, genome editing technology improved. CRISPR technology makes genome editing cheaper, faster and more efficient. CRISPRs are specialized stretches of DNA.[18] The CRISPR-associated Cas-9 protein is an enzyme that acts like a pair of molecular scissors. It is capable of cutting strands of DNA.[19] It is relevant to this inquiry because it allows the cutting and replacing of parts of DNA.[20] CRISPRs may serve a therapeutic purpose, in that they may allow technologists to efficiently remove or turn off the function of disease-causing genes and genetic mutations.[21] However, transhumanists[22] assert that CRISPR technology carries the potential for human enhancement. Instead of disabling disease genes, CRISPRs could be used to modify genes associated with undesirable traits such as aging and muscle degeneration. For instance, the Nuffield Council on Bioethics notes in its ethical review that CRISPR technology may be used to improve night vision or enhance an individual's sense of smell.[23]

So far, CRISPR-Cas 9 has been used to make seeds for rice, potatoes and soybeans more resistant to pests.[24] It has also been used to edit the genome of mosquitoes that carry malaria, making them unable to transmit disease.[25] In 2015, researchers also used this technology to create smaller pigs with

18. Nat'l Instit. of Health, *What are Genome editing and CRISPR-Cas9*?, https://ghr.nlm.nih.gov/primer/genomicresearch/genomeediting.

19. Aparna Vidyasagar, *What is CRISPR?,* LIVESCIENCE (Apr. 20, 2018), https://www.livescience.com/58790-crispr-explained.html.

20. Nat'l Instit. of Health, *What are Genome Editing and CRISPR-Cas9?,* https://ghr.nlm.nih.gov/primer/genomicresearch/genomeediting.

21. *Id.*

22. "Transhumanism is a way of thinking about the future that is based on the premise that the human species in its current form does not represent the end of our development but rather a comparatively early phase."
What is Transhumanism?, Transhumanism FAQ, https://whatistranshumanism.org (last visited Dec. 17, 2019).

23. NUFFIELD COUNCIL ON BIOETHICS, *Genome Editing: An Ethical Review* (Sept. 2016), http://nuffieldbioethics.org/wp-content/uploads/Genome-editing-an-ethical-review.pdf.

24. Marcelo de Araujo, *Editing the Genome of Human Beings: CRISPR-Cas9 and the Ethics of Genetic Enhancement*, 27 J. Evolution & Tech. 24, 24 (July 2017). *See*Michael Specter, *The Gene Hackers*, THE NEW YORKER MAG. (Nov. 16, 2015), http://www.newyorker.com/magazine/2015/11/16/the-gene-hackers. *See also* Claire Ainsworth, *Agriculture: A New Breed of Edits*. 528 NATURE S15 (Dec. 3, 2015).

25. Heidi Ledford & Ewen Callaway, *'Gene drive' Mosquitoes Engineered to Fight Malaria,* NATURE, Nov. 23, 2015, https://www.nature.com/news/gene-drive-mosquitoes-engineered-to-fight-malaria-1.18858.

different coat colors and patterns for use as pets.[26] This technology can also be used to create "chimera" pigs that contain the cells of both pigs and humans for the purpose of engineering organs for transplantation into human beings.[27] Policy makers, animal rights activists and others express concerns over the use of CRISPR technology. "Some fear... that [genetically modified] mosquitoes, once released in the wild, could behave in very unpredictable ways."[28] Animal rights activists' argue that it is morally wrong to use [genetically modified] pigs to give human beings new pets.[29]

Using CRISPR technology to edit human genomes creates the greatest cause for concern. In April 2015, Chinese researchers "published a paper about using CRISPR-Cas9 in an experiment involving eighty-six human embryos."[30] They aimed to find a cure for hereditary beta-thalassemia using non-viable embryos. The scientific community responded to their paper with concerns. Some researchers and bioethicists deemed their experiment morally unacceptable and called for an international moratorium on "any research involving the editing of human genes."[31] Others welcomed the experiment for its potential to cure disease.[32] Although such use of CRISPR technology remains controversial, no moratorium exists.

In April 2016, a team of Chinese scientists published a new paper on using CRISPR-Cas9 on 213 human zygotes.[33] Their experiment aimed to induce a mutation that would make some people immune to the Human Immunodeficiency Virus (HIV).[34] During that year, research teams in several other countries received permission to conduct CRISPR-Cas9 research. Scientists at the Francis Crick Institute in the United Kingdom received permission from the Human Fertilisation and Embryology Authority (HFEA) to use CRISPR-Cas9 on human embryos, provided that the embryos were not used to start

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26. David Cyranoski, *Gene-edited 'Micropigs' to be Sold as Pets at Chinese Institute*, NATURE, Oct. 1, 2015, https://www.nature.com/news/gene-edited-micropigs-to-be-sold-as-pets-at-chinese-institute-1.18448.

27. Sara Reardon, *New Life for Pig Organs,* 527 NATURE 152, 152 (2015).

28. Araujo, *supra* note 23, at 25.

29. *Id.*

30. Araujo, *supra* note 23, at 26. *See* Puping Liang et al., *CRISPR/Cas9-mediated Gene Editing in Human Tripronuclear Zygotes*, 6 PROTEIN & CELL 363, 367-68 (2015).

31. Araujo, *supra* note 23, at 26. *See* Robert Pollack, *Eugenics Lurk in The Shadow of CRISPR*, 348 SCIENCE 871 (2015). *See also* Edward Lanphier et al, *Don't Edit The Human Germ Line,* 519 Nature 410 (2015); Press Statement, Center for Genetics and Society, Public Interest Group Calls for Strengthening Global Policies Against Human Germline Modification (Apr. 22, 2015), https://www.geneticsandsociety.org/press-statement/public-interest-group-calls-strengthening-global-policies-against-human-germline (advocating against the creation of genetically modified embryos in China)

32. Julian Savulescu et al., *The Moral Imperative to Continue Gene Editing Research on Human Embryos*, 6 PROTEIN & CELL 476 (2015) (advocating to continue gene editing research).

33. Araujo, *supra* note 23, 26. *See also* Xiangjin Kang et al., *Introducing Precise Genetic Modifications Into Human 3PN Embryos by CRISPR/Cas-mediated Genome Editing*, 33 J. ASSIST. REPROD. GENET. 581 (2016).

34. *Id.*

pregnancy.[35] Researchers at the Karolinska Institute in Sweden also received permission to carry out similar research.[36] The US National Institute of Health (NIH) approved the use of CRISPR-Cas9 for engineering human immune cells to make them capable of fighting off some types of cancer.[37] Later in 2016, a team of Chinese scientists took research further by using CRISPR-Cas9 to edit human cells outside the human body. They injected the edited cells into a patient with lung cancer.[38] It is expected that CRISPR-Cas9 technology will soon be used to edit human cells within the human body.[39] Accordingly, it is not useful to speculate about whether CRISPR technology will be used to modify DNA sequences. It is already being used for that purpose.[40] In Part III, this paper focuses on legal and ethical ways to make the use of this technology safe and fair.

For the defense sector, genome editing technology creates cause for unease. In his 2016 threat assessment report to the US Senate, James Clapper, Director of National Intelligence, classified genome editing as a Weapon of Mass Destruction.[41] In the hands of countries with questionable ethical standards, the threat would be heightened because new methods of genome editing are relatively low cost and easy to use.[42] Mr. Clapper noted the dangers associated with germline editing, particularly the danger of passing on changes to future generations. He did not elaborate on any bioweapons scenarios, but news reports covering his assessment quoted scientists raising concerns about whether CRISPR could be used to make "killer mosquito" plagues that wipe out staple crops or even a virus that attacks people's DNA.[43] For our purposes, it is clear that CRISPR technology and its uses raise concerns about

35. Araujo, *supra* note 23, 26. Francis Crick Institute, *HFEA Approval for New Genome Editing Techniques*, (Jan. 28, 2016), https://www.crick.ac.uk/news/science-news/2016/02/01/hfea-decision/.

36. Araujo, *supra* note 23, 26. Ewen Callaway, *Embryo-editing Research Gathers Momentum*, 532 NATURE 289, 289 (2016).

37. Araujo, *supra* note 23, 26. Jocelyn Kaiser, *First Proposed Human Test of CRISPR Passes Initial Safety Review*, SCIENCE MAG., Jun. 21, 2016, https://www.sciencemag.org/news/2016/06/first-proposed-human-test-crispr-passes-initial-safety-review.

38. David Cyranoski, CRISPR Gene-editing Tested in a Person For the First Time, 539 NATURE 479 (2016). Araujo, *supra* note 23, 26.

39. Michael Le Page, *Boom in Human Gene Editing as 20 CRISPR Trials Gear Up*, NEW SCIENTIST (May 30, 2017), https://www.newscientist.com/article/2133095-boom-in-human-gene-editing-as-20-crispr-trials-gear-up/ (CRISPR trial in China to try editing the genomes of cells inside the body to eliminate cancer-causing HPV virus).

40. Araujo, *supra* note 23, at 26.

41. *WORLD THREAT ASSESSMENT OF THE U.S. INTELLIGENCE COMMUNITY: Before the S. Comm. of Armed Serv*., 114th Cong. 6, 9 (2016) (statement for Rec. of James R. Clapper, Dir., Off. of the Dir. of Nat'l Intelligence).

42. *Id.*

43. Antonio Regalado, *Top U.S. Intelligence Official Calls Gene Editing a WMD Threat*, MIT TECH. REV. (Feb.9, 2016, https://www.technologyreview.com/s/600774/top-us-intelligence-official-calls-gene-editing-a-wmd-threat/.)

fair and proper use. The next section examines some practical challenges related to CRISPR technology and human enhancement.

PART II: SUPER HUMANS

(A) Super Soldiers: Ideas, Genes and DARPA

(i) DARPA and Soldiers

Fiction popularized super soldiers, but recent technological advancements suggest that they may not be as fictional as they seem. In the Captain America series, the super soldier serum made the world safer and better. However, in Marvel's Iron Man 3, a terrorist organization stole the genetic mix to create super soldiers who could survive injuries, regenerate limbs and demonstrate extraordinary strength, endurance, and agility.[44] Although both the series and the film were fictional, defense applications of emerging genetic technology call that classification into question.

In the US, the Pentagon earmarks considerable resources for human enhancement research that could create enhanced soldiers.[45] The Defense Advanced Research Projects Agency (DARPA) is tasked with this research. In 1958, the US established DARPA in response to the surprise Sputnik launch. Mainly, through programs such as DARPA, the US sought to prevent strategic surprises from negatively impacting its national security.[46] It also aimed to maintain the technological superiority of its military. DARPA is considered the primary innovation engine of the Department of Defense.[47] It uses applied research to address emerging and potential problems.[48]

DARPA's six offices include: Biological Technologies Office, Defense Sciences Office, Information Innovation Office, Microsystems Technology Office, Strategic Technology Office and Tactical Technology Office.[49] DARPA recently launched its Biological Technologies Office. In 2016-2017,

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44. Wynn, *supra* note 3, at 116.

45. Michael Hanlon, *'Super Soldiers': The Quest for the Ultimate Human Killing Machine,* INDEP. (Nov. 16, 2011 https://www.independent.co.uk/news/science/super-soldiers-the-quest-for-the-ultimate-human-killing-machine-6263279.html [http://perma.cc/VK9R-HRAQ]), (statinghttps://www.darpa.mil/about-us/about-darp that the Pentagon is spending $400 million a year on this technology. *See* Ujala Sehgal & Robert Johnson, *15 Facts About Military Spending That Will Blow Your Mind,* BUS. INSIDER (Oct. 14, 2011) [http://perma.cc/V2ED-LJNR.]). See also Sawin*, supra* note 2, at 108.

46. Wynn, *supra* note 3, at 118. *See also*, DARPA, *About us*, https://www.darpa.mil/about-us/about-darpa (last visited Apr. 9, 2018).

47. *Id.*

48. *Id.*

49. DARPA, *Our Offices*, https://www.darpa.mil/about-us/offices (last visited Apr. 9, 2018).

this office, with its budget of $296 million, explored challenges at the intersection of biology and engineering.[50]

DARPA lists several programs focused on self-healing and preventing injuries among soldiers. DARPA's Safe Genes platform specifically protects military personnel from accidental or intentional misuse of genome editing technologies.[51] It states:

> Overall, the Safe Genes program is creating a layered, modular, and adaptable solution set to: protect warfighters and the homeland against intentional or accidental misuse of genome editing technologies; prevent and/or reverse unwanted genetic changes in a given biological system; and facilitate the development of safe, precise, and effective medical treatments that use gene editors. (emphasis added).[52]

With regard to CRISPR technologies in particular, DARPA states:

> University of California, Berkeley team led by Dr. Jennifer Doudna will investigate the development of novel, safe gene editing tools for use as antiviral agents in animal models, targeting the Zika and Ebola viruses. The team will also aim to identify anti-CRISPR proteins capable of inhibiting unwanted genome-editing activity, while developing novel strategies for delivery of genome editors and inhibitors.[53]

It appears that DARPA, and by extension, authorities within the US government take the threat of unwanted genome editing and genetic modification seriously. But at the same time, DARPA's therapeutic arm, even within the safe gene program, self-admittedly seeks to "facilitate the development of safe, precise, and effective medical treatments that use gene editors."[54] Plausibly, as the distinction between therapeutic use and enhancement blurs and alters, concerns arise about enhancement technologies.

Peter Singer of the Brookings Institute reported on DARPA's Metabolically Dominant Soldier program.[55] Writing about DARPA director Callaghan's talk at its 50th anniversary, Singer noted that the US military is studying ways to use "technology and biology to meld man and machine in order to transcend limits of the human body."[56] The project director was quoted as

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50. Dina Fine Maron, *DARPA's Biotech Chief Says 2017 Will Blow Our Minds*, SCI. AM. (Jan. 9, 2017, https://www.scientificamerican.com/article/darpa-rsquo-s-biotech-chief-says-2017-will-ldquo-blow-our-minds-rdquo/).

51. DARPA, *Safe Genes* https://www.darpa.mil/program/safe-genes (last visited on Apr. 9, 2018).

52. *Id.*

53. DARPA website, https://www.darpa.mil/news-events/2017-07-19 (last visited on April 8, 2018).

54. DARPA, *Safe Genes*, *supra* note 48

55. Peter Singer, *How to be all that you can be: A look into Pentagon's Five Step Plan for making Iron Man real,* BROOKINGS INS. (May 2, 2008), https://www.brookings.edu/articles/how-to-be-all-that-you-can-be-a-look-at-the-pentagons-five-step-plan-for-making-iron-man-real/.

56. *Id.*

saying, "My measure of success is that International Olympic Committee bans everything we do."[57]

DARPA also funds a project aimed at writing the Human Genome. The Human Genome Project allowed us to map and sequence the genome. For some scientists at the Center of Excellence for Engineering Biology, the next step involved writing entire genomes and synthesizing them from scratch.[58] DARPA funded the center's Boeke and Harris Wang from Columbia University with $500,000 for a genome writing pilot project. They will use DARPA's funds to engineer human cells that are self-sufficient nutrient factories. By exploiting genes from bacteria, plants and fungi, this project aims to engineer human cells capable of manufacturing nutrients that un-engineered human cells cannot. In its proposal for synthesizing prototrophic human genome, the pilot project team noted uses mainly related to combating malnutrition, food shortages, and more economical biosynthesis of medicines.[59] But DARPA's involvement suggested that it sought to use this technology to create self-sustaining soldiers with limited need to eat.

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57. Joe Bielitzki, as quoted in Joel Garreau, *Perfecting the Human* (May 30, 2005) [cited Apr. 4. 2007], http://mindfully.org/Technology/2005/Perfecting-The-Human30may05.htm. See also JOEL GARREAU, RADICAL EVOLUTION: THE PROMISE AND PERILS OF ENHANCING OUR MINDS – WHAT IT MEANS TO BE HUMAN, 34, (Doubleday, 1st ed. 2005). excerpted at: http://www.lycaeum.org/mv/BX/BookKnit_RADICAL_EVOLUTION.html (last visited on Apr.10, 2018). In relevant part, Garreau quotes Bielitzki as saying

"Take the moment, for example, when it finally sinks in that Bielitzki is talking about fixing your cells so that you could live off your fat. A man who has worked out for years in an unsuccessful attempt to control his potbelly quickly raises his hand. "Me, me," he croaks. "Give some to me" Bielitzki acknowledges the potential for spin-off technologies. "Forty billion dollars a year goes into the weight loss industry in this country," he muses. "This will change it." A science and technology policy wonk, deeply worried about engineered human evolution in all its forms, stops dead when told about the potential for cell enhancement to conquer fat. "It does what?" she asks. "Okay, so I burn in hell for this. Sign me up" "Will it have significant dual use?" Bielitzki asks. "Probably. Will the International Olympic Committee ban it? Absolutely. My measure of success for this is that the International Olympic Committee bans everything that we do. We know that Lance Armstrong is different than everybody else. Can we safely induce it in anybody in a short period of time? That's really what metabolic dominance is about. Will there be a commercial market for it? Probably. Somebody has to make it. Is this a classified project at this point? No. This is all open."p. 34

See also Peter Singer, *supra* note 52.

58. Jeff D. Boeke, George Church, Andrew Hessel, Nancy J. Kelley, *Genome Project-write: A Grand Challenge Using Synthesis, Gene Editing and Other Technologies to Understand, Engineer and Test Living Systems,*1, 2 (2016), http://engineeringbiologycenter.org/wp-content/uploads/2016/12/GP-Write-WhitePaper.pdf.

59. Harris Wang, Columbia University, *Synthesizing a Prototrophic Human Genome*, Center of Excellence in Engineering Biology, http://engineeringbiologycenter.org/wp-content/uploads/2017/10/Wang-Pilot-Project.pdf. *See also* Ed Yong, *Now That We Can Read the Genomes, Can We Write Them?* THE ATLANTIC (May 10, 2017), https://www.theatlantic.com/science/archive/2017/05/we-can-read-genomes-easily-now-what-about-writing-them/526086/.

(ii) Beyond Human?

Christopher Sawin traces the impetus for developing enhanced soldiers to changes in conventional warfare and fallouts from recent wars. Since losing several soldiers during the wars in Iraq and Afghanistan, the US Department of Defense has "heavily funded programs aimed at enhancing soldiers for warfare by altering the genetic code towards making soldiers that are stronger, smarter and lack empathy," Sawin writes.[60] Noting the importance of such programs for future operational military dominance, Sawin examines the risk that super soldiers will no longer resemble other humans, genetically or otherwise. Writing about this aspect specifically, Margaret Foster Riley explores the human rights implications of using CRISPR technologies to de-extinct Neanderthals, create humanzees or enhanced human beings. She notes, "technology has the potential to blur who – or what – is actually human," giving rise to several questions about the applications of human rights laws and principles.[61]

In particular, the literature on super soldiers raises concerns related to their capacity for empathy. Although diminishing human intuitions and capacity for empathy may help create efficient killing squads, concerns arise about whether super soldiers will be inclined to engage in indiscriminate killing, unable to distinguish between enemy combatants and civilians during war.

Questions about empathy arise in conjunction with concerns about post-traumatic stress disorder (PTSD) among US war veterans. Although estimates of PTSD vary widely across wars and eras, data from the recent Iraq and Afghanistan wars suggest that the problem is a significant one.[62] In a US government study of 60,000 Iraq and Afghanistan veterans, 13.5 percent of deployed and non-deployed veterans screened positive for PTSD.[63] Other studies suggested that the rate was as high as 20 to 30 percent.[64] DARPA's

60. *See* Sawin*, supra* note ~~8~~. *See also* Sam Hason, *DARPA's Next Generation of Super Zombie Soldiers,* BUS. FIN. .NEWS *(Aug.31, 2015),* https://rightedition.com/2015/09/02/darpas-next-generation-of-super-zombie-soldiers/ [http://perma.cc/MKB2-H5QU] (recognizing that using enhanced soldiers would outperform traditional soldiers in warfare).

61. Margaret Foster Riley, *CRISPR Creations and Human Rights,* 11 L. & ETHICS OF HUM. RTS. 225, 232 (2017).

62. Miriam Reisman, *PTSD Treatment for Veterans: What's Working, What's New, and What's Next,* 41 PHARM. THER. 623 (2016).

63. Erin K. Dursa et. al., Prevalence of a Positive Screen for PTSD Among OEF/OIF and OEF/OIF-Era Veterans in a Large Population-Based Cohort, 27 J. of Traumatic Stress 542 (Oct 2014), https://onlinelibrary.wiley.com/doi/epdf/10.1002/jts.21956

64. *Invisible Wounds of War: Psychological and Cognitive Injuries, Their Consequences, and Services to Assist Recovery,* RAND CORPORATION (T. Tanielian & L.H. Jaycox, eds., 2008). *See also* U.S. Department of Veterans Affairs, *PTSD in Iraq and Afghanistan Veterans* (Jun. 3, 2015), www.publichealth.va.gov/epidemiology/studies/new-generation/ptsd.asp.

Systems-Based Neurotechnology for Emerging Therapies (SUBNETS) program seeks to prevent and treat neuropsychiatric illnesses including PTSD among soldiers.[65]

Sawin quotes reports indicating that in 2009, DAPRA experimented on enhanced pigs by creating 'semi-undead' pigs.[66] Reportedly, the experiment aimed to study whether humans could be genetically conditioned to have "restricted blood-loss and diminished emotional capacity."[67] In 2012, he writes that DARPA started "piloting projects for the biological tampering and gene modification of soldiers to help combat effects of PTSD."[68] Reports indicate that these programs also allowed DARPA to use deep brain stimulation to control enhanced soldiers during live combat.[69]

By contrast, Lara Wynn presents a more nuanced perspective. She notes "as evidenced by data and information released from DARPA, there has been some incorporation of the new biotechnology into American military systems' soldiers . . . but most of the biotechnology and genetic engineering is still in developmental stages."[70]

Overall, in the absence of categorical acknowledgment from DARPA regarding the existence of a program genetically modifying humans to create super soldiers, it cannot be further verified whether DARPA is in fact creating genetically modified super soldiers, as Sawin asserts. Nonetheless, DARPA's Safe Genes program suggests it may have the technology to use genome editing for therapeutic purposes. Since the line between therapeutic use and enhancement purpose can sometimes be hard to distinguish, it may be plausible to contend that DARPA could use genome editing for enhancement purposes. For our purposes, the capacity of DARPA, other countries' agencies and private researchers to use technology for enhancement purposes raises pertinent legal and ethical questions examined in Part III.

(iii) Beyond Genes

Beyond genetics, DARPA's efforts to enhance soldiers using other means incorporate several initiatives. Its exoskeleton receives particular attention. In 2001, DAPRA unveiled two exoskeleton programs. In 2013, it partnered with US Special Operations Command to create a super-soldier suit called

65. DARPA, *Systems-Based Neurotechnology for Emerging Therapies (SUBNETS*), https://www.darpa.mil/program/systems-based-neurotechnology-for-emerging-therapies (last visited Apr. 9, 2018)

66. Sawin, *supra* note 2, at 122. *See also* Heyes, *supra* note 1.

67. *Id.*

68. Sawin, *supra* note 2, at 124. *See also* Andrew Curtiss, *Captain America and Super Soldiers - Are we ready for what DARPA has in store?*, EXAMINER.COM (Apr. 8, 2014), http://perma.cc/QN58-E2VK (government project helping veterans suffering PTSD).

69. *Id.*

70. Wynn, *supra* note 3, at 114.

TALOS (Tactical Assault Light Operator Suit). At a manufacturing innovation event, President Obama said, "I am here to announce that we are building Iron Man.[71] The exoskeleton enables soldiers to run faster and carry heavier weights.[72] In 2003, Jan Walker, the spokesman for DARPA, confirmed that the Pentagon was "working out ways to resist the effects of sleep deprivation. If our fighters can do that, we can fundamentally change the order of battle, and it would make a revolutionary difference."[73] DARPA's "Extended Performance Warfighter" program aims to use technology to create a 24/7 soldier, capable of going on for days or weeks without sleep and without fatigue. Towards this end, DARPA is reportedly testing helmets with transcranial magnetic stimulation (TMS). These helmets would emit magnetic waves to stimulate targeted areas of the brain when soldiers start tiring.[74]

Under the rubric of "Augmented Cognition", DARPA pursued military technologies such as goggles capable of monitoring a soldier's brain signals to detect potential threats before the soldier's conscious mind becomes aware of those threats.[75] DARPA has also experimented with implanted electrodes towards the creation of brain-net, a system that will permit brains to communicate without the need for speech.[76] Pain reduction methods also feature prominently in DARPA's projects. Towards that end, Rinat Neuroscience is working on pain vaccines that can block the sensation of pain for almost one month.[77] Soldiers accelerated recovery through photobiomodulation or WARP devices is being tested to speed up soldiers' healing process.[78]

The technologies discussed in this section, genetic or otherwise, carry the potential to change the nature of modern warfare, and as such, challenge ex-

71. Annie Jacobson, *Engineering Humans for War*, The Atlantic, September 13, 2015, https://www.theatlantic.com/international/archive/2015/09/military-technology-pentagon-robots/406786/ .

72. Wynn, *supra* note 3, at 119. *See also* Bruce Ubin, *First Look at DARPA Funded Exoskeleton for Super Soldiers,* FORBES, (Oct. 29, 2014), https://www.forbes.com/sites/bruceupbin/2014/10/29/first-look-at-a-darpa-funded-exoskeleton-for-super-soldiers/#213c0ee962a0 (providing details on DARPA's exoskeleton).

73. Charles Laurence, *Ready for War in 2005: The Soldier Who Never Sleeps,* THE TELEGRAPH (Jan. 05, 2003), https://www.telegraph.co.uk/news/worldnews/northamerica/usa/1417976/Ready-for-war-in-2005-the-soldier-who-never-sleeps.html.

74. Peter Singer, *supra* note 52.

75. Sharon Weinberg, *Ten extraordinary Pentagon mind experiments*, BBC, (Nov. 18, 2014) http://www.bbc.com/future/story/20130311-ten-military-mind-experiments.

76. *Id.*

77. Brian Wang, $3 Billion Dollar Super Soldier Program: 10 times muscle endurance, 7 foot vertical leap, wall crawling, personal flight and more, The Next Big Future, (July 8, 2008), https://www.nextbigfuture.com/2008/07/3-billion-super-soldier-program-10.html

78. Peter Singer, *supra* note 52. See Garreau, *supra* note 54. *See also* WARP Light Therapy, http://www.warp-light.com/res_faq.html (last visited on Apr. 24, 2018).

isting legal and ethical regimes. The next section explores the impact of genetic innovations in sports and commercial fields before moving on to discuss legal concerns.

(B) Other Super Humans

Beyond military applications, concerns about human enhancement also surface in connection with sports and general commercial use. In sports, gene doping is deemed the newest threat to fair play. Concerns stem from the success of gene therapy trials. Anti-doping authorities fear that they may be faced with a form of doping that is hard to detect.[79]

Sporting authorities have long known that genetics can impact sporting performance. In 1964, Eero Mäntyranta, a Finnish cross-country skier, drew attention because of his impressive performance at the Olympics. Later studies showed that he had a natural mutation in his EPO receptor gene which significantly enhanced his endurance.[80]

The World Anti-Doping Agency (WADA) defines gene doping as "the non-therapeutic use of genes, genetic elements and/or cells that have the capacity to enhance athletic performance."[81] WADA does not define therapeutic use. In the future, it may be possible to treat patients who have muscular disorders with genetic medicine. Such genetic medicines could improve patients' muscle strength.[82] Would the WADA anti-doping regime allow such patients to compete in sporting activities? It remains unclear whether that would be the case.

Concerns about gene doping primarily emerge from what we know about gene therapy.[83] Gene therapy typically involves delivering genetic material to cells within the body. These cells produce encoded protein.[84] The expressed protein is relatively indistinguishable endogenous protein. This similarity is important for treatment.[85] It ensures that the immune system does not attack the expressed protein. This also generates the appeal for gene doping purposes. Since expressed and endogenous proteins are virtually indistinguishable, athletes can use this method with relatively little fear of detection.[86]

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79. Fabian Filipp, *Is Science Killing Sport? Gene Therapy and Its Possible Abuse in Doping*, 8 EMBO REP. 433 (2017).

80. H. J. Haisma & O. de Hon, *Gene Doping*, 27 Int'l J. Sports Med. 257, 262 (2006).

81. World Anti-Doping Agency (WADA), Gene Doping, https://www.wada-ama.org/en/content/what-is-prohibited/prohibited-at-all-times/gene-doping (last visited on Apr. 24, 2018).

82. H.J. Haisma, *supra* note 76 at 260.

83. David Gould, *Gene Doping: Gene Delivery for Olympic Victory*, BRITISH J. OF CLINICAL PHARMACOLOGY 292, 292 (Oct. 22, 2012).

84. *Id.* at 293.

85. *Id.*

86. *Id.*

Although gene therapy studies have revealed mixed results, some gene therapy drugs have received regulatory approval in the US and Europe.[87] In recent years, concerns related to sports have emerged with regard to Repoxygen gene therapy drug and "Schwarzenegger mice."[88] For the most part, gene doping issues arise in connection with enhancing muscle performance, improving oxygen delivery, reducing pain sensations and accelerating wound healing.[89]

In 2006, Thomas Springstein, a German coach, found himself in trouble for trying to acquire Repoxygen. Repoxygen was a gene therapy drug developed in a pharmaceutical laboratory in Oxford, UK, for use in fighting anemia. [90]Repoxygen manufacturers stopped production in 2003 when it appeared that the drug would not be profitable. The drug utilizes a viral vector to deliver a human erythropoietin (EPO) gene into the host DNA.[91] Under the right circumstances, the gene directs the host cell to start producing EPO which increases the production of red blood cells. With more red blood cells, more oxygen is transported to muscles. Athletes have been known to inject themselves with synthetic EPO.[92] But Repoxygen can potentially cause the stable production of natural EPO.[93] Presumably, Coach Springstein found this genetic drug and its undetectable use attractive. German authorities arrested Springstein for giving performance enhancement drugs to athletes. Prosecutors read into evidence Springstein's email requesting information on how to acquire Repoxygen.[94] However, they found no Repoxygen in the raid on his apartment. It remains unclear whether he ever managed to acquire and administer Repoxygen.[95] Nevertheless, his case illustrates that gene therapy drugs could be misused to improve sporting performance.

In the US, concerns about gene doping started appearing in the 1990s, with news reports suggesting that H. Lee Sweeney's lab was producing

87. Emily Mullen, *Tracking the Cost of Gene Therapy*, MIT TECH. REV. (Oct. 24, 2017), https://www.technologyreview.com/s/609197/tracking-the-cost-of-gene-therapy/ (detailing the way that cost and related market factors make approved gene therapy drugs commercially unsuccessful). *See also* Timothe Cynober, *Why Are There Only 10 Cell and Gene Therapies in Europe*, LABIOTECH.EU (Apr. 4, 2018), https://labiotech.eu/atmp-cell-gene-therapy-ema/ (discussing problems associated with regulatory approval and commercial viability, noting that approved gene therapies have been safe, but not commercially viable).

88. Gretchen Reynolds, *Outlaw DNA*, N.Y. TIMES (June 3, 2007), https://www.nytimes.com/2007/06/03/sports/playmagazine/0603play-hot.html.

89. Gould, *supra* note 79 at 293-94.

90. Reynolds, *supra* note 84.

91. Gould, *supra* note 79 at 293.

92. Reynolds, *supra* note 84.

93. *Id.*

94. *Id.*

95. *Id.*

"Schwarzenegger mice."[96] Sweeney focused his research on a gene that produces a protein called IGF-1. This protein helps regulate muscle growth. His experiments worked: rats injected with an extra copy of IGF-1 gene gained more muscle mass, became stronger and lost their muscle mass slower than rats who were not injected.[97] Within sports, this therapy could help athletes gain and preserve muscle mass to improve their performance. [98] These examples suggest that we have cause to be concerned about hard to detect gene doping or enhancement in athletes.

Beyond sports, news reports suggest that genetic technologies may be used for general enhancement purposes. Elizabeth Parrish, CEO of BioViva, a biotech startup, claims to have undergone anti-aging genetic modification. She received two of her own company's experimental gene therapies: one to protect against loss of muscle mass with age, and the other to battle stem cell depletion responsible for diverse age-related diseases and infirmities.[99] George Church, a Harvard researcher who listed BioViva in his list of companies to watch, observed that it is possible to enhance lifespan by genetic modification and Parrish's claim was plausible.[100] Other professors and scholars remain skeptical of Parrish's claims.[101] Regardless of the veracity of her claims, the potential for such enhancement merits an assessment of relevant legal standards.

PART III: LEGAL CONTEXT

(A) Statutes and Conventions

Having examined relevant advancements in genetic technology, we now turn to governing statutes and conventions. At the international level, UNESCO's University Declaration of the Human Genome and Human Rights, International Covenant on Economic, Social and Cultural Rights (ICESCR), the Geneva Conventions, Biological Weapons Convention of 1972, and the Oviedo Convention of the EU are relevant. With regard to nation-state legislation, this paper explores relevant U.S. laws.

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96. Melinda Wenner, *How to Be Popular During the Olympics: Be H. Lee Sweeney, Gene Doping Expert*, SCI. AM. (Aug. 5, 2018), https://www.scientificamerican.com/article/olympics-gene-doping-expert/.

97. *Id.*

98. Reynolds, *supra* note 84.

99. Press Statement, BioViva USA, Inc., *First Gene Therapy Successful Against Human Aging* (Apr. 26, 2016), https://bioviva-science.com/blog/2017/3/2/first-gene-therapy-successful-against-human-aging

100. Antonio Regalado, *A Tale of Do It Yourself Gene Therapy*, MIT TECHNOLOGY REVIEW (Oct. 14, 2015), https://www.technologyreview.com/s/542371/a-tale-of-do-it-yourself-gene-therapy/.

101. *Id.*

The 53rd Session of the UN General Assembly endorsed UNESCO's Universal Declaration on the Human Genome and Human Rights in 1997.[102] Article 1 of the Declaration recognizes that the human genome "underlies the fundamental unity of all members of the human family, as well as the recognition of their inherent dignity and diversity."[103] Although the Declaration recognizes the human genome as the "heritage of humanity" (Article 1), requires non-discrimination based on genetic characteristics (Article 6), and requires consent for genetic treatment (Article 5), it also permits limitations to the principles of consent and confidentiality "prescribed by law, with compelling reasons within the bounds of public international law and international law of human rights." (Article 9).[104] With regard to human enhancement, it is unclear whether that is categorically unlawful under this Declaration. It is also unclear what circumstances would permit limitations on an individual's right to consent to genetic treatment. Could soldiers' right to explicitly consent to genetic treatment be qualified by the collective national interest in enhancing their capabilities? The Declaration and state of the law at this time does not give us a conclusive answer.[105]

The Oviedo Convention of the EU has a more definitive answer for our purposes.[106] Through Article 13, it specifies that an intervention "seeking to modify the human genome may only be undertaken for preventive, diagnostic or therapeutic purposes and only if its aim is not to introduce any modification in the genome of any descendants."[107] Accordingly, it makes clear that EU member states may not lawfully engage in human enhancement. Nonetheless, since the distinction between therapy and enhancement is open to debate, EU states may enhance their citizens under the guise of therapy. For instance, soldiers or athletes may receive treatment to make them run faster or carry oxygen to better treat "fatigue" or "exhaustion."

The Biological Weapons Convention (BWC) of 1972 bans the development, production and stockpiling of "(i) microbial or other biological agents, or toxins whatever their origin or means of production in quantities that have no justification for prophylactic, protective or other peaceful purposes and (ii) weapons, equipment or means of delivery designed to use such agents or

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102. U.N. Educ., Sci. & Cultural Org., Universal Declaration on the Human Genome and Human Rights, http://www.unesco.org/new/en/social-and-human-sciences/themes/bioethics/human-genome-and-human-rights/..

103. G.A. Res. 29, Universal Declaration on the Human Genome and Human Rights, (Nov. 11, 1997), [hereinafter Human Genome Declaration]. See also G.A. Dec. 53/152, U.N. Doc. A/RES/53/152 (Dec. 9, 1998), *supra* note 97, art. 1.

104. Human Genome Declaration, *supra* note 97 , arts. 1, 5, 6, & 9.

105. Human Genome Declaration, *supra* note 97. See also Lara Wynn, *supra* note 3, at 117.

106. Convention for the Protection of Human Rights and Dignity of the Human Being with regard to the Application of Biology and Medicine: Convention on Human Rights and Biomedicine, art. 13, Apr. 4, 1997, 164 E.T.S.

107. *Id.* See also Lara Wynn, *supra* note 3, at 117.

toxins for hostile purposes or in armed conflict" (Article 1).[108] Lara Wynn suggests that super soldiers may be prohibited weapons under the BWC depending on use, especially if such soldiers are designed for mass destruction.[109] However, that argument is not without problems. The BWC does not define weapons. It is unclear why enhanced soldiers should count as weapons. Even if super soldiers were weapons, the BWC prohibits using "weapons, equipment or means of delivery" for the purpose of using bioagents or toxins for hostile purposes. Rules of statutory interpretation require that we interpret the term "weapon" based on its context or list.[110] Since the term "weapon" is used alongside equipment and means of delivery, here the term weapon may be thought of in the sense of a delivery system. Using weapons or delivery systems to deliver bioagents and toxins for hostile purposes or armed conflict is clearly prohibited. But the prohibition may not extend to weapons that are not designed for delivering bioagents or toxins. What we know of super soldiers does not suggest that they are going to be vessels for delivering bioagents or toxins. Accordingly, the BWC does not categorically prohibit developing super soldiers.

From international humanitarian law, the Geneva Conventions, Additional Protocol 1, Article 35(2) is relevant to our discussion. Article 35 (2) prohibits the employment of weapons, "projectiles and material and methods of warfare of a nature to cause superfluous injury and unnecessary suffering."[111] As such, Article 35(2) emphasizes the need to balance military objectives with the protection of human dignity.[112] To the extent that super soldiers constitute a means or method of warfare, they must not cause superfluous injury or unnecessary suffering. The precise meaning of superfluous injury or unnecessary suffering causes debate. Antonio Cassese described it as one of the

108. Convention on the Prohibition of the Development, Production and Stockpiling of Bacteriological (Biological) and Toxin Weapons and on Their Destruction, art.1, 10 Apr.1972, 26 U. S.T. 583, 1015 U.N.T.S. 163 [hereinafter BWC].

109. Wynn, *supra* note 3, at 121.

110. *See* discussion in Yates v. United States, 135 S. Ct. 1074, 191 L. Ed. 2d 64 (2015) (Justice Ginsburg, with three Justices concurring and one Justice concurring in the judgment, at 1085 states that under the principle of "*noscitur a sociis*," i.e., a word is known by the company it keeps, courts avoid ascribing to one word in a federal statute a meaning so broad that it is inconsistent with its accompanying words, thus giving unintended breadth to the Acts of Congress. A canon related to *noscitur a sociis, ejusdem generis,* counsels: "Where general words follow specific words in a statutory enumeration, the general words are [usually] construed to embrace only objects similar in nature to those objects enumerated by the preceding specific words. *Washington State Dept. of Social and Health Servs. v. Guardianship Estate of Keffeler*, 537 U.S. 371, 384, 123 S.Ct. 1017, 154 L. Ed. 2d 972 (2003)."

111. Protocol Additional to the Geneva Conventions of 12 August 1949, and relating to the Protection of Victims of International Armed Conflicts (Protocol 1) art. 35 (2), June 8, 1977, 1125 U.N.T.S. 3, reprinted in 16 I.L.M. 1391 (1977).

112. *Id*. *See also* Sawin, *supra* note 2, at 112-116.

"most unclear and controversial rules of warfare."[113] The International Court of Justice ("ICJ") defined unnecessary suffering as "a harm greater than that unavoidable to achieve legitimate military objectives."[114] The concept of superfluity emerges from French legal principles, specifically that of "maux superfluous."[115] The level of superfluity or degree of suffering may be assessed based on the intensity of pain, the degree of permanent suffering and the likelihood of death.[116] It is unclear whether the use of super soldiers may in all cases cause superfluous injury or unnecessary suffering. To the extent that super soldiers carry out necessary military objectives in a targeted and efficient fashion, they may not be prohibited within the meaning of Article 35(2).[117] Additionally, enhancing soldiers could protect soldiers, making them safer and more resilient in times of war. As such, enhancing them may be necessary for improving their safety, and preventing them from experiencing unnecessary pain or suffering. Thus, it appears that Article 35(2) also does not categorically prohibit human enhancement for military purposes.

So far, we have considered international laws potentially prohibiting human enhancement. We now investigate whether soldiers, athletes and people more generally may claim a right to access genetic enhancement technology. The ICECSR requires state parties to recognize that "right of everyone to the enjoyment of the highest attainable standard of physical and mental health."[118] Enhancement may fall within the scope of the highest attainable standard of health today. Although the U.S. did not ratify the ICECSR, other state parties are required to comply with its stipulations. To the extent that the ICECSR is now part of customary international law, the U.S. and non-

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113. ANTONIO CASSESE, *WEAPONS CAUSING UNNECESSARY SUFFERING: ARE THEY PROHIBITED?* in THE HUMAN DIMENSION OF INTERNATIONAL LAW: SELECTED PAPERS OF ANTONIO CASSESE 192, 197-17 (2008).

114. Legality of the Threat or Use of Nuclear Weapons, Advisory Opinion, 679 I.C.J. Rep. 226, ¶ 78 (July 8) (see paragraph 78, on page 257 for full quote: "a harm greater than that unavoidable to achieve legitimate military objectives. If an envisaged use of weapons would not meet the requirements of humanitarian law, a threat to engage in such use would also be contrary to that law.")

115. Henri Meyrowitz, *The Principle of Superfluous Injury or Unnecessary suffering: From the Declaration of St Petersburg of 1868 to Additional Protocol 1 of 1977*, 34 INT'L REV. OF THE RED CROSS 98-122 (1994).

116. Superfluous Injury or Unnecessary Suffering, WEAPONS LAW ENCYCLOPEDIA (Nov. 30, 2013), http://www.weaponslaw.org/glossary/superfluous-injury-or-unnecessary-suffering [https://perma.cc/6KK2-3KQ7] (defining what the terms "superfluous injury" and "unnecessary suffering" mean).

117. *See* Michael Hanlon, *'Super Soldiers': The Quest for the Ultimate Human Killing Machine,* INDEP. (Nov. 16, 2011, https://www.independent.co.uk/news/science/super-soldiers-the-quest-for-the-ultimate-human-killing-machine-6263279.html [~~*archived at*~~ http://perma.cc/VK9R-HRAQ]). *See also* ~~Christopher~~ Sawin, *supra* note 3, at 132.

118. International Covenant on Economic, Social and Cultural Rights (ICECSR), art. 12, Dec. 16, 1966, S. Treaty Doc. No. 95-19, 6 I.L.M. 360 (1967), 993 U.N.T.S. 3.

ratifying states may also be obliged to respect it.[119] Viewed in this way, it could be argued that soldiers have a right to benefit from genetic technology, at least for therapeutic purposes.

Concerning U.S. national law, the US Public Health and Biosecurity Act of 2002 ("2002 Act") and general FDA guidelines are relevant for our investigation. The 2002 Act provides for a coordination and response system in relation to threats emanating from bioterrorism and public health emergencies, but it does not specifically address the issue of human enhancement. Regarding the FDA's jurisdiction, the Human Genome Editing report by the National Academy of Sciences suggests that human genome-editing technologies are considered gene therapies with regard to FDA oversight.[120] FDA regulates human genome editing under its existing framework for biological products, which includes gene therapy products. The FDA has authorized a number of gene therapy trials but has not yet approved a gene therapy for market. If one is approved, it will still be subject to the FDA's ongoing monitoring and, if necessary, restrictions on its use. [121] However, since DARPA's technology does not count as a product for sale on the market, the FDA's oversight may not extend to DARPA's genetic technologies developed for military purposes. Commercial applications of genetic enhancement for athletes or other humans, may however, fall within the scope of the FDA's authority. That acknowledged, the existing framework leaves much to be desired for a coherent and principled approach to legislation on this topic. The next section analyzes risks and benefits of enhancement technology.

(B) Risks and Benefits

In terms of risks, current soldier enhancement programs appear to have among their aims preventing PTSD among soldiers and altering soldiers' capacity to feel emotions. This raises concerns about the moral decision-making of such soldiers. Soldiers who receive transcranial magnetic stimulation in targeted brain areas or genetic treatment to prevent emotions from clouding decision making could make decisions differently from untreated soldiers. The concern here is that super soldiers may become efficient killing

119. Eleanor D. Kinney, *The International Human Right to Health: What does this mean for our nation and the world?,* 34 IND. LAW REV., 1457, 65 2001 (arguing that the U.S. and non-ratifying states may also be required to comply with the international human right to health. In U.S. states such as Alaska or Hawaii, it is already recognized that either the legislature (in Alaska) or the state (in Hawaii) must provide for the promotion and protection of public health).

120. NATIONAL ACADEMIES OF SCIENCES, ENGINEERING AND MEDICINE, HUMAN GENOME EDITING: SCIENCE, ETHICS AND GOVERNANCE (Washington, DC: The National Academies Press 2017) 35(2017).

121. *Id.* at 35-36.

machines, displaying diminished capacity for compassion and mercy.[122] Reducing their capacity for emotion could also impact their ability to make judgments about the necessary use of force. Critics consider whether such enhanced soldiers could easily violate the prohibition against causing "unnecessary suffering and superfluous injury" within the meaning of the Geneva Conventions.[123]

Concerns also arise about using magnetic chips or transcranial magnetic stimulation in helmets to remotely control soldiers.[124] Can we try such soldiers for war crimes when their capacity to make decisions was diminished or externally controlled? Given their reduced capacity for decision making, and the external control exerted, could we think of super soldiers as machines or weapons, somewhat distinct from other humans? If so, would these enhanced men or women have rights different from those of others? These questions remain open for debate.[125]

Additionally, the existence of this technology means that terrorist groups and other irresponsible actors may exploit and misuse this technology. In the wrong hands, such human enhancement technology could have dangerous consequences.[126]

In the arena of sports, the non-uniform use of doping technology could create significant discrepancies in sporting results and unfairly advantage those bending the rules undetected.[127] More broadly, the commercial use of genetic enhancement could enhance inequality. Those with the means could pay to live longer, be stronger and more intelligent. This could further disadvantage the already poor and disadvantaged. It could also increase inequality with regard to access to opportunities, further entrenching and magnifying existing social problems.

With regard to benefits, using human enhancement technology for military purposes can help make warfare safer and more targeted. With more efficient and precise super soldiers, accidental killings and collateral damage may be significantly reduced.[128] Such soldiers may also be categorically trained to reduce the possibility of superfluous or unnecessary suffering. Enhancing soldiers may also help protect soldiers from unnecessary physical or psychological injuries, making war relatively "safer" for soldiers.[129]

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122. *See* Sawin, *supra* note 2, at 122- 123.
123. *Id.*
124. *Id*. at 119.
125. *See* Riley, *supra* note 58, at 247-252.
126. *See* Wynn, *supra* note 3, at 115.
127. *See* Filipp, *supra* note 75.
128. *See* Sawin, *supra* note 2, at 126-131.
129. *Id.*

With regard to sports, the argument in favor of gene doping is that all athletes should have access to enhancement technology once it is safe to use. This approach would solve the inequality and fair play problem. It could also help address problems with undetected use.[130] Nonetheless, it is questionable whether all inequality problems would be sufficiently addressed. Currently, athletes, however poor or disadvantaged, can perform well in international sports if they train long and hard. If genetic enhancement were to come within this mix, it would introduce cost and technology based barriers to entry, favoring richer athletes from technologically advanced countries over poorer athletes from less technologically advanced countries.

With regard to general non-therapeutic use of gene technology, people would benefit from access to technology that improves their longevity, physical or other characteristics, and overall health. However, the inequality problem with accessing such technology would persist. Could we solve that problem by making access to enhancement technology a basic right? Universal access could provide a solution, but it is unclear whether the world's capitalist economies would embrace that right.

(C) Conclusion

Human genetic enhancement technology gives humankind the opportunity to do great good and cause great harm. While these technologies carry several benefits, the general ethical obligation to do no harm impresses upon us the need to take stock of the risks. The risk that terrorists or non-state actors may use enhancement technology carries dangerous consequences. Individual agency, identity and capacity to consent may also stand considerably compromised in the military context.

Although expecting countries to turn back the clock on these technologies would be unrealistic, it would be reasonable to expect some regulation in this field. The BWC does not address challenges produced by genome editing technologies. Following up on the Human Genome Declaration, the international community would benefit from a declaration or convention governing the use of genome editing technologies. Countries must agree on permissible uses, clearly distinguish between therapeutic purposes and enhancement uses, and grant individuals fair and equal opportunity to access therapeutic uses. Deviations from permitted uses must be rigorously policed and punished. We may be unable to undo this technology, but we can and should regulate its use.

130. Michael Le Page, "Gene Doping in Sports Could Make the Olympics Fairer and Safer," THE NEW SCIENTIST (Aug. 5, 2016), https://www.newscientist.com/article/2100181-gene-doping-in-sport-could-make-the-olympics-fairer-and-safer/.