GENETIC ENGINEERING: UNWANTED CONSEQUENCES

Mahmoud El Mabrouk, BSc[1]; Zahra Mohamed, BSc[2]
[1]Department of Physics and Astronomy, University of Waterloo, melmabro@uwaterloo.ca; [2]Faculty of Health, University of Waterloo,

ISSN 2816-2420

ABSTRACT

Within the last 50 years, the idea of genetic engineering to modify the human genome has surfaced, becoming an extremely revolutionary yet highly controversial topic. With rapid advances in genetic research, the machinery used to perform such gene-editing procedures has already been developed; genetically mutating humans is now possible. The question is no longer "Can we" but now, "Should we". The ethical concerns surrounding this issue have been thoroughly discussed in the science community, causing widespread debate on whether research should be allowed in this field of study. Many scientists believe that research in this field should be encouraged to further study genetic diseases, different means of reproduction, and other life-altering concepts such as physiological and psychological enhancement. On the other hand, many believe such research should be completely prohibited as these practices can potentially become extremely problematic due to the predicted and unknown implications that could be faced as a result of genetic engineering. Never before have we had such power and control over our own biological makeup. Considering that human lives are at risk under these practices, germline genetic engineering should be universally prohibited as it is unethical, unsafe, and medically unnecessary.

INTRODUCTION

Genetic engineering is the process of modifying the makeup of a living organism by manipulating its genetic material.[1] First manifested in 1973 by Stanley N. Cohen and Herbert W. Boyer through viable genetically modified *Escherichia coli* bacteria,[2] scientific advancements allowed for the use of gene-editing technology such as CRISPR (Clustered Regularly Interspaced Short Palindromic Repeats) to detect, modify or delete certain genes,[3] thus leading to many applications such as the production of insulin and human growth hormones.[2] However, medical research granted scientific fiction an entryway to reality; multicellular organisms of complexities parallel to typical plants and animals were genetically engineered to favour the survival of the human race.[4] The scope of this biotechnological miracle went even further; the first cloned animal, Dolly the Sheep, was born July 5, 1996.[5] Appropriately, genetically modified organisms acquired proponents and opponents who still vigorously debate this controversial topic.[6] Yet, another natural question with serious implications arises: What about humans? Human genetic engineering has already made huge strides in showing promising treatments for diseases such as cancer, cystic fibrosis, and heart diseases.[7] By eliminating unwanted traits and/or producing beneficial ones, many aim to use germline editing to terminate the inheritance of genetic disorders. However, should non-medical genetic engineering be employed, perhaps to design an ideal baby? That would be an unwise traverse to a slippery slope of discrimination, warfare, and ethical issues.

EUGENICS

Eugenics is the advocacy of selective human breeding to strengthen "desirable" traits by encouraging selective mating, thereby producing a "superior" human race.[8] This is not a new concept – the U.S. was the first to systematically sterilize inferior-deemed individuals in the early 1900s.[8] Furthermore, the Nazi government in 1933 forcefully sterilized at least 400,000 Germans against their will under the "Law for the Prevention of Progeny with Hereditary Diseases."[9] Adolf Hitler adopted these same eugenics ideas and established a program of euthanasia for adults and children, where his unethical ideas eventually led to the extermination of millions of Jews.[9] Using genetic engineering unnecessarily to please one's desires of an "ideal" child is comparable to eugenics; as a matter of fact, it is a strong promoter of eugenics due to its unparalleled efficacy relative to traditional selective breeding.[10] Hitler's ideas could be repeated, this time with the more efficient genetic engineering to carry out the diabolical ideas. The concept of "superiority" would become more prevalent, aided by the support of genetic engineering. This would perpetuate discrimination and a world where some traits, seen as inferior to others, are in need of elimination. This obviously creates great concern. The potential to create a societal hierarchy based on social subjectivity and racial bias is verily possible – to advocate equality and exercise non-medical genetic engineering is paradoxical.

NOVEL AGENT OF WAR

Human civilization took part in war heavily; the first war recorded took place sometime in 2700 BCE, millenia before the 20th century world wars,[11] and wars are still ongoing.[12] However, the form of combat evolved rapidly with the advancement of science and technology. Infantry warfare is the oldest form of conflict known, yet military technology saw an introduction of chemical/biological warfare in World War I.[13]

Yet, human genetic engineering could produce a form of warfare only realized in fictional stories – preparing stronger and faster soldiers before their birth. These soldiers would also have their freedom stripped away from them by being tasked with a specific goal from birth. Their will would be molded carefully. Some of the consequences already started to appear; genetic engineering is already exploited by biomedical researchers for military use.[14] The question now is whether a military system, comprised of birthed soldiers with the sole purpose of militant behaviour, will truly come into existence.

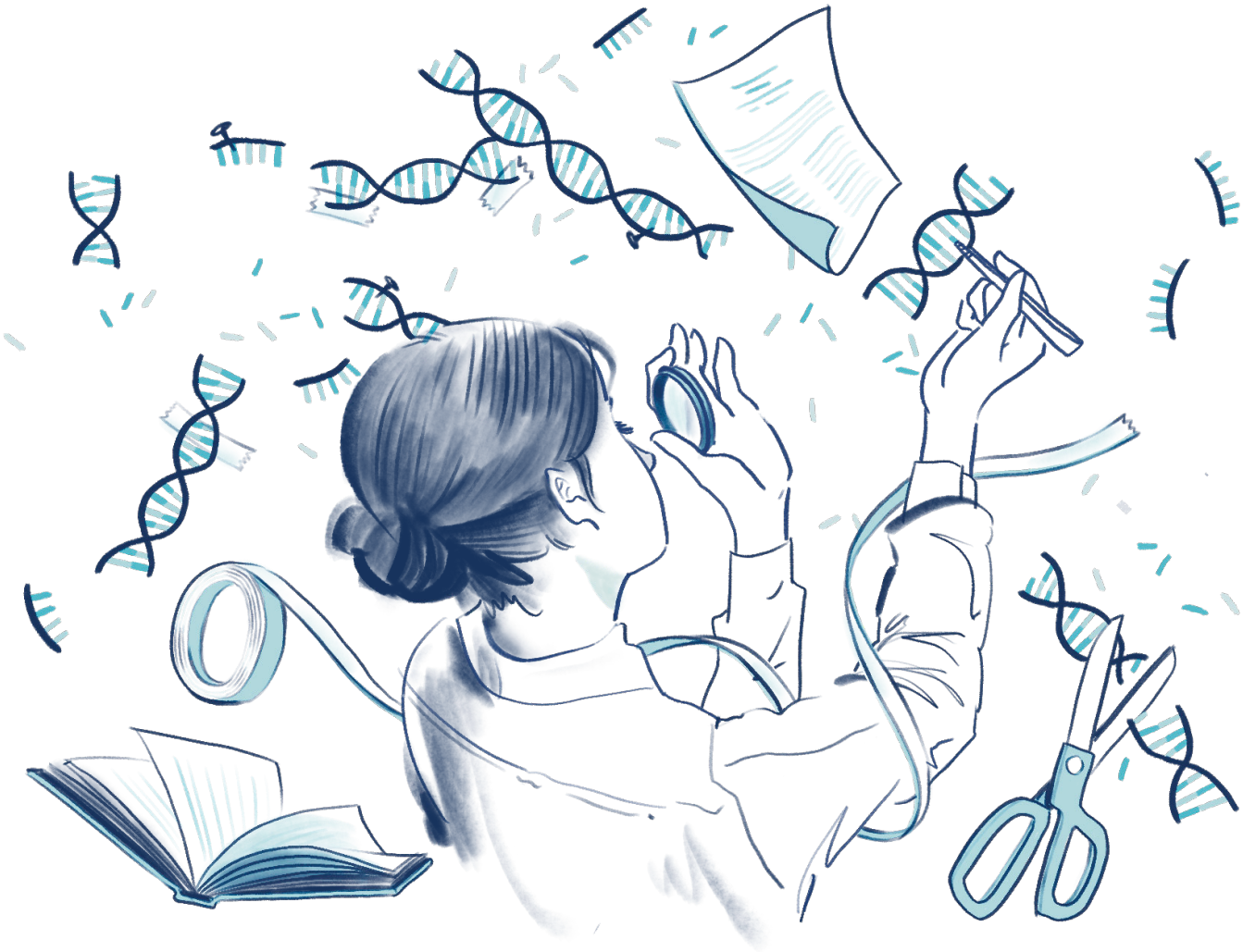
SAFETY CONCERNS

The Centre for Genetics and Society has stated their support for somatic gene editing research to medically treat living humans, but strongly suggest implementing laws against germline modifications on human embryos due to the adverse implications that could occur.[15] Experimenting with sex cells poses the risk of pregnancy complications such as miscarriages, stillbirths, and maternal injuries.[15] Professionals in the field of genetic research are wary of two kinds of gene editing complications known as off-target repeats, which is when edits are made in the wrong location of the genome, and mosaicism, in which errors in cell division cause some cells to inherit the edit but not others.[16] Even if the genetically modified individual is born seemingly healthy; it is possible that they can develop issues later in life.[15] While this may be a problem for the modified child, all of their offspring and future generations will be at risk too as these modifications are permanent, heritable, and irreversible.[17] Not only must we consider the possible consequences that genome modification could have on individual health, but we must consider its potential effects on the environment as well. Genetic engineering can manipulate a human's genome to such an extent that it can make humans incompatible with their environments.[1] This can cause ecological issues, with its effects being similar to that of what a non-native species would do in a foreign habitat,

disrupting the natural order within the ecosystem.[1] For example, an error in the modified genes could result in a species that is unsuitable for its respective climate or an unwanted resistance to antibiotics, which could be lethal.[18] Legally permitting gene editing practices is not worthwhile due to the potential consequences on human and environmental health.

SOCIAL ISSUES

The ability to select traits and edit genes through genetic engineering contributes to the outrageous idea that humans are genetically perfectible species. If germline editing were to be legally practiced, the temptation to use these technologies for superfluous and non-medical reasons would be highly prevalent. Using gene editing for enhancement purposes may create a separate species of genetically modified humans who are seen as superior, allowing them to thrive in physical and social contexts, inevitably creating a great divide in society. Giving society the option to edit their children's genes will foster unhealthy competition and will create a world where parents may feel morally obligated to give their children a "head start," striving to give them a competitive edge over others. The psychological effect of genetic editing on childhood development must be considered; children who receive certain traits may feel pressured to live according to those traits. For instance, a child with genetically enhanced athleticism might feel forced into pursuing a career in sport due to their modifications, despite their own wishes. This can cause turmoil within the mind of the developing child, altering their sense of identity and self-esteem. While it is acceptable to offer your child opportunities such as sports training, it is immoral to coerce them into a predetermined genetic mold.



CONSENT

One major ethical consideration for genetic modification is the issue of consent. In this process, the parents of the embryo are the only consenting party, as the embryo,who will soon develop into a living baby, has no say in the procedure and did not allow for their genes to be edited. In the Journal of Medical Ethics, philosopher Matthew Liao discusses the implications of genetic engineering, mentioning how every person should have the right to govern their own life.[18] Autonomy, the freedom allowing those to live their lives on their own terms, is a basic human right that should be available to all, and to alter a human's life through gene editing without their consent is a complete violation of that right. The problem of permission arises again when the genetically modified human has children; all the offspring that inherit the modifications will have gene edits that they did not consent to.

NECESSITY

While many support the idea of genetic engineering to improve the human race by weeding out undesirable traits, the existing process of natural selection offers a more ethical method of doing so. In natural selection, characteristics of a species are passed on due to their competence in promoting survival and reproduction, whereas in genetic engineering, due to the lack of clarity separating the difference between medical and enhancement uses, traits are selected in less of a moral manner.[19] Existing methods, such as preimplantation genetic diagnosis (PGD), offer the same benefits as genome editing but with much less risk.[16] PGD is used for the genetic screening of multiple embryos to identify the most favourable one for birth, as opposed to deliberately modifying genes via genetic engineering.[16] This process then uses in vitro fertilization to implant the selected egg into the uterus.[16] This screening process promotes the monitoring of genetic disorders and enables parents who fear passing on defective genes to give their future child the best chance of survival at a more cost- efficient and ethical price.[16]

CONCLUSION

It is more difficult to negate the occurrence of an event than its confirmation. That is why completing an extensive and predictive study on the psychological, sociological, and economic reaction to artificial human design must be carried out before any public use of this biotechnology should even be considered. While it is evident that genetic engineering holds prodigious potential for the treatment of life-threatening diseases by directly editing the mutant genes, it can also cause detrimental damage to society. Genetic engineering should not be allowed as it is a risky, immoral, and medically unnecessary procedure.

Acknowledgements: We acknowledge the JUHR Team for the reviewal of the manuscript and the facilitation of its publication in the journal.

Conflicts of Interest: The authors, Mahmoud El Mabrouk and Zahra Mohamed, are editors on the JUHR Editorial Team but had no involvement in the peer-review process or decision to accept this article.

Keywords: Genetic engineering, eugenics, germline editing, consent, warfare

Received 10-23-2021
Accepted 01-08-2022
DOI: 10.15353/juhr.v1i1. January.4675

REFERENCES

1. Patra S, Andrew AA. Human, Social, and Environmental Impacts of Human Genet. Journal of Biomedical Sciences. 2015 Jul 1;4(2)
2. The Editors of Encyclopaedia Britannica. Genetic engineering. In: Encyclopedia Britannica [Internet]. 2017 [cited 2021 Jul 25]. Available from: https://www.britannica.com/science/genetic-engineering
3. Cong L, Ran FA, Cox D, Lin S, Barretto R, Habib N, Hsu PD, Wu X, Jiang W, Marraffini LA, Zhang F. Multiplex genome engineering using CRISPR/Cas systems. Science. 2013 Feb 15;339(6121):819-23
4. National Geographic Society. Genetically Modified Organisms [Internet]. Genetically Modified Organisms | National Geographic Society. 2019 [cited 2021 Jul 25]. Available from: https://www.nationalgeographic.org/encyclopedia/genetically-modified- organisms/
5. Scientific American. 20 Years after Dolly the Sheep Led the Way - Where Is Cloning Now? Scientific American [Internet]. [cited 2021 Jul 25]; Available from: https://www.scientificamerican.com/article/20-years-after-dolly-the-sheep-led-the- way- where-is-cloning-now/
6. Keatley KL. CONTROVERSY OVER GENETICALLY MODIFIED ORGANISMS: THE GOVERNING LAWS AND REGULATIONS. Quality Assurance [Internet]. 2011 Jan 19;8(1):33–6. Available from: https://www.tandfonline.com/doi/abs/10.1080/105294100753209174
7. Gene therapy [Internet]. Mayo Clinic. Mayo Foundation for Medical Education and Research (MFMER); 2017 [cited 2021 Jul 25]. Available from: https://www.mayoclinic.org/tests-procedures/gene-therapy/about/pac-20384619
8. What is eugenics? [Internet]. Personal Genetics Education Project. [cited 2021 Jul 25]. Available from: https://pged.org/history-eugenics-and-genetics/#ref
9. Norrgard K. Human Testing, the Eugenics Movement, and IRBs [Internet]. Scitable. Nature Education; [cited 2021 Jul 25]. Available from: https://www.nature.com/scitable/topicpage/human-testing-the-eugenics- movement-and- irbs-724/
10. Selective breeding and gene technology [Internet]. Bitesize. BBC; [cited 2021 Jul 25]. Available from: https://www.bbc.co.uk/bitesize/guides/zp8pqhv/revision/5
11. Mark JJ. War in Ancient Times. In: World History Encyclopedia [Internet]. 2009 [cited2021 Jul 25]. Available from: https://www.worldhistory.org/war/ 276
12. List of ongoing armed conflicts [Internet]. Wikipedia. Wikimedia Foundation; 2021 [cited 2021 Nov 14]. Available from: https://en.wikipedia.org/wiki/List_of_ongoing_armed_conflicts
13. Military Technology in World War I [Internet]. The Library of Congress. [cited 2021 Jul 25]. Available from: https://www.loc.gov/collections/world-war-i-rotogravures/articles-and-essays/military-technology-in-world-war-i/
14. Van Aken J, Hammond E. Genetic engineering and biological weapons. EMBO reports [Internet]. 2003 May 9;4(S1). Available from: https://www.embopress.org/doi/full/10.1038/sj.embor.embor860
15. Human gene editing frequently asked questions [Internet]. Center for Genetics and Society. [cited 2021 Oct 17]. Available from: https://www.geneticsandsociety.org/internal-content/human-gene-editing-frequently-asked-questions
16. Araki M, Ishii T. International regulatory landscape and integration of corrective genome editing into in vitro fertilization. Reproductive biology and endocrinology. 2014 Dec;12(1):1-2
17. Lappé M. Ethical issues in manipulating the human germ line. The Journal of Medicine and Philosophy. 1991 Dec 1;16(6):621-39
18. Liao SM. The ethics of using genetic engineering for sex selection. Journal of Medical Ethics. 2005 Feb 1;31(2):116-8
19. Arber W. Genetic engineering compared to natural genetic variations. New Biotechnology. 2010 Nov 30;27(5):517-21