OPEN ACCESS

Kashf Journal of Multidisciplinary Research
Vol: 01 Issue 11 (2024)
P-ISSN: 3007-1992 E-ISSN: 3007-200X
https://kjmr.com.pk

NAVIGATING GENOME EDITING IN THE ERA OF ARTIFICIAL INTELLIGENCE-ISLAMIC BIOETHICAL CONSIDERATIONS IN CRISPR

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Article Info

Abstract

The development of artificial intelligence (AI) and genome editing techniques like CRISPR has entirely shifted the medical field, offering unparalleled progress in manipulating genes, evaluations, and personalized therapy. Such as a Chinese Scientist "He Jiankui" altered the genes CCR5 in an experiment through the CRISPR technique that shocked the world. He was sentenced to 3 years for "Illegal Medical Practice". The International Bioethics Committee (IBC) under UNESCO wrote a report in 2021 about protecting future generations elaborating article 16 of the Universal Declaration on Bioethics and Human Rights, 2005. Still, the moral ramifications of genome editing require meticulous examination, especially in speckled societal and religious settings. This research examines the incorporation of gene editing and AI technologies in healthcare from the perspective of Islamic bioethics. such as inviolability, human honour, and the concept of fairness. This paper delineates the anticipated advantages of gene editing in tackling inherited diseases and raising the precision of diagnoses. It also explores the moral quandaries which encompass issues such as manipulating genes and data confidentiality. Islamic bioethics draws its origins from the Quran, Hadith, and the Shariah laws. It provides valuable perspectives highlighting the significance of ethical accountability, intellectual agreement, and the goal of collective welfare. By conducting a thorough examination of current bioethical research and analyzing instances from nations, it emphasizes the potential of Islamic moral structures to guide the appropriate utilization of gene editing and AI in the field of medicine. Moreover, it explores the influence of religious intellectuals in modifying laws and promoting a diverse discourse that connects technological advances with spiritual values. This research suggests a series of scruples for incorporating gene-editing and AI into health care, based on Islamic ethics.

Keywords: *Genome Editing, AI, Islam, Bioethics, CRISPR.*

Introduction

In traditional genetics, genomic regions associated with the breeder's objective were chosen for gene-modifying operations. The likelihood of genetic changes in experimental organisms was then increased by scientists using radiation and chemical mutagens. These techniques were costly and time-consuming, despite their utility. In contrast, the direction of reverse genetics is the opposite of what classical genetics refers to as forward genetic screening. Reverse genetics is a technique in molecular genetics that examines the phenotypic consequences of certain modified gene sequences to provide light on a gene's function. Robb provided definitions and comparisons for the phrases "gene editing," or "genome engineering. Genetic sequence design and modification is known as genome engineering and through the use of DNA repair mechanisms, site-specific alterations may be incorporated into genomic DNA using genome editing and gene editing procedures[1].

Gene editing or genome editing is the process of making extremely precise modifications to a living organism's DNA sequence, hence modifying its genetic composition. To accomplish gene editing, enzymes are used, specifically nucleases that have been designed to target a specific DNA sequence. These enzymes create cuts in the DNA strands that allow replacement DNA to be inserted in place of the current DNA[2]. The molecular tool CRISPR-Cas9, which was developed by American scientist Feng Zhang and colleagues, is a crucial component of gene-editing technologies. In 2012, American scientist Jennifer Doudna, French scientist Emmanuelle Charpentier, and colleagues with the precise functioning of CRISPR-Cas9 were able to delete and insert DNA in the correct regions[3].

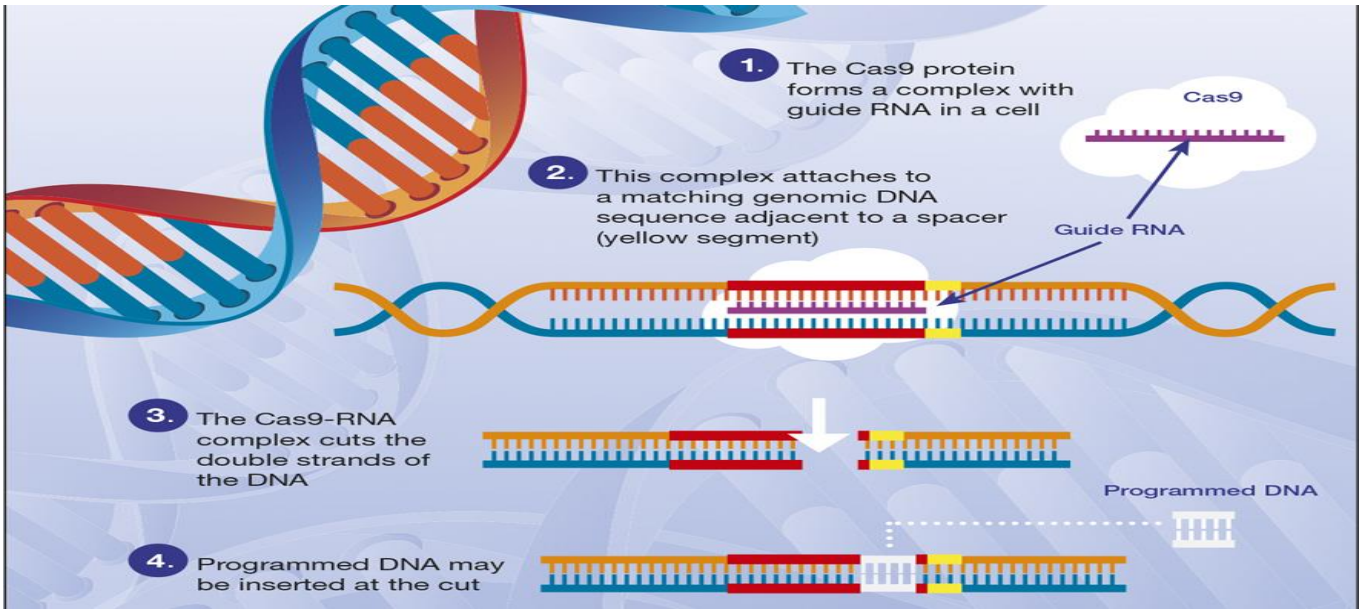
CRISPR-Cas9 has also raised ethical questions regarding safety, unforeseen effects, and socioeconomic inequality. Though CRISPR-Cas9 exhibits extraordinary accuracy, it may not be flawless, resulting in off-target consequences and possible health risks. Concerns over the effects on future generations are raised by the fact that it is unclear what these changes will mean in the long run. Since future generations cannot consent to genetic modifications, the concepts of "designer babies" and germline editing provide moral conundrums about consent. Strong legal frameworks, global collaboration, and open public discourse are necessary to address these ethical issues. Robust regulatory frameworks, multinational collaboration, and inclusive public iscourse are necessary for the responsible use of CRISPR-Cas9[4].

[1] G. Brett Robb, "Genome Editing with CRISPR-Cas: An Overview," *Current Protocols Essential Laboratory Techniques* 19, no. 1 (December 2019): e36, https://doi.org/10.1002/cpet.36.

[2] "Gene Editing | Definition, History, & CRISPR-Cas9 | Britannica," June 11, 2024, https://www.britannica.com/science/gene-editing.

[3] Phirose Kemprai, "CRISPR/Cas9–A Highly Targeted Genome Editing Technique," 2022, http://97.74.83.185:8080/jspui/bitstream/123456789/40/1/CRISPR-Cas9%20Genome%20PDF.pdf.

[4] Fani Memi, Aglaia Ntokou, and Irinna Papangeli, "CRISPR/Cas9 Gene-Editing: Research Technologies, Clinical Applications and Ethical Considerations," *Seminars in Perinatology*, Gene Editing (CRISPR), 42, no. 8 (December 1, 2018): 487–500, https://doi.org/10.1053/j.semperi.2018.09.003.



CRISPR' WORK[5]

Technologies based on CRISPR-based genome editing have exciting prospects for the betterment of medicinal therapies and comprehending genes. On the other hand, issues with these technologies include the requirement for ideal guide RNAs (gRNAs) and off-target effects. As a precise, cost-effective, and efficient alternative to genome editing, artificial intelligence (AI) has gained popularity. The best gRNAs for a given target sequence are predicted using AI models such as Deep CRISPR, CRISTA, and DeepHF. These models take into account the target sequence's genomic context, the kind of Cas protein, the intended mutation type, the on-target/off-target scores, and any possible effects on the cell's phenotypic and gene function. Aside from optimizing base editing, prime editing, and epigenome editing methods, AI also allows for precise DNA modification without requiring donor DNA templates or homology-directed repair[6].

AI helps to enable individualized therapies based on genetic profiles in conjunction with genome editing and precision medicine. Costs, off-target editing, distribution strategies, and safety in clinical applications are among the ongoing difficulties. The combination of genome editing with artificial intelligence (AI) is expanding the field of genetics, biomedicine, and healthcare by enabling the development of tailored medication based on unique genetic profiles[7].

Muslim approaches to biomedical-ethical concerns might be classified according to their technique. Some academics draw ethical concepts from sacred writings, such as the Qur'an and the Prophet's Sunna, while others take into account the larger context of social, cultural, and historical elements. Islamic bioethics links religious theories and Islamic law to inform practical ethical judgments in contemporary medicine. The preservation of life, beneficence and non-maleficence, human autonomy, and informed consent are some of the ideas that help academics and professionals navigate difficult

[5] "CRISPR: Implications for Materials Science," Cambridge Core, accessed September 29, 2024, https://www.cambridge.org/core/journals/mrs-bulletin/news/crispr-implications-for-materials-science.

[6] Shriniket Dixit et al., "Advancing Genome Editing with Artificial Intelligence: Opportunities, Challenges, and Future Directions," *Frontiers in Bioengineering and Biotechnology* 11 (2024): 1335901.

[7] Francisco M. De La Vega et al., "Artificial Intelligence Enables Comprehensive Genome Interpretation and Nomination of Candidate Diagnoses for Rare Genetic Diseases," *Genome Medicine* 13, no. 1 (October 14, 2021): 153, https://doi.org/10.1186/s13073-021-00965-0.

medical decisions[8]. Diverse opinions exist about organ transplantation; some accept it under certain circumstances, while others are wary because they fear pollution of the body.

The balance between averting damage and honoring God's design is taken into consideration in ethical considerations surrounding genetic testing, especially prenatal testing. Concerns of paternity, embryo status, and the function of intention in reproduction are brought up by in vitro fertilization (IVF). In general, Islamic bioethics places a strong emphasis on the value of protecting life, weighing personal autonomy, and honoring divine will[9].

The article's primary goal is to apply Islamic bioethics to the ethical analysis of the integration of AI and CRISPR technologies in healthcare, with a particular emphasis on human dignity, justice, and responsible usage. We used qualitative research methodology for data analysis of previous research, journals, Newspapers and any other primary or secondary source. The study's three clear objectives are as follows:

- To investigate, in light of Islamic bioethics, the moral implications of AI and CRISPR technology.
- Taking Islamic ethical precepts into account, assess the possible advantages of gene editing in treating hereditary disorders.
- To offer Islamic bioethical principles for the ethical incorporation of genome editing and AI into healthcare.

The Backlash and Global Repercussion

A biophysicist from the Southern University of Science and Technology in Shenzhen, China named Dr. He Jiankui made a statement that shocked the scientific community in late 2018. Using CRISPR-Cas9 technology, he claimed to have successfully altered the twin girls' genomes to make them immune to HIV infection[10]. However, this ground-breaking experiment sparked a flurry of discussion rather than merely raising eyebrows.

The Double-edged Sword of the CCR5 Gene:

The CCR5 gene is at the center of this dispute. A protein that is encoded by this gene facilitates HIV entry into immune cells. As part of his plan, Dr. He disabled a portion of the CCR5 gene to resemble the CCR5-Δ32 mutation, which naturally occurs and gives HIV resistance. Sounds good, doesn't it? Not quite so quickly, though.

1. Unintentional Repercussions: Although the CCR5-Δ32 mutation confers protection against HIV, it also seems to increase susceptibility to other illnesses, including influenza and West Nile virus. Thus, we are engaged in a dangerous genetic game[11].
2. Moral Conundrums: Scientists and moral philosophers were left perplexed. It had never been done previously to modify a person's germline, which means that these changes may be inherited by subsequent generations.
   Was it in charge? Was it morally right? "Hold up, He!" said the whole scientific community in unison as they raised their eyebrows.
3. Failure of Self-Regulation: The scientific community's attempt to regulate itself was deemed a failure because of Dr. He's experiment. That is a kind way of stating, "We were blind to this." The CRISPR box

[8] Abdulaziz Sachedina, *Islamic Biomedical Ethics: Principles and Application* (OUP USA, 2009), https://books.google.com/books?hl=en&lr=&id=9wEc0ss0s5UC&oi=fnd&pg=PR9&dq=https://academic.oup.com/book/32853&ots=sIlmXFPfuL&sig=2VMzSivYKPmtoxQzSkNH13f2nvI.

[9] Mohammed Ali Al-Bar and Hassan Chamsi-Pasha, *Contemporary Bioethics: Islamic Perspective* (Springer Nature, 2015), https://library.oapen.org/bitstream/handle/20.500.12657/28011/1/1001986.pdf.

[10] "Gene Editing | Definition, History, & CRISPR-Cas9 | Britannica."

[11] Sara Reardon, "Gene Edits to 'CRISPR Babies' Might Have Shortened Their Life Expectancy," *Nature* 570, no. 7759 (June 3, 2019): 16–17, https://doi.org/10.1038/d41586-019-01739-w.

had been unlocked and the genie was no longer in the bottle.

International Norms Broken: Dr. He's work was promptly denounced during the second international meeting on human gene editing, which took place in Hong Kong. They thought it was immoral and careless. Global standards? Broken.

National Committees Intervene: Referring to germline editing as "irresponsible" and "a serious violation of ethical obligations," national ethics councils and committees offered their opinions. They requested stronger global governance because they felt that a red line had been crossed[12].

The Opinion of the Media: The media didn't mince words. They referred to it as "dangerous," "illegal," and "irresponsible." Dr. He's standing? Faded.

Lessons Learned and the Road Ahead:

To address the monitoring and governance of human gene editing, the World Health Organization (WHO) convened a group of experts. We anxiously anticipate their proposals because they will have a significant impact on this field's future[13]. As critics correctly noted, there are alternative methods to stop HIV transmission, including cesarean sections for moms living with HIV. Perhaps we should direct our CRISPR efforts toward something else, like treating genetic illnesses? The scientific prestige of China was also jeopardized by Dr. He's experiment. They bet everything without checking their cards as if they were playing genetic poker[14].

International Bioethics

The International Bioethics Committee (IBC) of UNESCO was founded in 1993 and provides an important international platform for the discussion of moral and legal questions resulting from developments in the life sciences and their applications. The IBC, which is made up of 36 independent experts from a variety of fields, including genetics, law, philosophy, and medicine, guarantees that human rights and dignity are upheld in the face of technological advancement[15]. The main goal of the IBC is to encourage contemplation on the moral and legal issues raised by bio-sciences research. It promotes communication, knowledge sharing, and increased consciousness among the general public, expert organizations, and bioethics decision-makers. The IBC is called by the UNESCO Director-General at least once a year.

The Committee works in working groups and has in-depth discussions throughout its meetings. The IBC develops recommendations and guidance on certain bioethical concerns, and they are agreed upon by consensus. The Director-General receives these suggestions, which are extensively circulated and forwarded to the Executive Board, the General Conference, and the Member States. At IBC meetings, official observers from UNESCO Member States and Associate Members take part. Invited non-member states with permanent observer missions are welcome to participate in IBC meetings are also observed by the United Nations and other organizations that have agreements on reciprocal representation. Invitations may be extended to foreign governmental and non-governmental groups that share the goals of the IBC.

Experts and pertinent persons or organizations are contacted regarding issues falling under the purview of the IBC. The IBC has been governed by certain statutes that specify its purpose,

[12] Reardon.
[13] MengMeng Xu, "CCR5-Δ32 Biology, Gene Editing, and Warnings for the Future of CRISPR-Cas9 as a Human and Humane Gene Editing Tool," *Cell & Bioscience* 10, no. 1 (December 2020): 48, https://doi.org/10.1186/s13578-020-00410-6.
[14] Deng Luo et al., "China's Stem Cell Research and Knowledge Levels of Medical Practitioners and Students," ed. Yujing Li, *Stem Cells International* 2021 (May 18, 2021): 1–8, https://doi.org/10.1155/2021/6667743.
[15] "International Bioethics Committee (IBC) | UNESCO," accessed September 29, 2024, https://www.unesco.org/en/ethics-science-technology/ibc.

structure, and methods of operation since 1998. The Committee's activity is governed by these norms, which guarantee consistency and openness. Addressing moral and legal issues of life sciences research and applications is the IBC's primary responsibility. It addresses topics like biotechnology, genetic research, and developing technologies. The Committee's suggestions influence the development of international bioethical standards. The IBC has examined subjects including neuroethics in recent years. The IBC has studied subjects including neuroethics in the past few years. Its studies support the establishment of "neuro rights" as a means of addressing the moral quandaries raised by developments in neuroscience[16]. The IBC has also considered human rights and the human genome[17].

The Universal Declaration on Bioethics and Human Rights was overwhelmingly approved by the UNESCO General Conference in October 2005. In bringing together the concepts that direct ethical concerns in medicine, the life sciences, and related technologies applied to humans, this historic proclamation marks a turning point in the history of bioethics[18]. The regulations controlling the respect for human dignity, human rights, and fundamental freedoms provide a strong foundation for the Declaration's ideals. It acknowledges that moral dilemmas brought about by scientific and technical advancements must be considered while maintaining respect for each person's dignity and the universal observance of human rights.

The Declaration recognizes the fundamental relationship between ethics and human rights in the particular situation of bioethics by enshrining bioethics within the framework of international human rights. It highlights the idea that respect for human life should always come first in ethical matters. The International Declaration on Human Genetic Data (2003), the Universal Declaration of Human Rights (1948), and the Universal Declaration on the Human Genome and Human Rights (1997) are some of the international treaties that serve as models for the Declaration. It also takes into account local norms and rules of conduct, highlighting the idea that moral principles ought to be applied to all people, regardless of their ethnicity, nationality, or religion.

The Declaration acknowledges the influence of life sciences on the genetic makeup of future generations. It demands that the long-term effects of scientific discoveries be carefully considered to make sure that the things we do now do not jeopardize the welfare of future generations. The Declaration highlights that cultural variety should not compromise basic freedoms and human rights, even as it embraces cultural diversity as a source of creativity and innovation. It recognizes the biological, psychological, social, cultural, and spiritual aspects of an individual's identity[19]. According to the Declaration, advancements in science and technology should be accompanied by moral sensibility and ethical contemplation. Making decisions about new problems in medicine and the biological sciences requires careful consideration of bioethics.

Foundations of Islamic Bioethics

The Bases of Islamic Morality Islamic ethics (أخلاق إسلامية) is a deep discipline that considers moral behavior with the goals of defining "good character" and obtaining "God's pleasure" (Raza-e Ilahi)[20]. It is not the same as simple "Islamic

[16] "International Bioethics Committee (IBC) | UNESCO."
[17] "Report of the IBC on Updating Its Reflection on the Human Genome and Human Rights - UNESCO Digital Library," accessed September 29, 2024, https://unesdoc.unesco.org/ark:/48223/pf0000233258.
[18] "Universal Declaration on Bioethics and Human Rights - UNESCO Digital Library," accessed September 29, 2024, https://unesdoc.unesco.org/ark:/48223/pf0000146180.
[19] authorCorporate:International Bioethics Committee, "Report of the International Bioethics Committee (IBC) on the Principle of Protecting Future Generations," 2021, https://unesdoc.unesco.org/ark:/48223/pf0000378723.
[20] "Islamic Ethics," in *Wikipedia*, September 18, 2024, https://en.wikipedia.org/w/index.php?title=Islamic_ethics&oldid=1246293168.

morality," which addresses certain standards or behavioral guidelines. Let's examine the main texts that influence Islamic ethics:

The Quran: The main source of instruction for Muslims is the Quran, which was revealed to the Prophet Muhammad (peace be upon him). It includes revelations from God on a variety of subjects, including justice, compassion, morality, and human behavior. The verses of the Quran offer essential guidelines for moral behavior. **The Hadith:** The words, deeds, and endorsements of the Prophet Muhammad are referred to in the Hadith. These stories, which have been compiled by historians, provide real-world instances of how the Prophet lived an ethical life. The Hadith literature offers comprehensive advice on a wide range of topics, including economic affairs and interpersonal relationships.

Shariah Law: Frequently misinterpreted, Shariah is a complete system that incorporates moral, religious, and legal precepts rather than a single, inflexible legal rule. It is based on the Quran and Hadith, as well as on personal reasoning (ijtihād) and consensus (ijmā). Shariah regulates many facets of life, including criminal justice, contracts, and family concerns[21].

Importance of Shariah Law for Muslims

Shariah upholds Tawhid (توحيد), the idea that Allah is one, as a cornerstone of Islam. It guides Muslims toward observance of Islamic teachings and appropriate worship. Shariah comprises regulations meant to establish equity and justice in society. By outlining appropriate behavior, it helps to create a welcoming and caring community. Shariah emphasizes illness prevention while discussing both individual and societal health. Promoting reciprocal assistance, cultivates collaboration amongst people. Worship customs and business transactions are governed by Shariah[22].

In Islamic theology and philosophy, akhlaq (أتلاق) refers to the practice of virtue, morality, and manners. Originating from the Arabic root khlq, it includes ethics, temperament, nature, and disposition. Akhlaq promotes making a deliberate effort to overcome innate tendencies and develop moral character. It is consistent with the more general idea of "virtue ethics," which places more emphasis on moral character than strict regulations. Specified Manners The term "adab" (أدب) describes the required Islamic manners. It includes civility, morality, decency, kindness, and refinement. Muslims engage with people according to adab, which places a strong emphasis on thoughtfulness, kindness, and respect. It encompasses social interactions, personal behavior, and even creative expression[23].

It is important to acknowledge that Islamic ethics are subject to cultural evolution. The

[21] Abdulrazaq Suleiman Ibrahim et al., "The Ethical Compass of Islamic Corporate Social Responsibility: A Path to Sustainable Impact," in *Corporate Social Responsibility - A Global Perspective* (IntechOpen, 2024), https://doi.org/10.5772/intechopen.1005405.

[22] ADDIN ZOTERO_ITEM CSL_CITATION {"citationID":"yR2mQ7Zo","properties":{"formattedCitation":"\\uc0\\u8220{}Islam | Religion, Beliefs, Practices, & Facts | Britannica,\\uc0\\u8221{} September 28, 2024, https://www.britannica.com/topic/Islam.","plainCitation":"“Islam | Religion, Beliefs, Practices, & Facts | Britannica,” September 28, 2024, https://www.britannica.com/topic/Islam.","noteIndex":21},"citationItems":[{"id":507,"uris":["http://zotero.org/users/local/hxEZ2Gde/items/FGTV4RJ7"],"itemData":{"id":507,"type":"webpage","abstract":"Islam, major world religion that emphasizes monotheism, the unity of God ('Allah' in Arabic), and Muhammad as his final messenger in a series of revelations. As the literal word of God, the Qur'an makes known the will of God, to which humans must surrender (lending the name Islam, meaning 'surrender').","language":"en","title":"Islam | Religion, Beliefs, Practices, & Facts | Britannica","URL":"https://www.britannica.com/topic/Islam","accessed":{"date-parts":[["2024",9,29]]},"issued":{"date-parts":[["2024",9,28]]}}}],"schema":"https://github.com/citation-style-language/schema/raw/master/csl-citation.json"} “Islam | Religion, Beliefs, Practices, & Facts | Britannica,” September 28, 2024, https://www.britannica.com/topic/Islam.ibid

[23] “Islam | Religion, Beliefs, Practices, & Facts | Britannica,” September 28, 2024, https://www.britannica.com/topic/Islam.

interpretation of the Quran and Hadith reflects modern conditions even if they offer timeless ideas. Muslim-majority nations apply Shariah in various ways, taking historical, political, and cultural contexts into account. Islamic ethical values are derived from the Prophet's teachings, the divine direction found in the Quran, and the complex framework of Shariah. Together, they form a moral compass that points Muslims in the direction of justice, compassion, and moral perfection.

The inviolability of human life is a fundamental tenet of Islamic bioethics. This idea highlights the sacredness of life and is derived from the Quranic concept of "dhimma."[24]

Islamic teachings provide a strong emphasis on human dignity, which emphasizes the intrinsic value of every person. The Quran emphasizes how special humans are as God's vicegerents on Earth, elevating them above all other creations. Everyone is entitled to this dignity, regardless of socioeconomic standing, gender, or ethnicity. Thus, Islamic bioethics promotes the maintenance of dignity in medical decisions, upholding privacy and autonomy while guaranteeing compassionate treatment[25]. An essential Islamic virtue is justice (adl). It ensures fair treatment for everyone by permeating bioethical principles. Fairness in resource distribution, access to healthcare, and research involvement are prioritized in Islamic law, or fiqh. Decisions on clinical studies, the distribution of limited resources, and organ transplantation are all influenced by the fairness principle[26].

Different approaches are used by academics to address bioethical issues:

Textual Approach: The Quran and Hadith are the primary scriptural sources used in this technique. From these works, scholars extrapolate moral lessons by considering certain settings.

Contextual Approach: In this method, academics take into account the larger context, which includes social, historical, and cultural aspects. They bring scripture truths into harmony with modern conditions.

Para-textual Approach: This method combines scriptural sources with ijtihad or reasonable reasoning. It aims to close the gap between modernity and tradition by tackling fresh bioethical issues[27].

Artificial intelligence, genetic engineering, and assisted reproductive technologies are contemporary issues that Islamic bioethics addresses. To handle these complications, scholars modify conventional assumptions through continuous discourse.

Gene Editing and Its Importance in Healthcare

The gene editing equivalent of a Swiss Army knife is CRISPR, short for "clustered regularly interspaced short palindromic repeats." It's a field that has revolutionized biomedical research and has great potential for curing hereditary diseases; it's not only a tool. The CRISPR gene was first identified as an immune system in bacteria and

[24] "Bioethics in Islam: Principles, Perspectives, Comparisons - Bill of Health," November 9, 2017, https://blog.petrieflom.law.harvard.edu/2017/11/09/bioethics-in-islam-principles-perspectives-comparisons/.

[25] Kiarash Aramesh, "Human Dignity in Islamic Bioethics," eweb:304714 (Medical Ethics and History of Medicine Research Center, Medical Sciences/ University of Tehran. Iran, February 2007), https://repository.library.georgetown.edu/handle/10822/966303.

[26] Alexander Woodman, Mohammed Ali Albar, and Hassan Chamsi-Pasha, "Introduction to Islamic Medical Ethics | Journal of the British Islamic Medical Association," August 16, 2019, https://www.jbima.com/article/introduction-to-islamic-medical-ethics/.

[27] Hossein Dabbagh, S. Yaser Mirdamadi, and Rafiq R. Ajani, "Approaches to Muslim Biomedical Ethics: A Classification and Critique," *Journal of Bioethical Inquiry* 20, no. 2 (June 2023): 327–39, https://doi.org/10.1007/s11673-023-10239-6.

archaea. With the help of CRISPR, these tiny fighters can identify and eradicate certain viral invaders by integrating viral DNA fragments into their genome[28]. Consider it as microbial memory, akin to a viral "Wanted" poster. This technique was developed by researchers, who used it to create a potent gene-editing tool.

CRISPR modifies DNA sequences precisely by functioning as molecular scissors. A bacterium absorbs some of the intruder's DNA into its own genome when a virus or other invader gets into the cell. Afterwards, during further infections, CRISPR-associated proteins, or Cas proteins, utilize this knowledge to identify and remove matching viral DNA. The treatment of blood diseases has been transformed by CRISPR/Cas9 technology. Through ex vivo (outside the body) modification of hematopoietic stem cells, scientists can rectify genetic abnormalities. Promising outcomes have been obtained from clinical studies. Notably, Casgevy, the first CRISPR-based medication for transfusion-dependent β-thalassemia and severe sickle cell disease, was recently authorized by the FDA[29].

CRISPR is also being used to target primary immune deficiencies and other hematopoietic diseases. Because of CRISPR's adaptability, cellular and animal models for diseases like Duchenne muscular dystrophy (DMD) have been produced. The goal of research utilizing CRISPR is to genetically restore the synthesis of dystrophin, the protein that is absent in DMD. Animal models have shown encouraging outcomes, but there are still obstacles to overcome before clinical translation can occur[30].

Healthcare is changing as a result of artificial intelligence (AI), particularly in diagnostics. AI analyzes a tremendous amount of medical data, including imaging, wearable technology, and patient records, finding connections and patterns that human eyes could overlook. Better patient outcomes are the result of earlier and more accurate diagnoses have never been more accurate in the analysis of medical imagery, including MRIs and X-rays[31]. Radiologists become complete clinical decision-makers after evolving from diagnosticians. AI algorithms use genetic data to forecast medical outcomes. This combination benefits both tailored treatment plans and biomarker discoveries[32]. Expert cooperation guarantees morally sound and reliable AI solutions. By facilitating worldwide access to AI-driven diagnostics, we are democratizing healthcare.

In conclusion, AI and CRISPR are comparable to the dynamic pair that is contemporary medicine. Our genetic code is edited by CRISPR, and AI reads it with extreme precision. They are rewriting the story of health and recovery together[33].

Ethical Conundrums in AI Integration and Gene Editing

Genetic manipulation is the process of changing an embryo's DNA, which has an impact on both the person and subsequent generations. Safety, unforeseen repercussions, and the possibility of eugenic applications are among the ethical issues[34]. It is morally difficult to strike a balance between therapeutic and enhancement aims, and informed consent and autonomy are essential. Given that gene treatments are costly and not

[28] "What Is CRISPR? A Bioengineer Explains," accessed September 29, 2024, https://news.stanford.edu/stories/2024/06/stanford-explainer-crispr-gene-editing-and-beyond.

[29] Marine Laurent et al., "CRISPR-Based Gene Therapies: From Preclinical to Clinical Treatments," *Cells* 13, no. 10 (January 2024): 800, https://doi.org/10.3390/cells13100800.

[30] ibid

[31] "How AI Is Improving Diagnostics and Health Outcomes," World Economic Forum, September 25, 2024, https://www.weforum.org/agenda/2024/09/ai-diagnostics-health-outcomes/.

[32] "Diagnostics," accessed September 29, 2024, https://www.mdpi.com/journal/diagnostics/special_issues/NR723T6615.

[33] "How AI Is Improving Diagnostics and Health Outcomes."

[34] "AI and Gene-Editing Pioneers to Discuss Ethics," accessed September 29, 2024, https://news.stanford.edu/stories/2019/11/ai-gene-editing-pioneers-discuss-ethics.

always available, equity and access are significant ethical issues. Unintended outcomes, including mosaicism and off-target effects, continue to be a worry, therefore it's critical to weigh the possible hazards of therapy against its advantages. Because gene editing technology may be used for both good and bad, it presents a dual-use problem that calls for protection against abuse, such as bioterrorism.

Privacy and data confidentiality are important concerns in healthcare with AI enhancements[35]. AI technology is frequently acquired by private companies, which are important players in the acquisition, use, and security of patient health data. When data is in private hands, privacy issues surface and AI-driven techniques may jeopardize the de-identification or anonymization of patient health data. Under private custodianship, re-identification risks rise and affect patient privacy. Patient agency, permission, openness in AI interactions, and risk communication should all be prioritized in regulations. Sophisticated data anonymization techniques are encouraged by the need for systemic supervision and protection. Concerning safety, equality, access, unexpected effects, and data confidentiality, genetic tinkering poses ethical difficulties. Ensuring informed consent, upholding autonomy, and instituting institutional supervision are crucial in safeguarding patients and promoting ethical utilization of genetic therapies[36].

Islamic bioethics is a comprehensive approach that takes into account communal health, collective welfare (maslaha), and individual rights. The preservation of life and the "no harm" concept are emphasized in the Quran, along with the significance of reciprocal care and the role that intellectual agreement (ijma) plays in bioethical decision-making. The concept of fard kifayah, or communal responsibility, emphasizes the duty of the Muslim community to provide for necessities including social assistance, healthcare, and education. Ijma maintains uniformity and continuity in moral judgments while striking a balance between the needs of the general good (maslaha), preventing damage (data), and individual autonomy. It covers topics not specifically covered in the Quran or Hadith, and to reach a consensus, experts apply rigorous ethical reasoning[37].

Islam values human life as a priceless gift from Allah, and the Quran highlights the value of both human dignity and divine creation. This sacredness should not be violated or life put in peril by genetic alterations[38]. Islam supports seeking medical care and protecting life, yet it may be incompatible with the sanctity of life to modify genes for non-essential purposes. Gene therapy is acceptable as long as it accomplishes these goals without harming anyone and is used only for therapeutic, not destructive, purposes. Islamic ethics seek to cure genetic defects while upholding the dignity of life, placing a higher priority on preventing damage (darbar) and guaranteeing benefit (maslaha). Restrictions on genetic modification include making sure that genetic alterations don't have a deleterious effect on offspring, discouraging sex change procedures, changing an individual's physical characteristics, or changing the body as a whole[39].

[35] Mousa Al-kfairy et al., "Ethical Challenges and Solutions of Generative AI: An Interdisciplinary Perspective," *Informatics* 11, no. 3 (September 2024): 58, https://doi.org/10.3390/informatics11030058.

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[38] tech@whyislam.org, "Undefined," accessed September 29, 2024, https://www.whyislam.org/a-muslim-view-on-respecting-life/undefined.

[39] "Gene Therapy: Islamic Rules and Regulations - Fiqh," Islam Online, March 26, 2023, https://fiqh.islamonline.net/en/gene-therapy-islamic-rules-and-regulations/.

Islamic Perspective on Genetic Modification

Islam places a strong emphasis on the value of human dignity and the sanctity of life, regardless of race, language, or clan. In Islam, gene therapy is acceptable provided it complies with Shariah goals and meets requirements including causing no harm during the process, being used safely in agriculture, and not having an adverse influence on future generations. Since human dignity is seen as a gift from God, genome editing ought to uphold this fundamental dignity[40]. Technologies that change genomes, such as CRISPR, pose moral questions and put conventional ideas of human integrity in jeopardy. It is essential to weigh the therapeutic advantages against any hazards while also honoring innate dignity. Fairness, compassion, and care for the weak are central to Islamic ideas of social justice and equality, and medical advancements like CRISPR should help all facets of society. Fair access and the general good must come first in ethical matters.

Talks on bioethics are greatly influenced by religious experts, especially when it comes to new technology like AI and gene editing[41]. They provide valuable theological insights into bioethical discussions, offering advice on moral conundrums and striking a balance between tradition and advancement. Medical innovation standards that are consistent with Shariah guarantee that all elements of medical practice, including treatment, organ transplantation, and end-of-life care, comply with Islamic values. Several nations with a majority of Muslims are creating legal frameworks for AI and gene editing while taking social norms, cultural background, and religious beliefs into account[42]. The role of Islamic ethics in public engagement includes working with Muslim communities to address concerns, dispel myths, and encourage well-informed decision-making concerning bioethical issues. Islamic ethics places a strong emphasis on overall health, which includes mental, emotional, and spiritual well-being[43]. Scholars advocate for ethical discourses that balance scientific breakthroughs with spiritual ideals. This means that discussions on CRISPR, AI, and medical innovations should consider these interrelated aspects[44].

Genome Editing and AI in Muslim-majority Nations

Saudi Arabia has pioneered genomic research and execution. Scholars have investigated the potential of CRISPR in addressing genetic illnesses that are common in the area. Policymakers and religious experts keep a close eye on the ethical issues surrounding gene editing[45]. The United Arab Emirates (UAE) and other nations with a majority of Muslims have embraced AI in healthcare. Personalized treatment regimens, telemedicine, and AI-driven diagnostics are quickly becoming commonplace. AI systems that focus on patient well-being and conform to Islamic beliefs are guaranteed by ethical norms[46]. To solve ethical dilemmas,

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[45] Mohammed Ghaly, "Islamic Ethical Perspectives on Human Genome Editing," *Issues in Science and Technology* 35, no. 3 (2019): 45–48.

[46] "Human Germline Gene Editing from Maslahah Perspective: The Case of the World's First Gene Edited Babies | Journal of Bioethical Inquiry," accessed

academics use collective reasoning, or al-ijtihad al-jama'i. They work with biological specialists and take inspiration from Islamic texts such as the Quran and Sunna. Policy choices and the conversation around responsible implementation are shaped by case studies using CRISPR and AI.

Shariah-compliant regulations prioritize communal welfare, life preservation, and damage prevention. Therapeutic genome editing is consistent with these ideas. Academics weigh the trade-off between social gain and individual well-being. Many nations have created legal frameworks on AI and gene editing. Social values, cultural background, and Islamic principles are all integrated into these frameworks[47]. They guarantee that scientific developments uphold religious tolerance and benefit society. In public debate, issues are raised, misunderstandings are cleared up, and well-informed decision-making is encouraged. To involve communities, researchers, politicians, and bioethicists work together. Talks on ethics ought to be inclusive and sensitive to cultural differences. Holistic well-being, encompassing mental, spiritual, and bodily health, is emphasized in Islamic principles. CRISPR and AI ought to fit under these interrelated categories. Academics support moral conversations that balance spiritual principles with new technology[48].

Future Recommendation

These are some suggestions for the future that will pave new paths for the medical industry.

- Create bioethical principles for CRISPR and AI in healthcare that are consistent with Shariah.
- Encourage public participation in ethical dialogues about genome editing and understanding of the technology.
- In nations where Muslims predominate, establish specialized review bodies for bioethics.
- Promote interdisciplinary cooperation between researchers in religion, ethics, and science. Assure fair access to CRISPR and AI technologies following Islamic justice ideals.

September 29, 2024, https://link.springer.com/article/10.1007/s11673-021-10101-7.

[47] "The Ethics of Gene Editing from an Islamic Perspective: A Focus on the Recent Gene Editing of the Chinese Twins | Science and Engineering Ethics," accessed September 29, 2024, https://link.springer.com/article/10.1007/s11948-020-00205-5.

[48] Mohammad Yaqub Chaudhary, "Initial Considerations for Islamic Digital Ethics," *Philosophy & Technology* 33, no. 4 (December 1, 2020): 639–57, https://doi.org/10.1007/s13347-020-00418-3.

Conclusion

In conclusion, revolutionary developments in healthcare, especially in the fields of gene editing and customized treatment, are possible thanks to the combination of AI and CRISPR technology. But these developments also bring up important moral issues, particularly when considered from the perspective of Islamic bioethics, which places a strong emphasis on social justice, human dignity, and the sanctity of life. Islamic bioethics offers a sophisticated framework for assessing the appropriate use of modern technologies by referencing ideas found in the Quran, Hadith, and Shariah law. It is critical to include religious academics and communities in conversations on genome editing that strike a balance between scientific advancement and moral and spiritual principles. In the end, this research emphasizes the necessity of a deliberate and inclusive strategy that honors the moral precepts of many religious traditions as well as the state of contemporary medicine to ensure the ethical application of genome editing and artificial intelligence in healthcare