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Muslims and Modern Biotechnology: Issues, Concerns and the Way Forward

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Abstract

The article under consideration provides a conceptual and descriptive estimate of vast applications of modern biotechnology and the debates surrounding its use among Muslims. This research discusses bioethical issues in relevance to Islamic law (Maqasid al-Sharia) and the major jurisprudential

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maxims (Qawaid Fiqhiyyah) while suggesting the way forward for the Muslim community in such unprecedented situations

Keywords: Islam, Muslims, Biotechnology, Crispr, Genome, Stem Cell Technology, Cloning

Introduction to Biotechnology

Biotechnology is a vast field as it links biological science to the development of technology. Biotechnology intends to exploit organisms especially microorganisms or their biological processes to produce products that are beneficial for mankind (Dundar *et al*., 2019; Ramachandran *et al*., 2022). From the historical perspective the fermentation of wine and, preparation of yogurt, cheese, and bread through microbial metabolic processes were the applications of biotechnology. Nonetheless, modern biotechnology has made groundbreaking discoveries, especially in last the decade to fight against deadly pathogenic diseases, manage the increasing world's food supply, overcome energy crises through biofuels, and to have more efficient industrial processes (Dundar *et al*., 2019). Due to numerous applications of biotechnology in 2012, Kafarski used different colors to distinguish core areas of research. These colors such as red (medicinal), white (industrial), blue (marine), green (agricultural), and brown (desert biotechnology), among the others, are known as "Colors of Biotechnology". (Barcelos *et al*., 2018).

Merging biotechnology with advanced fields like nanotechnology and computer technology (bioinformatics) has created room for vast applications,

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particularly in medicine, agriculture, and industry. For example, there is microscopic equipment that can be introduced into body (nanotechnology) and results are analyzed with computer technology (Sadeer *et al*., 2023). Cloning and stem cell research in modern biotechnology has opened a new domain of regenerative medicine in which dead or malfunctioning cells, tissues, and organs are replaced. Besides health care in agriculture biotechnology has led to the production of genetically modified organisms (GMOs) and genetically modified food products. In the industrial sector, we find applications of novel and robust enzymes screened from microorganisms inhabiting diverse and extreme environments. These novel catalysts are mutated through genetic engineering to improve or suppress their activity. As an eco-friendly approach biotechnological enzymes are used to convert harmful pollutants to harmless substances and contribute to environment cleanup (Eskandar *et al*., 2023). Advanced applications of biotechnology and contribution towards humankind:

Whole Genome Sequencing and the Human Genome Project

The magnanimous project of sequencing the human genome was started in 1990. The rough draft of the "Human Genome Project" was completed by the year 2000 which comprises almost 90% of the human genome and the final version was prepared by the year 2003. It was a huge breakthrough in the field of biotechnology and it required the participation and efforts of numerous scientists as well as public and private programs. The major aim of the project was to electronically capture the data about the placement of every chromosome and the

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physical location of genes on chromosomes (Dundar *et al*., 2019).

Advancements in whole genome sequencing (WGS) resulted in the 100,000 Genome Project of England (2012-2018). The purpose of this project was to figure out the role of genomics in healthcare, integrating WGS in routine healthcare, and developing the world's largest genomic healthcare data assets. Under this project, the 100,000 genomes from 85,000 NHS patients in the UK suffering from a rare disease of cancer were sequenced and analyzed (Trotman *et al*., 2022; Lyulcheva-Bennett et al., 2023). Such data is a source of a multitude of novel genetic variations whose diagnostic potential is yet to be discovered (Lyulcheva-Bennett *et al*., 2023).

Stem Cell Technology and Cloning

Stem cell technology is one of the applications of biotechnology. The graph of stem cell research and its applications in drug development, cancer treatment, immunohistochemistry, and tissue engineering are escalating tremendously from 2013 to 2024 and a 25.5% annual growth rate was observed in the stem cell market between 2015 and 2022. The core ability of stem cells to divide and differentiate into different specialized cell types has resulted in the development and progress of stem cell technology. Due to the ability to regenerate and replace damaged tissues the adult and embryonic stem cells have potential applications in regenerative medicine. For example, embryonic stem cells are used as a cure for diabetes as these cells have the ability to replace the damaged beta-pancreatic cells that are involved in insulin secretion (Debich and

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Bill, 2022). Stem cell technology is applied for the treatment of various malignant and non-malignant diseases and transplantable organs such as the liver or heart are produced through mesenchyme stem cells and tissue engineering. Moreover, whole organisms can be cloned through stem cells (Deo *et al*., 2022).

The female dolly sheep was cloned for the first time in 1996. The dolly was cloned through the process of nuclear transfer by using the adult somatic cells from the mammary gland of the sheep. Cloning of the dolly was a major breakthrough as it revealed that the whole new embryo can be cloned from the somatic cells obtained from a specific part body or the cell can be obtained from a fully developed adult organism (Niemann *et al*., 2008). Through somatic cell nuclear transfer (SCNT) the species that are endangered or at the brink of extinction can be conserved. For example, the Pyrenean ibex (wild mountain goat) which was declared extinct in the year 2000 was cloned by Spanish scientists using DNA from its skin samples. Unfortunately, it did not survive long and died because of lung defects (Kincaid, 2022). In the year 2022 reconstructed embryos of first- and second-generation cloned goats by SCNT foster the efficiency of transgenic cloned animal production (Song *et al*., 2022).

Advanced Gene Editing Technologies

Since the double helical structure of DNA was given by Watson and Crick in 1953 since then scientists have been putting their efforts into artificially modifying the DNA and then noticing the changes that have occurred in an organism as a result of those mutations. In year 1990, the

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first gene editing trial was done on a four-years-old girl when adenosine deaminase (ADA) producing genes were cast into the DNA of WBCs (***Akhtar et al., 2011).***

Recently studies regarding functional genomics are occurring at a fast pace because of advancements in genome editing technologies that are capable of precisely modifying the genome of an organism. One such hot and useful genome editing technology of today's world is clustered regularly interspaced short palindromic repeats associated with protein 9 (CRISPR-Cas9). CRISPR-Cas9 is an enzyme that is used to target a particular segment of the DNA by adding or deleting genes or by creating point mutations. There are various applications of this gene editing system in medicine, animal breeding, plant and environmental sciences (Tavakoli *et al*., 2021).

Through CRISPR technology genes activation, suppression, insertion or deletion in prokaryotes or eukaryotes can be performed effortlessly for example while using CRISPR technology the genome of *H. hispanica* is modified in order to make it adaptable to non-lytic viruses (Khan *et al*., 2016). CRISPR-Cas9 is successfully applied in the agriculture sector to improve crop yield and nutrition and enhance its resistance against several diseases, pathogens, and other biotic stresses like drought, salinity, temperature, etc. (Tavakoli *et al*., 2021). For example, in order to improve disease resistance in rice mitogen-activated protein kinase-5 (***OsMPK5***) gene was removed through the CRISPR-Cas9 system

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(Hillary *et al*., 2019).

Other genome editing techniques are the nuclease enzymes i.e., zinc finger nuclease (ZFNs) and transcription activator-like effector nuclease (TALENs). ZNF are the proteins that perform targetable DNA cutting (Mehravar *et al*., 2019). TALENs are an indispensable gene editing tool through which double-stranded breaks (DBs) are created precisely in targeted sequence. These DBs activate DNA repair pathways that lead to repair [Bhardwaj *et al*., 2021]. All genome editing techniques have their pros and cons but CRISPR holds an edge over ZFNs and TALENs because of its several advantages like less complex, low cost, high speed, and efficiency (Tavakoli *et al*., 2021).

Genetically Modified Organisms (GMOs)

Genetically modified organisms (GMOs) are the result of advancements in modern biotechnology. A GMO is an organism whose genetic makeup has been modified in the lab in order to have the desired trait or product (Fridovich-Keil and Diaz, 2023). GMOs are produced by reproductive cloning and recombinant DNA technology. Reproductive Cloning is the intended production of genetically identical organisms either by embryo splitting or by somatic cell nuclear transfer (National Research Council, 2002). In recombinant DNA technology, different genetic materials are recombined and then inserted into the host for an altered expression (Griffiths, 2023). GMOs have revolutionized the agriculture sector for instance genetically engineered crops are produced that have higher yields and are resistant to extreme temperatures, salinity, pests, and insect attacks. Moreover,

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genetically modified foods are more nutritious for example genetically modified golden rice produces beta carotene 20 % more than its natural variety (Fridovich-Keil and Diaz, 2023).

Vaccine and Therapeutics

With advancements in genomics and reduction in the cost of WGS modern biotechnology has provided a platform for the development of vaccines against fatal diseases. The vaccine is a live attenuated microbe or a part of a microbe like sugar or protein that induces a protective immune response. Vaccines are based on inactivated toxins (toxoids), surface antigens, recombinant DNA or mRNA, recombinant plasmids, immunologic adjuvants, microencapsulation, nanoparticle-based delivery systems, and novel antigen expression systems such as bacteriophages, etc. (Priya *et al*., 2022). These biotechnology-based vaccines have proved effective against killing viruses, for example, nano vaccine MalariVax is active is against malaria while Mosqurix® works against both HBV and *Plasmodium falciparum* (Wang *et al*., 2019; Nooraei *et al*., 2021).

Advancements in Biotechnology: Opportunities and Bioethical Concerns for Muslims

As discussed above modern biotechnology has limitless potential and is positively contributing to society while revolutionizing medical, industrial, agricultural, and environmental sectors but the crust of the discussion is to bridge the relationship between modern biotechnology and bioethics from an Islamic perspective. Although genome sequencing, advanced gene editing technologies,

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stem cell therapy, production of GMOs, and drug development in modern biotechnology have improved the quality of life at the same time, there are some ethical issues related to religion, faith, and belief that must be addressed. Understanding these ethical issues will provide the best possible solutions to the problems (Engku Ahmad Zaki *et al*., 2013).

Cloning

The cloning technique has several merits and demerits. The advantages of cloning include the propagation of plants and animals with desired traits, recreating or conservation of extinct or endangered species, treating infertility, eliminating hereditary diseases by gene cloning, recovering damaged tissues, replacing damaged organs such as heart or liver, etc. Besides benefits there are also some drawbacks of cloning such as the inadaptability of cloned organisms to environmental stresses, genetic problems and complexities in the long run, premature aging problems for example in the case of cloned dolly sheep, reduction in the genetic variability and biological disorders for example cancer and threat that cloned organisms will take over human beings, it is against the nature, it damages religious and moral beliefs, it is against traditions like marriage and family relationships etc (Nabavizadeh *et al*., 2016).

According to Islam therapeutic cloning i.e., cloning of human cells for disease treatment or replacing diseased organs is allowed by most religious scholars. In the case of reproductive cloning, there are different religious schools of thought. According to Sunni scholars reproductive cloning of humans is

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completely not allowed as it is playing with nature while Shia scholars have different viewpoints in this regard. One category has completely banned it because of its potential disadvantages. The second category (Ayatollah Sistani and Ayatollah Moosavi Ardabili) has allowed it if the purpose is to reconstruct the damaged tissue. The act of cloning is not outlawed because, there is no Islamic proof that reprogramming a zygote—which is still too immature to be recognized as a human, so there is no room for fear of murder—is haram, hence it makes no sense to outlaw the act of cloning itself. The third category (Ayatollahs Seyed Kazem Haery and Seyed Sadegh Shirazi) believes that it is not prohibited naturally but because of possible negative outcomes, it is considered a secondary prohibition (Nabavizadeh *et al*., 2016; Hosseinabadi *et al*., 2021).

CRISPR/Cas9: The Gene Editing Technology

Genome editing technologies have brought magnificent changes in the world but at the same time, some religious ethical concerns are also linked with it. CRISPR/Cas9 has an edge over other genome editing technologies because of reduced cost and greater targeting efficacy. CRISPR technology is applied to treat diseases, and hereditary disorders. An effective gene therapy in animal models (mouse) and humans has been accomplished through CRISPR/Cas9 (Musunuru, 2021). Although CRISPR has provided the opportunity to the understand mechanisms of different genetic maladies certain ethical concerns are put forward by the Muslim community regarding germline modifications (embryo, egg, sperm, or DNA) (Alsomali *et al*., 2021).

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The ethical issues in Science such as the application of CRISPR technology in germline editing are not referenced from the Quran and Sunnah directly so for such issues "ijtihad" is preferred. In "ijtihad" Muslim jurists thoroughly work on the ethical issue and collect proofs from both the sources (Quran and Sunnah) to give final decision (Fatwa) (Isa *et al*., 2016). According to the objectives of Islamic law (Maqasid al-Shari'a) and the major jurisprudential maxims (Qawaid Fiqhiyyah) CRISPR technology for therapeutic purposes is permissible either it is for germ line modification but the safety or ethical concerns must be resolved (Alsomali *et al*., 2021).

According to the basic Islamic principle "Preservation of human beings and their lineage", positive use of technology is always encouraged for example preventing the transmission of genetic diseases in descendants. However, the attainment of such an objective must be done while considering all the safety considerations and preventing any contradiction to other Shariah principles such as equal or more damage to human beings and future generations (Isa *et al*., 2020).

Genetically Modified Organisms and Products

The cutting-edge application of modern biotechnology GMOs has raised ethical concerns according to Islam. Genetically modified is beneficial for the world as it has created easy access to food and saved many lives but according to the Islamic ethical perspective genetically modified food must be halal i.e. it is free from religiously prohibited ingredients and the process applied to acquire it

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must also be thoyibban. If genetically modified food does not maintain these criteria, then it is not permitted to be used according to Maqasid al-Shari'ah (objectives of shariah) (Idris *et al*., 2020; Deo *et al.*, 2022). The modified genes are not limited to a particular generation rather they are transmitted to the progeny so the offspring with better traits will replace the natural beings and their unexplored influence on the ecosystem might disturb its balance. Another bioethical concern for the Muslim community is that genetically modified food may have unknown allergenic or toxic side effects (Zupan 2019). According to Islam the genetically modified products must not contain genes from forbidden sources like pork (Rapi *et al*., 2020). The National Council of Fatwa Islamic Affairs Malaysia in 2011 gave the rule that:

"The use of forbidden materials and materials detrimental to humans and the environment in the production of GM food is banned. Whereas, halal livestock is permissible only when the animals are slaughtered in accordance with the procedures prescribed by the Shari'ah."
(National Council of Fatwa Islamic Affairs Malaysia, 2011; Idris *et al*., 2020).

In the Islamic context genetically modified products must be properly labeled i.e., the sources of gene extraction must be mentioned. If the genetically modified food is licensed halal by the Department of Islamic Development Malaysia (JAKIM) then it is considered harmless and it contains a logo of 'Genetically Modified Food' on its packaging. The labeling of the genetically

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modified products is mandatory as people have the right to be aware of what they are consuming (Rapi *et al*., 2020).

Vaccine Development

Vaccination the most promising application of modern biotechnology has saved millions of lives worldwide. Protecting human life is the foremost objective of the worldwide vaccination program. Vaccination programs have proven fruitful in eradicating the lethal diseases from the world like smallpox etc. In alliance with Maqasid al-Shari'a i.e., religion (din), life (nafs), lineage (nasl), intellect (aql), and property (mal) the primary goal is to preserve the quality of human life (Islam *et al*., 2018; Ghazali *et al*., 2023). There is a Hadith of Prophet Mohammad S.A.W. in the context of disease treatment narrated in Sahih al Bukhari:

"There is no disease that Allah has created, except that He also has created its treatment"
(Sahih al Bukhari, no. 5678).

The ethical concern regarding vaccination is that the ingredients used for the development of vaccines must be halal. For example, there was no acceptability towards the use of two vaccines Rotarix and Rotateq against Rotavirus because they contained trypsin derived from pigs during their manufacturing procedure. Similarly, vaccines derived from forbidden sources in Islam (swine, pig) are prohibited from being consumed (Khoo *et al*., 2020).

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Way Forward

Muslims are obligated by their religious beliefs to abstain from using techniques and products that are forbidden in their daily lives. The Quran and Sunnah provide the fundamental guidelines for what is and is not permitted. However, the guidelines provided by the Quran and Sunnah are quite broad. In actuality, Muslims would have to devise new resolutions every time a new type of product or method of product manufacturing emerged. This is the point at which the halal certification becomes relevant. The certification serves as proof that the edicts of the religion have been adhered to. The ongoing settlement of fatwas under the light of Islamic law (Maqasid al-Sharia) on diverse halal-related bioethical issues is required in order to serve as a guide for the authorities responsible for halal certification (Asa et al., 2018).

Conclusion:

The study has discussed the importance of modern biotechnology and how its applications have revolutionized the world. The study has compiled and analyzed the opportunities created for Muslims with the advancements in the field of Biotechnology and what are the bioethical issues in Islam related to the use of the latest techniques like genetic engineering, vaccine development, cloning and stem cell technology, GMO production, etc. This research has discussed these bioethical issues in relevance to Islamic law (Maqasid al-Sharia) and the major jurisprudential maxims (Qawaid Fiqhiyyah) while suggesting the way forward for the Muslim community.

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