Genetic Engineering:

An attempt to ask the right questions

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Abstract

The question "what is the Islamic stance of genetic engineering?" is quite overgeneralized and increasingly becoming irrelevant. We need to, first, understand the complex developments in this field, and then perhaps ask specific questions about specific issues. The issues involved are not only moral, but also philosophical, environmental, political, economic, social, legal, strategic, etc. This report attempts to identify some important questions and cites some related references. Eventually, it outlines - in brief and general terms - a new approach to researching this field, based on a "maqasid methodology".

Fiqhi opinions on genetic engineering

In my view, contemporary Islamic law (*al-fiqh al-mu'asir*) is still at the general statements stage in this field. A survey of the body of related fatwas - including previous FCNA fatwas - shows the need for a higher level of sophistication in fatwa, in order to match the technologies that scientists in this field have reached.

Generally, there is an agreement amongst contemporary scholars that genetic engineering includes what is useful and thus lawful, and what is harmful and thus prohibited. And fatwas generally allow research and treatments related to a person's genome only after what they call a "rigorous and prior assessment of the risks and potential benefits",[1] which is according to what they call "consultations with specialists".[2] Thus, fatwas in contemporary juridical literature fall under the following categories:

Genomes fatwas: 1- No person shall be subjected to any form of "discrimination" based on his/her genetic characteristics. 2- Genetic engineering cannot be used for "evil" or "aggressive" purposes. 3- The creation of "hybrid organisms", motivated by entertainment or curiosity, is prohibited.

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[1] Examples of related Fatwa Council decisions: Islamic Organization for Medical Sciences (I.O.M.S.) (Kuwait):The 11th symposium: (Genetics, genetic engineering, genome and gene therapy - Islamic vision), with the participation of Islamic Fiqh Academy in Jeddah, the Regional Office of the World Health Organization in Alexandria and the Islamic Educational, Scientific and Cultural Organization 13 - 15 October 1998, http://shamela.ws/browse.php/book-8356/page-18586#page-18586; International Islamic Fiqh Academy, Decision no. 203 (9/21) on Genetics, Genetic Engineering and Human Genome: http://www.iifa-aifi.org/2416.html

[2] FCNA - Fatwa answering the question: "What is the Islamic stance on embryonic stem-cell research?", FCNA archives.

Gene "therapy" fatwas: 1- Genetic engineering may not be used as a policy to an "improvement" of the human race. 2- Any attempt at "genetic tampering" with the human personality or interference with its capacity for individual responsibility is prohibited. 3- This type of treatment should not cause "greater harm" than the already present.

Human cloning/Stem cell fatwas: Fatwas strictly prohibited "human cloning" and "designer babies" because humans are only created by Allah and to avoid "harm" to nature and family.[3]

The following is a quick survey of a selection of the latest developments and technologies in these areas mentioned above, including some references to related fatwas and opinions.

1. Genome editing

The debate about genome editing is not new but has regained attention following the discovery that CRISPR[4] has the potential to make such editing more accurate and even "easier" in comparison to older technologies.[5] As of 2014, there were about 40 countries that discouraged or banned research on germline editing, including 15 nations in Western Europe, because of "ethical and safety concerns".[6]

This new technique still under discussion, according to WHO this recent application of tools such as CRISPR-Cas9 to edit the human genome need to develop the standards in this area. Newly (closed on Feb 2019) WHO solicited proposals for nominations of experts to serve on its Expert Advisory Committee on Developing Global Standards for Governance and Oversight of Human Gene editing.[7]

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[3] Refer to: https://www.researchgate.net/publication/321049666_Human_genetic_issues_from_scientific_and_Islamic_perspectives

[4] For more information on CRISPR, refer to: Barrangou R (2015). "The roles of CRISPR-Cas systems in adaptive immunity and beyond". Current Opinion in Immunology. 32: 36–41. doi:10.1016/j.coi.2014.12.008. PMID 25574773. Zhang F, Wen Y, Guo X (2014). "CRISPR/Cas9 for genome editing: progress, implications and challenges". Human Molecular Genetics. 23 (R1): R40–6. doi:10.1093/hmg/ddu125. PMID 24651067. CRISPR-CAS9, TALENS and ZFNS - the battle in gene editing https://www.ptglab.com/news/blog/crispr-cas9-talens-and-zfns-the-battle-in-gene-editing. Hsu PD, Lander ES, Zhang F (June 2014). "Development and applications of CRISPR-Cas9 for genome engineering". Cell. 157 (6): 1262–78. doi:10.1016/j.cell.2014.05.010. PMC 4343198. PMID 24906146. Horvath P, Barrangou R (January 2010). "CRISPR/Cas, the immune system of bacteria and archaea". Science. 327 (5962): 167–70. doi:10.1126/science.1179555. PMID 20056882.

[5] The National Human Genome Research Institute, Genome Editing, https://www.genome.gov/27569225/what-are-the-ethical-concerns-about-genome-editing/

[6] The National Human Genome Research Institute, Genome Editing, https://www.genome.gov/27569225/what-are-the-ethical-concerns-about-genome-editing/

[7] https://www.who.int/ethics/topics/human-genome-editing/en/

A. Human genome editing : A scientist in China claim to have created "the world's first genetically edited baby".[8] Bioethicists and researchers generally believe that human genome editing for reproductive purposes should not be attempted at this time.[9]

B. The manufacturing of materials from petrochemicals could potentially be replaced by harnessing synthetic biology to make products using biology on an industrial scale. It has been suggested that synthetic biology might offer solutions to the urgent challenge of climate change – potentially offering microbes that sequester carbon dioxide, better energy storage and greener chemical and industrial processes. For example, the manufacture of materials from petrochemicals could potentially be replaced by harnessing synthetic biology to make products using biology on an industrial scale.[10]

C. There are also current and future research applications such as: High value natural products which could be produced by harnessing synthetic biology systems include the malaria drug artemisinin - derived from the sweet wormwood plant; the chemotherapy drug paclitaxel (Taxol) that requires six 100-year-old Pacific yew trees to derive enough for the treatment of one patient; perfumier's ingredient ambergris expelled from the intestines of sperm whales onto the ocean floor; food flavouring vanillin from the vanilla orchid, etc.[11]

D. Harnessing biology to build inorganic materials also has the benefit of using soft, biological templates offering flexibility, and overcoming physical materials problems such as lattice mismatch issues.[12]

E. Gene editing in wild animals: Scientists do have concerns about the way gene editing could be used, the increasing use of CRISPR to edit the genomes of wild animal populations. Unless properly regulated and contained, this research has the potential to rapidly alter ecosystems in irreversible and damaging ways.[13]

F. Scientists used CRISPR to modify mosquitoes and the fruit fly Drosophila melanogaster. And in combination with another molecular-biology technique called gene drive, they

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[8] https://www.theguardian.com/science/2018/nov/26/worlds-first-gene-edited-babies-created-in-china-claims-scientist

[9] The National Human Genome Research Institute, Genome Editing, https://www.genome.gov/27569225/what-are-the-ethical-concerns-about-genome-editing/

[10] Sackler Forum 2015 , Trends in synthetic biology and gain of function and regulatory implications, Page 9, National Academy of science, http://www.nasonline.org/programs/sackler-forum/sackler-forum-2015-report.pdf

[11] Sackler Forum 2015 , Trends in synthetic biology and gain of function and regulatory implications, Page 14, National Academy of science, http://www.nasonline.org/programs/sackler-forum/sackler-forum-2015-report.pdf

[12] Refer to: https://www.genomecanada.ca/

[13] Madeleine P. Ball: Regulate gene editing in wild animals. (Nature) 12 May 2015, https://www.nature.com/news/regulate-gene-editing-in-wild-animals-1.17523

have found a way to massively increase the efficiency of spreading these transformations to offspring and through the population. Once introduced, these genetic changes are self-propagating. If released beyond the laboratory, the effects would spread with every new generation and would quickly run out of control.

G. **Cas9 gene drives curb malaria:** Gene drives are only one of several promising strategies for genetically modifying mosquitoes to decrease transmission of malaria parasites to humans.[14] Gene drives may also be used to potentially spread particular genomic alterations through targeted wild populations over many generations. It uses mosquitoes as an example of a target species – and illustrates how the versatile genome editing tool called CRISPR makes it possible.[15] Scientist are still learning how ecosystems work, so the process of gene drive must be evaluated on a case-by-case basis. because it is possible that a particular altered trait could cause unexpected and possibly harmful side-effects on other organisms when spread through a particular species using a drive.[16]

There is a related concern for the environment according the World Health Organization[17]: 1- The capability of the GMO to escape and potentially introduce the engineered genes into wild populations; 2- the persistence of the gene after the GMO has been harvested; 3-the susceptibility of non-target organisms (e.g. insects which are not pests) to the gene product; 4-the stability of the gene; 5-the reduction in the spectrum of other plants including loss of biodiversity; and 6-increased use of chemicals in agriculture).

The question is: How can you estimate the unexpected negative consequences that negatively affect the environment? For example, one type of sugar beet that had been engineered to be resistant to a specific herbicide ended up unintentionally having the genes to resist a different herbicide. When farmers went to eliminate the crop, they still found that a small percentage had survived).[18] Another example is the migration of genes from GM plants into conventional crops or related species in the wild.

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[14] Luke Alphey. Can CRISPR-Cas9 gene drives curb malaria?, Nature Biotechnology volume 34, pages 149–150 (2016), https://www.nature.com/articles/nbt.3473

[15] https://www.synthego.com/blog/gene-drive-crispr

[16] (We can learn to build and optimize gene drives in a species without risking release into wild populations by separating required components (so they can't be copied together) and having them cut sequences that aren't present in wild populations. • Drives that could theoretically spread through a wild population could be safely developed and tested in laboratories located in areas where the target species can't survive and find mates. For example, drives affecting tropical species could be developed and tested in temperate laboratories and vice versa.). Hansjörg Wyss Institute for Biologically Inspired Engineering at Harvard University: https://wyss.harvard.edu/staticfiles/newsroom/pressreleases/Gene%20drives%20FAQ%20FINAL.pdf

[17] Frequently asked questions on genetically modified foods, https://www.who.int/foodsafety/areas_work/food-technology/faq-genetically-modified-food/en/

[18] http://www.geneticallymodifiedfoods.co.uk/ethical-concerns-gm-foods.html

2. Gene therapy

Questions: What are the determinants of the use of gene therapy? How can the damage be measured? Who measures the extent of harm to the patient?

There are a number of important challenges and ethical organizational implications that will require a whole organization strategy:

1) Impact of genomics on current healthcare services, resources and patient pathways (including equity of access to genomic tests). 2) Ensuring that systems are in place for genomic and related clinical data collection, storage and sharing. 3) Responsible policies for responding to unexpected findings and using secondary finds effectively.[19]

The following are some related emerging technologies:

A. Genetic manipulation of stem cells: replacement of cartilage, heart valves, cerebrospinal shunts

B. Commercial companies are deriving therapeutic proteins, such as monoclonal antibodies, from the milk of transgenic cows, goats, rabbits, and mice, and using them to administer drugs in treatment protocols for rheumatoid arthritis, cancer, and other autoimmune disorders.

C. Xenotransplantation (the transplantation of living tissues or organs from one species to another) For ex.: the use of cell transplantation therapy for patients with spinal cord injury or Parkinson's disease.

D. The production of human eggs from blood cells in the breakthrough to treat infertility.

3. Genetic modification

Question: Is it permissible to use genetic modification to prevented future disease? or to resist future infectious diseases such as HIV?

A related Fatwa from the International Islamic Fiqh Academy, Decision no. 203 (9/21) on Genetics, Genetic Engineering and Human Genome: Genetic engineering may not be used to alter the infrastructure for the prevention of disease, or to attempt to tamper with the human personality or interfere with its eligibility.[20]

The following are further questions that were not answered in related fatwas so far:

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[19] Hilary Burton & Ingrid Slade: Public health and genomics (Genomics in mainstream medicine), HEE Genomics Education Programme Health Education England, August 2017, http://www.phgfoundation.org/documents/public-health-and-genomics.pdf

[20] International Islamic Fiqh Academy, Decision no. 203 (9/21) on Genetics, Genetic Engineering and Human Genome: http://www.iifa-aifi.org/2416.html

- Is it permissible for a parent to decide to have a new child with appropriate characteristics to donate to his older brother who is ill?
- Is it permissible to use genetic modification for the treatment of a disease spread in a country for an entire generation?
- Are parents entitled to change the sex of the fetus?
- Is it permissible to use genetic modification to determine physical and mental characteristics such as eye color and IQ?
- If it is permissible, will these improvements in offspring be fair? Or will the rich get it? Will there be a single layer that can improve her offspring to shine the most beautiful and smart, for example?

4. Creating new species

Question: Is Creating new species permissible in Islam?

The following are further questions that were not answered in related fatwas so far:

- The Issue of Species Boundaries.
- Give children every advantage: Creating new physical or behavioral traits

5. **Scientific and research uses**

The following are further questions that were not answered in related fatwas so far:

- Create animal models for research to mimic diseases or study development by mutating or silencing genes. For example, a mouse model has been developed to test the deleterious effects of mutations in cancer by introducing loss of function mutations in tumor suppressor genes or gaining of function in proto-oncogenes.[21]
- The experimental use of animals: create animals that would suffer as a result of genetic alteration

6. The use of genetic engineering in plants and animals:

The use of genetic engineering in plants and animals is permissible, but restricted to the most important controls: (1) This use shall not result in immediate or future damage. (2) Such use is for a valid purpose permitted, without tampering or waste. (3) To be conducted by those with experience and trust. (4) Genetic engineering may not be used for harmful purposes.

The following are further questions that were not answered in related fatwas so far:

- Creating human-animal hybrids for specific research purposes?

[21] https://www.omicsonline.org/open-access/ethical-issues-in-genome-editing-using-crisprcas9-system-2155-9627-1000266.php?aid=70914

- The blending of animal and human DNA results, in chimeric entities possessing degrees of intelligence or sentience never before seen in nonhuman animals.
- Combining animal DNA or human DNA with plant DNA.
- Transplantation of cells or organs from animals to humans.

7. Genetically modified foods:

We have been mixing species of plants and animals for thousands of years through selective breading. Breading through genetic engineering is a different topic. But according to the Islamic Jurisprudence Council (IJC), foods derived from biotechnology-improved (GMO) crops are all "halal". Some scholars have suggested that foods derived from biotechnology-improved crops could possibly become haram (non-halal) if they contain DNA from forbidden foods, such as pork.[22]

And according to world health organization, genetically modified foods currently available on the international market have passed safety assessments and are not likely to present risks for human health.[23]

Genetically Modified Crops & Halal Workshop held on the second day of the 5th World Halal Forum 2010, sought to begin discussions on the Islamic stance of Genetically Modified Food. (At the end of the workshop panelists and participants unanimously agreed to the following statement: A. Biotech crops and products have undergone intensive food and environment safety tests and are acceptable in the Islamic world as Halal, provided the sources are Halal. B. Biotechnology awareness building strategies that would encourage and improve public participation in the decision-making process on biotechnology-related issues. C. Biotechnology awareness and education programs need to be established by private and public sectors to increase biotechnology perception in the country. D. The role of Islamic scholars (Ulama) in scientific discussions involving the developments of biotechnology, in particular the production of food derived from genetically modified crops must be enhanced.)[24]

International Islamic Figh Academy decided not to allow the use of fodder on: dead residues, blood, pork, hormones, antibiotics, agent materials.[25]

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[22] http://www.agbioworld.org/biotech-info/religion/halal.html

[23] Frequently asked questions on genetically modified foods, the World Health Organization https://www.who.int/foodsafety/areas_work/food-technology/faq-genetically-modified-food/en/

[24] GENETICALLY MODIFIED (GM) CROPS & HALAL WORKSHOP REPOR, WORLD HALAL FORUM 2010, 22 JUNE 2010 KUALA LUMPUR CONVENTION CENTRE, http://www.ask-force.org/web/Islam/GM-Crops-World-Halal-Forum-Kuala-Lumpur-2010.pdf

[25] "The impossibility and consumption of additives in food and medicine" Decision No. 210 (6/22) second session, period: 2-5 Jumada II 1436 H, corresponding to 22-25 March 2015, International Islamic Figh Academy, established by the Organization of Islamic Cooperation, http://www.iifa-aifi.org/3988.html

Question: What are the main issues of concern for human health?

According to the World Health Organization[26] : 1) **Allergenicity**: As a matter of principle, the transfer of genes from commonly allergenic organisms to non-allergic organisms is discouraged unless it can be demonstrated that the protein product of the transferred gene is not allergenic. 2) **Gene transfer**: Gene transfer from GM foods to cells of the body or to bacteria in the gastrointestinal tract would cause concern if the transferred genetic material adversely affects human health. 3) **Outcrossing**: The migration of genes from GM plants into conventional crops or related species in the wild (referred to as "outcrossing"), as well as the mixing of crops derived from conventional seeds with GM crops, may have an indirect effect on food safety and food security. Cases have been reported where GM crops approved for animal feed or industrial use were detected at low levels in the products intended for human consumption).

The following are further questions that were not answered in related fatwas so far:[27]

- How do scientists determine if a new GM food is safe for human consumption?
- Who will control this to ensure that all product in market will be safe?
- Are there implications for the rights of farmers to own their crops?
- How do we govern intellectual property rights to genes ?.
- How do we control the migration of genes from GM plants into conventional crops or related species in the wild? One type of sugar beet that had been engineered to be resistant to a specific herbicide ended up unintentionally having the genes to resist a different herbicide. When farmers went to eliminate the crop, they still found that a small percentage had survived.[28]

7. Defence applications:

This is an important area of research, from an Islamic law point of view, due to its special context and application. We now have bullet-proof skin,[29] and many other weapons that are already in use.[30]

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[26] Frequently asked questions on genetically modified foods, https://www.who.int/foodsafety/areas_work/food-technology/faq-genetically-modified-food/en/

[27] According to the World Health Organization, genetically modified foods have an impact on farmers' rights: https://www.who.int/foodsafety/areas_work/food-technology/faq-genetically-modified-food/en/

[28] http://www.geneticallymodifiedfoods.co.uk/ethical-concerns-gm-foods.html

[29] https://labiotech.eu/bioart/bulletproof-skin-goat-milk-spider-silk/

[30] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1326447/

DISCUSSION

All of the above issues, questions and fatwas beg a number of fundamental questions, including:

1. How do we define "discrimination" in relation to genetic engineering? And does it include depriving a certain section of the human race from the latest technology of genetic engineering?
2. How do we define "aggressive" procedures? And what is the relation between this definition and defence purposes for individuals or nations?
3. How do we define "changing God's creation", including "genetic copying" and "hybrid organisms"? Does that include material or animal genetic components? Is the issue with animal components the prohibition of (the consumption of) alcohol and pork, as we see in some fatwas, or are there other ethical considerations?
4. What do we mean by genetic therapy? What constitutes an illness, from an Islamic point of view? Is infertility, for example, a "disease" that requires therapy or is it a "natural" division of providence?
5. How do we define genetic improvement and tampering? And what if they are for the sake of a stronger/healthier individual or nation? And what about "improvement" of other species, such as plants and animals?
6. How do we assess benefit and harm in this field?
7. What are the different levels and forms of the so called human cloning and designer babies?
8. Are the above ethical questions restricted to humans, or do we ask the same questions for plants and animals?

In my view, the above questions -and many others- require a new approach that is phenomena-based case-by-case rather than general judgements, and that considers a larger number of fundamental elements of reasoning (*usul al-ijtihad*). The following is a simple list of these fundamentals of what is introduced elsewhere as the "Maqasid Approach":[31] 1) objectives, 2) concepts, 3) human categories, 4) universal laws, 5) values, 6) proofs, and 7) rulings.

In terms of objectives (*maqasid*), the purposes behind these technologies have to be part of judging them. The relationship between the human purposes and the divine purposes have to be explored.

Concepts (*mafaheem*), such as: discrimination, evil, aggressive, hybrid organisms, therapy, improvement, tampering, benefit, harm, etc., have to be defined in terms of the Islamic meanings and within the Islamic worldview.

Human categories (*fi'at*) are not the same when it comes to genetic engineering. Examples are: men, women, spouses, parents, soldiers, rulers, disabled persons, ill persons, etc. How can we define the human categories involved in these processes in light of the Quranic guidance?

[31] Refer to the Maqasid Institute research project at: www.maqasid.org

Universal laws of Allah (*sunan ilahiyyah*) are natural higher-level processes that Allah created at the core of the creation of the universe. What are the universal laws related to the human innate nature (*fitrah*) and related to human civilization (‘*umran*), and how do they impact our judgement of genetic engineering?

Values (*qiam*) are related to morality, beauty and utility - according to the Islamic definitions of these dimensions. How can values be part of our judgements in this field?

Proofs (*hujaj*) are at the heart of the logic that we use in our arguments about this subject. How can we follow a Quranic and Prophetic way of arguing?

Finally, there are no direct statements in the Islamic sources about genetic engineering. However, the stated rulings (*ahkam*) of obligations and forbiddances in the Shariah have to be an integral part of the final judgements.

In terms of process, this will require a large multi-disciplinary committee to work on issuing these fatwas, rather than the usual “expert advise”. It will also require a strategy for the Umma and humanity.