Human Genetics and its Applications
A Comparative Juristic Study

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Dr. Al-Ludaimi was born in Aleppo, Syria, in 1966. He is a dentist who graduated from Al-Baath University in 1989. He holds a Master's degree in Islamic Jurisprudence from Damascus University, 2006, and a Master of Comparative Jurisprudence from Omdurman University, 2005. He has a degree in Sharia from the University of Damascus in 1998 and a diploma in Comparative Jurisprudence from Omdurman University in 2001. He has published many researches in scientific journals.

The book contains three chapters; in chapter one, the author described the scientific background of cells, human genetics and mode of inheritance of genetic material. He also described the concept of genetic applications including genetic screening, diagnostic and therapeutic interventions and cloning. This was followed by an extensive review and exploration of different Islamic rulings used in proving or refuting lineages and the role of evidence (*bayyina*) Islamic rulings. Considering genetic fingerprint as evidence, he discussed its application in proving or refuting paternity, adultery, civil status proof and other crimes. This was followed by discussing the legitimacy of genetic applications including screening, diagnostic and therapeutic intervention in various stages of the human body, as well as cloning and research in the genetic field.

A summary of the relevant points are as follows:

Firstly: the genetic fingerprint and its role in Islamic rulings.

The author defined lineage and its importance in Islam. He also mentioned that Sharia lineages tends to be confirmed with simple evidence but require strong ones to be refuted. According to the strength of evidence, the author ordered them as following: wedlock (*firash*), father affirmation (*ta'kid al-ubuwwa*), evidence (*bayyina*), clues (*adilla*) and random draw (*qur'a*). The author reported and discussed different opinions of Islamic scholars with regards to the use of clues as a method of evidence in paternity conflicts in Islamic rulings, while outweighing the supporting opinions that it can be used as evidence. Genetic fingerprint is considered a strong clue and proof that can confirm identity, and it is medically proven that by using genetic fingerprint, we can confirm or deny the relationship between two individuals as well as relating the separated body parts to the right person in case of disasters, for example. The author considered genetic fingerprint to be conclusive evidence (*qarina qati'a*) that constitute a basic means of proof and can be used independently wherever there is no text that contradicts it, so it cannot be prioritized in the Juristic laws derived directly from the Quran and Sunnah. For example, it can be used in conflicts of lineages, major offences and prescribed punishment as well as proof of personal status. The author concluded that the basic means of refuting paternity is the oath of condemnation (*li'an*). However, if a genetic fingerprint was available before the oath of condemnation, the author recommends that genetic fingerprints can be used as an accepted method of proving paternity and the five oaths can be avoided. Therefore, it cannot be used to prove or reject paternity if there is proof that is endorsed by Sharia, like wedlock and evidence.

The author mentioned situations where paternity can be refuted without the oath of condemnation: a boy who cannot father a child, pregnancy after two years of the husband's death or divorce and a husband who stopped sleeping with his wife or is away by distance, as well as a castrated man. He also mentioned that, in a situation where the father accuses his wife of committing adultery, she has the right to ask for genetic fingerprint to prove that the child belongs to him. On the other hand, the father has no right to ask for genetic fingerprint for his child without his wife's approval. Similarly, it is not allowed to use genetic fingerprints to verify stable lineages. For example, if a man claimed to be a father of a child who is well known to be a son of another and wants to have genetic fingerprints, this is not allowed.

The author reported situations where genetic fingerprint is superior to other tools. For example, in paternity conflicts where they are not out of wedlock or any evidence or conditions of children from adultery, genetic fingerprint is superior to any other method. In the case of mixing newborn babies in hospitals, IVF, accidents and disasters, the author recommends to link children to their mothers' genetic fingerprints to find the family and avoid using the fathers' genetic fingerprints, because the purpose is to find the family and not to verify paternity.

Regarding the role of genetic fingerprints in crimes of major offenses and prescribed punishment, the author concludes that it cannot be used as an independent method of confirmation, except in limited situations, like proving libel (*qadhf*), adultery and rape. In these conditions, genetic fingerprints can have conclusive evidence; for example, semen analysis found inside the victim will confirm rape or adultery in addition to other supporting evidence like witnesses. Genetic fingerprint has no role in conditions of drinking alcohol or apostasy. Discretionary crimes (*ta'zir*) are treated similarly as crimes of major offences and prescribed punishment. In a civil status, genetic fingerprints can be used as a basic method to prove the identity of individuals and it is superior to other tools like thumb prints and blood groups.

In the area of genetic applications, the author concluded that genetic screening is not obligatory for any contract, except in some conditions where hereditary disease prevalence is high, in which the authorities can mandate such investigations. Genetic screening is permissible and preferred before marriage in families with genetic diseases. This also applies to diagnostic genetic testing including antenatal screening. According to antenatal screening results, the author concluded that abortion is permissible before four months (120 days) of pregnancy in cases of confirmed severe inherited diseases or congenital anomalies, but it is forbidden after four months of a confirmed disease and forty days in an unconfirmed or mild disease. Genetic intervention, whether therapeutic or modification, is basically permissible in all human cells and organs at different age stages, unless it leads to definite or probable harm. Therefore, somatic cells' intervention is permissible because it rarely leads to harm. On the other hand, genetic intervention in germ cells is forbidden because it most probably leads to tremendous damage. The author believes that germ line intervention has advanced research results, and genetic scientists predict that the next 20 years constitute a critical period due to an explosion of research information in this field. The

author adds: "This practice may lead to human monster due to mixing human genes with other species that can be inherited through generations". Even though it is not currently in practice, scientists think it will be practically available soon, so it is wise to pre-prepare and discuss all the possibilities. Intervention for selection of newborns is generally permissible unless there is clear evidence or possibility that it would lead to fetal harm.

Regarding cloning, the author divided it into two categories. Reproductive cloning, in which an identical human is generated, which is completely prohibited except in some situations like an infertile married couple who would like to have a baby under strict regulations. Cloning of human tissues and organs for therapeutic purposes like organ transplantation is permissible, provided that it is taken within the permissible period of the embryo age (14-18 days) and does not lead to mixing of lineages. Parents have the right to give consent for stem cells' isolation from their embryo and this should not be considered as possession for the institute. The author also added that it is permissible to use storage banks for the embryos only if it will be used for permissible purposes. Parents should not get paid in return for the cells isolated from their genes, but it is permissible for the health institute to get paid for their work and expenses but not for the organs generated as this is prohibited.

In the area of personality traits, criminal activities and its relation to genetics, the author concluded that even if some genetic traits are found to be associated with alcoholism, theft and other crimes, the individual carries full responsibility for their actions.
Genetic research takes the ruling of the field under research; for example, research on a prohibited field like germ line genetic intervention is prohibited because genetic intervention on germ line is prohibited and so on.

The author recommends that there should be no financial benefit contract between the research participant and the institute. The author could not find detailed background about the patent's right, but depending on new studies, he recommended that if the information protected is not critical, the patentee has the right to gain profit from their work. However, if protecting the information may lead to harm, then the patentee's right will be dropped for the benefit of the majority.

Critical Comments on the book and Relevant topics to the project

The book is written in a simple way that can be easily understood, supported by diagrams for further clarification when needed. The author elaborated on several topics relating to ethics and genetics and discussed both juristic and scientific points of view, in addition to presenting recommendations for Islamic conferences and other non-Islamic laws in dealing with certain conflicts. The book contains several topics relevant to our project "Indigenizing Genomics in the Gulf Region (IGGR): The Missing Islamic Bioethical Discourse".

It is clear that lineage is highly protected in Islamic law. Although it is established by testimony of only one woman at birth or claims of a father, strong available evidence is required to deny lineage.

Regarding prioritizing of oath of condemnation in proving or refuting paternity, if the father falsely gave the oath of condemnation (i.e. lying), this will take the right of the child to belong to his real father and may have disastrous consequences on the community. On the other hand, if the father was correct regarding his accusation of his wife's adultery, but she was already pregnant from him before committing adultery, he will deprive the child from his right lineage. Therefore, we would recommend confirming paternity after the oath of condemnation to protect the right of the child and prevent false accusations. As we mentioned above, even if the wife has committed adultery, the child could still be the husband's, and this must be dealt with separately. We would like to add that adultery or rape can be committed regardless of the pregnancy status, so the child's fingerprint cannot be used to refute adultery or rape if negative. For rape or adultery, other methods of proof like the suspect's semen or hair follicle in the female's genitalia can be used in addition to other evidence like witnesses.

In situations where the author concluded that paternity could be refuted without the oath of condemnation, like partners who have been separated for more than two years, a boy who is too young to father a child, an infertile or a castrated man, we disagree with the author, because nowadays, due to advances in genetic intervention, cloning, in vitro fertilization and sperm banking these could enable a man to father a child. Therefore, genetic fingerprint would be the most accurate tool to prove or refute paternity.

In conditions where there is no evidence of wedlock or witnesses, for example children resulting from adultery or mixing of newborns in hospitals, we agree with the author to use genetic fingerprint as a primary method of proof. Similarly, in disasters or mixing of newborns, identifying babies with their mother's genetic fingerprints is preferred to maintain families' integrity.

Genetic fingerprint can play a major role in some crimes of major offences, in addition to other supporting evidence, such as in the case of adultery where the sperm of the accused is found in the woman's genitalia. It can also confirm the presence of a person in the crime scene; in crimes like murder, theft, robbery or banditry, by comparing tissues or cells found in the crime scene with that of the accused , but this cannot prove accusations unless combined with other methods of proof like witnesses(1).

Using genetic fingerprint in civil status is easier and more accurate than any other available methods, as well as it being easier to trace suspects in certain crimes when data is available at hand.

We agree with the author that genetic testing would be helpful in prevention or early detection of certain genetic diseases that would be otherwise fatal. Premarital genetic testing can help people detect possible risks and plan on clear bases depending on the type of disease. For example, a carrier of a disease has higher chances of getting healthy children compared to when both parents are carriers. Hemophilia is a bleeding disorder with prolonged clotting process and thus increased risk of bleeding after minor trauma and sometimes spontaneously in severe cases. The genes associated with these conditions are located on the X chromosome, which is one of the two sex chromosomes. In males (who have only one X chromosome), one altered copy of the gene in each cell is sufficient to cause the condition. In females (who have two X chromosomes), a mutation would have to occur in both copies of the gene to cause the disorder. A characteristic of X-linked inheritance is that fathers cannot pass X-linked traits to their sons. In X-linked recessive inheritance, a female with one altered copy of the gene in each cell is called a carrier. If a man is affected with hemophilia and got married to a non-carrier woman, they have 0% chance of having children affected with the disease, where all boys will be unaffected, but all daughters will be carriers, which do not mean sufferers as mentioned above. On the other hand, if a woman is a carrier and gets married to a non-carrier man, she has 50% chance of getting affected boys and carrier girls as in figure (1). This percentage increases significantly when the father is affected and the mother is a carrier as in figure (2). As we noticed from the above discussion, an affected father does not pass the gene to his sons, so it will be wiser to select a male baby and the opposite is true when the mother is the carrier as in figure (3). Therefore, we recommend pre-marital testing, especially when there is high prevalence of genetic disorders.

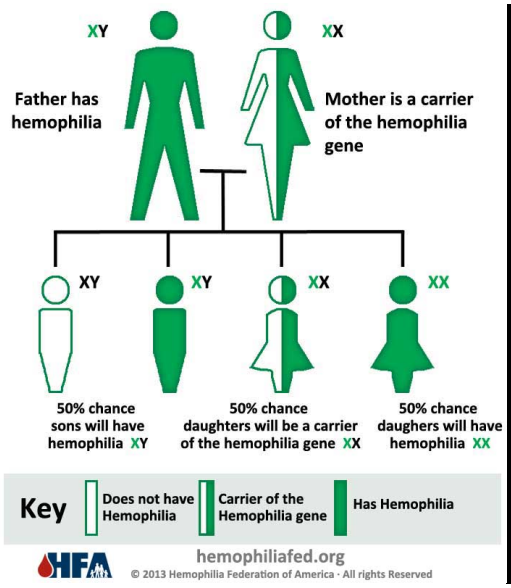

Figure 1 affected father + carrier mother

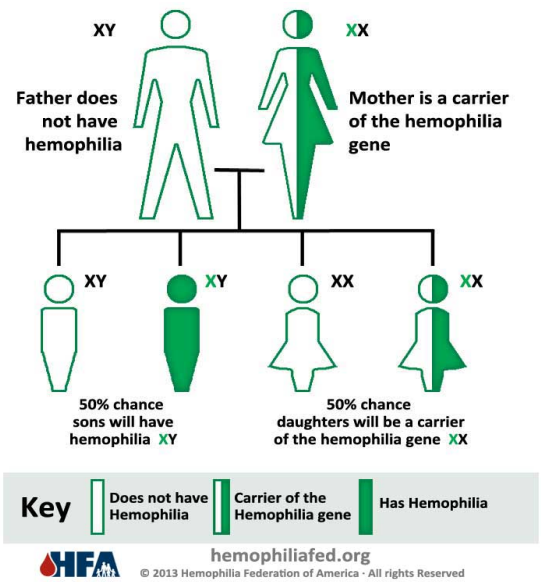

figure 2: carrier mother

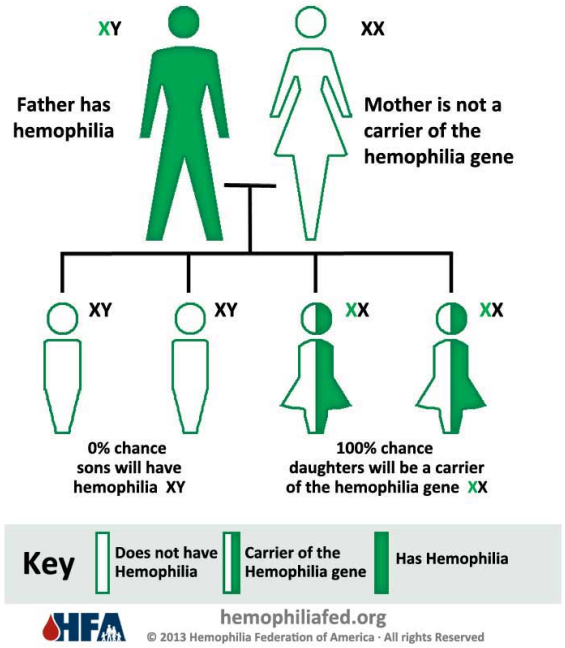

Figure 3: affected father + normal mother
Figures reproduced from hemophiliafed.org

Regarding antenatal screening, we agree with screening as it may detect fatal or severely disabling diseases resulting from chromosomal, metabolic or congenital disorders. For example, chromosomal anomalies can be diagnosed by early screening using blood samples from the mother, like cell-free DNA testing. During prenatal cell-free DNA screening, DNA from the mother and fetus is extracted from a maternal blood sample and screened for the increased chance of specific chromosome problems, such as Down syndrome, trisomy 13 and trisomy 18. Prenatal cell-free DNA screening can be used as early as 10 weeks gestational age, which is within the period where abortion is permissible if indicated [(2)].

We agree with the author that germ line genetic intervention may lead to serious consequences, but this should not stop therapeutic or diagnostic intervention proven scientifically to be lifesaving. For example, mitochondrial donation in severe mitochondrial inherited disease.

Mitochondria are cellular components that contain their own DNA (mtDNA) and are responsible for generating more than 90% of the body's energy. Most pathogenic mtDNA mutations affect children, who frequently suffer catastrophic organ failure. Mitochondrial dysfunction typically damages cells of the brain, heart, liver, skeletal muscles, kidney and the endocrine and respiratory systems. Currently, treatment is limited to symptomatic management using vitamins and supplements. The mtDNA makes up only 0.1% of the entire human DNA. As mitochondria are transmitted exclusively through mothers, a woman with defective mtDNA could potentially use her and her partner's own nuclear DNA in combination with the healthy mitochondria of a female donor and have a child who is 99.9% genetically identical to her and her partner[(3)]. In September 2016, it was publicly announced that a male child was born earlier in the same year as a result of an MRT technique carried out by a US doctor in a Mexican fertility clinic for the purpose of preventing the transmission of Leigh Syndrome, a form of mitochondrial disease[(4)]. As per the announcement at the time, the child is doing well with a very low level of mutant mtDNA.

In the UK, the recommendation of both the Nuffield Council on Bioethics[(5)] and the Human Fertilization and Embryology Authority [(6)], which has since been enacted into law, is to not recognize the role of the mitochondria as a parent of the baby. Two major reasons given for this recommendation are: (1) mtDNA does not encode for phenotypic traits shared between a donor

and the resultant child that are constitutive of an individual's unique identity, and (2) mtDNA donation does not establish a unique genetic connection between mitochondrial donor and the resultant child [7]. One of the social and ethical problems is the right of the donor and her relation to the baby. In Islam, as long as polygamy and breast-feeding is permissible, it is possible that the baby can have more than one mother. Moreover, if the newborn baby is a girl, the mtDNA will be inherited through the generations to come. Therefore, we would recommend that mitochondrial donation for serious diseases should be considered as a treatment option to be extensively discussed by Muslim scholars. The long-term safety of mitochondrial transfer will be revealed with time.

The author concluded that abortion is not permissible after 120 days. What if we confirmed that the fetus has a fatal disease after this period? For example, anencephaly, a congenital anomaly where the bone that covers the brain is not formed. This can be diagnosed using blood tests, amniotic fluid and ultrasound scans and it is not compatible with life [8]. If not aborted, the mother will be suffering (both physically and psychologically) throughout the pregnancy period with a fetus known to have a disease not compatible with life (has no treatment for the time being).

Sex selection may lead to variation in ratio between males and females as well as possible planned abortions of a baby from unwanted sex. We would advise to prohibit sex selection unless there is a strong medical reason, such as in the case of a family with hemophilia as discussed above.

Some genetic traits are found to be associated with addiction, theft and other crimes, yet the individual carries full responsibility for their actions. These genes make the person susceptible but this does not mean that it is inevitable, because some people share the same genes but they do not share the same behavior, which means that there are other environmental factors that play a role [9].

Cloning is a type of asexual reproduction. A child created by cloning would be an exact replica of an existing or deceased person. We agree with the author that under marital relations, cloning

will help infertile couples to have children, but this will need extensive discussion from a juristic point of view [10].

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