

Jewish vs Jew-ish: Possible Proof Through Mitochondrial Misconception

By Danielle Pasternak

Israel has always been known as a homeland and safe space for Jews all over the world. On May 14th 1948, the State of Israel was established; Jews everywhere were overjoyed, as they now knew that they had a country to call their own. Israel has a policy known as *Hok Hasbivut*, or the Law of Return, which allows anyone who is Jewish to claim Israeli citizenship. The Law of Return identifies someone who is Jewish as having at least one Jewish grandparent, or as someone who is married to someone who is Jewish. According to *halacha*, only someone born to a Jewish mother or someone who converted to Judaism through an Orthodox conversion is considered to be Jewish. The Chief Rabbinate of Israel recognizes someone as a Jew based on the Orthodox Jewish law, not according to the Law of Return [1]. This would mean that a person can be Jewish according to the State of Israel, but not *halachically* Jewish according to rabbinical law.

Since Israel is a Jewish state, there is no separation of church and state. Only an Orthodox Israeli Rabbi can marry a Jewish couple, and the laws of marriage are held according to Orthodox *halacha*. As mentioned, one anticipating marriage has to be *halachically* Jewish. Therefore, many immigrants who settled in Israel under the Law of Return cannot marry a *halachically*-recognized Jew in Israel, because they are not identified as Jews according to *halacha*, and/or lack proof that identifies them as Jewish [2].

With insufficient evidence to prove someone is Jewish, many hoped to turn towards DNA tests as a last resort. The majority of one's DNA is located in the nucleus of the cell, however, a small amount of extranuclear DNA is found in mitochondria in the cytoplasm. This DNA is known as mitochondrial DNA (mtDNA) [3]. Mitochondria, commonly referred to as “the powerhouse of the cell,” are responsible for converting energy obtained from food into energy that the body can use [4].

Mitochondrial DNA was thought to be transmitted only from mother to child. This is noteworthy because being *halachically* Jewish is also only transmitted from mother to child. Thus, the B'Mareh HaBazak says that for clarity on whether or not someone is Jewish, a mtDNA test can be done. If the

mtDNA test indicates transmission from a Jewish mother, it would seem to be proof of one's Jewish origin. The mtDNA is passed down identically from mother to offspring, unless a change occurred by random mutation [5]. However, *halacha* denies the validity of a mtDNA test to prove that someone is Jewish [6].

It has long been believed that mtDNA originated entirely from the mother, through the egg, even though sperm also contains mitochondria. A sperm cell is composed of three sections, the head, the midpiece, and the tail. The head contains the genetic information (*i.e.*, the haploid number of nuclear chromosome), the tail functions as a rotor for sperm movement, and the midpiece, containing mitochondria (with mtDNA), connects the head to the tail [7]. Many have thought that during fertilization only the head of the sperm penetrates the egg. This would indicate that mtDNA would only be inherited from the mother because the part of the sperm holding the mtDNA would never enter the egg and, therefore, would not contribute to the mitochondrial genetic material of the eventual offspring. However, recent studies have shown that the midpiece enters the egg as well, not just the head of the sperm [8]. Apparently, the father's mtDNA enters the egg, and the resulting embryo and fetus would have mtDNA from both parents. This new understanding of mtDNA transmission disqualifies mtDNA as a potential form of determining if someone is *halachically* Jewish because mtDNA is not only passed down through the mother.

With many new technological advances regarding mtDNA, new *halachic* challenges are introduced. Mitochondrial-based diseases result from malfunctioning mitochondria and the inability of cells to produce sufficient chemical energy for maintaining bodily functioning. Currently, there are no treatments for individuals suffering from many of these disorders. However, current studies on *in vitro* fertilization (IVF) technology have developed a procedure whereby these mtDNA diseases can be prevented from occurring. New procedures known as “mitochondrial replacement therapy” can allow parents to have healthy, unaffected children.

Mitochondrial replacement therapy involves using an egg from a healthy donor. The nucleus is removed from the egg of the would-be mother with the mtDNA disease and is inserted into the enucleated egg from the donor. The hybrid egg (*i.e.*, consisting of healthy cytoplasm and mitochondria from the donor plus a healthy haploid nucleus from the would-be mother) is now fertilized with a sperm cell from the father. The zygote contains nuclear DNA from the mother, nuclear DNA from the father, and the mtDNA from the mitochondrial donor [10].

The fetus produced from mitochondrial replacement therapy would offer a way for mothers with mutated mtDNA not to transmit it to their offspring. 99.9 % of the fetus's DNA would come from its parents, while the remaining 0.1 % would come from the cytoplasmic donor. This child who is born from mitochondrial replacement therapy would therefore have 3 biological parents [11]. This raises multiple *halachic* questions. What is the *halachic* status of a baby if the female mtDNA donor is not Jewish? Would both mothers have to be Jewish for the baby to be Jewish? The first male child born to a *Bat-Kohen* or *Bat-Levi* does not require a *Pidyon Haben*, whereas the first

male child born to a *Bat-Yisroel* does require a *Pidyon Haben*. The question regarding this issue is what would the status of a first born baby whose mother and mitochondrial donor differ be in terms of priestly status [12]?

With technology developing constantly, many new procedures and treatments are always proceeding. Topics of DNA replication and donors involved in infertility, bring rise to many *halachic* questions about a baby's Jewish status. With many different opinions and, as of now, no set *halachic* guidelines, the question of whether or not one is Jewish or Jew-ish based on mtDNA still remains unanswered.

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