What Came First: The Bible or the Gene?

By **Yonina Loskove**

According to Biblical accounts, the Jewish Priesthood, known as *Cohanim*, was established about 3,300 years ago when the Israelites were traversing the desert towards Israel. Traditionally, *Cohanim* are direct descendants of Aaron, the brother of Moses, and are from the Tribe of Levi. The Jewish Priesthood continues today as a patriarchal lineage, as it says in Numbers, 25:13, "And it shall be to him [Aaron] and to his descendants after him a covenant of everlasting Priesthood." While it has always been tradition that the *Cohanic* title is passed from father to son, there is no specific physical distinction that distinguishes a *Cohen* from a Levite or an Israelite. This lack of physical variation from one Jewish male to another has led to the conduction of DNA studies to confirm this ancient Biblical tradition.

Dr. Karl Skorecki, a *Cohen* of Eastern European descent, stumbled upon the realization that there is a possible DNA relation between all *Cohanim*. Dr. Skorecki noticed that another *Cohen* had joined morning services; a man of Sephardic descent with acutely contrasting physical features to his own. He realized then that there must be some underlying hidden trait that connects him to this man and in turn both of them back to Aaron. Dr. Skorecki hypothesized that since the title of Priesthood is passed from father to son, perhaps the connection between him and this Sephardic Jew is something that is only passed from father to son, the Y chromosome. [1]

The somatic, or body, cells of humans contain 46 chromosomes: 22 pairs of autosomes and one pair of sex chromosomes. In males, the sex chromosomes consist of a large X chromosome and a smaller Y chromosome, whereas in human females, the sex chromosomes consist of a pair of X chromosomes. Unlike most other chromosomes found in the human genome, the Y chromosome is transmitted only from father to son. The Y chromosome mainly contains non-coding protein regions with little homology with the X chromosome; thus, during gametogenesis there is little genetic recombination between the Y and the X chromosome. Because the Y chromosome remains essentially unchanged, any minor mutation within the non-coding sections of the chromosome persists generationally from father to son. One of the most significant mutations, unique-event polymorphism (UEP), is an allelic mutation that happens so infrequently that it can be used as a genetic marker. UEPs are usually found in a haplogroup, a combination of alleles that are linked and tend to be inherited together as a unit. Because UEPs are so infrequent and are typically inherited together, once the mutation occurs in one generation, it endures in the same family lineage for centuries. Therefore, if there is a specific UEP found on a Y-chromosome in the non-coding region, it is likely that the mutation occurred in a past ancestor, and if other people worldwide have the same UEP, then they must have also descended from that same ancestor. [1]

To determine whether there is a commonality amongst all *Cohanim*, Dr. Skorecki, along with Professor Michael Hammer of University of Alabama, conducted a study to test their hypothesis. An experimental group of 188 Jewish males was composed, consisting of Israelites, Levites, and *Cohanim* from Ashkenazic or Sephardic descent. Of this sample population, 68 individuals were *Cohanim*. All subjects underwent a Y chromosome analysis through buccal cell DNA extraction. The scientists focused on two Y chromosome markers, one of which was the YAP sequence, to determine genetic commonalities between the experimental subjects. YAP in particular is a fairly new mutation sequence in human evolution and can therefore determine the historical ancestry of both an individual and population based on whether they are YAP+ or YAP-. [1]

The results of the buccal swab samples revealed that less than 2% of the *Cohanim* were YAP+, while more than 18% of the other Jews in the sample exhibited YAP+. The results were also studied based on participant geographical origins; whether they were considered Ashkenazi or Sephardi. Both Ashkenazi and Sephardi Jews displayed a 15-20% presence of YAP+, but neither Ashkenazi nor Sephardi *Cohanim* showed a YAP+ result. These results signified that the Y chromosome DNA of *Cohanim* is distinct from all other Jewish males. [1]

Dr. Skorecki and his fellow colleagues conducted another study in order to obtain more conclusive data for the distinction of the *Cohanic* Y chromosome. Dr. Skorecki, Neil Bradman, and David B. Goldstein increased the sample size of Jewish males to 306, in which 106 were *Cohanim*. The number of Y chromosomal markers tested was also increased from two to twelve. The data analysis revealed that 97 of the 106 *Cohanim* shared the same array of six chromosomal markers. This selection of markers was termed the Cohen modal haplotype (CMH), which became the genetic signature of Jewish Priesthood. [2]

The approximate date the polymorphisms occurred on the Y chromosome was also studied to determine the genealogical ancestry of *Cohanic* lineage. Differences amongst *Cohanic* DNA at microsatellites, DNA sequences that are repeated numerous times within the DNA, were investigated due to their ability to fluctuate from one generation to the next. If all *Cohanic* DNA has a similar amount of microsatellites, the polymorphism must have occurred recently in human evolution. However, if the number of microsatellites differ greatly amongst *Cohanic* DNA, then the *Cohanic* Y chromosome must have been established a long time ago. Based on mathematical

calculations derived from the number of microsatellites mutations of the *Cohanic* DNA samples, Dr. Skorecki and colleagues determined that the *Cohanic* Y-chromosome was established about 2,100 to 3,250 years ago - about the time Jews traditionally believe Aaron and his family were given the privilege of the Jewish Priesthood. [2]

However, despite the discovery of CMH, other researchers identified faults in Dr. Skorecki's results. It was determined through other studies that some of the UEPs that characterize the CMH are found in low resolution in certain non-Jewish populations, that the specific markers of the CMH do not provide the phylogenetic resolution needed to determine the geographic genesis of the CMH line, and past results do not acknowledge the possibility that the *Cohanic* lineage could be a compiled lineage from numerous *Cohanic* ancestors. [3]

To resolve these quandaries, another study was conducted by M.F. Hammer and D.M. Cehar using buccal samples from a total of 3,674 individuals of whom were Israelite, Levite, and Cohanim, with a total of 215 *Cohanim*. Seventy-five binary markers of the Y chromosome were researched, yielding a total of thirty-seven haplogroups. A unique paragroup from haplogroup J, termed J-P58, predominated in *Cohanic* DNA with a frequency of 51.6% in Ashkenazi *Cohanim* and 38.7% in Non-Ashkenazi *Cohanim*. In contrast, the most a single haplogroup presented uniformly in Israelite samples was never higher than a frequency of 14%. [3]

The study then researched the six markers that composed the original CMH with the 99 *Cohanim* that exhibited the J-P58 paragroup. From the *Cohanic* sample, 87 individuals carried the CMH, with 10 *Cohanim* carrying a haplotype that was one-step removed from the original CMH, and 2 *Cohanim* carrying a haplotype that was two or more steps removed from the original CMH. The study then increased the original CMH to encompass a total of twelve markers. This twelve-locus haplotype was present in 43 of the 99 *Cohanim* who had the original CMH. This new twelve marker CMH haplotype was termed "the extended CMH." The extended CMH also showcased two varying haplotypes with one-step mutations at two hypermutatable point mutation sites. The extended CMH and the two varying haplotypes were found in a total of 64.6% of Ashkenazi and Non-Ashkenazi *Cohanim*. [3]

While the original CMH is carried by other Jews at a frequency of 5-8% and by other non-Jewish populations, like Jordanians, at a frequency of 7%, the extended CMH and its two varied haplotypes were observed in *Cohamin* with a frequency of 29.8% and in other Jews with a frequency of 1.5%. Even though CMH is found mainly in *Cohanim*, the J-P58 paragroup is found at high frequencies amongst populations found in the Near East region of the Middle East. This is supported by a high frequency of J-P58 in Yemenites (67%) and Jordanians (55%). The frequency of this paragroup considerably lowers when the population sample moves outside of the Near East, thus proving that ancient *Cohanim* were geographically from the Middle East.

To estimate the date of the original polymorphic CMH J-P58 lineage, an additional ten markers were added to the twelve markers that compose the extended CMH. By employing a Bayesian-based coalescence analysis using BATWING, it was determined that the *Cohanic* lineage originated approximately 4,415 years ago. Due to the high frequency of the extended CMH and the J-P58 paragroups amongst Asheknazi and non-Ashkenazi *Cohanim*, and the determination of the ancestral date and geographical location of the first CMH mutation, the analysis confirms the notion that the CMH and Jewish priesthood began from a single patrilineal lineage in an era before the Jewish diaspora in the Middle East. [3]

Due to the promising results of *Cohanic* DNA analysis, this method of *Cohanic* determination was employed to search for lost Jews. One tribe in Africa in particular, the Lemba tribe, has an oral tradition that they are Jewish descendants that left Judea and relocated to Senna, North Africa, about 2500 years ago. To determine the legitimacy of their claim, a research study was conducted to determine if the male lineage of their clan holds the CMH haplotype. 399 Y chromosomes from the Lemba tribe were analyzed based on the CMH six mutation markers and six microsatellites. The buccal samples yielded high frequencies of YAP-sequencing and CMH haplotypes. This discovery helps sustain the Lemba oral tradition of them being descendants of the ancient Hebrews and introduces the possibility of the existence of other lost Jewish tribes with a genetic correlation to other Jewish populations. [4]

Genetics has not only been a useful proof for an ancient paternal *Cohanic* lineage, but it has also been helpful in reconstructing the genealogical and geographical history of the Jewish people. Despite large geographical distances between multiple Jewish communities, similar genetic profiles have remained consistent for generations in Jewish heredity. Not only are there genetic commonalities found amongst European, North African, Near Eastern, and Arabian Peninsula Jews, but there are also genetic similarities between Ashkenazi and Sephardi Jews and the Middle Eastern populace. This proves that both Ashkenazi and Sephardi Jews are originally from the Middle East, debunking the theory that Ashkenazi Jews originated from the pre-tenth century Kuzar tribe of the Turko-Asian empire. [5]

As researchers continue to analyze the genetic variations amongst Jews and further investigate the genealogical ancestry of the Jewish people, it mustn't be forgotten that the basis of these studies originates from Biblical tradition.

As it says in Leviticus, 20:26, "And you are to be holy to me; for I the G-d am holy and I have separated you from the nations to be Mine." Whether there be a genetic, theological, or practical distinction between Jews and non-Jews, according to tradition, the Jewish people will always be separated from all others as the Chosen People of G-d. [6]

Acknowledgements

I would like to express my gratitude to my parents for all the support they have provided me with throughout my academic career. I would also like to thank Dr. Babich for his assistance with this article; specifically for his guidance with research material and for commentary that greatly improved this manuscript.

References

[1] Skorecki, Karl, Sara Selig, Shraga Blazer, Robert Bradman, Neil Bradman, P. J. Waburton, Monica Ismajlowicz, and Michael F. Hammer. "Y Chromosomes of Jewish Priests." *Nature* 385.6611 (1997): 32.

[2] Travis, John. "The Priests' Chromosome?" *Science News* 154.14 (1998): 218.

[3] Hammer, Michael F., Doron M. Behar, Tatiana M. Karafet, Fernando L. Mendez, Brian Hallmark, Tamar Erez, Lev A. Zhivotovsky, Saharon Rosset, and Karl Skorecki. "Extended Y Chromosome Haplotypes Resolve Multiple and Unique Lineages of the Jewish Priesthood." *Human Genetics* 126.5 (2009): 707-17.

[4] Thomas, Mark G., Tudor Parfitt, Deborah A. Weiss, Karl Skorecki, James F. Wilson, Magdel Le Roux, Neil Bradman, and David B. Goldstein. "Y Chromosomes Traveling South: The Cohen Modal Haplotype and the Origins of the Lembaâthe âBlack Jews of Southern Africaâ." *The American Journal of Human Genetics* 66.2 (2000): 674-86.

[5] Kleiman, Rabbi Yaakov. "Jewish Genes." *Aish.com*. N.p., n.d. Web. 10 Jan. 2017.

[6] Kleiman, Rabbi Yaakov. "The Cohanim - DNA Connection." *Aish.com*. N.p., n.d. Web. 10 Jan. 2017.