Crowd Sourced Genealogy and Direct-to-Consumer DNA Testing: Implications for the Jewish People*

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Introduction

Interest in genealogical mapping has dramatically increased in recent years. New online tools are available for individuals to research their family history and collaborate with distant relatives to build family trees. Concurrently, advances in genetic research and computing technology have enabled direct-to-consumer (DTC) genealogical mapping through DNA analysis at affordable prices.

The possible existence of Jewish ancestry is among the many discoveries sometimes made by individuals taking advantage of these advances in genealogical mapping. Companies that provide DTC DNA testing even boast that their product can "infer whether or not and to what degree you may have Jewish ancestry"[1] or "discover your Jewish ancestry."[2]

DNA test results have led many consumers into exploring their newly discovered Jewish roots. Such developments offer exciting opportunities for connecting, engaging, and strengthening the bonds of the Jewish people.

According to Bennett Greenspan, President and CEO of Family Tree DNA, a leading company in the field, some people even convert to Judaism after discovering the possibility of Jewish ancestry in their DNA.[3] By 2005 the *New York Times* observed that due to DNA tests, "embraces of Judaism are growing more common in parts of the (American) Southwest" among Hispanics who believe they are descendants of Marranos.[4]

Furthermore, Jewish genealogy, especially Ashkenazi genealogy, has been and continues to be the focus of many scientific studies aimed at determining the history and genealogical origins of Ashkenazi Jewry.

Few non-scientists can grasp the biology, algorithmic calculations, and probabilistic nature at the foundation of published genetic studies and consumer DNA tests. Still, as they gain widespread public attention, DTC DNA testing has the potential to inform one's sense of identity, despite the controversial questions loaded with political implications that may arise.

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The goal of this paper is to introduce readers to the tools available online for conventional genealogical research, the advances in genetic research, the types of results generated from DTC DNA tests, and the implications that these tools and developments could have on the Jewish people, such as:

- Could these new tools affect connectedness of the Jewish people?
- Could awareness among Jews that they are "distant cousins," based on science, create or reinforce group solidarity?
- How should individuals who believe they have discovered Jewish roots be treated by the Jewish community?
- How do these developments influence the way Jewish identity is conceived?
- Could these tools be used to strengthen an individual's Jewish identity or lead to new forms of Jewish community involvement?
- How can the Jewish people prevent DNA tests from becoming a device of alienation?

Individuals should not be surprised if someone has already included them or some of their relatives in an existing family tree

This paper is divided into five sections: a review of the advances and applications of genealogy research and genetic sciences; how these advances are affecting various non-Jewish population groups; the tools available online for genealogical research; a specific example of the types of results generated by DTC DNA tests; and the implications that these advances have on the Jewish people, both on the individual and collective level.

The State of Genealogical Research and Genetic Sciences

Over the last decade there has been significant growth in the commercialization of genealogical mapping. Dozens of new businesses now exist that enable consumers to trace their family history online by searching official documents, such as immigration and military records, birth and death certificates, and census data. These companies harness the power of virtual social networks and crowd sourcing to connect individuals with close and distant relatives to collaborate on building interconnected family trees with embedded historical data. Myheritage.com, an Israeli start-up and one of the leading genealogical websites, has over 75 million registered members using their website, with 1.5 billion people included in over 27 million family trees hosted on their site.[5]

Users build their family trees with information known about their relatives and ancestors and the website then automatically finds matching historical records, providing further information and embedding evidence into a family tree. The website finds matches between family trees, providing individuals the ability to effortlessly build their family tree with existing trees. The more relatives an individual enters into his or her family tree, the higher the probability that he or she will match with existing trees. Users should not be surprised to start a family tree on a genealogical website and find that someone has

already included them or some of their relatives in an existing tree.[6]

Although there are several websites and applications that create family trees, there is a standard file type for saving the genealogical data that comprises a family tree known as GEDCOM (Genealogical Data Communication).[7] This standardization enables the sharing and distribution of digital family trees without issues of non-compatibility. In practice, this has contributed to the spreading of digital family trees across various platforms, websites, and companies.

As more and more individuals input their family trees on genealogical and ancestry websites, it becomes increasingly possible to weave all the trees together in order to create a mega tree with each family tree serving as a building block or corner stone of a larger tree.

The ability of making a family tree, however, has been limited by the amount of existing knowledge a family possesses about itself. Families that have remained in one geographic location for several generations, and have maintained the same culture and spoken the same language, are far more likely to have a deeper knowledge about their family history than those that have migrated across continents, as was typical of Jewish families during the past century.

Even with the sharing of family trees as described above, without knowing the names of specific family members or whether, for example, a great grandfather had any siblings, it is almost impossible to find evidence of their existence. This is especially the case when researching ancestors who were first generation immigrants. The changing of family names to fit into a new country and the disconnection from siblings and cousins in the home country (before the advent of modern communications), were historically common place for first generation immigrants and it poses a challenge for their biological descendants researching their family as it existed in the old world.

However, over the last decade, advances in genetic research and computing technology have been closing the gap of what individuals know about their family history and relatives. Since 1990, when the international scientific community, with funding from the U.S. Department of Energy's Office of Health and Environmental Research, began a 15-year project to map the human genome, every year the power and speed at which computers are able to sequence the constituent DNA increases as the cost decreases.[8] In 2002 the cost of sequencing one million base of DNA (the human genome contains 3 billion base pairs) was around $5000, today the cost is around $0.06.[9] This dramatic decrease in cost has enabled DNA sequencing to become accessible beyond mega-funded laboratories.

Decreased cost has enabled DNA sequencing to become accessible beyond mega-funded laboratories

Although the main impetus and funding justification for DNA research was for medical purposes, new areas of scientific research are

being explored utilizing DNA sequencing. One area of research that benefited tremendously from these developments is molecular anthropology, which uses DNA analysis to study evolution, human migration patterns, and genealogical relationships between human populations. By collecting and analyzing the portion of DNA that is inherited from only one parent, scientists have been able to classify maternal and paternal linages into haplogroups. Haplogroups are often described as ancient clans or tribes that may have lived within close geographical proximity at one point in history. It is more accurate, however, to think of haplogroups as groups of people who share one common direct maternal or paternal ancestor who lived sometime in the last tens of thousands of years.

As in the game of telephone, as the DNA sequence is passed from generation to generation, it gets changed slightly

The many academic and medical studies published utilizing DNA analysis for health, demographic, and population studies quickly generated commercial applications. With DNA testing becoming less expensive over the last decade, several new companies were established that offer direct-to-consumer DNA analysis for genealogical and medical purposes.[10] Today, for less than $100 one can "discover your lineage, find relatives and more" by having your DNA analyzed.[11]

Consumers are able to find near and distant relatives through DNA matching, expanding their family tree and ancestral knowledge in ways unimaginable only 25 years ago. As a result of these products, individuals and families are learning more about their ancestors and origins. Genealogical DNA analysis is especially useful for individuals who have only a limited knowledge of their family history or are interested in their deep historical roots.

It needs to be understood that it is not the case that a DNA test analyzes a genome (the totality of DNA found in one cell) or genes (the functional sections of DNA) and then determines if that DNA is Jewish or not. There is no specific gene or genetic marker that that is proof positive that one is Jewish. Genealogical DNA tests compare the DNA of an individual with an existing database in order to find matching or very similar DNA sequences and then determine genealogical relationships.

A DNA test can be explained through an analogy of the game of telephone. In the game of telephone, an individual starts with a phrase and privately passes it on to one person, who in turn passes on to another. Once the phrase passes through everyone in the game, the starting phrase and the resultant phrase are compared for differences. Imagine a giant game of telephone with 63 people in which each person transmits the phrase to two people instead of only one. At the end of the game, instead of one resulting phrase, there would be 32 phrases and each phrase would have been passed 5 times. The resulting phrases

would presumably share similarities, and perhaps some would be identical. The closer the phrases are on the chain, the more similarities the phrases would share.

A DNA sequence is like the message transmitted in the game of telephone. Except a DNA sequence is fantastically more complex. The human genome found in a DNA sequence contains more than 3 billion base pairs (those horizontal bars bridging the double strands of a DNA molecule). The human genome is 99.9% similar among all humans, the .1% that is different can be thought of as a genetic code or fingerprint. An individual's genetic code is composed of a combination of half of each of their parent's genetic code. For various reasons, DNA gets slightly mutated when it is transmitted and those mutations get hardwired into the DNA. The next time the DNA is transmitted from one generation to the another, the mutation might remain intact and could be transmitted from one generation to another. As long as that portion of the DNA sequence does not get altered or mutated again, it serves as a unique genealogical stamp, or "genetic marker" that one individual passes on to their descendants.

As in the game of telephone, as the DNA sequence is passed from generation to generation, it gets slightly changed and altered. The more times it is transmitted, the more it varies from its original form. Conversely, the more similarities two DNA sequences share, the closer they are likely to be along the chain of transmission.

It should be noted, however, that the American Society of Human Genetics warns consumers that everyone has thousands of ancestors, segments of DNA get transferred in a "non-deterministic" manner, and only a "fraction" of one's descendants can be traceable through DNA testing.[12] That is to say, the length and portion of DNA that are transferred from parent to child are seemingly random. Not all our ancestors contribute equally to the make-up of our DNA; inevitably traces of some ancestors will be more dominate than others, and some ancestors may not be traceable at all. Without taking DNA samples directly from all of one's ancestors, it is impossible to truly map one's genealogy. The Society states that "the genomic segments contributed by a particular ancestor are far from all being uniquely identifiable, so even if one's genome has those specific genome contributions, identification of particular ancestry is always uncertain and statistical."[13]

Through complex statistical analysis, computers are able to predict how closely two DNA samples are related

Through complex statistical analysis, computers are able to predict how closely two samples of DNA are related. Without comparing a DNA sample to an existing dataset of DNA there is little information that can be generated for genealogical exploration. The larger the dataset of DNA samples, and the more biographical details known about the individuals whose DNA is in the

database, such as where their ancestors lived, the more the test can reveal. A DNA test will only tell a test-taker that he/she shares some DNA with another person or a group of people alive today and previously sampled. Therefore, individuals seeking genealogical information about themselves through DNA testing will only be able to see how their DNA compares with others.[14]

For this reason, companies may include in their DNA database not only their specific customer's DNA, but DNA samples taken during scientific studies. For example, Family Tree DNA includes the dataset collected by Doron Behar et al. for the article "Genome Wide Structure of the Jewish People," published in Nature in 2010.[15] The dataset includes DNA samples from 14 Jewish Diaspora communities and 69 non-Jewish "old world" population areas.[16]

Genealogical DNA testing is especially popular in the African American and Native American communities

As DNA tests inevitably become cheaper and more DNA samples are added to large databases and analyzed for demographic and genealogical purposes, the overall picture of how people around the world are related will become clearer.

The Effect on Non-Jewish Populations

On an individual level, consumers are taking DNA tests for personal interest and are learning something new about themselves and their ancestral origins. Already in 2006, a *New York Times* article stated, "genetic tests, once obscure tools for scientists, have begun to influence everyday lives in many ways. The tests are reshaping people's sense of themselves," albeit more so in the United States than in other countries.[17]

DNA testing for genealogical purposes is especially popular within the African American and Native American communities. Both communities have an interest in exploring their ancestral roots, but for very different reasons. African Americans, many of whom are descendants of slaves, have no record of their ancestors' precise geographical origins. Through genealogical testing, African Americans are able to learn more about their pre-slavery roots. In 2006, PBS ran a four-part TV series called "African American Lives" that traced the ancestry of famous African Americans such as Whoopi Goldberg, Quincy Jones, and Oprah Winfrey using DNA analysis. The show's success prompted PBS to produce a sequel series with an educational outreach component to raise awareness about genealogical research.[18]

Within the Native American community, a few tribes have utilized forms of DNA testing to prove familial linage for tribal affiliation and benefits[19]. Some college applicants are even doing DNA tests to detect Native American ancestry in order to improve their application profiles.[20] Kim Tallbear,

an anthropologist at the University of Texas and member of a Native American tribe, made the following comments to New Scientist magazine on why the issue of DNA testing has generated controversy within the Native American community:

> I think there is suspicion by many Native Americans that scientists, who are largely not Native American, want to turn our history into another immigrant narrative that says "We're all really immigrants, we're all equal, you have no special claims to anything." There are also people who don't want to have a molecular narrative of history shoved down their throats. They would prefer to privilege the tribal creation stories that root us in the landscapes we come from.[21]

Tools Available for Jewish Genealogical Research

With regard to conventional genealogical research, there are several free online databases dedicated specifically to Jewish genealogical research. JewishGen.org, which is affiliated with the Museum of Jewish Heritage in New York, features thousands of free easy to use databases consisting of over 20 million Jewish historical records, such as burial registries, *yizkor* book entries, and various pieces of data collected within Jewish communities during the 19th century by state and local officials.[22] JewishGen.org acts as a hub connecting genealogists researching Jewish families and towns, enabling the sharing of research and exchange of information. It is also part of the Family Tree of the Jewish People project which aims "to provide a powerful resource to connect individuals researching the same Jewish family branches, to re-connect their families, and to increase interest in Jewish genealogy."[23] It is in partnership with the International Association of Jewish Genealogical Societies (IAJGS), and Beit Hatefutsoth (Museum of the Diaspora) in Tel Aviv and it consists of more than 5 million names.[24]

The World Zionist Organization maintains the Central Zionist Archive, the official archive of the Zionist movement. It contains millions of documents and records, many of which have been digitized and made accessible through a searchable online database. Over the past decade the Archive decided to engage in the field of genealogy, offering a research service to consumers interested in their family history as well as hosting a course in genealogical research in their office in Jerusalem.[25] The Government of Israel also maintains a State archive, which has some electronic records accessible through their Hebrew webpage. Yad Vashem has led an international effort to create a database of victims of the *Shoah*. To date, the database, accessible online, contains biographical information on 4 million victims.[26]

JewishGen.org features 20 million Jewish historical records

Recently, there has been a bridging between Jewish genealogical websites and DNA testing. Both Beit Hatefutsoth and Jewishgen.org, for example, advertise DNA testing for Jewish genealogical purposes by Family Tree DNA.

While genealogical DNA tests are not yet changing the Jewish community as a whole in any major way, they are becoming popular enough on an individual level to suffice exploring what the test results show, what the results mean, and what the policy implications are.

The DNA test kit contains two cotton mouth-swabs and two tiny plastic vials

Sample Results

In preparation for the writing of this chapter, a JPPI fellow had his DNA tested through Family Tree DNA in order to better understand the type of information provided to consumers.

Specifically, JPPI purchased three different tests: The first test called the Family Finder is an Autosomal DNA test, which examines parts of one's DNA that could have been transmitted by any ancestor. Although this test is the broadest in that it provides general information about the mixture of all ancestors and allows individuals to find cousins within the past five generations, it doesn't provide specific information about one's direct paternal or maternal linages.

The second test performed focused on mitochondrial DNA, which is only inherited maternally. Since the mitochondrial DNA (mtDNA) is only passed from mother to child, and if that child is a female to her descendants etc., it carries information on one's direct maternal lineage exclusively. Although all men receive mitochondrial DNA through their mothers, they do not pass it on to their children. The specific mtDNA test that JPPI purchased, mtDNA+, provides consumers with information on their maternal haplogroup as well as matching consumers with individuals who share a common maternal ancestor going back 28 generations, approximately 700 years.[27]

The third DNA test performed focused only on the Y-Chromosome which is passed exclusively from father to son (women do not have a Y-Chromosome) and therefore carries information on one's direct paternal linage. The specific test ordered, Y-DNA37, analyzes 37 genetic markers and can predict relationships within the past eight generations.[28] These three tests cost around $320 USD in total, but each test can be purchased separately.

Once ordered through the company's website the DNA test kit arrives by mail. The kit contains two cotton mouth-swabs and two tiny plastic vials to put the cotton swabs into after the tester scrapes the inside of his or her cheek. The tester then mails the samples back to the company and waits several weeks for the results to become available online.

The results JPPI received from the DNA tests demonstrated the extent to which the tests could

influence one's perceived identity and ethnic affiliation. Figure 1 below shows the "Ethnic Makeup" based on the results of the "Family Finder" test, which analyzed autosomal DNA. According to the test, "Jewish Diaspora" makes up the largest percentage of ancestral origins. That is to say, when comparing the autosomal DNA of the test taker to various reference population groups included in the company's database, the sample resembles most closely that of Ashkenazim. Geographically, the focal point of ancestral "origins" is the area formerly known as the Pale of Settlement.

The results also indicate that some of the ancestors of the test taker may have been of Middle Eastern and European origin. According to Bennet Greenspan of Family Tree DNA, the presence of European and Middle Eastern ancestors can be explained by the observation that Ashkenazim have a combination of paternal Middle Eastern ancestry and European maternal ancestry. It should be noted that all four of the test taker's grandparents were born in Canada and all his great grandparents were born in Europe.

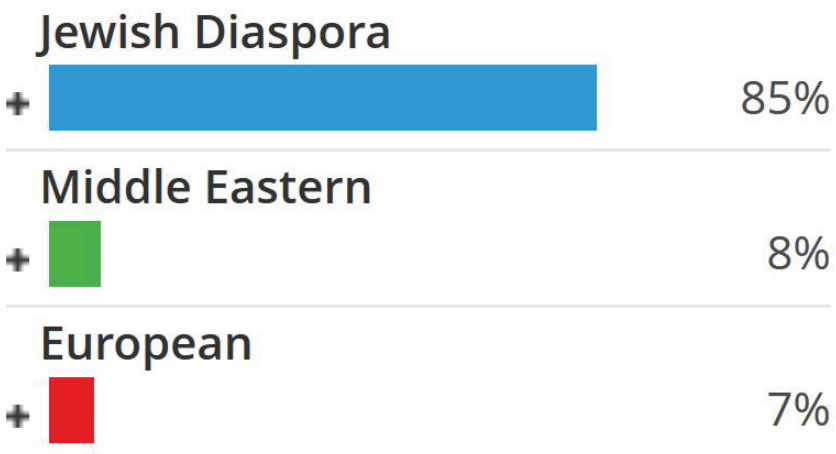

Figure 1

Another aspect of the results the autosomal DNA test generated is the "Family Finder" which matches the tester's DNA with other customers who are possible relatives.[29] The company states that it can match second cousins with 99% accuracy, third cousins at 90%, and fourth cousins at 50%. In this particular case, the test identified hundreds of possible relatives, but the JPPI fellow was only able to verify that three of the matches were indeed relatives (a second cousin once removed, a second cousin twice removed, and a third cousin once removed).

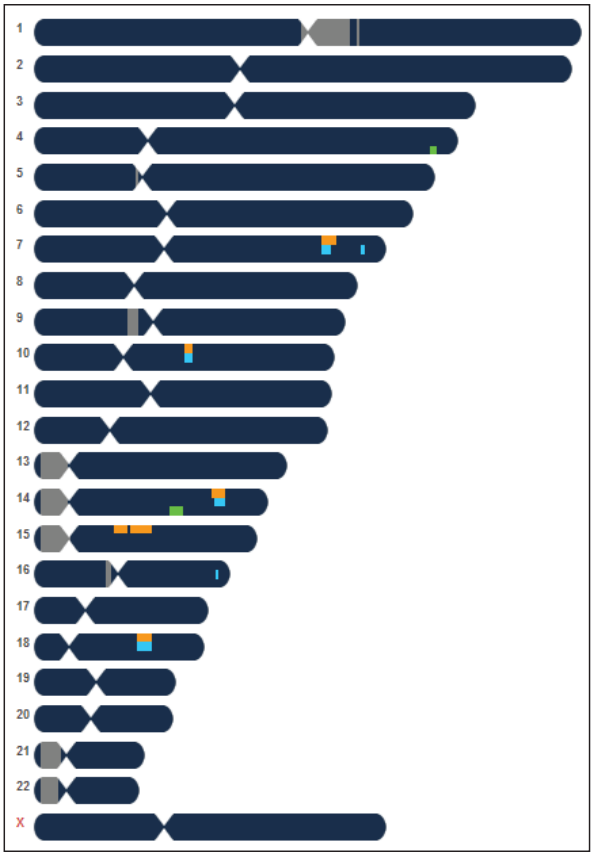

Figure 2

Figure 2 is a visual representation produced by FTDNA of the tester's DNA sample, divided into the 23 chromosome pairs. The tester's DNA is being compared with the DNA samples of three specifically selected individuals, two known blood relatives (father and daughter) the FTDNA was able to match and one individual that FTNDA identified as a possible distant cousin, but which could not be verified by the tester. The areas where the color blocks appear over the blue are the parts in the DNA sample that are identical. The larger the overlap, the longer the matching sequence.

The results of the mtDNA test, which carries information on the direct maternal linage exclusively, also suggested Jewish heritage. Specifically, among the 100 people in the database who match with the tester's mtDNA, roughly 50% are identified as "Ashkenazi," 2% as "Alsace," and the rest are not specifically defined beyond maternal country of origin. While it is most likely that the test-taker's direct maternal ancestor was Ashkenazi, it is also possible that this ancestor was Alsace and not Jewish at all.

The maternal haplogroup was identified as H, considered to be "the most common and most diverse maternal lineage in Europe" and is believed to have emerged 25,000 – 30,000 years ago in the northeastern Mediterranean.[30] Among Jews, 23% of Ashkenazi linages are rooted within haplogroup H.[31]

The tests results of the Y-DNA, which deal exclusively with the direct paternal linage, also suggested Jewish ancestry. Among the individuals whose sample identified as a "genetic match," 65% self-identified as some variant of Ashkenazi or Sephardi. Similar to the mtDNA results, no other ethnic or religious description was provided among all those individuals who were genetic matches. That is to say, of the roughly 35% genetic matches that did not define themselves as Sephardi or Ashkenazi, no alternative identity was provided. According to the test results, it is most likely that the direct paternal ancestor had Jewish ancestry, but it also means there is a 35% chance that the ancestor was not Jewish.

The haplogroup identified for the Y-DNA is J-M267 (commonly known as J1), which is a common haplogroup in the Fertile Crescent in the Middle East, having its origins linked to the expansion of pastoralism.[32]

Interestingly, the results of these DNA tests are congruent with the studies conducted by Behar et al. (2010) and Costa et al. (2013), which examine the origins of the Jewish people through DNA analysis. Specifically, the tester's maternal linage suggests a prehistoric European ancestry, while the paternal linage suggests Middle Eastern origins during the corresponding era.

The test results shared above are from tests that can be purchased separately. For some individuals interested in DNA tests for genealogical purposes, but on a limited budget, purchasing only one type of test could lead to misleading or incomplete results. For example, neither the Y-DNA test or mtDNA test described above gave results that specifically refer to any Middle Eastern origins, while the results of the autosomal DNA test did. Also, as the technology of DNA tests continues to advance and a larger database of DNA samples is available for comparison, the amount of information generated will be of a much higher resolution than available today. Therefore, individuals should not draw too many conclusions about their ancestral origins from a single DNA test or even expect to have a complete understanding of their genealogy from several tests. Moreover, the tests are probabilistic, meaning there is an element of chance involved that could lead to results based on mere coincidence.

Implications for the Jewish People

Historically, Jewish interest in genetic research was primarily, if not exclusively, driven by the well-established fact that parts of the Jewish population were suffering from some genetic or genetically influenced diseases, more so than the general population which they were living in. As such, Jewish communities embraced molecular based genetic testing as a means of combatting lethal inherited diseases such as Tay-Sachs. Perhaps because of the overwhelmingly positive results associated with genetic testing for medical purposes, Jews have not shied away from embracing DNA testing for genealogical purposes.

Jews have not shied away from embracing DNA testing for genealogical purposes

In the 2010 Annual Assessment JPPI included an article, "New Findings Concerning the Genome Structure of the Jewish People," which focused on the potential consequences of scientific genetic studies that focus on the Jewish people. The article briefly discussed two studies that "found important traces of ancient Jewish history – of common geographic origin, past migrations and conversions into Judaism – in the current genome structure of the Jewish people." Through the article JPPI raised the following important question which is even more relevant today because of the personal nature of DNA testing: "Can awareness among Jews that they are "distant cousins," this time

based not on religious tradition but on science, create or reinforce their group solidarity?"

If the answer for even some Jews is yes, which inevitably it is, there is great opportunity to take advantage of this new source of solidarity to strengthen Jewish peoplehood and educate those with a newfound interest in Judaism. For example, there could be an organized group trip to Israel for individuals who believe they have newly discovered Jewish roots.

It needs to be emphasized that identifying genetic commonalities among the Jewish people and studying Jewish genealogy is not synonymous with racial studies on Jews. If anything, recent scientific studies show that the Jewish people are neither genetically homogenous nor genetically unique. Race is in many ways a socially constructed concept with increasing negative connotations. Many people, especially among younger generations, are turned off by racial categorizations and definitions. Understanding what genealogical mapping and the human genome can tell us about the origins of the Jewish people need not have anything to do with race.

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How do these new tools affect connectedness of the Jewish people?

If one considers that the Jewish people is a big interconnected family made up of smaller more closely related families, then the more a family remains connected, the more connected the Jewish people is as a whole. Conversely, if Jewish families lose their connectedness, we are more likely to see a drifting apart of the Jewish people as a whole.

The last 150 years have witnessed massive migrations of the Jewish people throughout the world. As Jewish families relocated, they often broke apart from their larger families – starting a new life in the new world often meant leaving the old life and the family history behind. Furthermore, the *Shoah* destroyed countless amounts of families and genealogical data.

The advances described above have the ability to help relatives that had been separated for generations find each other, even if those individuals don't live in the same continent or speak the same language. The tools also function, like most virtual social networks, as a mechanism to keep families connected and in communication.

Moreover, due to differences of language and culture, perhaps it is difficult for Jews in one part of the world to feel truly connected with Jews in another part of the world, especially in situations where neither are facing persecution. Genealogical mapping has the ability to introduce, at least virtually, individuals to members of their own extended family living in other parts of the world, reinforcing the notion of *Klal Israel*. There is a tremendous benefit, therefore, in embracing these tools as a mechanism to strengthen inter and intra-community bonds.

Considering that until the end of the 19th century the Jewish people consisted of communities living

in population enclaves throughout the world, where the overwhelming majority married other Jews, it is reasonable to assume that a mega-family tree of the Jewish people would be easier to build compared to other Western communities or ethnic populations, barring of course the huge gap in the family tree as a result of the *Shoah*.

How do these developments influence the way Jewish identity is conceived?

Some argue that for many Jews the synagogue has lost its appeal as the central hub of Jewish life. The recent Pew study (discussed at length elsewhere in this assessment) states that "U.S. Jews see being Jewish as more a matter of ancestry, culture and values than of religious observance."[33] If that is true, it is reasonable to expect some individuals to conceive of their Jewish identity as a result of their ancestry alone and not by their current practices, cultural milieu, or beliefs. Is it possible then, to have this category of Jews be engaged or involved in some way with a Jewish community? Perhaps the virtual networks being created by those engaged in genealogical research offer a new form of Jewish involvement. That is to say, if individuals identify themselves as part of the Jewish community because of their ancestry, then learning more about their ancestry and celebrating their heritage could be considered a form of Jewish engagement. Strengthening these individual's sense of Jewish heritage or deepening their knowledge of their ancestor's beliefs and customs through these new tools has the potential to reinforce their Jewish identity and lead to other forms of Jewish engagement.

Therefore, Jewish communal organizations, such as synagogues, cemeteries, and societies, along with the official Zionist and Israel archives, should expand the amount and accessibility of electronic records containing genealogical information to assist those engaged in such research.

Jews who do not connect strongly with Israel or who are even hostile to the idea of Zionism could be deeply impacted by DNA test results similar to the ones above. Those who associate Zionism with colonialism and not a genuine returning of a people to their historical homeland could be surprised to know that they themselves actually have ancestral origins in the Land of Israel.

> An extreme example of the effect of learning about Jewish heritage is the bizarre story of Csanad Szegedi, a member of the European Parliament and former leader of Hungary's extreme right-wing Jobbik political party known for his anti-Semitic rhetoric, who learned of his Jewish heritage only after becoming party leader.[34] Not only did Szegedi dissociate from the Jobbik party, he is now reportedly "enamored with Judaism" and living an active Jewish lifestyle.[35]

One major challenge that will arise due to DTC DNA tests is the likelihood that a committed Jew will find the results of a DNA test off-putting. Imagine an individual, perhaps someone adopted, who is raised Jewish and committed to the Jewish people, but as an adult discovers that s/he likely did not have any Jewish ancestors, or someone who has one Jewish parent and receives DNA

test results that suggest she is only '15% Jewish.' Further still, deeply committed Zionists who do not find any traces of Middle Eastern roots within their DNA, might begin to question the relevance of Zionism within their Jewish identity.

Overall, test results have the potential to deeply affect one's self-conception of belonging to the Jewish people, especially if the individual is only marginally involved in a Jewish community. Therefore, an important policy priority should be to prevent DNA tests from becoming a device of alienation away from the Jewish people.

Results could spark interest in exploring Jewish heritage and foster engagement in the Jewish community

The amount that an individual's DNA sequence correlates to DNA sequences common among Jews is not an indication of Jewishness. It needs to be stressed and understood that there is no one singular exclusively Jewish linage extending from Abraham to the present day. There has always been some degree of intermarriage throughout Jewish history. Even King David's Great-Grandmother Ruth was a Moabite convert to Judaism.

In his day, Maimonides (Rambam) wrote a famous letter to Obadiah the Proselyte in response to the latter's question, that even though he is a convert to Judaism is he allowed to use the first person plurals 'us,' 'we,' and 'our' in reference to the Jewish people in prayer, alone and in the synagogue. Maimonides concluded that those who adopt Judaism and follow the laws of the Torah are counted among the descendants of Abraham: "In the same way as he converted his contemporaries through his words and teaching, he converts future generations through the testament he left to his children and household after him."[36]

For individuals who become aware of their Jewish ancestry as a result of taking a DNA test, the results could spark interest in exploring their Jewish heritage and becoming engaged in the Jewish community. Perhaps these individuals could even become active supporters of Israel. Although actively promoting DNA tests for these purposes among non-Jews is tantamount to proselytism, it is important for Jewish organizations to be aware of the types of results generated from DNA tests and the potential effect they have on one's identity. To learn from a test perceived to be scientific that you have Jewish heritage and to be told by a Jewish community that you are not really Jewish could be confusing and disheartening. Leaders of the Jewish community especially should not be dismissive of individuals who approach them claiming to be a distant relative; rather, they should use it as an opportunity for engagement.

Along with the interest among consumers for home DNA testing, there has recently been a variety of academic studies which utilize DNA testing to answer the question of where the Jewish people, or specifically Ashkenazim, come from (Behar et al. 2003, 2010, Elhaik 2012, Costa et al. 2013). Although not necessarily understood by the average reader, the studies' conclusions gain

widespread publicity and raise controversial questions with political implications.

One such recent study published in October 2013 in the journal "Nature Communications" suggests "a significant role for the conversion of women in the formation of Ashkenazi communities" and that "the great majority of Ashkenazi maternal lineages were not brought from the Levant."[37]

Previously, in 2012, a controversial article in the scientific journal "Genome Biology and Evolution" claimed to have conducted DNA analysis that supports the Khazarian myth, that "Eastern European Jews descended from the Khazars, an amalgam of Turkic clans that settled the Caucasus in the early centuries CE and converted to Judaism in the 8th century."[38]

Conversely, Behar, with the collaboration of many experts, concludes that DNA analysis can "trace the origins of most Jewish Diaspora communities to the Levant."[39] While this conclusion supports the Jewish-Zionist historical narrative, previously mentioned studies challenge or even refute it. Much like the field of archeology, in which artifacts can be used as evidence to support or challenge long-held historical conceptions, genetic studies can be designed or interpreted to support one historical narrative over another.

Just as the State of Israel has invested resources into the study and promotion of archeology, in part to demonstrate and strengthen the connection of the Jewish people to the land of Israel, by investing in the fields of genetic research and molecular anthropology, Israeli scientists could be at the forefront of this growing field not only to demonstrate the historical connection of the Jewish people to the Land of Israel, but to help refute studies that manipulate data in order to undermine that connection.

Endnotes

1. (23AndMe, 2013)
2. (FamilyTreeDNA, 2014)
3. (Greenspan, 2013)
4. (Romero, 2005)
5. (MyHeritage.com, 2014)
6. It is important to note that, although an individual builds a family tree, by definition, the tree is composed of many, even thousands of people. For every individual who creates a family tree, many more individuals, willing or not, are added as well.
7. Created by the Mormon Church in order to help in their quest of post-mortem conversion of ancestors.
8. (The National Human Genome Research Institute, 2014)
9. (The National Human Genome Research Institute, 2014)
10. Recently, companies offering DNA analysis for medical purposes have been scrutinized and subsequently shut down by the U.S. Food and Drug Administration.
11. (23AndMe, 2013)
12. (The American Society of Human Genetics, 2008)
13. (The American Society of Human Genetics, 2008)
14. Since full genomic sequencing is still very expensive, around $10,000, DTC tests only do a basic examination of one's DNA. As such, the results generated shed light on relationships within the past 5 – 8 generations.
15. (FamilyTreeDNA, 2014)
16. (Behar, 2010)
17. (Harmon, 2006)
18. (PBS, 2013)
19. (Taylor, 2014)
20. (Harmon, 2006)
21. (Geddes, 2014)
22. (Blatt & Groll, 2013)
23. (JewishGen, 2014)
24. (JewishGen, 2014)
25. (World Zionist Organization, 2014)
26. (Yad Vashem, 2014)
27. (Family Tree DNA, 2014)
28. (Family Tree DNA, 2014)
29. Customers are given the option not to be included in the family matches of other customers.
30. (Eupedia, 2014)
31. (Costa, et al., 2013)
32. (Eupedia, 2014)
33. (Pew Research Center, 2013, p. 47)
34. (Gorodni, 2012)
35. (Aderet, 2013)
36. (Maimonides)
37. (Costa, et al., 2013)
38. (Elhaik, 2012)
39. (Behar, 2010)

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