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This study discusses how DNA testing can help genealogists and family historians further their research and go beyond their paper trail in validating the identity of their ancestors. It looks at the three kinds of DNA tests, their value to genealogical research, and their limitations. Several case studies for each type of testing are also presented. The three kinds of DNA testing are mitochondrial, Y-DNA, and autosomal. The mitochondrial DNA is passed down from a mother to her children and is useful in determining the direct maternal ancestry. The Y-DNA is passed down only from a father to his son and is useful in determining the direct paternal ancestry. The autosomal DNA is passed down from both the mother and the father and is useful in determining recent ancestry from all ancestors. The kind of DNA test taken depends on the researchers' goals. A genealogical paper trail is still required to understand and work with the results of a DNA test and to further one's research. A DNA test by itself cannot identify who one's ancestors were; however, when used in tandem with genealogical research, it can help to build a clearer picture of who they might have been.

Headings:

Genealogy

Genetic Research

Genetic Testing

AN ANALYSIS AND COMPARISON OF DNA TESTING RESULTS AND THEIR USEFULNESS IN FAMILY HISTORY RESEARCH

by
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Introduction

With the advent of the *Who Do You Think You Are?* reality TV show, the hobby of genealogy and family history is becoming more and more popular. Commercial advertisements aired during the show like those from *Ancestry.com* suggest that with the click of a button you can find out where you came from, who your great-grandparents were, and what street your grandparents lived on. Knowing where we came from is important because it helps us identify who we are today and where we fit into society (Bishop 993). Why wouldn't we want to do it if is as easy as the click of a button?

Unfortunately, family history research is not as easy as the click of a button, as anyone who has been doing it before the internet came along can attest to. Before there was the internet and a "click of a button," there were long letters written, long car drives to and from cemeteries several hours away from home, and several hours spent hunched over dusty old records or microfilm in a courthouse or library looking for clues about our elusive ancestors.

Before the internet, genealogists kept very detailed records about what they found, where they found it and when so they wouldn't go looking for it again or so they could tell the next person where they had gotten their information from (Yakel 6). Oftentimes, they recorded what they *didn't* find as well for the same reasons mentioned above.

Before the internet genealogists took great care in documenting their research because they had to. If they didn't document what source they recorded a birth date from and a question arose about its accuracy later, they couldn't just get up and make another seven-hour trip back to the courthouse to look it up again to verify the information; it wouldn't be feasible.

However, with the internet and ease of use of online databases like *Ancestry.com*, genealogists can now record information about a fact such as a birth date without recording where they got the information from because there is an inherent belief that that information will always be available for them to “look up” again in the future.

Although genealogists would love to be able to put their hands on the “really old” original documents that document their ancestors’ lives, there seems to be more of an overwhelming need to fill in the holes of their family tree quickly and easily than a desire to spend a week pouring over dusty records just to answer one question about one ancestor. Thus the original documents, which are out of the reach of the internet users, seem to be going untouched.

It is not surprising then, that the next best thing to a “click of a button” that gives you instant access to all of the available digitized records about your ancestors would be the “swab of the cheek” that would tell you all you need to know about *more* of your ancestors; you know the ones you never knew about - the man who fathered your entire line of Smith males back in the 1600s in Wales or the 450 cousins you never knew you had all over the world.

Isn’t it the same thing? Just another “click of a button?” With the same expectation? To instantly be told who one’s ancestors are or where one came from? This is what commercial DNA testing companies are promising customers these days it seems. Or at least that is how many genealogists are interpreting *their* advertisements.

DNA testing is becoming less and less expensive these days. Back in the early 2000s when Y-DNA testing first became available through Family Tree DNA, owned by *Gene by Gene, Ltd.*, a twelve marker test costs \$99.00. The same twelve marker test has since dropped in price and currently costs \$49.00 (“12-marker Y-DNA Test,” *Family Tree DNA*). The autosomal test

originally started off at \$300 and has since dropped in price to \$99.00 in the course of only three years ("Relative Finder Test," *23AndMe*; Moore, "*23andMe Receives \$50 Million*").

DNA testing can certainly tell you a lot about yourself, your ancestors and your ethnicity, but only if you have the background information to go along with it. Some level of genealogical research has to have been done in order to understand and benefit from the results of a DNA test. What kind of DNA test you take will depend on what your goals are as well and every kind of DNA test has its limitations.

There are three kinds of DNA tests that are currently available through commercial testing companies for genealogical purposes - The mitochondrial (mtDNA), Y-DNA, and autosomal (atDNA) tests.

The mitochondrial DNA test looks at your direct maternal ancestry: your mother's mother's mother and so on. Mitochondrial DNA is passed down relatively unchanged from a mother to her children (Sykes 54). Although the mtDNA test is taken mostly by females, males can also take the test if they are interested in tracing their *mother's* maternal line. This test can be useful for female ancestor research but will usually only tell you about your deep ancestry, going back thousands of years. This is due to the slow mutation rate (changes in the DNA) of the mitochondrial DNA. You could end up with a high number of matches, but some of them might be related through a common ancestor you share from a few hundred years ago or a few thousand years ago (Kennett 67).

A mitochondrial DNA test is recommended for people who have a hypothesis to test based on the paper trail that they have already followed (Kennett 67). For example, if you have a female ancestor whose place of birth is known but maiden name is unknown, and you locate a set of potential parents and siblings who lived in the same location, you can then follow that family's paper trail and identify a living maternal line descendant to test. This descendant's

results could be compared to your own results to see if you are related. If you are related, there's a good chance your hypothesis was correct; if you are not related, then you can eliminate that family unit as being the parents of your ancestor.

The Y-DNA is similar to the mtDNA test except it looks at your direct *paternal* ancestry: your father's father's father and so on. This test can only be taken by males as it reports values on the Y chromosome which only gets passed on to the males from their fathers. Females do not have a Y chromosome because they have two X chromosomes. Males have both an X and a Y chromosome.

Because the Y chromosome is passed down relatively unchanged from generation to generation, it usually follows the paternal surname of the man carrying it. For example, if a man named "Smith" takes the Y-DNA test, and his Y-DNA was passed down uninterrupted, that is, there were no illegitimate births, adoptions, or name changes along the way, sometimes referred to as a "non-paternal event," (Kennet 29-30) from generation to generation, then he should match other men named "Smith." If, however, he matches men named "Jones," then that might mean that a non-paternal event had occurred somewhere down the line. In this latter case, a genealogical paper trail and list of documented sources would be helpful to determine what exactly had happened and when.

Y-DNA testing can be especially useful for people who may not have a paper trail established yet, such as adoptees. Adoptees are usually given their mother's surname at birth, but upon adoption, are quickly given the surname of their adopted parents. A high-resolution match with someone will offer at a minimum a good starting point for a possible surname of their birth father. Family Tree DNA set up a special project on their website ("Adopted Project," *FamilyTreeDNA.com*) for adoptees to join. According to Kennett (38) the company now claims

that between 30 and 40 percent of adoptees who are tested through the project have found matches “with a potential ancestral surname.”

Y-DNA testing has a wide range of benefits. In addition to helping adoptees determine a possible surname of their birth father, it can help you determine if two men living in the same town or in two different countries are related. For example, in the case study discussed in this paper, descendants from two Kerchner immigrants who arrived in Pennsylvania in the early 1700s were tested to determine if they were related to each other; members of the Kerchner family turned to Y-DNA testing because a relationship could not be inferred from a genealogical paper trail. Likewise, when a Hurst family history book implied that the American Hursts were descended from an ancestor named Henry Hurst who lived in England in the 1600s, but the paper trail did not match up, researchers turned to Y-DNA testing to determine the truth: a Y-DNA test was taken by descendants of both the American and English Hursts and compared.

Although the mitochondrial and Y-DNA tests can be very effective in furthering your genealogical research, and work especially well when you have a testable hypothesis, they are limited in that they only tell you about two distinct lines of your family - either your paternal side or your maternal side (Kennett 80). All of the lines in the middle are ignored with these tests and the number of ancestors that you can learn about via DNA is dramatically decreased by limiting yourself to taking just these two tests. You can cast a wider net and glean information about your more recent ancestors by taking a new and more powerful test called an autosomal DNA test.

The autosomal (atDNA) test is the newest test currently available. This tests the nuclear DNA inside of your cells which is passed down from both your mother and your father via sets of twenty-two chromosomes. Unlike the Y and mtDNA which is passed down relatively unchanged

through each generation, the atDNA changes randomly as it is passed down, but you still receive bits and pieces from each of your ancestors through every generation.

The atDNA test is available for both men and women to take. It looks at over 700,000 markers and measures the DNA shared between two people. The length of shared DNA between individuals is reported in either centimorgans (cM) or percentages. This number contributes to the predicted relationship between two people. The higher the percentage of DNA shared between two people, the closer the relationship. The DNA testing company provides the user with a list of “matches” and a “predicted” relationship. It is then up to the user to determine exactly how they are “related” to their matches by comparing their paper trails and genealogical family trees.

The autosomal DNA test is being used heavily by adoptees and people who have surrendered their children and wish to locate them again. Although adoptees do not yet have paper trails to confer and compare to, they can use the paper trails of their matches to construct a likely family structure to which they might fit in. Likewise, people who are looking to fill in gaps in their family trees find the autosomal DNA test particularly useful. If you ever wondered what happened to the brother of your third great-grandfather, for example, and you find a cousin who descends from him, then you might be able to compare notes and fill in some gaps in both of your trees.

Regardless of what kind of DNA test is taken, a genealogical paper trail is still required to be used in tandem in order to understand and work with the results. DNA by itself cannot provide all the answers, and even when used in tandem with the genealogical paper trail, still has some limitations. None of the three tests - mtDNA, Y-DNA, or atDNA can tell you exactly how you are related to another person or who your ancestors are. But they can offer you guidelines to help you continue your search.

The following case studies illustrate how DNA testing can be used to validate or disprove genealogical paper trails, help further genealogical research and link modern times to people and events from hundreds of years earlier. Limitations of the kinds of testing used in each example are also discussed.

The Hursts of Shenandoah Valley, Virginia

In 1950, John C. Hurst published one of the first family genealogy books on the Hurst family of Shenandoah Valley, Virginia. Most of his research, he claimed, had been taken from letters written to his father by B. F. Hurst. According to this research, he had determined that the Hursts of Shenandoah, Virginia were descended from three brothers named John, William, and James who had emigrated to the Colonies in 1730 along with their father, Henry Hurst, from Leckhampstead, Buckinghamshire, England (J. Hurst preface). Later research conducted in the British Archives and Virginia Parish records brought into question the validity of these former statements by J. C. Hurst. Unfortunately this information had already been propagated to hundreds of online genealogical trees with an unwillingness to change the incorrect information until a replacement family unit had been constructed. Thus the Hurst family researchers turned to Y-DNA testing to see if they could piece together a new family unit and determine when, where, and from whom the Shenandoah Valley Hursts had really come from.

Researchers first decided to see if Y-DNA testing could tell them if two families living in the Shenandoah County area of Virginia during the early 1700s were related. The first family consisted of Absalom Hurst and his brother John "Mill Creek" Hurst, both believed to be the sons of Thomas Hurst (Padgett 210). They lived in the Southern part of Shenandoah County which had originally been Stafford County and which is now Page County, Virginia (W. Hurst, "Hurst Surname DNA Project Success Stories").

The second family of Shenandoah County was that of William “Brindle Bill” Hurst and his two sons William and “Captain” John Hurst (J. Hurst 7). They lived in the Northern part of Shenandoah County which is now Warren County.

Because these two lines lived close to each other, it was usually assumed by researchers that they were related. That these two lines were related was questioned, however, by a respected Hurst family genealogist named Gwen Hurst in the early 2000s (W. Hurst, “Hurst Surname DNA Project Success Stories”). In 2003, descendants of both lines decided to test Gwen Hurst’s theory by taking a 37 marker Y-DNA test, the “biggest” test available at that time.

Initially four men descended from the Southern part of Shenandoah Valley (now Page County) were tested for Y-DNA on 37 markers to ensure that they were related to each other. Two men with genealogical paper trails back to Absalom Hurst and 2 men with unknown paper trails were tested. Test number A02 and A03 are descended from Absalom Hurst, born about 1750, via his sons John (A02) and William (A03). Test number A01 is descended from James Hurst, born about 1773, who is believed to be the son of John “Mill Creek” Hurst, Absalom Hurst’s brother. The fourth Hurst man tested, number A04, is a descendant of Jeremiah Hurst, born about 1785 (“Hurst DNA Project,” *Family Tree DNA*). At the time the DNA test was taken in 2003, the father of Jeremiah Hurst was unknown but suspected to be Absalom Hurst (W. Hurst, “Re: Squire Hurst (Absalom Hurst)”). Absalom and John “Mill Creek” Hurst were both sons of Thomas Hurst of Stafford County, Virginia (Padgett 210).

Figure 1 shows the results of the 37-marker Y-DNA test for the first four Hurst descendants tested. All four men tested had the same exact marker values for each allele (“Hurst DNA Project,” *Family Tree DNA*). This confirmed that all four men were related within a genealogical time frame, or within the last 600 years, when surnames were adopted. The descendant of James, who is presumed to be the son of John “Mill Creek” Hurst, was related to

descendants of the sons of Absalom Hurst, John and William, and to the descendant of Jeremiah Hurst who was believed to also be a son of Absalom Hurst.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37
Paternal Ancestor Name	DYS393	DYS390	DYS19	DYS391	DYS385a	DYS385b	DYS426	DYS388	DYS439	DYS389i	DYS392	DYS389ii	DYS458	DYS459a	DYS459b	DYS455	DYS454	DYS447	DYS437	DYS448	DYS449	DYS464a	DYS464b	DYS464c	DYS464d	DYS460	Y-GATA-H4	YCAI	YCAII	DYS456	DYS607	DYS576	DYS570	CDYa	CDYb	DYS442	DYS438
A01 - James Hurst b. ca 1773	14	23	14	10	11	14	12	12	12	13	13	29	17	9	10	11	11	25	14	19	29	15	16	17	18	11	11	19	22	15	14	16	17	37	39	12	12
A03 - Absalom Hurst - 1750, Stafford Co., VA	14	23	14	10	11	14	12	12	12	13	13	29	17	9	10	11	11	25	14	19	29	15	16	17	18	11	11	19	22	15	14	16	17	37	39	12	12
A02 - Absalom Hurst - 1750	14	23	14	10	11	14	12	12	12	13	13	29	17	9	10	11	11	25	14	19	29	15	16	17	18	11	11	19	22	15	14	16	17	37	39	12	12
A04 - Jeremiah Hurst, b: est. 1785, d: 1 Dec 1854	14	23	14	10	11	14	12	12	12	13	13	29	17	9	10	11	11	25	14	19	29	15	16	17	18	11	11	19	22	15	14	16	17	37	39	12	12

Figure 1. The 37-marker Y-DNA results of the descendants of Absalom Hurst, James Hurst, and Jeremiah Hurst tested.

Two more men were tested who were descendants of William “Brindle Bill” Hurst of the Northern part of Shenandoah County, Virginia, now Warren County. With the exception of DYS marker 385b, the DNA marker values for the descendants of William “Brindle Bill” Hurst were exactly the same as those for the descendants of Absalom (A02, A03), John “Mill Creek” (A01), and Jeremiah Hurst (A04) who were tested previously. Both men tested are descended from “Captain John” Hurst, a son of William “Brindle Bill” Hurst (W. Hurst, e-mail). Figure 2 show the results of the 37-marker Y-DNA test for the two descendants of William “Brindle Bill” Hurst compared to the first four Hurst descendants previously tested. All six Hurst men tested had the same exact marker values except for A07 who had a mismatch on DYS385b. This mismatch on marker DYS385b is shown in blue in figure 2.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37
Paternal Ancestor Name	DYS393	DYS390	DYS19	DYS391	DYS385a	DYS385b	DYS426	DYS388	DYS439	DYS389i	DYS392	DYS389ii	DYS458	DYS459a	DYS459b	DYS455	DYS454	DYS447	DYS437	DYS448	DYS449	DYS464a	DYS464b	DYS464c	DYS464d	DYS460	Y-GATA-H4	YCAI	YCAII	DYS456	DYS607	DYS576	DYS570	CDYa	CDYb	DYS442	DYS438
A01 - James Hurst b. ca 1773	14	23	14	10	11	14	12	12	12	13	13	29	17	9	10	11	11	25	14	19	29	15	16	17	18	11	11	19	22	15	14	16	17	37	39	12	12
A03 - Absalom Hurst - 1750, Stafford Co., VA	14	23	14	10	11	14	12	12	12	13	13	29	17	9	10	11	11	25	14	19	29	15	16	17	18	11	11	19	22	15	14	16	17	37	39	12	12
A02 - Absalom Hurst - 1750	14	23	14	10	11	14	12	12	12	13	13	29	17	9	10	11	11	25	14	19	29	15	16	17	18	11	11	19	22	15	14	16	17	37	39	12	12
A04 - Jeremiah Hurst, b: est. 1785, d: 1 Dec 1854	14	23	14	10	11	14	12	12	12	13	13	29	17	9	10	11	11	25	14	19	29	15	16	17	18	11	11	19	22	15	14	16	17	37	39	12	12
A07 - William (Brindle Bill) Hurst - 1710	14	23	14	10	11	11	12	12	12	13	13	29	17	9	10	11	11	25	14	19	29	15	16	17	18	11	11	19	22	15	14	16	17	37	39	12	12
A06 - William (Brindle Bill) Hurst - 1710	14	23	14	10	11	14	12	12	12	13	13	29	17	9	10	11	11	25	14	19	29	15	16	17	18	11	11	19	22	15	14	16	17	37	39	12	12

Figure 2. The 37-marker Y-DNA results of the descendants of William “Brindle Bill” Hurst compared to the first four Hurst men who were previously tested. Marker 385 is a fast-mutating marker.

DYS marker 385 is a fast mutating marker, so it is not unusual to see differences in these values (“Group Administration Page (GAP): Reference, FAQ no. 60.” *Family Tree DNA*).

Differences in values of fast mutating markers can usually tell you when familial lines split off from each other. In this case, the mutation probably occurred sometime between the birth of “Captain John” Hurst’s sons and the births of the two men who were tested. Although this single mutation is present in A07, he is still considered to be “tightly related” to the other five testers according to Family Tree DNA’s FAQs page (“Interpreting Genetic Distance”), therefore concluding that the two Hurst families from both the Northern and Southern parts of the Shenandoah Valley of Virginia are related.

The Hursts of Carroll County, Virginia

Four Hursts have been identified as the children of William Hurst Sr. and Rachel Cummings with documented genealogical paper trails. They are said to have been “of Carroll County,” Virginia even though the county lines changed several times and encompassed at one time or another Montgomery, Pulaski, and Wythe counties. These four children named William Hurst, Jr., Catherine Hurst, Franklin Hurst, and Lucinda Hurst (Harris, “William Hurst Family Tree”) have been widely accepted by genealogists as the children of William and Rachel mainly due to their ties to Carroll County, or their death certificates which identified their parents as William and Rachel Hurst (W. Hurst, “Identification of the Founders of the Hurst Family”).

Other Hursts living in neighboring counties had previously been rejected as children of William and Rachel because they did not live in Carroll County. One such example is Joseph Hurst who was included on an 1835 Wythe County lease from Francis Allison to William Hurst Sr., Joseph Hurst, and William Hurst, Jr. (W. Hurst, “Hurst family of Carroll County, Virginia”). The William Hurst Sr. mentioned in this lease is believed to be the same William Hurst who was married to Rachel Cummings and the father of the four Hurst children discussed in this case. The William Hurst Jr., mentioned in the lease is believed to be his son. That Joseph Hurst was mentioned along with William Hurst Sr. and William Hurst Jr. on this lease indicates a probable familial relationship existed between the three men.

The existence of the 1835 lease, while providing strong corroborative evidence that these men were related, was not enough conclusive “proof” to convince researchers that these three men were related. Therefore, a Y-DNA test was taken by descendants of both William

Hurst, Jr. and Joseph Hurst in order to determine if these two Hurst men living in neighboring counties were related. Figure 3 shows the results of the 25-marker Y-DNA test for these first two Hurst descendants tested. Both men tested had the same exact marker values, indicating that William Hurst, Jr. and Joseph Hurst were in fact related (“Hurst DNA Project,” *Family Tree DNA*).

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Paternal Ancestor Name	DYS393	DYS390	DYS19	DYS391	DYS385a	DYS385b	DYS426	DYS388	DYS439	DYS389i	DYS392	DYS389ii	DYS458	DYS459a	DYS459b	DYS455	DYS454	DYS447	DYS437	DYS448	DYS449	DYS464a	DYS464b	DYS464c	DYS464d
E02 - Joseph Hurst - 1801	13	24	14	11	11	14	12	12	12	13	13	30	16	9	9	11	11	24	14	18	28	15	15	16	17
E03 - William Hurst Jr. - 1803	13	24	14	11	11	14	12	12	12	13	13	30	16	9	9	11	11	24	14	18	28	15	15	16	17

Figure 3. The 25-marker Y-DNA results of the descendants of William Hurst, Jr. of Carroll County, Virginia and Joseph Hurst of Wythe County, Virginia.

Furthermore, the test results of William Hurst, Jr. and Joseph Hurst were compared to the results of the descendants of the “Northern Virginia” Hursts. Figure 4 shows the results of the 25-marker Y-DNA test for William Hurst, Jr. and Joseph Hurst (highlighted in yellow) compared to the Hurst men tested who descend from the Northern Virginia Hursts. Although the results from the Northern Virginia Hursts were similar to the Carroll County Hursts, they were not identical. Their marker values were similar enough, however, to indicate that the Hursts of Carroll County (which now included Joseph Hurst of Wythe County) are related to the Hursts of Northern Virginia (“Hurst DNA Project,” *Family Tree DNA*).

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Paternal Ancestor Name	DYS393	DYS390	DYS19	DYS391	DYS385a	DYS385b	DYS426	DYS388	DYS439	DYS389i	DYS392	DYS389ii	DYS458	DYS459a	DYS459b	DYS455	DYS454	DYS447	DYS437	DYS448	DYS449	DYS464a	DYS464b	DYS464c	DYS464d
MIN	13	23	14	10	11	14	12	12	12	13	13	29	16	8	9	11	10	24	14	18	28	15	15	16	17
MAX	13	24	15	11	11	14	12	12	12	13	13	30	19	9	11	11	11	25	15	19	32	15	15	17	17
MODE	13	24	14	11	11	14	12	12	12	13	13	30	16	9	11	11	11	24	14	18	28	15	15	16	17
E13 David Jon Broadhurst, b. 1844, Goldsboro, NC	13	23	14	11	11	14	12	12	12	13	13	29	19	9	10	11	11	24	15	19	28	15	15	17	17
E01 - John D. Hurst - 1805	13	23	14	11	11	14	12	12	12	13	13	30	16	9	10	11	11	24	14	18	28	15	15	16	17
E04 - Samuel Hurst - 1808	13	23	14	11	11	14	12	12	12	13	13	30	16	9	9	11	11	24	14	18	28	15	15	16	17
H01 - John Hurst - b. 1735 VA	13	23	15	11	11	14	12	12	12	13	13	29	17	8	10	11	11	25	15	19	32	15	15	16	17
E09 - William Reid Hurst b. 1828 GA, b. 1904 GA	13	24	14	10	11	14	12	12	12	13	13	30	16	9	11	11	11	24	14	18	28	15	15	17	17
E10 - William Washington Hurst b, 1788, NC	13	24	14	11	11	14	12	12	12	13	13	30	16	9	11	11	11	24	14	18	28	15	15	16	17
E08 - Paul Futhy Steele (adopted) b. 1906 CA	13	24	14	11	11	14	12	12	12	13	13	30	16	9	11	11	11	24	14	18	28	15	15	16	17
E05 - Jesse Hurst b. 1750 NC	13	24	14	11	11	14	12	12	12	13	13	30	16	9	11	11	11	24	14	18	28	15	15	16	17
E12 Spencer G. Hurst b. 1810	13	24	14	11	11	14	12	12	12	13	13	30	16	9	11	11	11	24	14	18	28	15	15	16	17
E06 - J T Hirst, b.c. 1878	13	24	14	11	11	14	12	12	12	13	13	30	16	9	11	11	11	24	14	18	28	15	15	16	17
E07 - Isaac Hust (1799-1879)	13	24	14	11	11	14	12	12	12	13	13	30	16	9	11	11	11	24	14	18	28	15	15	16	17
E11 William Joseph b. 1775 VA	13	24	14	11	11	14	12	12	12	13	13	30	16	9	9	11	10	24	14	18	28	15	15	16	17
E02 - Joseph Hurst - 1801	13	24	14	11	11	14	12	12	12	13	13	30	16	9	9	11	11	24	14	18	28	15	15	16	17
E03 - William Hurst Jr. - 1803	13	24	14	11	11	14	12	12	12	13	13	30	16	9	9	11	11	24	14	18	28	15	15	16	17
Unknown	13	24	14	11	11	14	12	12	12	13	13	30	16	9	9	11	11	24	14	18	28	15	15	16	17

Figure 4. The 25-marker Y-DNA results of the Carroll County, Virginia Hursts (E02 and E03) compared to the Northern Virginia Hursts.

Another possible son of William Hurst, Sr. is Samuel Hurst born about 1808. One of Samuel's descendants also took the Y-DNA test and came back as a close match to both the Carroll County and the Northern Virginia Hursts. He is represented as E04 in Figure 4 ("Hurst DNA Project," *Family Tree DNA*). The descendant of Samuel Hurst carries a marker value of "9" for DYS marker 459b, which is the same value carried by the descendants of the Carroll County Hursts - William Hurst Jr. and Joseph Hurst. However, the descendant of Samuel Hurst also carries a marker value of "23" for DYS marker 390, which is the same value carried by the descendants of the Northern Virginia Hursts. Unfortunately, in this example, the Y-DNA can only tell you that Samuel Hurst is related to both of these lines. It cannot, however, tell you exactly how he is related to each of these two lines. This is one of the limitations to the Y-DNA test.

Henry Hurst of Leckhampstead Parish, Buckinghamshire, England

Determining if two lines living in close proximity are related is generally a good first step in the genealogical process. However, when relationships between lines in close proximity are established, it then becomes necessary to look at how they got there in the first place. The Hursts of Shenandoah had long ago been rumored to have descended from three brothers named James, John, and William who had immigrated to the Colonies from England with their father Henry Hurst around 1730.

This rumor of the three “brothers” had started about sixty years ago when J. C. Hurst published a book, *The Hursts of Shenandoah Valley*. In the preface of the book, he stated that the Hursts of Shenandoah Valley were descended from Henry Hurst of Leckhampstead Parish, Buckinghamshire, England, and his wife Mary Bill (J. S. Hurst 53) via their three sons named William, John and James who were all born in England. He further stated that all three “brothers” left England and came to the Colonies with their father about 1730. He also maintained that the information linking the Shenandoah Valley Hursts to Henry Hurst of Leckhampstead, England was relayed to him by his father, an example of incorporating oral tradition into genealogical “research.” No other corroborating evidence or proof to back his father’s statements up was provided in his book.

Since the publication of John C and Simeon Hurst’s books, researchers have found several British records that conflicted with the information contained within their books.

Unfortunately, by the time the research had been done in England, the information from these books had been copied to most published Hurst genealogies and continues to be copied today even though the information contained within has been publicly refuted (Reed, "Re: Henry Hurst b1679").

According to the research records found in England, there was a Henry Hurst who was born in Leckhampstead Parish, Buckinghamshire, England who was apprenticed out to a Pattenmaker's Company in London in 1695/6 (Reed, "Re: Henry Hurst b1679"). While under this apprenticeship, he married to Sarah Sapsford (not Mary Bills) 19 September 1701 in Felmersham, Bedfordshire, England. June Reed stated that "Sarah was pregnant at the time of marriage which explains why it took place so far from her London home" (Reed, "Henry Hurst b1679"). Five children were baptized to this couple from 1702 to 1708 at Saint Dunstan's and All Saints Church in Stepney, London, England. Henry Hurst was again mentioned in the Patternmaker's records in 1710. These records indicate that Henry's wife and children were still in England in 1708 and that Henry himself was still in England until at least 1710 (Reed, "Henry Hurst").

The Henry Hurst who was said to have married Mary Bill (J. S. Hurst 53) was actually a man named Hendrick Hurst who married Mary Bill in Boston in 1704 (Reed, "Henry Hurst"). Henry Hurst of Leckhampstead, England could not have been the same man as Hendrick Hurst who married Mary Bill in Boston, Massachusetts in 1704 because he was still in London baptizing his youngest child in 1708 and being mentioned in the Patternmaker's records in 1710 (Reed, "Henry Hurst").

To alleviate any doubt that the Hursts of Shenandoah were not related to Henry of Leckhampstead, England, Y-DNA testing was done on descendants of both lines. Four men related to the Henry Hurst of Leckhampstead Parish, England were tested for Y-DNA in order to

be compared to the Y-DNA of the descendants of the Shenandoah Valley, Virginia Hursts. Not only did the DNA markers vary significantly, but so did the haplogroup which is the genetic population to which each person is assigned ("Haplogroup," ISOGG Wiki). The haplogroup for the Shenandoah Valley, Virginia Hursts is "R" and that of the Leckhampstead, England Hursts is "I." A difference of haplogroups indicates that these two lines are **not related at all** ("Stewart Stuart DNA Project" *Family Tree DNA*), thus disproving the information published in J. C. Hurst's book *The Hursts of Shenandoah Valley* and several published genealogies on the web including online family trees (preface).

Figure 5 shows the results of the 37-marker Y-DNA test for the Leckhampstead Parish, England Hursts compared to the Shenandoah Valley, Virginia Hursts.

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37
Paternal Ancestor Name	Haplogroup	DYS393	DYS390	DYS19	DYS391	DYS385a	DYS385b	DYS426	DYS388	DYS439	DYS389I	DYS392	DYS389II	DYS458	DYS459a	DYS459b	DYS455	DYS454	DYS447	DYS437	DYS448	DYS449	DYS464a	DYS464b	DYS464c	DYS464d	DYS460	Y-GATA-H4	YCAI	YCAII	DYS456	DYS607	DYS576	DYS570	CDYa	CDYb	DYS442	DYS438
A - Shenandoah Valley, Virginia																																						
A01 - James Hurst b. ca 1773	R1b1a2	14	23	14	10	11	14	12	12	12	13	29	17	9	10	11	11	25	14	19	29	15	16	17	18	11	11	19	22	15	14	16	17	37	39	12	12	
A03 - Absalom Hurst - 1750, Stafford Co., VA	R1b1a2a1	14	23	14	10	11	14	12	12	12	13	29	17	9	10	11	11	25	14	19	29	15	16	17	18	11	11	19	22	15	14	16	17	37	39	12	12	
A02 - Absalom Hurst - 1750	R1b1a2a1	14	23	14	10	11	14	12	12	12	13	29	17	9	10	11	11	25	14	19	29	15	16	17	18	11	11	19	22	15	14	16	17	37	39	12	12	
A04 - Jeremiah Hurst, b. est. 1785, d. 1 Dec 1854	R1b1a2	14	23	14	10	11	14	12	12	12	13	29	17	9	10	11	11	25	14	19	29	15	16	17	18	11	11	19	22	15	14	16	17	37	39	12	12	
A07 - William (Brindle Bill) Hurst - 1710	R1b1a2	14	23	14	10	11	11	12	12	12	13	29	17	9	10	11	11	25	14	19	29	15	16	17	18	11	11	19	22	15	14	16	17	37	39	12	12	
A06 - William (Brindle Bill) Hurst - 1710	R1b1a2	14	23	14	10	11	14	12	12	12	13	29	17	9	10	11	11	25	14	19	29	15	16	17	18	11	11	19	22	15	14	16	17	37	39	12	12	
B - England																																						
B01 - Henry Hurst of England - 1774	I1	13	23	14	10	15	16	11	14	11	12	11	30	15	8	9	8	11	23	16	20	29	12	15	15	15	10	10	19	21	15	14	16	19	35	36	12	10
B04 - Richard Curtis Hurst - b. 1769	I1	13	23	14	10	15	16	11	14	11	12	11	30	15	8	9	8	11	23	16	20	29	12	15	15	15	11	10	19	21	15	14	17	19	35	36	12	10
B02 - Henry Hurst of England - 1774	I1	13	23	14	10	15	16	11	14	11	12	11	30	15	8	9	8	11	23	16	20	29	15	15	15	15	10	10	19	21	15	14	16	19	35	36	12	10
B03 - William Hurst - England - 1640	-	13	23	14	10	15	16	11	14	11	12	12	31	15	8	9	8	11	23	16	20	29	12	15	15	16												

Figure 5. The 37-marker Y-DNA results of the Shenandoah Valley, Virginia Hursts compared to the Leckhampstead Parish, England Hursts.

Identification and testing of surname-specific men living in England is especially helpful in determining where one's Colonial ancestors came from. Connecting living lines in the United States to living lines in Europe is a goal sought by many surname projects. The Hurst project has identified six independent lines living in the United States to date. Two lines from England have been tested and compared to the six lines in the United States, however, no matches have been found. The Hurst family project continues to search for Hursts in England who are willing to take the Y-DNA test with the goal of identifying the paternal ancestor of the Virginia lines.

The Kerchner Family Roadblocks

The Hurst family surname project has achieved many successes through Y-DNA testing. To date, they have been able to verify that the Hurst families of Northern and Southern Shenandoah Valley, Virginia are related, but are NOT related to Henry Hurst of Leckhampstead Parish, England, contrary to what the published genealogies had previously stated; and that William Hurst, Jr. of Carroll County, Virginia and Joseph Hurst of neighboring Wythe County Virginia were closely related. All of these conclusions are supported by the direct comparison of the Y-DNA marker values of each Hurst family descendant tested.

Unfortunately, Y-DNA is not always so black and white. Mutations, recombinations, and false negatives can sometimes get in the way of interpreting the results and in coming to sound conclusions about the relatedness of two or more individuals. The Kerchner family surname project contains an example of one of the roadblocks that can be encountered when working with Y-DNA testing and how it can be overcome, even in the absence of a genealogical paper trail.

The Kerchner family started doing Y-DNA testing in 2001 in order to determine if two immigrants, Adam Kerchner and Frederick Kerchner, who arrived in Pennsylvania within ten years of each other in the mid-1750s, were related (Kerchner). Although no church or vital records were found that connected the two men, the naming patterns of their children were similar enough to make researchers suspect that they were somehow related. If they were related as was assumed, then the Kerchner descendants hoped to find a Kerchner male line in Germany to tie the immigrant men to.

At the time that the first two tests were taken by Kerchner family descendants in 2001, only a low resolution 12-marker test was available. Descendants who matched on at least 11 of 12 marker values were considered to be “related” by industry standards; Descendants who matched on 10 or less markers were considered to be “not related” (“Interpreting Genetic Distance,” *Family Tree DNA*). The first two descendants of the Kerchner family who were tested, one from Adam and one from Frederick, matched on only 10 of the 12 markers, indicating that they were “not related.” Figure 6 shows the results of the 12-marker Y-DNA test for the first two descendants of Adam and Frederick Kerchner tested (Kerchner). The mismatches on DYS385b and DYS389ii are shown in blue.

FamilyTreeDNA.com Y-DNA Results														
DYS Locus Allele Values/DYS Marker STR "Repeats" Numbers														
Results from Initial 12 DYS Loci/Markers														
			1	2	3	4	5	6	7	8	9	10	11	12
Kit #	Paternal Ancestor Name	Haplogroup	DYS393	DYS390	DYS19	DYS391	DYS385a	DYS385b	DYS426	DYS388	DYS439	DYS389i	DYS392	DYS389ii
577	Adam Kerchner	R1b1	13	24	14	11	11	16	12	12	12	13	13	29
581	Frederick Kerchner	R1b1	13	24	14	11	11	15	12	12	12	13	13	28

Figure 6. The 12-marker Y-DNA results of the descendants of Adam Kerchner (Kit # 577) and Frederick Kerchner (Kit # 581) who were tested first. Marker 385 is a fast-mutating marker.

In order to verify that the paper trails of the descendants of Adam and Frederick Kerchner were correct and that no non-paternal events (NPEs) such as illegitimacy or adoption had taken place, and to verify that the reported haplotypes (series of numerical marker values) were representative of their respective ancestral lines, the researchers of the Kerchner family had additional descendants of both lines Y-DNA tested.

To validate the Adam Kerchner line, two second cousins who had documented paper trails back to Adam Kerchner were tested and compared to each other on the Y-DNA. Both men who were tested represent lines that stayed in Pennsylvania, where their ancestor, Adam

Kerchner, originally immigrated to. Descendants from this line are represented as kit numbers 577 and 784 in the Y-DNA results. Figure 7 shows the results of the 12-marker Y-DNA test for the two descendants of Adam Kerchner who remained in Pennsylvania (Kerchner). Both men tested had the same exact marker values, thus validating that this haplotype is representative of their ancestral line, and therefore confirming that these two men are related within a genealogically relevant time frame.

FamilyTreeDNA.com Y-DNA Results														
DYS Locus Allele Values/DYS Marker STR "Repeats" Numbers														
Results from Initial 12 DYS Loci/Markers														
			1	2	3	4	5	6	7	8	9	10	11	12
Kit #	Paternal Ancestor Name	Haplogroup	DYS393	DYS390	DYS19	DYS391	DYS385a	DYS385b	DYS426	DYS388	DYS439	DYS389i	DYS392	DYS389ii
577	Adam Kerchner (Pennsylvania)	R1b1	13	24	14	11	11	16	12	12	12	13	13	29
784	Adam Kerchner (Pennsylvania)	R1b1	13	24	14	11	11	16	12	12	12	13	13	29

Figure 7. The 12-marker Y-DNA results of the two descendants of Adam Kerchner who remained in Pennsylvania.

The haplotype of Frederick Kerchner (represented by kit number 581) who immigrated to Pennsylvania about ten years after Adam Kerchner, and to whom the descendant of Adam Kerchner (represented by kit number 577) was initially compared, was also validated by Y-DNA testing. His 12-marker Y-DNA results were compared to those belonging to a second man (represented by kit number 8670) who also claimed to be descended from Frederick Kerchner according to a documented genealogical paper trail. Figure 8 shows the results of the 12-marker Y-DNA test for the two descendants of Frederick Kerchner. Both men tested had the same exact marker values, thus validating that this haplotype is representative of their ancestral line, and therefore confirming that these two men are related within a genealogically relevant time frame.

FamilyTreeDNA.com Y-DNA Results														
DYS Locus Allele Values/DYS Marker STR "Repeats" Numbers														
Results from Initial 12 DYS Loci/Markers														
			1	2	3	4	5	6	7	8	9	10	11	12
Kit #	Paternal Ancestor Name	Haplogroup	DYS393	DYS390	DYS19	DYS391	DYS385a	DYS385b	DYS426	DYS388	DYS439	DYS389i	DYS392	DYS389ii
581	Frederick Kerchner (Karriger line from Michigan)	R1b1	13	24	14	11	11	15	12	12	12	13	13	28
8670	Frederick Kerchner (Karriger/Kariger line from Indiana)	R1b1	13	24	14	11	11	15	12	12	12	13	13	28

Figure 8. The 12-marker Y-DNA results of the two descendants of Frederick Kerchner whose lines changed their name to Kerriger/Kariger after moving West from Pennsylvania.

By the end of 2001, two descendants from each of Adam and Frederick Kerchner's lines had been Y-DNA tested for 12 markers. Marker values for both descendants of each line came back as an exact match to each other, validating their ancestral haplotypes.

Unfortunately, the marker values of the two lines represented by Adam and Frederick did not match to each other on enough markers to determine a close relationship between the two lines. The haplotypes of the two lines matched on only 10 of 12 marker values, not enough to have a common ancestor within a genealogically relevant time frame, or within the last 600 years since surnames started being adopted ("Interpreting Genetic Distance," *Family Tree DNA*). Members of the Kerchner family surname project still felt there had to be a connection between the two immigrants though, and when additional testing became available a few years later, they took the opportunity to investigate this connection further.

In the second round of Y-DNA testing, the four descendants of the two immigrant Kerchner lines (kit numbers 577 and 784 representing Adam Kerchner and 581 and 8670 representing Frederick Kerchner) were then tested for 37 markers on the Y-DNA. According to industry standards, descendants who matched on at least 34 of 37 marker values were considered to be "related" ("Interpreting Genetic Distance," *Family Tree DNA*). The four Kerchner descendants representing the two lines of Adam and Frederick Kerchner matched to each other on 34 out of 37 markers indicating that they *were* related, even though the initial 12-

marker test indicated that they were *not* ("Interpreting Genetic Distance," *Family Tree DNA*).

Figure 9 shows the results of the 37-marker Y-DNA test for the descendants of Adam Kerchner compared to the descendants of Frederick Kerchner (Kerchner). The mismatches are shown in yellow.

FamilyTreeDNA.com Y-DNA Results																																							
DYS Locus Allele Values/DYS Marker STR "Repeats" Numbers																																							
Results from 37 DYS Loci/Markers																																							
Kit #	Paternal Ancestor Name	Haplogroup	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37
		DYS393	DYS390	DYS19	DYS391	DYS385a	DYS385b	DYS426	DYS388	DYS439	DYS389i	DYS392	DYS458	DYS459a	DYS459b	DYS455	DYS454	DYS447	DYS437	DYS449	DYS464a	DYS464b	DYS464c	DYS464d	DYS460	Y-GA-TA-Ha	YCAI	YCAII	DYS456	DYS607	DYS576	DYS570	CDYa	CDYb	DYS448	DYS438			
577	Adam Kerchner (From PA)	R1b1	13	24	14	11	11	16	12	12	12	13	29	17	8	10	11	11	26	15	19	30	15	15	16	15	11	11	19	22	16	15	18	17	36	37	12	12	
784	Adam Kerchner (From PA)	R1b1	13	24	14	11	11	16	12	12	12	13	29	17	8	10	11	11	26	15	19	30	15	15	16	15	11	11	19	22	16	15	18	17	36	37	12	12	
581	Frederick Kerchner (Karriger line from Michigan)	R1b1	13	24	14	11	11	15	12	12	12	13	28	17	8	10	11	11	26	15	19	30	15	15	16	16	11	11	19	22	16	15	17	17	36	37	12	12	
8670	Frederick Kerchner (Karriger/Karrier line from India)	R1b1	13	24	14	11	11	15	12	12	12	13	28	17	8	10	11	11	26	15	19	30	15	15	16	16	11	11	19	22	16	15	17	17	36	37	12	12	

Figure 9. The 37-marker Y-DNA results of the four descendants of Adam and Frederick Kerchner tested with Y-DNA.

Although Y-DNA testing was able to determine that these two immigrants, Adam and Frederick Kerchner, were related within a genealogically relevant time frame, it was not able to determine *how* they were related, that is, brothers, father-son, uncle-nephew, cousins, etc. Not being able to determine the exact relationship between two men is one of the limitations of Y-DNA testing, as illustrated in the both the Kershner family and Carroll County Hurst family examples. Y-DNA testing is a tool that can be used in family history, but cannot stand alone and should be used in conjunction with genealogical research.

The question of relatedness between the two immigrants could possibly be answered by finding out who the immigrants' ancestors were back in Germany. This would have to be achieved by using a combination of genealogical research and Y-DNA testing. It is not feasible to start Y-DNA testing all men named Kerchner with its variations currently living in Germany. Instead, further research of the various Kerchner names in the United States would need to be performed with the hopes of finding someone with a genealogical paper trail back to Germany. Only after a paper trail is established, and a common ancestor identified, would Y-DNA testing be beneficial. Y-DNA testing could continue, however, in the United States, in order to prove

that various lines are descended from the two immigrants Adam and Frederick Kerchner of Pennsylvania.

Thomas Jefferson and Sally Hemings

Although Y-DNA testing is useful in determining that two or more individuals *are* related, it is limited in that it cannot determine *how* they are related, as previously illustrated in the Hurst and Kerchner family surname projects. This limitation quickly became apparent when Y-DNA testing was enlisted to try to answer the nearly 200-year old question of whether or not Thomas Jefferson had fathered the children of his slave, Sally Hemings.

Traditional genealogical research produced mounds of circumstantial evidence which was used to build a case against Thomas Jefferson being the father of Sally Hemings' children. However Jefferson himself, his immediate family, and his descendants denied that this relationship ever existed (Lander and Ellis 14; "Report of the Research Committee," Appendix F), causing a rift between the two families to grow wider with time. Although several independent authoritative sources supported the defense of both sides, each one seemed to be outweighed by the other due to apparent inconsistencies in the evidence.

Whether Thomas Jefferson fathered Sally Hemings' children was not the only question at hand when Y-DNA testing was introduced in 1998. The question of who was Sally Heming's first born child, or more specifically, was that child Thomas Woodson, as Woodson's descendants purported, was also a question under heavy scrutiny by historians and family members alike.

In the case of Thomas Woodson, his descendants consistently and independently maintained the same oral history: that Thomas Woodson was born about 1790, shortly after Thomas Jefferson and Sally Hemings returned from a trip to France, and therefore was the first

born son of Sally Hemings by Thomas Jefferson. However no documents have been found to support Woodson's descendants' claim that he was a son of Sally Hemings at all (Foster et al 27). In fact, according to Helen Leary's analysis of the evidence (174), Thomas Woodson's year of birth was actually earlier than 1790 - more like 1784 or 1785 - in which case, Sally Hemings would have only been around ten years old. Likewise, Woodson would have been conceived prior to Sally's arrival in Paris.

The other and more compelling evidence against Thomas Woodson being a son of Sally Hemings is the account of Sally Hemings' younger son Madison. In 1873, Madison told a newspaper reporter that Thomas Jefferson was the father of "all" of Sally's children naming himself, Beverly, Harriet, and Eston ("Report of the Research Committee," Appendix F). A child named Thomas was not mentioned, thereby challenging the Woodson descendants' oral history of descent by Sally Hemings and Thomas Jefferson.

Although Sally's youngest son Eston never said one way or another who his father was, his descendants had always maintained that Thomas Jefferson was his father. In the twentieth century, however, his descendants rescinded their claim of Thomas Jefferson being Eston's father in favor of Jefferson's uncle ("Report of the Research Committee," Appendix F).

Other conflicting, but heavily weighted evidence exists regarding the parentage of Sally's children. Thomas Jefferson's grandchildren, Thomas Jefferson Randolph and Ellen Coolridge, both claimed that Sally's children were fathered by one of Thomas Jefferson's nephews, either Peter or Samuel Carr (Foster et al 27). Thomas Jefferson Randolph told biographer Henry S. Randall in 1868 that it was Peter Carr who fathered Sally's children, as was told to him by his mother; in 1858, his sister Ellen Coolridge, however, said it was Samuel Carr who fathered Sally's children ("Report of the Research Committee," Appendix F).

Although the testimony of Thomas Jefferson's own legitimate descendants was weighted more heavily than that of the Sally Hemings and Thomas Woodson's descendants, it still could not resolve the question of parentage of Sally Hemings' children due to the conflicting information about the Carr family that it presented. The only information that all of the historical and genealogical records and oral histories could provide about the family of Sally Hemings was circumstantial evidence which pointed towards a member of the Jefferson household as being the father of Sally's children. Figure 10 shows the pedigree of Thomas Jefferson alongside that of Sally Hemings.

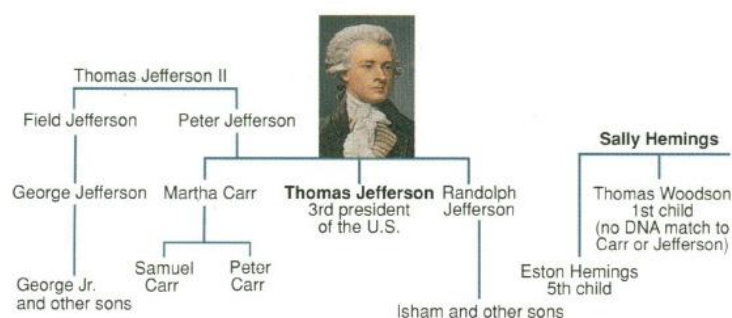


Figure 10. The pedigree of Thomas Jefferson alongside his slave Sally Hemings.

In an attempt to resolve the question of who fathered Sally Hemings' children, Y-DNA testing was enlisted. In 1998, the first round of Y-DNA testing was performed on several descendants of the Jefferson and Hemings families by Eugene Foster: five direct line males descended from two sons of Thomas Woodson and one direct line male descended from Eston Hemings were compared to five direct line Jefferson males descended from two sons of Thomas Jefferson's paternal uncle, Field Jefferson and three direct line males descended from three sons of Samuel and Peter Carr's grandfather, John Carr (Foster et al 27). Thomas Jefferson did not have any sons which is why descendants from Thomas' uncle, Field Jefferson, were used in the Y-DNA study.

Eleven markers were tested in the Y-DNA test and compared. Four of the five descendants of Field Jefferson were an exact match to each other on 11 out of 11 markers. The fifth descendant differed by only one marker value, probably due to a mutation that occurred in more recent times. Two of the three descendants of John Carr were an exact match to each other on 11 out of 11 markers. The third descendant differed by only one marker value, probably due to a mutation that occurred in more recent times. The three descendants of John Carr were not a match to the five descendants of Field Jefferson. The Y-DNA profiles of the two groups were very different from each other (Foster et al 27).

Four of the five descendants of Thomas Woodson were also an exact match to each other on 11 out of 11 markers. The fifth descendant had an entirely different DNA profile altogether, matching on only 4 out of 11 markers, indicating a non-paternal event (illegitimacy, adoption, or name change) probably took place somewhere in his line. The Woodson descendants did not match either the Jefferson or Carr descendants, indicating Thomas Woodson was not fathered by a Jefferson or a Carr from either of these lines tested (Foster et al 27).

The descendant of Eston Hemings was an exact match on 11 out of 11 markers to the four descendants of Field Jefferson, indicating that he was fathered by a Jefferson (Foster et al 27). However, because the Y-DNA is carried down through every direct line male relatively unchanged and is in common between fathers and sons, brothers, uncles and nephews, etc., it is not possible to determine whether Thomas Jefferson was the Jefferson that fathered Eston Hemings. Thomas Jefferson's brother Randolph Jefferson or his nephews, children of his brother Randolph, could have fathered Sally's children (Marshall 153).

This is an example of how DNA is limited in what it can and can't do and oftentimes must be accompanied by traditional genealogical research. The results of the Y-DNA test proved

that Thomas Woodson was not fathered by a Jefferson or a Carr, thus bringing into question the oral history of the Woodson descendants and thus further challenging the idea that Thomas Woodson was even a son of Sally Hemings to begin with.

The results of the Y-DNA test also proved that Sally Hemings' youngest son Eston Hemings was fathered by a Jefferson and not a Carr, thus challenging the testimony of Thomas Jefferson's grandchildren who stated that Sally's children were fathered by Thomas Jefferson's nephews named Samuel or Peter Carr. However, exactly *which* Jefferson fathered Eston is a question still left unanswered due to the limitations of the Y-DNA being passed down unchanged from generation to generation between all direct line Jefferson males. However, most historical evidence points to Thomas Jefferson being the father of Sally Hemings' children (Leary 207).

There have been several advances in direct-to-consumer DNA testing since these results were published in 1998. Additional tests like the mitochondrial (mtDNA) and autosomal (atDNA) DNA tests offer alternatives to the Y-DNA test. The mitochondrial DNA is carried through the direct female line from your mother's mother's mother and so on and can usually only be applied to females. A male can take the test, however, if he is interested in tracing the ancestry of his mother's direct female line. The mitochondrial test could not be applied to any of Sally Hemings' descendants because she did not have any daughters that survived to adulthood, so there would not be any direct line female descendants to test for comparison.

The Y-DNA test was unable to prove whether Thomas Jefferson fathered Sally Hemings' children because it is passed unchanged through each descendant of each generation and all of the Jefferson males have the same Y-DNA marker values. The mtDNA test would not be feasible in this case either due to the unavailability of female descendants to test. This left the autosomal (atDNA) test as the only alternative.

Autosomal DNA testing, when combined with family tree building, can be a very powerful tool for genealogy if used properly. In order to determine if the descendants of Sally Heming's children were fathered by Thomas Jefferson, their atDNA test results would have to be compared to the atDNA test results of the descendants of Thomas Jefferson.

Autosomal Testing

Autosomal testing investigates the 22 chromosomes that are stored within the cell nucleus. Each chromosome comes in a pair of two, one received from each of our parents. Whereas the Y-DNA and mtDNA is unchanged from generation to generation, the atDNA gets blended. Each child gets 50% of their parents' DNA and there is no way to predict which 50% of their parents' DNA they will receive.

Direct-to-consumer autosomal tests measure the amount of DNA that is shared between two people on each of their chromosomes. Depending on which company is used to test for autosomal DNA, the amount of DNA shared between you and your matches is either measured in centimorgans (cM) or percentages.

According to industry standards, a minimum of 5.5 centimorgans (cM) ("Understanding Results FAQ no. 608," *Family Tree DNA*) or 0.1 % of continuous shared DNA is required to be identified as a match to another person. The measurement of centimorgans can be converted to percentages by dividing the total number of centimorgans by 68 (Moore, "23andMe Receives \$50 Million"). This number contributes to the predicted relationship between two people. The higher the percentage of DNA shared between two people, the closer the relationship. For example, a mother and daughter share 3,352 cM of shared DNA between them. Dividing 3,352 cM by 68 results in a percentage of 49.3, roughly 50%. A child shares 50% of his or her DNA with each parent.

The autosomal test can be very sensitive but it does have its limitations. It can, for example, pick up DNA that is shared between 4th and 5th cousins who may have shared a set of

3rd or 4th great-grandparents six or seven generations back. However, anything beyond that amount of time and the DNA gets too diluted to be picked up by traditional scientific methods offered by direct-to-consumer companies. This is moderately possible in the case of comparing the descendants of Thomas Jefferson to the descendants of Sally Hemings, both of whom lived in the 18th century.

If a descendant of Sally Hemings does NOT share a minimum of 5.5 cM of DNA with a descendant of Thomas Jefferson, then according to industry standards, they are not a match and therefore should not be deemed as “related” to one another. However, it is possible that the connection between the two descendants who were tested and compared was too far back to be picked up by the test.

Autosomal testing between descendants of the Jefferson and Hemings families has actually already been underway, and quite the opposite of the scenario mentioned above has been observed. Oftentimes, the descendants of the two families have been matched to each other with no problem but showing up as close 2nd or 3rd cousin matches; If the DNA they shared was passed down from a common ancestor of either Thomas Jefferson or Sally Hemings, than their predicted relationship would be much more distant than the 2nd or 3rd cousins reported; it would be more like 5th or 6th cousins.

Determining for sure that a match or its shared autosomal DNA is due to a certain common ancestor is tedious. Autosomal DNA test results do not tell you which DNA you receive from your mother or your father or which ancestor you and your match have in common. The DNA received from each side of the family can, however, be determined by testing additional family members. People who match to you and your father, for example, can be assigned as paternal matches and those who match to you and your mother can be assigned as maternal matches.

Ambiguity occurs when some people are identified as being connected to both sides of your family by showing up as a match to both your mother and your father. This is probably what occurred in the case of the Thomas Jefferson and Sally Hemings descendants and prevents the descendants and historians from finding further proof that Thomas Jefferson was the father of Sally Hemings' children.

According to the genealogical paper trail, Sally Hemings was the half-sister of Thomas Jefferson's wife, Martha Wayles. Any descendants of the two families who show up as a match to each other have the potential to show up as being more closely related because they are, in actuality, double cousins. Figure 11 shows the relationship between two double cousins from the Jefferson and Hemings families.

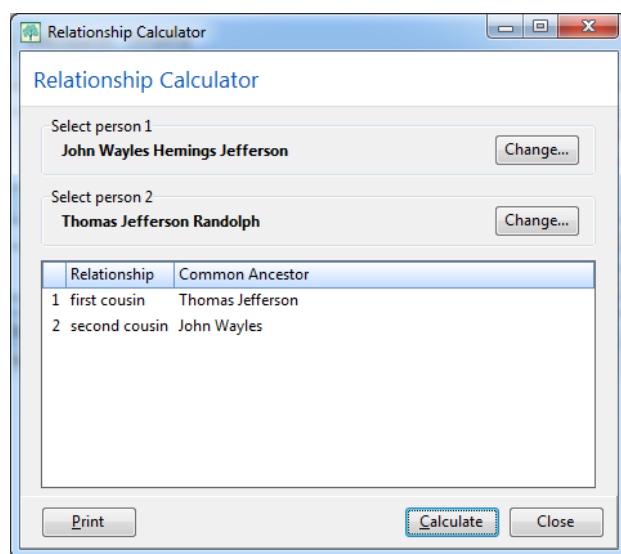


Figure 11. Relationship calculator: John Wayles Hemings-Jefferson vs. Thomas Jefferson Randolph

In the first example, the son of Eston Hemings named John Wayles Hemings ("John Wayles Jefferson," *Wikipedia: The Free Encyclopedia*) was a first cousin of Thomas Jefferson Randolph, the son of Thomas Jefferson's daughter Martha. Their common ancestor, or grandfather, was Thomas Jefferson. They were actually first *half* cousins because they had

different grandmothers. John Wayles Heming's grandmother was Sally Hemings and Thomas Jefferson Randolph's grandmother was Martha Wayles Jefferson.

In the second example, John Wayles Hemings and Thomas Jefferson Randolph were second cousins and their common ancestor was their great-grandfather, John Wayles. They were also *half* second cousins because their grandmothers, Sally Hemings and Martha Wayles Jefferson were half-sisters. The bottom line is that descendants of both families would share autosomal DNA regardless of paternity because Thomas Jefferson's wife Martha Wayles and Sally Hemings were half-sisters, both women probably sharing some DNA they received from their father John Wayles which was then passed down through their children.

Richard Hill – an Adoptee

Although autosomal DNA testing was not very beneficial in determining the parentage of Sally Hemings' children, it can be very useful in helping adoptees determine their maternal and paternal surnames, and finding connections to their birth families. Richard Hill's book *Finding Family* illustrates how the various DNA tests can be used to help adoptees find their birth families, while also discussing the limitations of each test.

Richard Hill, the author of *Finding Family*, found out he was adopted in 1964, the year he graduated high school. It took him over 30 years and several DNA tests later to determine the names of his birth parents. He first learned the name of his birth mother, Jackie, from his adoptive father who was on his deathbed when he finally shared the details of Richard's adoption. From talking with a family friend, he learned that Jackie had died a year following his birth. He was also able to narrow down a list of names of possible birth fathers based on where his mother had worked and who she had associated with, including the owner of a bar who often drove her home at night.

In addition to talking to family members and friends, Richard requested copies of his original birth certificate. His birth certificate listed his father's ethnicity as "Polish." Because the owner of the bar did not have a Polish name, Richard eliminated him as a possible birth father and instead focused on another acquaintance of his birth mother's who *did* have a Polish surname, and who also happened to have been named in his adoption file. Although Hill's file was sealed in the State of Michigan, a judge agreed to allow a "confidential intermediary" to look at his file, learn the identities of his birth parents and track them down, with the

understanding that they could not divulge this information to Hill himself (Hill 101) without the named person's explicit permission. The man named in his file agreed to meet and take a DNA test, even though he had his reservations about his ability to have children. Unfortunately, a paternity test taken in 1990 proved that this man was *not* Richard's birth father.

Non-identifying information (information that is provided to adoptees that does not give away the birth parents' names) and information listed on birth certificates, often contains falsities or half-truths, especially in the case of adoption files (Craft, "Non-Identifying Information"). In an interview to About.com, one adoptee admitted that he turned to a DNA test to determine the validity of a statement contained in his non-identifying information that said his father was of Welsh descent: "I want to confirm that I do have some Welsh in me...I'm not sure I can believe the Welsh part though. I don't know how much of it I can trust" (Craft, "Your Family History and DNA Testing").

Richard was so disappointed by the results of the paternity test with the man with the Polish name that he let several years pass before he resumed his search again for his birth father. While at a party one night a friend suggested he take the Y-DNA test which gives information about the paternal line. In January of 2007, Richard took the test and matched to a man with the surname of Richards on 25 of 25 markers (Hill 162). Unfortunately, Richard and his match were not able to find any connections between them. His match had never been to Michigan where Richard lived and Richard had no ties to Florida, where his match lived. It is often the case that people who match to one another on the Y-DNA test do not have a recent connection because the test goes back hundreds and sometimes thousands of years due to the unchanging nature of the Y-DNA as it is passed down from generation to generation.

With the Y-DNA test being a seemingly dead end, Richard went back to following the paper trail again. He decided this time to not narrow his search to the Polish ethnicity, having

learned his lesson the first time. He went back and interviewed his mother's family and friends. After receiving a lot of confusing and conflicting information, similar to what he had experienced with his adoption files, he requested his mother's employment records from the Social Security office and looked into where she had worked. He looked at the bar owner again who had been known to drive her home after work and take her out a few times.

Unfortunately the bar that Jackie worked at prior to becoming pregnant with her son Richard was no longer there. Richard learned through interviewing the local townspeople that the bar owner and his four brothers were surnamed "Richards," however, they were all deceased. He was able to reconstruct their family tree, however, and locate and contact the brothers' sons. This revelation of the Richards surname fell in line nicely with what the results of the Y-DNA test had told him.

At the time that contact was made with the bar owners' brothers' sons in 2007, the only DNA test that was available to take was a sibling test which looked at fifteen distinct markers thought to be good for determining familial relationships (Hill 206). This type of sibling test compares the short tandem repeats or STRs that each individual has inside their DNA. Short tandem repeats are represented by the number of repeats of the same DNA sequence consisting of the nucleotides A, T, C, and G which are then counted on each marker and reported as a numeric value.

Every individual inherits one STR from each parent resulting in two values located on each marker. Paternity testing between a child and his or her parent is easy because the two values on each marker came from either their mother or father. Richard Hill describes these as "required values," or more simply, a reference standard. Because there is no reference sample from a parent to compare to with sibling testing, labs are forced to rely on statistical analysis in order to determine the level of relationship between two individuals (Gaytmenn et al 161).

In Richard's case, the lab was not able to confidently determine one of the five men tested as being a half-brother to Richard after the first run. Richard matched almost identically to at least three of the five men tested (Hill 206). If one of them was his half-brother, their score would have been at least three times higher than the other four. Upon further investigation, Richard found that only eleven of the fifteen markers had been reported which meant that five had somehow been omitted. The lab explained that sometimes bacteria interfere with results (Hill 207).

Richard and the five men then resubmitted their DNA via a blood test (instead of a saliva test). A few weeks later the lab told Richard that the son of the owner of the bar where his mother had worked was his half-brother which meant that that man's father was also Richard's father. Although the numbers made more sense, and the scores between Richard and this man were almost five times higher than the other four men, Richard was not convinced. He knew enough about basic Mendelian genetics to know that the probability of two blue-eyed parents having a brown-eyed son like himself was very slim; the bar owner and his mother were both blue-eyed.

In 2009 Richard decided to cast his net into the DNA pool again. He took advantage of the new autosomal DNA (atDNA) tests being offered by DNA testing companies 23AndMe and Family Tree DNA. The atDNA test looks at over 700,000 markers instead of fifteen which is all the sibling test looks at, and actually *measures* the DNA shared between two people instead of just *calculating* the probability that two people have a common ancestor. The atDNA test measures the length of shared DNA between individuals and reports it in either centimorgans (cM) or percentages. This number contributes to the predicted relationship between two people. The higher the percentage of DNA shared between two people, the closer the relationship.

The atDNA test by itself did not tell him anything new. He found some new cousins that he didn't know he had. Then he had his cousin Vern (one of the men who took the sibling test who was *not* identified as the half-brother) and his sister Elaine (the sister of Doug - the *only* man who was identified as Richard's half-brother by the sibling test) take the test. According to the results, Vern came back as a 25% match to Richard indicating a half-sibling relationship instead of a first cousin relationship which was expected based on the results of the sibling test (Hill 233). Either Vern's father had fathered all four of them - Richard, Vern, Elaine and Doug by Vern's mother or Doug was not really Richard's half-brother and the sibling test had made a mistake.

The test of Richard's purported half-sister Elaine came back and she was reported as a first cousin, sharing about 12.5 % of DNA in common with Richard. Therefore, Elaine and Doug were not Richard's *half-siblings*, but were instead *cousins*, thus proving the sibling DNA test had been wrong (Hill 233-235).

Richard Hill's book *Finding Family* illustrates how traditional genealogical research can be combined with DNA testing to determine who one's birth parents are. It also illustrates how DNA testing has limitations: just as genealogical research can hit a brick wall, sometimes DNA testing can only take you so far, thus hitting some brick walls of its own. Hill hit several brick walls but his perseverance eventually led him to the names of both his birth parents. With regard to the name of his birth father, he followed the clues:

1. A paper trail gave him the name of a possible father but a paternity DNA test proved that this man was not his father
2. A Y-DNA test told Richard that the surname of his birth father was possibly "Richards" which conflicted with the paper trail indicating his father had been Polish, but matched the surname of the bar owner where his mother worked

3. According to the paper trail, the bar owner was one of five brothers with the Richards surname who knew his mother and were all good candidates to be his birth father
4. A sibling DNA test taken by Hill and the sons of the five Richards brothers identified the bar owner as his Hill's father, even though basic Mendelian genetics pointed towards this being highly unlikely
5. A new and advanced autosomal DNA test proved that the sibling DNA test had been incorrect and the man who had been identified as his cousin by the sibling test was really his half brother
6. Another autosomal DNA taken by the sister of the man who had been identified as Hill's half-brother by the sibling DNA test proved that she was in fact a cousin

By narrowing down the list of candidates via a paper trail, and employing new advances in DNA testing, Richard Hill was able to identify one man out of five brothers as his father

The Kelly Sisters

Richard Hill's success in finding his birth parents was due mostly in part to his perseverance in following the paper trail and testing out various hypotheses about who his birth father could be. Most DNA tests cannot provide any conclusive results without first having the paper trail and some kind of hypothesis to test out. Having a testable hypothesis is especially essential when considering taking a mitochondrial test which is used to determine who one's maternal ancestors might be. William Hurst was quite successful in using Y-DNA to determine if various Hurst men in Virginia were related to each other, but he also wanted to look at one of his maternal ancestors, so he employed the use of the mitochondrial DNA test.

In 2003, he had read a message board post written by Dr. Ann Turner that said: "Females can have their mitochondrial DNA tested, but the results don't help with connections in the genealogical time frame...they tell you about your "deep" ancestry from many thousands of years ago."

From Dr. Turner's statement, it did not seem like there was much use in mitochondrial testing. When used "in isolation," this is probably true; however, when combined with a genealogical paper trail, or a "hypothesis" built off of a paper trail, it can be very useful. If you suspect that two people might be related through a female lineage, for example, then mitochondrial DNA *can* help. In order to come to this conclusion, though, you must first follow the paper trail.

William Hurst had been following the paper trail of his ancestors for a long time. He suspected that his great-grandmother Catherine Kelly and another woman, Martha Kelly were

related according to the paper trail. Martha and Catherine were about the same age, living in the same part of Wythe County, Virginia at about the same time. Surprisingly, both women had a daughter who had been married to the same man, William R. Wheeler, William Hurst's great-grandfather (W. Hurst, "[DNA] Proposed practical use of mtDNA").

After reading Dr. Turner's message about how mitochondrial DNA testing could be used to determine if two people were related along the maternal line, William Hurst decided to test out his hypothesis to see if Martha and Catherine were in fact related, possibly even sisters. He combed through his family tree and identified living descendants of both Martha and Catherine who could be tested for mitochondrial DNA.

Since mitochondrial DNA is passed down to us from our mothers, the candidates had to be direct line female descendants of both Martha and Catherine or their daughters' daughters' daughters and so on. Also included in the mix would be any males who were the sons of the daughters' daughters' daughters, including William Hurst's own father. Unfortunately, William's father had already passed away as had his father's sisters, but he was able to secure one of his father's nieces as a candidate (W. Hurst, "[DNA] Practical mtDNA Test"). The volunteer from Martha's side of the family was a male half-cousin who was descended from William's great-grandfather William R. Wheeler and his 2nd wife Eliza Jane Runyon. William is descended from William R. Wheeler and his first wife Mary Lindsey, thus the "half" cousinship (W. Hurst, "Parents of Catherine Kelly Lindsey").

William Hurst's two cousins took the mtDNA Plus test which looks at two regions of the mitochondrial DNA (instead of just one region) and reports results back as mutations or differences from a standard reference set of values called the Cambridge Reference Sequence (CRS). This dual region test allows for a higher-resolution match to be made.

Initially, William's cousin from his Dad's side of the family was a match on one region (HVR1) to another person in the Family Tree DNA database. According to the FAQs posted on the Family Tree DNA website, they have a 50% chance of sharing a common maternal ancestor within the last fifty-two generations, or about 1,300 years. This was long before surnames were even adopted, and therefore, not genealogically relevant, just as Dr. Turner had predicted. Fortunately, when William's half-cousin's test results came back in, they were an exact match to the first cousin's tests results on *both* HVR1 and HVR2 regions, thus indicating a common maternal ancestor was shared between them more recently (W. Hurst, "[DNA] Practical mtDNA test").

The common maternal ancestor that William Hurst believed Martha Kelly and Catherine Kelly shared and which was now confirmed by mtDNA, was a woman named Elizabeth Cummings (W. Hurst, "[DNA] Practical mtDNA test"). Because Martha and Catherine were born only two years apart, Hurst argued that they had probably been sisters and that Elizabeth Cummings, who had been married to John Kelly, had probably been their mother. John Kelly had previously been connected as the father of Martha Kelly via a genealogical paper trail, therefore mitochondrial DNA testing aided in confirming this relationship as well (W. Hurst, "Parents of Catherine Kelly Lindsey").

Mitochondrial DNA, because it is so stable and does not mutate at a very fast rate, is also ideal for identifying historical remains. One case in which mtDNA played a major role in was the identification of the remains of the Royal Romanoff family.

The Royal Romanov Family

On July 16, 1918, the Royal Romanov family and four of their employees were executed at the Ipatiev House at Yekaterinburg, Russia, where they were being held prisoner after the Russian monarchy had been overthrown. Because their remains were never found, or recorded, rumors abounded about whether or not the Royal family had actually been killed or had survived and escaped to Germany (Sykes 65).

In 1991 after the fall of the Soviet Union, amateur archaeologists Alexander Avdonin and Gely Ryabov came forward and said they had found the remains of nine bodies, presumed to be the Royal family, buried in a shallow grave outside of Yekaterinburg (Gill, "Identification of the Remains of the Romanov Family" 130).

Two kinds of DNA testing were performed on the bones from the nine bodies found in the mass grave. A paternity test was the first test performed in order to establish whether or not the bodies buried in the grave were part of a family unit. Paternity testing analyzes the short tandem repeats (STRs) of DNA which is passed down from parents to their children. STRs are repeating sequences of DNA consisting of the nucleotides A, T, C, and G. The number of repeats is counted on each marker or "allele" to give the reported value (Kennett 24).

All of the marker values combined forms a haplotype or genetic signature ("Short Tandem Repeats," *ISOGG Wiki*). For example, if the father has an STR marker value of "9,10," this means that he has nine repeats of that sequence on one allele and ten repeats of it on the other allele. If the mother has an STR value of "8,12," and the child has a value of "10,12," then you know that the 10 was inherited from the father and the 12 was inherited from the mother.

In the case of the mass grave, the STR analysis indicated that the marker values of the children were inherited from the two adult bodies which meant that a familial unit existed in the grave. The STR analysis also indicated the sex of each body (Gill, “Identification of the Remains of the Romanov Family” 131). The nine bodies were believed to be Tsar Nicholas Romanov II and Tsarina Alexandra Feodorovna, three of their five children, their Physician Dr. Eugeny Botkin, and three servants (Sykes 65-66). Two bodies were missing though - those of the Crown Prince Tsarevich Alexei and one of his sisters (Gill, “Identification of the Remains of the Romanov Family” 130). Table 1 shows the haplotypes of the nine bodies found in the mass grave (Gill, “Identification of the Remains of the Romanov Family” 131).

Table 1. STR genotypes for the nine skeletons					
Skeleton	HUMVWA/31	HUMTH01	HUMF13A1	HUMFES/FPS	HUMACTBP2
Tsar	15,16	7,10	7,7	12,12	11,32
Tsarina	15,16	8,8	3,5	12,13	32,36
child 1	15,16	8,10	5,7	12,13	11,32
child 2	15,16	7,8	5,7	12,13	11,36
child 3	15,16	8,10	3,7	12,13	32,36
servant 1	14,20	9,10	6,16	10,11	ND
servant 2	15,17	6,9	5,7	8,10	ND
servant 3	16,17	6,6	6,7	11,12	ND
Doctor	17,17	6,10	5,7	10,11	11,30

The haplotypes of the servants and the doctor are included as well to show the differences in repeat values. For marker HUMVWA/31, the Tsar and Tsarina both had 15,16 for values, which meant that their children could only have 15 or 16 as values as well. This was the case for all three children. For marker HUMTH01, the Tsar had marker values 7,10 and the Tsarina had 8,8. Child 1 had marker values 8,10. They inherited the 8 from the Tsarina and the 10 from the Tsar. Child 2 had marker values 7,8. They inherited the 7 from the Tsar and the 8 from the Tsarina. Child 3 had marker values 8,10. They inherited the 8 from the Tsarina and the 10 from the Tsar. For marker HUMF13A1, the Tsar had two 7s, therefore every child had to have

at least one 7. A value of 3 or 5 came from the Tsarina. The same was true for marker HUMFES/FPS. A marker value of 12 came from the Tsar and 13 came from the Tsarina.

Servant 1 had values of 14,20 on marker HUMVWA. If any of the children were related to him, they would have either a 14 or a 20 as one of their values. This was not the case as none of the children had either of these values; therefore the servant was not a family member of the other five and was excluded. Although Servant 2 shared two values in common with the family, it was not enough to determine that he was a family member, therefore he was excluded. The same was true for Servant 3 and the Doctor.

Once the familial unit had been established via STR testing, additional DNA testing was performed to determine if the bodies did in fact belong to the Romanov family. The mitochondrial DNA test was the second test performed on all nine bodies that had been buried in the grave. The female adult, presumed to be the Tsarina, and all three of the children had the same exact mitochondrial sequence; this was expected because children inherit their mitochondrial DNA from their mothers. The adult male, presumed to be Tsar Nicholas II, had a different sequence from that of the adult female and the three children; this was also expected because he would have inherited his mitochondrial sequence from his mother. Children do not share mitochondrial sequences with their fathers because mitochondrial DNA is only passed down to children from their mothers (Sykes 66).

Although the mitochondrial DNA results showed that the bones recovered were from a related family, by themselves they could not prove that they were from the Romanov family. Mitochondrial sequences from living maternal descendants of both the Tsar and Tsarina were required for comparison to confirm that the bones were that of the Romanov family.

Two of Tsar Nicholas' cousins, the Duke of Fife and Princess Xenia Cheremeteff Sfiri, shared a maternal descendency with him through his grandmother, Louise of Hesse-Cassel, the

The sequences of mitochondrial DNA are reported as differences from a reference standard called the Cambridge Reference Sequence or CRS (“Cambridge Reference Sequence,” *ISOGG Wiki*). The mitochondrial sequence of HRH Prince Philip was “111, 357” which means his mitochondrial DNA differed from the reference sequence at the 111th and 357th positions out of 500 possible positions (Sykes 68). The mitochondrial sequence of the Tsarina was an exact match to HRH Prince Philip with differences on the 111th and 357th positions. The sequences of the three children buried with her were also exactly the same as was expected if the Tsarina’s mitochondrial DNA had been passed down from a mother to her children (Sykes 68).

The mitochondrial sequences between the Tsar and his living relatives, however, were not exactly the same. Tsar Nicholas’ two relatives, the Duke of Fife and Princess Xenia, had differences on the 126th, 169th, 294th, and 296th positions. Although Tsar Nicholas had the same differences on the 126th, 294th, and 296th positions, he did not have the same difference on the 169th position that they had. Whereas his cousins had a thymine at this position, Nicholas had a cytosine. This difference in their mitochondrial DNA test results cast doubt upon Tsar Nicholas being the adult male who was buried with the Tsarina and their three children.

Another possibility was that the test was inconclusive or had errors. In order to clear this up, further testing was performed. Upon closer investigation, Gill noticed that Tsar Nicholas had not one, but two peaks in his DNA profile at position 169 (“Identification of the Remains of the Romanov Family” 132). He actually had *both* thymine and cytosine at that position, a condition known as heteroplasmy. When the DNA was cloned and the cytosine was separated from the thymine, his profile exhibited the same exact sequence as his living relatives which included the appearance of the thymine on the 169th position in seven of the clones (Gill, “Identification of the Remains of the Romanov Family” 132).

Nicholas' brother, the Grand Duke of Russia Georgij Romanov, whose body had been exhumed for testing comparison, also had this heteroplasmy on position 169 (Coble, "Mystery Solved" 2). Evidently their mother had passed down two different sequences of mitochondrial DNA to them. Thought to be a very rare condition at the time, heteroplasmy is in fact a very common mutation but one that was not easily detected in most commercially available systems at the time (Coble, "The Identification of the Romanovs" 3).

Even though the issue of the heteroplasmy had been cleared up and it was concluded that Nicholas' mitochondrial DNA was exactly the same as his living relatives', there was still some doubt over whether or not the mass grave contained the remains of the Romanov family. The Romanov family consisted of seven family members - Tsar Nicholas II, Tsarina Alexandra, Alexei, Olga, Tatiana, Maria, and Anastasia - but only five bodies had been recovered in the grave outside of Yekaterinburg. Did the Prince and one of his sisters survive or were they buried elsewhere as some historical accounts had detailed (Sykes 65-66)?

Several people had come forward over the years purporting to be one of the missing children. The most famous case was that of a mentally ill woman called Anna Anderson who claimed to be Anastasia after trying to commit suicide in 1920 ("Anna Anderson," *Wikipedia: The Free Encyclopedia*). After the remains of the Romanov family were found in 1991, some of Anderson's mitochondrial DNA was tested for comparison against the remains and against the living descendants of the Romanov family. Anderson's DNA did not match that of the Romanov family, indicating she was not Anastasia Romanov. It was a match, however, to that of Karl Maucher, a great-nephew of Franziska Schanzkowska, who Anderson was later identified as (Gill, "Establishing the Identity" 9).

The question of whether two of the Romanov children had escaped death was answered in 2007 when archaeologists found an additional two bodies seventy meters away

from where the first nine bodies were buried. Autosomal STR testing confirmed one body was a male and one was a female and bone measurements indicated they were in their teens (Coble, "Mystery Solved" 2-3).

Mitochondrial DNA testing was performed on the two newly discovered bodies as well as on the original remains of the Romanov family found in the first grave. The sequences from the two newly discovered bodies were an exact match to the Tsarina, indicating that they were the two missing Romanov children and that no children had survived the execution (Coble, "Mystery Solved" 3-4).

The case of the missing Romanov family was instrumental in illustrating how DNA can be used in forensic and missing persons cases. Taken together, the DNA shows that the remains found in the mass grave and in the smaller grave found seventy meters away, were those of the Romanov family. The STR analysis and sex typing was used to show that a family unit comprised of an adult male, an adult female, and three female children was present in the mass grave (Coble, "The Identification of the Romanovs" 3). Mitochondrial DNA analysis was used to link the Tsar and Tsarina to living relatives and therefore show that the family was "almost certainly" that of the Romanovs who had been executed in 1918 (Gill, "Identification of the Remains of the Romanov Family" 134).

In addition to the DNA, a genealogical paper trail had been instrumental in identifying and locating the living maternal line relatives of both Tsar Nicholas II and Tsarina Alexandra. Other anthropological evidence had also been used in concluding that the family was that of the Romanovs: the wound patterns matched the historical accounts; the bodies were found in the correct locations; the bodies were of the correct age; and they were aristocratic in that they had gold and platinum fillings in their dental work (Gill, "Identification of the Remains of the

Romanov Family” 134). The Romanov case is an excellent illustration of how DNA, in combination with a paper trail, can be used to solve a seventy year old mystery.

Conclusion

Traditional genealogical research started off with letter writing and trips to court houses, libraries and archives. Once all of these resources had been expended, and the researcher could go no further back in their family tree, they are said to have hit a “brick wall.” Recent advances in technology, however, have allowed greater access to previously untapped resources such as digital scans of primary documents provided via the internet and DNA test results of men and women living all over the world.

As illustrated in this paper, DNA testing can be a powerful tool but cannot be used in isolation. A DNA test will not tell you who your ancestors are. Traditional genealogical research is still required to be performed before introducing a DNA test into the mix. Most DNA tests work best with a testable hypothesis and many have limitations to what they can and cannot do or tell you. This paper illustrated that DNA testing can help genealogists further their research and provide links to both the near and distant past, depending on their goals.

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