

# Understanding & Using DNA Test Results (Genetic Genealogy)

If you are using this document to decide which DNA test to take, please read the entire document including the discussion on security before deciding which test or tests to take.

The document provides a summary of DNA tests and some of the processes you may use to match individuals listed as potential relatives. While going into some details, it is not intended to be a comprehensive explanation of DNA. Use it as a general guide to what DNA is, the type of tests available, and how these compliment your basic DNA test results. The later examples describe how you may expand beyond and compliment a basic DNA test.

Remember, to obtain the best results from a DNA test, you must have a good family tree.

There are three principal tests:

- Autosomal DNA
- Y-DNA
- Mitochondrial DNA

Depending upon which test has been taken, the results may include:

- Autosomal (atDNA) results for chromosomes 1-22
- Results for chromosome 23 (X-DNA & Y-DNA)
- Ethnicity estimate
- Mitochondrial DNA (mtDNA)
- Haplotypes/Haplogroups
- A list of individuals potentially matching your DNA results (up to 6<sup>th</sup> cousin)
- DNA Clustering
- Phased DNA
- Some DNA Tools or other matching processes based upon various family trees.

An Autosomal DNA test is the most popular form of test and the least expensive. It is offered by a variety of companies. Each company provides different ethnic results and sometimes different tools for evaluating results. A company may have an alternate fee or subscription process for additional tools to extend your DNA matching or see additional information.

*(My personal recommendation is to use Ancestry and then 23&Me. This is based upon Ancestry having the largest USA database and that neither Ancestry, nor 23&Me allow uploads of DNA tests taken elsewhere. MyHeritage is more useful outside the USA as they have a greater following overseas. MyHeritage is also the most progressive of the DNA testing companies and has a chromosome browser which Ancestry does not. The lack of a chromosome browser in Ancestry can be overcome by downloading the Ancestry DNA results and then uploading them to [www.gedmatch.com](http://www.gedmatch.com) or MyHeritage. Gedmatch while not a DNA tester, is a free site providing matches from many different DNA test sources and contains useful free DNA Matching tools.)*

## What is DNA

DNA or Deoxyribonucleic Acid is not a living organism but a chemical compound that carries genetic information telling our bodies how to build cells, what type of cells to build and where to build them. It is a double helix consisting of smaller units called nucleotides. A nucleotide is a molecule comprised of a sugar, a phosphate and one of the bases (Adenine, Guanine, Thymine and Cytosine). The sides of the double helix are comprised of sugar and phosphate molecules connected by a chemical bond.

The nucleotides are the building blocks of DNA and contain one of four bases.

- **Adenine**
- **Guanine**
- **Thymine**
- **Cytosine**

Adenine always links with Thymine, and Cytosine always links with Guanine. They are referred to by their initials A, G, T, and C. If one side of the helix is AGAT it is easy to know the other which is TCTA. These are known as “*Base Pairs*” and there are an estimated 3.2 billion base pairs in the human genome.

### Some DNA Basics

Human DNA is linear and contains 23 pairs of chromosomes for a total of 46 chromosomes. These are divided into 22 Autosomes and one pair of ‘sex chromosomes, the latter is sometimes referred to as chromosome 23.

- The sex chromosome is divided into a ‘Y’ chromosome and an ‘X’ chromosome
- The Y-chromosome is passed down only through the male lineage
- The X-Chromosome is passed down from both the male and female lineage in the following manner:
  - A son receives the Y-chromosome from his father and his X-chromosome from his mother, therefore a son has one X and one Y-chromosome
  - A daughter receives one X-chromosome from her father and one X-chromosome from her mother, therefore a daughter has two X-chromosomes

### How do you get your DNA?

Each of your parents provide 50% of their DNA to you. Each parent inherited their DNA from their parents. As a result, about 25% of your DNA is from your four Grandparents. As you go back in time and up the ancestral tree, the DNA you receive from your ancestors becomes more diluted at each generation.

At conception, when you receive your DNA, it has been ‘randomized’ which is a normal part of the DNA inheritance process. Understand, that while you and your siblings receive a lot of common DNA, each of your siblings will also receive some different pieces of DNA. Only twins are almost identical in their DNA however, even twins have differences which show up in more complex and specialized DNA tests. Generally, you should test one twin.

### More on Y-DNA

This is a moderately expensive test and comes in a variety of prices depending upon the options you choose. The test is only available for males. It uses “*Base Pairs*” which are two nucleobases bound to each other; the building blocks of the DNA double helix.

- It tests for “*Short Tandem Repeats*” or STR’s which are patterns of two or more nucleotides that repeat and are adjacent to each other. The pattern can range from 2 to 16 base pairs
- It follows only the direct ‘male’ lineage, son to father, father to grandfather and grandfather to great-grandfather etc.
- It is used to follow the unbroken male line back many generations, even if a family surname has changed
- It is useful for tracing the male pedigree, however the test only accounts for a small portion of your total family history
- If a female wishes to know her Y-DNA, she should ask a brother or uncle on the direct male line to take a Y-DNA test
- The best test for Y-DNA is provided by “*FamilyTreeDNA*” ([www.familytreedna.com](http://www.familytreedna.com))

- A Y-37 test examines and reports the number of STR's at 37 specific markers in your genetic code. The closer the match at each marker the closer the relationship.

A Y-37 test is the minimum useful Y-DNA test and larger tests such as a Y-111, or Big-Y, look at additional markers to help refine Y-DNA matches. The trend has been to increase the number of markers used in Y-DNA testing. A Big-Y test currently uses 700 markers.

## More on X-DNA

This is sometimes included as part of a basic autosomal test. X-DNA is useful for tracing lineage for females. It is often overlooked as a useful research area. A female gets one X-chromosome from her mother and one from her father.

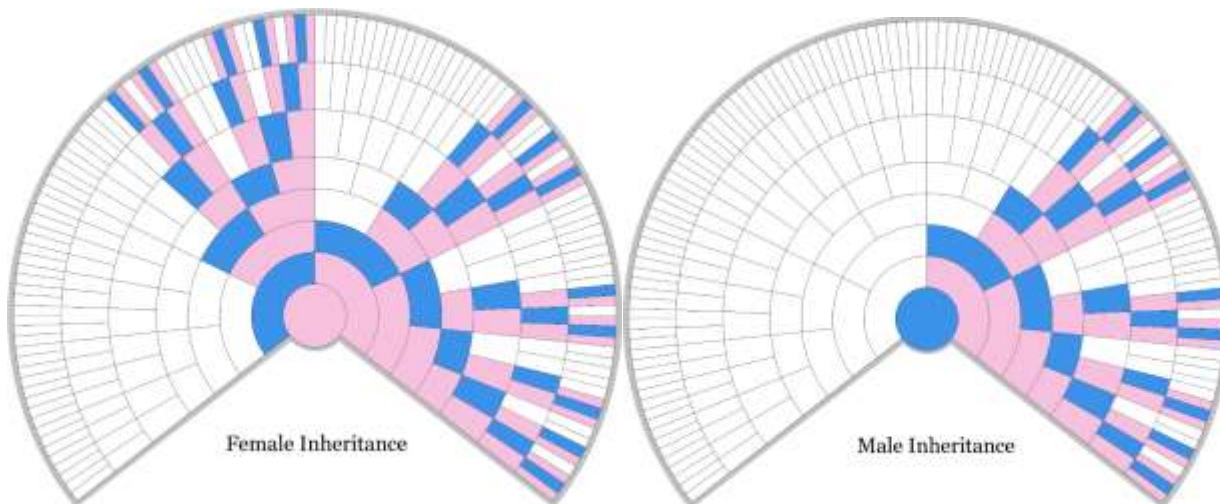
The X-chromosome a daughter receives from her mother contains a mixture of both of her maternal grandmothers' X-DNA. The X chromosome she receives from her father only contains her paternal grandmother's DNA. Some recombination of the X-chromosome does occur along with dilution of female ancestral data. If two females share X-DNA they have a common female ancestor somewhere in their tree.

Because female names change during marriage it is useful to prepare a list of all known female ancestor names before researching X-DNA matches.

Be aware of the following:

- X-DNA does **NOT** pass through two subsequent generations of males
- MyHeritage does **NOT** provide X-DNA results
- Ancestry.com provides X-DNA results however, the results are only visible if you transfer your Ancestry DNA test to another site that provides a chromosome viewer, preferably GEDMatch.
- 23&Me, FamilyTreeDNA, and LivingDNA do provide X-DNA results. Gedmatch, FamilyTreeDNA and 23&Me can analyze and match X-DNA results

The following chart shows X-DNA female and male inheritance. Blue is male and pink is female.



Because a female has two X-chromosomes, there are more options for tracing maternal ancestry. It traces the inheritance of the X-chromosome through GGGGG-grandparents or 128 ancestors.

With 128 ancestors, a female will have 34 potential contributors (13 males and 21 females). Because of his one X-chromosome, a male will have a potential of 21 contributors (8 males and 13 females).

## **More on Mitochondrial DNA**

Mitochondrial DNA (mtDNA) is the most plentiful DNA in the body and is obtained from the material surrounding the core of a Genome. It is a small loop of DNA with 16,569 base pairs. It is frequently the first test used by Anthropologists when investigating ancient remains such as Ötzi (Ice Man). I have a mtDNA link to him along with many, many millions of other individuals.

Unlike Y-DNA, Mitochondrial DNA does not mutate frequently so a result may be valid within a 125 or a ten-thousand-year period. mtDNA Tests may include Hypervariable regions 1 and 2 (HVR1/HVR2) or mtFull Sequence which adds the coding region. The table below summarizes the chances of finding a match based upon the type of test taken.

- To prove related ancestry, many additional tests may be required
- It is a less useful as a test for the average person for analyzing ancestry
- It is an expensive test and provides information about the direct female lineage over many generations
- It provides information for only one part of your family lineage
- It requires detailed family trees for both individuals seeking to identify a relationship
- Unlike atDNA, mtDNA is unchanged from one generation to the next

Type of Match	mtDNA Region Compared at Family Tree DNA	Time to Most Recent Common Ancestor
HVR1 exact match	16,001–16,569 (HVR1)	50-percent chance of common ancestor within about fifty-two generations (1,300 years)
HVR1 & HVR2 exact match	16,001–16,569 (HVR1) and 1–574 (HVR2)	50-percent chance of common ancestor within about twenty-eight generations (700 years)
Full Sequence exact match	16,001–16,569 (HVR1) 1–574 (HVR2) 575–16,000 (Coding Region)	95-percent chance of common ancestor within about twenty-two generations (550 years)

## **More on Autosomal DNA**

Autosomal DNA (atDNA) is the least expensive and therefore the most common test individuals take. Depending upon the company used for testing, you generally receive results in the form of ethnicity, a list of potential matches and sometimes tools to help identify these matches based upon trees submitted by other subscribers. The closeness of a match is usually determined using centimorgans. The higher the number of centimorgans, the closer the match.

The autosomal test looks at chromosomes 1-22 with some companies including the X-match on chromosome 23. A few testing companies also provide information for Haplogroups.

Generally, autosomal tests are useful for about 6 or 7 generations or about 250 years. There are exceptions to this rule for endogamous populations which is beyond the scope of this document. If you are more than 50 years of age, the theoretical maximum you can trace your ancestor's DNA is to the early 1700's. To do this requires many individual DNA tests from different branches of your family tree. Fortunately, as more people take tests, this is becoming easier to do.

### How closely do you match an individual?

The term 'Centimorgan' (cM) is used as a benchmark for determining how close you match someone. While not exact, a centimorgan of 3,500 would indicate a child and 1,800 a nephew or niece. As you get to a first cousin once removed, the centimorgans have dropped to about 300. This drop continues and a fourth or fifth cousin may show as little as 7-20 centimorgans. Seven centimorgans is usually the minimum considered useful for autosomal matching. There is a useful tool at: [www.dnapainter.com/tools/sharedcmv4](http://www.dnapainter.com/tools/sharedcmv4) which helps determine relationships based upon total centimorgans.

## Ethnicity Results

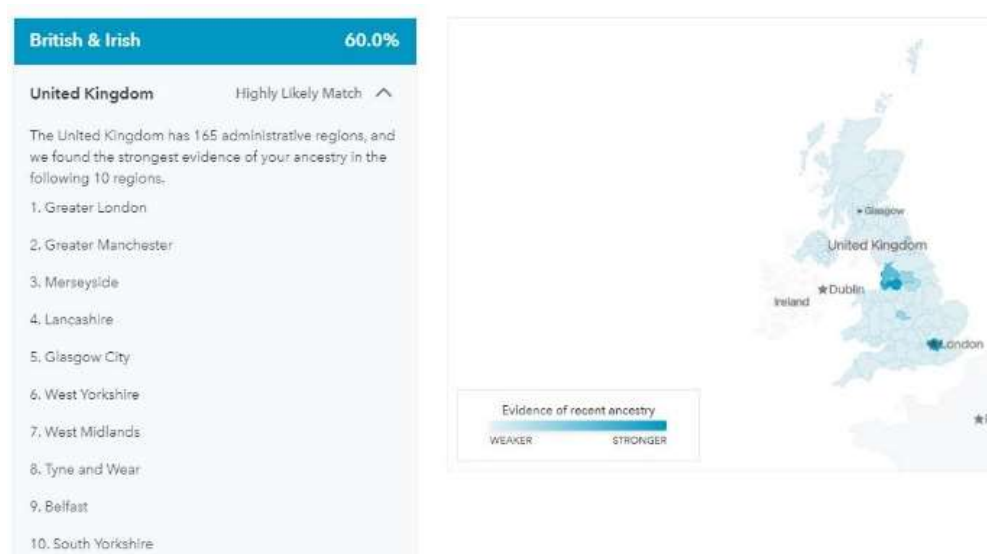
Each company uses different research sources and algorithms for determining ethnicity. While some companies results overlap, it is not unusual to see different ethnic results between companies. As DNA research in this area is still new and continuing to develop, your ethnic results will change over time as each company updates their ethnicity tools based on new research. For example, In the last 8 years, Ancestry has updated ethnic results at least three times.

The following sample shows my personal ethnicity results by DNA test company.

	Ancestry %	My Heritage %	23&Me%	LivingDNA%	FamilyTreeDNA%
England, Wales & Northwestern Europe	70.0				
Ireland & Scotland	28.0				
Baltics	1.0				
Norway	1.0				
English		79.9			
Scandinavian		9.7			
Irish, Scottish, Welsh		3.6			
East Europe		6.8			
British & Irish			60.0		
French & German			21.7		
Scandinavian			3.7		
Broadly Northwestern European			14.0		
Broadly European			0.3		
Other/Unassigned			0.3		
Great Britain & Ireland				95.6	
Scandinavia				4.3	
Other/Unassigned				0.1	
British Isles					31.0
West & Central Europe					43.0
Scandinavia					19.0
East Europe					7.0
<b>TOTALS</b>	<b>100.0</b>	<b>100.0</b>	<b>100.0</b>	<b>100.0</b>	<b>100.0</b>

As more people take DNA tests combined with improved research into ethnicity, it is expected ethnic results will improve and eventually become refined within a compact geographic area.

Some companies have researched specific geographic areas and offer free DNA tests to people who have a proven heritage over many generations within a select locale. An example is LivingDNA who have divided the UK into at least 30 plus geographic regions and provide UK ethnic results a percentage of common DNA for each location. 23&Me provide something similar. The following example is from 23&Me.



## Lost Ancestral DNA

Due to the dilution of Ancestral DNA at each generation, third cousins will have lost some ancestral links. The following real example shows the results for my two children. MRCA stands for; *'The most recent common ancestor.'*

Match Name	Cousin Relationship	Chromosome	Father	Son	Daughter	Shared Segments	Largest Segment cM Mum or Dad	Total cMs	MRCA Relationship	Birth - Death Dates
Robert Blair	3c2r	7	Y	Y	Y	1	30.7	30.7	John McKJenzie Johnson-Jemima Maria Prior	1796-1872 - 1803-1863
Ann Gledhill	3c1r	7	Y	Y	N	3	21.8	56.9	John Kempster - Margaret Molineaux	1784-1816 - 1781-????
Arthur Gledhill	3c1r	7	Y	Y	Y	2	21.0	34.0	John Kempster - Margaret Molineaux	1784-1816 - 1781-????
MSL Davis	2c2r	10	Y	Y	Y	7	32.3	110.6	John Eastham Whiteside - Mary Jane McBride	1837-1923 - 1839-1895
Christian Johannes Scheffer	3c	5	Y	N	Y	8	39.4	178.6	Justus Hendrik Meyer - Margaretha van der Lith	1798-1839 - 1801-1867
Jean Grove	2c2r	16	Y	Y	Y	6	34.4	124.3	Hendrik Ooswaldt Albertijn Meyer - Clara Francis Johnson	1828-1908 - 1833-1914
Johan Heinrich Scheffer	3c1r	22	Y	N	Y	5	28.4	85.9	Justus Hendrik Meyer - Margaretha van der Lith	1798-1839 - 1801-1867
Helen Hogan	2c1r	7	Y	Y	Y	7	36.9	128.7	James Johnson - Jane Maguie	1834-1876 - 1840-1876
James Lewis	1c2r	1	Y	Y	Y	6	19.6	85.0	Joseph Johnson - Margaret Ann Whiteside	1859-1917 - 1859-1947
lynette Russell	2c2r	10	Y	Y	Y	7	31.9	110.6	John Eastham Whiteside - Mary Jane McBride	1837-1923 - 1839-1895
William Meyer	2c	11	Y	Y	Y	17	81.6	590.0	Gert Hendrik Meyer - Elizabeth Frederika DuPlessis	1837-1884 - 1841-1922
Beth Maxwell	1c3r	13	Y	Y	Y	9	27.9	117.5	Joseph Johnson - Margaret Ann Whiteside	1859-1917 - 1859-1947
Aletta Van der Walt	2c1r	4	Y	Y	Y	7	46.0	189.0	Gert Hendrik Meyer - Elizabeth Frederika DuPlessis	1837-1884 - 1841-1922
Bernard Armstrong	2c2r	18	Y	Y	N	3	36.9	96.3	John Eastham Whiteside - Mary Jane McBride	1837-1923 - 1839-1895
Norma Hayden	2c2r	8	Y	Y	Y	10	30.9	164.1	John Eastham Whiteside - Mary Jane McBride	1837-1923 - 1839-1895
Laetitia Liebenberg	5c	15	Y	N	Y	3	34.7	59.4	Daniel DuPlessis - Helena Aletta Olivier	1732-1781 - 1738-1781
Peter Anthony Winquist	5c	4	Y	Y	Y	2	25.9	49.2	Johannes Gerhardus Terreblanche - Helena Elizabeth DuPlessis	1758-1837 - 1758-1833
Babsie Soine	5c	15	Y	Y	Y	3	22.8	45.0	George Friedrick Rautenbach - Maria Magdalena Margaretha Ferreira	1724-1805 - 1733-1815

My son lost all the ancestral information for the Scheffer and Liebenberg branches of his family tree while my daughter lost information about her Gledhill and Armstrong family branches. Gedmatch provides a report called "My Evil Twin" which will produce a similar report. It requires you have a DNA test for one parent and a child for this analysis.

The loss of Ancestral data also means you lose ethnic information, especially if your ancestors come from different parts of the world.

## Number of cousins - Limiting your research

Assuming an average family size and a generation of 25-30 years, you will have many fourth cousins. A study by Ancestry using British data sources over the last 200 years produced the following statistic for the number of cousins a British person might be expected to have:

Relationship	# Cousins
First Cousins	5
Second Cousins	28
Third Cousins	175
Fourth Cousins	1,570
Fifth Cousins	17,300
Sixth Cousins	174,000

Because of this, it is important to limit family research to your direct ancestors; plus, a manageable number of cousins based upon no more than three or four generations. Someone who is listed as a fifth cousin i.e. a descendant of your GGG-Grandparents is going to be one of more than 15,000 possible descendants.

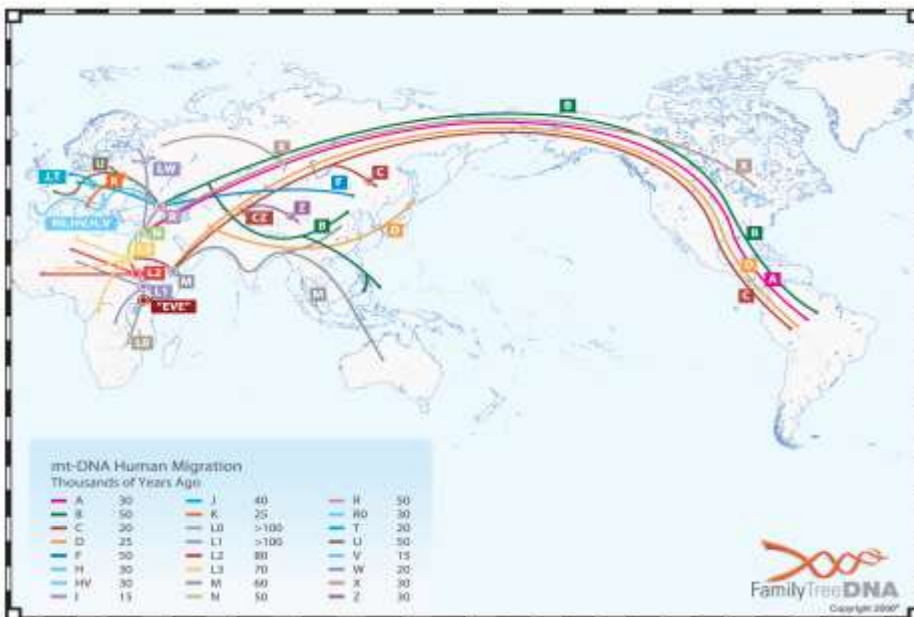
It is sensible to generate a cut-off for people requesting genealogy information from you if they are fifth cousins and have no useful family tree. It is unlikely that either of you will be able to complete a match unless you both have extensive family trees.

## **More about Haplotypes & Haplogroups**

A haplotype is a group of alleles that are inherited from a single parent. An allele is a variant or mutation of one or more given genes at the same place on a chromosome.

A haplogroup is a group of Haplotypes which indicates people with the same variation share a common and distant ancestor. Females have one defined haplogroup inherited from their mother and one can be inferred from their father (Y-DNA) if a male relative takes a Y-DNA test.

Males receive one from their father and one from their mother. Haplogroup assignments are a measure of your deeper roots; this allows you to trace distant human migration and evolution. The following example shows the development of mitochondrial Haplogroups through human migration.



Not all testing companies provide paternal and maternal haplogroup results. LivingDNA, 23&Me and FamilyTreeDNA provide Haplogroup results as a part of their test. Ancestry and MyHeritage do not.

However, there are testing differences and some of the results you receive may be closer to predictions. It requires the testing of branch-defining single-nucleotide polymorphisms (SNP's) to determine which is your specific subclade or branch of the genomic tree. The tests specific to ensuring accurate results are Y-DNA and Mitochondrial DNA done by FamilytreeDNA.

The branches of the Y-DNA (Male) Haplotree can be seen at: <https://www.familytreedna.com/public/y-dna-haplotree/A>

The branches of the mtDNA (Female) Haplotree can be seen at: <https://www.familytreedna.com/public/mt-dna-haplotree/L>

## **More about Security**

If you wish to take a DNA test, do not be misled by well-meaning individuals who frequently know little about genealogy or DNA. There is a lot of misleading information from the media and other sources concerning the risk of taking a DNA test. Currently, most criminals have their DNA recorded as have individuals in the US Military since 1992. Combined these databases account for more than 20 % of the US population.

Taking a DNA test is a personal decision and should be made after doing your own research and not taking the advice of others. Always read the 'fine-print' of the company you plan to use. Regardless of any statements, all DNA databases in the USA are subject to specific searches based upon legal justification and the appropriate judicial approvals.

All DNA testing companies provide the ability to delete your DNA profile at any time. In some cases, individuals take a DNA test out of curiosity to obtain ethnic information and then after a few months, delete their DNA profile. It is not particularly 'Genealogist Friendly' however it does occur, and I have one instance of this within my own family.

As with anything of a personal nature, it is a good idea to designate an heir, in writing, for your DNA test (Beneficiary Agreement). If an individual is managing your DNA data, it is also a good idea to ensure an 'Informed consent' agreement is in place. Samples of these types of documents can be found on the internet.

## **More on who to test and why**

Taking an atDNA test or a Y-DNA test is usually dependent upon an individual's interest in their heritage including ethnicity. However, it is not unusual for family genealogists to sponsor or cover the cost of some tests when they need specific DNA information.

From my personal experience, you should consider the following sequence for atDNA testing:

1. The oldest family members, as they have the richest ancestral information.
2. Test living Uncles & Aunts and if they are gone, test their children; your first cousins. This provides DNA information from your four grandparents, assuming they are not still alive.
3. Test each sibling as each will have some unique pieces of ancestral DNA from your parents. This will capture any difference in ethnicity.

If you have a 'daughter-out' situation, i.e. where the male line has no more male descendants, it is advisable to ask the last male descendant to take a Y-DNA test, preferably a Y-111 or larger test. This captures information about the male ancestral line for both current and future genealogists.

## **Using Autosomal DNA tests for Genetic Genealogy**

This section expands upon autosomal test results. It describes some of the ways to add value to your existing atDNA test beyond the tools and information provided by a DNA testing company.

### **Simple DNA Analysis**

Matching various individual chromosomal information is useful for proving family relationships. While useful within the immediate or close family, it becomes more valuable at the first, second and subsequent cousin levels.

I maintain my personal DNA matches in a spreadsheet. This data can then be copied to a program called DNA-Painter ([www.dnapainter.com](http://www.dnapainter.com)). The example shown is for chromosome one and is divided into paternal and maternal lines. Lines in white are unknown and being researched. The Centromere is the spindle of fibers between the same chromosome segments.



I/M	Match Name	Chromosome	Start point	End point	cMs	# SNPs	Source	Cousin Level	MIRCA	MIRCA Years	My Relationship
M	Leonard Pollock	1	752,721	5,689,702	14.5	1,049	GM	1c	Joseph Johnson - Margaret Ann Whiteside	1859-1917 - 1859-1947	Grand Parents
M	Beth Maxwell	1	5,288,559	10,824,835	9.9	3,328	Mh	1c3r	Joseph Johnson - Margaret Ann Whiteside	1859-1917 - 1859-1947	Grand Parents
P	Rosina Malan	1	5,901,895	11,638,064	8.9	3,328	Mh				
M	Leonard Pollock	1	35,239,992	54,068,567	17.7	2,278	GM	1c	Joseph Johnson - Margaret Ann Whiteside	1859-1917 - 1859-1947	Grand Parents
M	Adrian Pollock	1	37,020,422	54,619,337	17.0	2,192	GM	1c1r	Joseph Johnson - Margaret Ann Whiteside	1859-1917 - 1859-1947	Grand Parents
P	Derrick Gordon Meyer	1	37,270,283	48,639,817	12.1	5632	Mh	2c1r	Gert Hendrik Meyer - Elizabeth Frederika DuPlessis	1837-1884 - 1841-1922	G-Grandparents
M	John Wood	1	41,402,399	56,867,989	12.4	7,296	Mh	1c	Joseph Johnson - Margaret Ann Whiteside	1859-1917 - 1859-1947	Grand Parents
	CO	1	48,196,590	57,048,961	7.7	1,516	23Me				
M	Rachael Thomas	1	49,031,238	56,783,425	6.3	1,259	238Me		Joseph Johnson - Margaret Ann Whiteside	1859-1917 - 1859-1947	Grand Parents
P	Marilyn Smith	1	74,314,526	95,452,496	23.2	10,880	Mh				
P	Johan Loots	1	84,678,418	96,510,531	12.5	2,431	23Me				
M	Beth Maxwell	1	85,497,812	102,415,679	16.7	8,960	Mh	1c3r	Joseph Johnson - Margaret Ann Whiteside	1859-1917 - 1859-1947	Grand Parents
M	Adrian Pollock	1	90,598,884	102,706,568	10.9	1,714	GM	1c1r	Joseph Johnson - Margaret Ann Whiteside	1859-1917 - 1859-1947	Grand Parents
M	Leonard Pollock	1	90,598,884	102,426,168	10.6	1,680	GM	1c	Joseph Johnson - Margaret Ann Whiteside	1859-1917 - 1859-1947	Grand Parents
P	William Meyer	1	99,231,250	163,344,782	49.4	7,102	23Me	2c	Gert Hendrik Meyer - Elizabeth Frederika DuPlessis	1837-1884 - 1841-1922	G-Grandparents
	Cody Nelson	1	102,563,851	106,026,345	3.9	292	FTDNA				
	Alex Yeates	1	116,917,485	162,932,038	29.1	9,984	Mh				
M	MSL Davis	1	117,840,080	120,224,361	1.9	600	FTDNA	2c2r	John Eastham Whiteside - Mary Jane McBride	1837-1923 - 1839-1895	G-GrandParents
	<b>Centromere-01</b>	<b>1</b>	<b>121,535,434</b>	<b>124,535,434</b>							
	Anabela Nobre	1	144,270,181	150,316,682	2.5	412	FTDNA				
P	Lehan Ben Van der Walt	1	163,683,716	178,719,941	17.2	8,064	Mh				
M	John Wood	1	167,404,969	181,294,048	14.1	7040	Mh	1c	Joseph Johnson - Margaret Ann Whiteside	1859-1917 - 1859-1947	Grand Parents
M	MSL Davis	1	169,440,035	171,377,576	1.8	600	FTDNA	2c2r	John Eastham Whiteside - Mary Jane McBride	1837-1923 - 1839-1895	G-GrandParents
P	Lehan Ben Van der Walt	1	184,346,908	194,053,931	7.0	3,968	Mh				
P	Nicolette Math	1	193,782,054	196,432,002	1.7	300	FTDNA				
M	James Lewis	1	198,043,518	212,410,155	19.6	3,135	23Me	1c2r	Joseph Johnson - Margaret Ann Whiteside	1859-1917 - 1859-1947	Grand Parents
P	Doreen Cope	1	218,517,668	226,952,313	7.4	4,096	Mh				
M	John Wood	1	222,008,026	249,222,527	46.2	16511	Mh	1c	Joseph Johnson - Margaret Ann Whiteside	1859-1917 - 1859-1947	Grand Parents
M	MSL Davis	1	224,845,209	231,872,385	9.2	2,200	FTDNA	2c2r	John Eastham Whiteside - Mary Jane McBride	1837-1923 - 1839-1895	G-GrandParents
M	lynette Russell	1	229,121,587	234,232,523	8.6	3,456	Mh	2c2r	John Eastham Whiteside - Mary Jane McBride	1837-1923 - 1839-1895	G-GrandParents

In this process, you can view individual relationships at the chromosomal level. You see that Beth Maxwell and Adrian Pollock share portions of chromosome one. You do need to know which side of the family the individual belongs to; Maternal or Paternal. While Beth Maxwell and Rosina Malan appear to share data, they are in fact not related and are on different paternal and maternal sides of my family. (Pink is maternal and blue is paternal).

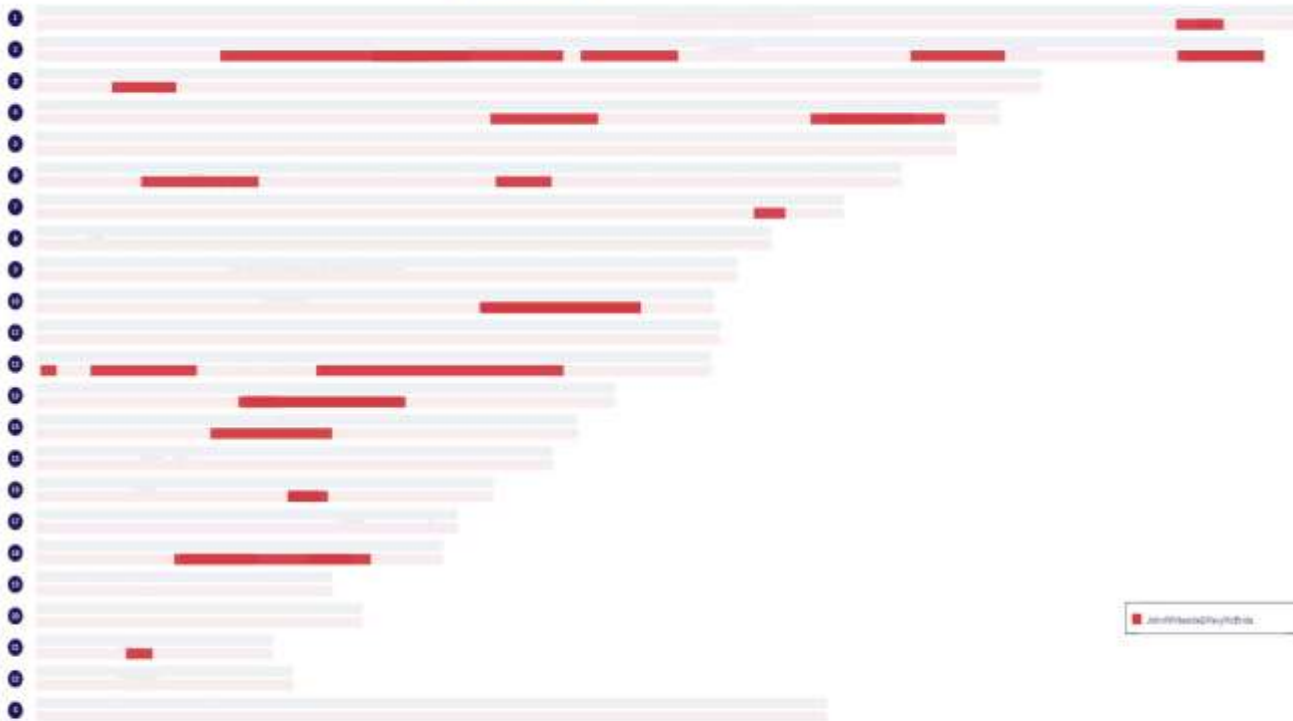
Providing you have a good family tree, as you compare the DNA of second cousins, you will begin to identify matched pieces of DNA from both your Grandparents and Great-Grandparents. Indeed, if you have done extensive DNA tests within various branches of your ancestral tree, it becomes possible to build portions of your ancestors' DNA.

This proves useful for identifying and validating unknown DNA matches. It provides a focus for further traditional genealogical research and therefore, requires less research time to place an unknown person in the family tree.

Chromosome maps are useful because:

- Everyone can compile a personal map of what DNA they received from their parents and therefore their ancestors
- Ancestor DNA maps can be created by comparing chromosomes from different branches of a family tree
- These pseudo DNA results are then be used to perform comparisons locating lost relatives through refined matching; relatives that would be overlooked due to small chromosome segments (centimorgan counts).

The following is an ancestral chromosome map for my Great-Grandparents. The maps were generated using DNA Painter. As more family individuals take DNA tests, their DNA profiles will be added to this chart. Currently it contains about 25% of my Great-Grandparents DNA.



The second chart is an example of a personal DNA map. It shows where I received my DNA. The earliest piece of DNA is for my GGG-Grandparents and dates to about 1760. It is color coded to represent each pair of ancestors; Grandparents, Great-Grandparents, and GG-Grandparents, etc.

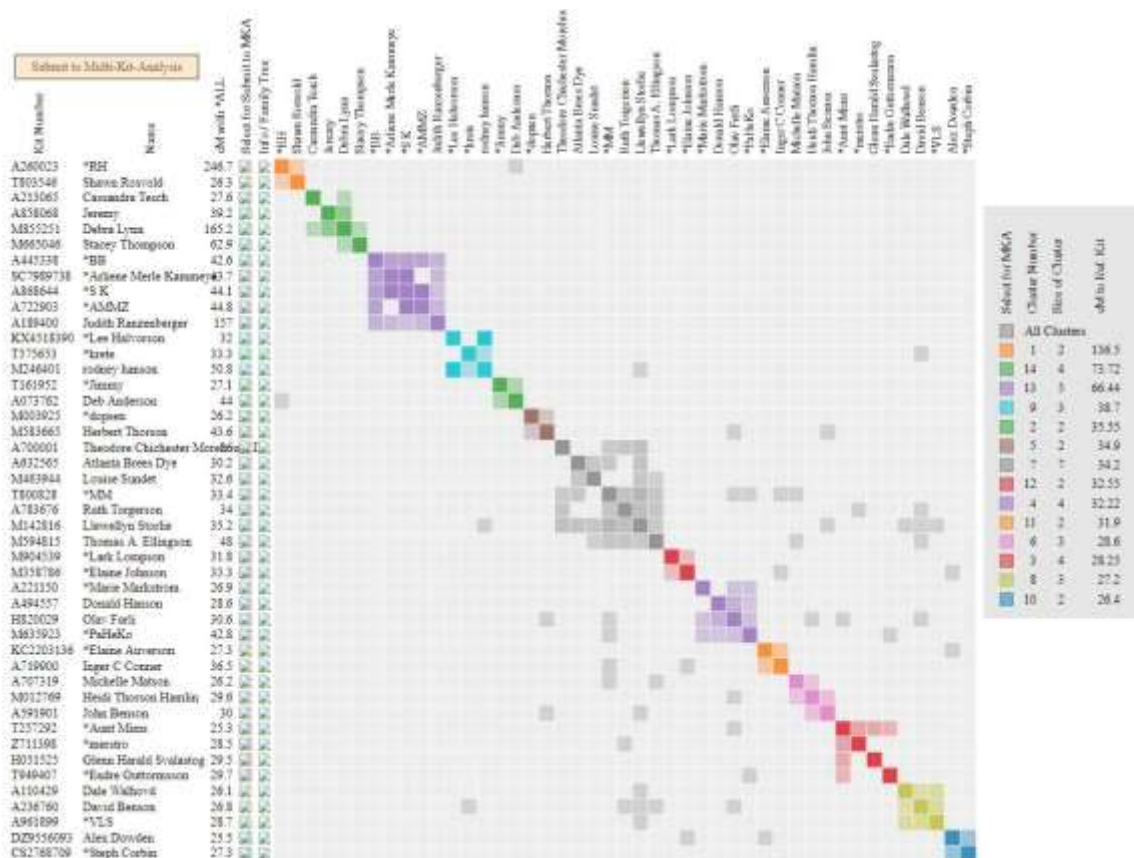


## Clustering

Clustering is a valuable DNA analysis tool. It takes your DNA matches and organizes them into common groups of individuals related by their DNA. Each group of related individuals are branches of your family tree. Groups are not necessarily related to one another. A group may be family branches that have married into your bloodline where one or more individuals in that group have a possible relationship to you.

Results frequently depend upon how many individuals have taken a DNA test within each cluster group and if you recognize an individual within the cluster group.

The following cluster example was produced from Gedmatch.



Once an individual is identified in a group, others in that group are related. This helps refine the traditional genealogical process by narrowing the research scope. There can be different results if there are endogamous populations. This often produces large clusters of individuals. These should be looked at carefully as they may be a disproportionate due to large number of individuals, who are all distantly related, taking a DNA-Test within one geographic region. It might be due to a more active interest in Genealogy and DNA testing within a single country.

There are currently two companies that provide DNA clustering.

- My Heritage includes it as part of their full subscription. They will process your request and send you an email with the attached cluster file
- Gedmatch offers the service as part of a monthly subscription. This can be a one-month subscription which provides additional DNA tools
- Cluster reports from MyHeritage and Gedmatch can be loaded directly into DNA Painter.

Be aware that clustering can be done using Ancestry, however it is somewhat convoluted and beyond the scope of this document.

## Phasing

Phasing is the process of separating an individual's DNA by their ancestral relationship. Most commonly this is done between parents and children; assuming one of each has been tested. Phasing can also extend to your ancestors if you have several DNA tests from various family tree branches.

If you are a child and both parents are dead, it is still possible to phase most of the DNA using blood related Uncles or Aunts; assuming they are alive. Using their DNA makes it possible to phase one or more of your parent's DNA. Other possibilities exist but they are also beyond the scope of this document.

Phasing makes it easier to identify maternal or paternal relationship.

## Phasing by company

- Ancestry automatically phases child/parent DNA and displays the results
- MyHeritage phases parent/child DNA but does not provide a tool to see the result
- FamilyTreeDNA requires building a family tree and then linking the parent/child relationship in the tree
- 23&Me will automatically phase the parent/child DNA and display the result
- LivingDNA phases parent child/parent data but provides no tool to see the results

## **Taking a DNA Test**

To expand the number of DNA matches, individuals often take multiple tests or upload a test to other locations. Always keep track of any DNA test you have taken, especially if you have uploaded your DNA profile to other sites.

This information should include:

- The company used
- Type of test (atDNA/mtDNA/Y-DNA)
- Date the test was taken
- The result if mtDNA or Y-DNA (Haplogroups)
- ID or 'Kit' number for the test

If you have uploaded a DNA test to another site, identify the original company used for the test and the date of the upload. Because companies are commercial operations that can fail, merge or close, it is advisable to download your DNA test and store it in a safe location.

## **DNA Testing Companies**

Beyond the matching options provided by various test companies, each has some different and useful tools that are frequently overlooked. Most testing companies attempt to establish a family relationship using both DNA results and family histories. The ultimate target is to build a family tree based solely on DNA relationships.

This would appear easy; however, there are challenges including the DNA of endogamous groups, adoptions, and close marriages within a family. Even with these challenges some companies are attempting to reverse engineer DNA to produce an approximation of a family tree.

There are over 200 companies offering DNA tests, some specializing in ethnic testing such as African, Asian and Native America Indian. National Geographic who offered a DNA test in 2005 discontinued their Geno 2.0 Ancestry Kits in May 2019.

The following summarizes the offerings from the most popular DNA testing companies.

### Ancestry

While Ancestry does not provide a chromosome browser, it does provide a useful tool called "ThruLines."

This tool displays each ancestral level, parent, grandparents, great-grandparents etc. It attempts to build a prototype of your family tree.

By selecting any individual at any ancestral level, it builds a tree for that individual. It identifies any individual who has taken a DNA test with Ancestry and includes this information in the tree. Data is compiled from family trees posted by other assumed relatives. The results sometimes indicate if there are missing individuals within the family tree.

The DNA search options provide several ways to locate DNA matches; the most powerful is comparing your shared DNA matches. Assuming you know which branch an individual belongs; these matches can help identify relatives and relationships for that branch of your family tree.

### MyHeritage

MyHeritage can produce a cluster report. There is a browser allowing chromosomal comparisons between individuals and groups of individuals. When looking at matches, a box next to a match indicates if that match triangulates with another individual also matching you. While this is useful, research is required to establish the relationship.

Their primary tool is called “Theory of Family Relativity.” The tool is available where you and another individual share a family relationship, and MyHeritage has enough common names to produce a sample relationship tree. The process uses family trees submitted by others and attempts to link a relationship using two or more of these trees. It provides a confidence level for the relationship between each tree it uses. Frequently, more than one matching option is shown. These can be useful for identifying potential links to more distant relationships such as fourth or fifth cousins.

### 23&Me

This is one of the early companies providing DNA tests. Their original extended DNA test which included several health/medical variants ran afoul of the FDA as the FDA considered them exceeding the boundaries of Genetic Genealogy testing. After discussion, the FDA settled on how far DNA testing companies can go in analyzing and reporting an individual’s DNA, especially those for health and health trends.

Results are identified as coming from more than 1,000 distinct regions of the world. They provide a range of tools for evaluating matches including a chromosome tool. Their process of building a family tree using only DNA results and those of your matches, is more advanced than other companies.

This company is the only one that provides genetic Neanderthal variants in their DNA test. Their test also identifies your paternal and maternal haplogroups. There is a larger range of security options than other companies for protecting and displaying a DNA test.

### FamilyTreeDNA

Another early adopter of DNA tests. While they offer atDNA tests, they are especially known for their Y-DNA and mtDNA tests and the support they provide for these special tests. If you are interested in either of these tests, this is the company to use. A family tree may be created or uploaded from a GEDCOM. While the site has useful search capabilities, the results lack in detail and are somewhat primitive.

### LivingDNA

A British based company that had lots of promise but stumbled along the way. They have since recovered and are rushing to catch up to other testing companies by offering a range of tools. Their selling point is they have regionalized areas of the world by a percentage of your DNA. For example, the UK is divided into 22 regions and recently, they added 72 African sub-regions. Living DNA provide Haplogroup results as part of their atDNA test.

## **DNA Tools**

The following companies do not offer DNA tests, instead they offer services and tools for analyzing and visualizing DNA information. These tools provide valuable methods for extending DNA analysis beyond the integrated tools provided by DNA testing companies.

### GEDMatch

GEDMatch is a free site and allows individuals to upload atDNA tests performed by other companies. Because this site is collaborative and contains individual DNA tests from many other sources; it is especially useful for capturing matching data from DNA tests that would not otherwise be available.

The tools allow individuals to match DNA results across different test sites including Ancestry, MyHeritage, 23&Me, FamilyTreeDNA and others. They provide an extensive set of tools for evaluating DNA matches including tools for clustering, phasing, and other options. Some tools require a subscription; however, their basic tools are free as is registration for the site. They recently launched ‘Ancestor Projects’ which is an option to join a DNA group based upon ethnicity or geographic location.

## DNA Painter

DNA painter provides a series of useful tools including a Shared cM tool, chromosome mapping, a “what are the odds” tool, a cluster painter and individual DNA match filters. These are all useful tools for analyzing and visualizing DNA.

## **Adoption and other uses**

Genealogy sites with DNA records are frequently used by individuals searching for one or more of their ‘Birth’ parents. While some individuals have success, it is not always an easy process and frequently requires considerable research; often using traditional Genealogical research.

Likewise, there is considerable discussion related to using genealogical databases for solving crimes. Again, these research techniques, while well understood, are not an instant solution and require intensive research by specialists in Genetic Genealogy.

## **Useful WEB links** (Hyperlinks are active if reading this document on a computer)

### **Internet:**

[www.myheritage.com](http://www.myheritage.com)

[www.ancestry.com](http://www.ancestry.com)

<https://www.23andme.com/?mkbanner=true>

[www.familytreedna.com](http://www.familytreedna.com)

[www.livingdna.com](http://www.livingdna.com)

[www.gedmatch.com](http://www.gedmatch.com)

[www.isogg.org](http://www.isogg.org)

[www.dnapainter.com](http://www.dnapainter.com)

[www.dnapainter.com/tools/sharedcmv4](http://www.dnapainter.com/tools/sharedcmv4)

[www.en.wikipedia.org/wiki/DNA\\_database#United States](http://www.en.wikipedia.org/wiki/DNA_database#United_States)

DNA Tests and family trees.

DNA Tests and family trees.

DNA Tests and family trees.

DNA Tests and family trees-Has useful reference materials.

DNA Tests-Useful for the UK.

DNA Matching and analysis.

International Society of Genetic Genealogy.

Visualizations and chromosome mapping. Has a range of useful tools.

Tool to evaluate cMs and relationships.

Summary about DNA databases, worldwide.

### **Books:**

The Family Tree Guide to DNA Testing and Genetic Genealogy - Blaine T. Bettinger

Genetic Genealogy-The Basics and Beyond – Emily D. Aulicino

### **Video/Webinars**

[www.youtube.com](http://www.youtube.com)

<https://familytreewebinars.com/>

Search for ‘Genetic Genealogy’ for a range of useful videos.

Provide a range of useful webinars including over 100 on DNA. Some are free and some require an annual subscription.

### **Haplotree Information**

[www.familytreedna.com/public/y-dna-haplotree/A](http://www.familytreedna.com/public/y-dna-haplotree/A)

[www.familytreedna.com/public/mt-dna-haplotree/L](http://www.familytreedna.com/public/mt-dna-haplotree/L)

Male Haplotree information.

Female Haplotree Information.

### **BLOGS & My Worksheets**

<https://jm-ancestry.blogspot.com/>

[www.thegeneticgenealogist.com](http://www.thegeneticgenealogist.com)

[www.blog.kittycooper.com/other-blogs-and-resources/dna-blogs/](http://www.blog.kittycooper.com/other-blogs-and-resources/dna-blogs/)

For downloading the blank worksheets in this document.

DNA site for Blaine Bettinger with useful information.

Contains useful DNA information and other links to other DNA sites.

### **Adoption Resources**

<https://dnaadoption.org/>

[www.adopteddna.com](http://www.adopteddna.com)

[www.isogg.org/wiki/Genetic\\_genealogy\\_blogs](http://www.isogg.org/wiki/Genetic_genealogy_blogs)

Resources for individuals tracing their birth parents or siblings.

Richard Hill BLOG that includes DNA information for adoptees.

A large list of Genetic Genealogy Blogs

### Document history

Various diagrams are ©Blaine T. Bettinger/FamilyTreeDNA/John Meyer

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