Using Autosomal DNA for Genealogy

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This is one article of a series on using DNA for genealogical research. There are several types of DNA tests offered for genealogical purposes. Researchers must understand that only like tests can be compared: Y-DNA to Y-DNA, mitochondrial DNA (mtDNA) to mtDNA, and autosomal DNA (atDNA) to autosomal DNA. To use DNA to solve a problem, an understanding of DNA inheritance and the limits of the evidence is paramount. This article covers atDNA.

WHAT CAN YOU DO WITH atDNA?

In the last five years or so the technology for testing autosomal DNA has reached an affordable price with accuracy and a resolution useful for genealogy. Hundreds of thousands of people have taken atDNA tests in recent years.[1] Those who have tested represent a small percentage of the world population of seven billion. Today we can analyze many markers and correlate what we learn with traditional genealogical research in a meaningful way.[2]

Autosomal DNA allows both men and women to analyze the DNA inherited from **all** of the ancestors on our pedigree chart, at least for recent generations. Where Y-DNA and mtDNA are passed from a parent unchanged unless a mutation occurs, atDNA is remixed, randomly recombined, to create a unique DNA signature for each child. Each child receives a new combination of atDNA from the parents. This recombination means atDNA requires significant analysis to provide evidence to answer a genealogical question. It isn't easy, but persistent genealogists are doing it.

DNA cousins, those with whom we have an atDNA match, can provide clues to expand a family tree past brick walls. We can find atDNA matches out to the third cousin level (five generations), sometimes more. A strong match confirms a common ancestor; not matching a suspected fourth or more distant cousin is not conclusive and could be due to recombination splitting the DNA to the point a match can no longer be detected.

WHAT IS atDNA AND HOW IS IT INHERITED?

Each cell of our body usually has twenty-three pairs of chromosomes in the nucleus. Chromosomes one through twenty-two are the autosomes. The twenty-third pair of chromosomes defines gender:

All URLs accessed 13 February 2014.

[1] "Autosomal DNA testing comparison chart," *Wiki,* International Society of Genetic Genealogists (ISOGG) (online at http://www.isogg.org/wiki/Autosomal_DNA_testing_comparison_chart); comparison of atDNA tests with database size estimates and date test was first offered.

[2] Debbie Kennett, *DNA and Social Networking: A Guide to Genealogy in the Twenty-first Century* (Gloucestershire, UK: History Press, 2011). Richard Hill, *Finding Family: My Search for Roots and the Secrets in My DNA* (n.p.: self-published, 2012).

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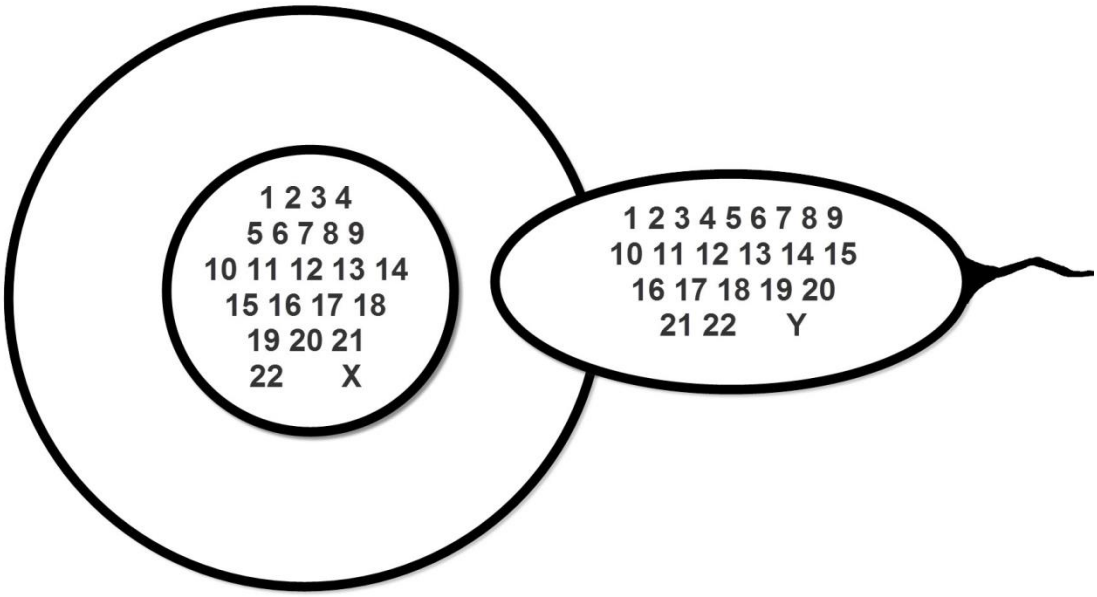
an X-Y pair in males, a pair of Xs in females.[3] The autosomes are a randomly recombined mix of the atDNA our parents inherited from our grandparents. Our father inherited a pair of chromosomes number one, one from his mother and one from his father. That pair breaks apart and recombines into a new chromosome one that we inherit. The same thing happens with our father's paired chromosomes two through twenty-two and with the chromosomes our mother got from her parents. The chromosomes are then passed to us through the egg and sperm. See figure 1.

Figure 1.



Egg and sperm showing chromosomes
© 2014, Debbie Parker Wayne

Only one-half of the atDNA of each parent passes to a child. Because of recombination only about one-fourth of the atDNA of each grandparent passes to a grandchild. The actual amount of atDNA inherited from a particular grandparent can vary due to random recombination. In figure 2, each half of the body represents a chromosome received from one parent. The left half represents, for example, the chromosome one inherited from our father with the two colors representing the atDNA from each of his parents. The chromosome is a random mix of segments from each grandparent. The right half of the body represents the corresponding chromosome inherited from our mother with the two colors representing atDNA segments inherited from each of her parents.

[3] Megan Smolenyak Smolenyak and Ann Turner, *Trace Your Roots with DNA: Using Genetic Tests to Explore Your Family Tree* (Emmaus, Penn., Rodale Press, 2004), 25.

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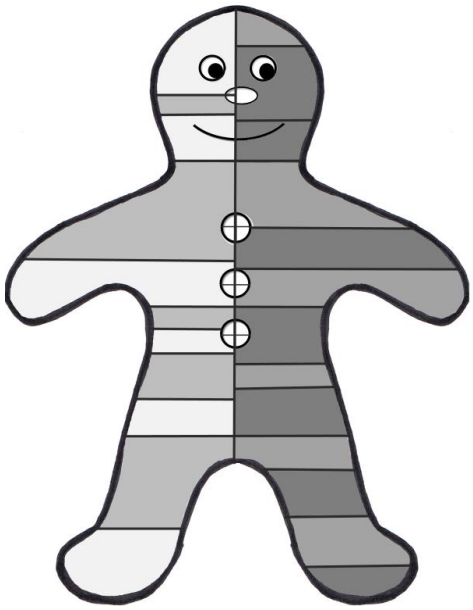
Figure 2.



With each generation recombination may further divide and shorten the DNA segments. An autosomal DNA test can reliably match those with a common ancestor back five or six generations. A meticulously researched family tree going back many generations is needed to determine who the common ancestor was. A tree with collateral relatives and geography can be useful when a DNA tester hasn't researched back far enough to identify the common ancestor.

The atDNA test offered today for genealogical purposes looks primarily at 500,000 or more individual locations or markers on the chromosomes. The value at each location of one person is compared to the same location of another person to determine if their DNA matches. If the match is a long segment these two people have a common ancestor in recent generations. If two people match on small segments they may have a common ancestor further back in time. Or perhaps those small segments are common to many humans due to the fact that we all share common ancestors if we go far enough back.

Math can predict a range of possible relationships, not an exact relationship, between two people based on the amount of shared DNA. See table 1 for a list of shared DNA percentages for some relationships; a more complete color chart can be found online.[4] In the future, as more people test and we test more locations on each chromosome, we may learn more and use different mathematical algorithms to interpret the DNA test results more accurately.[5]

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[4] Debbie Parker Wayne, "Percentage Shared atDNA Chart," *Deb's Delvings* blog, posted 29 October 2013 (http://debsdelvings.blogspot.com/2013/10/percentage-shared-atdna-chart.html).

[5] Kennett, *DNA and Social Networking*, chapter 5. Blaine Bettinger, PhD (Biochemistry), *Using Genome Wide SNP Scans to Explore Your Genetic Heritage,* posted 2 August 2010, *The Genetic Genealogist* blog (http://www.thegeneticgenealogist.com/).

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Table 1. Percent of shared atDNA				
YOU Focus Person	Parent 50%	Grandparent Half-sibling 25%	Great Grandparent Half-aunt/ uncle Half-niece/ nephew 12.5%	2nd Great Grandparent 6.25%
Parent 50%	Sibling 50%	Aunt/uncle Niece/nephew 25%	Great aunt/uncle 12.5%	2nd Great aunt/uncle 6.25%
Grandparent Half-sibling 25%	Aunt/uncle Niece/nephew 25%	1st cousin 12.5%	1st cousin once removed 6.25%	1st cousin 2x removed 3.13%
Great Grandparent Half-aunt/ uncle Half-niece/ nephew 12.5%	Great aunt/uncle 12.5%	1st cousin once removed 6.25%	2nd cousin 3.13%	2nd cousin once removed 1.56%
2nd Great Grandparent 6.25%	2nd Great aunt/uncle 6.25%	1st cousin 2x removed 3.13%	2nd cousin once removed 1.56%	3rd cousin .78%
Chance of finding a match: 99% or higher for 2nd cousins or closer; 90% or higher for 3rd cousins; 50% or higher for 4th cousins[6]. For complete table Debbie Parker Wayne, "Percentage Shared atDNA Chart," Deb's Delvings Blog, posted 29 October 2013 (http://debsdelvings.blogspot.com/2013/10/percentage-shared-atdna-chart.html).				

atDNA TEST RESULTS

The atDNA test results consist of raw DNA data. See table 2 for sample raw data. There is no haplogroup associated with atDNA as there is with Y-DNA and mtDNA. The raw data includes a list of marker names, chromosome numbers and locations on that chromosome, and the chemical found on each chromosome at that location. The chemicals are Adenine, Cytosine, Guanine, Thymine, each usually represented by the first letter of the name—A, C, G, or T. Everything else we get from an atDNA test is based on analysis of the data and comparing it to other testers.

Table 2. Raw Data: Raw DNA data is usually downloaded as CSV, XLS, or ZIP file			
Marker name	chromosome	position	genotype
rs6603813	1	2032940	GT
rs10019828	4	182219514	TG
rs2341009	22	49480446	AA

The data is compared to population database samples to provide an admixture or "ethnicity" percentage prediction. These predictions are the least useful element for a genealogist. The

[6] "How do I calculate cousinship?" and "What is the probability that my relative and I share enough DNA for Family Finder to detect?," Frequently Asked Questions, *Family Tree DNA* (http://www.familytreedna.com/faq/answers/default.aspx?faqid=17).

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admixture prediction depends on how closely your DNA matches the samples in the database and exactly how the DNA recombined as it was passed to each new generation. As you go back further in time a person will have less DNA from any given ancestor. For example, if a Native American ancestor was far enough back in the family tree there may be no Native American DNA detected. We need more time for the population databases and algorithms to mature before these admixture predictions become important for genealogical research.

The atDNA data is compared to others who have tested to provide a list of "DNA matches." See table 3 for a sample list. We can work with those people to determine who our common ancestor may be. Some companies provide tools to help us with analysis: chromosome browsers, triangulation and matrix tools, access to family tree data and surname lists, or shaky leaf hints on the tree of someone who has matching DNA and a matching person or couple in their family tree. For in-depth analysis of DNA matches we need the segment data listing the chromosome number and start and stop points of matching segments for each person in our match list. See table 4 for sample detailed match data.

Tools help with analysis of the DNA data. A basic spreadsheet can be used for some analysis. Many tools for analysis are being created by genetic genealogists who have programming skills. A key point here is that it takes work to determine who a common ancestor is. The DNA data can only indicate you are related to another tester and give a ballpark estimate of how you may be related. Correlating the DNA data with traditional research helps identify the common ancestor and the relationship between two testers. The right match verifies your research is accurate and can be evidence to support a theory of kinship when conclusive documentary evidence is lacking. If the tester with matching DNA has an accurate tree going back farther than yours, that person can help you expand your tree.

Table 3. Match data: A list of matches may be downloaded

	Match Date	Relation-ship range	Suggested Relation-ship	Shared CM	Longest Block	Known Relation-ship	e-mail	Ancestral Surnames
John Doe	3/9/2012	2nd-4th cousin	3rd cousin	64.38	35.82		john@x.com	Carter, Richards, Smith
Mary Smith	4/6/2012	3rd to 5th cousin	4th cousin	30.24	18.01	3rd cousin	private	Carter, Smith
Dau Smith	8/6/2012	4th to remote cousin	--	45.49	10.54		mary@x.com	

Table 4. Detailed match data: Chromosome Browser match results

Name	Match Name	Chromo-some	Start Location	End Location	CentiMorgans	Matching SNPS
Me	Mary Smith	2	184378109	190231010	2.19	900
Me	Wanda Smith	11	37162511	79872779	30.32	9100
Me	Wanda Smith	12	103885115	113509874	11.24	2377

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USING atDNA TEST RESULTS

Some of the basic steps for using atDNA are similar to those for Y-DNA and mtDNA, but more effort is required to go beyond the basics.

Complete all lines of your pedigree as far back as possible. Including collateral lines may help determine who a common ancestor may be. Document this to share with atDNA matches looking for a common ancestor. List your ancestral names, dates, and geographic origins. The more information included, the easier it will be to determine when a person is common to two family trees.

Create a privatized pedigree chart. For example, list information on your earliest known ancestors down to a great-grandparent or a recent generation that is no longer living. Include geographic locations and dates for comparisons.

Review any ancestral information shared by your DNA matches, and contact the person for more information. Contact the matches who share the largest segments of DNA first as the common ancestor is likely to be more recent. If a common ancestor cannot be identified by name, look for patterns that provide additional research clues such as geographic locales, spouses' names, and so on. Matches may not have posted everything they know online. Some people don't respond to contacts, but an attempt should be made. Be patient; the person may respond months after an initial query.

More in-depth analysis of the DNA data may be covered in future articles and can be found by studying chromosome mapping.[7]

RESOURCES

This article is a short introduction to atDNA. For information on tests offered by different companies see each vendor's web site and the International Society of Genetic Genealogists (ISOGG) Wiki pages.[8]

Debbie Parker Wayne, CG, CGL, is experienced using DNA analysis, as well as more traditional techniques, for genealogical research in Texas, the South and West. She coordinates the *Practical Genetic Genealogy* course at the Genealogical Research Institute of Pittsburgh, the *Getting Started with Genetic Genealogy* course at Salt Lake Institute of Genealogy, and is the Texas State Genealogical Society's DNA Project Director. See http://debbiewayne.com/ for more information.

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[7] "Chromosome mapping," Wiki, *ISOGG* (online at http://www.isogg.org/wiki/Chromosome_mapping).
[8] "Autosomal DNA testing comparison chart," Wiki, *ISOGG* (online at http://www.isogg.org/wiki/Autosomal_DNA_testing_comparison_chart).

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