An Introduction to DNA and Genealogy

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Have you heard your friends and fellow genealogists enthuse about DNA but don't know what it's all about? Wondering if a DNA test is right for you? Come learn about DNA, why it's valuable, which tests you can take, and how it might help you in your genealogy research.

What is DNA?

DNA, or deoxyribonucleic acid, is the genetic code that defines your biological characteristics. DNA is made up of strings of individual bases or nucleotides which are paired with their counterparts. These strings of DNA are coiled into packages or chromosomes. Chromosomes are found in the nucleus (or center) of most cells. Each nucleus contains 23 paired (46 total) chromosomes. One of these paired chromosomes (the sex chromosomes, usually identified as X and Y) defines whether you are biologically male or biologically female. The other 22 paired chromosomes are known as autosomes.

Many cells also have mitochondria, which act as the powerhouse of the cell. These mitochondria are located outside the cell's nucleus but have their own DNA.

Why is DNA Valuable?

DNA is valuable because it is inherited. Your DNA is a composite of your parents' DNA, your grandparents' DNA, and your great-grandparents' DNA. Half of your DNA comes from your father and half from your mother. Because DNA is inherited, it is most useful for genealogy when it is compared with the DNA of other people. When you share segments of DNA with other people, you can assume that you both descend from the same ancestor. By searching your family trees (created through traditional paper trail research), you can locate that common ancestor and verify the relationship.

Types of DNA

yDNA – The Y chromosome (one of the two paired sex chromosomes) is carried only by men and is passed from father to son. By comparing the Y chromosome of two males, you can determine whether they share a common patrilineal ancestor.

mtDNA – MtDNA, or mitochondrial DNA, is found in a cell's mitochondria. Mitochondria are passed from a mother to all her children, regardless of whether they are male or female. By comparing the mitochondrial DNA of two individuals, you can determine whether they share a common matrilineal ancestor.

atDNA – Autosomal DNA includes all the chromosomes except for the sex chromosomes. Autosomal DNA can help identify ancestors within the last 5-7 generations. Because you only inherit half of each of your parents' DNA, some of your ancestors "fall off" your genetic tree (meaning you did not inherit any of their DNA). You are guaranteed to only share DNA with 2nd cousins or closer.

xDNA – The X chromosome has a unique inheritance pattern because it can never be passed from father to son. The X chromosome inherited from Mom was recombined from her grandparents. If two individuals share matching xDNA, their common ancestor can be found along specific ancestral lines.

Your DNA Results

Ethnicity

DNA companies provide a guess as to your ethnic origins. Your ethnicity is based on the comparison of your DNA to reference samples collected by each DNA company from around the world. Ethnicity may provide hints that may help with your research. However, don't worry if your ethnicity does not exactly match the origins of the ancestors you identified through paper trail research.

Match Lists

DNA companies provide a list of people with whom you share DNA. The relationship between you and your matches is predicted by the amount of shared DNA (atDNA) or the number of mutations (differences) between you and a match (yDNA and mtDNA). Follow traditional records to confirm the exact relationship between you and your matches.

Genealogy Problems

You can use your DNA results to help solve genealogy problems. DNA can help identify unknown parents due to adoption, mis-attributed parentage, or unknown parents. DNA can also be used to point to new avenues of research on brick wall cases. DNA can also be used to confirm relationships hypothesized by surviving records.

Chromosome Mapping

Chromosome mapping is the process of assigning segments of your DNA to specific ancestors. Once you know how you are related to a match, you can assume that the DNA segments you share were inherited from your common ancestor. You can then assign those segments to that ancestor using a visual representation of your chromosomes. There are online tools that can help with this process. See Other Resources below to learn more.

Projects

Many genealogists who test their Y and mitochondrial DNA join projects. Projects are grouped by geographic regions, surnames, or haplogroups. Projects are run by knowledgeable administrators who group the DNA of project members based on unique markers. After joining a project, check to see how your DNA compares to the DNA of others in the project.

DNA Companies

FamilyTreeDNA – FamilyTreeDNA tests yDNA, mtDNA, and atDNA (called Family Finder). Your DNA is collected by scraping your cheek. FamilyTreeDNA provides ethnicity, match tools, and a chromosome browser. (www.familytreedna.com)

23andMe – 23andMe tests autosomal DNA and provides Y and mitochondrial haplogroups. DNA is collected by spitting into a tube. 23andMe also has ethnicity tools and match comparisons. 23andMe also offers to test for health data. (www.23andme.com)

AncestryDNA – AncestryDNA tests autosomal DNA. Your DNA is collected by spitting into a tube. Results are tied to your Ancestry.com account and family tree. AncestryDNA provides ethnicity results, match lists, migrations, and has recently introduced ThruLines™. (www.ancestry.com/dna)

MyHeritage – MyHeritage DNA tests autosomal DNA. Your DNA is collected by scraping your check. MyHeritage provides ethnicity results, match lists, and recently introduced the Theory of Family Relativity™. (www.myheritage.com/dna)

LivingDNA – LivingDNA tests autosomal DNA and provides Y and mitochondrial haplogroups. DNA is collected by spitting into a tube. LivingDNA provides ethnicity results and match lists. (livingdna.com)

3rd Party Tools and Resources

GedMatch Genesis – GedMatch lets you upload and compare your raw DNA data from most DNA testing companies. GedMatch also provides additional admixture tools, one-to-many comparison, one-to-one comparisons, and more. Requires registration and contribution of a raw DNA file. Advanced features require a fee. (genesis.gedmatch.com)

DNAGedcom – DNAGedcom gathers your DNA data from DNA testing companies and uses advanced tools to analyze and work with your DNA data. Advanced features require a fee. (dnagedcom.com)

DNA Painter – DNAPainter allows you to map your chromosomes. DNAPainter also hosts additional tools including the Shared centiMorgan tool and the What Are the Odds Tool. (dnapainter.com)

Genetic Affairs – Genetic Affairs pulls new DNA matches from DNA testing companies on a regular cycle. Genetic Affairs also lets you AutoCluster your matches. (geneticaffairs.com)

Learn More

ISOGG Wiki – The International Society of Genetic Genealogists has created and maintains a wiki (community written encyclopedia) on DNA and how it used for genealogy. (isogg.org/wiki)

Genetic Genealogy Standards – The genetic genealogy community has established a set of standards for genealogists using DNA as part of research. (www.geneticgenealogystandards.com)

FamilySearch.org – FamilySearch has created a comprehensive set of informational pages that introduce key DNA concepts and link to additional resources. (www.familysearch.org/dna-testing)

Published Books on Genetic Genealogy

- Blaine T. Bettinger and Debbie Parker Wayne, **Genetic Genealogy in Practice**, (Arlington, VA : National Genealogical Society, 2016), FHL Call Number 929.1 B466g.
- Blaine Bettinger, **The Family Tree Guide to DNA Testing and Genetic Genealogy**, (Cincinnati, Ohio : Family Tree Books : 2016), FHL Call Number 929.1 B466f.
- Debbie Parker Wayne, ed., **Advanced Genetic Genealogy: Techniques and Case Studies**, (Cushing, Texas : Wayne Books : 2019).

DNA Vocabulary

Admixture: see **Ethnic Origins**

Autosomes: numbered (non-sex) chromosomes

atDNA (autosomal DNA): 22 numbered chromosomes (also called autosomes); shared segments longer than 7-10 centiMorgans indicate a probable common ancestor

Base Pair: two complementary bases located on opposing DNA strands; see nucleotide

cMs (centiMorgans): a unit of measurement for DNA segments

Chromosome: a package for carrying DNA in the nucleus of cells

Chromosome Browser: a feature offered by some genealogy companies allowing you to view matching segments on a visual representation of the chromosomes

Chromosome Mapping: the process of assigning DNA segments to specific ancestors

DNA (deoxyribonucleic acid): the genetic code that defines your biological characteristics

DNA Circle: a feature of AncestryDNA that connects users who have a common ancestor and who share DNA

DNA Project: a group of people whose DNA or surname indicates a biological connection; project administrators for DNA projects are knowledgeable and group the DNA results of project members

Endogamy: when a population becomes genetically isolated over multiple generations making it

difficult to use DNA to identify true relationships; examples include island populations and Ashkenazi Jews

Ethnic Origins: the percentage of your DNA inherited from specific ethnicities based on a comparison between your DNA and reference samples; different companies report ethnic origins differently

Family Finder: autosomal DNA test offered by FamilyTreeDNA

Genetic Communities: a feature on AncestryDNA which groups Ancestry members into common ancestral geographic regions based on similarities in DNA (also called **Migrations**)

Genetic Distance: on FTDNA, the number of mutations that differentiate two individuals in yDNA and mtDNA results; on GEDMatch, the suggested number of generations between two individuals and their common ancestor based on their matching segments

Genetic Genealogy: the use of DNA to identify family members, both living and deceased

Genetic Genealogy Standards: ethical and usage standards for genealogists using DNA

Haplogroup: group of similar haplotypes that share a common ancestor based on a single mutation

Haplogroup Project: a project for all individuals with the same haplogroup

Haplotype: a group of alleles that are inherited together, also known as a genetic signature

IBD (inherited by design): segments of DNA that are longer than 10 centiMorgans are considered to be inherited by design, probably indicating a common ancestor

IBS (inherited by state): segments of DNA that are shorter than 7 centiMorgans are considered to be inherited by state, probably indicating no common ancestor

ISOGG Wiki: a wiki built and maintained by the International Society of Genetic Genealogists

Match: individual identified by a DNA company as having shared segments of DNA

Mitochondria: located in the cytoplasm of a cell, the mitochondria are the cell's powerhouses

MRCA (most recent common ancestor): the most recent ancestor or ancestral couple that is shared by two individuals who have matching segments of DNA

mtDNA (mitochondrial DNA): DNA associated with a cell's mitochondria; passed down from mother to child

Mutation: a change in the DNA

NPE (non-paternal event): when the father identified through paper trail research is not the biological father; in yDNA when there is a break between the surname of the son and the surname of the biological father

Nuclear DNA: DNA located in the cell's nucleus; made up of 23 paired chromosomes

Nucleotide: the basic structure of DNA; there are four known nucleotides

Paper Trail: genealogy done by researching traditional records such as census, probate, vital, etc.

Phasing: the process of assigning DNA to each parent

Surname Project: a project consisting of DNA samples from all individuals with the same surname

Triangulation: the process of triangulating a DNA match with paper trail records, leading to the most recent common ancestor

xDNA: one of two sex chromosomes; individuals with two X chromosomes are female; x chromosomes have a unique inheritance pattern because an X chromosome cannot be passed from father to son.

yDNA: one of two sex chromosomes; individuals with a Y chromosome are male; yDNA is passed from father to son