



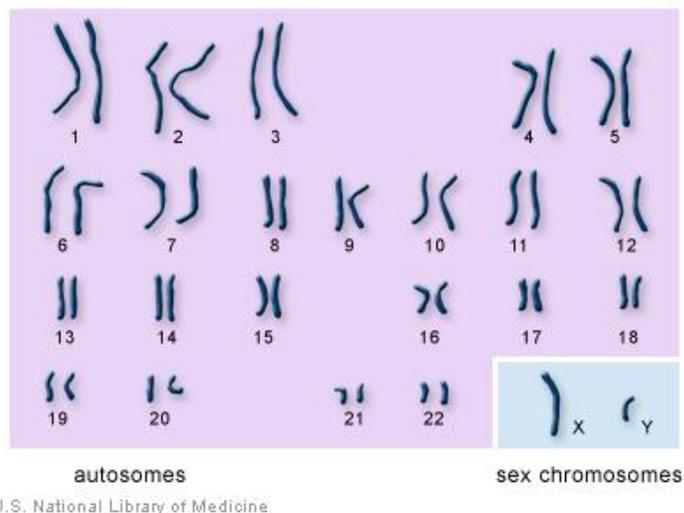
## Introduction: Y-DNA Introduction (or Who's your Daddy?)

### Lesson 1. Introduction to Y-DNA

**Objective:** Understand **STR** Y-DNA and how it affects your genealogy

**Tools:** This lesson will introduce you to Y-DNA and how it is used in genealogy.

- Words and phrases in **bold** indicate important terminology. Please consult the glossary included with the course material.
- Click any entry in the Table of Contents to jump to that part of the lesson.
- Class notes are at the end of the lesson.



Lesson written by Gale French

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## Section 1. DNA: Introduction to Basic Genetics

Here's a simplified overview of all the science you need to know to work with your DNA results.<sup>1</sup>

### We're all related

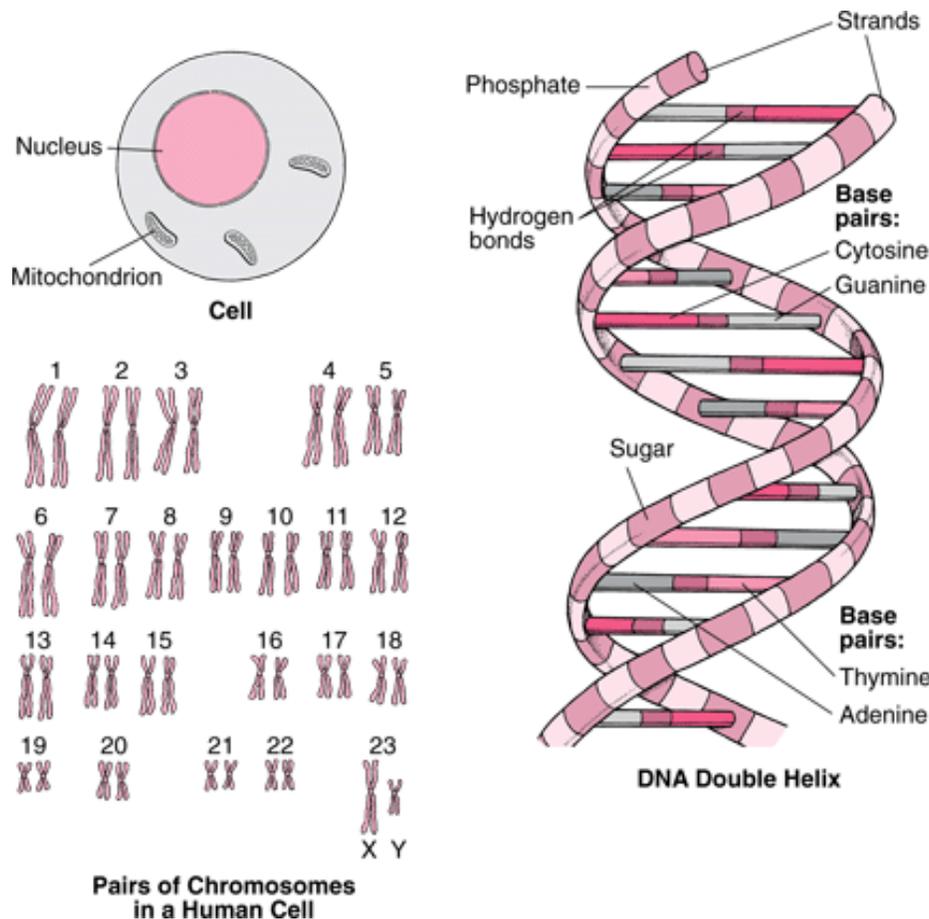
You are related to every human being on earth, making you a *bona fide* member of the species *Homo sapiens*. In fact, you share<sup>2</sup> 99.5% of your genetic makeup with your mom, your dad, the neighbor down the street, a baker in France -- even the Pope!

That's because of deoxyribonucleic acid (**DNA**). DNA contains the instructions that form and maintain living organisms. It tells apples to become apples, dogs to become dogs and humans to become -- you guessed it -- humans.

But what makes an apple green or red? A dog black or spotted? Your eyes brown or blue? **Genes** do. Genes are segments of DNA that are **coded** to determine traits. Each human has the same number of them -- over 20,000 -- which collectively form your **genome**.

All of this DNA is organized into cell delivery packages called **chromosomes** which are passed from parents to their offspring. A fruit fly has four chromosomes. A dog has 39. And you have 46.

You inherited 23 chromosomes from your mother and 23 from your dad. The last pair, the **allosomes**, are the sex chromosomes that determined your gender.

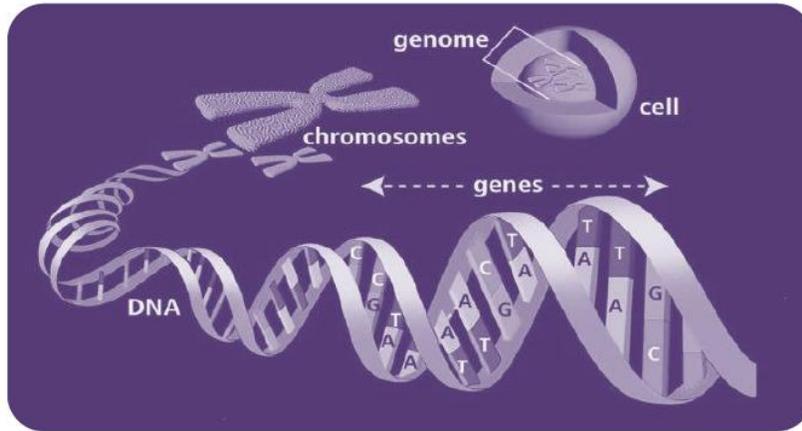


<sup>1</sup> Materials for Section 1 come from Autosomal class developed by Mesa Foard

<sup>2</sup> Source: 23andMe.com

But what do those other 22 pairs of chromosomes do? These are the **autosomes**, and they determine everything else about a human other than gender.

## DNA > Genes > Chromosomes > Cells = The Human Genome



You may be thinking that if we're all related, what makes us unique? What makes us biologically different from each other? Good question. It's the combination of autosomal DNA (atDNA) in that little .5% which we inherited directly from our ancestors that makes us unique among the billions of other people on earth.<sup>3</sup>



### Genome

The word "**genome**" is comprised of the words "gene" and "chromosome" to describe the entire genetic code of a human.

<sup>3</sup> Unless you're an identical twin.

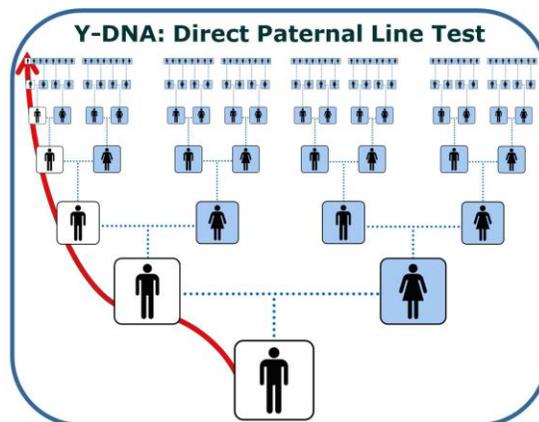
## Section 2. DNA Basics

### Types of DNA

There are four basic types of DNA used in genealogical testing:

#### 1. Y-DNA - DNA derived from the Y Chromosome

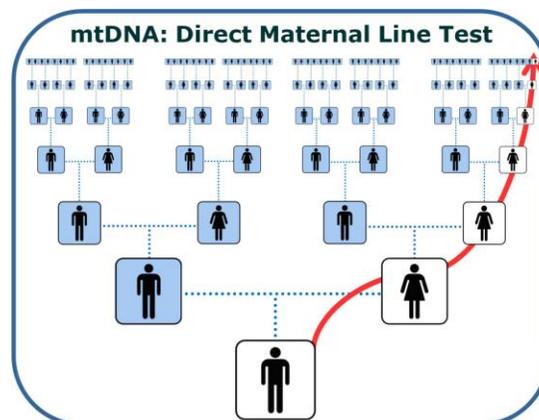
The Y-chromosome is only passed down from a father to a son, unchanged from generation to generation (unless a random naturally occurring change called a **mutation** happens). The result of that mutation (called a **marker**) can be traced through many generations as that man will pass it on to his sons, and to every male in the family for many generations. On average, mutations in any marker are estimated to occur only once in every 500 generations.



The Y-DNA **STR** test offers a clear path from you to a known, or likely, direct paternal ancestor(s).

#### 2. mtDNA - **Mitochondrial** DNA

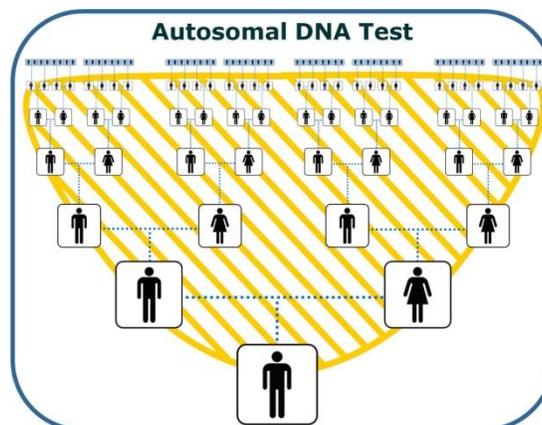
mtDNA is the line that follows your mother's maternal ancestry. This line consists entirely of women, although both men and women have their mother's mtDNA. This means that fathers do not pass on their mtDNA to their children. Your mtDNA can trace your mother, her mother, her mother's mother, and so forth, and offers a clear path from you to a known, or likely, direct maternal ancestor.



#### 3. atDNA - **Autosomal** DNA

atDNA is inherited randomly; you will inherit segments that your mother passed on to you, some that your father passed to you, some from your grandparents and maybe even some from your paternal third great-grandmother.

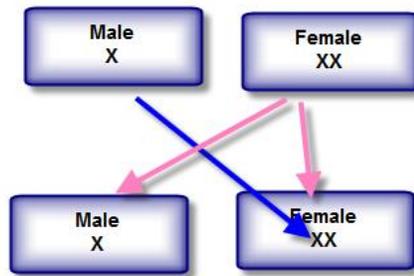
This test is designed to find relatives on any of your ancestral lines within the last 5 generations.



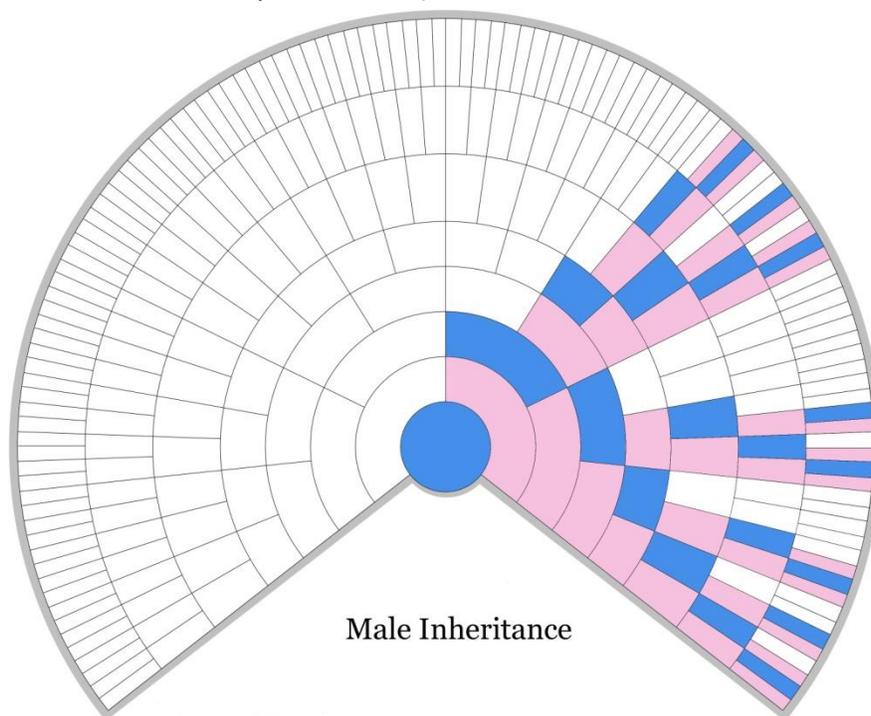
#### 4. X-DNA - X-Chromosome DNA

##### What is X-DNA?

It is really quite simple. A man passes down his X chromosome only to his daughter. A woman passes down her X chromosome to both her sons and daughters. Now let's reverse the picture. A man gets his chromosome from his mother, not his father. A woman gets hers from both her mother and father. We are saying the same thing, but one description might make more sense to you than the other.



A male never gets an X from another male. The chart below<sup>4</sup> shows the X-Chromosome inheritance pattern (where blue is male and pink is female).



This lesson will concentrate on the **Y-DNA**.



##### Pop Quiz #1

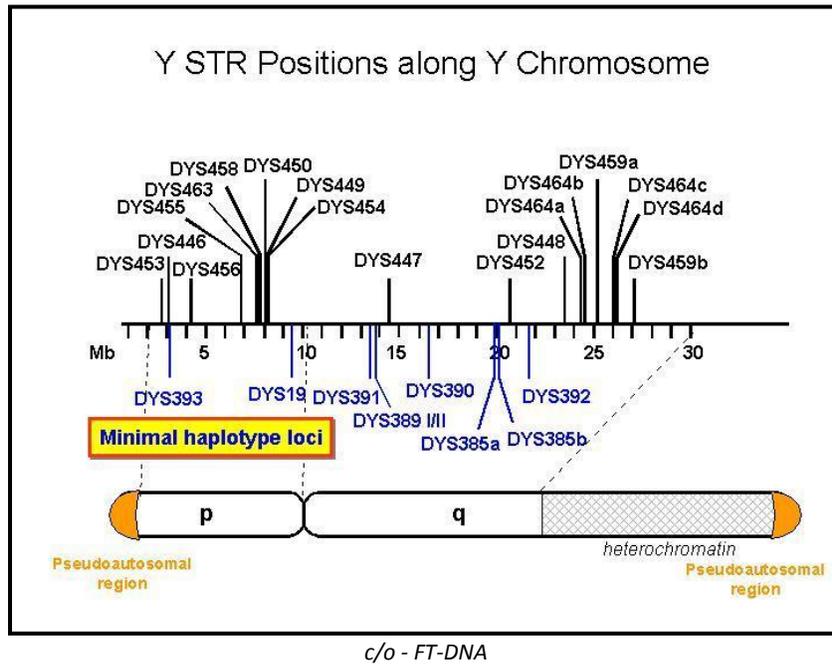
I'm a male named Smith researching a surname line that came from a female ancestor named Jones. Can I use the Y-DNA test to find if I match Jones?

<sup>4</sup> Source: Blaine Bettinger

## DNA Comparison - Y &amp; mtDNA

Compare and Contrast	Y Chromosome	Mitochondrial DNA
Where found	Males only	Males and females
Size	About 60,000,000 bases; only 23,000,000 sequenced	16,569 bases, all sequenced
Inheritance	From father	From mother
Function	Determines gender	Generates energy
Essential for life	No	Yes
Laboratory technique	Length of STRs	Actual sequence
Cost	Less expensive	More expensive
Polymorphism	Number of repeats	Base substitution
Mutation rate per generation	0.002 per STR (may vary from STR to STR)	0.00001 per base (may vary from site to site)
Sample haplotype format	14-24-12-11-13-13	16192T 16270T
Haplotype diversity	High	High
Longevity of haplotype	Pattern can last hundreds of years	Pattern can last thousands of years
Hereditary disorders	None identified to date	Yes (but not in the HVR)
Identify a person for forensic purposes	Can include some or exclude many, but not unique	Can include some or exclude many, but not unique
Present in hair shaft	No	Yes
Recovery from ancient remains	Very difficult	Possible, depending on conditions *





### STR Marker Tests

The types of Y-DNA tests vary by the number of markers which are examined. There are:

1. 12 Marker (for use in limited cases)
2. 37 Marker (there used to be a 25 Marker test)
3. 67 Marker (now only available as an Upgrade)
4. 111 Marker

The more markers that are tested, provide a better possibility of identifying paternal matches for more generations. The fewer mismatches testers show, the shorter the time that has elapsed since their **Most Recent Common Ancestor (MRCA)**. The goal is to find a person(s) that match the most markers with you. That means a very close relationship. It is recommended that you start testing with a minimum of 37 markers.

### Y-DNA Genetic Distance

When talking about two or more Y-Chromosome STR haplotypes, **Genetic Distance** is the total number of differences, or mutations, between two sets of results. The lower the number, the closer you are related. In general, it is found by summing the differences between each STR marker. For example, kit B111 and B222 have allele values of 29 and 28 respectively at **DYS389-2**. This is a difference of 1 {29-28= 1}. Because this is the only difference in their Y-DNA12 profiles, their genetic distance is 1. It has nothing to do with Generations; just math!

		D	D	D	D	D	D	D	D	D	D	D	D
		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
		S	S	S	S	S	S	S	S	S	S	S	S
	Kit	3	3	1	3	3	4	3	4	3	3	3	3
	Surname	9	9	9	9	8	2	8	3	8	9	8	8
		3	0		1	5	6	8	9	9	2	9	9
										1			2
	B111	Smith	12	23	14	10	17-18	11	12	11	12	14	29
	B222	Smith	12	23	14	10	17-18	11	12	11	12	14	28
	B333	Smythe	12	22	14	10	16-17	11	12	11	12	14	29



**Pop Quiz #2**

What is the Genetic Distance between kit B222 and B333? (*be careful!!!*)

At 67 markers, this table shows the probability that your common ancestor (MRCA) lived no longer than this number of generations ago.

Genetic Distance	50%	90%	95%
0	2	5	7
1	4	8	9
2	6	12	14

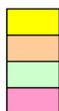


**Pop Quiz #3**

From the table above, in the case between kit B111 and B222 where the genetic distance was 1, what is the probability that their MRCA is within the last 4 generations?

The percent chance of a common ancestor within a given time is not an exact science, thus the calculations vary as the genetic distance grows. The following table refines the table above and shows the probability for multiple markers (the key for the 2nd row is: #markers/genetic dist. (e.g., 25/1 means 25 markers test with one difference):

		Percent Chance of a Common Ancestor in Genealogical Terms, Based on Alleles and Genetic Distance																	
Generations	Years	12/0	12/1	25/0	25/1	25/2	37/0	37/1	37/2	37/3	37/4	67/0	67/1	67/2	67/3	67/4	67/5	67/6	67/7
4	100	34	7	61	27	8	83	59-83	31-46	11-31	4-12	90	71	46	12-24	10	4	1-4	0-1
8	200	56	20	85	58	29	97	90-97	71-86	45-71	27-44	99	95	86	48-69	47-49	29-33	17-30	6-15
12	300	71	33	94	78	52	100	98	90-97	74-91	58-73	100	99	97	77-91	79-81	64-68	50-65	27-46
16	400	81	46	98	89	70	100	100	97-99	90-97	80-89	100	100	100	92-98	94	86-89	77-87	55-74
20	500	87	57	99	95	83	100	100	99	96-99	92-96	100	100	100	97-100	99	96-97	92-96	78-90
24	600	91	68	100	98	90	100	100	100	99-100	98-99	100	100	100	99-100	100	99	97-99	91-97



Excellent probability of a common ancestor in genealogy terms.  
 Fair probability of a common ancestor in genealogy terms.  
 Weak probability of a common ancestor in genealogy terms.  
 Statistically poor probability of a common ancestor in genealogy terms.

Do you see that the more markers tested increases your probability of finding a MRCA?

## Section 4. Y-DNA Testing

### Why get Tested?

The Y-DNA test is designed to trace the direct paternal line (your father's, father's, father's, etc.). Take the Y-DNA test:

1. If you want to prove/validate a direct relationship with an ancestor for which you have a "paper" trail
2. If you want to match to a more distant ancestor in your line (past your own research) further than autosomal testing can
3. If you want to map the migration pattern or find the geographic origin of your **Haplogroup**
4. If you are adopted or don't know your biological father and want to find possible surnames/leads
5. To benefit others and preserve data for posterity

As an example of #1 and #2, I had done the "paper" research that took my paternal line back to William French [b:1813 TN] and was sure that his parents were William French [b:1780 SC] and Nancy Chapman. I had 'D.E.F' from a known son (Thomas J. French) of that pair test and the Y-DNA results verified the relationship with DNA! I both validated my research and extended my tree one level with the addition of William French [b:1780 SC].



### What gets Tested?

Y-DNA testing<sup>6</sup> involves looking at Y-STR segments of DNA on the Y chromosome. The STR segments which are examined are referred to as **genetic markers** and occur in what is considered non-coding DNA or "junk" DNA.

### Where to get Tested

Today, the only<sup>7</sup> place to get Y-DNA STR testing is at Family Tree DNA ([FamilyTreeDNA.com](http://FamilyTreeDNA.com)). Lesson 2 will tell you what to do once you have your test results.

<sup>6</sup> Source: [http://www.isogg.org/wiki/Y\\_chromosome\\_DNA\\_tests](http://www.isogg.org/wiki/Y_chromosome_DNA_tests)

<sup>7</sup> Ancestry.com discontinued (and deleted!) their Y-DNA tests and results in August 2014

<http://www.yourgeneticgenealogist.com/2014/06/ancestrycom-officially-retires-y-dna.html>

## Kinds of Y-DNA Tests

### Y-STR

Y-DNA Short Tandem Repeat (STR) testing tells about the most recent generations (1 to 45) of a male's paternal heritage. This is the most common test taken.

### Y-SNP

Single Nucleotide Polymorphisms (SNPs) tell of the line's deeper history and trace back to ancient times.

### Big-Y

The BIG Y test is a direct paternal lineage SNP test and an STR test. It's designed to explore deep ancestral links on our common paternal tree. It tests both thousands of known branch markers and millions of places where there may be new branch markers. It is intended for expert users with an interest in advancing science.<sup>8</sup>

## Haplogroup

The Y-DNA test will also give you your Y-haplogroup. A haplogroup is a set of similar **haplotypes** that share a common ancestor having the same single nucleotide polymorphism (SNP) mutation in all haplotypes. The haplogroup is shown as an alphanumeric code: e.g., R1a1a or (R-M512).

Haplogroup will be covered in more detail in Lesson 2.

## Surnames

Y-DNA usually follows the same inheritance pattern as surnames. As the surname is passed down from father to son, so is the Y-DNA. Because of this, males can often identify which direct paternal ancestral line to which he belongs by matching others with the same (or similar; e.g., Smith/Smythe) surnames.

We'll look at Surname Projects in Lesson 2.



### Pop Quiz #4

I am a woman; can I take the Y-DNA test?

<sup>8</sup> Source: FT-DNA

## Section 5. Glossary

- **Allele** - One of the possible values for a marker or a gene.
- **Base** - A base is a unit or building block of DNA. Adenine (A), cytosine (C), guanine (G), and thymine (T) are the four primary bases in DNA. The order of bases is the sequence of DNA.
- **Genetic Distance** - Genetic Distance is the number of differences, or mutations, between two sets of results. A genetic distance of zero means there are no differences in the results being compared against one another

# of Markers	Genetic (Allelic) Distance											
	0	1	2	3	4	5	6	7	8	9	10	
12	Related	Possibly Related	Probably Not Related	Not Related								
25	Related	Related	Probably Related	Probably Not Related	Not Related							
37	Very Tightly Related	Tightly Related	Related		Probably Related	Possibly Related	Not Related					
67	Very Tightly Related	Tightly Related		Related		Related		Probably Related	Possibly Related		Not Related	

- **Haplogroup** - A haplogroup is a major branch on either the maternal or paternal tree of humankind based on the results of SNP testing. Haplogroups are associated with early human migrations. Today these can be associated with a geographic region or regions.
- **Haplotype** - A haplotype is the set of values for a group of DNA test values. For example, the result of the Y-DNA12 test for one person is their haplotype.
- **Locus** - A locus is a specific location in your genetic code. In a genetic map of our DNA, the locus tells us where to find any base. The plural of locus is loci.
- **Marker** - A marker is a physical location (locus) on the chromosome. The term is often used colloquially in genetic genealogy to refer to a short tandem repeat (STR).
- **Short Tandem Repeat (STR)** - A short DNA motif (pattern) repeated in tandem. ATGC repeated eleven times would give the marker a value or allele of 11.
- **Y-Chromosome** - One of the two sex chromosomes, X and Y. The Y-Chromosome passes down from father to son. Females do not receive it. As the Y-Chromosome is passed on through the paternal line, it is valuable for surname based genealogy studies.
- **Y-DNA Backbone test** - If a person's Y-DNA haplogroup cannot be predicted with 100% confidence, the SNP Assurance Program at FTDNA will test your sample with our Backbone SNP test for FREE. This test is a "deep" multiple SNP test. Specifically, if we cannot predict a person's Y-DNA haplogroup with sufficient confidence that they can join the National Geographic's Genographic Project, we will automatically perform a Backbone SNP test in order to identify the haplogroup assignment. Backbone tests take about 6-8 weeks from the time they are ordered.

<https://dnaadoption.org/acronyms/>

<https://dnaadoption.org/glossary/>

## Section 6. Resources

Once you have clues to people who might match your DNA, there are gold mines of resources just waiting to help you move farther along in your search.

### Internet

- The resources we've used in class, of course: [FamilyTreeDNA.com](http://FamilyTreeDNA.com)
- DNAAdoption - [www.dnaadoption.org](http://www.dnaadoption.org)
- ISOGG: <http://www.isogg.org>
- Kitty Cooper's BLOG - <https://blog.kittycooper.com/2021/01/can-y-dna-solve-an-unknown-parentage-case/>
- There are many surname project websites, often associated with Y-DNA tests. Here's one example: <http://freepages.genealogy.rootsweb.ancestry.com/~woodydnaproject/index.htm>.
- If you haven't found what you want yet, visit Cindy's List <http://www.cyndislist.com/> for an incredible list of genealogy resources organized by category.

### Books

- Bettinger, Blaine T. - "***Guide to DNA Testing and Genetic Genealogy***" ©2016, Family Tree Books, Cincinnati, OH [ISBN-13: 9781440343326 9781440345395] << available as book or e-Book>>
- Aulicino, Emily - "***Genetic Genealogy: The Basics and Beyond***", ©2014, AuthorHouse LLC, Bloomington, IN [ISBN-13: 9781491840900]
- Smolenyak, Megan & Turner, Ann - "***Trace Your Roots With DNA: Use Your DNA to Complete Your Family Tree***", ©2004, Rodel Books, New York [ISBN 1594860068 (ISBN13: 9781594860065)]
- Pomery, Chris - "***DNA and family history : how genetic testing can advance your genealogical research***", ©2004, Dundurn Group, Toronto, Ontario
- Dowell, David R. (Ph.D.) - "***NextGen Genealogy: The DNA Connection***", ©2015, Santa Barbara, California : LIBRARIES UNLIMITED, an imprint of ABC-CLIO, LLC
- Hill, Richard - "***Finding Family: my search for roots and the secrets in my DNA***", ©2012, Richard Hill (self published), Grand Rapids, Michigan. << available as book or e-Book>>
- Griffeth, Bill- "***The Stranger in My Genes***", ©2016, UPNE Book Partners, Lebanon, NH [ISBN-13: 978-0-88082-344-9]

### You

- Use your personal network. If you have friends or family who are interested in family history or genealogy, brainstorm with them about where to look for information. They may have ideas or resources that can help in your search.
- Give back. Share what you know and help others when you can. The old saying, "What goes around, comes around" has been proven over and over and over.

### Section 7. Pop Quiz Answers

- No. You can only match other Smiths; you will need to find a male Jones to take a Y-DNA test to research ancestors in the Jones line. Sometimes you have to go back up the family tree and come down again to find the right male to test.

An Autosomal test could tell you if you are related to the female Jones (if she is within 5-6 generations).

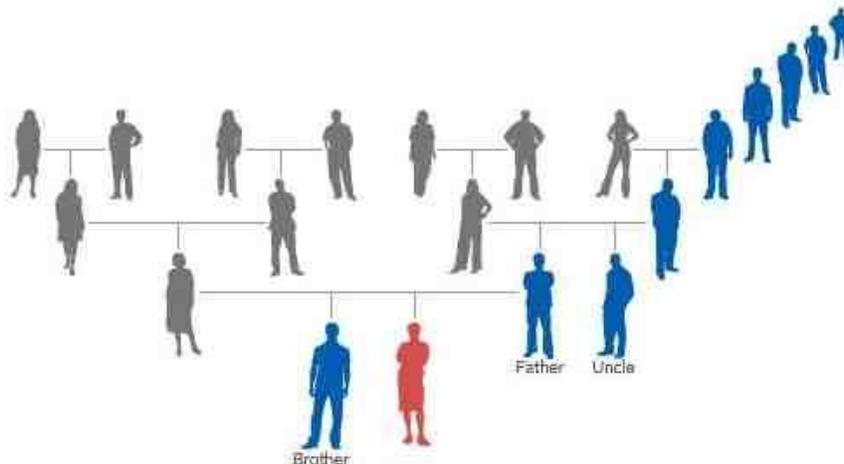
- Genetic Distance = **4!** Though the difference is on a single DYS (385), since both values are different that counts as 2. So with DYS 390 & 38912 also being different, the total is four.

Kit	Surname	D	D	D	D	D	D	D	D	D	D	D
		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
		S	S	S	S	S	S	S	S	S	S	S
		3	3	1	3	3	4	3	4	3	3	3
		9	9	9	9	8	2	8	3	8	9	8
		3	0		1	5	6	8	9	9	2	9
									1		2	
B111	Smith	12	23	14	10	17-18	11	12	11	12	14	<b>29</b>
B222	Smith	12	23	14	10	17-18	11	12	11	12	14	<b>28</b>
B333	Smythe	12	<b>22</b>	14	10	<b>16-17</b>	11	12	11	12	14	<b>29</b>

- 50%

Genetic Distance	<b>50%</b>	<b>90%</b>	<b>95%</b>
0	2	5	7
<b>1</b>	<b>4</b>	8	9
2	6	12	14

- No. Even though a woman does not have her own Y chromosome, analysis of Y-DNA of a living relative (e.g., father, brother, uncle) can reveal information about her paternal lineage.



c/o - Sorenson Molecular Genealogy Foundation

## Section 8. Epilogue

### Class Notes

#### *Summary*

Y-DNA can trace the origins of a surname and can be used to find other people who shared an ancestor on this paternal line.

#### *Access to Materials*

Your Moodle login will continue to be available to you. If you'd like to retake the class, you are welcome to sign up as space is available. No additional donation will be requested (although they are certainly welcome!). Email [DNAAdoptionHelp@gmail.com](mailto:DNAAdoptionHelp@gmail.com) if you wish to re-take this class.

#### *Class Forum*

The class forum will be available for follow-up questions for an additional 4 weeks subsequent to the posting of Lesson 3. Participants will also have the option of re-taking this class for free within the next year. Contact [DNAAdoptionHelp@gmail.com](mailto:DNAAdoptionHelp@gmail.com) if you wish to re-take this class.

*Stay in Touch! Let us know how your journey is going.*

[DNAAdoptionHelp@gmail.com](mailto:DNAAdoptionHelp@gmail.com)



*image c/o - www.superherostuff.com*

I don't want any adoptees or those searching for bio-fathers or NPEs to be offended by this image; my daughter gave me this T-Shirt & I think it's hilarious, even with my own family NPE. I wore it at RootsTech and got great responses. I think it's a **great** comment on who you've been told all along was your father, and finding out differently.