Genealogy and DNA

What is DNA?

Where is DNA located?

What does DNA do?

How does DNA show relationship?

How can DNA be used in Genealogy?

How do I get my DNA tested?

Before I answer these questions I want to first tell you what your DNA **can** and **cannot** tell you about your genealogy?

1. DNA **can** tell you if you and another person are **really related**
   (related means sharing DNA. The more related 2 people are the more DNA they share, full siblings are most related)

2. DNA **can** tell you if you and another person have a **common ancestor**

3. DNA **cannot** tell you **who** that common ancestor **was**

4. DNA **can** tell you the **general area** of the world from where your distant *maternal* and *paternal* **ancestors originated**

5. DNA **cannot** tell you anything **specific** about **who** your ancestors were

The DNA tests for Genealogy:

The mitochondria DNA test (mtDNA):

For females and males:

The results of this test will identify the World Female Clan to which you belong. (referred to as a Haplogroup)

You can learn the area of the world where your most ancient female ancestor originated.

There are over 6 billion people in the world today and all fit into just 36 major clan groups! The vast majority people whose female ancestors are from Western Europe fit into only 7 of these clans."The Seven Daughters of Eve." 47% of all people of Western European descent belongs to only 1 of these clans named "Helena"

Each of the 36 clans had one founder woman.

The other DNA test is for males only (but it also applies to their female relatives)

The Y- chromosome test:

For males only: but applies to female relatives of that man

The results of this test will identify the World Male Clan to which you belong. There are 15 of these.

You can learn the area of the world from where your most ancient male ancestor originated.

You can also determine if you and another man descend from the same common male ancestor.

You can learn the distribution of men with an identical or similar
Y chromosome

Both the **mitochondria** DNA and the **Y chromosome** DNA test
test rely on the presence or absence of identifiable areas of DNA referred to as **markers**.
The presence or absence of these markers
is characteristic of each of the world clans of both men and women.

DNA – deoxyribonucleic acid, the most unique chemical in all living things....

DNA is a complex chemical made from 4 common *elements*: hydrogen, carbon, nitrogen &phosphorus

DNA is a code. The code is embedded in 4 *chemicals*, A-T-C-G. These have chemical names but are most often referred to by their
first letters. DNA is found in 2 places **cells**, the small units that build living things

1. In the **nucleus** in every body cell

2. In a cell structures called the **mitochondria**

Because if its unique nature DNA can do two amazing things:

1. DNA can **duplicate** itself
2. DNA is the code for the production of a class of chemicals
   in our bodies called **proteins**

Proteins are used for:

1. **building cell parts** which then build body parts
2. chemicals that **control** a huge number of chemical reactions in our bodies that in the long run make our bodies function

As a result of all of this the **DNA of the nucleus** it is responsible for determining 3 categories of characteristics:

1. **Physical traits** (eye color, height, shape of facial features)
2. **Chemical traits** (blood type, ability to digest certain foods, ability to taste certain chemicals)
3. **Behavioral traits** (musical ability, verbal abilities, left handedness)

Nuclear DNA exists as 46 minute ribbon-like structures called *chromosomes* in each body cell

The combination of chromosomes in each person is unique except for identical twins.

However, all people in the world share 99.9% of their ***nuclear*** DNA.

Whatever differences exist among people are extremely small when compared to the similarities that exist.
Chromosomes are passed from parents to children in egg and sperm cells.
Each parent provides 23 specific chromosomes to his or her children.

In the vast number of families DNA is passed unchanged from parent to child.

Each child receives a **slightly different combination** of his or her parents chromosomes *but* the combinations are near enough like that of the parents
that a DNA test can identify the parents of a child with extreme accuracy.

**Because of the shuffling of nuclear DNA its use for identifying more distant ancestors is limited except for 1 specific chromosome in men
called the Y chromosome**.

Chromosomes are in pairs one member of each pair coming form each parent.

All of the chromosomes have equal partners.

There is **on**e exception and that is in **men** only.

The chromosomes pairs are identified by numbers 1-22.

Pair number 23 is identified by letters X and Y.

In females this 23rd pair consists of two X chromosomes. [XX]

Egg cells from women carry one X chromosome.

Therefore, mothers can only give their children an X chromosome.

In males this 23rd pair consists of one X and one Y chromosome. [XY]

When sperm cells are formed 50% of them contain an X chromosome and
50% carry the Y chromosome.

If a baby receives an X from its father it will be a girl and
if it receives a Y it will be a boy.

The father is solely responsible for determining the sex of his children.

Father ➜ Mother ↘	**Y**	**X**
X	**X Y♂**	**X X♀**
X	**X Y♂**	**X X♀**

Therefore, all men carry the Y chromosome of his father, his father's father & all the direct male ancestors for as far back in time as one would want to go.

Chromosomes have identifiable sections or subunits called **genes** or alleles.

DNA tests call the genes or alleles markers

The Y chromosome is very small and has **very few *useful* genes.**

A huge amount of the Y chromosome is **useless** DNA.

Remember, DNA is made from a very few chemicals.
Because it is not so easy to remember these names the are referred to by their first letters:

A T C G These 4 chemicals are called **BASES**

These are arranged in a unique **linear sequence** that is very specific to each person.

Remember the in the vast majority of children the DNA of his or her parents is passed on unchanged.

However, one of the unique properties of DNA is its ability to change

Any changes in the **order** of these 4 chemicals called a mutation.

ATT CGT AGT CTA GGC TTA AAA CGA GGC CTA

ATT CGT AGT CTA GGG TTA AAA CGA GGC CTA

The C changed to a G

The mutation *must* occur in the **DNA of an egg or sperm** and that egg or sperm must be the one that makes a new baby for that mutation to enter the human population.

When a child is born with a mutation three things can happen:

1. **A change** in the baby (may be beneficial or harmful)
2. **No noticeable** change in the baby
3. **A change so devastating** the child does not survive

The result of mutations is **variety** among people and all plants and animals

If a mutation is beneficial it remains in the population. Most bad mutations are eliminated (natural selection)

If a mutation occurs in a part of a chromosome that is useless
it has no affect on an individual.

If a mutation is not affected by **selective action** against it,
it will **remain** in the population.

Therefore, if a mutation has taken place on a Y chromosome in a section of useless DNA it will not be eliminated and it will be passed on **unchanged** to the **male descendants** of that man.

Identifiable changes have taken place over the past several thousands of years and have been passed down unchanged to the male descendants of the men who had these mutations.

Upon careful analysis of very specific sections of the Y chromosome men can be placed in certain categories called **Haplogroups** or clans based on the mutations their ancestors have had. This is not as simple as it sounds but to make it simple men placed in the same **Haplogroup** have the same or very similar mutations which means they have the same male ancestors.

Some of these changes have been passed down with little further change for thousands of years.

This is what the a scientist sees as a result of a DNA test.
The different colors represent an A C T or G

Remember, the structure of DNA is a linear sequence of A T C G

ATCG TTAG ACCT TTGGA AAGGCTAGAG

How the Y chromosome is used to show if 2 men are related:

In certain areas of the useless DNA on the Y chromosome there are **sequence repetitions**. These are called Short Tandem Repeats (STR).

Example: ATTCTG ATTCTG ATTCTG ATTCTG ATTCTG ATTCTG

When Y chromosome DNA is analyzed the number of repeats are noted in several locations and recorded.

Men who have the same number of repeats in the same locations of the Y chromosome have descended from a the same man – their common ancestor. These men make a Haplogroup.

The number of locations tested is usually 10, 25 or 37

If two men are exactly alike then they have a 100% chance of having a common direct ancestor.

On the following page is the certificate showing the analysis of my Y chromosome. I first had the 10 marker test done by the Oxford Ancestor lab and then I had the 25 marker test done by the Family Tree DNA lab. I was identified as Haplogroup J2.

On the Oxford Ancestor Y clan chart I am identified as descending from a man given the name of Re. The founder man of one of the world male clans.

Then I had the National Geographic project test my Y. All three labs agreeded.

My Y chromosome shows that my most distant male ancestor came from the Fertile Crescent. The area between the Tigris and the Euphrates rivers.... Iraq!

Thus, the **distant ancestry** of a man can be worked out by identifying the repetitions (markers) in the useless areas of the Y chromosome and all men with the same number of repeats in the same place on the Y chromosome have a distant common ancestor and belong to a Clan or Haplogroup.

Use of the results of the Y test in genealogy: How related are you?

Another use of your Y chromosome test result is to determine the probability of a **common ancestor** between two men.

If your have a 25 marker test done and you have a 25/25 match with another man there is a 50% chance that your **MOST RECENT COMMON ANCESTOR** (MRCA) lived no longer than 3 generations ago and a 90% chance that your MRCA lived no longer than 10 generations ago. Further back than that there is a good chance that there would have been a mutation in either your direct line from the MRCA or the other man's line. The greater the difference (24/25 or 23/25 match) **the farther back in time** was the Common Ancestor.

Number of matching markers	50% probability that the MRCA was no longer than this number of generations	90% probability that the MRCA was no longer than this number of generations	95% probability that the MRCA was no longer than this number of generations
25/25	3	10	13
24/25	7	16	20
23/25	11	23	27

There are two things you can learn from the Y chromosome DNA.

1. If you are closely related to another man
2. Your Y Clan and your Haplogroup and the place of origin of your most distant male ancestor.

The Y chromosome test is more specific than the mitochondria test.

MITOCHONDRIA

Most of our DNA is in the nucleus of our cells

However, there is another small cell structure that also carries some DNA and this structure is called the **mitochondria** This DNA is referred to as **mtDNA**

The function of mitochondria is to change the food we eat into useable energy and has nothing to do with controlling any of our characteristics.

The DNA in the mitochondria controls the structure and function of the mitochondria

Some of the DNA in a mitochondria is also useless. Mutations here have no affect.

The DNA of mitochondria is in a ring not straight ribbons as in the cell nucleus.

The diagram is that of the DNA of a mitochondria.

Because of the way egg and sperm cells are made only mothers pass mtDNA to their children... to both daughters and sons.

When there is a mutations in the useless area of mtDNA there is no selective pressure for or against that mutation so it is passed from **mothers to their children** unchanged for many generations.

Therefore, all of the descendants of one woman will have the same mitochondrial DNA and this can be passed on indefinitely.

Through careful studies of thousands of people around the world it has been determined that there are about **36 distinct major** mitochondrial Haplogroups or Clans. These groups cross national borders and people who are considered in different racial groups belong to the same clan. People in the same racial group can actually be in different Maternal Clans. .

Two Scottish men were tested for mtDNA. Their families had lived in Scotland for hundreds of years. When tested, one man's DNA showed he had Polynesian female ancestors and the other man showed he had Portuguese female ancestors. Most likely the male ancestors of these men had been on ships that traveled to these places. They each chose a wife while there, brought them home to Scotland and their descendants blended into the Scottish population.

If you have your mtDNA tested you can be placed into one of these 36 groups. Most people of western European ancestry fall into 7 mtDNA groups. 47% of this group descend from just one of these: a woman that lived **about 20,000** years ago in France nicknamed "**Helena**." She probably lived somewhere in southern France along the Dordogne River Valley. But you might not be! Anne descends from Ulrike from central and western Eurasia.

Of course the specific identification of these 7 women is impossible.

However, by mapping the frequency of people within each mtDNA group the most likely location of the origin of this group can be determined

Also because of the *rate* at which mutation take place in mtDNA it can be determined a general time in history when each of these woman lived. The rate of mutation is different for different racial groups and different areas of the chromosome.

Of the 36 world wide groups of mtDNA the one with the least number of changes compared to the other groups is the oldest.

The oldest groups are found in Africa.

The oldest group is about 150,000 - 200,000 years old.

Also based on information from mtDNA it has been determined that the first migration of people **out of**

Africa was about 50,000 years ago

Modern non-African people in Europe, Asia, Australia and North and South America are descended from these people who migrated out of Africa approximately 50,000 years ago

The 7 mtDNA groups of Europe have developed since this first migration from Africa

How the Mitochondrial test differs from the Y test.

Remember DNA is composed of a series just 4 chemicals known as **bases**
identified by the letters A, C T & G

Normally unchanged sequences of ACTG are passed from mothers to her children.

Sometimes, however, there is a change in the DNA, a mutation. One base may be replaced by another. For example, the original segment of **TTA CTG CA<u>G</u>** might have a change and become **TTA CTG CA<u>T</u>**. Many things cause these changes, radiation, chemicals etc.

If this change takes place in the cell that becomes an egg cell and this egg cell became a female child the change would be passed to all the offspring of this woman.

There is a section 400 bases long, out of the millions, that is most commonly used for the test.

Each of the 7 "Daughters of Eve" has a unique order of bases

A different type of change is looked for on the Y chromosome, the formation of **repeating sections** of DNA .

For the Y test, longer or shorter sections of the repeats are identified. You pay more for the longer tests. Family Tree DNA will take your Oxford Ancestor 10 repeat test results and extend it to the 25 marker test.

My order is: 15, 15, 24, 11, 11, 12, 9, 16, 12, 11. At point DYS 19 I have 15 repeats, at point DYS 388 I have 15 repeats etc.

If you have your DNA tested there are limits to the conclusions you can make.

Remember, the areas that are looked at are referred to as useless DNA areas.
It is because they **are** useless that they have been kept by your DNA in the first place.

You cannot make statements like, "Well, no wonder the men in our family look alike, they share genes."

I read one comment from a woman who descends from Helena who lived in the area where the famous

Lascaux Caves are located in France with the beautiful ancient art . She stated, "Oh, that explains why my family is so artistic." You *cannot* say this. These kinds of ancestral relationships are determined from mitochondrial DNA and Y Chromosome DNA and this DNA had nothing to do with your characteristics. Nuclear DNA controls your traits.

DNA can reveal some surprising results. The companies state in their information that they are "not responsible for your ancestors!"
Remember the Scottish men!

How to have DNA testing done:

There are many companies that do DNA testing. I have used the following:

Oxford Ancestors, London, England
The National Geographic Society, doing a world wide project
Family Tree DNA, Houston, TX ,not to be confused with *Family Tree Maker* genealogy software.

1. You need decide what you want to know and why

2. Decide if you want to have your mitochondrial DNA or your Y chromosome or both tested

3. Decide how extensive of an analysis you want (10, 25 or 37 markers)

4. Contact the company you want to do the analysis.

5. You will receive a kit in the mail with an identification number and the tools to make the test. Record your identification number and remember where recorded it.

6. The kit will contain a little cell collection tool, either a very small cylindrical brush or other small plastic device that sort of looks like a tooth brush

7. You scrape it on the inside of your cheek a certain number of times and then drop in into a little bottle of preservative and mail it back

You may wait up to 3 weeks to get your results.

You will receive some sort of documentation stating the results of your test. You will receive booklets and other information on how to interpret your results. Oxford Ancestors, Family Tree DNA and National Geographic have web pages you can access to find various bits of information. There are web based forums through which you can contact other people to whom you may be related. They also have other ways to make contact with related people. **You must give written permission to be listed in their public database.**
National Geographic has a DNA project going on. They have teamed up with Spencer Wells, author of *The Journey of Man* which tells the story of the use of Y chromosome DNA to trace the migration of

people around the world. The main purpose of this project is to expand the world wide database of DNA information to get a more detailed picture of how people became distributed over the world and determine the Haplogroups and sub-haplogroups and their world wide distribution.

To receive follow up information from the National Geographic Society you must go on their website and enter your ID number. When I checked it out I was surprised to find that it had very interesting information. It tells you what Haplogroup you are in and it confirmed other tests. It give you a certificate to print out and also a map showing the migration pattern of your ancient ancestors. Then are pages to print out explaining where each of your marker mutations originated and what humans in that region were doing at that time. It gives quite a bit of detail but it all refers to ancient anonymous ancestors.

From Family Tree DNA you get certificates and information on your Haplogroup and they provide web pages for contacting possible relatives.

Oxford ancestors is the most expensive but you get more for your money. You get quite a bit of information on how they do the test, your matrilineal and patrilineal lines. You can get certificates, maps and other information from Oxford ancestors but you pay extra for these. You also get an autographed copy of Bryan Sykes' book, *The Seven Daughters of Eve*. You get information on using your information in genealogy. Oxford Ancestors provices ways of getting in contact with possible relatives, meaning people with the same or similar DNA.

I had my Y done by Oxford. The results from Family Tree DNA and National Geographic both put me in Haplogroup J2.

From the Family Tree DNA web page I have been contacted by one man. George A. Field. We have identical Y DNA. I have been able to identify our common ancestor.

Here is an example of how Y chromosome data might be useful:

We have a dead end in our Field Family genealogy. We have documents to connect us back to an Abraham Field of VA, born about 1636. We cannot connect him with anyone earlier. The Field family "tradition" says he is the son of a Henry Field (1611), an immigrant from England. There are records of this Henry arriving in VA but then he seems to disappear. Family tradition also says Henry had 2 brothers that immigrated to America. One was Darby Field. This man did exist. He went to the New England area and is the ancestor of a great number of Field descendants. If we could get a direct male descent of Darby to have his Y DNA tested and if his was identical to mine or extremely close to mine this would lend credibility to the family tradition. It would not prove beyond a shadow of a doubt that the story is true but would make it a lot more believable.

Acknowledgments:

Miriam Grasz Field and Howard Field, my mother and father. They began researching family genealogy about 1967. They accumulated a tremendous amount of data and by the early 1970's it was overwhelming to them. My mother gave me several boxes of documents and said, "Here, you write the book!"

Anne Field: the woman who helped me pass on my DNA. In 1996, I purchased Anne's computer. She had left the Family Tree Maker program on it with her family genealogy. Our daughter, Lucie, was living with me at the time and when we looked at it there was just a small amount of Field Family genealogy entered into the program. I told Lucie that I had a lot more information than that from my parents. So I drug out the boxes and Lucie and began a life long project of entering the data. Thus began our consuming interest in family genealogy. Anne's greatest contribution to my genealogy was finding an article published in *Genealogies of Kentucky Families*, which made it possible for me to get past one of the biggest hurdle in my Field Family Genealogy.

Lucie Field: our daughter. Lucie has been my partner in my quest for ancestors, relatives and interesting facts about our extended family. Lucie and I have taken several trips across the USA in search of information on many branches of our family. We have tramped through innumerable cemeteries, combed the archives of county courthouses, genealogical societies, libraries, surveyors offices, got lost on back roads searching for historical family locations and visited a wide variety of relatives. Lucie is the researcher and I like the travel, the photography, corresponding and web page creation.

Dorothy Naman: my high school biology teacher at Roosevelt High School, Fresno. Mrs. Naman was the person in my life that was my inspiration. She opened up the world of biology to me and gave direction in my life. I was in her biology class just four years after Watson, Crick and Frankland discovered the structure of DNA. I have modeled my life after Mrs. Naman and have spent 44 years teaching biology and learning moor about DNA and general genetics and its application to genealogy.

Roy E. Appleman: the author of, "Joseph and Reubin Field, Kentucky Frontiersmen of the Lewis and Clark Expedition and Their Father, Abraham." I knew that two of the men on the Lewis and Clark Expedition were Joseph and Reubin Field. I was extremely curious to discover if I were related to them. My parent's research strongly suggested a connection but that connection was elusive. Roy Appleman was a historian for the National Parks Service. He decided as a retirement project to research the ancestry of the Field brothers. His extensive research was published in the above mentioned publication. His data provided that lost link. Joseph and Reuben or the Corps of Discovery were brothers of Keen Field of Gibson County, Indiana, my 4th great grandfather. Keen was the great-grandson of Abraham Field (1699-1774) of Culpeper County, Virginia. This Abraham was

the direct descendant or the oldest known Abraham Field in our family line. This information connected me back to the early beginnings of the United States.

Victor Field: my son who is my only hope of passing my Y chromosome on to my descendants thus becoming the founder of the Field Clan that will be discovered by researchers 20,000 years from now!

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