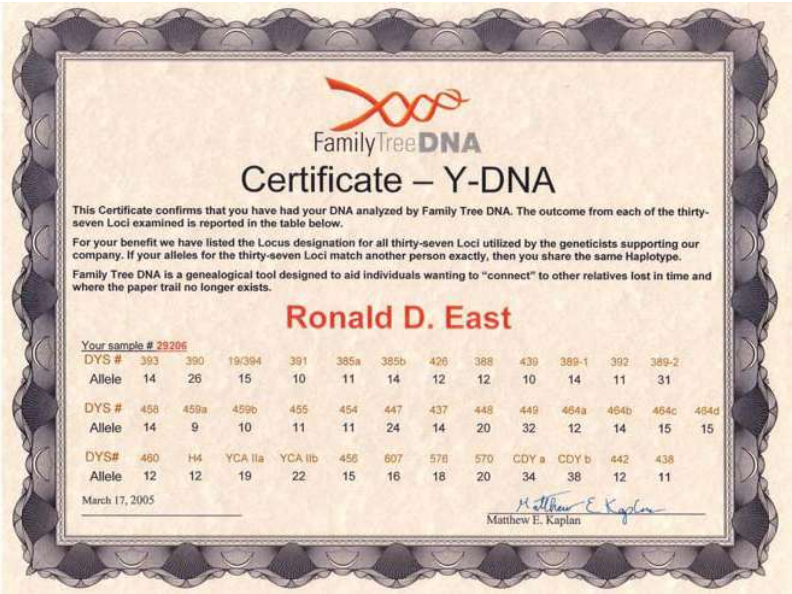
IT'S ALL IN THE GENES

This is the first of three articles about DNA and how it is used in family history research. This first article is about DNA itself – what it is and what it does. The next article will be about the Y-chromosomal DNA and the last article about mitochondrial DNA. Words appearing in bold italic type are referred to in a Glossary at the end of the article.

I hope when we have finished these articles that you will be able to understand fully what a DNA test certificate means:



FamilyTreeDNA

Certificate – Y-DNA

This Certificate confirms that you have had your DNA analyzed by Family Tree DNA. The outcome from each of the thirty-seven Loci examined is reported in the table below.

For your benefit we have listed the Locus designation for all thirty-seven Loci utilized by the geneticists supporting our company. If your alleles for the thirty-seven Loci match another person exactly, then you share the same Haplotype.

Family Tree DNA is a genealogical tool designed to aid individuals wanting to "connect" to other relatives lost in time and where the paper trail no longer exists.

Ronald D. East

Your sample # 29206

DYS #	393	390	19/394	391	385a	385b	426	388	439	389-1	392	389-2	
Allele	14	26	15	10	11	14	12	12	10	14	11	31	
DYS #	458	459a	459b	455	454	447	437	448	449	464a	464b	464c	464d
Allele	14	9	10	11	11	24	14	20	32	12	14	15	15
DYS#	460	H4	YCA IIa	YCA IIb	456	607	576	570	CDY a	CDY b	442	438	
Allele	12	12	19	22	15	16	18	20	34	38	12	11	

March 17, 2005

Matthew E. Kaplan

DNA is amazing stuff. It is the stuff that makes us what we are: whether a human being or a fruit fly, whether male or female, the colour of our eyes, how tall we will grow - indeed every feature that makes each one of us so special.

Human beings are made of cells. Some are muscle cells, some are brain cells, some are bone cells, some are blood cells, some are fat cells (that we would like fewer of, particularly after Christmas); they all come together in the right number and in the right order to build a human being. An adult human is made up of about 100 thousand ***billion*** cells. If you were to count the cells in your body, non stop, at the rate of one cell every second, you would still be counting them 3 million years from now – about the age of the oldest human fossil record on earth. It would make you something of a fossil, too, if you were still around to count them!

It is in the central region of the cell called the ***nucleus*** that ***DNA*** is found. The ***nucleus*** contains 46 thread-like molecules called ***chromosomes*** (but see below about the sex cells). It is these ***chromosomes*** that are made from ***DNA***. They are the blueprints that make us what we are: they are our genetic code.

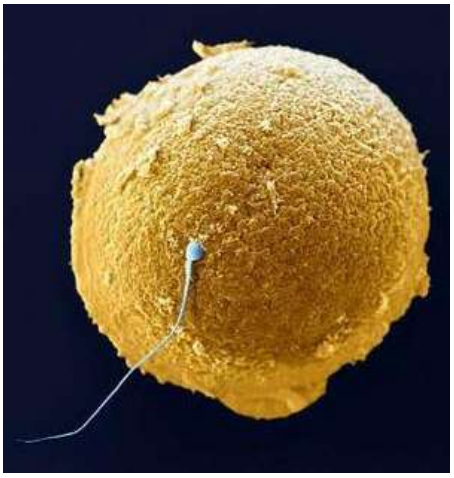
Amazingly, every cell in your body contains an identical set of these 46 ***chromosomes***. In other words, every cell contains a complete copy of your genetic code – regardless of what kind of cell it is, whether muscle cell or brain cell.

If the ***DNA*** in all the ***chromosomes*** in a single cell were stretched out and laid end-to-end it would reach 2 metres in length. The total length of the all the ***chromosomes*** in your body is therefore 2 metres x 100 thousand ***billion*** cells = 200 thousand ***billion*** kilometres or the distance of about 700 journeys to the sun and back!

And that is just in you! Imagine how far into space the ***DNA*** in all human beings on earth would stretch – all 6.7 ***billion*** of us!

However, that's enough of this mind blowing stuff for the moment. Let's get down to earth again and ask where did these ***chromosomes***, your genetic code, come from?

Well, it's all down to sex , as ever. You inherited 23 of these ***chromosomes*** from your father's sperm at the moment of conception. The other 23 ***chromosomes*** came from your mother's egg. Note that the sperm and egg cells contain only 23 ***chromosomes*** each – the only cells in your body to contain this number of ***chromosomes***. The 46 ***chromosomes*** contain all the instructions needed to make you who and what you are.



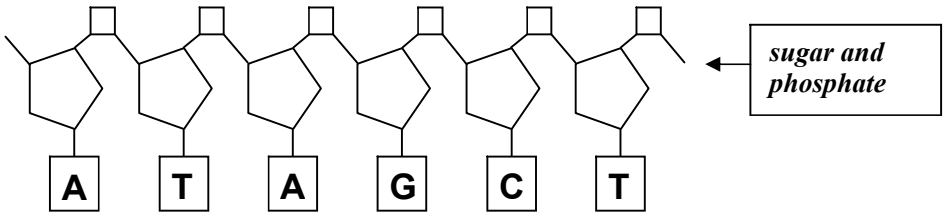
Together, the sperm and the egg produce a single fertilised cell that then divides in the womb and makes 2 copies. Each of these then divides and made 4 copies and they in turn makes 8 copies and so on until eventually there is a baby ready to be born – made up of about 430 ***billion*** cells.

We continue to grow throughout childhood making more copies of our cells until we reach that staggering total of about 100 thousand ***billion*** cells in the adult human body.

Amazingly, every time a cell divides, perfect copies are also made of those 46 ***chromosomes*** to give to the new cells. So, every cell in your body contains a copy of that blue print that was first given, in my case, 62 years ago when I was conceived!

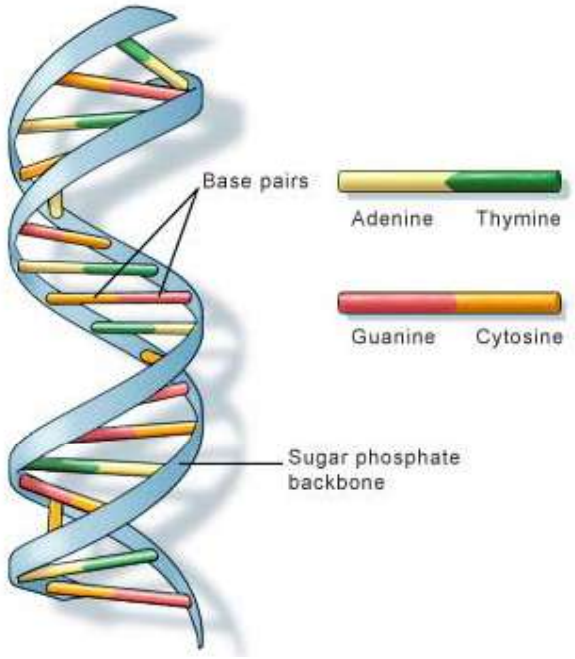
So how does this ***DNA*** in the ***chromosomes*** work?

In fact, ***DNA*** is a just a string of only four simple molecules called bases. They are called adenine, tyrosine guanine and cytosine, but from now on we will refer to them only by the initial letters in their names: A, T, G and C. They are strung out, apparently at random, like the strand of a necklace made up of four different gemstones, like this:

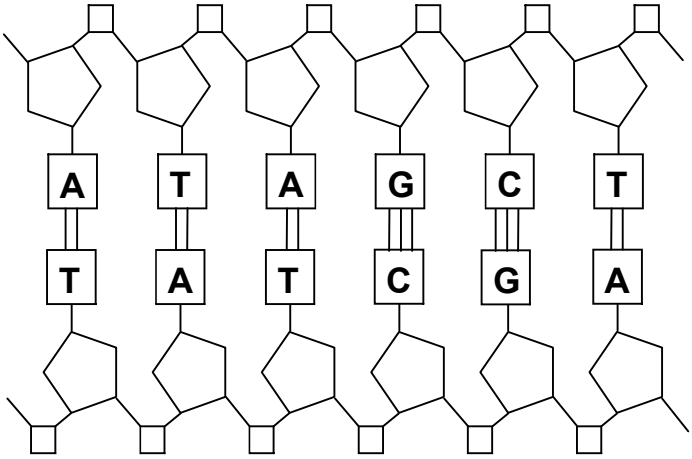


The string from which the bases are strung is made up of sugar and phosphate molecules. The sugar is called deoxyribose from whence the letters ***DNA*** (Deoxyribo Nucleic Acid) derive.

In fact there are two strands of ***DNA***. These are linked together at the bases and are coiled around each other in a long spiral (called a helix). Even the links between the strands are simple: C only links with T and G only with C. These are called ***base pairs***.



If the ***DNA*** in a chromosome is uncoiled and laid flat, the order of the ***bases*** can be read:



So what does this sequence of ***bases*** do?

The ***bases*** are read, in order, as a series of three letter 'words' called codons . Each ***codon*** is a key for a molecule of an amino acid. We obtain these ***amino acids*** from the food we eat. They are transported in the blood stream to the cells. We need 22 different ***amino acids*** in our diet. Here are just six of these ***amino acids*** and the ***codons*** which are their keys:

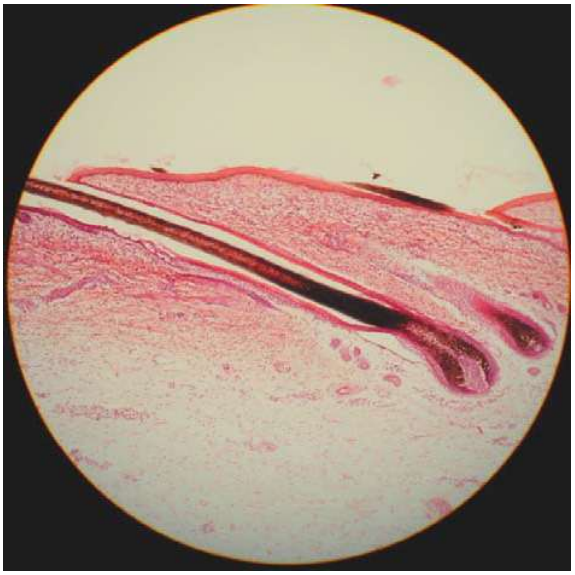
Amino acid	Symbol	Codon
serine	ser	TCT
threonine	thr	ACC

lysine	lys	AAA
glycine	gly	GGT
alanine	ala	GCC
isoleucine	ile	ATC

Amino acids are joined together in the cell to make ***proteins***. ***Proteins*** are what tissues in the body are made from and also complex molecules like enzymes, hormones and antibodies.

The cell needs to know which ***amino acids*** to choose and the order in which they are to be brought, in order to make a molecule of a particular ***protein***. The cell also needs to know when to start assembling the ***amino acids*** into a ***protein*** and when to stop so there are START and STOP ***codons***, too:

Instruction	**Codon**
START	ATG
STOP	TGA



Here is an example.

Hair is made from a ***protein*** called keratin. Keratin is made by the cells in a hair follicle (there are about a million such cells at the root of every hair):

Keratin is made from 552 ***amino acids***. They are chosen and assembled in the right order in the follicle cell to make keratin. This is done by a sequence of 1656 ***bases*** (= 3x552 codons = 552 ***amino acids***) on a chromosome which is called the ***gene*** for keratin. Here are the first few ***codons*** from that ***gene***:

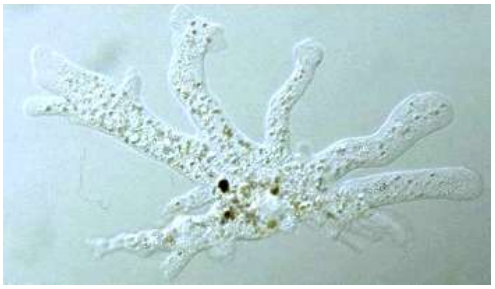
Bases:
ATGTCTACCAAAACCACCATC …… then 1644 more ***bases*** until ….. TGA

Divide the bases off into threes to give the codons :
ATG TCT ACC AAA ACC ACC ATC …….. TGA

Amino acids:
START --- ser--- thr --- lys --- thr --- thr --- ile --- …….. STOP

The cell keeps adding more ***amino acids*** in the correct order until it comes to the STOP ***codon***, at which point the molecule of keratin is complete. The molecule goes on to join millions of other keratin molecules made by the other follicle cells that together form a human hair.

In this way your cells keep manufacturing the ***proteins*** that your body needs for growth, repair and to keep it functioning. It also explains why you need to have your hair cut regularly (those of you that have any hair!).



Altogether, we have about 3 ***billion base pairs*** in our ***chromosomes*** and about 20 000 ***genes*** – as befits an organism as complex as a human being. However, the number of ***base pairs*** is no clue to the complexity of an organism. There is an amoeba that possesses 670 ***billion base pairs*** in its chromosomes!

Furthermore, our ***genes*** are not special to us, either. We share about 98% of our ***genes*** with chimpanzees, about 85% with a harvest mouse, 60% with a fruit fly and even 50% with the banana it flies around!

DNA is truly amazing stuff but the story is complex. If you need some help, please e-mail me: ronald.east@binternet.com.

GLOSSARY

base one of the four molecules A, T, G or C that make up our genetic code
base pair G paired with C or A paired with T
gene a sequence of that assemble ***amino acids*** to make a ***protein***
codon a sequence of three bases that identify a particular amino acid
amino acid a molecule obtained by digesting foods, particularly meat, eggs, pulses etc.
nucleus the central part of a cell that contains ***chromosomes***
chromosomes coiled, very long molecules made from ***DNA***
DNA deoxyribonucleic acid
protein a molecule made by joining ***amino acids*** together
billion is one thousand million or 1000 000 000 or 10^9