

# Y-CHROMOSOME DNA

## *A MOLECULAR TOOL FOR GENEALOGICAL RESEARCH*

JOHN HYBERT WILLIAMSON  
Davidson, NC 28036  
johybert@bellsouth.net

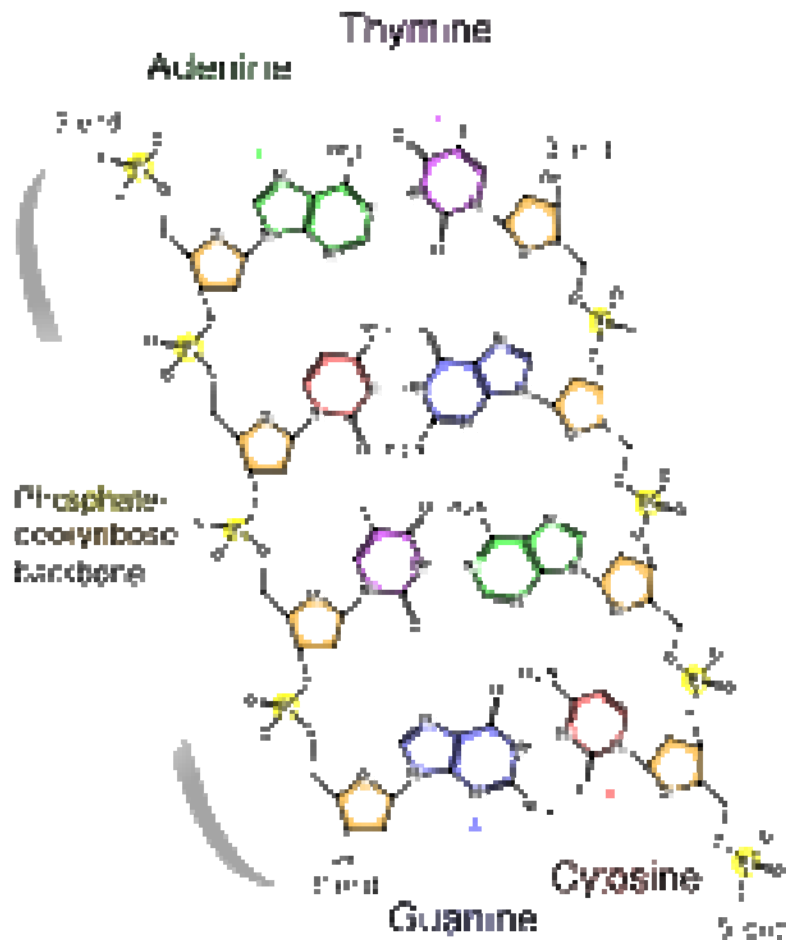
# Y Chromosomal DNA

1. A powerful tool in our search for ancestral relationships
2. Does not replace any of our other tools, such as:
  - a. Family records
  - b. Census data
  - c. Birth certificates
  - d. Death certificates
3. Y chromosome DNA has its limitations.
  - a. Requires cells from a male
  - b. Requires direct male lineages; no intervening female
4. Not really expensive

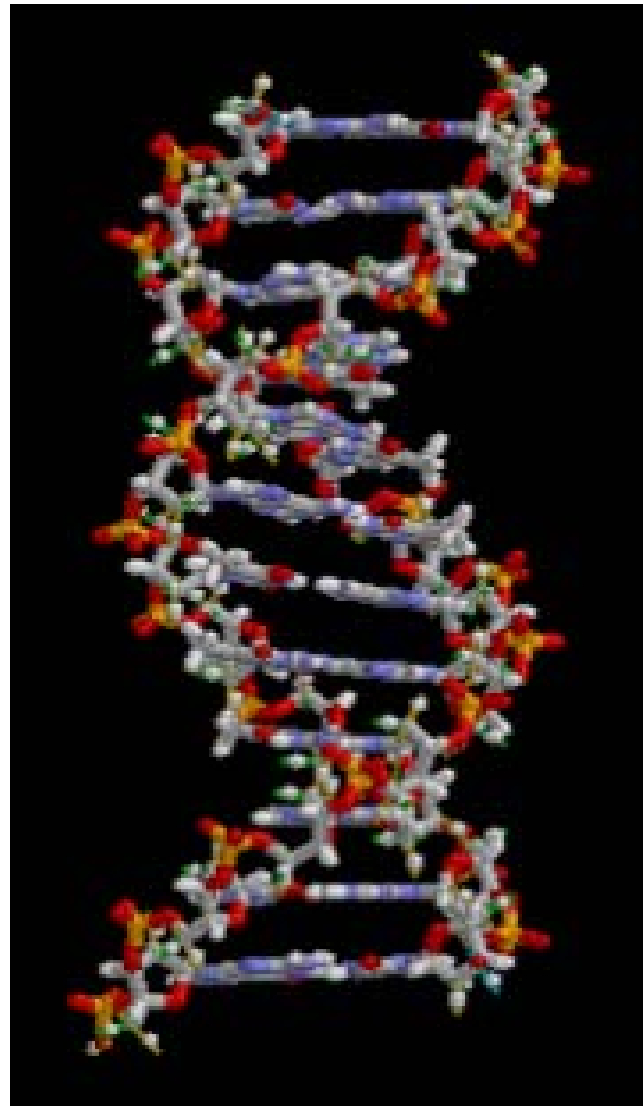
# WHAT IS DNA?

*[Deoxyribonucleic acid]*

1. The genetic material – proven 1940 - 1950
2. A double stranded, helical molecule – described 1953
3. Composed of four nitrogenous bases  
    [Adenine, Guanine, Cytosine, Thymine]
4. These bases occur in pairs  
    [A:T and C:G]
5. Has a “sugar-phosphate backbone”
6. Strands are held together by hydrogen bonds
7. There are ten base-pairs per helix



Base pairing in DNA



3-D model of DNA

# CHROMOSOMES

1. “Colored bodies”
2. Found in cell nucleus
3. Occur in pairs
4. Carry DNA (and proteins)
5. Absorb certain chemicals (stains) for visualization
6. Specific numbers within a species

# CHROMOSOME TERMINOLOGY

Diploid ( $2n$ ) – cells have 2 sets of chromosomes

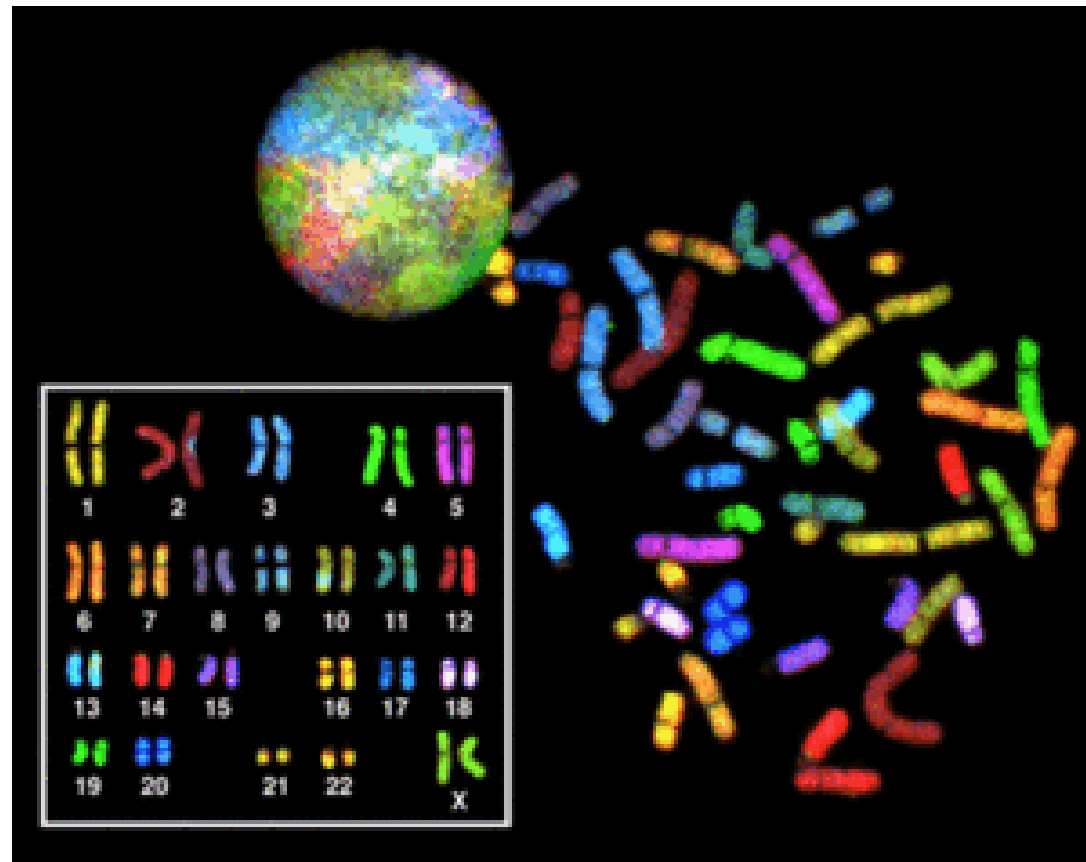
Haploid ( $n$ ) – cells have 1 set of chromosomes  
(reproductive cells)

Autosomes – all of the chromosomes, except the sex chromosomes

Sex chromosomes – a pair of chromosomes associated with sex determination

Centromere – constriction in chromosome where spindle fibers attach

# HUMAN CHROMOSOMES (FEMALE)



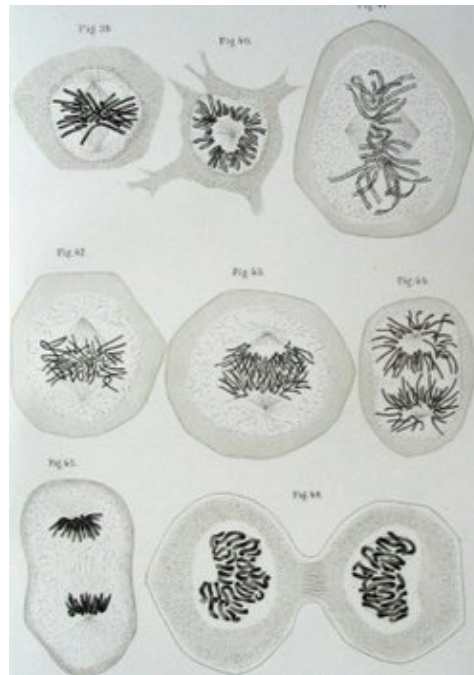
## CHROMOSOME NUMBERS IN SOME DIPLOID ORGANISMS

---

Fruit fly	8	Guinea pig	18	Arabidopsis	10
Dove	16	Snail	24	Rye	14
Earthworm	36	Gray fox	66	Maize	20
Mosquito	6	Red fox	38	Tomato	24
King crab	208	White tail	70	Pepper	24
Domestic cat	38	Domestic pig	38	Einkorn wheat	14
Mouse	40	Rat	42	Durum wheat	28
Rabbit	44	Hamster	44	Bread wheat	42
Hare	46	Sheep	54	Wild tobacco	24
Gorilla	48	Chimp	48	Cultivated tobacco	48
Orangutan	48	Human	46	Old world cotton	24
Elephant	56	Cow	60	New world cotton	48
Donkey	62	Horse	64	Bean	22
Dog	78	Chicken	39	Radish	18
		Opossum	22	Shrimp	258
Goldfish	100+	Silkworm	28	Adders tongue	1262

# MITOSIS

1. Somatic cell division ( $2n$  number of chromosomes)
2. DNA replicates, producing exact copies
3. Chromosomes duplicate, producing copies
4. Cells divide, producing two exact copies of the original cell



# MEIOSIS

1. Reproductive cell division
2. DNA replicates
3. Chromosomes pair and duplicate
4. Cell divides twice, producing four cells with one set ( $n$ , the haploid number) of chromosomes

## Fertilization

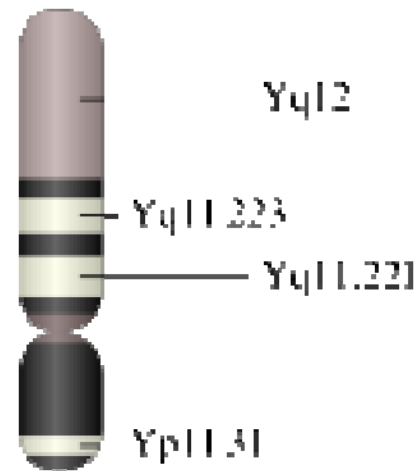
One sperm fuses with one egg, generating a fertilized egg (a zygote), reestablishing the  $2n$  (diploid) number of chromosomes

## Sex determination

In mammals, sex is determined by the presence or absence of a Y chromosome. Females have two sets of autosomes and 2 X chromosomes. Males have 2 sets of autosomes and one X and one Y chromosome.

# THE HUMAN Y CHROMOSOME

1. More than *twenty-seven* Y-specific proteins-coding genes
2. More than *28,000* single nucleotide polymorphisms (SNPs)
3. About *200* micro-satellites – tandemly organized repeats of 2-8 nucleotides
4. More than *60* tri-, tetra- and pentanucleotide repetitive sequences



# SUMMARY LIST OF Y CHROMOSOME LOCI, REPEAT MOTIF AND REPEAT NUMBERS

<u>DYS#</u>	<u>Allele Range</u>	<u>Repeat Motif</u>			
19	10-19	TAGA	442	10-14	TATC
385a/b	7-28	GAAA	443	12-17	TTCC
389 I	9-17	(TCTG) (TCTA)	444	11-15	TAGA
389 II	24-34	(TCTA) (TCTG)	445	10-13	TTTA
390	17-28	(TCTA) (TCTG)	446	10-18	TCTCT
391	6-14	TCTA	447	22-29	TAAWA
392	6-17	TAT	448	20-26	AGAGAT
393	9-17	AGAT	449	26-36	TTTC
YCAa II a/b	11-25	CA	450	8-11	TTTTA
388	10-18	ATT	452	27-33	YATAC
425	10-14	TGT	453	9-13	AAAT
426	10-12	GTT	454	10-12	AAAT
434	9-12	TAAT (CTAT)	455	8-12	AAAT
435	9-13	TGGA	456	13-18	AGAT
436	9-15	GTT	458	13-20	GAAA
437	13-17	TCTA	459 a/b	7-10	TAAA
438	6-14	TTTTC	460	7-12	ATAG
439	9-14	AGAT	461	8-14	(TAGA) CAGA
441	12-18	CCTT	462	8-14	TATG
			463	18-27	AARGG

464	11-20	CCTT	557	(16*)	TTTC
481	20-30	CTT	565	9-14	TAAA
485	10-18	TTA	570	12-23	TTTC
490	(12*)	TTA	572	8-12	AAAT
495	12-18	AAT	573	8-11	TTTA
497	13-16	TAT	575	(10*)	AAAT
505	9-15	TCCT	576	13-21	AAAG
508	8-15	TATC	594	(10*)	TAAAA
520	18-26	ATAS	607	(15*)	AAGG
522	8-17	GATA	626	(18*)	AAAG
525	(10*)	TAGA	632	(9*)	CATT
531	11-13	AAAT	635	17-27	TSTA
532	9-17	CTTT	641	(10*)	TAAA
533	9-14	ATCT	643	7-15	CTTTT
534	10-20	CTTT	H4	8-13	TAGA
540	(12*)	TTAT	C4	20-25	TSTA
549	10-14	AGAT	A10	13-18	TAGA
556	(11*)	AATA			

\*Reference allele; range not given;

Source: [www.cstl.nist.gov/biotech/strbase/ystr\\_fact.htm](http://www.cstl.nist.gov/biotech/strbase/ystr_fact.htm)

Last updated 07/10/2006

## EXAMPLE OF A TANDEMLY REPEATED SEQUENCE

Y chromosome gene: DYS 435

Repeated motif: TGGA

Number of repeats: 9 – 13

**9:** TGGA TGGA TGGA TGGA TGGA TGGA TGGA TGGA TGGA

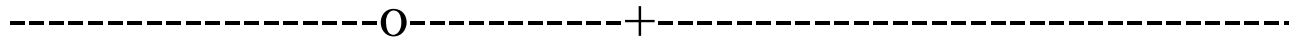
**10:** TGGA TGGA TGGA TGGA TGGA TGGA TGGA TGGA TGGA TGGA

**11:** TGGA TGGA TGGA TGGA TGGA TGGA TGGA TGGA TGGA TGGA TGGA

**12:** TGGA TGGA TGGA TGGA TGGA TGGA TGGA TGGA TGGA TGGA TGGA TGGA

**13:** TGGA TGGA TGGA TGGA TGGA TGGA TGGA TGGA TGGA TGGA TGGA TGGA TGGA

## Y Chromosome



DYS#19

-----  
(TAGA)<sub>x</sub>    x = 10 – 19

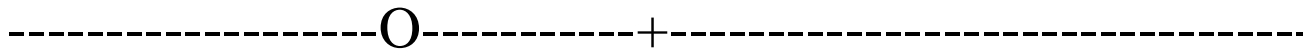
My value: 14

If we are unrelated:

What is the probability that your value *will* be 14?

What is the probability that your value *will not* be 14?

## Y Chromosome



DYS#391

-----  
(TCTA)<sub>x</sub>    x = 6 – 14

My value: 11

If we are unrelated:

What is the probability that your value *will* be 11?

What is the probability that your value *will not* be 11?

# Y-CHROMOSOME DNA PROFILES

John Williamson, NC, and Dan Williamson, LA

## 393 390 19 391 385a 385b 426 388 439 389-1 392 389-2

13 23 14 11 11 14 12 12 13 13 14 17

13 23 14 11 11 14 12 12 13 13 14 17

## 458 459a 459b 455 454 447 437 448 449 464a 464b 464c 464d

17 9 10 11 11 24 15 19 30 15 15 16 18

17 9 10 11 11 24 15 19 30 15 15 16 18

## 460 H4 YCAa YCAb 456 607 576 570 CDYa CDYb 442 438

11 11 19 23 15 15 18 17 38 40 11 12

11 11 19 23 15 15 18 17 38 40 11 12

# Y-CHROMOSOME DNA PROFILES

John Williamson, NC, and Richard Williamson, AZ

**393 390 19 391 385a 385b 426 388 439 389-1 392 389-2**

13 23 14 11 11 14 12 12 13 13 14 17

*14 24* 14 11 *12* 14 12 12 *12 14 13 30*

**458 459a 459b 455 454 447 437 448 449 464a 464b 464c 464d**

17 9 10 11 11 24 15 19 30 15 15 16 18

*18* 9 10 11 11 24 15 19 *29 14 14* 16 *16*

**460 H4 YCAa YCAb 456 607 576 570 CDYa CDYb 442 438**

11 11 19 23 15 15 18 17 38 40 11 12

*10 10* 19 23 *17* 15 *17* 17 *36* *37 12 12*

## Y-CHROMOSOME DNA PROFILES

John Williamson, NC, and Hubert Williamson, NC

**393 390 19 391 385a 385b 426 388 439 389-1 392 389-2**

13 23 14 11 11 14 12 12 13 13 14 17

13 23 14 *10* 11 14 12 12 13 13 14 17

**458 459a 459b 455 454 447 437 448 449 464a 464b 464c 464d**

17 9 10 11 11 24 15 19 30 15 15 16 18

17 9 10 11 11 24 15 19 30 15 15 16 18

**460 H4 YCAa YCAb 456 607 576 570 CDYa CDYb 442 438**

11 11 19 23 15 15 18 17 38 40 11 12

11 11 19 23 15 15 18 17 38 40 11 12

## CONCLUSIONS

1. Y-chromosome DNA is a powerful genealogical tool
2. Y-chromosome profiling is not expensive

Two assays, at \$149 each, proved that the original ancestor of Bug Hill Williamson clan and the original ancestor of the Evergreen Williamson clan were closely related.