GLOSSARY

ALLELE – One specific form or variant of a limited set of possible forms or variants of a gene, such as black, brown, and blonde (alleles) when referring to hair color (gene for hair color). In forensic DNA, it refers to the number of short tandem repeats at a locus.

AMELOGENIN – A protein involved in forming tooth enamel; it is encoded on the sex chromosomes and is used as an indicator of the sex of the individual.

AUTOSOMAL DNA – DNA that is not the sex chromosomes; codes for everything except the sex of the individual.

CAPILLARY ELECTROPHORESIS – A type of analytical technology used in forensic DNA analysis.

CHROMOSOME – A single unit of organized DNA, resembling an "X". Humans have 23 pairs of chromosomes.

CODIS – Short for "Convicted Offender DNA Identification System". It is a national database of DNA profiles of convicted offenders that can be searched.

DIFFERENTIAL DNA EXTRACTION – A specialized method that separates sperm cells from other types of cells.

DNA – Short for "deoxyribonucleic acid".

GENE – A region of DNA that codes for some attribute.

GENOMIC DNA – The entire body of DNA that comprises a person's genetic makeup. It includes the autosomal and the sex chromosomes, but not mitochondrial DNA.

HETEROZYGOUS – At any given locus, the individual possesses two alleles that are different from each other.

HOMOZYGOUS – At any given locus, the individual possesses two alleles that are identical to each other.

LOCI – Plural of locus.

LOCUS – Latin for "location", referring to a particular place on DNA. It is identical to a gene, except that it refers to the noncoding regions.

MITOCHONDRIA – An organelle in a cell, which is actually a primitive organism, responsible for generating power.

MITOCHONDRIAL DNA – The DNA in mitochondria, which can be analyzed. It is maternally inherited.

NUCLEAR DNA – The DNA in the nucleus of a cell. It is synonymous with "genomic DNA".

NUCLEOTIDE – The basic building block of DNA. It is comprised of a nitrogen base, a deoxyribose sugar, and a phosphate group.

PCR – Short for "polymerase chain reaction". It is the artificial process of replicating DNA.

PENTANUCLEOTIDE – A sequence of five nucleotides.

POLYMERASE – An enzyme that reads and replicates DNA.

STR – Short for "short tandem repeat". It is a repeating sequence of nucleotides, each sequence of varying length.

TAQ – Short for *Thermus aquaticus*, which is a species of bacteria that evolved around underwater geothermal vents. Specifically, it is the polymerase from this species.

THERMAL CYCLER – Machine that precisely cycles temperatures, which is essential to PCR.

TRINUCLEOTIDE – A sequence of three nucleotides.

TETRANUCLEOTIDE – A sequence of four nucleotides.

Y-STR – STRs found exclusively on the human Y chromosome, which can be analyzed. It is paternally inherited.

ABOUT

Guardian Forensic Sciences is a new model in the field of forensic science, combining years of skill and experience with a cooperative and multidisciplinary approach, simple and innovative techniques, and new technologies.

Arthur W. Young holds a Bachelor of Science in Pre-Medical Sciences from the University of Southwestern Louisiana. Among his areas of expertise are photography, blood stain pattern interpretation, microscopy, anatomy, physiology, biochemistry, and audio-visual technology.

Katherine L. Cross holds a Bachelor of Science in Biology from the University of North Carolina at Charlotte and a Master of Science from the University of Florida. Other areas of expertise include genetics, blood stain pattern interpretation, and geology.

Both are members of the American Academy of Forensic Sciences, the Mid-Atlantic Association of Forensic Scientists, the Southern Association of Forensic Scientists, the Association of Forensic DNA Analysts and Administrators, and the International Association of Blood Stain Pattern Analysts. Both are also Fellows of the American Board of Criminalistics.

Their combined forensic experience spans four decades, in both the public and the private sectors, covering both high-profile and "cold" cases, and crimes ranging from burglary to serial sexual assault and serial homicide. Both are well versed in traditional and contemporary methods, including ABO typing, polymorphic isoenzyme typing, and others.

 The information in this brochure is only meant as a quick reference and introduction to forensic DNA analysis and not final or all-inclusive.

GUARDIAN FORENSIC SCIENCES

1021 OLD YORK ROAD
SUITE 202
ABINGTON, PA 19001

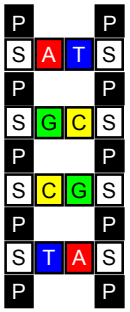
OFFICE
215-277-1780

FAX
215-277-1785

UNITYFAX.COM
215-933-5221

WWW.GUARDIANFORENSICSCIENCES.COM

WHAT IS DNA?



The structure of DNA is very simple. It resembles a ladder, where the two vertical "uprights" are alternating sequences of deoxyribose sugar ("S") and phosphate groups ("P"). The horizontal "rungs" are complementary pairs of nitrogen bases. There are four kinds: adenine ("A"), thymine ("T"), guanine ("G"), and cytosine ("C"). Because of their sizes and shapes, "A" only pairs with "T" and "G" only pairs with "C". Just as a cassette encodes sound on an electromagnetic tape, DNA encodes life in the *sequence* of the nitrogen bases. When DNA is "read", it is decoded to form the proteins that determine your height, sex, eye color, and everything else – all of which were inherited from the mother and the father. These coding regions of our DNA are our genes.

Stitched between our genes are non-coding regions, called loci (singular: locus), also referred to as "junk DNA". These regions are not filled with random sequences, but with repeating sequences of nitrogen bases. If the repeating sequence is four bases long, it is called a "tetranucleotide"; if it is five, then it is called a "pentanucleotide". The repeating sequences may occur a few times to dozens of times. The more repeats there are at a locus, the longer the locus becomes.

The lay definition for "gene" has deviated from the scientific one. Instead of saying, "she has the genes for blue eyes", it is more accurate to say, "she has the blue alleles for eye color". Generally speaking, whereas a gene is a unit of heredity, an allele is a specific type or form of that unit, such as a color. In forensic DNA analysis, the number of repeats at a locus can be regarded as an allele because they can be inherited.

DNA REPLICATION

If one were to split the DNA "ladder" vertically up the middle, it would be possible to "rebuild" the opposing strand, by the specific complementarity of the base pairs ("A":"T" and "C":"G"). There would then be two copies of DNA, both identical to the original. This is how DNA replicates itself.

Polymerase chain reaction (PCR) is a method of inducing DNA to replicate itself artificially. Whereas one cycle produces two copies of the original strand of DNA, two cycles would produce four copies, three cycles would produce eight copies, four cycles would produce sixteen copies, etc. Forensic DNA analysis uses 28-32 cycles, which produces billions of copies.

POTENTIAL SOURCES OF DNA

TYPES OF EVIDENCE	POTENTIAL SOURCES OF DNA										
	BLOOD	SALIVA	SEMEN	VAGINAL FLUID	URINE	FECES	SKIN / TISSUE	OIL / SEBUM	HAIR	SWEAT / TEARS	NASAL MUCUS
Adhesive note							X	X			
Adhesive tape							X	X			
Bandage	X						X		X	X	
Bullets / Cartridges		?					X	X			
Cell phone		X					X	X		?	?
Chewing gum		X					X				
Cigarette butt		X									
Condom	X	?	X	X		?	X	X	?		
Cup / bottle / straw		X					?	?			
Envelope / stamp		X					X	X			
Eyeglasses							X	X		X	
Facial tissue	?	?	?	?	?	?	X	X	?	?	X
Fingernails	?	X	?	?		?	X	X			?
Gloves	?	X					X	X	X	X	?
Gun / magazine	X	?					X	X		?	
Mask		X					X	X	X	X	X
Paper		?					X	X			
Paper towel	?	?	?	?	?	?	X	X	?	?	X
Pen / pencil		X					X	X		?	
Shells (spent)		?					X	X			
Steering wheel	?	X					X	X	X	X	X

X = probably present on this type of evidence
? = possibly present on this type of evidence

CONTAMINATION

In forensic DNA analysis, contamination occurs when DNA from an outside source is introduced to the evidence. All contamination can be classified into one or more of the following categories:

- Self-contamination – When a person's own DNA contaminates evidence. Solution: Wear disposable gloves and a mask.
- Cross-contamination – When DNA from one item of evidence contaminates another item. Solution: Change disposable gloves often.
- Secondary contamination – When DNA contaminates an intermediary item, such as a pen, a camera, a clipboard, or doorknob, which then contaminates a clean pair of gloves. Solution: Avoid touching intermediary items when wearing gloves.

LOW-TEMPLATE DNA ANALYSIS

Also known as "contact DNA" or "touch DNA", this method takes the sensitivity of today's forensic DNA technology to its extreme, detecting the minute quantities of DNA found in a small handful of cells. There are several factors that affect its success:

- Duration of contact with the surface (longer = better)
- Size of the surface area (larger = better)
- Hardness of the surface (harder = better)
- Texture of the surface (textured = better)
- Amount of force exerted on the surface (more force = better)

Collecting such evidence is best performed by the laboratory, where ideal conditions exist. When that is not possible, moisten a sterile cotton swab with distilled water and rub against the areas of the evidence that is likely to contain trapped cells. Pay particular attention to nooks and crannies, where cells are not easily removed (it will usually appear as a gray or brown crud).

Y-STR ANALYSIS

Y-STR analysis is a special type of forensic DNA analysis that is capable of detecting male DNA, even in mixtures that contain over 99% female DNA. It is like a homing missile that searches for and identifies male DNA. Its disadvantage is that Y-STR profiles are not unique and do not identify any single male, but rather, his paternal lineage (*e.g.*, a grandfather, his sons, and his grandsons will all share the same Y-STR profile). It is also useful in cases where a reference sample from a particular individual is not available, by using a reference sample from a suitable paternal relative.

MITOCHONDRIAL DNA ANALYSIS

Mitochondrial DNA analysis is a special type of forensic DNA analysis. It is extremely sensitive and successful with degraded samples. It is the preferred technology for hairs, where a hair root is not present. Its disadvantage is that mitochondrial DNA profiles are not unique and do not identify any single person. Mitochondria (and its DNA) are maternally inherited and therefore identify a maternal lineage (*e.g.*, a grandmother, her children, and her daughter's children will all share the same mitochondrial DNA profile). It is also useful in cases where a reference sample from a particular individual is not available, by using a reference sample from a suitable maternal relative.