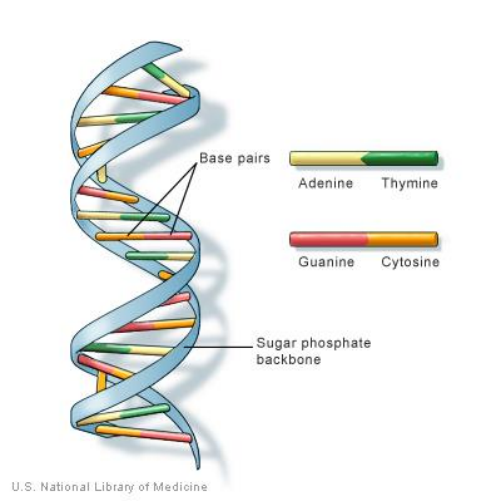
The DNA molecule is comprised of three basic parts: a 5-carbon sugar, a phosphate group, and a nucleotide base. The nucleotide bases are joined together by phosphodiester bonds to form single stranded DNA molecules in a 5' – 3' direction. The DNA double helix is formed when two single stranded molecules pair complementary bases (adenine to thymine or guanine to cytosine) with the strands oriented in opposite directions. These double helix molecules are then condensed in the cell by wrapping the DNA strands around histone proteins to form the chromosome structure.



What size DNA fragments comprise a DNA profile? The segments of noncoding DNA that are targeted by human identification (HID) technology are small. The size range for forensic DNA fragments is in the 50 – 500 nucleotide base range. On a molecular ruler, that is a very small fragment of DNA. Why do scientists utilize small fragments? Evidence from crime scenes are often exposed to bacteria, sunlight, chemicals, fungi, and humidity which all can contribute to the degradation or break down of longer DNA molecules. If you target small DNA fragments in a sample, the success rate is greater although not guaranteed for generating a DNA profile.

Forensic DNA

IDENTACODE NEWSLETTER

Human nuclear DNA is contained in 23 pairs of chromosomes. One set of chromosomes (50%) of DNA in a child is inherited from the mother and the other set (50%) of DNA in a child is inherited from the father. This is the basis for pattern matching of DNA results in paternity testing. For civil or criminal DNA casework, specific regions of DNA (regions that do not code for your physical features) are targeted in an enzymatic copying process called PCR (polymerase chain reaction) which allows forensic scientists to visualize extremely small amounts of DNA, even down to the single cell. If the quantity and quality is sufficient in the forensic test, a full DNA profile will be obtained from the evidence and a comparison to the known reference samples of victims, suspects or defendants and other individuals who may be relevant to the crime scene or case can be made.

Human DNA

The Human Genome Project began in 1990 with the goal of sequencing or decoding the entire human genome to allow study for medicine, gene regulation, aging processes and genetic diversity. Drafts of the human genome have been produced in 2001 by a Public Consortium of laboratories and also by a private organization called Celera Genomics. Later versions which are composite sequences of DNA from several individuals indicate 99% of the human genome has been decoded. The task now is to determine what the function, if any, is of these DNA sequences. Some sequences are known to code for proteins and regulate different gene function. Other sequences are called structural DNA or noncoding regions. Forensic DNA tests target the noncoding structural regions of DNA and therefore are not associated with any medical conditions or physical features of an individual human.

The target of forensic DNA tests are regions of tandem repeating DNA called STRs (short tandem repeats) with unknown function. These regions are very diverse in the human population and have been mapped to specific positions on chromosomes (locus or loci). The number of repeats can be measured as differences in DNA fragment size and converted mathematically to a number value (allele). The string of number values represents an individual's unique identifying human barcode or DNA profile.

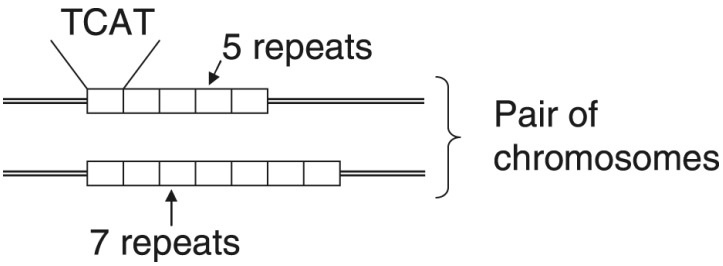


Figure 1. Example of a locus with a 5 allele from one parent and a 7 allele from the other parent, each of different size. Each repeating unit is a 4 nucleotide base repeat. Example sequence of repeat shown here is TCAT but sequences can differ at different loci on different chromosomes. (Reference: doi.ieeecomputersociety.org)

Short tandem repeats (STRs) are not only present in humans but they are also used for forensic identification of other organisms including cats, horses, dogs and plants. Custom assays and commercial nonhuman identification kits are available and used when needed for forensic evidence and sourcing back to the original organism to show linkages between individual animals or plants and confirm pedigree information by generating unique barcodes. Like all DNA profiles, the more informative the marker system, the more conclusively one can identify the individual or organism.