How DNA Evidence Works

DNA fingerprinting, also called forensic DNA analysis, is considered by many to be the police investigator's secret weapon, a means of building cases or reanalyzing crimes using tiny bits of cryptic evidence. Indeed, since 1986, when DNA evidence first entered the courtroom, the technique has aided in the prosecution or defense of hundreds of cases, and in the exoneration of dozens of people wrongly convicted.

As the acceptance of DNA evidence in the courtroom has grown, so has its importance, for the simple reason that physical evidence linking suspects to crimes is often very sparse. Sometimes the weight of an entire case -- even the life of the individual on trial -- rides on just a few drops of blood or strands of hair. But as the reinvestigation of the 1954 murder of Marilyn Sheppard shows, the quality of evidence can dramatically affect the amount of information that evidence provides.

In general, forensic DNA analysts compare the genetic makeup of tissue samples in search of similarities and differences among them. They do this not by comparing all of the DNA contained in each cell, but instead by marking a small number of segments and then checking for the presence or absence of those segments in each sample.

One of the most common techniques, called variable number tandem repeat (VNTR) analysis, isolates DNA segments that all have the same sequence of repeating letters (ATCATCATC, for example). It organizes these repeating segments according to length, marks segments of a few different lengths, and then compares samples based on the presence or absence of same-length segments. Two samples that have as many as ten or twelve of these segments in common have very little chance -- one in several million -- of being from two different people. Because VNTR analysis relies on samples that contain relatively long strands of intact DNA, the technique usually cannot be used to analyze tissues as old as the bloodstains found in the Sheppard house. For decades-old samples, forensic analysts use instead a variety of polymerase chain reaction (PCR) techniques, including DQA1. The DQA1 analysis focuses on one tiny segment of the genome. This segment, the DQA locus, holds eight alleles, each of which codes for a different protein, and six of which can be marked and used for forensic analysis.

In a DQA1 analysis, lab technicians compare samples with regard to the presence or absence of these six DQA alleles. However, because the alleles come in a small number of combinations (just forty-two), it's possible that a person could match a sample from a crime scene without being the source of that sample. For this reason, DQA1 is typically used only to rule out suspects, and not implicate them.