Law Enforcement Management Institute

The Role of DNA-Based Identification in Criminal Investigations

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By

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The Role of DNA-Based testing in Criminal Investigations

Over a century ago, the use of fingerprints revolutionized efforts of law enforcement in the field of personal identification. Now, science has advanced the field of identification again with the advent of "DNA fingerprinting."

DNA, deoxyribonucleic acid, is the building block of life, the blue print or master plan of an individual. In humans, as in all living organisms, DNA is found in every cell of the body and determines our inherited characteristics. Traits such as blood type, eye color, body size, and susceptibility or resistance to certain kinds of diseases are all determined by our DNA. DNA makes an individual unique. Except in the case of identical twins, no two people share the exact same DNA makeup.[1]

A spiral shaped, double helix molecule, DNA is found in the nucleus of organic cells. James Watson and Francis Crick discovered and made a working model of the structure of DNA in the early 1950's. Understanding of the structure of DNA has helped scientists answer many questions concerning the basic framework of life. Moreover, the practical application of DNA based technologies in other fields of study have been numerous.

The application that has most benefitted law enforcement is identification of an individual from evidence left at a crime scene.[2]

The DNA based identification test, referred to as "DNA Fingerprinting", is a process that separates and marks the unique combination of DNA strands found in body cells. The process can be divided into four main steps.

Step one is the isolation and purification of DNA molecules from a number of different biological samples. The samples found most often at crime scenes are blood and semen stains. Stains the size of a nickel are sufficient to obtain a DNA pattern. Vaginal swabs taken shortly after a sexual assault are also a source of a suspect's DNA. After extracting the DNA from the samples, its is purified using standard lab techniques to remove as much contaminating material as possible.

Step two of the procedure is the cutting of DNA molecules into segments using restriction enzymes. Restriction enzymes are "molecular scissors" which recognize specific sites in the DNA molecule and cut the DNA at those sites, generating a large number of different size fragments.[3]

Following fragmentation of the DNA is step three, which involves electrophoresis and transfer of the DNA fragments. After the DNA has been cut into numerous fragments it can be loaded onto one end of an agarose gel. An electrical current is then applied from one end of the gel to the other, causing the smaller DNA fragments to move further through the gel than the larger ones. After several hours of electrophoresis, the DNA fragments are removed from the gel and separated according to size. During step three, the DNA fragments are also chemically treated while still in the gel to actually separate the two DNA strands from one another. The DNA can now be permanently fixed to a nylon membrane for marking and identification.[4]

In step four, the fragments of DNA are marked and identified by using DNA probes. DNA probes are small pieces of single stranded DNA which will bind to complimentary regions of other single stranded DNA. These DNA probes are selected because they will bind to DNA fragment sizes which are uncommon. The DNA probes are labeled with a radioactive particle that tracks where on the nylon membrane the probe has attached.[5] After hybridization with a labeled probe, the nylon membrane is placed next to a piece of x-ray film and left for several days. A radioactive probe will bind to specific DNA fragments on the nylon membrane, creating a dark band on the x-ray film. The DNA pattern obtained from each sample is compared to the pattern obtained from each suspect in the case. Matching patterns would indicate inclusion of an individual as a suspect and, conversely, a non-matching pattern would exclude an individual as a suspect.[8]

DNA based identification testing can be useful in a variety of circumstances. Forensic cases may involve comparing DNA patterns recovered from available evidence with DNA patterns generated from blood cells of the alleged suspect. Most of these cases involve a rape or a homicide. In some cases, evidentiary samples may be matched with the victim to place the suspect at the crime scene.

Identity testing has been used to determine paternity in incest cases and in cases involving children born to rape victims. Testing has also been used to identify body remains of missing persons by comparison with the missing person's parents. Moreover, DNA technology in civil litigation has helped to resolve cases of child custody, child support and fraudulent inheritance.

DNA testing will be challenged in court on a regular basis the more that it is used. Typically, DNA matching is challenged on the basis of possible human error by the lab technician. Laboratories offering this type of testing must be ready to perform the tests using the highest standards of quality control and, as always, with the appropriate documentation necessary to preserve the chain of custody. Currently, three commercial labs offer DNA identification service: Cellmark Diagnostics in Germantown, Maryland, Lifecodes Corporation of Valhalla, New York and GeneScreen of Dallas, Texas.[7] The Federal Bureau of Investigation began DNA testing in 1989 and offers the service to state and local agencies on a priority basis. Also, several state labs are currently developing DNA testing programs.

In addition to DNA fingerprinting, gene amplification polymerase chain reaction testing offers promise in the field of criminal investigation. A much smaller sample base such as a single strand of hair or a degraded DNA sample will yield results. Although gene amplification PCR testing has been used in a handful cases, all resulting in conviction, because of the smaller sample base it will continue to face court challenges regarding accuracy. As of yet, no case involving gene amplification PCR testing has finished the appeals process.[8]

Legislation in a few states requires that blood samples for genetic testing be taken from convicted sex offenders as a condition of release. Such a file would provide a reference against which blood, semen or hair from a crime scene might be compared. There is also a need for establishment of civil files containing the voluntarily furnished

DNA samples of individuals. In the event of disasters or missing persons cases, this information would be invaluable to the medical examiner in identifying unknown bodies or partial remains.[9]

The FBI is taking the lead in this new technology, but success depends on the support of all law enforcement agencies.[10] The FBI is also developing a program to share this technology with state and local crime labs throughout the United States. The research is directed at not only development of methods, but also at establishing the scientific validity and reliability of these methods to insure that evidence derived from forensic analysis of DNA can withstand legal challenge in court.[11]

It is anticipated that within two to three years, DNA testing of evidence will be on a routine basis. There is a high level of interest in this technology and if the demand is to be satisfied, administrators must take steps now to provide personnel and equipment resources.

While DNA technology will provide a new tool for law enforcement, it will not replace the forensic methods now used in the crime labs. Not all specimens will be suitable for DNA testing or tests conducted may not give a conclusive result. In these cases serological tests will still be necessary to provide information from evidence materials. There will always be a need to identify, isolate, preserve, and analyze types of evidence such as firearms, tool marks and other physical evidence. Investigators processing crime scenes need to make sure other types of evidence are not overlooked in hope of a positive DNA result.[12]

The test itself can only accomplish so much. To utilize the results most effectively, other steps must also be taken:

First, appropriate quality control measures must be designed, adopted and standardized so that the results can withstand defense challenges in court.

Second, mechanisms should also be created to monitor the effectiveness of testing labs. Then standards could be developed on a national level, thereby enhancing for such labs the credibility of their results.

Finally, it is inevitable that the existence of the testing labs will permit the formation of a national data bank of DNA prints from all convicted criminals. The National Crime Information Center would likely be responsible for the organization and operation of the data bank along the lines of the conventional fingerprinting system currently being used by police agencies throughout the United States.[13]

DNA testing has already contributed greatly to law enforcement's arsenal in the fight against crime. Future improvements in testing procedures and standards will further benefit the public on two fronts: one, more crimes can be cleared and more perpetrators arrested; and two, the conviction rate among those arrested will increase.

End Notes

1. "FBI Announces New DNA Policy." F.B.I. Law Enforcement Bulletin. March, '89 Vol.58 pp.23.

2. Sessions, William S. "I Didn't do it-DNA Testing." Police Chief Oct. '88 Vol. 55 pp.12.

3. Giles Bob. "DNA Fingerprinting Meets Courtroom Challenges." The Texas Prosecutor. July/Aug. '89. Vol.19 pp.11-13.

4. Ibid.

5. Ibid.

6. Ibid.

7. Ibid.

8. Ibid.

9. Hicks, John W. "DNA Profiling: A Tool For Law Enforcement." FBI Law Enforcement Bulletin. Aug., '88 Vol. 46 pp. 12.

10. Police chief, supra.

11. Hicks, supra.

12. Ibid.

13. Ibid.