HISTORY AND FUTURE OF DNA TYPING

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Over the past 15 years, the forensic biology field has made great strides. Molecular biology procedures have become available and are pervasive for analysis of forensic biological specimens. The multilocus probe analysis by restriction fragment length polymorphism (RFLP) analysis developed by Alec Jeffreys exploited genetic differences among individuals. DNA typing quickly progressed to the use of single locus variable number of tandem repeat (VNTR) loci by RFLP analysis. Single locus analysis offered greater sensitivity, increased species specificity, and standard statistical interpretations compared with the multilocus approach. VNTR typing was adopted by many crime laboratories in the United States and was the workhorse system of the late 1980's through most of the 1990's. However, the use of the polymerase chain reaction (PCR) method made DNA analyses more sensitive, simpler, faster, more amenable to analyzing degraded samples, and potentially automatable. PCR is a sample preparation technique in which relatively large amounts of specific DNA sequences of DNA can be generated from relatively small (picogram or nanogram) quantities of DNA. A cadre of methods based on the PCR are available, such as allele-specific oligonucleotide typing (i.e., basically the chip format) for the HLA-DQA1 and Polymarker loci, electrophoretic separation and silver staining of the D1S80 locus (a VNTR locus) amplicons, electrophoretic separation and detection of short tandem repeat (STR) loci by silver or fluorescence, and mitochondrial DNA sequencing (now using multiple capillary arrays). Improved extraction procedures, quantitation procedures, quality assurance guidelines/standards, proficiency testing, interpretation guidelines, and statistical analyses also have been developed.

No field has benefited more from the tools of molecular biology than forensic science. DNA technology affords the forensic scientist the ability to eliminate individuals who have been falsely associated with a biological sample and to reduce the number of potential contributors to a few (if not one) individuals. Inculpations are strong evidence regarding the source of the biological sample. Today, some wrongly convicted people have been exonerated because of DNA evidence. Moreover, in casework, individuals are excluded routinely.

In 1989, the Technical Working Group on DNA Analysis Methods (TWGDAM, now SWGDAM), cognizant of the large number of sexual assaults in the United States and the tendency for sex offenders to repeat crimes (i.e., recidivism), proposed the concept of combining forensic DNA technology with computer science capabilities to aid in resolving violent crimes. The realization of the full use of DNA typing technology has come to fruition by the development by the FBI of a national DNA databank called CODIS (Combined DNA Index System). The two main objectives for CODIS operations are: 1) assist investigators in the identification of suspects of violent crimes, and 2) increase the efficacy of forensic laboratories by providing software to conduct DNA casework and perform statistical calculations. Since cases can be analyzed more rapidly and DNA databanks can be generated more rapidly than a decade ago, DNA databanking has been established and used to search DNA profiles/records to help resolve a large number of violent crimes.

Since the inception of forensic DNA profiling, there has been a debate in the legal setting regarding admissibility on the methods and the practices of computing DNA profile frequencies. While the

scientific basis of DNA typing were sound, both the methodology and the statistical interpretations were aggressively challenged in court. The methods challenge focused on reliability and validity testing. The statistics debate focused on the reliability of the assumption of independence for applying the product rule to derive estimates of DNA profile frequencies. The result of the forensic community's effort to support the technology (by research and data analysis) is that DNA typing has met both Frye and Daubert criteria for admissibility.

Because of the human genome project, additional technologies may come available to further augment the forensic DNA typer's capabilities. These include: chip technology, micro arrays, multi column capillary electrophoresis, mass spectrometry, portable PCR devices, robotics, etc.