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DNA EVIDENCE

Paul C. Giannelli
Albert J. Weatherhead III & Richard W. Weatherhead
Professor of Law, Case Western Reserve University
and
David Magee
Class of 1992, CWRU Law School

The initial reports on DNA evidence were dramatic. "Foolproof" was the way *Time* described DNA evidence. *DNA Prints: Foolproof Crime Test,* Time, Jan. 26, 1987, at 66. A later article used the term "revolutionizing." Toufexis, *Convicted by Their Genes: A New Forensic Test is Revolutionizing Criminal Prosecutions,* Time, Oct. 31, 1988, at 74. A judge wrote that it was "single greatest advance in the search for truth . . . since the advent of cross-examination." People v. Wesley, 140 Misc. 2d 306, 308, 533 N.Y.S.2d 643, 644 (N.Y. Co. Ct. 1988).

Promotional literature from the commercial DNA laboratories was equally sensational. They claimed that DNA has "the power to identify one individual in the world's population" and "the chance that any two people will have the same DNA print is one in 30 billion." Neufeld & Colman, *When Science Takes the Witness Stand*, 262 Scientific American 46, 50 (May 1990). *See also* Burk, *DNA Identification: Possibilities and Pitfalls Revisited,* 31 Jurimetrics J. 53, 85 n. 119 (Fall 1990) ("Cellmark entitled one of its informational brochures *DNA Fingerprinting, The Ultimate Identification Test.").*

DNA printing was reported in 1985 by Dr. Alec Jeffreys of the University of Leicester, England. Jeffreys, Wilson & Thein, *Hypervariable "Minisatellite" Regions in Human DNA*, 314 Nature 67 (1985); Gill, Jeffreys & Werrett, *Forensic Application of DNA "Fingerprints,"* 318 Nature 577 (1985); Jeffreys, Wilson & Thein, *Individual-Specific "Fingerprints" of Human DNA*, 316 Nature 76 (1985). It is a by-product of research in molecular biology.

THE DNA MOLECULE

DNA (deoxyribonucleic acid) is a chemical messenger of genetic information, a code that gives both common and individual characteristics to people. DNA is found in packages called chromosomes. Humans have 23 pairs of chromosomes, half of which are inherited from each parent. Every person has a unique genetic signature that is derived from the genetic dispatches of the DNA present in their cells. Except for identical twins, no two individuals share the same DNA pattern.

DNA is found in every body cell, except red blood cells. Blood, however, may still be used as evidence because white cells and other components of blood have DNA.

With few exceptions, DNA does not vary from cell to cell. Each cell contains the *entire* genetic code, although each cell reads only the part of the code that it needs to perform its job. Thus, blood obtained from a suspect can be compared with semen or hair cells from a crime scene.

Structure of the Molecule

DNA is composed of a chain of nuceleotide bases twisted into a double helix structure, resembling a twisted ladder. Each rung of the helix is a "base pair." There are four nucleotide bases which compose DNA: Adenine (A), Thymine (T), Cytosine (C), and Guanine (G). These bases are paired according to a "base-pair" rule: A pairs only with T, and C pairs only with G.

The order of the base pairs on the DNA ladder is known as the DNA sequence; it constitutes the "genetic code." In other words, these base pairs provide specific instructions to the cell; a sequence of base pairs that is the source for a particular trait is called a gene.

A single DNA molecule contains roughly three billion base pairs. If unraveled, it would measure approximately six feet. Approximately 99% of the base pairs found in humans is the same. It is the area of base pair variation that is used in DNA analysis. These base pairs are called "polymorphisms." Approximately three million base pairs are thought to be polymorphic.

The length of each polymorphism depends on the number of repeat core sequences. The core sequence is called a VNTR (Variable Number Tandem Repeat). The total fragment length is called a Restriction Fragment Length Polymorphism (RFLP). Alternate forms of RFLPs are called alleles. Some RFLPs exhibit only two alternate forms, while others are hypervariable—they have many alternate forms. For example, at a given locus (site) on the DNA ladder one person might have a 32-base pair segment, a second person a 28-base pair segment, and a third person a 19-base pair segment. Some loci have as many as 50 to 100 different forms (alleles). DNA analysis is based on these differences in segment lengths.

Public Defender Hyman Friedman
Cuyahoga County Public Defender Office, 1200 Ontario Street, Cleveland, Ohio 44113
Telephone (216) 443-7223

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Forensic Identifications

Examining every polymorphic site on the DNA molecule is not practical. Instead, DNA analysis focuses on four or five highly polymorphic or hypervariable sites or loci. These sites are examined to determine whether the evidence and suspect samples contain matching alleles (segment lengths).

> DNA tests are designed to detect these highly polymorphic loci and to distinguish among the alleles that exist there. DNA analysis does not examine an individual's entire genome, but rather a snapshot of a specific area. And because DNA from any two individuals is more alike than different, relatives or unrelated persons can share the same allele or alleles at any given locus — even highly polymorphic loci. Thus, forensic uses of DNA tests depend on examining several loci to determine whether DNA types from two different samples match. Office of Technology Assessment, Genetic Witness: Forensic Uses of DNA Tests 42-43 (1990) (hereinafter cited as OTA Report).

Once a match is declared, population frequencies are used to report the frequency that such an event could occur randomly. The frequencies of each matching band on the autorads are multiplied (according to the "product rule") to estimate the population frequency of the overall DNA pattern. In sum, DNA identification evidence involves two fields: molecular biology and population genetics. The procedure involves two corresponding steps — first, determining whether the bands at several loci match, and second, calculating the population frequency for the matching bands.

DNA TYPING

The most commonly used DNA test detects size variations between individuals. The process used to measure these size distinctions is called restriction fragment length polymorphism (RFLP) analysis. Two of the commercial laboratories, Cellmark and Lifecodes, and the F.B.I. laboratory use this process.

RFLP Analysis

RFLP analysis involves six steps.

1. *Extraction.* The first step in the procedure is chemical extraction of the DNA from the forensic sample. A biological sample may be obtained from blood, semen, skin, saliva, or hair roots. A sufficiently large, intact (high molecular weight) DNA molecule must be obtained from the sample for the RFLP analysis to be successful. The sample obtained also may be fractionated or purified to separate out DNA from other individuals.

2. *Fragmentation (cutting).* The DNA strands are cut into fragments by a restriction enzyme. The enzymes act as "biological scissors," cutting the DNA at specific points and at the same place every time they are applied. The lengths of these fragments at certain locations, however, will differ for each person. This is the key to DNA identification. Different laboratories use different enzymes.

3. *Gel Electrophoresis.* Next, the fragments are separated by size in an agarose gel (which resembles a slab of gelatin). The gel is electrically polarized. Since DNA is negatively charged, the fragments travel towards the positive end of the gel. The distance the fragments travel in the gel is dependent upon their size; thus, the shorter fragments, which weigh less, travel further in the gel. Fragments of a known size are run alongside the forensic samples; these allow for measurement of RFLPs in the units of base pairs.

4. *Southern Blotting.* Because gels are difficult to work with, the separated DNA is transferred to a nitrocellulose sheet. This step is known as Southern blotting. The fragments are transferred in exactly the same positions that they occupied in the gel. The end result is that the fragments are permanently fixed to their locations.

5. *Hybridization.* Hybridization involves the use of a radioactive probe to locate a specific polymorphic region of the DNA. The probe is a short single strand of DNA that seeks out its complementary base sequence in the fragment. The probe bonds with RFLPs of all sizes that have the corresponding core sequence. This process is like finding a needle in a haystack; the probe acts like a magnet.

Different laboratories use different probes. Each probe will produce one or two bands. Four to six probes will be used in each analysis.

6. *Autoradiography.* Autoradiography permits the visualization of the probes bonding with the RFLPs. The nylon membrane is placed against a piece of x-ray film. The radioactive probes expose the film at their specific locations. Once the film has been processed, black bands or autorads appear where the radioactive probes are bonded to the RFLPs. The autorads are sometimes described as being similar to supermarket bar code patterns.

Determining a Match

Once these six steps are completed, the laboratory must interpret the results. A single locus probe produces one to two bands for each sample. Each band on the autoradiograph must be measured; then the analyst must determine whether the bands from the forensic sample match those of the test subject at that locus. Interpretation of the autoradiograph can be done visually or with the aid of a computer measuring system. Visual comparison introduces an element of subjectivity into the process.

Different standards for declaring a match have been used by different laboratories. Lifecodes declares a match if two bands do not differ by more than +/- 1.8%. The F.B.I. laboratory uses a +/- 2.5 match window for determining a match. The interpreter declares a match, a definite non-match, or inconclusive results. The site for each probe is examined to determine whether a match exists at each locus.

Statistical Probabilities

Once a match has been determined, a statistical probability is attached to the alleles or group of genes that appear at that probe site. A probability is computed that estimates the probability that someone randomly selected from the population would have a DNA profile identical to the forensic sample. A number of people will have the same fragment length at one locus. Consequently, more than one probe is used, so that sufficient individualization

can be estimated.

The different laboratories have developed tables of allele frequencies. The frequencies of the individual alleles are multiplied together, and an aggregate probability estimate is computed. This aggregate probability estimate gives DNA analysis its strong evidential weight. Very low statistical probabilities are possible — for example, a probability that 1 in 30 million could possibly match this DNA pattern (using matches at four or five loci).

Another Method: PCR

Another DNA testing procedure used by Cetus Corporation, is the polymerase chain reaction (PCR). PCR analysis requires far less biological material than RFLP technologies. In many instances the forensic sample may be too small, or too damaged by environmental conditions, to be subjected to RFLP testing. In this case PCR technology may be able to overcome this problem. PCR is essentially DNA amplification or molecular photocopying. It allows a scientist to take an insufficient forensic sample and amplify it until enough DNA is present for further analysis.

The distinct advantage of PCR is that smaller, older samples can be used. DNA from a 7,000 year old body preserved in a peat bog has been tested. OTA Report at 50. The disadvantage of PCR analysis is that the procedure cannot produce the high probabilities of RFLP analysis. Currently, DNA typing techniques using both PCR and RFLP are being developed. These would allow PCR amplification and then RFLP analysis; hence, smaller forensic samples could be analyzed.

PROBLEMS

Population Genetics

The validity of DNA testing does not hinge on population statistics, yet the interpretation of the results does. They are used to achieve a probability of how often a particular DNA profile will appear in the population. For the calculations to be reliable, all the DNA fragments tested must be statistically independent. For this assumption to be true, individuals must reproduce randomly so that distinct subgroups (population substructure) are absent. The OTA Report states:

> One critical factor: These basic calculations are only valid when applied to populations in which the DNA fragments are statistically independent. Otherwise, the value calculated might greatly underestimate the true occurrence of the pattern in the general population — making a match seem rarer than it actually is. Essentially, the population must be one where individuals randomly marry and reproduce, so that distinct subgroups are absent. In such freely mixed populations, there will be no correlation between the alleles on the maternal and paternal chromosomes (Hardy-Weinberg equilibrium) and no correlation between alleles at different loci (no linkage disequilibrium). OTA Report at 67.

There has been considerable criticism of different laboratory calculations and their failure to take into account the existence of population substructure. In State v. Caldwell, 260 Ga. 278, 393 S.E.2d 436 (1990), the Georgia Supreme Court determined that the population was not in equilibrium and thus "more conservative figures" should be used. *Id.* at 444. Two experts testifying for the prosecution in United States v. Yee, 134 F.R.D. 161 (1990), also conceded that population substructure was "conceivable" and expected in the caucasian population. *Id.* at 182. A number of courts have allowed DNA evidence of a match, but excluded the population frequency probability or required that a lower probability be used. State v. Schwartz, 447 N.W.2d 422, 428 (Minn. 1989); People v. Wesley, 140 Misc. 306, 332, 533 N.Y.S.2d 643, 659 (Sup. Ct. 1989)

To combat the problem of population substructure, the F.B.I. laboratory has instituted a procedure of "binning" the allele. The fixed bin structure places the allele in a bin that represents a cluster of alleles; thus, an "overestimation of frequencies" is attained "which favors the defendant." United States v. Yee, 134 F.R.D. 161, 182 (1990). An expert testifying for the court in the *Yee* case was skeptical about the procedure. Dr. Lander expressed concern over the method, testifying that "the fact that . . . it might turn out to be right doesn't mean that it's got valid scientific method underlying it." *Id.* at 183. This scientific concern over population substructure remains a critical legal issue.

Band Shift

Another problem area in DNA testing is "band shifting." Band shift occurs when test lanes on the gel do not run uniformly. Differences in DNA concentration or other sample conditions can contribute to this difference in lanes. Thus, sometimes the bands do not align perfectly even though one person's DNA is tested. From an evidentiary perspective, the question is whether this misalignment is due to band shift (same person and thus a match) or because two different persons are involved.

Band shifting has been noted in a number of cases. In *Caldwell*, the DNA tests showed signs of band shift, but the court still allowed the evidence of a match to be admitted. 393 S.E.2d at 443. In a Maine case, a sample tested by Lifecodes showed signs of band shifting, and the prosecution withdrew the evidence. Norman, *Maine Case Deals Blow to DNA Fingerprinting,* 246 Science 1556, 1557 (1989).

In response to this problem, the F.B.I. has instituted quality control procedures, which include running test lanes in the gel along with the evidence samples. Some experts have been skeptical that these safeguards are sufficient. In *Yee* a defense expert indicated that "the unpredictability of band shifting at the F.B.I. laboratory adversely affects the population database work." 134 F.R.D. at 179. A F.B.I. expert, however, has stated that if band shifting occurs "outside the limit required to declare a match, there are really only two alternatives: Declare that the samples don't match or that the evidence is inconclusive." Norman, *supra* at 1557. In other words, false positives will not result from band shifting.

Contamination

Another potential problem is contamination and degradation of the DNA sample. Most forensic samples are obtained in less than ideal conditions. Therefore, the samples can be contaminated or degraded in a number of ways. If insufficient amounts of DNA are present in the sample, autorads may be hard to detect or not appear at all. Also,

forensic samples can contain contaminants or DNA from additional sources that interfere with the use of restriction enzymes or gel electrophoresis. Therefore, age, environmental exposure, and possible contamination of the sample all play a part in whether a successful DNA analysis can be run.

Different scientific studies have examined the problem of sample degradation. Dr. Alec Jeffrey's study found that sufficient high molecular weight DNA can be extracted from 4-year old blood and semen samples. Gill, Jeffreys & Werrett, *Forensic Application of DNA "Fingerprints,"* 318 Nature 577 (1985). Another study examined the effects of ultraviolet light, heat, humidity, and soil contamination on DNA samples. The study concluded that of the four categories "[s]oil or its contaminants does appear to affect the DNA integrity." McNally, Shaler, Barid, Balazs, DeForest & Kobilinsky, *Evaluation of DNA Isolated From Human Bloodstains Exposed to Ultra-violet Light, Heat, Humidity, and Soil Contamination,* 34 J. Forensic Sci. 1059 (1989).

A prosecution expert in the *Yee* case testified:

> I think the conclusion is essentially for all the environmental insults that have been described, one of three things can happen. Either it has no effect on the outcome of the analysis, or it leads to . . . the difference (destruction) of the DNA in its entirety. Or under some circumstances it leads to a pattern on the gel which is so obviously distorted and inappropriate that it leads to an (inconclusive). 134 F.R.D. at 176.

In other words, even if contamination is a problem, it will not result in false positives. But two defense experts testified that the effects of environmental insults were "unresolved" and "felt that more validation studies should be done." *Id.* at 178 & 180.

Quality Assurance

Critics have attacked DNA laboratories for failing to establish quality control procedures to safeguard against technical and human error. The lack of outside proficiency testing programs and inspections has become an important issue. TWGDAM has published proficiency testing guidelines. *Guidelines for a Proficiency Testing Program for DNA Restriction Fragment Length Polymorphism Analysis,* 17 Crime Lab. Digest 59 (Jul. 1990). TWGDAM stands for "Technical Working Group on DNA Analysis Methods" and is sponsored by the F.B.I. In addition, a bill, entitled the DNA Proficiency Act of 1991, has been introduced in Congress. *See* Hicks, *Understanding the DNA Proficiency Testing Act of 1991,* 18 Crime Lab. Digest 3 (Jan. 1991).

NOVEL SCIENTIFIC EVIDENCE

Generally, the courts have used two different standards to determine the admissibility of scientific evidence. The traditional test is the *Frye* or "general acceptance" test. The *Frye* test requires that a novel scientific procedure be generally accepted by the relevant scientific community before evidence derived from that procedure is admissible. *See* Giannelli, *The Admissibility of Novel Scientific Evidence: Frye v. United States, Half-Century Later,* 80 Colum. L. Rev. 1197 (1980).

A substantial minority of courts have rejected the *Frye* test in favor of what is known as the "relevancy" test. The Ohio Supreme Court took this approach in State v. Williams, 4 Ohio St.3d 53, 446 N.E.2d 444 (1983). *See* Giannelli, Ohio Evidence Manual § 702.08 (1988) (admissibility of scientific evidence). Under the relevancy approach, general acceptance by the scientific community is just one factor that may be considered in determining the reliability of scientific evidence.

CASES ADMITTING DNA EVIDENCE

A majority of courts that have considered the admissibility of DNA evidence have ruled such evidence admissible. "First introduced into U.S. criminal proceedings in 1986, forensic DNA analysis has since been admitted into evidence in at least 185 cases by 38 States and U.S. military as of January 1, 1990." OTA Report at 14. That report is now over a year old. Today, there are many more favorable rulings. The Ohio cases include: State v. Blair, No. 2659, 1990 Ohio App. Lexis 5812 (Dec. 24, 1990); State v. Lee, No. 90CA004741, 1990 Ohio App. Lexis 5311 (Dec. 5, 1990); State v. Pierce, 1990 WL 97596 (Ohio App. Jul. 9, 1990).

Other Cases

Other reported cases include: United States v. Jakobetz, 747 F. Supp. 250 (D. Vt. 1990); Martinez v. State, 549 So.2d 694 (Fla. Ct. App. 1989); Andrews v. State, 533 So. 2d 841 (Fla. Dist. Ct. App. 1988), *rev. denied,* 542 So.2d 1332 (Fla. 1989); Caldwell v. State, 260 Ga. 278, 393 S.E.2d 436 (1990); People v. Thomas, 137 Ill. 2d 500, 561 N.E.2d 57 (1990), *cert. denied,* 111 S. Ct. 1092 (1991); Smith v. Deppish, 48 Crim. L. Rep. 1524 (Kan. Mar. 1, 1991); Cobey v. State, 80 Md. App. 31, 559 A.2d 391, *cert. denied,* 317 Md. 542, 565 A.2d 670 (1989); People v. Shi Fu Huang, 145 Misc.2d 513, 546 N.Y.S.2d 920 (Sup. Ct. 1989); State v. Pennington, 327 N.C. 89, 393 S.E.2d 847 (1990); State v. Ford, 392 S.E.2d 781 (S.C. 1990); State v. Wimberly, 49 (BNA) Crim. L. Rep. 1016 (S.D. Mar. 20, 1991); Glover v. State, 787 S.W.2d 544 (Tex. App. 1990); Kelly v. State, 792 S.W.2d 579 (Tex. App. 1990), *rev. granted* Oct. 10, 1990; Spencer v. Commonwealth, 240 Va. 78, 393 S.E.2d 609 (1990), *cert. denied,* 111 S. Ct. 281 (1990); Spencer v. Commonwealth, 238 Va. 275, 384 S.E.2d 775 (1989), *cert. denied,* 110 S. Ct. 759 (1990); State v. Spencer, 238 Va. 295, 384 S.E.2d 785 (1989), *cert. denied,* 110 S.Ct. 1171 (1990); State v. Woodall, 385 S.E.2d 253 (W.Va. 1989).

See generally Annotation, *Admissibility of DNA Identification Evidence,* 84 A.L.R.4th 313 (1991).

United States v. Yee

One of the leading DNA cases was tried in the federal court in Toledo: United States v. Yee, 134 F.R.D. 161 (N.D. Ohio 1991). Magistrate James Carr held an extensive six-week hearing and wrote an exhaustive report, in which he discussed both the scientific and legal issues. In addition, each side was represented by able attorneys who had access to impressive expert witnesses. DNA evidence was admitted.

Scientific Support

Moreover, these cases are supported by much of the scientific community. The theory and much of the procedures used in DNA testing are not disputed. The OTA

report found that "forensic uses of DNA tests are both reliable and valid when properly performed and analyzed by skilled personnel." OTA Report at 7-8.

Nevertheless, qualifications appear even in some of the reports and cases that favor DNA evidence. For example, the OTA report also recognized that "[s]erious questions are raised . . . about how best to ensure that any particular *test result* is reliable." OTA Report at 83 (emphasis in original). The report goes on to identify several issues: "These questions focus on data interpretation, how to minimize realistic human error, and the appropriate level of monitoring to ensure quality. Such questions, which stem from actual court cases, underscore the need to develop both technical and operational standards now." *Id.*

Moreover, Magistrate Carr's report contains several disquieting passages:

> [T]he F.B.I. program of proficiency testing has serious deficiencies . . . United States v. Yee, 134 F.R.D. at 208.
>
> I do not either disregard or discount the accuracy of many of the criticisms about the remarkably poor quality of the F.B.I.'s work and infidelity to important scientific principles.
>
> [R]esearch must be undertaken to devise a means of responding more fully to the possibilities of substructure . . . *Id.* at 210.

CASES EXCLUDING DNA EVIDENCE

The acceptance of DNA evidence by the courts has not been universal. There have a number of "problem" cases.

The Initial Cases

The most publicized case rejecting DNA evidence was People v. Castro, 144 Misc. 2d 956, 545 N.Y.S.2d 985 (Sup. Ct. 1989). It was also one of the first cases in which the defense mounted a serious challenge to admissibility. The ruling in *Castro*, however, was quite limited. The court accepted the general validity of DNA evidence; it ruled only that the results in *Castro* were inadmissible. *See* Harmon, *How Has DNA Evidence Fared? Beauty is in the Eye of the Beholder,* 1 Expert Evidence Reporter 149 (Feb. 1990).

In *Castro* two experts for the prosecution and two for the defense met, with the approval of the other experts. They issued a joint statement, which included the following conclusions:

> [T]he DNA data in this case are not scientifically reliable enough to support the assertion that the samples and . . . do or do not match.
>
> If this data were submitted to a peer reviewed journal in support of a conclusion, it would not be accepted. Further experimentation would be required. *See* Lander, *DNA Fingerprinting On Trial,* 339 Nature 501, 504 (1989).

The fact that Castro later pleaded guilty does not diminish the significance of the case. *Castro* raised the possibility that fundamental flaws existed, at least in the procedures of one DNA laboratory. *See id.*

Castro was followed by the *MaCleod* case, in which the prosecutor withdrew the DNA evidence after the defense successfully challenged Lifecodes' procedure for dealing with band shifting. Norman, *Maine Case Deals Blow to DNA Fingerprinting,* 246 Science 1556 (Dec. 1989).

In *New York v. Neysmith* the defendant was charged with rape. To prove his innocence, the defendant hired Lifecodes to compare this blood with semen samples from the crime scene. The laboratory excluded the defendant based on its results. The prosecutor then obtained a court order for a second test. Lifecodes reported that the second sample did not match the first sample submitted. Blood and semen samples were then sent to Cellmark, which confirmed Lifecodes original exclusion of the defendant. Lifecodes later admitted to the prosecutor that an error had occurred. Lander, *DNA Fingerprinting On Trial,* 339 Nature 501, 505 (1989).

See also State v. Wheeler, No. C89-0901CR (Washington Co., Oregon) (Mar. 8, 1990 ruling excluding DNA evidence from trial).

Proficiency Tests Results

Then in State v. Schwartz 447 N.W.2d 422, 426 (Minn. 1989), the Minnesota Supreme Court cited a proficiency test in which Cellmark, another commercial laboratory, made a false identification in a proficiency test:

> We are troubled by the fact that Cellmark admitted having "falsely identified two samples as coming from the same subject" during a proficiency test performed by the California Association of Crime Laboratory Directors (CACLD). Out of 44 total samples, Cellmark made one incorrect match, which was considered too high an error rate by some experts.

The Court went on to exclude the evidence. The OTA Report summarizes these proficiency tests:

> With respect to blind trials of forensic DNA testing in the United States, CACLD [California Association of Crime Laboratory Directors] organized trials using case-simulated samples in 1987 and 1988. The three major commercial facilities then performing forensic DNA analysis participated in each trial. In the first trial, out of 50 samples, 2 firms each declared 1 false match that *could have resulted in the conviction of an innocent person.* The errors apparently arose from sample handling problems. The third company declared no false matches. In the second trial, one company again reported an incorrect match. Office of Technology Assessment, Genetic Witness: Forensic Uses of DNA Tests 79-80 (1990) (emphasis added).

A False Positive

Some supporters of DNA evidence have claimed that the "possibility of coming up with a false positive is virtually impossible." Labaton, *DNA Fingerprinting Under Increasing Criticism,* The (Canton) Repository, Jun. 24, 1990, at H7 (quoting John Hicks, Assistant Director of FBI Laboratory Division). Nevertheless, a recent account of an Illinois murder case revealed a "false positive" in a homicide prosecution: "Cellmark shortly determined that Lifecodes had made a significant measurement mistake in sizing the bands on the autorads." Starrs, *The Fallibility of Forensic DNA Testing: Of Proficiency in Public and Private Laboratories — Part One,* 14 Scientific Sleuthing Review 10 (Spring 1990) (discussing People v. Irons, Erie, Illinois). *See also* Starrs, *The Fallibility of Forensic DNA Testing: Of Proficiency in Public and Private Laboratories — Part Two,* 14 Scientific Sleuthing Review 12 (Fall 1990)

(discussing two cases in which FBI analysts mistranscribed population frequencies statistics in reporting DNA results).

Recent Cases

A number of recent cases have also excluded DNA evidence. In United States v. Two Bulls, 918 F.2d 56 (8th Cir. 1990), the Eighth Circuit ruled that the trial court erred by admitting DNA evidence without first determining whether the "testing procedures used by the FBI lab in this case were conducted properly." *Id.* at 61. Accordingly, the court remanded with instructions for the trial court to rule as a matter of law "(1) whether DNA evidence is scientifically acceptable, (2) whether there are certain standard procedures that should be followed in conducting these tests, and (3) whether these standards were followed in this case." *Id. See also Ex Parte* Perry, 49 Crim. L. Rep. (BNA) 1113 (Ala. Sup. Ct. April 19, 1991) (prosecution failed to establish DNA tests were properly performed).

In Commonwealth v. Curin, 409 Mass. 218, 565 N.E.2d 440 (1991), the Massachusetts Supreme Court held that DNA evidence had *not* gained general acceptance in the scientific community. Cross-examination of a prosecution expert developed the following information:

> The prosecution's expert, who was a Cellmark employee, acknowledged that there was uncertainty concerning the appropriateness of the assumptions Cellmark made about the use of its data base for the determination of genetic probabilities. . . No study of Cellmark's data base had been published. . .565 N.E. at 443 n. 9.

In People v. Fleming, 90-CR-2716 (Cook Co. Ct., Ill. Mar. 12, 1991), a County Circuit Court ruled DNA evidence inadmissible. The court wrote: "[T]here is substantial disagreement within the scientific community as to the population genetics issues that are central to the F.B.I.'s method of calculating statistical probabilities." *Id.* at 35. Accordingly, general acceptance within the scientific community had not been achieved. *See also* State v. Despain, No. 15589 (Ariz. Super. Ct. Feb. 12, 1991) (holding FBI DNA procedures not generally accepted).

DNA EVIDENCE FOR THE DEFENSE

In a number of cases the defense, not the prosecution, has attempted to rely on DNA evidence. Indeed, its first forensic use by Dr. Jeffreys in England involved the exculpation of a suspect. OTA Report at 8.

In State v. Woodall, 385 S.E.2d 253 (W.Va. 1989), the West Virginia Supreme Court upheld the admissibility of DNA evidence. The test had been sought by the defense, but the trial judge refused to permit the test pretrial. A posttrial test proved inconclusive, possibly because an insufficient sample existed. A recent newspaper account states that a later DNA test exonerated Woodall, who was seeking a new trial. Here, the prosecutors are claiming the test is unreliable. Cleveland Plain Dealer, Mar. 27, 1991, at 3C, col. 4.

In Dabbs v. Vergari, 48 Crim. L. Rep. 1275 (N.Y. Sup. Ct. Nov. 29, 1990), the court ruled that a defendant convicted of rape in 1984 is entitled to have evidentiary samples subjected to DNA analysis.

Sometimes, however, things do not turn out the way one expects. Rickey Hammond, accused of kidnaping and rape, was tried in Hartford, Connecticut. A DNA expert from the F.B.I. testified for the defense; he said that semen stains taken from the victim's panties did not come from Hammond. Nevertheless, the jury convicted. Ewing, "Conn. Jury Disregards DNA Test," Nat'l L.J., April 23, 1990, at 9, col. 1.

PRETRIAL DISCOVERY

The need for extensive pretrial discovery in DNA cases is obvious. Yet, opposition to discovery is not uncommon. In *Spencer* the defense sought discovery of the expert's "work notes," which formed the basis of his report. The Virginia Supreme Court ruled that they were not discoverable. 384 S.E.2d at 791.

In United States v. Yee, 129 F.R.D. 629 (N.D. Ohio 1990), the government also opposed discovery of DNA analysis performed by the FBI. The defense sought production of matching criteria, environmental insult studies, population data, and proficiency tests. The prosecution argued that these materials were not scientific "reports" under Fed. R. Crim. P. 16(a)(1)(D). In an important decision, Magistrate Carr ruled that "predicate materials" were discoverable. The need for discovery was underscored by the lack of "extensive independent scientific assessment and replication of the reliability of the procedures that have been developed by the F.B.I. . ."*Id.* at 631.

Other courts also have recognized the need for discovery. One court wrote: "The fair trial and due process rights are implicated when data relied upon by a laboratory in performing [DNA] tests are not available to the opposing side for review and cross-examination." State v. Schwartz, 447 N.W.2d 422, 427 (Minn. 1989). Moreover, the court in People v. Castro, 144 Misc. 2d 956, 545 N.Y.S.2d 985 (Sup. Ct. 1989), recognized the need for extensive discovery:

> The proponent, whether defense or prosecution, must give discovery to the adversary, which must include: 1) Copies of autorads, with the opportunity to examine the originals. 2) Copies of laboratory books. 3) Copies of quality control tests run on material utilized. 4) Copies of reports by the testing laboratory issued to proponent. 5) A written report by the testing laboratory setting forth the method used to declare a match or non-match, with actual size measurements, and mean or average size measurement, if applicable, together with standard deviation used. 6) A statement by the testing lab, setting forth the method used to calculate the allele frequency in the relevant population. 7) A copy of the data pool for each loci examined. 8) A certification by the testing lab that the same rule used to declare a match was used to determine the allele frequency in the population. 9) A statement, setting forth observed contaminants, the reasons therefore, and tests performed to determine the origin and the results thereof. 10) If the sample is degraded, a statement setting forth the tests performed and the results thereof. 11) A statement setting forth any other observed defects or laboratory errors, the reasons therefore and the results thereof. 12) Chain of custody documents. *Id.* at 978-79, 545 N.Y.S.2d at 999.

These decisions are supported by the American Bar Association standards on discovery, which state:

> The need for full and fair disclosure is especially apparent with respect to scientific proof and the testimony of experts. This sort of evidence is practically impossible for the adversary to test or rebut at trial without an advance opportunity to examine it closely. ABA Standards Relating to Discovery and Procedure Before Trial 66 (Approved draft 1970).

The issue is discussed in detail in Giannelli, *Criminal Discovery, Scientific Evidence, and DNA*, 44 Vanderbilt L. Rev. 793 (May 1991).

DEFENSE EXPERTS

In 1989 the Virginia Supreme Court upheld the admissibility of DNA evidence in Spencer v. Commonwealth, 238 Va. 295, 384 S.E.2d 785 (1989), *cert. denied*, 110 S.Ct. 1171 (1990). Spencer was convicted of burglary, rape, and murder, and he was sentenced to death. A DNA expert from Lifecodes testified that the statistical likelihood of finding duplication of Spencer's particular DNA pattern, which matched the evidence pattern, was 1 in 705 million.

Prosecution experts "testified unequivocally that there was no disagreement in the scientific community about the reliability of DNA print testing," *Id.* 305, 384 S.E.2d at 792, and there was "no dissent whatsoever in the scientific community." *Id.* at 314, 384 S.E.2d at 797. Later cases, however, demonstrate that there is indeed a "dissent" in the scientific community.

The lack of defense experts is not surprising. With novel scientific evidence there is often a delay before independent experts appreciate how science is being used in the courtroom. When "voiceprint" evidence was introduced in the 1970s, the same problem existed. A National Academy of Sciences report noted that a "striking fact about the trials involving voicegram evidence to date is the very large proportion in which the only experts testifying were those called by the state." National Academy of Sciences, On The Theory and Practice of Voice Identification 49 (1979). *See also* People v. Chapter, 13 Crim. L. Rep. (BNA) 2479 (Cal. Super. 1973) ("In approximately eighty percent of the twenty-five [voiceprint] cases in which such expert testimony/opinion was admitted there was no opposing expert testimony on the issue of reliability and general acceptability of the scientific community . . .")

One of the justifications for the *Frye* rule, which requires the scientific technique gain "general acceptance" in the scientific community as a prerequisite to admissibility, focuses on this point: The *Frye* test guarantees that "a minimal reserve of experts exists who can critically examine the validity of a scientific determination in a particular case." United States v. Addison, 498 F.2d 741, 743-44 (D.C. Cir. 1974).

Right to Expert Assistance

Securing expert assistance may not be easy for indigent defendants. One article reports: "In recent DNA cases in Oklahoma and Alabama, . . . the defense did not retain any experts, because the presiding judge had refused to authorize funds." Neufeld & Colman, *When Science Takes the Witness Stand,* 262 Scientific American 46, 53 (May 1990).

The U.S. Supreme Court recognized a limited constitutional right to expert assistance in Ake v. Oklahoma, 470 U.S. 68 (1985), and many states recognize this right by statute. *See generally* P. Giannelli & E. Imwinkelried, Scientific Evidence ch. 4 (1986).

The need for expert assistance is obvious when DNA evidence is first encountered at trial.

CONCLUSION

This article briefly summarizes some of the legal issues that have arisen in the DNA cases. Despite some initial problems, the use of DNA evidence will probably become a fact of life in criminal trials. The underlying theory and much of the implementing procedures are scientifically sound. Nevertheless, defense attorneys should not accept the admission of such evidence without challenge — too many things have gone wrong in the initial cases.

REFERENCES

P. Giannelli & E. Imwinkelried, Scientific Evidence (Supp. 1990); Office of Technology Assessment, Genetic Witness: Forensic Uses of DNA Tests 79-80 (1990); Farley & Harrington (editors), Forensic DNA Technology (Lewis Pub. 1990); L. Kirby, DNA Fingerprinting: An Introduction (Stockton Press 1990); Burk, *DNA Identification: Possibilities and Pitfalls,* 31 Jurimetrics J. 53 (Fall 1990); Thompson & Ford, *DNA Typing: Acceptance and Weight of the New Genetic Identification Tests,* 75 Va. L. Rev. 45 (1989).