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DNA Fingerprinting: A Guide to Admissibility and Use

Ricardo Fontg

Comment

DNA Fingerprinting: A Guide to Admissibility and Use

I. INTRODUCTION

Forensic scientists have long hoped for the ability "to identify the origin of blood and body-fluid stains with the same degree of certainty as fingerprints."[1] Recent advances in recombinant deoxyribonucleic acid ("DNA") research offer scientists the necessary technology. Consequently, DNA technology now provides the judicial system with a powerful new test to identify criminal suspects and to trace paternity.

Every individual, except an identical twin, possesses a unique genetic "blueprint" known as DNA. DNA is found in every chromosome of every cell in the human body; thus, an individual's blood, semen, skin, and hair can provide virtual positive identification of that person through his or her DNA.[2] Because of this unique pattern, scientists can use DNA tests to identify individuals much like criminologists use fingerprints to identify individuals.

DNA fingerprinting has several forensic applications. First, DNA evidence recovered from the scene of a crime can link a suspect to the crime.[3] In particular, DNA tests are quite useful in rape cases,[4] where the outcome of the prosecution often hinges on the victim's word against the word of the alleged attacker. DNA tests can also be utilized in cases where the court is attempting to determine a child's father. Because "[p]ortions of DNA are transmitted from parent to child . . . DNA tests can tell the courts whether two people are related by comparing their DNA."[5] Third, DNA tests are also helpful to determine whether a crime is part of a series of crimes or whether it is merely a "copy-cat" crime. Police can compare DNA obtained from different crime scenes and determine whether there were different perpetra-

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1. Barbara E. Dodd, *DNA Fingerprinting in Matters of Family and Crime,* 26 NATURE 506, 506 (1985).

2. *See* Ricki Lewis, *Witness for the Prosecution,* DISCOVER, June 1988, at 47.

3. Laurel Beeler & William R. Wiebe, Comment, *DNA Identification Tests and the Courts,* 63 WASH. L. REV. 903, 955 n.2 (1988).

4. *Id.*

5. *See id.* at 905 n.2.

tors.[6] Finally, DNA fingerprinting can be used to exculpate wrongly accused individuals.[7]

Many scientists firmly accept the scientific reliability and accuracy of DNA fingerprints.[8] Consequently, genetic fingerprinting is quickly becoming an established identification tool in law enforcement. A variety of issues must be resolved, however, as applications of DNA fingerprinting become more widespread. In addition to these issues, doubts are beginning to surface concerning the accuracy of DNA fingerprinting; some scientists and commentators question DNA fingerprinting's infallibility in application. In short, there are no empirical studies to date that support the claims of infallibility asserted by the companies that conduct DNA tests for law enforcement agencies.[9]

This Comment discusses the current law regarding DNA fingerprinting. A discussion of the history and development of DNA will familiarize the reader with DNA, its forensic applications, and the laboratories that perform the tests. In addition, this Comment discusses evidentiary and constitutional concerns relating to DNA fingerprinting. Such concerns will be evaluated both from the defense's and the prosecution's perspective to provide guidelines when defending or prosecuting a claim involving DNA evidence. In its final section, this Comment discusses the future of DNA fingerprinting in the courts and compares it to the advent of fingerprint and polygraph evidence, examining their benefits and weaknesses.

II. AN OVERVIEW OF DNA FINGERPRINTING

DNA fingerprinting was discovered in 1985 during the study of other genetic phenomena known as "hypervariable regions."[10] The DNA technique arose by chance from research "that was not aimed specifically at solving

6. *Id.* at 956.

7. *Id. See also* Clare M. Tande, *DNA Typing: A New Investigatory Tool,* 1989 DUKE L.J. 474, 474-75 (citing Regina v. Pitchfork, THE TIMES (London), Jan. 23, 1988, at col. 1 (Leicester Crown Court Jan. 22, 1988)) (by using DNA fingerprinting, English law enforcement authorities not only exculpated an innocent man, but also apprehended the true murderer when all other leads proved useless).

8. "The use of DNA probes has been so thoroughly assimilated into molecular biology that . . . it is hard to know how we get along without them." Beeler & Wiebe, *supra* note 3, at 907.

9. *See infra* notes 109-30 and accompanying text.

10. Beverly Merz, *DNA Fingerprints Come to Court,* 259 JAMA 2193, 2193 (1988).

practical problems."[11] Currently, three private laboratories[12] as well as the F.B.I. laboratory[13] engage in DNA fingerprinting.

Historically, "DNA tests were developed for use in the field of molecular biology in the search for the chromosomal location of particular genes, such as those that cause inherited diseases."[14] These tests were developed to allow physicians to predict the presence of an inherited disease at an early stage, thus allowing early treatment and successful cure of the disease.[15] In the clinical setting, "DNA tests have helped identify the defective DNA associated with Huntington's disease, Duchenne muscular dystrophy, sickle cell disease, cystic fibrosis, and other afflictions."[16]

Although specific laboratory procedures for DNA analysis vary, a general familiarity with how the tests work is useful to understand how DNA tests identify individuals:

> First, DNA is extracted from the forensic sample, such as semen, blood, or other cellular tissue. Second, the long strands of molecules which make up the DNA are chemically cut into fragments. These fragments are sorted by length. Third, a radioactive "probe" is added. This probe binds with specific portions of the DNA to create a pattern, which varies from individual to individual. Because the probe is radioactive, the pattern can be captured on x-ray film. Fourth, the pattern is compared with the pattern produced by the suspect's DNA. If the patterns match, the forensic sample is linked with a high degree of certainty to the suspect. If they do not match, the forensic sample did not come from the suspect.[17]

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11. Dodd, *supra* note 1, at 511 (Dr. Alec Jeffreys developed DNA fingerprinting. He is a British geneticist and professor of genetics at the University of Leicester, England).

12. The three private labs providing DNA testing are Lifecodes in Valhalla, N.Y.; Cellmark Diagnostic in Germantown, Md.; and Cetus Corp. in Emeryville, Cal. The three companies specialize in different approaches. Lifecodes concentrates on combinations of single-locus probes, Cellmark on multilocus and single-locus probes, and Cetus on the dot-blot method (Basically, the three DNA printing approaches differ in the clarity and sensitivity of the final result. *See infra* notes 34-41 and accompanying text for further distinctions among the three labs.).

13. Andrew H. Malcolm, *F.B.I. Opening Doors to Wide Use of Genetic Tests in Solving Crimes,* N.Y. TIMES, June 12, 1989, at A1, col 1 (the F.B.I. lab is also analyzing all three of the methods utilized by the private companies to determine the most appropriate one for various forensic situations).

14. Beeler & Wiebe, *supra* note 3, at 905; *see also* Ray White & Jean-Marc Lalouel, *Chromosome Mapping with DNA Markers,* SCI. AM., Feb. 1988, at 40.

15. *See* Beeler & Wieber, *supra* note 3, at 905 n.11.

16. *Id.* n.12-16.

17. *Id.* For an excellent overview of DNA fingerprinting, see generally Dan L. Burk, *DNA Fingerprinting: Possibilities and Pitfalls of a New Technique,* 28

The method of obtaining a DNA print varies among labs, but the principles behind the methodologies are constant. The process begins by extracting the DNA from a specimen of blood, semen, hair, or skin.[18] Once extracted and placed under a high-power microscope, the DNA appears like a ladder that has been twisted into a spiral. This structure is called the double helix. Within the double helix are four molecules that can be analogized to chemical building blocks. The sequence of these chemical blocks determines an individual's genetic code.[19]

Much of a person's genetic code, such as the number of arms and legs and fingers and toes, remains the same from individual to individual, and cannot be used to differentiate sample cell groups.[20] Other areas of the DNA, however, vary from one person to the next, with each configuration of chemical building blocks displaying a unique pattern.[21]

These areas are the regions that were being researched when the process for DNA typing was discovered.[22] It is in these regions that samples provide identification unique to a particular individual.[23] Enzymes are used to cut the DNA into sections to facilitate viewing the pattern of these regions.[24]

JURIMETRICS J. 455 (1988). Another introductory article discussing the new technique is K. F. Kelly et al., *Method and Application of DNA Fingerprinting: A Guide for the Non-scientist,* 1987 CRIM. L. REV. 105.

18. *See generally* Lewis, *supra* note 2, at 47-49.

19. The four chemical building blocks are adenine (A), cytosine (C), guanine (G), and thymine (T). They make up the sides of the double helix, each chemical building block only joining with its pair on the other side of the "ladder." A always attaches with T, and G with C, so that the sequence of building blocks on one strand is always complemented by the sequence on the other strand. *See generally id.* at 47-48.

20. *Id.* at 47.

21. *Id.* These areas are referred to as "junk DNA" as well as "mini-satellites" and "hypervariable regions." *See* Merz, *supra* note 10, at 2193.

22. *See* Merz, *supra* note 10 and accompanying text.

23. *Id.* at 2193; *see also* Thomas H. Maugh II, *"Fingerprints" in DNA Hold Identity Clues,* L.A. TIMES, Dec. 20, 1985, at I 1, col. 3.

24. CHARLES MCCORMICK, MCCORMICK ON EVIDENCE, § 205, at 74-75 (3d ed. Supp. 1987). Restriction enzymes cut the DNA strands whenever they encounter a specific sequence in the genetic code (the sequence of chemical building blocks in the DNA). The sites at which a restriction enzyme will chop a length of DNA thus depends on the DNA sequence; for example, the restriction enzyme Pst 1 always cuts at the sequence CTG-CAG. Because the restriction enzymes cut the DNA at characteristic locations, restriction fragments of various lengths are produced, usually in the range of several hundred to several thousand base pairs of chemical blocks. The mini-satellite regions, those unique to every individual, are excised by the restriction enzymes that have cut the DNA strands at the specified sequences of chemical building blocks or "stable regions," which flank either end of it. *See* Merz, *supra* note 10, at 2193.

These sections are then organized by size, and the excised fragments neatly aligned.[25] At this stage, the "DNA fingerprint" can be analogized to a conventional fingerprint before it has been dusted.[26]

To make the DNA print, man-made DNA probes are introduced to the DNA fragments.[27] The probes are tagged radioactively and contain those sequences of the chemical building blocks that determine individual traits. The probes attach themselves to the DNA fragments in which they fit.[28]

A piece of x-ray film is then placed over the probes that attached to the DNA fragments. After the film is developed, black bars on the film mark the location of the probes.[29] Because the individual traits encoded by the DNA in these regions differ from person to person, the bars from each of the different probes appear at different locations for each individual. The resulting pattern appears something like a supermarket bar code used on groceries.[30] This pattern is the unique DNA fingerprint.

The DNA print is an x-ray that can be displayed on a light box.[31] When the bar codes from two different samples match, the samples came from the same person.[32] In addition to this visual examination to determine a match, statistics are also employed. By consulting a database of how frequently a pattern appears, the DNA evidence is even more convincing.

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25. MCCORMICK, *supra* note 24, § 205, at 74. The sections are organized through a process called electrophoresis. Electrophoresis is a method to separate particles for both preparative and analytical studies of macromolecules. The particles are separated primarily by their charge and to a lesser extent on the basis of their size and shape. J. STENESH, DICTIONARY OF BIOCHEMISTRY 149 (1989). DNA restriction fragments are separated by electrophoresis to make the unique pattern that serves as the identity profile, or "DNA fingerprint." Thomas H. Maugh II, *Genetic Fingerprinting Joins Crime War*, L.A. TIMES, Jan. 7, 1988, at I 3, col. 1. Although electrophoresis is a part of the technique for making a DNA print, in the realm of scientific evidence, electrophoresis refers more specifically to the technique used by forensic scientists for separating red cell enzymes and serum proteins. *See* PAUL C. GIANELLI & EDWARD J. IMWINKELRIED, SCIENTIFIC EVIDENCE § 17-8(C), at 594-95 (1986).

26. *See* Lewis, *supra* note 2, at 49.

27. *Id.*

28. *Id.*

29. *Id.*

30. *Id.* Advocates of the technique say that the appearance of the DNA print in this fashion is an advantage because it can be explained easily to a jury. "Everyone is different and we just match them up," said Peter Gill, one of the researchers who developed the technique. Stephen Strauss, *DNA Fingerprinting*, TECH. REV., Feb.-Mar. 1988, at 8.

31. Lewis, *supra* note 2, at 50.

32. Debra Cassens Moss, *DNA—The New Fingerprints*, A.B.A. J., May 1, 1988, at 69.

> If DNA from two individuals is compared, the chances are about 20% that any given band will appear in both DNA fingerprints. The chances that two given bands will be present in both samples is [sic] 4%. And the chances that all 15 will be present in both are virtually nil: about three in 100 billion—or somewhat greater than the chance that conventional fingerprints from two individuals will be identical.[33]

Thus, according to its proponents, DNA fingerprinting can identify or exonerate an individual with virtual certainty.

According to officials at Cellmark Diagnostics, the company that holds an exclusive North American license to market Dr. A. J. Jeffreys' DNA technique, there is only a one in 30 billion chance that any two persons' DNA prints will match and create a false positive result (except in the case of identical twins).[34] The two other labs in the United States that offer DNA typing—Lifecodes Corporation and Cetus Corporation—claim slightly different rates of reliability. Lifecodes, which uses a technique very similar to Cellmark, claims a 99.9 percent probability that biological samples are derived from the same person if their two DNA patterns match.[35] Unlike the other two companies, Cetus does not guarantee that its typing will identify a suspect with virtual certainty;[36] it claims only that "one out of every several thousand people . . . could have left a particular sample."[37] Cetus, however, can type smaller biological samples than the other two companies because it uses a technique that "amplifies" the target DNA by creating numerous copies of it. Theoretically, Cetus can test a sample as small as a single hair cell,[38] and the company has actually produced a print from a sample as small as 40 sperm heads.[39] The other labs, Cellmark and Lifecodes, require larger samples, such as several hundred thousand sperm heads or a well-soaked blood stain the size of a quarter.[40] Unfortunately, police are less likely to find samples of this size at the typical crime scene. Indeed, many Cellmark

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33. Maugh *supra* note 23, at I 1, col. 1. The odds are measured in terms of millions or billions to one that two people will have the same genetic pattern. The figure most often cited is one in 30 billion. Merz, *supra* note 10, at 2193. *Compare id.* with Maugh, *supra* note 23, at I 3, col. 2 (the odds that conventional fingerprints from two individuals will be identical are about one in 64 billion).

34. Mark Thompson, *DNA Fingerprinting: Who Does it and How,* 8 CAL. LAW., June 1988, at 41.

35. *Id.*

36. *Id.*

37. *Id.*

38. *Id.*

39. *Id.*

40. *Id.*

and Lifecodes tests have produced inconclusive results because the samples were too small for their methods to work effectively.[41]

III. BENEFITS OF DNA FINGERPRINTING

The primary advantage of DNA typing is its remarkable accuracy and thus its ability to provide nearly positive identification. This accuracy is especially true of the Cellmark and Lifecodes techniques. Advocates of DNA typing in criminal investigations claim that the method can identify suspects with "virtual certainty."[42] DNA typing works much like fingerprinting and is much more accurate than traditional blood, semen, or hair-typing tests.[43]

DNA typing is particularly effective in rape cases. First, the method can test each semen sample of sufficient size.[44] Testing techniques traditionally used in rape investigations identify suspects based on antigens—proteins that are normally present in semen.[45] Nearly twenty percent of all males, however, do not secrete antigens, and thus traditional testing methods cannot identify those males.[46] DNA typing does not have this limitation, however, because semen always leaves DNA prints. Another advantage of DNA typing in rape cases is that the DNA found in sperm can be separated from the vaginal cells that are often mixed with sperm in forensic samples.[47] Although this mixing often has thwarted attempts at traditional testing of semen, it will not hinder DNA typing.[48]

DNA typing is also unique because of the range of forensic samples that it can test. Potential samples include blood, semen, hair, and skin scrapings.[49] Police are more likely to find these kinds of samples at crime scenes than fingerprints, particularly in rape investigations where semen samples may be the only available evidence.[50]

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41. *Id.*
42. Moss, *supra* note 32, at 66.
43. *Id.*
44. *Id.*
45. *Id.*
46. *Id.*
47. *See* Peter Gill et al., *Forensic Application of DNA 'Fingerprints,'* 318 NATURE 577, 577 (1985) ("sperm nuclei can be separated from vaginal cellular debris, obtained from semen-contaminated vaginal swabs, enabling positive identification of the male donor/suspect").
48. Burk, *supra* note 17, at 464.
49. Moss, *supra* note 32, at 66.
50. *See, e.g.,* United States v. Two Bulls, 918 F.2d 56 (8th Cir. 1990).

DNA typing can also be performed on forensic samples that have dried and aged, whereas traditional tests cannot.[51] The DNA's structure is sufficiently hardy so that law enforcement authorities may reopen old cases and compare forensic samples from a number of crimes, even if the samples have aged substantially, to see whether the same assailant was involved. Successful tests have been performed on samples up to four years old.[52]

Since the development of DNA fingerprinting as a forensic tool, proponents of the technique have predicted the establishment of a DNA data bank.[53] One commentator has urged as follows:

> Law enforcement officials have a sparkling, once-in-a-lifetime opportunity to take a dramatically bold step forward to significantly reduce crime in our state . . . .
>
> A data bank of bodily tissues taken from the scene of each unsolved crime (as well as solved crimes) needs to be established on an urgent basis. This data bank would represent a counterpart to the presently established fingerprint files but with an even greater capacity to resolve unsolved crimes. Blood specimens, hairs, mucous fluids, semen, and other human evidence removed from the scene of a crime must be saved and classified. In that manner, arrested detainees could have their DNA structure obtained upon detention, and checked against the data bank of unsolved crimes.[54]

The first data bank was established in King County, Washington, where an ordinance required everyone convicted of sex offenses to be "genetically fingerprinted."[55] The fingerprints are on file, ready for use in future investigations.[56] In 1985, California passed a law ordering all convicted sex offenders to provide blood and saliva specimens upon release from prison.[57]

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51. Moss, *supra* note 32, at 66.

52. Burk, *supra* note 17, at 464 ("Success has been reported in fingerprinting DNA from dried blood and semen samples up to four years old.").

53. *See* Philip Hilts, *New Crime Identification Tool Devised,* WASH. POST, Sept. 20, 1987, at A23 (according to James E. Starrs, attorney and forensic expert at George Washington University, "police will build DNA identification files like the massive fingerprint files that now exist); Gary Marx, *DNA "Fingerprints" May One Day Be Our National ID Card,* WALL ST. J., Apr. 20, 1989, at A14 (discussion of the possibility of DNA fingerprints as identifiers for national data banks).

54. Jerry Boris, *Time is Now for DNA Data Base,* PA. L.J. REP., Mar. 28, 1988, at 2.

55. Rob Stein, *Genetic Fingerprints: A Boon to Law Enforcement or a Rights Violation?,* PA. L.J. REP., May 2, 1988, at 12.

56. *See id.* at 10.

57. CAL. PENAL CODE § 290.2 (West 1988 & Supp. 1990). Because prisoners have limited Fourth Amendment rights, requiring them to provide blood and saliva samples does not appear to be a constitutional violation even absent individualized

These samples, numbering over 4,200 in 1988, will be submitted for DNA analysis and the results stored in a computerized forensic DNA data bank.[58]

Law enforcement authorities could easily computerize the data from DNA prints because of their bar code structure.[59] Fingerprints have occasionally been computerized, but their structure is too complex to accurately symbolize and to efficiently search by computer.[60] In contrast, DNA prints are easy to symbolize in a numeric form that is suitable for computer access.[61]

California Attorney General John Van de Kamp has called for a statewide computerized database of DNA fingerprints so that local police can use the system to match crime scene evidence to potential suspects.[62] Other states are considering establishing computerized genetic data banks of individuals convicted of violent crimes,[63] and the FBI is proposing a data bank as well.[64]

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suspicion. *See* Bell v. Wolfish, 441 U.S. 520, 546 (1979) (body cavity searches of inmates permitted without probable cause or reasonable suspicion); Ferguson v. Caldwell, 392 F. Supp. 750, 752 (D. Ariz. 1975) (no probable cause or warrant required for blood sample from prisoners). This restricted Fourth Amendment protection, however, appears to further the interest in effective prison management rather than the interests in future law enforcement.

58. Stephen G. Michaud, *DNA Detectives,* N.Y. TIMES, Nov. 6, 1988, § 6 (Magazine), at 73; *see also* CAL. PENAL CODE § 290.2 (West 1988).

59. Thompson, *supra* note 34, at 42.

60. *Id.*

61. California Attorney General John Van de Kamp predicts that within three to five years his office will have a database of genetic fingerprints on computer. When the system is on-line, local law enforcement officials say that "most rapists might as well leave calling cards at the scene of their crime." *Id.* at 42. Van de Kamp also has expressed concern, however, that such a database may threaten privacy interests. "It is one thing to have fingerprints and criminal histories accessible to tens of thousands of police officers . . . . It is another to have information on-line that can mark you as a carrier of AIDS, or prove that you are not genetically related to either of your parents." Moss, *supra* note 32, at 70.

62. *Id.* at 70.

63. Marx, *supra* note 53, at A14, col. 1.

64. Moss, *supra* note 32, at 70. The FBI reports that it expects to digitalize DNA test results, providing a variety of identification applications. *See* Michaud, *supra* note 58, at 104; *see also* Merz, *supra* note 10, at 2194 (reporting that the FBI is planning to build a DNA fingerprint computer data bank).

IV. POTENTIAL PROBLEMS WITH THE FORENSIC USE OF DNA TESTS

DNA tests can be performed only if the biological sample contains a sufficient amount of DNA.[65] For example, DNA tests currently require a bloodstain roughly the size of a quarter.[66] An insufficient sample, however, does not affect the reliability of DNA tests. If an inadequate sample is tested, the test is unreadable and produces no identification, and thus neither falsely incriminates an innocent suspect nor exculpates a guilty one. Therefore, an inadequate sample size does not affect the reliability of DNA tests because the results are merely inconclusive when an inadequate sample is tested.

Despite the attempts of some members of the legal community to prevent the use of the forensic technique until it is proven reliable enough to withstand judicial scrutiny, the promise of DNA identification evidence in criminal cases has proven too tempting for law enforcement officials to resist.[67] The technique has gained popularity at an exponential rate from its introduction in the United States in 1987.[68] The method was hailed initially as "foolproof" and 99 percent positive; such exaggerations were based on the testimony of interested parties, such as scientists from those companies that sell their test results at a profit and prosecutors who use the results to gain convictions.[69] Caught off guard by the storm, and perhaps assuming that there was no way around the damning evidence, defense attorneys were unable to combat the evidence effectively or find scientists to testify as experts against the procedure.

The first case to challenge the infallibility of DNA profiling was *People v. Castro,*[70] a double murder case in New York. Twenty-year-old Vilma Ponce and her two-year-old daughter were stabbed to death in their apartment on February 5, 1987. There were few leads until police arrested the building's superintendent, Joseph Castro, and found some dried blood that he said was his own in the grooves of his watch. Prosecutors sent that specimen, samples

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65. The use of DNA tests in paternity cases should not be affected by the sample size and environmental factors because an ample supply of high quality DNA material is available from all the parties.

66. George F. Sensabaugh, *Forensic Biology—Is Recombinant DNA Technology in its Future?,* 31 J. FORENSIC SCI. 393, 395 (1986).

67. In September 1987, only one-third of the nation's crime lab directors thought DNA typing was ready for forensic use. Mark Thompson, *DNA's Troubled Debut,* 8 CAL. LAW., June 1988, at 36, 44.

68. *Id.* at 41.

69. Dr. Michael Baird of Lifecodes stated, "If you're a criminal, it's like leaving your name, address, and social security number at the scene of the crime. It's that precise." Lewis, *supra* note 2, at 44.

70. 545 N.Y.S.2d 985 (Sup. Ct. 1989).

of the victims' blood, and a sample of Castro's blood to Lifecodes for DNA typing. Lifecodes declared a match between the DNA in the blood on the watch and the DNA in Vilma Ponce's blood. If the case had followed the normal course of events in prior cases involving DNA evidence, Castro would have pleaded guilty immediately, doubting his ability to fight the evidence in court.[71]

This case did not, however, follow the usual course of events. Defense attorneys Barry Scheck and Peter Neufeld located experts who agreed to testify against the admission of the DNA typing evidence. For twelve weeks New York Supreme Court Acting Judge Gerald Sheindlin listened to experts from both sides.[72] The defense experts uncovered such serious blunders committed by Lifecodes in performing the test that the prosecution's main expert witnesses recanted their position. In an unprecedented move, two expert witnesses for the defense and two for the prosecution, after consulting outside the courtroom, issued a statement declaring, "[t]he DNA data in this case are not scientifically reliable enough to support the assertion that the samples . . . do or do not match. If these data were submitted to a peer-reviewed journal in support of a conclusion, they would not be accepted. Further experimentation would be required."[73] Ultimately, Judge Sheindlin ruled the evidence of the match inadmissible.

People v. Castro highlighted the disparity between theory and reality. Members of the scientific community engaged in related diagnostic research should note the critical importance of the technique as applied to forensics. The relevance of this issue is a disparity in practice between scientists in forensic research and scientists in diagnostic research. For example, standards in the research laboratory do not need to be as strict as in the forensic laboratory.[74] Perhaps the most important difference is that in the forensic process an individual's future is linked directly to the accuracy of the result.

Recent literature reveals critical flaws in the application of the diagnostic technique to forensics that render DNA testing unreliable from a scientific standpoint. The main criticism is not that the test will never be reliable, but that the lack of uniform standards and quality controls allow problems in the technique to go unnoticed, thus resulting in the scientifically unreliable declaration of a match.[75]

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71. *See generally,* Marshall Ingwerson, *DNA Fingerprints: When the Proof is in the Genes,* CHRISTIAN SCI. MONITOR, Apr. 12, 1988, at 3.

72. *Castro,* 545 N.Y.S.2d at 985.

73. Eric S. Lander, *DNA Fingerprinting on Trial,* 339 NATURE 501, 504 (1989).

74. William C. Thompson & Simon Ford, *DNA Typing: Acceptance and Weight of the New Genetic Identification Tests,* 75 VA. L. REV. 45, 56-57 (1989).

75. Lander, *supra* note 73, at 501.

Recent court decisions have focused not on the reliability of the scientific theory behind DNA fingerprinting, but on the specific procedures followed in a particular case. Before results of the DNA typing technique can be accepted as scientifically reliable in forensics, the following controls and standards must be developed: (a) controls to ensure the accurate interpretation of results; (b) standards for declaring matches; (c) standards for determining the probability of a coincidental match and for determining the relevant population studies; (d) standards for record keeping; and (e) standards for proficiency testing in licensing.

A. Lack of Controls to Ensure Accurate Interpretation of Results

In the forensic laboratory, there are three problem areas that can lead to errors in declaring matches between samples of DNA. One area concerns the problems inherent in any scientific laboratory engaged in this type of research—namely, the problems of contamination and laboratory slop.[76] Second, specific to the forensic laboratory are the likely problems of contamination and degradation of the forensic sample. For example, evidence left at room temperature can be degraded by bacteria.[77] Finally, an inescapable problem, for forensic DNA profiling specifically, is the complexity of the results and potential examiner bias in interpreting those results. All three areas can cause the examiner to declare an improper match and can remain undetected unless specific controls are employed.

In *State v. Wimberly*,[78] the Supreme Court of South Dakota had to determine whether DNA fingerprinting evidence provided sufficiently reliable results for use in court. Specifically, the *Wimberly* court had to determine whether FBI procedures were sufficiently reliable. Although the court held DNA fingerprinting admissible, it stated that DNA fingerprint evidence remains subject to attack on other grounds:

> Issues pertaining to relevancy or prejudice may be raised. For example, expert testimony may be presented to impeach the particular procedures used in a specific test or the reliability of the results obtained. (citations omitted). In addition, traditional challenges to the admissibility of evidence such as the contamination of the sample or chain of custody questions may be presented. These issues relate to the weight of the evidence. The

76. Thompson & Ford, *supra* note 74, at 87 n.188.
77. People v. Miles, 577 N.E.2d 477, 483 (Ill. App. Ct. 1991).
78. 467 N.W.2d 499 (S.D. 1991).

evidence may be found to be so tainted that it is totally unreliable and, therefore, must be excluded.[79]

Reproducibility is the fundamental test for acceptance of results in the scientific community. For example, in *State v. Williams,*[80] the court stated that where there was testimony concerning the "guidelines for procedures and standards in the scientific community at large which allow [DNA] researchers to obtain reliable, reproducible results," then "the trial court did not err in admitting the evidence of the DNA testing and DNA identifications by finding the evidence to be reliable, scientific evidence."[81]

In *People v. Castro,*[82] the faulty interpretations of the autoradiographs were not reproducible. Many of the problems experienced in *Castro* can be rectified by implementing proper controls to catch errors and ensure accurate interpretation. Until proper controls are researched and implemented, the results obtained in DNA typing tests is not reliable.

B. Lack of Standards for Declaring Matches

Even today, when interpretation of the banding pattern is generally considered reliable, there is still a basic problem of lack of objective criteria in the scientific community for declaring a match.[83] With the advent of standard procedures promulgated by the FBI,[84] however, it is likely that laboratories engaged in DNA fingerprinting will adopt such procedures, thus creating a uniform system for declaring matches. In fact, *People v. Miles*[85] held that DNA evidence of a match was admissible where an expert witness had testified that Cellmark laboratory had adopted a written protocol for testing, and Cellmark followed the "Technical Working Group-Interagency Working Group of DNA Methodology" guidelines promulgated by the FBI.[86]

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79. *Id.* at 506 (citations omitted).

80. No. 1-90-175, 1991 WL 156545 (Ohio Ct. App. Aug. 16, 1991) (citing State v. Thomas, No. 90-AP-547 (Ohio Ct. App. June 11, 1991)).

81. *Id.* at *3.

82. 545 N.Y.S.2d 985 (Sup. Ct. 1988).

83. *See* Lander, *supra* note 73, at 501; Thompson & Ford, *supra* note 74, at 88.

84. *See generally* State v. Nelson, Cr.A. Nos. IK89-09-0882 to IK89-09-0884, 1991 WL 190308 (Del. Super. Ct. Sept. 11, 1991). For a detailed explanation of the FBI guidelines, *see id.* at *4 (citing United States v. Jakobetz, 747 F. Supp. 250 (D. Vt. 1990) (the six steps promulgated by the FBI are as follows: (1) extraction of the DNA; (2) restriction or digestion; (3) gel electrophoresis; (4) southern transfer; (5) hybridization; and (6) autoradiography)).

85. 577 N.E.2d 477 (Ill. App. Ct. 1991).

86. *Id.* at 483.

Cellmark's expert also testified that Lifecodes Corporation and all state and local crime laboratories performing DNA research utilized the same procedures as Cellmark.[87]

In *Miles,* the defendant cited numerous cases where Cellmark's testing procedures were found so unreliable that their results were inadmissible as evidence.[88] The court, noting that Cellmark had adopted the FBI's guidelines, discussed the specific procedures followed at Cellmark:

> When a case arrives at Cellmark, it is assigned to one person, who is responsible for performing tests and following testing procedures. Cellmark requires its scientists follow a written protocol in performing tests. Expiration dates ensure chemicals used in the processes are fresh. [The expert] testified instruments and equipment are kept in working order. A second Cellmark employee witnesses all steps in the chain of custody as well as many test procedures. Once the autorads are developed, the molecular biologist presents them to a Ph.D. scientist for review. The Ph.D. scientist reviews the entire case file in interpreting the autorad. Two Ph.D. scientists separately review each case and each writes a report of findings. The reports are combined in the final document sent to the client. A laboratory supervisor reviews the report before it is released to the client.[89]

The *Miles* court noted that any question concerning specific procedures used by the company would go to the weight of the evidence rather than its admissibility.[90] The court, however, said it may need to exclude the evidence entirely if the procedures are shown to produce an unreliable result.[91]

The determination of a standard for declaring matches can never be truly objective. The question of where to set the threshold determination for declaring a match is ultimately a policy question. The dilemma that is raised can be illustrated as follows: If a sample matches another sample in ten out of twelve bands, it is more likely that the two extra bands were produced by slop rather than that two random individuals sharing those ten bands in common. If the examiners adopt a high threshold for matches, they may exculpate a suspect whose DNA profile is a match. If the threshold is too low, they may declare a match between two different individuals and inculpate the innocent.[92]

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87. *Id.* at 481.
88. *Id.*
89. *Id.* at 483-84.
90. *Id.* at 483.
91. *Id.*
92. Thompson & Ford, *supra* note 74, at 88-91.

Thus, even if the scientific community defines matching standards, the standards will necessarily be subjective in nature. If the FBI is allowed to promulgate these standards, it is arguable that the state's need to fight crime will take precedence over the desire to protect individual rights. A low threshold for declaring a match threatens the presumption of innocence given a criminal defendant and undermines a justice system predicated on the notion that it is better to let the guilty go free than to condemn the innocent.

C. Lack of Standards for Determining Probability of a Coincidental Match and Lack of Relevant Population Studies

It is axiomatic to DNA fingerprinting that only an individual's DNA taken as a whole is unique.[93] Thus, the importance of DNA profiling lies in a scientist's ability to compare as many bands as possible between two samples, and if they appear to match, to calculate the probability that this match could be a coincidence. There are no standards in the scientific community for such calculations because diagnostic research does not require this step. The methods used to determine the probability statistic are likely to remain hotly contested by both the prosecution and the defense, because once the declaration of a match is in evidence, the jury might consider the statistical probability of a random match to determine if the sample found at the scene is indeed the defendant's.

The probability determinations involved in this calculation are currently problematic. The most important criticism is the choice of the relevant population when determining the probability of a coincidental match. For instance, the earlier quoted statistic that the chance that two individuals would share the same DNA profile is one in thirty billion is based on a study of fourteen British Caucasians.[94] Based on such a small homogeneous population, which could have a very different distribution of alleles than the population at large, the data generated simply does not translate into a reliable overall statistic for anyone in the population.[95]

The sufficiency of the size of the database used for population studies is a source of much debate.[96] There is no scientific consensus on the proper

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93. *See, e.g., Ex parte* Perry, No. 89-1534, 1991 WL 84132 (Ala. Apr. 19, 1991); State v. Davis, No. 71694, 1991 WL 134460 (Mo. July 23, 1991).

94. *See* Alec J. Jeffreys et al., *Hypervariable 'Minisatellite' Regions in Human DNA*, 314 NATURE 67, 68 (1985).

95. Burk, *supra* note 17, at 465-66.

96. In Cobey v. State, 559 A.2d 391 (Md. Ct. Spec. App.), *cert. denied*, 565 A.2d 670 (Md. 1989), where the court decided that the Cellmark DNA test results were reliable, the defendant unsuccessfully claimed that Cellmark's database of 700 individuals was insufficient, but had no expert witnesses to refute the four prosecution

database size from which it is acceptable to project statistics for an entire population.[97] For instance, the studies published by Lifecodes on allele frequency in a population have been based on small groups of about 200 or 300 people, mostly from New York.[98] Until a much wider database is built, statistical estimates about frequencies of alleles in the entire population should be conservative.[99]

Additionally, the lack of recordkeeping standards is far from trivial in evaluating the reliability of DNA fingerprint evidence. Validation and reproduction of the results by referring to accurate and complete records is crucial to the reliability of the technique. For example, Lifecodes failed to record which of its probes were contaminated, and continued to use and sell such probes, which could produce false positives in a DNA typing test.[100]

D. Lack of Proficiency Testing and Licensing Standards

"Forensic science, including DNA testing, is operating in a no man's land where there are no accredited standards for the laboratories," according to forensic evidence expert Randolph Jonakait.[101] Dr. Eric Lander echoes this sentiment: "At present, forensic science is virtually unregulated—with the paradoxical result that clinical laboratories must meet higher standards to be

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expert witnesses who claimed that the database fell within generally accepted scientific criteria.

The Florida District Court of Appeal similarly rejected appellant's arguments in Andrews v. State, 533 So. 2d 841, 850 (Fla. Dist. Ct. App. 1988), that Lifecode's database of 710 samples was too small to be statistically significant. The court cited testimony that stated as the database expands, the probability numbers do not drastically change. There were also no defense experts in this case to refute such testimony.

97. In *Andrews,* Dr. Baird testified that no one worries too much about the size of the database and appeared to base his statement on the fact that there was so little published on the subject. *Andrews,* 553 So. 2d at 849-50. The only set of guidelines of which he knew was a 1982 American Association of Blood Banks publication stating that database sizes from two to five hundred should be adequate. *Id.* This publication occurred before the development of forensic DNA typing, however, which studies many different rare alleles in the population, unlike paternity testing or protein gel electrophoresis.

98. *See* Thompson & Ford, *supra* note 74, at 84 n.177.

99. Mary-Claire King, *Invited Editorial: Genetic Testing of Identity and Relationship,* 44 AM. J. HUM. GENETICS 179, 180 (1989).

100. Thompson & Ford, *supra* note 74, at 94-96.

101. Timothy Clifford, *DNA Bills Stalled by Challenge,* NEWSDAY, June 15, 1989, at 5.

allowed to diagnose strep throat than forensic labs must meet to put a defendant on death row."[102]

Critics have lamented the lack of proficiency in forensic laboratories in the past. In a three-year study funded by the Justice Department, forensic laboratories received identical dried blood stains; 71.2 percent of the 128 labs participating in the study either mistyped the sample or reported inconclusive results.[103] This lack of proficiency in state laboratories is frightening, as most DNA typing will ultimately be performed by these same laboratories.

In 1987, the California Association of Crime Laboratories conducted the only proficiency testing to date of the three private laboratories engaged in DNA typing. Fifty samples were sent to each lab. Cetus and Cellmark mistakenly matched unrelated samples.[104] They did not complete fifty tests without inculpating an innocent person—surely an unproficient result. Although Lifecodes called all fifty samples correctly, its researchers, rather than the technicians who usually perform tests, completed the tests.[105] This type of testing is not nearly as rigorous as blind testing programs, where blind tests are interspread among real cases. The test only required stating whether there was a match, and not how close the match was or where the bands were located; thus the laboratories had a fifty percent chance of obtaining the correct result. Prudence dictates that passing a battery of blind tests should be required before a crime laboratory is allowed a license to make determinations that affect an individual's freedom.

A demand for specific licensing requirements is particularly appropriate because some individuals have urged caution, advising against readily accepting DNA fingerprinting as reliable evidence without considering the further verification of the test results' accuracy.[106] One concern is that most expert witnesses, who are strongly supportive of the test, come from the

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102. Lander, *supra* note 73, at 505.

103. Beeler & Wiebe, *supra* note 3, at 929 n.136.

104. Marcia Barinaga, *DNA Fingerprinting: Pitfalls Come to Light*, 339 NATURE 89, 89 (1989). They identified the problems as the non-binding of DNA to a filter and the accidental mixing of two samples.

105. *Id.*

106. California Attorney General John Van de Kamp once voiced strong objections to the immediate use of DNA fingerprints, although he envisioned a DNA data bank to be developed within three to five years. He currently has changed his position, however, and believes that the technique is now ready for use in criminal cases. Mark Thompson, *The Myth of DNA Fingerprints,* 9 CAL. LAW., 1989, at 34, 37.

commercial laboratories that offer DNA testing. It has been argued[107] that such testimony is equivalent to promotion of the companies' product.[108]

E. Statistical Evidence and Its Effect on the Jury

The admissibility of DNA fingerprints involves two types of evidence: evidence of a match between the samples, and statistical evidence of a random match.[109] The reliability of the statistics provided by commercial laboratories has not yet been exhaustively researched and documented. One suggestion is that the only truly accurate method to prove that no two individuals share the same DNA fingerprint is to test the entire population.[110] Obviously, there has been no such undertaking. Commercial laboratories are reluctant to discuss the bases of their statistics, but they claim to use sufficient population bases as approved by the American Association of Blood Banks.[111] The reliability of statistics based on DNA fingerprints obtained from crime scenes, rather than under ideal laboratory conditions, has yet to be extensively tested.[112] Again, once the FBI assumes a more active role in the field, the reliability of the statistics should become more firmly determined.[113]

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107. *See* Burk, *supra* note 17, at 468; *see also* Joseph P. Fried, *Prosecutors Move to Give DNA Evidence in Rape,* N.Y. TIMES, Sept. 30, 1988, at 16 (Defense attorney Kerry J. Katsorhis challenged the reliability of DNA evidence in a New York rape case: "You are relying on one group of people [Lifecodes] who are guns for hire, who are paid to testify.").

108. *Cf.* People v. Kelly, 549 P.2d 1240, 1249 (Cal. 1976) (an advocate of voiceprint analysis who testifies as an expert "may be too closely identified with the endorsement of voiceprint analysis to assess fairly and impartially the nature and extent of any opposing scientific views"); People v. Tobey, 257 N.W.2d 537 (Mich. 1977) (questioning whether a leading proponent of a technique could fairly testify about the admissibility of the technique).

109. *See generally* People v. Miles, 577 N.E.2d 477 (Ill. App. Ct. 1991).

110. *See* Sensabaugh, *supra* note 66, at 395. "The uniqueness of these 'fingerprints' can be truly established only by testing of all individuals, both living and dead. Clearly this is not possible, yet anything less leaves open the hypothetical possibility of an unobserved duplication." *Id.*

111. *See* Beeler & Wiebe, *supra* note 3, at 926.

112. *Id.* "To avoid concerns that environmental contamination could potentially produce false or misleading results, continued empirical testing must be conducted to clearly delineate the limits of DNA tests and to advise controls for the environmental factors which could affect analysis." *Id.*

113. A spokesman for the FBI, giving his opinion regarding control of DNA technology, stated, "[F]orensics is a public activity." Thompson, *supra* note 34, at 44 (quoting John Hicks, deputy assistant director of the FBI).

Recent state decisions have begun dealing with the issue of population frequency statistics in their analyses of DNA fingerprinting. In *People v. Miles,*[114] the Illinois Court of Appeals discussed how Cellmark Laboratories generated statistical probabilities of a random sample:

> The general procedure for generating such statistical probabilities begins by comparing the DNA from the evidence . . . to the DNA in the suspect's blood sample to determine if there is a match. If so, then the suspect's DNA is compared to information in Cellmark's African-American data base to determine the probability of an African-American other than the defendant leaving the semen stain on the bed sheet. [The Cellmark expert] testified the probability was 1 in 300,000.[115]

The defendant in *Miles* argued that Cellmark's population statistics created "a danger of producing misleading information."[116] The court held, however, that as an integral part of DNA identification process, the generation of probability statistics was admissible under the *Frye* standard.[117]

In *State v. Brown,*[118] the Supreme Court of Iowa also held that because both statistical evidence and evidence of a match are based on the same scientific methods and facts, statistical evidence should be admissible once the reliability of the scientific principles behind the testing procedure is established.[119] In *Brown,* the state introduced evidence of the reliability of the DNA fingerprinting procedure as well as the mathematical computations. The court noted, however, that its holding in *Brown* did not remove the issue of identity from the jury, which was free to disregard or disbelieve the expert testimony that had established the statistical probabilities of a random match.[120] Thus, "[t]he jury was free to compare the expert testimony and make its own judgment as to the weight to be given to the respective experts."[121]

In cases in which statistical frequencies are admitted into evidence, the prejudicial effect of such evidence on the jury presents a serious problem. Given the complex nature of the DNA testing process, coupled with the

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114. 577 N.E.2d 477 (Ill. App. Ct. 1991).

115. *Id.* at 484. The defendant in *Miles* was an African-American. *Id.* at 478. The data base for African-Americans at Cellmark consists of blood samples taken from about 200 to 300 African-Americans in Detroit, Michigan. *Id.* at 484.

116. *Id.* at 484-85.

117. *Id.* at 485; *see also infra* notes 133-37 and accompanying text for a discussion of the admissibility of DNA fingerprint evidence under the *Frye* standard.

118. 470 N.W.2d 30 (Iowa 1991).

119. *Id.* at 33.

120. *Id.* at 32-33.

121. *Id.* at 32.

extraordinarily high statistics quoted in court, jury members will likely be overwhelmed by such powerful identification evidence.[122] Indeed, DNA fingerprinting is considered extremely convincing evidence to juries who have heard hours of expert testimony and statistics regarding the improbability of misidentification or other errors in the procedure.[123] Of course, an argument that DNA evidence is unduly prejudicial succeeds only if the evidence leads the jury to decide an issue on improper grounds.[124] Evidence that simply damages a defendant's case is not prejudicial within the meaning of Rule 403 of the Federal Rules of Evidence.[125]

The Supreme Court of Alabama, in *Ex parte Perry,*[126] recognized the potential prejudicial effect that statistical evidence may have on the jury. In *Perry,* the court noted how the admissibility of DNA "matching" evidence and the admissibility of DNA population frequency statistics is not inherently interrelated.[127] From a mathematical/scientific standpoint, the court stated that evidence of a match does not automatically indicate the frequency with which a given DNA pattern might occur statistically; thus, "to establish population frequency generally requires data on the relevant populations involved as well as data for the mathematical, statistical analysis."[128]

From a legal standpoint, the *Perry* court noted that population frequency statistics may cause the jury to draw improper inferences. Namely, the court recognized the following:

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122. "[M]edia portrayal of the techniques as magically foolproof may make the admission of the test seriously misleading or prejudicial. Even the name 'fingerprinting' may create unsubstantiated beliefs and expectations in the minds of judges and jurors." Burk, *supra* note 17, at 468-69 (citing United States v. Williams, 583 F.2d 1194 (2d Cir. 1978)); *see also* Beeler & Wiebe, *supra* note 3, at 936 n.172 (collecting cases in which jurors accepted highly technical procedures without critical evaluation).

123. As one defense attorney stated: "If they print your guy with this stuff you're dead. You can't combat it. There is no defense to it." Michaud, *supra* note 58, at 89.

124. *See* FED. R. EVID. 403 advisory's committee's note.

125. Rule 403 states: "Although relevant, evidence may be excluded if its probative value is substantially outweighed by the danger of unfair prejudice, confusion of the issues, or misleading the jury, or by considerations of undue delay, waste of time, or needless presentation of cumulative evidence."
FED. R. EVID. 403; *see also* CHARLES MCCORMICK, EVIDENCE § 185 n.28 and accompanying text (Edward Cleary 3d ed. 1984).

126. No. 89-1534, 1991 WL 84132 (Ala. Apr. 19, 1991).

127. *Id.* at 12.

128. *Id.*

> [I]t is [not] necessarily wrong to inform the jury of the underlying statistical evidence but [sic] there is a real danger that the jury will use the evidence as a measure of the probability of the defendant's guilt or innocence and . . . [such] evidence will thereby undermine the presumption of innocence, erode the values served by the reasonable doubt standard, and dehumanize our system of justice.[129]

Thus, to prevent statistical evidence from having a "potentially exaggerated impact on the trier of fact," the Supreme Court of Alabama noted that otherwise admissible population statistics may be inadmissible if the prejudicial impact of the evidence outweighs its probative value.[130]

IV. ADMISSIBILITY STANDARDS USED TO EVALUATE NOVEL SCIENTIFIC EVIDENCE

Historically, federal and state courts have generally evaluated the reliability of novel scientific evidence under one of two standards: the general acceptance test first stated in *Frye v. United States*[131] (the "Frye test") or the more permissive standard set forth in the Federal Rules of Evidence (the "Federal Rules test").[132]

A. The Frye Test of General Acceptance

The *Frye* test is the primary test used by federal and state courts to determine the admissibility of scientific evidence, and thus is the standard that courts probably will use to evaluate DNA tests. Under the *Frye* test, courts admit evidence derived from novel scientific techniques only when the

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129. *Id.* (citing State v. Boyd, 331 N.W.2d 480, 483 (Minn. 1983)).

130. *Id.* at 13.

131. 293 F. 1013 (D.C. Cir. 1923).

132. FED. R. EVID. 401, 403, 701, 702, and 703. For convenience, the term "Federal Rules test" will be used to describe the identical tests applied by both state and federal courts. The state test actually is based upon state rules that parallel the Federal Rules of Evidence.

All federal courts are bound to follow the Federal Rules tests, although some federal courts also apply the *Frye* test. *See infra* note 133-37 and accompanying text. Similarly, some state courts apply both state evidence rules and the *Frye* test.

Alternatives have been proposed to the *Frye* and Federal Rules tests. For example, some commentators have proposed that independent panels of experts assess novel scientific evidence before it is admitted in court, but no such plan has been implemented. *See, e.g.*, Sheila Jasanoff & Dorothy Nelkin, *Science, Technology, and the Limits of Judicial Competence*, 22 JURIMETRICS J. 266, 274 (1982).

techniques have gained general acceptance in the relevant scientific community.[133]

By requiring acceptance of the techniques by scientists, the *Frye* test attempts to ensure that the techniques are reliable.[134] In effect, a technical jury of scientists passes judgment on the probative value of the evidence before it is presented to a lay jury, which might be unduly swayed by the perceived infallibility of "science."[135] Thus, under the *Frye* test, when scientists generally accept that novel scientific techniques are reliable, courts conclude that the techniques produce admissible evidence.[136]

When evaluating highly technical procedures such as DNA tests, courts often require a high degree of acceptance by scientists.[137] Both courts and

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133. *Frye*, 293 F. at 1014. In its opinion, the *Frye* court rejected the defendant's attempt to introduce the results of a lie-detector test and stated:

> Just when a scientific principle or discovery crosses the line between the experimental and demonstrable stages is difficult to define. Somewhere in this twilight zone the evidential force of principle must be recognized, and while courts will go a long way in admitting expert testimony deduced from a well-recognized scientific principle or discovery, the thing from which the deduction is made must be sufficiently established to have gained general acceptance in the particular field in which it belongs.

Id. Evaluating the qualifications of testifying experts and determining the relevant scientific community are problems under both the *Frye* and Federal Rules tests, and are discussed *infra* at notes 165-84 and accompanying text.

134. *See* United States v. Addison, 498 F.2d 741, 743-44 (D.C. Cir. 1974) (scientists are those most qualified to assess reliability).

135. People v. Barbara, 255 N.W.2d 171, 194 (Mich. 1977). Other justifications in favor of the *Frye* test are as follows. First, the *Frye* test ensures that a minimum pool of experts will be available to assess the novel scientific technique's reliability. *See infra* notes 165-84 and accompanying text. Second, a preliminary *Frye* hearing prevents the trial from becoming a time-consuming trial of the technique itself. Reed v. State, 391 A.2d 364, 371-72 (Md. 1978).

136. Though courts usually examine only the degree of scientific acceptance, sometimes they also examine whether the techniques are reliable, that is, empirically valid. *See, e.g.*, United States v. Franks, 511 F.2d 25, 33 n.12 (6th Cir.) (general acceptance is nearly synonymous with reliability; if a scientific process is reliable or sufficiently accurate, courts may deem it generally accepted), *cert denied*, 422 U.S. 1042 (1975); State v. Hall, 297 N.W.2d 80, 85 (Iowa 1980) (general acceptance is not required for admission if the reliability of evidence is otherwise established). These cases demonstrate that judges sometimes do not apply the *Frye* test when they feel it deprives the jury of reliable evidence, but instead directly assess the reliability of the technique themselves.

137. A strict standard of general acceptance is appropriate with complex scientific procedures because the jury is likely to accept them without critical scrutiny. *See generally supra* notes 109-30 and accompanying text. The *Frye* test does not quantify

juries lack the technical expertise to independently evaluate reliability. Instead, they must depend on expert testimony and thus require that the basis for the expert testimony is well-accepted by scientists as reliable. Therefore, proponents of DNA tests should expect that under the *Frye* test courts will require a broad level of scientific acceptance of DNA tests.

B. The Federal Rules Test

The principal alternative to the *Frye* test is the test embodied in the Federal Rules of Evidence, which favor the admission of all relevant evidence.[138] Under the Federal Rules test, courts treat scientific evidence like any other expert testimony.[139] Expert testimony is admissible if it is probative, but courts may refuse to admit expert testimony if the dangers of admitting it substantially outweigh its probative value.[140]

To be probative, expert testimony must be helpful to the trier of fact[141] and the evidence must be relevant.[142] In addition, the experts must be

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the amount of scientific acceptance needed to establish reliability. Different jurisdictions require varying degrees of general acceptance, although most courts apparently recognize that some divergence of views among scientists is inevitable. *See, e.g.,* United States v. Gould, 741 F.2d 45, 49 (4th Cir. 1984) (substantial acceptance); United States v. Zeiger, 350 F. Supp. 685, 688 (D.D.C.), *rev'd,* 475 F.2d 1280 (D.C. Cir. 1972) (acceptance must be "common to many, or the greatest number; widespread; prevalent; extensive though not universal."); People v. Guerra, 690 P.2d 635, 656 (Cal. 1984) (acceptance by a "clear majority"); Commonwealth v. Lykus, 327 N.E.2d 671, 678 n.6 (Mass. 1975) ("a degree of scientific divergence of view is inevitable").

138. FED. R. EVID. 401, 403, 702, 703.

139. MCCORMICK, *supra* note 125, § 203, at 605.

140. FED. R. EVID. 403, 702.

141. "If scientific, technical, or other specialized knowledge will assist the trier of fact to understand the evidence or to determine a fact in issue, a witness qualified as an expert by knowledge, skill, experience, training, or education, may testify thereto in the form of an opinion or otherwise." FED. R. EVID. 702.

Helpfulness to the trier of fact thus requires that the expert's testimony help the jury and that the expert is sufficiently qualified. In determining helpfulness, courts also look to the degree that the expert's testimony invades the province of the jury. *See, e.g.,* State v. Black, 745 P.2d 12, 19 (Wash. 1987) (expert testimony on rape trauma syndrome is merely an opinion as to the guilt of the defendant, thereby invading the exclusive province of the finder of fact).

142. FED. R. EVID. 401. Rule 401 defines relevant evidence as "evidence having any tendency to make the existence of any fact that is of consequence to the determination of the action more probable or less probable than it would be without the evidence."

qualified[143] and the basis for their testimony must be reasonably relied upon by experts[144] in the particular field to which the scientific technique belongs.[145]

Because the Federal Rules of Evidence require that the basis for expert testimony be reasonably relied upon by qualified experts, the Federal Rules test, like the *Frye* test, requires some degree of scientific acceptance of novel scientific techniques.[146] As under the *Frye* test, acceptance by scientists ensures that the scientific techniques are reliable. The Federal Rules test, however, is not identical to the *Frye* test of general acceptance, but is a more lenient standard that favors the admissibility of scientific evidence.[147]

Although the Federal Rules of Evidence allow courts to exclude relevant scientific evidence if its probative value is substantially outweighed by the dangers of unfair prejudice or confusion,[148] courts that apply the Federal Rules test often apply a liberal admissibility standard and admit scientific evidence.[149] These courts rely on trial safeguards to offset any dangers and

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143. FED. R. EVID. 702. Whether experts are qualified seems to require a separate inquiry from the question of whether courts should admit the results of novel scientific techniques. However, courts cannot determine the admissibility of novel scientific evidence without examining expert qualifications and the basis for expert opinion. *See generally* WEINSTEIN'S EVIDENCE, para. 702[04], at 702-23 (1986).

144. FED. R. EVID. 703. Rule 703 states:

> The facts or data in the particular case upon which an expert bases an opinion or inference may be those perceived by or made known to him at or before the hearing. If of a type reasonably relied upon by experts in the particular field in forming opinions or inferences upon the subject, the facts or data need not be admissible in evidence.

Rules 401 and 702 allow experts to testify about almost anything that is helpful and relevant. Rule 703 covers the permissible basis for an expert's opinion: expert opinion may be based on sources of information that are otherwise inadmissible (because of hearsay or other evidentiary rules) as long as the expert's reliance is reasonable. FED. R. EVID. 703.

145. The evaluation of expert qualifications and the definition of the relevant scientific community are concerns under both the *Frye* and Federal Rules tests and are discussed *infra* at notes 165-84 and accompanying text.

146. Paul C. Gianelli, *The Admissibility of Novel Scientific Evidence: Frye v. U.S., a Half Century Later*, 80 COLUM. L. REV. 1197, 1239-45 (1980).

147. MCCORMICK, *supra* note 125, § 203, at 608-09; *cf.* State v. Hall, 297 N.W.2d 80 (Iowa 1980) (general acceptance is not required to admit novel scientific evidence if reliability is otherwise established), *cert. denied*, 450 U.S. 927 (1981).

148. FED. R. EVID. 403.

149. United States v. Addison, 498 F.2d 741, 744 (D.C. Cir. 1974) (scientific evidence seems mystically infallible to a lay jury); People v. Kelly, 549 P.2d 1240, 1245 (Cal. 1976) (misleading aura of certainty often envelops a new scientific process). Jurors similarly may accept without critical scrutiny the testimony of highly qualified

presume that the jury can evaluate the evidence's reliability.[150] Trial safeguards include notice that the test was administered, discovery of test results, cross-examination of experts, use of opposing experts, and cautionary instructions to the jury.

Thus, novel scientific techniques can appear reliable under the Federal Rules test even if they do not have an established track record in the scientific community.[151] Conceivably, application of the Federal Rules test could result in the admission of any relevant evidence supported by qualified expert testimony unless the dangers of prejudice or confusion are overwhelming.[152] Accordingly, courts that apply the Federal Rules test may admit the results of DNA tests more readily than courts that apply the *Frye* test.

Nevertheless, under the Federal Rules test, courts might not apply a lenient admissibility test but instead might rigorously evaluate whether DNA tests are reliable. Courts might conclude that a heightened inquiry is appropriate because jurors, lacking technical expertise, tend to accept highly technical procedures without critical scrutiny and cannot assess reliability.[153]

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experts, such as DNA experts, who often have impressive credentials. *See id.* at 1245 (jurors "give considerable weight to 'scientific evidence' when presented by 'experts' with impressive credentials"); Smith v. United States, 389 A.2d 1356, 1359 (D.C. 1978) (air of authority surrounds expert opinion), *cert. denied*, 439 U.S. 1048 (1983).

150. Data generated by scientific procedures may possess an unwarranted air of certainty even though humans interpret the data. An example is the polygraph, where a juror may assume that because a polygraph reliably measures physiological responses, the interpretation linking those responses to the subject's truthfulness also is accurate. *See, e.g.*, United States v. Alexander, 526 F.2d 161, 168 (8th Cir. 1975) (polygraph evidence is shrouded with an aura of infallibility "akin to the ancient oracle of Delphi").

151. Jurors tend to be impressed by probabilities, so it is important that these probabilities be reliable. Lawrence H. Tribe, *Trial by Mathematics: Precision and Ritual in the Legal Process*, 84 HARV. L. REV. 1329, 1331 (1971).

152. Courts may criticize the name of the DNA tests. *See e.g.*, United States v. Baller, 519 F.2d 463, 465 n.1 (4th Cir.) (the term "voiceprint" suggests an air of accuracy that is unjustified and unwarranted), *cert. denied*, 423 U.S. 1019 (1975); State v. Coolidge, 260 A.2d 547, 560-61 (N.H. 1969) (hair analysis rejected in part because it was presented as being as infallible as fingerprints), *rev'd on other grounds*, 403 U.S. 443 (1971); State v. Black, 745 P.2d 12, 19 (Wash. 1987) (the term "rape trauma syndrome" creates an aura of reliability and suggests that the alleged victim was in fact raped and that the defendant is guilty of the crime).

153. Although all federal courts must follow the Federal Rules of Evidence, some federal courts (or state courts that apply state evidence rules) also apply the *Frye* test so that novel scientific techniques must meet the standards of the Federal Rules of Evidence and be based on a generally accepted scientific theory. *See, e.g.*, United States v. Kilgus, 571 F.2d 508, 510 (9th Cir. 1978).

DNA tests involve complex scientific procedures[154] that are explained in terms of probabilities.[155] Even the names of the tests—"DNA fingerprinting" or "DNA prints"—possess an air of certainty and reliability. Under the Federal Rules test, then, courts may well apply a *Frye*-type standard and rigorously review whether DNA tests are reliable.

Thus, courts that apply the Federal Rules test might apply a strict *Frye*-type admissibility standard to DNA tests or they might apply a lenient standard to admit the test results as long as they are supported by qualified expert testimony.[156] The following section contains an analysis of whether DNA test results are admissible under either a lenient test or a strict *Frye* analysis.[157]

The ambiguity of Rule 703's reasonable reliance standard may be one reason the federal courts continue to apply the *Frye* test or apply a stricter admissibility standard when the evidence is highly technical. *See supra* note 144 (discussing the ambiguity of Rule 703). Because the determination of "reasonable reliance under rule 702 is ambiguous and within the trial court's discretion, it is difficult to predict how critically courts that apply the Federal Rules test will evaluate DNA tests. *See supra* note 143.

154. Data generated by scientific procedures may possess an unwarranted air of certainty even though humans interpret the data. An example is the polygraph, where a juror may assume that because a polygraph reliably measures physiological responses, the interpretation linking those responses to the subject's truthfulness is also accurate. *See, e.g., Alexander,* 526 F.2d at 168 (polygraph evidence is shrouded with an aura of infallibility "akin to the ancient oracle of Delphi").

155. Jurors tend to be impressed by probabilities, so it is important that these probabilities be reliable. Tribe, *supra* note 151, at 1331.

156. Although all federal courts must follow the Federal Rules of Evidence, some federal courts (or state courts that apply state evidence rule) also apply the *Frye* test so that novel scientific techniques must meet the standards of the Federal Rules of Evidence and be based on a generally accepted scientific theory. *See, e.g., Kilgus,* 571 F.2d at 510.

The ambiguity of Rule 703's reasonable reliance standard may be one reason that federal courts continue to apply the *Frye* test or apply a stricter admissibility standard when the evidence is highly technical. *See supra* note 144 (discussing ambiguity in Rule 703). Because the determination of "reasonable reliance" under Rule 702 is ambiguous and is within the trial court's discretion, it is difficult to predict how critically courts that apply the Federal Rules test will evaluate DNA tests. *Id.*

157. In this section, the discussion of whether DNA test results are admissible under the Federal Rules test is limited to the lenient Federal Rules test. The determination of admissibility under a stricter, *Frye*-type Federal rules test is covered in the discussion of admissibility under the *Frye* test.

C. Admissibility of DNA Test Results

Under both the *Frye* and Federal Rules tests, courts probably will evaluate whether DNA test results are admissible by examining the soundness of the underlying scientific principle that explains DNA tests and the reliability of the test that applies the scientific principle.[158] In addition, each DNA test introduced as evidence must be administered properly,[159] but challenges to proper administration go towards the weight given to the evidence, not towards the evidence's admissibility.[160]

1. Soundness of the Underlying Scientific Principle

The beginning of this Comment established that the underlying scientific principle of DNA tests, that individuals have unique DNA patterns, is uniformly accepted by geneticists, medical researchers, and other scientists.[161] Their research and routine analysis of DNA confirm the principle that each individual's DNA is unique and is transmitted from generation to generation.[162] Their research also confirms that DNA can be isolated from a variety of biological sources, sorted by electrophoresis, and analyzed with radioactive probes to identify specific molecular patterns in the DNA.[163]

Thus, scientists agree that it is theoretically possible to identify individuals from their unique DNA patterns. Because the underlying scientific principle is generally accepted, thereby meeting both the *Frye* and Federal

158. *See, e.g., Kilgus,* 571 F.2d at 510 (admission of evidence from infrared tracking device predicated on the reliability of the underlying theory and the technique applying the theory); City of Seattle v. Peterson, 693 P.2d 757, 758 (Wash. Ct. App. 1985) (admission of radar evidence requires a valid scientific principle and evidence that the machine reliably employs the scientific principle).

159. *See* Gianelli, *supra* note 146, at 1201. Proper application of a particular test requires equipment that is in good condition, adherence to proper procedures, and qualified persons performing the test and interpreting the results. *Id.* at 1201-02. The difference between a reliable test and proper application of the test is that a reliable test requires standardized procedures that produce replicable results while proper testing on the particular occasion requires adherence to those standardized procedures.

160. Once a court accepts a novel scientific test as reliable, evidence derived from it must still meet the standards applied to the determination of the admissibility of other evidence. *See* MCCORMICK, *supra* note 125, § 203, at 605.

161. Because it is difficult to dispute commonly-recognized genetics principles, courts probably will not dispute the underlying scientific principles of DNA tests but instead may decide to review only the use of DNA tests in crime-solving or paternity discriminations.

162. *Supra* note 5 and accompanying text.

163. *See supra* notes 17-33 and accompanying text.

Rules tests, the pertinent inquiry becomes whether DNA tests employ this theory reliably in forensic situations.

2. Reliability of DNA Tests in Forensic Situations

In evaluating the reliability of novel scientific techniques, courts generally look to three sources: expert testimony from the relevant scientific community, scientific and legal writings, and judicial opinions from other jurisdictions.[164] This section contains an analysis of whether these sources establish the reliability of forensic DNA tests. Because courts require thorough testing of scientific techniques, this section also reviews the extent to which DNA tests have been empirically validated.

a. Expert Testimony

DNA tests are so technical that courts cannot independently assess their reliability. Instead, they must depend on testifying experts.[165] Thus, courts, regardless of whether they apply the *Frye* or Federal Rules test, probably will not evaluate the content of the expert testimony on DNA, but instead will require the testifying experts to be highly qualified.[166] To date, the experts that have testified in DNA cases have been well-qualified molecular biologists who are experienced in the use and analysis of DNA.[167] This section identifies the concerns that courts may have with the qualifications of experts in future DNA cases.

In general, two types of experts are likely to testify as to the reliability of DNA tests: molecular biologists from the laboratories that perform the

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164. United States v. Downing, 753 F.2d 1224 (3d Cir. 1985) (applied the Federal Rules test; enumerated factors that courts may consider when determining the reliability of novel scientific techniques including the level of acceptance in the scientific community, the testifying expert's qualifications, the existence of specialized literature dealing with the technique, the use that has been made of the technique, expert testimony in previous cases, the novelty of the technique, frequency and type of error, and the existence of testing standards).

Under the *Frye* test, judicial reliance on a previous court's finding of general acceptance may undercut the rationale that those who are most qualified to assess reliability should do so, although presumably the other jurisdictions have heard expert testimony from those scientists. *See* United States v. Addison, 498 F.2d 741, 743-44 (D.C. Cir. 1974).

165. *See* United States v. Wilson, 361 F. Supp. 510, 513 (D. Md. 1973) ("It is the rare attorney who knows as much as the expert.").

166. Experts must be qualified to testify about a particular technique by knowledge, skill, training, or education. FED. R. EVID. 702.

167. Beeler & Wiebe, *supra* note 3, at 940 n.189.

DNA test, and molecular biologists from the academic community.[168] Both have advantages and disadvantages.

Laboratory molecular biologists who testify are generally familiar with the laboratory facilities, the testing standards, and the type of DNA test used on the sample. These experts perform or supervise numerous tests and have valuable experience with forensic samples gathered under field conditions. Nevertheless, courts may conclude that the testimony of laboratory experts is tainted. The experts have intimate connections with the laboratories and financial interests in the DNA tests, and often their reputations and careers are built on the success of the tests and the admissibility of test results. Consequently, their testimony is susceptible to charges of bias.[169] Thus,

168. The FBI is currently testing the reliability of DNA tests. Molecular biologists from the FBI are qualified to testify, although courts may not allow testimony as to reliability from other forensic scientists. *See supra* note 13 and accompanying text.

169. For example, molecular biologists from Lifecodes, Cellmark Diagnostics, and Forensic Science Associates all have personal interests in the judicial acceptance of DNA tests. *See supra* notes 34-41 and accompanying text (discussing these laboratories).

courts may discount their testimony[170] as to the reliability of DNA tests[171] and look to the academic community to assess the tests impartially.[172]

Molecular biologists from the academic community are preferable as reliability experts because they have no financial interests in DNA testing.[173] They are likely to be knowledgeable about lab procedures and use similar tests in their research. Thus, they have the necessary background to evaluate whether DNA tests identify individuals accurately and whether forensic laboratory procedures are accepted as proper by the greater scientific community. One drawback of academic molecular biologists is that they may lack first-hand experience as to the reliability of the particular type of forensic DNA test being offered as evidence,[174] and they may be unfamiliar with the

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170. Courts might avoid the effects of biased testimony by appointing their own experts under FED. R. EVID. 706. Sometimes courts do not necessarily require an unbiased expert. *In re* Agent Orange Prod. Liab. Litig., 611 F. Supp. 1267, 1279-80 (E.D.N.Y. 1985) (expert testimony may have been influenced by personal interest, but the court found this interest bore on weight, not admissibility), *aff'd,* 818 F.2d 187 (2d Cir. 1987), *cert. denied,* 487 U.S. 1234 (1988). Some courts, however, have admitted new scientific evidence only upon testimony given by impartial, disinterested experts. Courts are particularly concerned when the expert developed the technique and profits by it. People v. Kelly, 549 P.2d 1240 (Cal. 1976) (reliability of voiceprints cannot be established by individuals whose careers depend on it); People v. Young, 391 N.W.2d 270, 274-75 (Mich. 1986) (general acceptance of electrophoresis method of blood typing must be established by disinterested and impartial experts; court excluded reliability testimony by two prosecution experts who were full-time employees of law enforcement agencies). Courts may worry that personal bias of the examiners can presuppose the outcome of the test. People v. Monigan, 390 N.E.2d 562, 568-69 (Ill. App. Ct. 1979) (subjectiveness surrounds the interpretation of polygraph results; claims of accuracy for the technique seem to come only from the polygraph examiners themselves).

171. If courts determine that DNA test results are admissible, the testimony of laboratory experts is still necessary to demonstrate that the actual test, whose results are being offered as evidence, was administered properly. This testimony goes to the weight given to the evidence, not to its reliability. *See generally supra* notes 133-57 and accompanying text.

172. *Young,* 391 N.W.2d at 276-77 (admitted nonforensic scientists as experts on DNA testing because they had the understanding and experience to evaluate the evidence).

173. *See id.* at 275-76 (a certain degree of interest must be tolerated if scientists familiar with a technique are to testify at all; allowed testimony from defense expert who opposed an electrophoresis technique, was an original developer of the technique but withdrew from the project, and was possibly seeking vindication; did not allow testimony from those whose livelihood depends on the success of the technique).

174. Different forensic labs, such as Lifecodes and Cellmark, use different types of DNA tests. *See supra* notes 34-41 and accompanying text.

forensic laboratory's capabilities and procedures.[175] The academic experts can remedy these deficiencies by familiarizing themselves with the lab facilities, the testing standards, and the type of DNA test used.

Both types of experts should testify as to the reliability of current DNA tests. Their combined testimony maximizes the trier of fact's knowledge of the reliability of forensic DNA testing and minimizes the adverse effects of biased testimony.[176] A broader base of experts also ensures that the defense has access to experts to rebut the testimony of the prosecution's experts.[177]

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175. Some courts have defined expertise as direct and empirical experience, and have excluded those with only theoretical knowledge. *See* Commonwealth v. Lykus, 327 N.E.2d 671 (Mass. 1975) (voiceprints); *see also* United States v. Henerdshot, 614 F.2d 648, 654 (9th Cir. 1980) (admitted shoeprint-lifting technique based on expert testimony by crime technicians); People v. Williams, 331 P.2d 251 (Cal. Ct. App. 1958) (medical profession unfamiliar with narcotics test; court selected the relevant community as those who would be expected to be familiar with its use and admitted the test).

Narrowly defining the field of experts as only those actually using a particular DNA test may result in a community of biased experts. An expert who develops a technique and profits by it may "accept" it without regard for its reliability. Thus, courts infrequently use this approach. *See Young*, 391 N.W.2d at 277 (academic geneticists, though unfamiliar with evidentiary bloodstain analysis, need only to explain the gaps in their knowledge for their judgment to be respected).

176. The combined testimony thus ensures that the testimony of "interested" experts can be corroborated. The bigger pool of experts also can demonstrate to courts that DNA tests have been generally accepted by a larger scientific discipline than the handful of molecular biologists who perform forensic DNA tests. *See Young,* 391 N.W.2d at 276-77 (because the community of scientists having direct empirical experience with electrophoresis of evidentiary bloodstains did not seem sufficiently large to reach the *Frye* objective of general acceptance, the court looked to nonforensic scientists using the test because they had the understanding and experience to evaluate the evidence). Courts may be lenient in admitting expert testimony when the defense has profferred experts to show lack of scientific acceptance. *See* State v. Chatman, 383 A.2d 440, 442 (N.J. Super. Ct. App. Div. 1978) (allowed expert with no practical experience to testify about atomic absorption spectometry because he had read all scientific literature and was familiar with the problems of the technique).

177. Only a few commercial laboratories perform DNA tests, so there are not many laboratory molecular biologists who can testify. Not all courts, however, are concerned with the availability of defense experts. *See* United States v. Franks, 511 F.2d 25, 33 (6th Cir.) (admitted voiceprints in part because of the absence of defense experts), *cert. denied*, 422 U.S. 1042 (1975). Lack of defense experts may signal lack of funds, not lack of expert opposition. While the state has access to forensic laboratories and outside experts, the defense may not be able to afford experts. Arguably, if the state intends to use DNA tests, it should pay for the tests for indigent defendants. *See, e.g.,* United States v. Stifel, 433 F.2d 431, 441 (6th Cir. 1970) (if the government uses neutron activation analysis, an expensive fact-finding tool, it must pay

Courts might not allow molecular biologists to testify about statistical frequencies,[178] which may be outside the scope of their expertise.[179] One solution is to retain genetic statisticians to testify regarding genetic marker frequencies. Many molecular biologists have some formal training in statistics, however, which should be sufficient to allow them to explain the DNA tests in terms of statistics.[180]

Finally, once courts determine that a particular DNA test is reliable, technicians with a lower level of education, such as a bachelor of science

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for the tests for indigent defendants), *cert. denied,* 401 U.S. 994 (1971).

A related concern is that the defense must have notice that the prosecution has run a DNA test. *See, e.g.,* United States v. Kelly, 420 F.2d 26, 29 (2d Cir. 1969) (neutron activated analysis was conducted after discovery; new trial ordered so defense could run its own tests).

The defense may also assert a right to retest samples. In Brady v. Maryland, 373 U.S. 83 (1963), the Supreme Court recognized a limited right to discover exculpatory evidence in the prosecution's possession. Some courts have considered whether this right translates into a right to retest samples or have evidence presented. *See* McNutt v. Superior Court, 648 P.2d 122 (Ariz. 1982) (blood samples must be preserved and disclosed). *But cf.* California v. Trombetta, 467 U.S. 479, 489 (1984) (no duty to preserve breath samples; intoxilyzer is so accurate that preservation is not likely to be exculpatory).

The defense similarly may challenge the loss or destruction of biological evidence or the failure to conduct tests. Most courts have not imposed a duty to take samples or run tests, although when a reliable and potentially exculpatory test exists, arguably such a duty should be imposed. *See, e.g.,* United States v. Henson, 486 F.2d 1292, 1298 n.3 (D.C. Cir. 1973) (no right to fingerprint analysis when police failed to perform analysis; court held that defendant had a duty to make the hands available for testing); People v. Robinson, 265 N.E.2d 543 (N.Y. 1970) (prosecution tested semen for blood type but failed to make potentially exculpatory test; court held that the defendant was denied due process when his motion for the exculpatory test was denied); *see also* Rock v. Arkansas, 483 U.S. 44 (1987) (per se state rule barring all hypnotically refreshed testimony by defendants is unconstitutional in light of present scientific knowledge).

178. *See supra* notes 109-30 and accompanying text (discussing the admissibility of statistical evidence).

179. *See, e.g.,* State v. Garrison, 585 P.2d 563 (Ariz. 1978) (Gordon, J., dissenting). In *Garrison,* the expert testified that there was an eight in one million chance that teeth marks were not made by the suspect. The dissent noted, "[W]hile Dr. Campbell may have a great deal of expertise in the actual comparison techniques of bite-mark identification, he is totally out of his field when the discussion turns to probability theory." *Id.* at 568; *see also* Dennis S. Karjala, Comment, *The Evidentiary Uses of Neutron Activation Analysis,* 59 CAL. L. REV. 997, 1031 (1971) (the qualifications of experts as chemists do not necessarily establish their competence to explain the statistical relevance of their tests).

180. *See generally* Weinstein, *supra* note 143, para. 702[04], at 702-21 to 702-29.

degree, are probably qualified to testify that they conducted DNA tests for the presence of DNA bands, found bands in specific locations, and calculated the percentage of the population that possess those bands.[181] In short, these technicians are qualified to determine whether DNA tests have been properly administered according to established procedures, which goes to the weight of the evidence. These technicians, however, are not qualified to determine whether DNA tests are significantly reliable so that the test results are admissible. The expertise of molecular biologists is necessary to assess the reliability and admissibility of DNA tests, testing procedures, and population frequencies. Accordingly, under both the *Frye* and Federal Rules tests, proponents of DNA tests will make persuasive presentations as to reliability by using molecular biologists as experts.[182]

Although courts rely primarily on expert testimony in determining reliability,[183] DNA tests must be accepted as reliable by a larger group in the scientific community than just the experts who testify for admissibility.[184] Scientific and legal writings may augment expert testimony to show the level of acceptance.

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181. *Id.*

182. Some courts require a high level of expertise. *See* People v. Young, 391 N.W.2d 270, 290 (Mich. 1986) (Boyle, J., dissenting) (for blood-typing case, majority allowed as experts only scientists, not technicians). *But cf.* State v. Crowder, 203 S.E.2d 38, 44 (N.C. 1974) (allowed forensic chemist with bachelor's of science and master's of science degrees and only 50 semester hours of chemistry to testify about atomic absorption spectrometry).

183. *See supra* notes 165-67 and accompanying text.

184. Under either the *Frye* or Federal Rules test, courts should not admit DNA tests based on a single expert's testimony, although a single expert probably could testify that a test is accepted by the scientific community. *Cf., e.g.,* United States v. Downing, 753 F.2d 1224, 1238 (3d Cir. 1985) (under the Federal Rules test, a technique that has attracted only minimal support is likely to be found unreliable); People v. Kelly, 549 P.2d 1240, 1248 (Cal. 1976) (questioned whether the testimony of a single witness is ever sufficient to represent general scientific acceptance); State v. Catanese, 368 So. 2d 975, 981 (La. 1979) (under the Federal Rules test, the testimony of a single expert is not enough to admit polygraph evidence) Burkett v. Northern, 715 P.2d 1159 (Wash. Ct. App. 1986) (one physician's testimony does not establish general acceptance of thermography because he failed to give numbers of supporters or publications supporting his statements).

b. *Scientific and Legal Writings*

A review of scientific literature confirms that individuals have unique DNA patterns and that forensic DNA tests can identify individuals reliably.[185] Most literature concerning the forensic use of DNA tests, however, is generated by commercial labs and other proponents of forensic DNA testing.[186] The literature thus is susceptible to the same charges of bias as is the testimony of experts from the commercial laboratories.[187]

Nevertheless, these articles are relevant for several reasons. First, they discuss problems, techniques, and testing methods that are unique to the forensic use of DNA tests.[188] Second, forensic journals offer the best opportunity for peer review and criticism of the various DNA tests.[189] Finally, because the authors of forensic articles concur that DNA tests are reliable, these articles suggest that the tests have achieved a certain level of scientific acceptance.[190] This acceptance, if supported by adequate empirical

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185. *See generally supra* note 8 and accompanying text.

186. *See, e.g.*, Peter Gill, *Forensic Application of DNA 'Fingerprints'*, 318 NATURE 577 (1985). Peter Gill is a scientist with the Home Offices's Central Research Establishment in the United Kingdom (an agency similar to the FBI's crime lab).

187. As a result, a court may attach more importance to the published articles of academics, whose livelihoods do not depend on the success of DNA tests. *See supra* notes 17-41 and accompanying text.

188. In the context of blood typing, one commentator has suggested that courts should be careful in assessing the adequacy of studies regarding the effects of forensic conditions (such as the effects of age and contamination of blood) because the studies often are conducted by interested parties such as law enforcement agencies (or, in the case of DNA tests, commercial laboratories). *See* Randolph N. Jonakait, *Will Blood Tell? Genetic Markers in Criminal Cases,* 31 EMORY L.J. 833 (1982).

189. Peer review journals are useful to impeach the credibility of expert witnesses or establish general acceptance because "a high standard of accuracy is engendered by various factors: the treatise is written primarily . . . for professionals, subject to scrutiny and exposure for inaccuracy, with the reputation of the writer at stake." FED. R. EVID 803 advisory committee note (learned treatises exception to the hearsay rule).

190. Because subsequent research often is reported only if there are inconsistencies or new findings, scientific literature does not document all research regarding the reliability of forensic DNA tests. Therefore, lack of refutation can be significant. David D. Dixon, Note, *The Admissibility of Electrophoresis Methods of Genetic Marker Bloodstain Typing Under the* Frye *Standard,* 11 OKLA. CITY U. L. REV. 773, 787 (1986). However, the numerous nonforensic scientific articles regarding DNA testing may allay this concern.

testing, may meet the general acceptance test of the *Frye* test[191] and the more lenient Federal Rules test.

Although courts also may review legal writings to establish whether a technique has been accepted by scientists,[192] commentators have not addressed the forensic use of DNA tests in any comprehensive detail. The legal literature that is available does support the admissibility of DNA test results.

c. Historical Development

Currently, the great majority of courts that have dealt with the issue of DNA fingerprinting have held that such evidence is admissible, whether under the *Frye* test[193] or under the Federal Rules test.[194] In addition, some states have begun legislating evidentiary statutes that make DNA evidence admissible.[195] This section will discuss the evolution of DNA admissibility and highlight key decisions since its introduction in the United States federal and state courts.

(1) *People v. Wesley*[196]

People v. Wesley involved a defendant charged with second degree burglary and with second degree murder. The prosecution sought to compare DNA found in bloodstained clothing retrieved from the defendant with DNA recovered from the deceased victim.[197] Additionally, the prosecution sought

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191. 293 F. 1013 (D.C. Cir. 1923).

192. *See supra* note 188.

193. *See e.g.,* Snowden v. State, 574 So. 2d 960, 966 (Ala. Crim. App. 1990); Smith v. Deppish, 807 P.2d 144, 159 (Kan. 1991); State v. Schwartz, 447 N.W.2d 422, 426 (Minn. 1989); State v. Davis, No. 71694, 1991 WL 134460 (Mo. July 26, 1991); Mandujano v. State, 799 S.W.2d 318, 321-22 (Tex. Ct. App. 1990); Glover v. State, 787 S.W.2d 544, 547-48 (Tex. Ct. App. 1990).

194. *See, e.g.,* King v. State, No. 05-90-00905-CR, 1991 WL 122396 (Tex. Ct. App. July 8, 1991); Burleson v. State, 802 S.W.2d 429, 441 (Tex. Ct. App. 1991); Kelly v. State, 792 S.W.2d 579, 584 (Tex. Ct. App. 1990).

195. *See e.g.,* IND. CODE ANN. § 35-37-4-13(b) (Burns 1991) (in criminal trial, DNA evidence is admissible without antecedent expert testimony that DNA evidence is reliable identification method); LA. REV. STAT. ANN. § 15.441.1 (West Supp. 1989) (providing for admissibility of DNA evidence); MD. CTS. & JUD. PROC. CODE ANN. § 10-915(c) (1989) (setting forth requirements to offer DNA evidence in a criminal proceeding); MINN. STAT. ANN. § 634.25 (West 1991) (in civil or criminal proceeding, DNA evidence admissible without antecedent expert testimony).

196. 533 N.Y.S.2d 643 (Co. Ct. 1988).

197. *Id.* at 643.

to compare the DNA from the bloodstained clothing with DNA to be extracted from defendant Wesley through a blood sample.[198]

In *Wesley,* the court recognized *Frye v. United States*[199] as the ultimate standard for the admission of scientific evidence.[200] In *Frye,* the Court of Appeals of the District of Columbia stated:

> Just when a scientific principle or discovery crosses the line between the experimental and demonstrable stages is difficult to define. Somewhere in this twilight zone the evidential force of the principle must be recognized, and while courts will go a long way in admitting expert testimony deduced from a well-recognized scientific principle or discovery, the thing from which the deduction is made *must be sufficiently established to have gained general acceptance in the particular field in which it belongs.*[201]

People v. Middleton[202] further refined the *Frye* standard, stating ". . . the test is not whether a particular procedure is unanimously endorsed by the scientific community, but whether it is generally acceptable as reliable."[203]

In *Wesley,* the court held that DNA fingerprinting satisfied the *Frye* standard because it is a scientific test that is reliable and has gained general acceptance in the scientific community.[204] In fact, not a single witness challenged the reliability or general acceptance of the DNA fingerprinting procedures.[205] The thrust of the defense's argument hinged on two propositions: (1) inadequacy of laboratory procedures, methodology, and quality control; and (2) inadequacy of the statistical analysis used to determine whether two samples match.[206]

The court rejected each of the defense's arguments.[207] The significance of this case, however, lies in the types of arguments made by the defense. The defense did not attempt to attack the evidentiary value of DNA fingerprinting. They attempted instead to establish inadequate laboratory protocol and statistical analysis. These arguments are important because, as will be discussed further, DNA fingerprinting will undoubtedly become fixed in our courts and the only available arguments to keep DNA fingerprint evidence out

198. *Id.*
199. 293 F. 1013 (D.C. Cir. 1923).
200. *Wesley,* 533 N.Y.S.2d at 645.
201. *Frye,* 293 F. at 1014 (emphasis added).
202. 429 N.E.2d 100 (N.Y. 1981).
203. *Id.* at 103.
204. *Wesley,* 533 N.Y.S.2d at 659.
205. *Id.*
206. *Id.* at 650.
207. *Id.* at 659.

of court will center around those made by the defense in *Wesley*.[208] In fact, *United States v. Two Bulls*,[209] the first federal appellate decision on the admissibility of DNA fingerprint evidence, correctly held that the issue is not whether to use the *Frye* standard, or the Relevancy test, but whether the proper laboratory procedures were followed.

(2) *Andrews v. State*[210]

In *Andrews v. State*, the defendant faced sexual battery and other charges in a burglary-related rape.[211] Over defendant's objection, the state presented DNA fingerprint evidence that matched defendant's DNA structure.[212] The sample came from a vaginal swab of the victim.[213] The defendant was convicted and subsequently appealed, contending that the trial court had abused its discretion by admitting into evidence the results of an unreliable DNA fingerprint test.[214] The court of appeals unanimously held that the DNA evidence was sufficiently relevant to be admissible under Florida Rules of Evidence.[215]

In the instant case, the Florida Court of Appeal for the Fifth District chose not to apply the *Frye* standard.[216] Instead, the court endorsed the relevancy test[217] for determining the admissibility of scientific evidence. Although the defendant challenged the admissibility of the specific DNA test administered to him,[218] the court found that the novelty of DNA fingerprint evidence called for re-examination of both the specific administration of the test and the general theory supporting it.[219]

To determine the general admissibility of DNA print evidence, the court first studied the Florida standard for admissibility of scientific evidence[220]

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208. Of course, here the author refers to arguments as to the evidentiary standards used to determine whether novel scientific evidence is admissible. Other attacks upon admissibility, such as constitutional attacks, remain viable alternatives.

209. 918 F.2d 56 (8th Cir. 1990).

210. 533 So. 2d 841 (Fla. Dist. Ct. App. 1988).

211. *Id.* at 842.

212. *Id* at 843.

213. *Id.*

214. *Id* at 842-43.

215. *Id* at 851.

216. *Id* at 846-47.

217. *Id.*

218. *Id.* at 843. Defendant's test was administered by Lifecodes Corporation.

219. *Id.*

220. *Id.* at 843-47.

and confessed its uncertainty as to *Frye's* status in Florida.[221] The Florida Supreme Court had neither accepted nor rejected *Frye*,[222] while at least two district courts of appeal had explicitly or implicitly adopted a relevancy test.[223] In recommending that Florida follow the relevancy test, the court reasoned that an approach based on the Federal Rules would, like *Frye*, prevent the admission into evidence of unreliable testimony, but would be less likely than *Frye* to exclude reliable testimony.[224]

The general acceptance standard articulated in *Frye* rests on the tacit assumption that only the scientific community may properly evaluate the reliability of scientific evidence.[225] As a result, *Frye's* general acceptance test requires courts to delegate their authority to evaluate the reliability of proffered evidence when that evidence is scientific evidence. However, *Frye* provided no guidelines for identifying either general acceptance or the relevant scientific field.[226]

The court's test is based on Federal Rules of Evidence 702 and 403.[227] Under this test, the court must determine that the proffered evidence is sufficiently reliable and material to the jury's resolution of factual disputes.[228] Evidence meeting this criteria is admissible unless its probative value is substantially outweighed by its potential to overwhelm, confuse, or mislead the jury.[229] Under this approach, lack of general acceptance does not cause inadmissibility *per se*, but weighs in the determination of whether the evidence is sufficiently reliable to assist the fact finder.[230]

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221. *Id.* at 843.

222. *Id.* at 844-45.

223. *Id.* at 844-46. Those courts were the First District Court of Appeal in Brown v. State, 426 So. 2d 76 (Fla. Dist. Ct. App. 1983) and the Fourth District Court of Appeal in Kruse v. State, 483 So. 2d 1383 (Fla. Dist. Ct. App. 1986).

224. *Andrews*, 533 So. 2d at 846-47.

225. United States v. Downing, 753 F.2d 1224, 1235-37 (3d Cir. 1984).

226. *Id.* at 1236.

227. Federal Rule 702 covers expert testimony. "If scientific, technical, or other specialized knowledge will assist the trier of fact to understand the evidence or to determine a fact in issue, a witness qualified as an expert by knowledge, skill, experience, training, or education, may testify thereto in the form of an opinion or otherwise." FED. R. EVID. 702.

Federal Rule 403 explains when relevant evidence may be excluded. "Although relevant, evidence may be excluded if its probative value is substantially outweighed by the danger of unfair prejudice, confusion of the issues, or misleading the jury, or by considerations of undue delay, waste of time, or needless presentation of cumulative evidence." FED. R. EVID. 403.

228. *Downing*, 753 F.2d at 1242.

229. *Id.* at 1237.

230. *Id.* at 1238.

Thus, having endorsed the relevancy test, the instant court then applied the test to determine the admissibility of DNA print evidence.[231] The court first examined the qualifications of the expert witnesses, all of whom testified for the state.[232] The court next considered the indicia of reliability of DNA print testing.[233] Testimony at trial revealed that DNA print testing had been in existence for ten years, its results were routinely used in other disciplines, and the procedure was generally accepted in the scientific community.[234] Finally, the court analyzed the procedures in the DNA test administered to appellant, and found each of appellant's allegations of methodological flaws to be without merit.[235] The court observed that if the DNA test is improperly administered, it ordinarily yields no result rather than an incorrect result.[236] Appellant's inability to produce experts to testify against the DNA test administered to him further weakened his case.[237]

Returning to the question of the admissibility of DNA-print evidence in general, the instant court found that such evidence met the standards for admissibility imposed by Florida's version of Federal Rule 702.[238] First, the court found the witnesses qualified as experts. Second, the DNA-print test results were helpful to the jury.[239] The only remaining portion of the admissibility inquiry was the determination of whether the potential prejudicial

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231. *Andrews*, 533 So. 2d at 849-50.

232. *Id.* at 847. The examination showed each expert to be experienced and well-trained. *Id.*

233. *Id.* at 847-48.

234. *Id.*

235. *Id.* at 848-49.

236. *Id.* at 849.

237. *Id.* at 851.

238. *Id.* at 849-51. FLA. STAT. ch. 90.702 differs from Federal Rule 702, *supra* note 143, principally in its final clause: "If scientific, technical, or other specialized knowledge will assist the trier of fact in understanding the evidence or in determining a fact in issue, a witness qualified as an expert by knowledge, skill, experience, training, or education may testify about it in the form of an opinion; however, the opinion is admissible only if it can be applied to evidence at trial." FLA. STAT. ch. 90.702 (1987).

239. *Andrews*, 533 So. 2d at 850. It is questionable whether appellant could have been convicted without the DNA-print evidence. Although appellant matched the general physical description of the assailant, the victim could not positively identify appellant. *Id.* at 842. An analysis of the semen sample taken from the victim revealed only that appellant's blood type matched that of the assailant. *Id.* at 842-43. Like 65 percent of the male population, however, appellant had type "O" blood. *Id.* at 843. The most damaging circumstantial evidence against appellant was that his fingerprints were found on a screen that was removed from the victim's window on the day of the assault. *Id.*

effect of the testimony substantially outweighed its probative value.[240] The court noted that DNA-print testing, unlike fingerprint or bite-mark analysis, does not permit the fact finder to examine physical evidence and independently evaluate the expert's conclusions.[241] While this feature warranted special caution, the court found that this alone did not make the evidence so unreliable as to justify its exclusion.[242] Thus, the court in *Andrews* deemed DNA fingerprint evidence admissible based on the Federal Rules relevancy analysis.

(3) *United States v. Two Bulls*[243]

The Eighth Circuit Court of Appeal was going to hear Two Bulls' appeal *en banc*; however, the appellant died before rehearing. As a result, the court off appeals vacated the scheduled rehearing and instructed the trial court to dismiss the indictment against Two Bulls.[244] Still, the court of appeals, in a three-judge panel decision, provided the following three-prong test to be satisfied before the admission of DNA fingerprint evidence: "(1) whether the 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."[245] In the instant case, the court recognized that the principles imposed for the admissibility of DNA fingerprint evidence apply regardless of whether the jurisdiction uses the *Frye* standard or the relevancy analysis of Federal Rule 702.[246] In short, the court provided that the focal issue when dealing with the admissibility of any questionable opinion evidence, such as DNA profiling, is whether there has been proper foundation as to acceptability and reliability.[247]

(4) *Ex parte Perry*[248]

In *Perry*, the court decided whether DNA evidence, used to identify the defendant as the perpetrator of a crime, is admissible in Alabama. In its

240. *Id.* at 849.

241. *Id.* at 850. The DNA-print test would only allow the jury to observe X-ray photographs of markings purported to be bands of DNA. *Id.* at 849.

242. *Id.* at 850.

243. 918 F.2d 56 (1990).

244. *See* United States v. Two Bulls, 925 F.2d 1127 (8th Cir. 1991).

245. *Two Bulls,* 918 F.2d at 61.

246. *Id.* at 60.

247. *Id.*

248. No. 89-1534, 1991 WL 84132 (Ala. Apr. 19, 1991).

holding the Alabama Supreme Court advocated a modified *Frye* test, which is similar to the test espoused in *United States v. Two Bulls:*[249]

> I. Is there a theory, generally accepted in the scientific community, that supports the conclusion that DNA forensic testing can produce reliable results?
> II. Are there current techniques that are capable of producing reliable results in DNA identification and that are generally accepted in the scientific community?
> III. In this particular case, did the testing laboratory perform generally accepted scientific techniques without error in the performance or interpretation of the tests?[250]

The *Perry* court thus focused on the principal concern surrounding the admissibility of DNA evidence: "however accepted and proper the scientific theory underlying DNA evidence analysis is, and however acceptable the techniques for DNA testing based on that theory, there remains the possibility for error in the interpretation and performance of the tests."[251]

Perry is also significant because it is the first appellate decision that outlines procedures available to the defendant for challenging DNA evidence.[252] The following guidelines, some of which the court borrowed from *New York v. Castro,*[253] should aid in the determination of the admissibility of DNA evidence and should help to produce uniformity in DNA evidentiary hearings:

> 1. The proponent of the DNA evidence, whether defense or prosecution, should give discovery to the adversary, which should include, upon request:
> a. Copies of autorads, with the opportunity to examine the originals.
> b. Copies of laboratory books.
> c. Copies of quality control tests run on material utilized.
> d. Copies of reports by the testing laboratory issued to the proponent.
> e. A written report by the testing laboratory setting forth the mean or average size measurement, if applicable, together with standard deviation used.
> f. A statement setting forth observed contaminants, the reasons therefore, and tests performed to determine the origin and the effects thereof.

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249. *Id.* at *8.
250. *Id.*
251. *Id.* at *7.
252. *Id.* at *13.
253. 545 N.Y.S.2d 985 (Sup. Ct. 1989).

g. If the sample is degraded, a statement setting forth the tests performed and the results thereof.
h. A statement setting forth any other observed defects or laboratory errors, the reasons therefore and the effects thereof.
i. Chain of custody documents.
j. A statement by the testing lab, setting forth the method used to calculate the allele frequency in the relevant population.
k. A copy of the data pool for each loci examined.
l. 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.

2. The proponent shall have the burden of going forward to establish that the tests and calculations were properly conducted. Once this burden is met, the burden of proof shifts to the adversary to prove, by a preponderance of the evidence, that the tests and calculations should be suppressed or modified.[254]

V. CONSTITUTIONAL CONSIDERATIONS OF DNA FINGERPRINTING

It is clear that DNA fingerprint evidence, if not already admissible, will eventually become admissible in all courts. The procedures used in the scientific analysis are the only issues to raise regarding admissibility. Many questions remain, however, regarding the constitutionality of DNA evidence used to convict a criminal defendant. These questions range from Fourth Amendment and invasion of privacy concerns, to due process concerns arising out of the right to expert services and the right to retest. Though these issues do not concern the evidentiary value of DNA fingerprinting, they should be evaluated during pre-trial motions on the admissibility of the evidence due to the potential for prejudicial effect on the defendant.

A. DNA Fingerprinting and the Fourth Amendment

From their inception, DNA fingerprints have been obtained primarily from blood samples. Although other body tissues and fluids are suitable for DNA testing procedures, blood provides the best sample from which a successful test result can be obtained.[255] In many criminal cases, law enforcement officials have been taking blood samples from defendants to perform DNA tests.[256]

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254. *Perry*, 1991 WL 84132 at *13-14 (citing *Castro*, 545 N.Y.S.2d at 999).

255. In every criminal case reported that included DNA evidence, blood samples were used in the DNA test process, though other types of samples may have been collected.

256. *See, e.g.*, People v. Wesley, 533 N.Y.S.2d 643 (Co. Ct. 1988). With respect

Samples for DNA fingerprinting, however, can also be obtained from hair, saliva, and skin cells.[257] The Fourth Amendment protections vary for defendants from whom those samples are taken.[258] Constitutional standards for Fourth Amendment violations are often influenced by the degree of the invasion of privacy[259] or the means of governmental intrusion.[260] Identification procedures must vary with the degree of the privacy intrusion and the means by which samples are obtained;[261] therefore, the standards under which the Fourth Amendment is satisfied generally depend upon the procedure utilized.

The constitutional validity of compulsory identification procedures, utilizing procedures other than blood testing, was recognized in *Davis v. Mississippi*.[262] Although the Court in *Davis* held that detention solely for the purpose of fingerprinting is protected by the Fourth Amendment and thus requires a warrant, it stated in dictum that

> because of the unique nature of the fingerprinting process, such detentions might, under narrowly defined circumstances, be found to comply with the Fourth Amendment even though there is not probable cause in the traditional sense . . . . Detention for fingerprinting may constitute a much less serious intrusion upon personal security than other types of police searches and detentions.[263]

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to paternity suits, see King v. Tanner, 539 N.Y.S.2d 617, 622 (Sup. Ct. 1989); *In re* Adoption of Baby Girl S., 532 N.Y.S.2d 634 (Sup. Ct. 1988).

257. *See* Lewis, *supra* note 2, at 47.

258. The Fourth Amendment provides:

> The right of the people to be secure in their persons, houses, papers, and effects, against unreasonable searches and seizure, shall not be violated, and no Warrants shall issue, but upon probable cause, supported by Oath or affirmation, and particularly describing the place to be searched, and the persons or things to be seized.

U.S. CONST. amend. IV.

259. *See, e.g.*, Katz v. United States, 389 U.S. 347 (1967).

260. *See, e.g.*, United States v. Dunn, 480 U.S. 294 (1987) (no Fourth Amendment search because there was no privacy intrusion when police officers viewed a barn from "open fields"); California v. Ciraolo, 476 U.S. 207 (1986) (aerial surveillance of backyard does not constitute a Fourth Amendment search).

261. Compelling a lineup, fingerprints, or a voice exemplar is obviously quite different from compelling a blood sample, plucking pubic hairs, or extracting objects from a person's body. *See* Winston v. Lee, 470 U.S. 753 (1985).

262. 394 U.S. 721 (1969).

263. *Id.* at 727.

The Court suggested a balancing approach, weighing the police need for the evidence against the severity of the personal intrusion.[264]

The Supreme Court took the balancing approach a step further in *Hayes v. Florida*.[265] The Court held that, without a warrant or probable cause, the police cannot forcibly take a person from his home and transport him to the police station for fingerprinting because that would be tantamount to an arrest.[266] The Court added, however, that does not imply "that a brief detention in the field for the purpose of fingerprinting, where there is only reasonable suspicion not amounting to probable cause, is necessarily impermissible under the Fourth Amendment."[267] The Court further suggested that it may be constitutional to seize a person on less than probable cause and remove him to the police station for fingerprinting under circumscribed procedures.[268] The protections of the Fourth Amendment are triggered, however, if the police activity becomes too intrusive or the stop takes too long in duration.[269]

When a suspect has blood or skin residue under his fingernails, and the police have probable cause to believe that such evidence is incriminating, the exigency of the circumstances vitiates the necessity of a warrant.[270] While probable cause is typically necessary to obtain such a sample, the exigency presented by the suspect's ability to wash away the evidence excuses the warrant requirement.

Constitutional treatment of the collection of hair or saliva samples under the Fourth Amendment, on the other hand, has been somewhat varied. A search warrant is usually required if no exigent circumstances are present, while probable cause alone will suffice if exigent circumstances are found to exist.[271] One state court held that no violation of the Fourth Amendment occurred when police officers plucked hairs from a defendant's scalp because the defendant was being arrested and the hairs were in plain view.[272]

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264. *Id.* at 727-28.

265. 470 U.S. 811 (1985).

266. *Id.* at 815-16.

267. *Id.* at 816.

268. *Id.* at 817.

269. *Id.* at 815-16.

270. *See* Cupp v. Murphy, 412 U.S. 291 (1973).

271. *See, e.g.,* State v. Ostroski, 518 A.2d 915 (Conn. 1986) (probable cause required to take a saliva sample because such action constitutes a search under the Fourth Amendment); State v. Reeves, 671 P.2d 553 (Kan. 1981) (upon probable cause supported by a search warrant, state can collect pubic hairs and blood and saliva samples); Pyle v. State, 645 P.2d 1390 (Okla. 1982) (taking of hair, blood, and saliva samples, pursuant to a search warrant, is valid under the Fourth Amendment).

272. State v. Sharpe, 200 S.E.2d 44 (N.C. 1973).

Overall, the validity of the identification procedures is still determined by balancing the public interest in effective law enforcement against the private interest in freedom from governmental intrusion.[273] In the end, though probable cause is currently required by most courts for hair and saliva samples, just as for blood samples, the extraordinary reliability of DNA fingerprints might prove persuasive in lowering the standard of reasonableness under the Fourth Amendment.[274]

B. The Threat to Privacy

Because law enforcement officials are currently collecting and storing blood and tissue samples to develop data banks,[275] the widespread establishment of such data banks poses a genuine threat to individual privacy. Through routine administrative procedures, a DNA file containing both criminal histories and personal genetic information could be compiled[276] without public awareness or consent.[277]

The proposed DNA data banks represent the equivalent of current methods of storing criminal information such as the maintenance of fingerprint files. Fingerprint files are widely accepted and regarded as a valuable tool in law enforcement. Little protection exists, however, from the improper release of criminal records, which can often be outdated or contain inaccurate information.[278] Notably, courts have recognized the dangers inherent in

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273. *See generally* Skinner v. Railway Labor Executives Ass'n, 489 U.S. 602, 619 (1989) (when "special needs" are present, "we have not hesitated to balance the governmental and privacy interest to assess the practicality of the warrant and probable cause requirements in the particular context"); New Jersey v. T.L.O., 469 U.S. 325, 355 (1985) (Brennan, J., dissenting).

274. *See* Merz, *supra* note 10 at 2194 ("While a court order is necessary to require a blood sample, gathering a few hairs in a comb is likely to be considered no more invasive than pressing fingertips to the ink pad.").

275. *See supra* notes 53-64 and accompanying text; *see also* CAL. PENAL CODE § 290.2 (West 1988) (providing for computerized data bank); MINN. STAT. § 299C.155 (West Supp. 1991) (providing for DNA analysis data and records).

276. Robin W. White & Jeremy D. Greenwood, *DNA Fingerprinting and the Law,* 51 MOD. L. REV. 145, 155 (1988).

277. *Id.*

278. *See* Ronald L. Doernberg & Donald H. Zeiger, *Due Process Versus Data Processing: An Analysis of Computerized Criminal History Information Systems,* 55 N.Y.U. L. REV. 1110 (1980); *see also* Arthur R. Miller, *The Privacy Revolution: A Report from the Barricades,* 19 WASHBURN L.J. 1, 13 (1979) ("One of the most potentially dangerous kinds of information circulating in the United States is criminal justice data, much of which is now computerized . . . [T]hese records circulate far beyond the law enforcement environment, even beyond government.").

keeping arrest records on file.[279] These arrest records present potential threats to individual privacy as well as threats of improper use to harm individuals. "The seriousness of the arrest record problem, although perhaps questionable in the past, is now too well documented to be doubted."[280] If DNA data banks also maintain criminal histories, then similar dangers of personal detriment will develop.

DNA data banks, however, differ from other recordkeeping procedures in that samples of blood and other body tissues containing an individual's genetic information must be collected and stored. By collecting blood samples, intimate information such as susceptibility to disease and family relationships could be released.[281] With this information available, it is likely that insurance companies, credit companies, and employers would seek access to their clients' or employees' DNA samples.[282]

Few protections currently exist to keep genetic information private; as the use of DNA testing has evolved, no corresponding regulation of the collection, storage, or use of DNA has developed.[283] Because inadequate safeguards are presently in place for medical records, there are no remedies for the potential harms that could result from illegal access and unauthorized use of medical information.[284] In addition, because DNA molecules contain a vast amount of information, some of which has yet to be deciphered, the potential harm that may result from access to DNA samples is impossible to predict.[285]

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279. *See, e.g.,* Menard v. Saxbe, 498 F.2d 1017 (D.C. Cir. 1974) (arrest record ordered expunged from FBI files; an individual with an arrest record is subject to closer police scrutiny in the future, and may suffer a detrimental effect on future employment and licensure for certain professions); Davidson v. Dill, 503 P.2d 157 (Colo. 1972) (court recognized right to privacy and ordered expungement of arrest record).

280. *Davidson,* 503 P.2d at 159-60.

281. Two examples of potential abuses of DNA blood samples are the disclosure of Acquired Immunodeficiency Syndrome (AIDS) information and the disclosure of drug screening test results.

282. *See* Michaud, *supra* note 58, § 6, at 88 (predicting insurance and employer DNA testing for susceptibility to genetic disease).

283. *See* Janet A. Koleran, Comment, *Confidentiality of Genetic Information,* 30 UCLA L. REV. 1283 (1983) (explaining common law remedies for breach of genetic confidentiality within the physician-patient relationship).

284. "Privacy rights of subjects of biomedical research are not adequately protected by existing statutory and case law. In its present state, the law lacks the uniformity and certainty required to protect individuals' expectations of privacy and confidential communications." Bernard R. Adams, Comment, *Medical Research and Personal Privacy,* 30 VILL. L. REV. 1077, 1118-19 (1985).

285. One commentator has questioned possible future uses of DNA fingerprints:

No court has recognized yet a right to genetic privacy, nor has any method of enforcement been developed to protect genetic information.[286] Legislation providing for the protection of these samples and the information potentially yielded from these samples must accompany the establishment of DNA data banks. If states must store blood samples in the interest of effective law enforcement, they must also provide security for these samples through strict requirements regarding the usage of and access to these samples. States must also develop remedies that hold the states responsible for any harm resulting from unauthorized access to or disclosure of confidential genetic information. In short, legislators should statutorily recognize and protect the right to genetic privacy.

C. The Right to Expert Services

The right to expert services is perhaps the most crucial component for an adequate defense to forestall the introduction of unreliable scientific evidence as complex and technical as DNA fingerprinting. Defense attorneys are not equipped to debate the prosecution experts because they do not have the requisite knowledge and because they cannot testify before the jury.

Courts have found a right to expert services provided by the government on several constitutional grounds.[287] In *Ake v. Oklahoma,*[288] the Supreme

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> Once DNA analysis comes to be seen as a familiar and benign crime control tactic, will the way be paved for more controversial uses—for example, denial of certain types of employment and insurance, or even the right to have children to those whose genetic makeup indicates they may be prone to particular illnesses or forms of anti-social behavior?

Marx, *supra* note 53, at A14.

286. *See* Vincent M. Brannigan, *Biotechnology: A First Order Technico-Legal Revolution,* 16 HOFSTRA L. REV. 545, 572 (1988) (debate over confidentiality in genetic indicators of disease resulting from advances in DNA analysis); Robert R. Wachbroit, *Making the Grade: Testing for Human Genetic Disorders,* 16 HOFSTRA L. REV. 583 (1988) (discussing issues of access to and confidentiality of information obtained from genetic screening, rights to genetic information, and employers' use of genetic information to determine genetic susceptibility to disease).

287. There are five constitutional grounds:

(1) The due process right to present a defense. *See* Ake v. Oklahoma, 470 U.S. 68 (1985) (denial of defendant's request for a court-appointed expert in psychiatry deprived due process to a defendant asserting the insanity defense).

(2) The right to equal protection, namely that an indigent defendant should have the basic tools for an adequate defense to place him on a similar level with the wealthier defendant. *See generally* Ross v. Moffit, 417 U.S. 600 (1974) (providing an adequate opportunity to present a defense but not to duplicate the full legal arsenal); Griffin v. Illinois, 351 U.S. 12 (1956) (plurality opinion).

Court recognized a due process right to a psychiatrist when the defendant's mental condition is at issue. Many courts have interpreted *Ake* to require not simply any expert, but a defense expert; in other words, an independent, non-government expert who will help the defendant's attorney prepare the defense and interpret the findings of the prosecution's expert witness.[289] Some courts have even determined that the expert supplied by the court must be partisan; that is, it would be considered ineffective assistance of counsel when a defense attorney relies on the state expert without requesting a defense expert.[290]

Courts do not, however, consider all denials of defense requests for expert services constitutional violations. There are at least four circumstances under which courts have denied expert services: (1) where the expert's information would not be pivotal; (2) where an "impartial" government expert would suffice; (3) where cross-examination of the prosecution's expert was effective; and (4) where the expert's testimony would not change the verdict.[291]

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(3) The Sixth Amendment right to effective assistance of counsel. It is considered ineffective assistance of counsel if defendant's counsel does not hire expert services when needed. *See* Jeffrey F. Gheut, Annotation, *Construction and Application of Provision in Subsection (e) of Criminal Justice Act of 1964 (18 U.S.C. § 3006A(e)) Concerning Right of Indigent Defendant to Aid in Obtaining Services of Investigator or Expert,* 6 A.L.R. FED. 1007 (1971) (citing Proffitt v. United States, 582 F.2d 854 (4th Cir. 1978)).

(4) The Sixth Amendment right to compulsory process, including the defendant's right to obtain witnesses in his favor. *See* People v. Watson, 221 N.E.2d 645 (Ill. 1966).

(5) The Sixth Amendment right to compulsory process, including the right to effectively cross-examine witnesses, which may require the aid of an expert. *See generally* John F. Decker, Comment, *Expert Services in the Defense of Criminal Cases: The Constitutional and Statutory Rights of Indigents,* 51 U. CIN. L. REV. 574 (1982); Note, *The Indigent's Right to an Adequate Defense: Expert and Investigational Assistance in Criminal Proceedings,* 55 CORNELL L. REV. 632 (1970).

288. 470 U.S. 68 (1985).

289. *See, e.g.,* United States v. Crews, 781 F.2d 826, 834 (10th Cir. 1986); United States v. Sloan, 776 F.2d 926, 929 (10th Cir. 1985); Barnard v. Henderson, 514 F.2d 744 (5th Cir. 1975); Marshall v. United States, 423 F.2d 1315, 1319 (10th Cir. 1970).

290. *See generally* United States v. Fessel, 531 F.2d 1275 (5th Cir. 1976); United States v. Edwards, 488 F.2d 1154 (5th Cir. 1974).

291. *See, e.g.,* United States v. Perrera, 842 F.2d 73 (4th Cir.) (defendant was not prejudiced by refusal to appoint handwriting expert to assist in responding to government's expert who merely corroborated other evidence that the defendant had signed the documents in an insurance fraud scheme), *cert. denied,* 488 U.S. 837 (1988); United States v. Brewer, 783 F.2d 841 (9th Cir.) (burden of showing actual prejudice by clear and convincing evidence not met if cross-examination of eyewitness seemed effective without the assistance of an expert), *cert. denied,* 479 U.S. 831

None of these circumstances applies to the admission of DNA profiling evidence. First, the evidence is almost always pivotal because it usually goes directly to the issue of guilt or innocence of the defendant. Second, the only way to show a lack of consensus or a lack of general acceptance in the scientific community is to have a defense expert testify to this effect. Third, cross-examination is rarely effective with a complex, technical subject such as DNA fingerprinting. A defense attorney who did not hire a defense expert—for advice at the very least—would be ineffective. Finally, where the defense expert is to testify as to the lack of reliability or the use of improper techniques, it is apparent that if the DNA evidence is pivotal to the outcome of the case, the evidence would always have the potential to change the outcome of the case.

Yet, the right to expert services is meaningless if the defendant's request is granted by the court but the defense is unable to secure expert services. Inability to secure expert services may occur for several reasons. First, the defense attorney may simply neglect the acquisition of expert services; however, the defendant can attack this on appeal as ineffective assistance of counsel.[292] A second reason is lack of resources for the indigent defendant. Although the federal government and about half of the states have statutes that provide funds for defense experts,[293] those funds are prohibitively low,[294]

(1986); United States v. Sanders, 459 F.2d 1001 (9th Cir. 1972) (trial court did not err in refusing defense request for expert medical witness because offer of proof showed that expert's testimony would not have changed the outcome); United States v. Jones, 320 F. Supp. 901 (E.D. Tenn. 1971) (post-conviction defense motion denied where defendant sought fingerprint expert to examine the evidence of the prosecution's expert, who was effectively cross-examined); *see also*, Decker, *supra* note 287, at 591-92, 597.

292. The Sixth Amendment provides:

> In all criminal prosecutions, the accused shall enjoy the right . . . to be confronted with the witnesses against him; to have compulsory process for obtaining witnesses in his favor, and to have the Assistance of Counsel for his defense.

U.S. CONST. amend. VI.

293. For a list of statutes, see Andre A. Moinssens et al., SCIENTIFIC EVIDENCE IN CRIMINAL CASES 14 (3d ed. 1986).

294. For example, the Federal Criminal Justice Act of 1964, 18 U.S.C. § 3006A(e) (1988), allows indigent defendants a maximum compensation of $1000 for expert and investigative services. 18 U.S.C. § 3006A(e)(3) (Supp. 1989). Providing for DNA testing and expert testimony costs much more than that. For instance, the prosecution in one case spent $9600 for the necessary expert testimony on DNA testing. Gary Taylor, *From One Speck, a Case is Made,* NAT'L L.J., Jan. 16, 1989, at 22, col. 2.

Some courts do not give compensation equal to what the government pays its witnesses, but rather, what is a fair and reasonable charge in the locality in which the

and the statutes suffer from the problematic interpretations of what is considered "necessary" to a defense.[295] Economic status is often an effective bar to an adequate defense.[296]

There is a final reason, unique to admissibility hearings for novel scientific evidence, why a defendant in a DNA fingerprinting admissibility hearing is effectively prevented from fulfilling his right to expert services. In short, no expert may exist in the field intimately acquainted with the forensic technique other than the biased proponents of the technique. The defense attorney is not qualified to initiate the process of scientific inquiry to generate possible opposition to the technique, and hence is unable to gather a pool of potential experts.

D. The Right to Retest

The admission of DNA typing evidence also creates an impact on the right to have an expert retest the prosecution's evidence. Some courts have found such a right as part of the defendant's right to an adequate defense.[297]

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services were rendered. *See* United States v. Pope, 251 F. Supp. 234, 241 (D. Neb. 1966).

295. For instance, courts do not allow expenditure of funds under the Federal Criminal Justice Act for "mere fishing expeditions," a subjective determination which could mean the indigent defendant is prevented financially from exploring a full defense. *See* United States v. Kasto, 584 F.2d 268, 273 (8th Cir. 1978) (trial court's denial of defendant's request for investigator services to investigate rape victim's reputation in the community not abuse of discretion because it was a "mere fishing expedition" and the defense did not show why the two court-appointed lawyers could not do the investigating), *cert. denied*, 440 U.S. 930 (1979). *But see* United States v. Schultz, 431 F.2d 907, 911 (8th Cir. 1970) (although an expenditure under the statute should not be authorized for a "mere fishing expedition," the expenditure should be provided if further investigation may prove beneficial), *cert. denied*, 416 U.S. 988 (1974).

296. "There can be no equal justice where the kind of trial a man gets depends on the amount of money he has." Griffin v. Illinois, 351 U.S. 12, 19 (1956) (Black, J.).

297. *See* Barnard v. Henderson, 514 F.2d 744, 746 (5th Cir. 1975) ("Fundamental fairness is violated when a criminal defendant . . . is denied the opportunity to have an expert of his choosing, bound by appropriate safeguards imposed by the Court, examine a piece of critical evidence whose nature is subject to varying expert opinion."); United States v. Stifel, 433 F.2d 431, 441 (6th Cir. 1970) (if the government is going to use expensive, time-consuming methods of factfinding, it must allow time for the defendant to make a similar test and the means for an indigent defendant to do so), *cert. denied*, 401 U.S. 994 (1971).

In addition to the constitutional right, courts also recognize the right to retest as part of defense discovery. Most jurisdictions have discovery rules that allow for

The right to retest is sometimes conditioned on a preliminary showing that the results will be favorable to the defendant,[298] or on a showing that the evidence is critical and "subject to varying expert opinion."[299]

Where the right to retest is recognized, the prosecution has an obligation to give notice of its intention to use the evidence so that the defense has an adequate opportunity to examine it.[300] Furthermore, if the prosecution's testing consumes the entire sample, as is often the case in DNA profiling, the prosecution is required in several states to contact the defense attorneys so that they can have their own expert present during the procedure.[301] Most courts have held, however, that it is not a constitutional violation if the prosecution expert consumes the evidence in a necessary test.[302]

The right to retest the sample is crucial to the issue of admissibility of DNA typing evidence and the adequacy of the defense. Even if the defense finds an expert to testify, that expert will find it difficult if not impossible to locate errors in the particular test as performed if she is not present when the testing is performed. For example, if the probes used in the test were contaminated and created a false positive, the defense expert will only be able to surmise that this scenario may have happened.

The reliability of a technique means that the test results can be reproduced; thus, it is imperative that members of the scientific community retest, or at least view, the procedure. When a technique is novel, this process must occur first in the scientific community, and not in the courtroom, to establish general reliability.

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disclosure of the prosecution's scientific reports to the defense, and many provide for defense inspection of documents and tangible objects, such as bullets, footprint impressions, articles of clothing, and materials found at the scene. Some interpret and extend the provision for inspection to include retesting. *See* FED. R. CRIM. P. 16 (broadly defining what can be discovered and inspected).

298. State v. Koennecke, 545 P.2d 127, 133 (Or. 1976).

299. *Barnard,* 514 F.2d at 746.

300. *See* United States v. Kelly, 420 F.2d 26 (2d Cir. 1969) (results of neutron activation analysis not admissible because defense was not informed of it until trial, and therefore had no opportunity to make similar tests and seek its own expert).

301. *See generally* COLO. REV. STAT. § 16-3-309 (1984) (outlines factors court should consider when deciding whether to admit the results of a test which consumed all but an unusable amount of the sample); OHIO REV. CODE ANN. § 2925.51(E) (Baldwin 1983); State v. Gaddis, 530 S.W.2d 64, 69 (Tenn. 1975); State v. Wright, 557 P.2d 1, 7 (Wash. 1976).

302. *See* Giannelli & Imwinkelried, *supra* note 25, at 109 n.98.

VI. CONCLUSION

DNA fingerprinting is a positive development in identification procedures, providing limitless possibilities for its utilization. Many issues regarding its admissibility and constitutionality will likely be litigated. Questions still persist concerning the accuracy of the underlying statistics and the reliability of experts from the commercial laboratories that perform the tests. In addition, scientists must firmly establish standards for testing procedures and laboratory protocol, which are increasingly under attack, before DNA fingerprints are admissible into evidence. The legislative branch must consider these concerns and implement legislation to promote uniformity and fairness.

If these issues are addressed, the advent of DNA fingerprinting is at hand. With the continued expansion of the test in criminal investigations and the establishment of DNA fingerprint files, this accurate and reliable identification tool will greatly aid law enforcement officials. These developments will help both prosecutors in proving their cases and defendants in exonerating themselves.

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