Chapter 4

DNA as Evidence

"Lawyers as a group evidence an appalling degree of scientific illiteracy, which ill equips them to educate and guide the bench in its decisions on admissibility of evidence proffered through expert witnesses,

Andre A. Moenssens
Professor of Law
University of Richmond

"In **testing** for admissibility of a particular type of scientific evidence, whatever the scientific 'voting' power may be, the courts cannot in any event surrender to scientists responsibility for determining the reliability of that evidence. "

United States v. Williams
583 F.2d 1194 (2d Cir. 1978)

"It (DNA) convinced me. They really never had an eyewitness to the rape. In my opinion, you could hang somebody with DNA fingerprinting. '

Murrel Casselman
Jury Foreman, State *of South Carolina v. Ford*

CONTENTS

Boxes

Figures

Tables

Chapter 4
DNA as Evidence

Scientific evidence is an important component of many criminal and civil trials. Because it involves technical information that is usually not well understood by laypersons, Congress, the States, and many courts have created standards governing the admission of such evidence. Scientific evidence covers a wide range of theories, procedures, and tests. Expert testimony, the primary method for introducing scientific evidence, has increased dramatically as technology has evolved.

DNA evidence is a new and dramatic forensic tool that is now at the courtroom door. How does it compare with other types of scientific evidence in terms of relevance, reliability, and impact? What are the primary evidentiary considerations faced by prosecutors in deciding whether to submit DNA evidence? What are the main obstacles for defense counsel in presenting or rebutting such evidence? What points must judges consider in deciding admissibility? Will DNA testing someday become so common that its admission will become routine, or even expected?

This chapter briefly explains what evidence is, the role of the expert witness in introducing scientific evidence, the standards for the admission of scientific evidence, and the use of genetic markers and DNA as evidence in U.S. courts.

WHAT IS EVIDENCE?

Evidence is data or information on which judgments are made. The law of evidence is the system of rules and standards by which the admission of proof in a court of law is regulated (29). Evidence takes many forms, including testimony of witnesses, records, documents, exhibits, facts stipulated by both sides, and anything perceptible to the five senses (20). The rules and standards that make up the law of evidence address the admissibility, relevancy, and sufficiency of various types of proof. The ultimate objective of evidence in a criminal case is to convince the judge or jury of the prosecution's or defense's contention.

Rules concerning the admission of evidence exist at both the Federal and State levels. The Federal Rules of Evidence (codified in volume 28 of the United States Code Annotated) govern proceedings in Federal courts and before U.S. magistrates (Rule 101). State rules of evidence govern proceedings in the tribunals of various State, county, and local jurisdictions. Although the Federal Rules of Evidence do not govern the proceedings in the courts of the 50 States, they serve as the model for the evidence codes of 32 States (19).

Enacted by Congress in 1975 (Public Law 93-595), the Federal Rules of Evidence address relevancy, privileges, witnesses, opinion and expert testimony, hearsay, authentication and identification, and the contents of certain types of tangible items.

STANDARDS FOR ADMITTING SCIENTIFIC EVIDENCE

The use of scientific evidence, although not new, presents a unique problem because it involves information that is "beyond the ken" of the average layperson (29). Such information normally cannot be presented without touching on data that are beyond firsthand observation of the facts of a particular case, and indeed requires the inclusion and examination of opinions not permitted under normal rules of evidence. This dilemma has resulted in the formation of rules-at the Federal and State level, both by statute and court action-for the admission of scientific testimony.

The Use of Expert Testimony

A general rule of evidence is that a witness may testify only to facts known to the witness through firsthand observation and inferences based on direct observations (e.g., the identity of a person, the color of a car, the rate of speed of an automobile). The testimony of a *lay* witness, therefore, does not usually extend to facts beyond direct observation. This requirement has its roots in English common law, which demanded that witnesses test@ only about ''what they see and hear' (29). Such a standard created the need for a special rule to permit the introduction-through an *expert* witness-of scientific evidence that is beyond the normal observation of a layperson.

Over the course of history, the courts have encountered issues that require analysis and explanation by persons with scientific or specialized knowledge or experience. This situation, associated with the development of various fields of science, led to the evidentiary use of expert testimony at trial (30). The

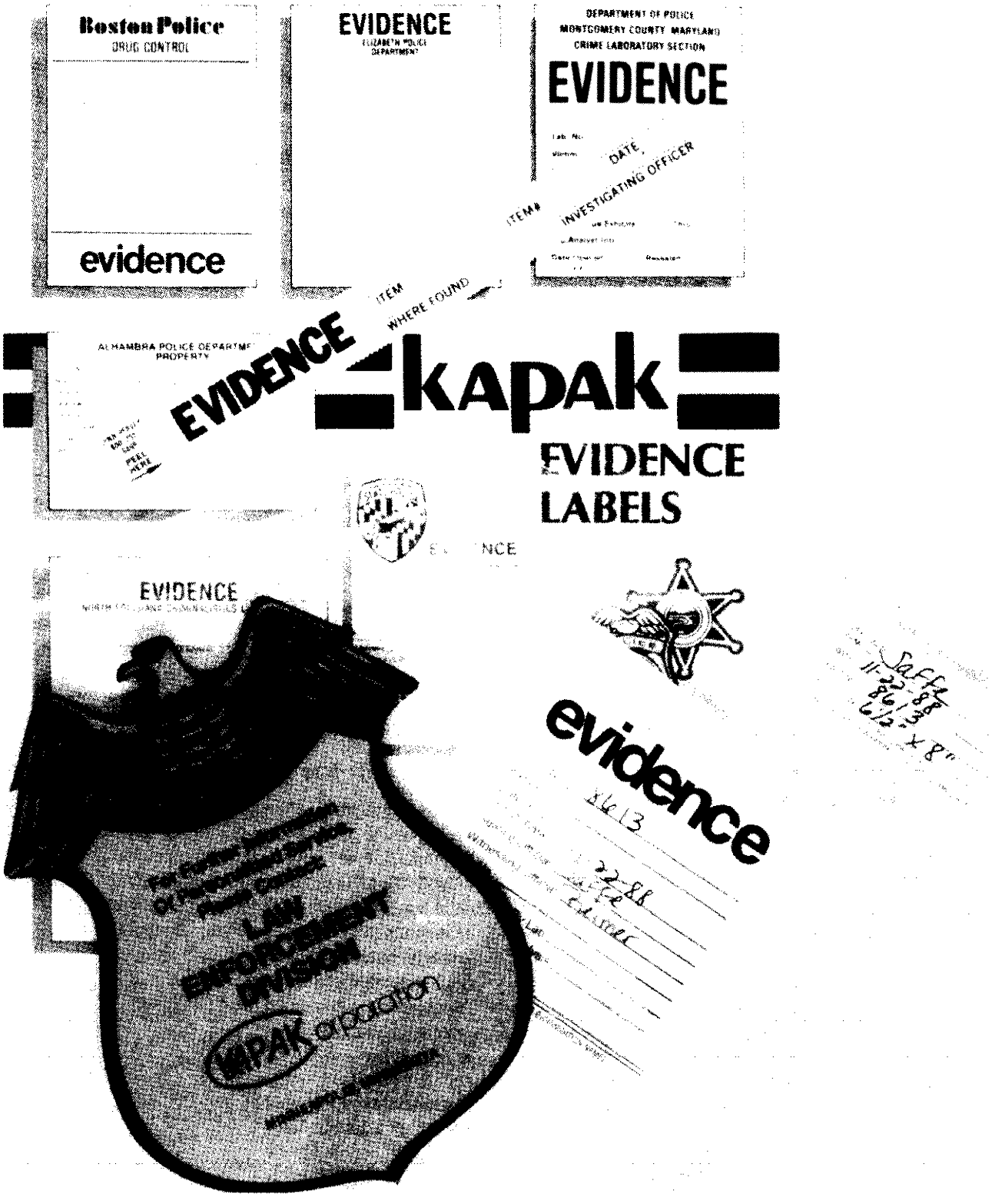


Photo credit: Office of Technology Assessment

use of expert witness testimony in U.S. criminal trials has expanded over time to include many relevant subjects.

Unlike an observer witness, the expert witness has the power to draw inferences from facts that a jury would not be competent to draw. To warrant the use of expert testimony, two elements are required:

- The subject of the inference must be so distinctively related to some science, profession, business, or occupation as to be beyond the ken of the average layperson.
- The expert must have sufficient skill, knowledge, or experience in that field or calling so that the opinion or inference will probably aid the judge or jury in the search for the truth.

The principal consideration, as stated by one treatise on evidence, is whether on *this subject* **a jury can** receive from *this person* appreciable help (44). It is through the use of expert testimony that scientific tests and data are introduced, explained, and rebutted.

A problem arises when an attempt is made to deduce expert opinion from a procedure that has not yet received widespread scientific recognition (30). A key element is whether the scientific test in question is trustworthy, which has two components—accuracy (validity) and consistency (reliability). The trustworthiness of scientific evidence is usually evaluated under one of two standards: the Frye test (or "general acceptance' test), or the relevancy test (based on the Federal Rules of Evidence) (table 4-l).

The Frye Test

The so-called Frye test, named after the defendant in a 1923 murder case (11), is the oldest and most often used test in determining the admissibility of scientific evidence. Under the Frye standard, courts admit evidence based on novel scientific techniques only when the technique has gained general acceptance in the scientific community to which it belongs.

Prior to his trial, James Alfonso Frye was subjected to a systolic blood pressure deception test (i.e., a lie detector test). As explained by the court:

> . . . the theory seems to be that the truth is spontaneous, and comes without conscious effort, while the utterance of a falsehood requires a conscious effort, which is reflected in the blood pressure. The rise thus produced is easily detected and distinguished from the rise produced by mere fear of the examination itself.

Frye's lawyer offered the scientist who conducted the test as an expert witness. The government's counsel objected to the use of such expert testimony, and the trial court sustained the government's objection. The appellate court's two-page decision cited no previous case law and ended with the following two paragraphs, which have evolved into the leading test for all types of novel expert testimony:

> Just when a scientific principle or discovery crosses the line between 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 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.
>
> We think the systolic blood pressure deception test has not yet gained such standing and scientific recognition among physiological and psychological authorities as would justify the courts in admitting the expert testimony deduced from the discovery, development, and experiments thus far made (11).

The general acceptance test under the Frye standard appears to require a two-step analysis:

- identifying the field in which the underlying theory falls (i.e., in determining whether the technique meets the test of acceptance in the scientific community, defining what community is relevant); and
- determining whether the principle has been accepted by most members of the identified field.

Fulfilling the first element can be difficult, especially if several fields of scientific endeavor are involved. Expert testimony for voice prints, for example, has been held by one court to include the

Table 4-l—Standards for Admitting Scientific Evidence

Standard	Test	Source
Frye	General acceptance by the scientific community	1923 case
Relevancy	Relevant to the trier-of-fact	Public Law 93-595

SOURCE: Office of Technology Assessment, 1990.

Photo credit: Technical Advisory Service for Attorneys

Photo credit: Margaret Anderson

James Alphonso Frye was convicted of the 1920 murder of a physician, Dr. Robert W. Brown, who was slain in his office, located in this building in Washington, DC.

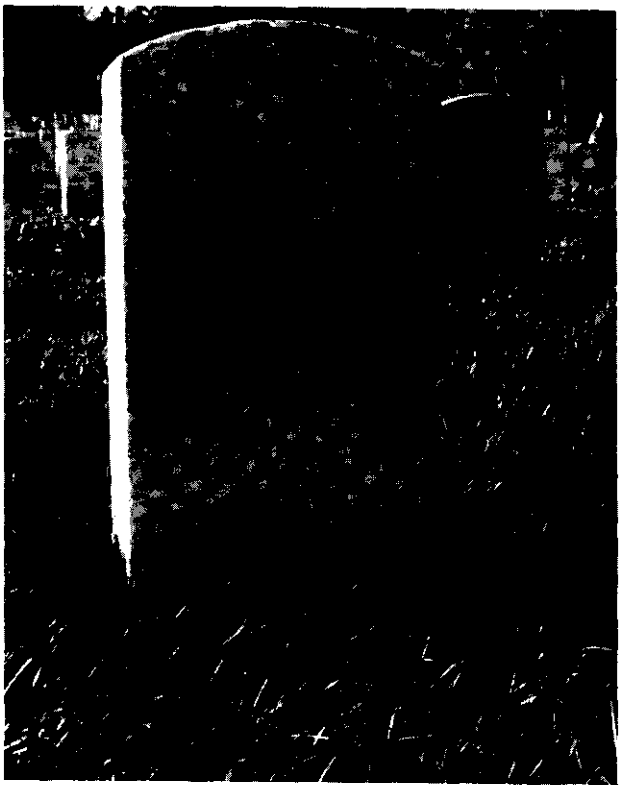


Photo credit: Holly Gwin

Burial site of James Alphonso Frye, Arlington National Cemetary, Arlington, VA.

fields of anatomy, physiology, physics, psychology, and linguistics (32).

Once the relevant field has been identified, inquiry can be made as to whether the technique in question has been "generally accepted" by members of that field. The *Frye* decision itself provides no specific threshold for what constitutes general acceptance, other than to note that at some point a principle crosses the line between "experimental and demonstrable stages" (11). Courts have developed varying definitions of what constitutes ' 'general acceptance" by members of the field (13).

The Frye test has several perceived advantages and drawbacks. Its proponents note that the test guarantees a minimal amount of support by experts for a scientific test or procedure prior to its introduction in a court of law. As noted by one court, the experts "form a kind of technical jury, which must first pass on the scientific status of a procedure before the lay jury utilizes it in making its findings of fact" (31).

On the other hand, ***the*** Frye test has been criticized for being difficult to apply and for relying on a theory of 'general acceptance' that may not equate with scientific reliability and validity. Some commentators note that workers in a novel area sharing a common goal can develop a technique that furthers their professional aims and they can "generally accept' it regardless of its scientific reliability (30). Others point out that a literal reading of the Frye standard would always result in a "cultural lag. " During this time, the new method can diffuse through the scientific discipline and create the requisite body of scientific opinion needed for general acceptance, but in that interim such evidence would be precluded (14).

The Relevancy Test

The alternative to the Frye standard is based on the Federal Rules of Evidence, which address the use of expert testimony and favors the admission of all relevant evidence.

Originally promulgated by the Supreme Court under its authority to prescribe the general rules for Federal civil and criminal proceedings, the Rules were subject to intense scrutiny by Congress prior to enactment in 1975. The Federal Rules of Evidence were designed to secure fairness, eliminate unjustifiable expense and delay, and develop the law of evidence so that the truth may be ascertained and a just verdict rendered (Rule 102). They codify a case-by-case common law approach to evidentiary matters in the Federal courts. The Rules have been amended in 1975, 1978, 1982, and 1984.

Relevant evidence is defined as that 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 (Rule 401). If a person is not testifying as an expert, such testimony in the form of opinions or inferences is limited to those opinions or inferences that are rationally based on the perception of the witness and helpful to a clear understanding of the testimony or the determination of a fact (Rule 701).

Rule 702 defines 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.

Rule 702 embraces a liberal interpretation concerning who is an expert and when a witness may testify in an expert capacity. The subject of the testimony need not be beyond lay comprehension, it can just be an area where expert help would be of assistance (34). This rule regulates the expert's major premise the types of theories, techniques, and principles that the expert may rely on (19).

Rule 703 describes the bases of opinion testimony by experts:

> The facts or data in the particular case upon which an expert bases an opinion or inference maybe those perceived by or made known to the expert 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.

This rule addresses the expert's minor premise, i.e., the case-specific information to which the expert will apply 'the major premise (19). The Advisory Committee that drafted the Federal Rules of Evidence noted that Rule 703 permits expert witnesses to draw facts or data from three possible sources:

- firsthand observation of the witness (e.g., a treating physician);
- hypothetical questions posed to the expert or testimony heard by the expert at trial; and
- presentation of data outside of the court (e.g., numerous publications, diagnoses, public opinion polls) (35).

Although an expert can rely on underlying data and need not disclose such data to the trier-of-fact (either a judge or a jury), the court retains the power to require the disclosure of underlying data. Underlying facts or data can also be investigated on cross-ex amination of the expert witness (Rule 705). The court can appoint its own expert witness in addition to experts supplied by the parties (Rule 706), which can help in situations in which the practice of shopping for experts, the venality of some experts, or the reluctance of reputable experts is viewed as a problem (35).

Some argue that the relevancy standard is more liberal than the Frye standard in permitting the admission of novel scientific evidence in that it generally permits the admission of evidence that is relevant (14). Others, however, note that both standards require levels of scrutiny that would force the proponent of DNA typing evidence to address precisely the same technical issues (15).

THE DEVELOPMENT OF BIOLOGICAL EVIDENCE

Forensic evidence has been admitted into Federal and State courts for decades. Such evidence spans a wide range of scientific and professional disciplines, and encompasses many arts and final products. Scientific evidence can be designed to identify a person or an object (e.g., through fingerprint analysis; bite mark analysis; microanalysis of fibers, hair,

paint, and trace evidence; photographs; or handwriting and document analysis); to describe a phenomenon or action (e.g., through radar speed detection); or to determine individualization (i.e., finding enough properties of comparison that can render it unique or show that two compared items shared a common origin).

Serology, the forensic field dealing with body fluids and their reactions and properties, plays a key role in the introduction of biological evidence. No area of forensic science progressed as rapidly during the 1970s as serological analysis (14). A variety of biological matter has been investigated for use in criminal and civil cases:

- Blood typing is most commonly used as evidence in crimes of violence, and has become widespread in paternity cases. Through analysis, conclusions can be reached as to the source (human or animal), type, and sex of source.
- Micro-serological analysis of a semen specimen can answer the following questions: Did the victim engage in sexual intercourse within the recent past? Is the semen of human origin? If so, can a defendant be excluded as the source?
- Identifying the genetic origin of saliva stains can be important if such evidence comes from a "secretor" (i.e., is part of the approximately 80 to 85 percent of the population having blood group substances in their body fluids, such as saliva, tears, and perspiration) or identifies the source as a "nonsecretor" (30).
- Hair retains its structural characteristics for extremely long periods, which makes it of potential importance in identifying corpses (e.g., disaster victims). The ascertainment of color, structure, and pigmentation can be probative in certain circumstances.

Forensic toxicology, which involves the study and identification of toxins, poisons, and other added substances, can yield important biological evidence in cases where the presence of alcohol or drugs is a relevant consideration.

CONSTITUTIONAL CONSIDERATIONS IN OBTAINING BIOLOGICAL EVIDENCE

By examining various types of biological evidence-blood, semen, hair, and now DNA—authorities can determine whether certain suspects are linked to various crimes. Before deciding whether such evidence meets established standards for admissibility, it must be determined whether procurement of the samples violates constitutional guarantees regarding self-incrimination, right to counsel, search and seizure, and due process. This discussion highlights several constitutional issues that can arise; a comprehensive examination of such issues is beyond the scope of this report. Constitutional issues relating to computer technology and informational privacy are discussed in chapter 5.

Self-Incrimination

Since the Fifth Amendment to the U.S. Constitution holds that "No person. . . shall be compelled in any criminal case to be a witness against himself," one constitutional issue raised is whether the information obtained from physical evidence constitutes self-incrimination. The leading case addressing this is *Schmerber v. California (37),* which involved a defendant who was arrested at a hospital while undergoing treatment for injuries suffered in an automobile accident. At the direction of police, a blood sample was obtained from the defendant, who claimed that the extraction violated the privilege against self-incrirnination. In rejecting this argument, the Supreme Court drew a distinction between communicative or testimonial evidence (which is subject to the privilege against self-incrimination) and physical or real evidence (which is not protected). The court noted that the privilege 'offers no protection against compulsion to submit to fingerprinting, photographing, or measurements, to write or speak for identification, to appear in court, to stand, to assume a stance, to walk, or to make a particular gesture. '

Under *Schmerber,* obtaining evidence for most forensic techniques is free from Fifth Amendment concerns because these techniques involve physical, not testimonial, evidence (14). DNA testing is likely to fall into this standard as long as the technology is

limited to identification purposes akin to fingerprints, voice exemplars, urine samples, and sobriety tests. Complications could arise, however, if DNA testing reveals information that is seen as being testimonial in nature (more akin to, e.g., compelled disclosures during a psychiatric examination) (10).

Right to Counsel

The Sixth Amendment guarantees an accused the right to have the assistance of counsel. Does the collection of biological trace evidence trigger the right to counsel? Generally, the answer is no, since the right to counsel attaches only after the initiation of adversary judicial criminal proceedings—whether by way of formal charge, preliminary hearing, indictment, information, or arraignment (23). The collection of biological samples most often occurs during the investigatory stage, prior to charges being filed or an arrest being made. Further, samples taken later in adversarial proceedings (e.g., prior to release, as mandated by several State laws) occurs after counsel has been obtained, and are subject to protections in the adversarial process such as discovery, cross-examination, and rebuttal evidence.

Search and Seizure

The Fourth Amendment guarantees the right to be secure against unreasonable searches and seizures. Since the Amendment extends to persons, houses, papers, and effects, issues relating to this area can extend to search and seizure of the person (e.g., arrest) as well as to obtaining samples from homes and other locations.

An arrest is a "seizure" of the person for Fourth Amendment purposes. For an arrest to occur, authorities must have probable cause that a crime has been committed and that the suspect is the person who committed the crime. Generally, if the arrest is valid, the seizure of physical evidence from the person arrested is also valid (14).

Case law and literature on the search and seizure of physical evidence is too comprehensive for discussion here. Fourth Amendment issues span a variety of legal questions involving a multitude of fact patterns. To date, OTA is aware of one appellate-level case involving DNA testing where Fourth Amendment issues were raised. In that one case, the court did not review the claim that the taking of a blood sample violated the Fourth Amendment, since defendant had consented to the procedure (8).

Because of the complexity of issues that can be raised on Fourth Amendment grounds, cases involving the search and seizure of evidence for DNA typing will undoubtedly arise; they are unlikely, however, to focus on issues unique to DNA evidence per se.

Due Process

The 14th Amendment of the Constitution forbids States from depriving any person of life, liberty, or property without due process of law. The 14th Amendment due process clause, as interpreted by the Supreme Court, protects individuals against State-sanctioned violations of the Bill of Rights (27). Since cases involving scientific evidence would probably be argued in terms of Fourth, Fifth, or Sixth Amendment grounds, one writer has suggested that the validity of an independent due process analysis in these cases is questionable (14).

THE ADMISSIBILITY OF DNA TESTS

DNA typing is the latest in a number of scientific techniques designed to link individuals to a crime scene, and has so far been widely accepted in U.S. courts. Three commercial laboratories-Lifecodes Corp. of Valhalla, NY; Cellmark Diagnostics of Germantown, MD; and Forensic Science Associates of Richmond, CA—and the Federal Bureau of Investigation (FBI) have provided expert testimony in 216 criminal cases (table 4-2). The FBI began testing samples for court use in December 1988 (18).

Acceptance in United States Courts

First introduced in a United States criminal court case in 1986, DNA testing gained national attention following its introduction in a Florida sexual assault case in 1987 (38) (box 4-A). As of January 1990,

Table 4-2—Expert Testimony, DNA Testing[a]

Company/institution	Number of cases
Lifecodes Corp. (Valhalla, NY)	94
Cellmark Diagnostics (Germantown, MD)	66
Forensic Science Associates (Richmond, CA)	15
Federal Bureau of Investigation (Washington, DC)	41

[a]Figures as of January 1990.

SOURCE: Office of Technology Assessment, 1990.

Box 4-A-Case Study: State of Florida v. Andrews

Throughout 1986, police in Orlando, FL suspected that one man was involved in over 20 cases of prowling, breaking and entering, and attempted sexual assault. In each case, the modus operandi was similar: the man would stalk his victim for weeks, prowling around her house and peeping through windows. When attacked, the victim had little or no opportunity to make a visual identification.

Until Tommie be Andrews was arrested, all police had to go on were composite drawings and several calls about a prowler. After his arrest, one rape victim (who had seen her assailant for only 6 seconds) picked Andrews out of a photo lineup.

When attorney Hal Uhrig was appointed to be the defense attorney for Tommie Ike Andrews, his concern was not about DNA evidence. Instead, he was worried about the amount of time and effort that would be required for him and his small law firm to defend Andrews against multiple rape charges. It was not until later, after prosecutor Jeffrey Ashton read an advertisement in a legal publication about DNA testing and employed the services of Lifecodes Corp., that Uhrig discovered he was involved in the first known DNA criminal case in the United States.

At Andrews' first trial, prosecutors successfully introduced results from the test by Lifecodes. The defense, however, successfully challenged the introduction of any testimony regarding the statistical probabilities resulting from the test. The trial ended in a hung jury.

Photo credit: Kevin O'Connor

Site of criminal trial for *State of Florida* v. *Tommie Lee Andrews,* Orlando FL.

At the retrial, DNA evidence was again admitted. This time, however, the prosecution was prepared to argue that statistical probabilities relating to the test should be introduced. The court, using a relevancy standard similar to that in the Federal Rules of Evidence, admitted the statistical data. Andrews was subsequently convicted.

Prosecutor Ashton said that he was unaware at the outset that this was the first case to use DNA testing in the United States. He feels that it will be a powerful tool in future investigations and cases, especially when the suspect is a serial rapist who is careful not to leave much evidence.

Defense attorney Uhrig said he came away from his experience in defending against DNA evidence most concerned about the use of statistical data, which he feels carries inordinate weight in the minds of the jury. As more population data are collected, the numbers could become much smaller and 'lose real-world meaning' to juries. Hypothetically, says Uhrig, odds of 10 billion to 1 could be introduced into court. But, if the defendant in such a case had an identical twin (and hence identical DNA patterns), the odds would then be 5 billion to 1 of a random match, but still a 50 percent probability that the DNA in question *did not* belong to the defendant. DNA typing, Uhrig said, may well result in more rape defenses that center on consent as opposed to alibi or denial defenses.

SOURCE: Office of Technology Assessment 1990.

DNA testing had been used in criminal investigatory work in at least 45 States and the District of Columbia and had been admitted by criminal courts in 38 States (see app. A). The numbers do not include civil cases of paternity (Lifecodes Corp. alone estimates that it processes 1,000 paternity tests annually) (4).

Sexual assaults and other crimes of violence (primarily homicides) are the types of criminal cases to which DNA testing has been and will be most often applied. It is a powerful investigative tool in such cases, since reliable eyewitness identification is often not obtained.

DNA testing has been initiated and admitted for both the prosecution and at the request of defendants (box 4-B). It has been admitted in several cases resulting in a death penalty sentence (box 4-C). Only recently has this technology been challenged in court cases on scientific grounds, although in one noteworthy case the challenge was to the application

Box 4-B —*Defense-Inititied Testing*

***State** of Kansas v. Mosley*

A Topeka man who spent 5 months in jail after being accused of sexually assaulting two women was set free April 13, 1989, when officials announced that laboratory tests determined he was innocent.

When he was released from the Shawnee County Jail, Johnny D. Mosley reported he was frustrated, but relieved. "I felt I was being treated unfairly. I hadn't done these crimes, and I was sick of being accused of doing them.'

Mosley had been accused in the attempted rape of a female gasoline station attendant, and of the rape of a woman who was abducted from a bus stop in Topeka. The victims both identified Mosley as their assailant.

In dismissing charges against Mosley, prosecutor Melanie Jack acknowledged that "the scientific evidence excluded him. It's the most sophisticated type of scientific evidence you can get."

State of Texas v. Trirnboli

A DNA test that triple-murder defendant Ronald Stephen Trimboli had hoped would clear his name has instead given prosecutors additional evidence against him.

Trimboli, charged in the June 1985 stabbing deaths of three Arlington, TX youths, requested the test by Lifecodes Corp., which concluded that semen found on the bedspread where one of the three victims was raped matched a sample Trimboli had given for the test.

A Johnson County jury convicted Trimboli of all three murders in April 1989, and he was sentenced to three life terms in prison.

SOURCES: *Associated Press* news wire articles, **1989.**

of one laboratory's test in one specific case, and not to the underlying concept of DNA testing itself (box 4-D).

Advantages of DNA Evidence

DNA evidence offers several unique advantages:

. DNA typing can be used to test any DNA-containing biological trace evidence. The composition of the DNA molecule essentially does not vary from cell to cell; therefore, the DNA in blood is identical to that in other biological material such as hair, semen, skin, and bone marrow (figure 4-1)(12).

- Except for identical twins, no two individuals are genetically exactly alike. Because of its uniqueness, DNA allows law enforcement officials greater precision than blood typing or other standard genetic techniques in identifying the source of a sample of semen, blood, hair, or tissue.
- Because DNA testing is so sensitive, only a trace amount of biological material is needed for identification purposes.
- DNA evidence can identify probative physical evidence in some cases. For example, semen left at the scene of a rape is more closely related to the commission of the crime of rape than is the presence of a fingerprint (2).
- DNA is more stable and robust than enzymes and proteins, the traditional genetic markers examined in forensic serology laboratories. The chances of obtaining results on older, mixed, and degraded specimens are better than with conventional techniques.
- DNA testing is especially useful in crimes of violence that often yield little useful evidence. Testing is potentially very helpful in identifying perpetrators of sexual assaults where a biological sample is likely to be found, witnesses are often lacking, and identification of the assailant by the victim is unreliable or nonexistent.
- DNA testing can save courts time and money by excluding innocent suspects, eliminating trials where a confession is obtained based on DNA evidence, and focusing defense issues in those cases that do go to trial (e.g., consent or alibi defenses) (9).
- Using DNA test results, the crime laboratory can establish databanks that could identify serial criminals. For example, law enforcement agencies could determine that the same rapist is responsible for a series of assaults in several different jurisdictions. As suspects are identified by investigators through DNA databanks, investigators can redirect and narrow their search for the perpetrator (16,17).
- DNA testing provides crime labs and forensic scientists a new tool that can be used for investigatory purposes (e.g., identifying remains) that, in coordination with other types of evidence, could lead to more arrests and convictions.

Box 4-C-Case Study: Commonwealth of Virginia v. Spencer

The multiple murder trials in Virginia of Timothy W. Spencer were the first cases in the United States where the admission of DNA evidence led to guilty verdicts resulting in a death penalty. Spencer was charged with the rapes and murders by strangulation of four women from Richmond, Arlington County, and Chesterfield County.

A test performed by Lifecodes was introduced in the first trial, in Arlington, over the objection of defense counsel. Defense attorney Jeffrey L. Everhart attacked the reliability of the test, arguing that the procedure was so new that only a few States had allowed the results to be used in criminal trials. One expert witness from Lifecodes said that only 1 in 705 million people could be expected to have a pattern that would match Spencer's DNA pattern ***and the same*** pattern in the evidence. In July 1988, an Arlington jury convicted Spencer of capital murder and recommended the death penalty.

At the opening arguments of Spencer's second trial, in Richmond, Commonwealth's Attorney Aubrey J. Davis said the DNA left at the scene of the crime was Spencer's: "He left his calling card at the residence of the victim." In November 1988, Spencer was found guilty and sentenced to death.

Spencer was subsequently convicted and sentenced to death a third and fourth time, in February and May 1989, respectively.

In Virginia, death sentence convictions are automatically reviewed by the State Supreme Court. In June 1989, the Virginia Supreme Court heard challenges to the DNA evidence. The arguments revealed that the defense had found no expert witnesses to challenge the DNA evidence submitted by the prosecution. In September 1989, the Court upheld the conviction of Spencer, declaring that the tests linking him to the crimes were scientifically reliable. The U.S. Supreme Court refused to hear Spencer's appeal, letting stand the Virginia high court decision.

SOURCES: Office of Technology Assessment, 1990, based on A. Cooper, "DNA Case is First Before a State High Court," National Law Journal, July 3, 1989:14; *Spencer v. Virginia, 384* S.E.2d (Va., 1989).

Criticisms and Limitations of DNA Evidence

There are no disadvantages to the use of DNA typing for identification purposes per se. However, several criticisms and limitations of this technology have been expressed:

- The development of DNA databanking poses an invasion of civil liberties, particularly due process (the taking of a sample without laying a foundation of probable cause) and privacy (since DNA can reveal more information than identity alone) (6). Such considerations are heard most frequently in regards to storing and databanking DNA (see ch. 5).
- Testing may involve the use of expert witnesses from private companies whose primary goal is to get into court first in order to achieve a judicial imprimatur of acceptability (36).
- DNA testing has been rushed into court without agreement being reached in the scientific community regarding standards that ensure the reliability of the evidence and guidelines for the interpretation of the results (24).
- The probability of a sample having come from any person other than the defendant can be so infinitesimal, according to statistical data, as to hold inordinate weight with a jury, thus obscuring other evidence (43).
- DNA evidence will not solve all crimes. Crime labs rely on a variety of methods in their investigations. DNA evidence, although increasing in popularity, is often not as probative as other types of physical evidence (25). As its use becomes commonplace, however, its admission could be expected by jurors even in cases where such evidence is not available for a variety of reasons.
- Many defendants will not be able to afford the cost of rebutting State-introduced DNA testing. Additional costs incurred in cases involving DNA evidence include testing, expert witness, and legal fees. If defendants cannot afford these costs, the differences between defense and prosecutorial resources, already large, could increase further (21).

Pretrial Hearings: Offering and Rebutting DNA Evidence

In order for evidence to be accepted into court, it must be offered by one of the parties and be admitted by the court. In most cases, questions regarding the admissibility of evidence are handled at a pretrial hearing. Pretrial hearings involving the admission of

SAMPLE REPORT

CELLMARK DIAGNOSTICS

REPORT OF LABORATORY EXAMINATION
OCTOBER 1, 1989

Cellmark Diagnostics
20271 Goldenrod Lane
Germantown, Maryland 20874
Telephone (301) 428-4980
800-USA-LABS
Fax (301) 428-4877

Detective Robert Smith
Johnstown Police Department
Johnstown, Maryland 20202

Your Case No. 89-1234
Our Case No. F890000

EXHIBITS:

The exhibits listed below were received for analysis on September 1, 1989:

Item #1 Sealed envelope labelled "vaginal swabs, victim" containing two (2) swabs

Item #2 Sealed envelope labelled "blood, victim" containing one (1) lavender top tube of blood labelled "blood, victim"

Item #3 Sealed envelope labelled "blood, suspect" containing one (1) lavender top tube of blood labelled "blood, suspect"

RESULTS:

DNA was extracted and DNA banding patterns were obtained from the items listed above using the restriction enzyme Hinf I and four single locus probes (MS1, MS31, MS43, g3). The DNA banding pattern obtained from the vaginal swabs from the victim (Item #1) contained the DNA banding pattern obtained from the blood sample from the victim (Item #2) and an additional DNA banding pattern. The second DNA banding pattern matches the DNA banding pattern obtained from the blood sample from the suspect (Item #3).

CONCLUSION:

The frequency of the DNA banding pattern obtained from the vaginal swabs and the blood sample from the suspect will be provided in a subsequent report.

Staff Molecular Biologist Ph.D.

SAMPLE REPORT

CELLMARK DIAGNOSTICS

SUPPLEMENTAL REPORT OF LABORATORY EXAMINATION
DECEMBER 12, 1989

Cellmark Diagnostics
20271 Goldenrod Lane
Germantown, Maryland 20874
Telephone (301) 428-4980
800-USA-LABS
Fax (301) 428-4877

Detective Robert Smith
Johnstown Police Department
Johnstown, Maryland 20202

Your Case No. 89-1234
Our Case No. F890000

In the Report of Laboratory Examination dated October 1, 1989, it was concluded that a DNA banding pattern obtained from the vaginal swabs from the victim matched the DNA banding pattern obtained from the blood from the suspect. Using the four single locus probes sequentially, the frequency in the Caucasian population of the DNA banding pattern obtained from the vaginal swabs and the suspect's blood sample is approximately one in 100 million.

The evidence will be returned by registered mail.

Staff Molecular Biologist Ph.D.

Photo credit: Cellmark Diagnostics

Sample report and supplement for fictitious criminal case.

scientific evidence are often known as Frye hearings (after the standard described earlier in this chapter). By holding a pretrial evidentiary hearing, the court can settle issues relating to whether to admit the evidence into court, thus sparing the jury from the time-consuming issues that can be raised regarding admissibility. Courts are likely to look at several factors: soundness of the underlying scientific principle, reliability of DNA tests, statistical evidence, relevant statutes, and case law.

Soundness of the Underlying Scientific Principle

The scientfic community agrees that each individual's DNA is unique, except for identical twins, and that it is theoretically possible to identy individuals from their unique DNA patterns. Because the underlying scientific theory is generally accepted (see ch. 3), the next level of inquiry relates to reliability of the tests (5).

Box 4-D--Case Study: People of New York v. Castro

The most heralded challenge against DNA typing to date is the New York case of *People v, Castro.* Jose Castro, a 38-year-old Hispanic, stood accused of murdering his neighbor Vilma Ponce and her 2-year-old daughter. Both victims were stabbed to death in their Bronx apartment building. A small bloodstain on Castro's watch was analyzed by Lifecodes Corp., which in its July 1987 forensic report determined with three DNA probes that the DNA pattern from the blood of Ponce matched that on the watch. The frequency, with the three probes, of these patterns in the Hispanic population was determined to be approximately 1 in 100 million.

A pretrial evidentiary hearing lasted 12 weeks and amassed 5,000 pages of testimony, much of it in the form of expert testimony. In an unusual move, four of the expert witnesses-representing both the prosecution and defense-met to review the scientific evidence after they had already testified. The result of this meeting was a two-page consensus statement that addressed the inadequacy of the scientific evidence and the legal procedures for assessing scientific evidence. Although the statement itself was not accepted as evidence in the pretrial hearing, the substance of the consensus document was introduced by the defense's recall of two prosecution expert witnesses to testify on its substance.

In August 1989, Judge Gerald Sheindlin issued a 41-page decision on the admissibility of the DNA identification tests. Noting that New York followed the Frye standard for admitting novel scientific evidence, a three-pronged test was advanced to determine whether the evidence should be admitted:

. Is there a theory, which is generally accepted by the scientific community, that supports the conclusion that DNA forensic testing can produce reliable results?
. Do techniques or experiments currently exist that are capable of producing reliable results in DNA identification and that are generally accepted in the scientific community?
. Did the testing laboratory perform the accepted scientific techniques in analyzing the forensic samples in this particular case?

Answering the first point, the court found that 'the evidence in this case clearly establishes unanimity amongst all the scientists that DNA identification is capable of producing reliable results." On the second point, the court noted that the techniques and experiments performed are not themselves novel or recently discovered, and are indeed reliable. Hence, the court concluded "that DNA forensic identification evidence meets the Frye standard. "

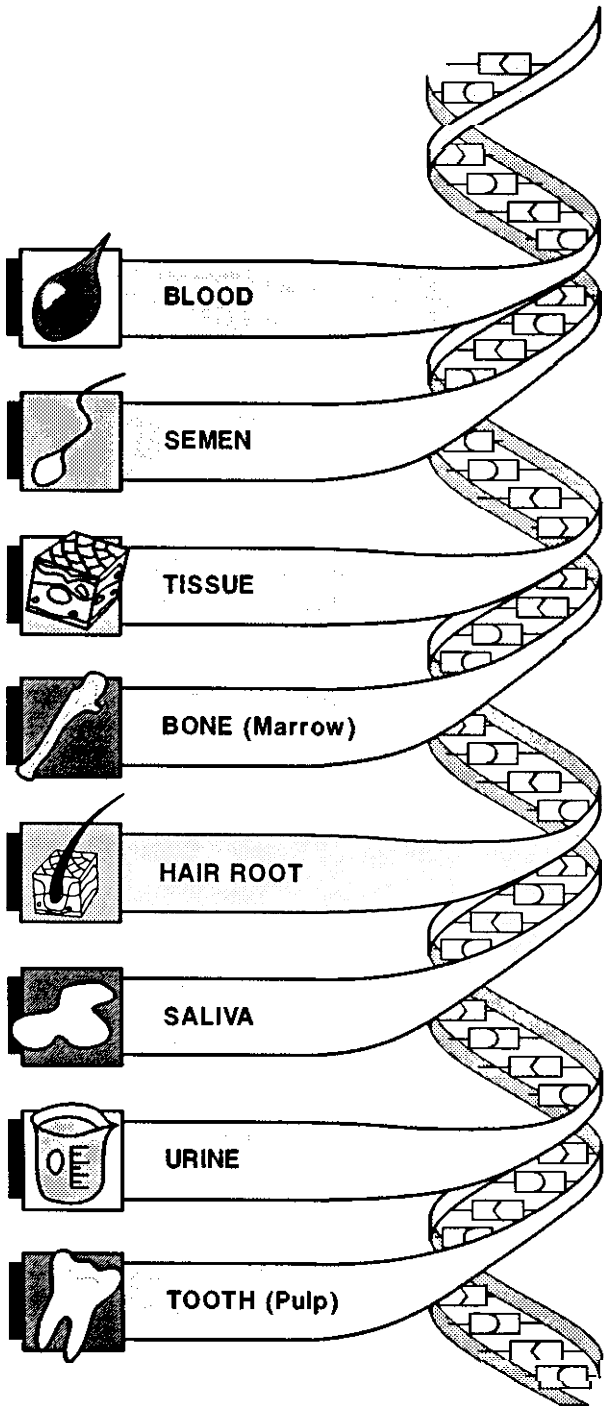
The court relied on the third question-the application of the scientific techniques to the particular case-in order to include certain DNA evidence and to exclude other DNA evidence. The DNA identification evidence of exclusion was deemed admissible, since the testing laboratory did substantially perform the scientifically accepted tests and thereby obtain sufficiently reliable results. However, the DNA identification evidence of inclusion was deemed inadmissible, since the testing laboratory failed in several major respects to use generally accepted scientific techniques and experiments for obtaining reliable results within a reasonable degree of certainty.

As a result, the DNA tests could be used to show that the blood found on Castro's wristwatch was not his, but tests purporting to show the blood was that of the victim could not be used. Judge Sheindlin also enunciated a set of guidelines for DNA pretrial hearings in the future.

Castro's case was never tried He pleaded guilty to the murders in late 1989.

SOURCES: "Decision on the Admissibility of DNA Identification Tests,' Supreme Court of the State of New York, County of Bronx: Criminal Term Part 28, *People v. Castro,* Indictment No. 1508/87; R. Lewin, "DNA Typing on the Witness Stand," *Science,* 244:1033.

Figure 4-l-Sources of DNA Evidence



SOURCE: Office of Technology Assessment, 1990.

Reliability of DNA Tests

Although there is consensus regarding the uniqueness of each individual's DNA and the ability to type an individual's DNA for identification purposes, debate still exists regarding experimental verificationcation (i.e., the presence of adequate population data), the reliability of different laboratories' testing and analytical protocols, the error ratio of tests that are performed, and the quality control of laboratories performing the tests (see ch. 3). Where serious doubts are raised about the reliability of a specific test result, inadmissibility can occur. To date, one State Supreme Court has overturned the use of DNA testing in one instance on the grounds of reliability (bOX 4-E).

DNA testing is complex, requiring a complicated series of procedures that must be carefully performed and analyzed by skilled personnel (see ch. 3). In evaluating scientific reliability, courts generally look to expert testimony from relevant scientific communities, scientific writings, and judicial opinions from other jurisdictions. Expert testimony is generally required because most judges and juries cannot independently assess the reliability of DNA tests. Expert testimony is likely to come from two sources:

- the laboratory that performed the DNA test; and
- scientists from the academic community who are familiar with the test but not financially involved with the lab conducting the test, and who can provide expert assistance on particular problems such as statistical frequencies.

If the court employs the Frye standard, individuals specializing in molecular biology and genetics will typically be called on to testify Scientists with relevant experience in certain specialized areas may also be appropriate if the issue focuses on dirty or degraded samples (which might require testimony on, e.g., environmental biology or physical anthropology), or on statistical probabilities (which involves, e.g., population genetics, evolutionary biology, and statistics) (42). It is at this stage-the pretrial hearing—that many aspects regarding reliability can be investigated and challenged, such as procedures and the credentials of personnel.

Statistical Evidence

According to the judge in the first DNA rape case in the United States (38), the most troublesome problem of admissibility involved how to express to

Box 4-E-Case Study: State of Minnesota v. Schwartz

In November 1989, the Minnesota Supreme Court was faced with the issue of whether to admit DNA testing in the case of Thomas Schwartz, who was charged with first-degree murder arising nom the stabbing death of a Minneapolis woman.

The Court ruled the test results inadmissible, even though it found DNA testing to be admissible under Minnesota's Frye standard if performed in accordance with appropriate standards and controls. In rejecting the test results, the Court focused on severaI issues, including reliability of the test results:

> While we agree that DNA typing is generally acceptable, we nevertheless believe reliability of the test results is crucial.
>
> Reliability is particularly important in criminal proceedings because a suspect may face the loss of liberty due to DNA identification. The experts acknowledged that DNA testing could produce a "false negative," where a match between DNA prints is not declaredwhen one in fact exists. Contradictory expert testimony was offered on whether a "false positive," where the wrong individual is identified as the contributor of the DNA sample, could result. We are troubled by the fact that Cellmark admitted having "falsely identified two samples as coming from the same subject" during a proficiency test performed by the California Association of Crime Laboratory Directors (CACLD).
>
> Out of 44 total samples, Cellmark made one incorrect match, which was considered too high an error rate by some experts. The possibility of ambiguous match conclusions is also disturbing. For example, the Cellmark report opined that the DNA from the [victim's stained blue jeans and blood] "are from the same individual," even though the banding patterns did not fit their match criteria. As a direct corollary, specific DNA test results are only as reliable and accurate as testing procedures used by the particular laboratory. . . .
>
> Although Cellmark has implemented protocols and certain quality control standards, deficiencies in several aspects exist . . . The director of Cellmark's Development Laboratory . . . admitted that because Cellmark did not meet all the minimum guidelines, such as formal methodology validation and published reports of experimental studies in peer review journals, the FBI likely would not consider the test ready for use in court. The experts also reviewed similar standards for DNA typing developed by CACLD. Again.. . Cellmark has not comported with all these standards.

SOURCE: *State of Minnesota v. Schwartz, majority* opinion of Chief Justice Popovich, Supreme Court of Minnesota, 447 N.W.2d 422 (Minn., 1989).

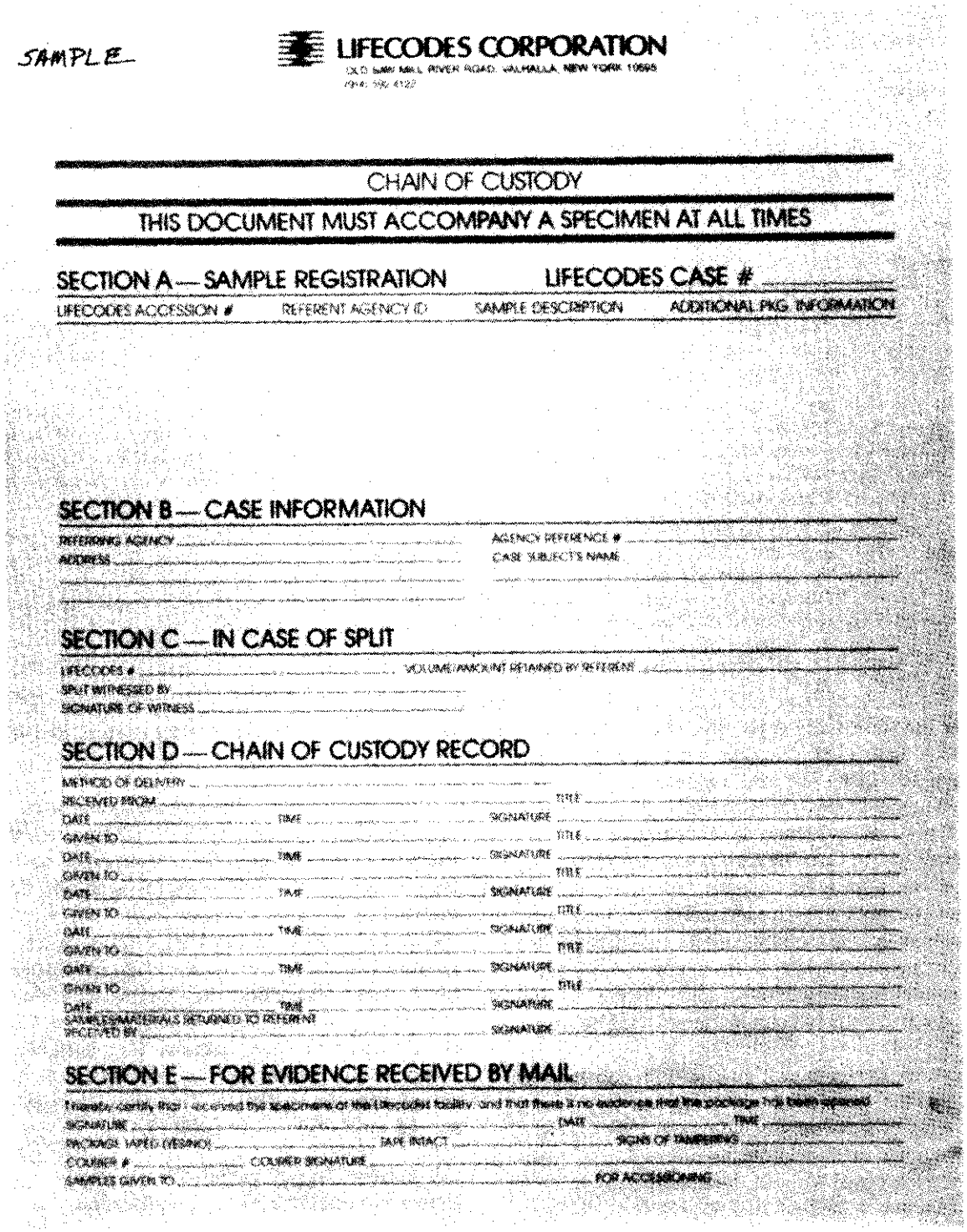
the jury the statistical probability of the results from the DNA test (33). 'Experts introduce statistical evidence to show that only a tiny fraction of a population possesses the suspect's characteristics. Such statistical evidence is not unique to DNA typing but has, in fact, been used with standard body fluid genetic typing for decades. However, because statistical probabilities introduced in DNA cases are extremely small (sometimes one in billions) and are generally presented-or at least perceived—as an absolute identification, courts must decide if numbers that are introduced can be understood by juries.

Courts generally admit probability calculations based on the empirical sampling of population frequencies of a particular biological characteristic (5), but courts in Minnesota had barred such testimony since it could suggest, by quantification, guilt beyond a reasonable doubt (39,40,41). In such cases, the evidence could be admitted to draw an inference (e.g., scientific evidence that the defendant was the father of a baby that was subsequently born to the victim can be admissible to prove that sexual intercourse occurred), but it could not take the form of a statistical probability. These cases were overturned by action of the Minnesota legislature in 1989 (see box 4-F).

Prior to the action taken by the Minnesota legislature, the defense attorney in the Nation's first DNA rape case (38) cited the Minnesota cases as support for excluding statistical data, an argument that was rejected by the trial court and addressed only briefly on appeal (1,43). In the first trial of Tommie Lee Andrews, statistical evidence was not admitted following defense objection. The case ended in a mistrial. On retrial, the statistical data were offered and ruled admissible, and the jury convicted Andrews. Both the prosecutor and defense attorney agreed that the statistical evidence was key to the second jury's finding of guilt (3,43).

The reliability of statistical evidence is a primary concern to one observer, who notes that:

> Despite . . . fundamental uncertainties, forensic laboratories blithely cite breathtaking frequencies: a recent report based on the study of only four RFLPs [restriction fragment length polymorphisms] announced that the chance of an alleged match occurring at random was 1 in 738,000,000,000,000.



SAMPLE

LIFECODES CORPORATION

(X.D SAW MILL RIVER ROAD, VALHALLA, NEW YORK 10595

CHAIN OF CUSTODY

THIS DOCUMENT MUST ACCOMPANY A SPECIMEN AT ALL TIMES

SECTION A — SAMPLE REGISTRATION LIFECODES CASE #

LIFECODES ACCESSION # REFERENT AGENCY ID SAMPLE DESCRIPTION ADDITIONAL PKG. INFORMATION

SECTION B — CASE INFORMATION

REFERRING AGENCY AGENCY REFERENCE #

ADDRESS CASE SUBJECT'S NAME

SECTION C — IN CASE OF SPLIT

LIFECODES # VOLUME/AMOUNT RETAINED BY REFERENT

SPLIT WITNESSED BY

SIGNATURE OF WITNESS

SECTION D — CHAIN OF CUSTODY RECORD

METHOD OF DELIVERY

RECEIVED FROM TITLE

DATE TIME SIGNATURE

GIVEN TO TITLE

DATE TIME SIGNATURE

GIVEN TO TITLE

DATE TIME SIGNATURE

GIVEN TO TITLE

DATE TIME SIGNATURE

GIVEN TO TITLE

DATE TIME SIGNATURE

GIVEN TO TITLE

DATE TIME SIGNATURE

SAMPLES/MATERIALS RETURNED TO REFERENT

RECEIVED BY SIGNATURE

SECTION E — FOR EVIDENCE RECEIVED BY MAIL

I hereby certify that I received the specimens at the Lifecodes facility and that there is no evidence that the package has been opened

SIGNATURE DATE TIME

PACKAGE TAPED (YES/NO) TAPE INTACT SIGNS OF TAMPERING

COURIER # COURIER SIGNATURE

SAMPLES GIVEN TO FOR ACCESSIONING

Photo credit: Lifecodes Corp.

Sample chain of custody form.

Box4-F-State Statutes: Admissibility of DNA Evidence

Several States have passed laws regarding the collection of DNA samples (see ch. 5). As of January 1990, four States have laws specifically addressing the admissibility of DNA test results:

- . Maryland in 1989 enacted legislation (House Bill No. 711) making DNA profile evidence automatically admissible to prove or disprove the identity of any person.
- . Mjnnesota in 1989 enacted a crime bill (Ch. 290, H.F. No. 59) permitting the admissibility of DNA analysis in criminal and civil cases without antecedent expert testimony that DNA analysis provides a trustworthy and reliable method of identifying characteristics in an individual's genetic material. The party offering the evidence must show that it meets the general standards of admissibility under the State's rules of evidence. The same bill also allows the admission of statistical population frequency evidence, based on genetic or blood test results, to demonstrate the fraction of the population that would have the same combination of genetic markers (various blood types or DNA types) as was found in a specific human biological specimen.
- ● Louisiana has adopteda statute(1989 LaRev.Stat., sec. 15.441.1) holding that "evidence of deoxyribonucleic acid profiles, genetic markers of the blood, and secretor status of the saliva offered to establish the identity of the offender of any crime is relevant as proof in conformity with the Louisana Code of Evidence. "
- . Nevada law states that ''whenever it it relevant in a civil or criminal action to determine the parentage or identity of any person or corpse, the court, by order, may direct. . . one or more blood or saliva tests . . . [that] may include analysis of a person's blood to determine its genetic markers and of a person's saliva to determine its secretor status. Whenever a test is ordered and made, the results of the test may be received in evidence" (1989 Nev.Rev.Stat.Ann., sec. 56.020 (1)(2)).

SOURCE: Office of Technology Assessment 1990.

It is my belief that we, the scientific community, have failed to set rigorous standards to which courts, attorneys and forensic testing laboratories can look for guidance-with the result that some of the conclusions presented to courts are quite unreliable (24).

Some argue that the admission of statistical information to the nth degree is pivotal to the success of DNA testing in forensic applications. Others strongly disagree, maintaining that even low statistical evidence in combination with other facts is sufficient for an attorney to persuade a jury.

Relevant Statutes

Some States have passed laws specifically governing the admissibility of certain scientific techniques (generally radar detection, blood tests, and intoxication tests). Several States have statutes regarding the taking of DNA samples from certain classes of defendants (see ch. 5) and four States have laws regarding the admissibility of DNA evidence itself as of January 1990 (box 4-F).

Case Law

Although many trial courts have ruled DNA evidence admissible, as of January 1990, only five appellate-level courts have addressed the relevant **issues on review (box *4-G).*** As more appellate courts review and rule on DNA evidence, a foundation of law on the subject will emerge and can be cited.

DNA Evidence at Trial

Following the pretrial Frye or evidentiary hearing, a court rules whether DNA testing will be admitted into evidence and, if so, under what conditions. Once at trial, any party may offer expert testimony. It is the obligation of the party calling expert witnesses to lay the foundation for such testimony. Such a foundation will normally include the qualifications and experience of the witness, details as to how DNA testing works, what procedures were followed, the results of the test, and the facts and opinions that can be drawn from the test results. During cross-examination, the opposing party can seek to limit the weight of the expert testimony. Such tactics include limiting the credibility of the opponent's expert.

Effective trial strategy can increase or limit the weight of expert testimony. Several recent articles on the admissibility and weight of DNA testing indicate that this area will be the subject of scholarly attention in the near future (5,7,26,42).

FINDINGS AND SUMMARY

DNA testing is the latest in a number of scientific techniques designed to identify individuals. Compared with other genetic techniques, DNA testing is

Box 4-G-Appelate Court Reviews of DNA Testing

Andrews v. *State of Florida* 533 So.2d 841, District Court of Appeal of Florida, Fifth District

The Andrew case (see also box 4-A) was the first appellate-level decision of a case challenging the admissibility of DNA testing. The District Court of Appeal upheld the admissibility of the DNA test, ruling that when a form of scientific expertise has no established track record in litigation, courts may look to a variety of factors that may bear on the reliability of the evidence, such as its relationship to more established modes of scientific analysis, the existence of specialized literature dealing with the technique, the qualifications and profossional stature of expert witnesses, and any nonjudicial uses of the scientific technique.

T&opinion noted:

> Admittedly, the scientific evidence here, unlike that presented with fingerprint, footprint or bite mark evidence, is highly technical, incapable of observation and requires the jury to either acceptor reject the scientist's conclusion that it can be done. While this factor requires courts to proceed with special caution . . . it does not of itself render the evidence unreliable.

Cobey v. *State of Maryland: 559* A.2d 391, Maryland Court of Special Appeals

Kenneth Cobey was convicted of rape, sexual offense, robbery, and theft. He appealed, arguing that the single-locus probe technique employed by Cellmark Diagnostics had not been aocepted by the scientific community, the database used by Cellmark was insufficient to support the conclusions drawn by it, and the State violated the Fourth Amendment to the U.S. Constitution when it failed to obtain a search warrant prior to drawing a blood sample from him.

In the opinion of the Court of Special Appeals, the trial court did not err in admitting the evidence, which was supported by expert testimony by the State, while the defendant produced no expert testimony challenging the probe or database. In finding that the State's Frye test requirements were met, the court held that "we are not, at this juncture, holding that DNA fingerprinting is now admissible willy-nilly in all criminal trials . . . .We are merely holding that, based on this record, [the trial judge] did not err in finding that DNA fingerprinting was generally acceptable in the scientific community and in permitting its introduction into evidence, since there was no evidence to the contrary."

Woodall v. State of West Virginia: 385 S.E.2d 253, Supreme Court of Appeals of West Virginia

Woodall, serving two life terms and 335 years in prison on 19 criminal counts stemming from the kidnap and rape of two women, had been rebuffed in his attempts to use DNA testing to prove his innocence. The West Virginia Supreme Court in December 1988 approved Woodall's motion to use DNA testing. The tests, conducted by Cellmark, proved inconclusive due to insufficient amounts of high molecular weight DNA in semen recovered from the crime scenes. As a result, no conclusion could be reached concerning the origin of the DNA in the samples.

The West Virginia Supreme Court, holding that such testing did meet West Virginia's Frye standard, refused Woodall's petition for anew trial, saying that the test's inconclusive (and thus irrelevant) results rendered harmless any decision not to admit the test at trial.

Spencer v. Commonwealth of Virginia: 384 S.E.2d 775,384 S.13.2d 785, Supreme Court of Virginia

In three unanimous rulings, the Virginia Supreme Court upheld the capital conviction of Timothy Spencer, ruling that submitted DNA test results submitted as evidence at two of Spenser's trials were shown to be 'a reliable scientific technique" (see also box 4-B).

State of Minnesota v. Schwartz: 447 N.W.2d 422, Supreme Court of Minnesota

In November 1989, the Minnesota Supreme Court barred the use of DNA evidence in a Minneapolis murder trial scheduled to commence in early 1990. The court ruled that forensic DNA typing had gained general acceptance in the scientific community and thus was admissible under the Frye standard. Admissibility in the present case, however, was denied on grounds that Cellmark tests failed to conform to certain reliability standards (see also box 4-E). The court also ruled that such test data must be made available for independent review by the opposing party.

SOURCE: (Mice of Technology Assessment 1990.

capable of statistically absolute identification (except with identical twins). As with any type of scientific evidence, it must meet certain requirements before it can be introduced into court as evidence.

Two standards-the Frye test and the relevancy test—govern the admission of scientific evidence. The Frye test permits the admission of scientific evidence based on novel scientific techniques only when the technique has gained general acceptance in the scientific community, The relevancy test, based on the Federal Rules of Evidence, permits the admission of relevant evidence that is helpful to the trier-of-fact.

As of January 1990, DNA testing had been used in criminal investigatory work in at least 45 States and the District of Columbia, and had been admitted by criminal courts in 38 States. All reported investigations and cases involved suspected crimes of violence (i.e., homicides or sexual assaults). As of January 1990, the three major companies using DNA testing and the FBI had provided expert testimony in 216 cases. Court cases-all of which have been filed since 1986-indicate that DNA evidence is generally accepted by the scientific community (in cases employing the Frye standard for admissibility) and relevant and helpful to judges and juries (in those cases employing the Federal Rules of Evidence model for admissibility). Appellate-level courts in five States have addressed the admissibility of DNA typing, with four of the courts approving the admissibility of such evidence. Four States have laws permitting the admission of DNA tests in judicial proceedings as of January 1990.

Because each person's genetic material is unique (except between identical twins), DNA testing offers the criminal justice system a more precise and powerful means of identification from a trace amount of biological material. Such evidence could be most useful in cases where eyewitness identification is faulty or nonexistent (e.g., rape) and could save courts time, as suspects are exonerated or confronted with such evidence. Such evidence can be obtained from any DNA-containing source and, because of its stable and robust nature, is more likely to provide usable data than enzymes and proteins used in traditional serological examinations.

Several concerns have been expressed regarding DNA as evidence, including the weight of statistical data, the lack of standards to ensure the reliability of the evidence, the potential bias of expert witnesses whose livelihood depends on the success of the technology, civil liberties considerations related to databanking of DNA information, and the financial costs defendants face in rebutting such evidence.

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