

## Chapter 6

# DNA Typing by Federal, State, and Local Crime Laboratories

“DNA typing will not significantly lower the crime rate in America. At most, it will simply add **to the** quality ethic that pertains to the process by which guilt is decided. But then, that is quite **a lot in** itself. The criminal justice system needs all the help that it can get.”

John I. Thornton  
Professor of Forensic Science  
University of California, Berkeley  
*Chemical & Engineering News*  
Nov. 20, 1989

# CONTENTS

	<i>Page</i>
FBI INVOLVEMENT IN DNA TYPING .....	141
STATE AND LOCAL CRIME LABORATORY INVOLVEMENT'... ..	144
Crime Laboratories' Views on FBI Role in DNA Testing .....	146
Crime Laboratories' Plans for DNA Testing .....	147
Crime Laboratories Not Conducting DNA Testing .....	147
Contracting for DNA Testing .....	148
Conducting DNA Testing Onsite .....	150
FINDINGS AND SUMMARY .....	152
CHAPTER 6 REFERENCES .....	153

## Boxes

	<i>Page</i>
6-A. Previous Surveys on Forensic DNA Testing .....	142
6-B. Uses of Forensic DNA Tests Internationally .....	145
6-C. American Society of Crime Laboratory Directors .....	146
6-D. DNA Typing in Virginia .....	151
6-E. The New York State Forensic DNA Analysis Panel .....	152

## Tables

	<i>Page</i>
6-1. Equipment Needs To Conduct DNA Typing .....	143
6-2. Operating Expenses for the FBI DNA Analysis Unit .....	144
6-3. Ranking of Importance of DNA Typing to Crime Laboratories .....	<b>146</b>
<b>6-4.</b> Suggested FBI Roles in DNA Testing .....	147
6-5. Crime Laboratory Involvement in DNA Testing .....	148
6-6. Crime Laboratory Plans To Conduct DNA Testing .....	148
6-7. Crime Laboratory Plans To Contract for DNA Testing in the Future .....	148
6-8. Costs for Forensic DNA Testing by <b>Private</b> Laboratories .....	149
6-9. Costs for Paternity DNA Testing by <b>Private</b> Laboratories .....	149
6-10. Facilities Contracted With for DNA Testing .....	149
6-11. Prescreening Tests .....	149
6-12. Paying for DNA Testing .....	150

## DNA Typing by Federal, State, and Local Crime Laboratories

---

Since November 1987, when a Florida criminal conviction based on DNA typing evidence received national attention, State and local crime laboratory interest in this technology has skyrocketed. (See app. A for descriptions of additional cases.) Immediately following this case, crime laboratories around the Nation began to explore their DNA typing options. Almost all U.S. crime laboratories have now heard of the technology. Many choose to contract with private companies currently conducting DNA testing for forensic purposes. Several others have taken the first steps necessary to provide onsite capability for DNA typing. Some States have enacted legislation requiring that certain groups of convicted offenders submit a blood or saliva specimen to be placed in a databank (see ch. 5).

This chapter reports the results of a 1989 OTA survey of State and local crime laboratories that built on earlier surveys (box 6-A; see app. B for survey instrument). Designed to determine the present and future extent of DNA typing by crime laboratories, the survey also evaluated the extent of onsite v. offsite capability. The survey population was derived from the 1988 Federal Bureau of Investigation (FBI) Directory of Crime Laboratories. The survey **was** mailed to 298 laboratories between February and May 1989. At least 1 survey from each of the 50 States **was** returned, along with surveys from the U.S. Virgin Islands and Puerto Rico. Eight States returned one questionnaire each for their entire laboratory systems, reducing the original sample by 41; in total, 221 questionnaires were completed and returned from the survey population of 257 (an 85 percent response rate).

In addition to discussing the results of the survey, this chapter presents a brief overview of the FBI's involvement in DNA typing. Survey results on crime laboratories' views on the potential role for this agency in DNA typing are analyzed in the context of the projections of the FBI. The involvement of the American Society of Crime Laboratory Directors (ASCLD) in DNA typing is also described, as are divergent approaches to forensic DNA analysis by two States: Virginia and New York.

### FBI INVOLVEMENT IN DNA TYPING

The FBI, established in 1908, is the investigative branch of the U.S. Department of Justice. Charged with responsibility for investigating violations of Federal law in criminal, civil, and security fields, the FBI also oversees the National Crime Information Center (see ch. 5) and offers training to law enforcement officers and forensic scientists. FBI facilities include 59 field offices throughout the United States, the FBI Academy in Quantico, VA, and the headquarters in Washington, DC.

The FBI Academy trains agents and other law enforcement officers and also researches new methods in forensic science. The Forensic Science Research and Training Center (FSRTC) of the FBI Laboratory, opened in 1981 at the FBI Academy, performs both long- and short-term research in the areas of biochemistry, immunology, chemistry, physics, and polygraph (42 U.S.C. sec. 3744). Long-term projects usually investigate new theories or technologies, while short-term projects often evaluate current methods for their value and reliability (17). The mandated mission of FSRTC is to provide quality research and training programs plus operational assistance in the forensic sciences to the FBI and other Federal, State, and local law enforcement agencies and crime laboratories (13).

With this goal in mind, FBI research scientists began investigating DNA typing in early 1985. Their involvement began with the cofunding of a project with the National Institutes of Health to examine mitochondrial DNA from blood samples for ethnic markers (13). Although not originally conceptualized as a method to examine DNA for identification purposes, the FBI accelerated its efforts in this area of research after the first scientific papers on DNA typing were published in 1985. A research scientist was assigned in early 1986 to investigate the potential of DNA technologies for forensic purposes. Site visits were made to private DNA testing labs in the United States and the United Kingdom, as well as to other institutions performing DNA research. In July 1987, the FBI decided to have a research team at FSRTC develop DNA typing for use in the headquarters' laboratory (13).

### **Box 6-A—Previous Surveys on Forensic DNA Testing**

At least five surveys on forensic DNA testing have been done previously, and provide a gauge of how quickly interest in DNA testing has increased. The first was conducted by the California Association of Crime Laboratory Directors' DNA Committee in September 1987. It was an informal poll given to members of the American Society of Crime Laboratory Directors (ASCLD) present at the 1987 annual meeting in Ernmitsburg, MD. At the time of the survey, levels of awareness and understanding of DNA typing among crime laboratory personnel were much lower than current levels. Respondents were asked if they did serological testing, and if so, they continued with the survey. Eighty-seven laboratories responded to the additional series of questions; 70 laboratories had discussed or considered the feasibility of DNA typing, while 17 had not. When asked if their laboratory had formed an opinion (a policy) on DNA typing, more than half (37) of the laboratories who had discussed the DNA issue had formed a policy. Of those, 20 labs responded that DNA testing was valid as a routine tool, and that they might contract out DNA typing. Seventeen felt that DNA typing was not yet appropriate for casework. Of the 33 whose laboratories had not yet formed an opinion on DNA typing, 13 felt DNA typing was not yet appropriate for casework and 5 felt that it was a valid tool and that they might contract out DNA typing on selected cases.

A second small survey was conducted at a DNA workshop at the University of New Haven, CT, in spring 1988. The results indicated that respondents were planning to implement DNA typing in collaboration with university labs, blood banking centers, and DNA typing labs. This indicated that each forensic laboratory planned to implement DNA typing in cooperation with a local collaborator, which could lead to a situation where labs would use a variety of different approaches and techniques with no standardization of the methodologies. However, when asked if there should be a standardized procedure, all respondents said one should be developed. According to the respondents, the following aspects should be standardized: DNA extraction procedure, restriction enzyme used, electrophoresis, Southern blotting, definition of probes, and data analysis. All those surveyed indicated there was a need for a national DNA data center. Information that should be incorporated into such a database included restriction enzymes, DNA standards, DNA probes, autoradiograms, DNA polymorphism population distributions, and DNA typing results in digitized form.

In part to assess its projected workload for DNA testing, the FBI conducted a small survey at the September 1988 ASCLD annual meeting held at the FBI Academy in Quantico, VA. From a survey population of 168 crime laboratory directors, 75 questionnaires were received (a response rate of 45 percent). Of those who responded, 34 crime lab directors representing 31 systems anticipated implementing some form of DNA typing by January 1990. Four laboratories would not have an impact on the FBI's workload, either because they were Federal labs, Canadian, or already performing DNA typing onsite. Approximately 120 investigations had been referred to these laboratories at that time. The remaining 27 laboratories that responded positively had submitted budget requests but had not yet received approval. The FBI assumed that the 93 laboratory directors who did not respond were not planning to implement onsite DNA testing, at the time alerting them to the possibility that much of this casework could be referred to the FBI. The OTA survey, however, indicates that plans for onsite testing are more widespread than at the time of the FBI survey.

Finally, two telephone surveys were conducted at court expense in early 1989. These telephone surveys of crime laboratory directors and molecular biologists were introduced in the case of *State of Indiana v. Hopkins* to raise questions about the admissibility of DNA typing results. The "Survey of Members of American Society of Crime Laboratory Directors" was responded to by 241 crime laboratories. Responses for the "Survey of Scientists Regarding DNA Typing" were elicited from 215 members of the Molecular Biology and Genetics Section of the American Society for Microbiology. Survey questions ranged from assessing whether DNA tests performed by private laboratories were ready for casework to identifying potential scientific problems with DNA typing. (The actual surveys and results were unavailable for review by OTA.)

SOURCES: Office of Technology Assessment, 1990, based in part on California Association of Crime Laboratory Directors' DNA Committee, "DNA Survey," Report #2, Nov. 19, 1987; H. Lee and R. Gaensslen, "The Need for Standardization of DNA Analysis Methods and a National DNA Database," paper prepared for the meeting "DNA Technology In Forensic Science," Quantico, VA, May 31-June 2, 1988; J. Kearney, Federal Bureau of Investigation "FBI Survey at 16th Annual Symposium on Crime Laboratory Development," September 1988; and W.F. Rowe, "DNA Testing Not Ready for Court? A Tale of Two Surveys," *Journal of Forensic Sciences* 34(4):803-805, July 1989.

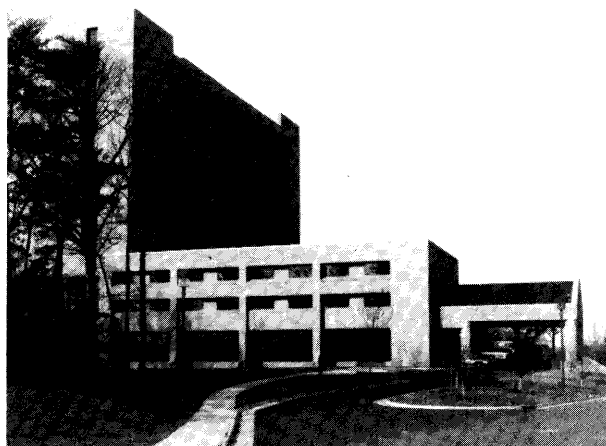


Photo credit: Holly Gwin

**Federal Bureau of Investigation Academy: Headquarters  
of the Forensic Science Research and Training Center,  
Quantico, VA.**

By January 1988, FSRTC had implemented DNA typing trials onsite. Personnel were trained and given proficiency tests through December 1988, and once the final validation process was completed, the DNA Analysis Unit, located at the FBI's headquarters facility, began accepting actual casework from other crime laboratories. The first case was reported in March 1989. A great deal of ongoing research at FSRTC still supplements DNA typing casework at the headquarters DNA Analysis Unit. Currently four laboratory personnel at FSRTC are doing DNA typing research and four others are involved in training and the development of a proficiency testing program (13). The FSRTC spent 20 percent (\$104,200) of its research and training equipment budget on DNA typing and 36 percent (\$143,200) of its supply budget on DNA typing in fiscal year 1989 (13).

As of July 1989, the FBI had received 536 case submissions consisting of 2,619 individual DNA samples (11); by November 1989, the number of cases had risen to over 1,000 (13). The FBI estimates the cost per sample to be \$98.50 (this figure includes labor but not the costs for facility use) (8). (See table 6-1 for equipment needs to perform DNA testing.) Monthly costs (excluding labor) have been estimated at \$18,100 (\$217,200 per year). However, because the FBI expects to process 25 percent more samples in the future, the annual amount has been adjusted to \$271,500 (table 6-2). The \$217,200 figure was based on the workload of five technicians, while the \$271,500 is based on a full staff laboratory of seven technicians; currently there are

**Table 6-1—Equipment Needs To Conduct DNA Typing**

Equipment item	Approximate cost per item (dollars)
Autoclave (bench top) . . . . .	4,600
UV spectrophotometer . . . . .	12,000
UV transilluminator . . . . .	2,300
Electrophoresis power supplies . . . . .	2,500 (minimum of 2)
Electrophoresis tanks . . . . .	400 (minimum of 4)
Microfuge (general use) . . . . .	1,200
Microfuge (dedicated to radioactive isotopes) . . . . .	1,200
Microliter pipettor (variable range) . . . . .	250
Water baths . . . . .	2,000 (2-3 required)
Vacuum centrifuge* . . . . .	4,300
Ultra-low temperature freezer . . . . .	6,300
Environmental rotary shaker* . . . . .	5,100
Vacuum oven* . . . . .	1,000
Gel photography equipment . . . . .	1,000
X-ray film autoprocessor' . . . . .	7,100
Platform shaker* . . . . .	1,000
Benchtop radioisotope counter OR . . . . .	2,400
Liquid scintillation counter . . . . .	12,000
Radioactivity survey meter . . . . .	250
Intensifying screens (pair) . . . . .	300 (5pairminimum)

● Denotes items considered desirable, but not absolutely necessary to conduct DNA typing.

SOURCE: Federal Bureau of Investigation, 1988.

six technicians working in the DNA Analysis Unit (13). At the moment, one technician can extract 25 to 30 samples per week. Based on a 48-week work year, the FBI anticipates an annual processing capability of 10,000 samples (8).

The FBI is transferring DNA typing technology to State and local crime laboratories through collaborative research projects, technical training courses, seminars, and publications (10). Scientists from State and local crime laboratories can participate in the Visiting Scientist program, through which forensic examiners learn DNA typing techniques (10). Analysts from at least 16 crime laboratory systems have participated in this program and 9 other systems are scheduled to participate in fiscal year 1990. In addition, free training courses are offered by FSRTC to personnel from State and local crime laboratories. Courses run from one day to several weeks. One-day courses are taught onsite by the FBI scientists; a 4-week course held two times since January 1989 has trained 60 students, and will be offered four times in fiscal year 1990, training 120 more students (13).

Two FBI symposia on DNA typing have included presentations by research scientists from academia, private labs, and the international forensic science community. (See box 6-B for information on uses of forensic DNA typing in other countries.) In addition

**Table 6-2-Operating Expenses for the FBI DNA Analysis Unit**

Estimated cost per sample excluding labor (10,000 samples per year) .....	\$ 28.50
Estimated cost per sample including labor (10,000 samples per year) .....	98.50
Monthly costs (excluding labor) .....	18,100.00
Yearly rests (with an estimated 25% more samples) .....	271,500.00

SOURCE: Federal Bureau of Investigation, 1989.

to these technology transfer mechanisms, the FBI publishes *Crime Laboratory Digest* quarterly, which has devoted several issues to DNA technology.

Following a suggestion at a June 1988 FBI seminar on DNA technology, an FBI Technical Working Group on DNA Analysis Methods (TWGDAM) was established. It first met in November 1988, and held three meetings in 1989, with the mission to evaluate DNA typing technologies used in State and local crime laboratories. To date, FBI, Lifecodes Corp. (a private company), and Canadian methods have all been considered. The group provides a forum for these labs to share information, protocols, and ideas related to DNA typing (12). It will also establish guidelines where appropriate (16).

Thirty-one representatives from 16 laboratories in the United States and Canada were chosen to serve on TWGDAM, based on how close the labs were to doing DNA typing. Initially, two representatives per lab were selected, although this has since been reduced to one per lab to allow other facilities to participate. Two academics were also chosen, one as a technical adviser for the polymerase chain reaction (PCR) method and the other for the restriction fragment length polymorphism (RFLP) technique.

Two TWGDAM subcommittees have been formed. One is addressing database developments and the other is considering quality control and quality assurance issues. The database subcommittee developed a theoretical model that was completed in October 1989. The FBI plans to create a working prototype of the model, to use for pilot studies with crime laboratories (4). The final report on quality assurance was published in July 1989 (16). TWGDAM will not be running a proficiency testing program. However, samples may be sent to TWGDAM members who are using the FBI method to measure the precision between laboratories.

1988  
Volume 15, Supplement No. 1

U.S. Department of Justice  
Federal Bureau of Investigation



## Crime Laboratory Digest

In This Issue

DNA Implementation

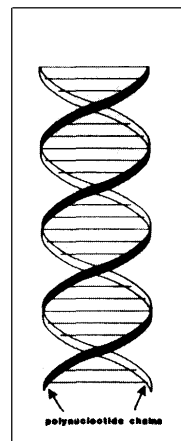


Photo credit: Federal Bureau of Investigation, Quantico, VA

An issue of the *Crime Laboratory Digest* devoted to DNA typing.

### STATE AND LOCAL CRIME LABORATORY INVOLVEMENT

Since the 1920s, when the first U.S. crime laboratories were established in Los Angeles and Chicago, they have proliferated across the country. Over half of those now operating opened their doors after 1970, often through Law Enforcement Assistance Administration funding (15). Currently, more than half of the crime laboratories in the United States provide at least some forensic serology services (2). The OTA survey of State and local crime laboratories revealed a wide range of efforts in DNA typing. Each State and local system has set up a crime laboratory uniquely suited to their needs. More often than not, DNA typing has become apart of those needs (box 6-C).

The number of nonclerical staff members in a lab ranged from 1 to 160, with an average staff size of 22. The OTA survey found that annual budgets ranged from \$10,000 to \$12 million, with an average of \$1,269,000. It should be noted that 18 percent of

### **Box 6-B—Uses of Forensic DNA Tests Internationally**

**An informal** OTA survey in January 1989 of 40 countries found that **at least** 15 have implemented **or are exploring** forensic applications of DNA tests<sup>1</sup> with most expecting to perform DNA typing of forensic samples in late 1989 or 1990. Two—the Republic of Korea and Yugoslavia—reported that such use of DNA identification was **not planned**. South Africa indicated that DNA typing is used only for **medical** applications at present, **but embassy staff did not say** whether this might be broadened to forensic uses. Yugoslavia also reported that such tests are used for **medical applications**.

**The extent** to which DNA typing technologies have been used abroad varies. In the United Kingdom, where forensic applications of DNA typing originated, single-locus and multilocus approaches have been fully accepted for criminal, paternity, and **immigration** casework. Over the past two years, Norway has gradually begun to use DNA typing in selected penal and **civil cases**. **In other countries**, DNA profiling is in an early, exploratory phase, with law enforcement units developing suitable systems and, in particular, collecting population data. In 1988, for example, Finland replaced traditional genetic human leukocyte antigen (HLA) typing for paternity cases with DNA-based profiling, which is now routinely used; DNA identification for criminal offenses has been on a selective basis.

The Israeli police intend to use DNA typing on a routine basis, and as of February 1989 were beginning trials on case samples. The Main Office of the Polish police and the Polish Academy of Sciences are conducting research on DNA typing for forensic applications and anticipate field applications at the end of 1989 for selected rape and murder cases. Explorations into DNA typing for paternity purposes in Poland has been discontinued due to lack of funding. In the State of South Australia, restriction fragment length polymorphism analysis is used for paternity testing, and polymerase chain reaction has been used for crime work. Two of New Zealand's three forensic laboratories plan to be performing DNA analysis by early 1990. Several countries, while currently in the development phase, have contracted with commercial laboratories on a limited basis.

Full international cooperation that would result in standardization and a coordinated investigative databank, as with some current National Crime Investigation Center files (see ch. 5), appears beyond **reach at the moment**. On the one hand, close coordination between the Royal Canadian Mounted Police and the Federal Bureau of Investigation will likely lead to effective data sharing from the outset—especially since the FBI anticipates its system eventually will become the de facto system in the United States. On the other hand, in anticipation of a unified European Community in 1992, officials of Denmark, Italy, the Netherlands, the United Kingdom, and Federal Republic of Germany met and agreed to a series of issues pertinent to standardization, including a designated restriction enzyme (different from the United States system) and a common probe. Nevertheless, although current technologies and applications appear to have advanced too far for international standardization for the present, the situation is likely to change as future technical advances are adopted. In the interim, the Federal Government could facilitate dialogue and encourage cooperative efforts leading toward a system amenable to DNA identification among, not just within, international criminal justice entities.

<sup>1</sup>Australia, Canada, Finland, India, Ireland, Israel, Italy, Japan, New Zealand, Norway, Poland, Sweden, Switzerland, United Kingdom, and West Germany.

SOURCE: Office of Technology Assessment, 1990.

those surveyed did not respond to this question, often because they are covered under a State budget. In addition, some who responded may have given the total State budget, which would inflate their response and hence the average. And some may have included staff salaries, while others may not have.

**Regardless of whether the responding crime laboratory was making plans to do DNA typing onsite, 78 percent of those surveyed said that DNA typing is very important to develop in order to advance the mission of their crime laboratory.**

The remainder said that DNA typing was “some-what important, but only an additional technology in an array of existing technologies” (15 percent), or that it was ‘not very important’ to their laboratory’s mission (5 percent) (table 6-3). Of the latter, most noted the response was prompted by very narrow forensic duties (e.g., drug analysis or arson investigation).

Respondents were asked to list what they perceived as the most important issues regarding DNA typing. The issues cited most often were standardi-

### **Box 6-C—American Society of Crime Laboratory Directors**

Formed in January 1974, the American Society of Crime Laboratory Directors (ASCLD) is the **national professional organization** of crime **laboratory administrators**. Its mission is to use management practices to improve crime laboratory operations. Officers are elected by the 15-member Board of Directors. The group's purposes are:

- . to promote and foster the development of laboratory management principles and techniques;
- to acquire, preserve, and **disseminate** information related to the utilization of crime laboratories;
- to maintain and improve communications among crime laboratory directors;
- . to promote, encourage, and maintain the highest standards of practice in the field of crime laboratory services;
- to promote an increase in the effective utilization of crime laboratory services;
- . to foster an increase in the effective utilization of crime laboratories in the criminal justice system;
- . to foster the continuous improvement of the quality of services offered by the crime laboratory; and
- to offer advisory and consultant services in the forensic sciences in support of the criminal justice system.

ASCLD sponsors programs for both proficiency testing and laboratory accreditation on a voluntary basis. Annual meetings are scheduled to coincide with the FBI's yearly crime laboratory development symposiums. In recent years, technical updates on DNA analysis have been given at the meetings. The first ASCLD position statement on DNA typing, adopted at the May 1988 Board of Directors meeting, stated that "DNA typing is an additional tool in the characterization of biological evidence in criminal investigations. It must be recognized that this procedure is only one part of the scientific analysis of evidence." At the May 1989 meeting, the organization formulated another policy statement on DNA typing, in which appropriate quality control and quality assurance measures and a common database system were identified as important. The establishment of a national DNA database system using the FBI's RFLP analysis program was supported as were implementation guidelines to help transfer DNA typing to State and local crime laboratories. In September 1989, ASCLD endorsed the TWGDAM quality assurance guidelines. Finally, ASCLD believes it has both a duty and a responsibility to establish standards for the forensic science community and cites its prior experience in establishing quality assurance programs through its national crime laboratory accreditation program (see ch. 3).

**SOURCES:** Office of Technology Assessment, 1990, based on "ASCLD DNA Statement," adopted by the ASCLD Board of Directors, May 3, 1989; American Society of Crime Laboratory Directors, pamphlet.

zation of DNA typing methods, courtroom approval and acceptance, proper training of laboratory personnel, establishment of a databank, quality assurance, and quality control. Other responses pointed to issues of developing population statistics, proficiency testing, costs and finding, continued research and development of methods, implementation and availability of the technology to local laboratories, certification, equipment needs, and confidentiality of results. It is clear that both standardization of the DNA typing process and its courtroom acceptance are of great concern to crime laboratories.

#### ***Crime Laboratories' Views on FBI Role in DNA Testing***

A large majority of respondents (96 percent) indicated that research (methods development and evaluation) is an appropriate role for the FBI in DNA testing (table 6-4). Training is also seen by a large majority (95 percent) as a role for the FBI, as is the maintenance of DNA data files (88 percent). Other suggestions were for the FBI to be used as a

**Table 6-3-Ranking of Importance of DNA Typing to Crime Laboratories**

**Question 1a: Do you believe DNA typing is very important, somewhat important, or not very important to the mission of your crime laboratory?**

	Number of labs	Percent of labs
Very important to develop for advancing the mission of this crime laboratory . . . . .	173	78
Somewhat important, but only an additional technology in an array of existing technologies. . . . .	34	15
Not very important to the mission of this crime laboratory . . . . .	10	5
No answer . . . . .	4	2

The code number of the question in the survey instrument (see app. B).  
SOURCE: Office of Technology Assessment, 1990.

reference library (77 percent), do casework for State and local laboratories (63 percent), provide proficiency samples for quality assurance (55 percent), define standards (48 percent), and certify lab personnel (24 percent) (table 6-4). (The FBI does plan to





Photo credit: Kevin O'Connor

The crime laboratory of the Metro-Dade Police Department in Miami, FL.

provide some level of proficiency testing to those laboratories using the FBI's DNA typing method (4,13 ).) Other suggested roles include providing probes and expert testimony, being available for onsite troubleshooting, offering refresher courses, assisting in complex cases, having staff available when labs start up, and publishing updates in methods and protocols. For the issue that many believe is the most pressing one facing forensic applications of DNA typing—that of defining standards—a minority of crime laboratories responding to the OTA survey (48 percent) proposed a role for the FBI. Moreover, some laboratories expressed serious concern about FBI involvement in this issue. They indicated that professional groups and forensic science associations should handle this, with the FBI helping to coordinate. The FBI's stated position on standards is that they will facilitate their establishment through the consensus building process of TWGDAM (11). (Some respondents to the survey may not have understood this distinction and may have taken the survey question to mean FBI-mandated standards, hence the lower affirmative response and perhaps the small negative response.)

As discussed earlier, the FBI is already doing many of the things that were cited by respondents as appropriate for the agency. Substantial research into methods development and evaluation has been and is currently underway at FSRTC. The FBI laborato-

Table 6-4-Suggested FBI Roles in DNA Testing

Question 4a: What role, if any, do you see for the FBI in DNA testing? (Please check all that apply).

Role	Percent of labs		
	Yes	No	No answer
Research (methods development and evaluation) . . . . .	96 <sup>b</sup>	2	2
Training . . . . .	95	3	3
Casework for State and local labs . . . . .	63	34	2
Maintenance of centralized DNA files . . . . .	88	10	2
Reference library . . . . .	77	20	3
Define standards . . . . .	48	49	2
Certify laboratory personnel . . . . .	24	73	2
Provide proficiency samples for quality assurance . . . . .	55	43	2
Other . . . . .	8	89	2

<sup>a</sup>The code number of the question in the survey instrument (see app. B.).

<sup>b</sup>Percentages may not add to 100 due to rounding.

SOURCE: Office of Technology Assessment, 1990.

ries have devoted considerable resources to training, and casework has been accepted since late 1988. Furthermore, several of the roles cited by the respondents are still under discussion. The possibility of a national database system is being researched (see ch. 5). Policies toward mandatory proficiency testing, defining standards, and lab personnel certification programs are still undefined.

### *Crime Laboratories' Plans for DNA Testing*

Considering how recently DNA testing has been introduced, interest and involvement in this new technology at the State and local crime laboratory level are extraordinary. The survey found that almost half of the laboratories (47 percent) presently contract with and have sent samples to either a private laboratory or the FBI, while 35 percent are not currently using DNA testing. Interest in having onsite capability for DNA testing is high among respondents (46 percent). Although more labs are scheduled to come on-line shortly, at the time of the survey only one was doing DNA tests onsite (table 6-5).

### *Crime Laboratories Not Conducting DNA Testing*

Nearly half those not currently conducting DNA testing have plans to start it in the next 1 to 2 years (24 percent have plans or funding to contract for it in the next 12 months, and 22 percent expect to start in the next 2 years). About one-fifth (21 percent) of those not conducting DNA testing have no plans to



Photo credit: Robyn Nishimi

Students in forensic DNA analysis training course at the Forensic Science Research and Training Center, FBI Academy, Quantico, VA.

do so in the next 1 to 2 years, and 33 percent of those surveyed did not answer the question, probably indicating the same situation (table 6-6).

When asked if they have provisions to contract out DNA testing in the future, over one-third of the respondents (37 percent) said they will contract as necessary. Another 34 percent said that they did not intend to do so. A small number of labs (13 percent) have provisions, but may not be able to due to cost (table 6-7).

### Contracting for DNA Testing

As of June 1989<sup>1</sup>, three private companies conducted DNA testing on a contract basis (Cellmark Diagnostics, Forensic Science Associates (FSA), and Lifecodes Corp.). Costs for the services of the three companies are presented in tables 6-8 and 6-9.

Cellmark Diagnostics established its Germantown, MD, laboratory in September 1987. It is a business unit of Imperial Chemical Industries Americas, Inc., which in turn is a subsidiary of the British-owned Imperial Chemical Industries PLC. Cellmark Diagnostics has the exclusive worldwide license to the “DNA fingerprinting”<sup>SM</sup> technique (based on RFLP analysis) developed by Dr. Alec Jeffreys in England and first used in the Leicester Crown Court case (see box 5-B). Cellmark has a technical staff of 20 (9). The estimated processing time is 4-8 weeks, depending on the nature of the evidence (5).

<sup>1</sup>Since the time of the survey, OTA has identified at least two other companies performing forensic DNA testing—Genescreen of Dallas, TX, and Gennan Corporation of Akron, OH.

Table 6-5-Crime Laboratory Involvement in DNA Testing

Question 8a: Have you plans for utilizing or do you currently utilize forensic DNA testing? (Please check all that apply).<sup>a</sup>

Use of testing	Number of labs= <sup>c</sup>	Percent of labs		
		Yes	No	No answer
Presently contracting . . . . .	104	47	50	3
DNA tests onsite . . . . .	1	0.5	97	3
Have plans for onsite DNA testing . . . . .	101	46	52	3
We do not currently use . . . . .	78	35	62	3

<sup>a</sup>The code number of the question in the survey instrument (see app. B).  
<sup>b</sup>Percentages may not add to 100 due to rounding.  
<sup>c</sup>Number of labs cannot be totaled because respondents were asked to check all responses that may apply.

SOURCE: Office of Technology Assessment, 1990.

Table 6-6-Crime Laboratory Plans To Conduct DNA Testing

Question 9a: If you are not currently conducting DNA testing either onsite or contracting, do you have plans or funding to contract for DNA testing?

Plans for testing	Number of labs	Percent of labs
In the next 12 months . . . . .	41	24
In the next 24 months . . . . .	37	22
Neither . . . . .	36	21
No answer . . . . .	57	33

<sup>a</sup>The code number of the question in the survey instrument (see app. B).  
 SOURCE: Office of Technology Assessment, 1990.

Table 6-7--Crime Laboratory Plans To Contract for DNA Testing in the Future

Question 10a: Do you have provisions to contract out DNA testing if necessary in the future?

Plans to contract	Number of labs	Percent of labs
Yes, we will contract out as necessary . . . . .	63	37P
No, we do not intend to contract . . . . .	58	34
Yes, we may have provisions, but cost may prevent us from contracting . . . . .	22	13
No answer . . . . .	29	17

<sup>a</sup>The code number of the question in the survey instrument (See app. B).  
<sup>b</sup>Percentages may not add to 100 due to rounding.  
 SOURCE: Office of Technology Assessment, 1990.

FSA is a small firm in Richmond, CA, that processes forensic samples using the PCR method under a licensing agreement with Cetus Corp. Cetus received a patent for the PCR method in 1987 and

**Table 6-8-Costs for Forensic DNA Testing by Private Laboratories<sup>a</sup>**

Service	Cellmark	Forensic Science Associates	Lifecodes
DNA testing .....	\$490/sample	\$1,500/case	\$325/sample
Processing isolated DNA sample .....	\$350/sample	Not available	\$200/sample
Expert witness (daily rate + expenses) .....	\$1,000/day (Ph.D.)	\$100-\$ 125/hr.	\$750/day
	\$750/day (non-Ph.D.)		
Processing of insufficient sample .....	\$210/sample	\$450/sample	\$125/sample

<sup>a</sup>Information current as of June 1989.

SOURCE: Office of Technology Assessment, 1990.

markets a PCR HLA *DQcx-1* test kit for use by crime laboratories.

Established in 1982, Lifecodes Corp. is located in Valhalla, NY. They began doing research and development into the RFLP method in 1982, and started doing forensic testing commercially in early 1987 (3). Currently employing a staff of six forensic scientists, Lifecodes estimates a turnaround time for processing samples to be 2-3 months (18). Lifecodes will be marketing a test kit in early 1990 that will contain all the necessary reagents for processing a sample from DNA extraction to final hybridized Southern blot (14). This kit will follow the FBI protocol, and is viewed by some as significant on two counts: as an indication that there will be a ready supply of testing materials for crime laboratories, and because it indicates the support by a company that uses its own method for a national standardized protocol based on the FBI method (11). Additionally, one of Lifecodes' high priority development issues is to develop a test kit that will use nonradioactive probes (14).

As previously mentioned, 47 percent of laboratories have contracted for forensic DNA analysis. When asked which facilities they had contracted with, most laboratories surveyed (65 percent) had dealt with Lifecodes, nearly half (48 percent) with Cellmark, one-fifth (21 percent) with FSA, and 22 percent with other facilities (including the FBI) (table 6-10). It should be noted that users do not formally contract with the FBI, their services are available at no charge to law enforcement agencies in connection with their investigation of criminal (not civil) matters (11). Also, crime laboratories can contract with more than one facility. Of those who listed the number sent to each facility, 277 cases were sent to Lifecodes, 191 to Cellmark, 45 to FSA, and 40 to other facilities. Prior to sending specimens out to private laboratories, nearly three-quarters (74 percent) conduct a prescreening test (table 6-11).

**Table 6-9-Costs for Paternity DNA Testing by Private Laboratories<sup>a</sup>**

Service	Cellmark	Lifecodes
DNA testing of whole blood .....	\$200/sample	\$150/sample
DNA testing of nonblood sample .....	\$350/sample	\$300-450/sample
Expert witness (daily rate + expenses) .....	\$500/day	\$750/day
Processing of insufficient sample .....	\$210/sample	\$50-125/sample

<sup>a</sup>Information current as of June 1989.

SOURCE: Office of Technology Assessment, 1990.

**Table 6-10-Facilities Contracted With for DNA Testing**

Question 12a: Which facilities have you contracted with?		
Facility	Number of labs	Percent of labs
Cellmark .....	51	48
Forensic Science Associates .....	22	21
LifeCodes .....	70	65
Other .....	23	22

<sup>a</sup>The code number of the question in the survey instrument (see app. B).

SOURCE: Office of Technology Assessment, 1990.

**Table 6-11—Prescreening Tests**

Question 13a: When you send specimens out to private laboratories, do you conduct a prescreening test on them beforehand?		
Prescreening	Number of labs	Percent of labs
Yes .....	80	74
No .....	21	19
No answer .....	7	7

<sup>a</sup>The code number of the question in the survey instrument (see app. B).

SOURCE: Office of Technology Assessment, 1990.

Respondents were asked to estimate the number of samples they anticipated sending out yearly. The results show that the expected usefulness of contract DNA testing varies widely. Estimates of the number of annual samples ranged from 2 to 3,000 with the average being 120. Over half the laboratories (65

percent) plan to restrict or institute a formal protocol to determine the types of crimes that DNA testing can be used on. When asked what criteria they would use to determine these crimes, cost, the failure of conventional methods, and a prescreening test were mentioned. Others said they planned to follow the FBI's criteria. Respondents indicated that homicide, sexual assault, violent crime, and serial crimes all merited use of DNA typing. Hit-and-run accidents as well as robbery were also cited. The use of DNA testing would be warranted on hit-and-run accidents that involve serious bodily injury or death, such as when a pedestrian or a child on a bicycle is struck. The technology would have no utility in a "property damage" hit-and-run accident (11).

In contrast to the large number of facilities that have contracted for forensic DNA testing, budget proposals for onsite DNA typing have not been submitted by many crime laboratories. Of the 104 laboratories contracting for outside services, nearly half (49 percent) have not submitted budget provisions to do DNA analysis onsite. This can be compared with the 38 percent that have submitted a budget but have not yet had it approved (table 6-12). The survey revealed a wide variation in budget requests. (As noted earlier, numbers may be inflated by budget requests from entire State systems.) Budget requests for DNA analysis in State and local crime laboratories range from \$5,000 to \$4.6 million (for a State system).

Many crime laboratories have devised innovative financing plans for DNA typing. For example, one State plans to use some of the proceeds from the State cigarette tax (6). Another growing source of funding for State and local crime laboratories is money, goods, and property confiscated from drug dealers (1). Problems in financing crime laboratories, in general, have arisen in other States. In one, local county law enforcement agencies are now paying for their use of the State crime laboratories, even though they never had to previously (7). These labs will run out of funds unless the counties pay up. Although this particular situation is not directly related to DNA typing costs, similar situations could arise as States try to raise funds necessary for DNA analysis.

**Table 6-12—Paying for DNA Testing**

Question 11a: If you are not conducting DNA analysis onsite, have you submitted budget provisions to do so that have not yet been approved?

Budget submitted	Number of labs	Percent of labs
Yes . . . . .	41	38
No . . . . .	53	49
No answer . . . . .	14	13

<sup>a</sup>The code number of the question in the survey instrument(see app. B).

SOURCE: Office of Technology Assessment, 1990.

### *Conducting DNA Testing Onsite*

*The* cost of submitting samples to private laboratories has been cited as the reason for pursuing onsite DNA testing by some members of the crime laboratory community. Although, for facilities without a large case load, it could be more cost-effective to continue contracting. It is apparent that there will soon be a score of crime labs conducting DNA tests onsite. Some respondents have established facilities, but have not yet begun to accept casework. For the purposes of this survey, OTA defined "labs conducting DNA testing onsite" as those actually accepting casework. Although several were close to starting up, only one laboratory was actually conducting DNA testing onsite at the time of the survey. Located in Norfolk, VA, the laboratory began casework on May 1, 1989 (box 6-D)<sup>2</sup>. The annual budget in that section is \$100,000, and currently it has two forensic scientists performing DNA testing. An increase in professional staff positions is expected, and staff handling DNA samples required training above and beyond their academic and work experience. The new positions also required training in molecular biology and genetics, and courses at the FBI Academy.

When ranking factors important in the decision to pursue DNA typing onsite, the Virginia laboratory indicated that evidence control was most important, that having state-of-the-art technology was important, that the cost of contracting out was not very important, and that the least important factor was having a short turnaround time.

Although the possibility of a noncriminal justice agency using the DNA typing facility for other purposes has been proposed in some States, this was not the case in Virginia. No noncriminal justice agencies were planning to use the crime laboratory

<sup>2</sup>because confidentiality was ensured in the survey, permission to disclose the laboratory's identity was received from Paul Ferrara of the Virginia Bureau of Forensic Science.

**Box 6-D—DNA Typing in Virginia**

**In May 1989**, Virginia became the first State in the Nation to conduct onsite DNA testing. Serving all law enforcement agencies in the State, all prosecuting attorneys, and the State medical examiner, the Bureau of Forensic Science processes over 60,000 cases a year. The Bureau began discussions on a State DNA testing facility in 1987, and in spring 1987, a representative of LifeCodes Corp. visited the headquarters facility in Richmond, VA, to propose a 1-year technology transfer program. Under the terms of the program, selected Virginia laboratory personnel received 4 weeks of training at the Lifecodes facility in New York to learn DNA typing procedures and quality control measures, and take a proficiency test. Having made a commitment to training in DNA typing procedures, the Bureau requested \$85,000 for January to July 1988 to purchase the needed equipment. An additional request of \$206,000 was made for July 1988 to June 1990. Both budget requests were granted in full by the Virginia State Legislature. A budget request for the 1990 to 1992 biennium for \$1,050,000 is pending.

DNA testing was deemed admissible in the court system of Virginia after it was submitted as evidence in the Timothy Spencer case (see ch. 4). In March 1989, the Governor signed legislation calling for mandatory samples from all convicted sex offenders. Currently, the State has 2,100 incarcerated sex offenders. Until money is received to create a databank, samples will be stored and, as of July 1989, all convicted sex offenders have been providing samples that will be stored until funding to perform these tests is available. The Tidewater Regional Forensic facility in Norfolk was chosen to be Virginia's first DNA typing laboratory. It has capacity of 300 to 400 cases per year. Turnaround time for processing samples is currently 10 to 12 weeks. It is staffed by two scientists (with a third planned) and one technician. In addition to the Lifecodes training, the scientists have also received training from the FBI.

It is important to note also that the Virginia Bureau of Forensic Science has recently decided **to switch from the Lifecodes** system and instead has adopted the FBI protocol for DNA testing. Although both systems rely on the same **technical** foundation, the step was taken by Virginia in an effort **to foster and promote standardization** of methods (important for a national databank) among the first forensic laboratories performing DNA analyses. The Virginia Bureau of Forensic Science also has adopted the TWGDAM guidelines for quality assurance.

**SOURCE:** P. Ferrara, personal **communications** and presentation at "International Symposium on the Forensic Aspects of DNA Analysis," Quantico, VA, June 22, 1989.



*Photo credit: Robyn Nishimi*

Scientist at the Tidewater Regional Forensic Laboratory in Norfolk, VA, a laboratory of the Virginia Bureau of Forensic Science.

for paternity, child support enforcement, or missing persons. Virginia's crime laboratory is creating DNA data files at this time for suspects under investigation. These particular files will be maintained at the State level, and Virginia is working with the FBI on a pilot project to create a national DNA databank. Any DNA testing material not specifically related to an ongoing investigation will be stored as autoradiograms, electronically captured prints, or membranes. Virginia intends to restrict the types of crimes DNA testing can be used on.

Not all State and local crime laboratories will be able to implement DNA typing quite as smoothly, although some, such as New York, have planned extensively (box 6-E). Virginia's experience is also unique in the general lack of controversy about the privacy issues involved. In addition, money for the program was approved by the State legislature with relative ease. Nevertheless, the OTA survey indicates that crime laboratories are moving rapidly toward onsite DNA testing regardless of potential controversies.

### **Box 6-E—The New York State Forensic DNA Analysis Panel**

In July 1988, the State of New York formed a panel to assess issues surrounding forensic DNA testing before implementing such procedures. The panel consisted of prosecutors and defense attorneys, scientists, policymakers, legal scholars, and experts in law enforcement. In September 1989, the panel released its report on DNA testing. Included were its recommendations for a program to implement DNA testing in New York.

Scientific issues covered in the report included a discussion of the limits of traditional identification techniques, problems associated with the existing technologies and population studies, and quality control issues. The legal section covered national court rulings on DNA admissibility, as well as the different standards that should be applied when DNA results are admitted for inclusionary v. exclusionary purposes. Concerns about private and public laboratories' procedures were highlighted in the policy issues section. Finally, the report laid out a model program for forensic DNA testing implementation in New York State.

Rather than have each State and local laboratory in New York implement DNA typing on their own, the report recommended that a statewide DNA network be created. This network would eventually be served by at least three regional forensic DNA testing laboratories. Coordination on issues such as quality assurance, quality control, and safety would occur for the laboratories. In addition, there would be an accreditation process for both public and private forensic DNA typing laboratories operating in the State.

Two advisory bodies would oversee the operations of the network—an advisory committee that would establish uniform standards, and a scientific review board to assist the courts in evaluating the technologies that were used in specific cases. Members of the scientific review board could serve as expert advisers to the courts if necessary. The report acknowledged that many complex issues are associated with the creation of a DNA databank. If the privacy concerns were appropriately addressed, the report recommended legislation requiring those convicted of violent sex crimes or other designated offenses to give DNA specimens. It also recommended that the State begin preliminary developmental work to overcome any technical problems involved in creating such a databank. The innovative approach to implementation of forensic DNA analysis taken by the State of New York might enable them to avoid future problems that could have arisen in the absence of such a report.

SOURCE: Office of Technology Assessment, 1990, based on *DNA: Report of New York State Forensic DNA Analysis Panel*, Sept. 6, 1989.

## **FINDINGS AND SUMMARY**

Although DNA analysis has only been in use in the U.S. criminal justice system for a short time, it has been quickly incorporated into the array of investigative biological technologies used by State and local crime laboratories. A 1989 OTA survey of 221 crime laboratories found that over three-quarters (78 percent) believe DNA typing is very important to their mission. Nearly half (47 percent) were contracting for this service with an outside facility, and 46 percent have plans to implement onsite DNA testing. OTA found a diversity in crime laboratory budgets and staff size. Yet while some systems will be able to finance onsite DNA typing facilities, others may not even be able to cover the costs of contracting. However, if the use of DNA testing for forensic purposes continues to increase at the present rate, it is not inconceivable that all crime laboratories will reach a point where access to **DNA typing will be essential.**

The FBI DNA Analysis Unit began accepting casework in December 1988. Several mechanisms

are used by the FBI to transfer DNA typing technologies to State and local crime laboratories. When these labs were asked about the appropriate roles for the FBI, defining standards (48 percent) and providing certification for laboratory personnel (24 percent) were ranked the lowest. Also, while it is clear that the crime laboratories feel standards should be set, who should set them is not at all clear.

A large majority of crime laboratories (95 percent) said that DNA results should be incorporated into a database for exchange among law enforcement agencies. (Efforts are currently under way in the Federal Government (see ch. 5) to create such a database.) In addition, a number of States have already passed legislation requiring blood or saliva samples from convicted sex offenders.

Three companies were providing DNA testing on a contract basis at the time of the OTA survey. OTA found that laboratories anticipated sending out anywhere from 2 to 3,000 samples annually in the future. Nearly two-thirds of the crime labs (65 percent) will restrict or institute a formal protocol to

determine which crimes are appropriate for DNA testing. Of the 104 laboratories contracting for tests, nearly half (49 percent) have not submitted budget provisions to do their own DNA analysis onsite. Laboratories can continue contracting or use the FBI DNA Analysis Unit at no cost. It is unclear if the FBI will be able to handle the case load of those labs.

At the time of the survey, OTA found only one facility conducting onsite DNA typing. Many others were nearly ready to accept casework, however, and in the next few years large numbers of crime laboratories will probably be conducting DNA typing onsite. It would be helpful if issues such as Standardization and courtroom approval and acceptance two issues viewed as important by survey respondents could be settled prior to their coming on-line with DNA typing.

## CHAPTER 6 REFERENCES

1. *Associated Press*, "State's Top Cop Wants Drug Money to Pay for New Crime Lab," June 22, 1989.
2. Bashinski, J. S., and Fisher, B., "Methods of Genetic Marker Typing: A Survey of the Current State of the Art," American Academy of Forensic Sciences, Colorado Springs, CO, 1988.
3. California Association of Crime Laboratory Directors, "DNA Committee Report," Nov. 19, 1987.
4. Castonguay, R.T, Federal Bureau of Investigation, Washington, DC, personal communication, April 1989.
5. Cellmark Diagnostics, *Forensic Testing Facts*, November 1988.
6. Conrad, D., *Associated Press*, "State Police Moving Toward Genetic Fingerprints," July 7, 1989.
7. Edwardsen, E., *Associated Press*, "Counties to Pay Up for State Police Lab Work," July 5, 1989.
8. Eubanks, B., "DNA Operational Up-Date," paper presented at the American Society of Crime Lab Directors Board of Directors Meeting, Quantico, VA, May 2, 1989.
9. Forman, L., Cellmark Corp., Germantown, MD, personal communication, September 1989.
10. Hicks, J.W., Federal Bureau of Investigation, testimony before U.S. Senate, Subcommittee on the Constitution, Committee on the Judiciary, Mar. 15, 1989.
11. Hicks, J.W., Federal Bureau of Investigation, Washington, DC, personal communication, August 1989.
12. Kearney, J., "Summary of the First Meeting of the Technical Working Group on DNA Analysis Methods," *Crime Laboratory Digest 15(4)*, October 1988.
13. Kearney, J., Federal Bureau of Investigation, Quantico, VA, personal communications, April, August, October, and December 1989.
14. Page, L. A., Lifecodes Corp., personal communication, November 1989.
15. Peterson, J., "The Crime Lab," *Thinking about the Police: Contemporary Readings* (New York NY: McGraw Hill, 1983).
16. Technical Working Group on DNA Analysis Methods (TWGDAM), Quality Assurance Subcommittee, "Guidelines for a Quality Assurance Program for DNA Restriction Fragment Length Polymorphism Analysis," *Crime Laboratory Digest 16(2):41-59*, April-July 1989.
17. U.S. Department of Justice, Federal Bureau of Investigation, FBI Academy, Forensic Science Research and Training Center, *Annual Report, 1988*.
18. Winkler, J.K., Lifecodes Corp., personal communication, April 1989.