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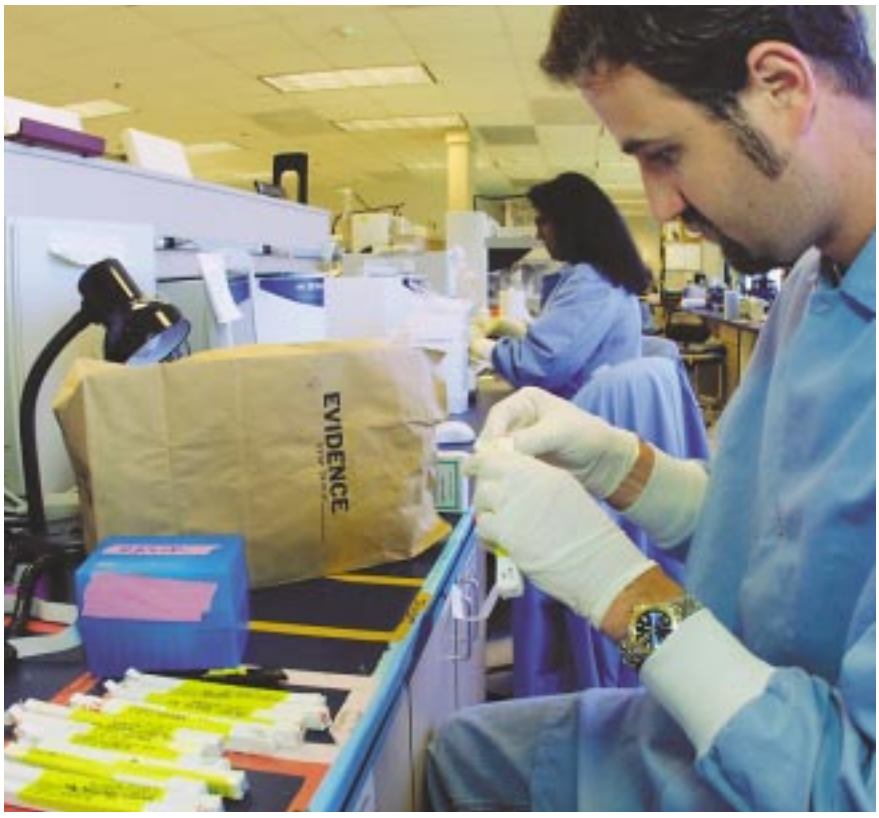

STARTING POINT **Myriad Genetics lab technician Drew Carter opens evidence bags containing individual DNA samples collected by New York State Police from the site of the World Trade Center disaster.**

CHEMISTS NEEDED FOR FORENSIC ANALYSES

Huge evidence backlog creates private-sector opportunities for forensic DNA analysts

WILLIAM G. SCHULZ, C&EN WASHINGTON

EMPLOYMENT OPPORTUNITIES IN forensic DNA analysis are on the verge of explosive growth. That's the conclusion of many forensic scientists and other experts who say that the power of DNA identification technologies, coupled with advanced computer technology, is poised to open a new era in U.S. efforts to fight and prevent crime—provided those efforts are funded.

Assessing DNA evidence backlog and related work, Mark D. Stolorow, Cellmark Diagnostics general manager of forensics, says, "We're looking at a tsunami of physical evidence that will overwhelm the public sector." He compares the future employment opportunities for scientists interested in forensic DNA analysis with the dot-com hiring sprees of the mid-1990s.

And that's even without factoring in the enormous number of samples waiting to be DNA tested for the purpose of identifying victims of the World Trade Center disaster.

"The DNA technology is incomparable," says Paul Ferrara, a chemist who is director of the Virginia Division of Forensic Sciences in Richmond. But in order to fulfill its promise, "approximately 10,000 new forensic scientists will be needed over the next decade," Ferrara says. And that need crosses all science disciplines.

Chemists and biologists at every degree level—with requisite courses in biochemistry, genetics, and statistics coupled with at least six months of on-the-job training—are among the army of scientific personnel needed to tackle the job. Processing the current backlog of forensic DNA evidence and expanding local, state, and national databases of DNA evidence obtained from crime scenes, as well as from convicted offenders, will require a massive effort.

VIRGINIA DIVISION OF FORENSIC SCIENCE PHOTO

Ferrara

THE WORK is quite literally piling up. In public crime-lab refrigerators across the country, huge backlogs of DNA evidence now sit unprocessed because of shortfalls in state and local funding. The samples are grim reminders of the sorts of violent crime—rapes, sexual assaults, and nonfatal stabbings and shootings—that continue to plague U.S. citizens.

No one has a good handle on the exact size of the DNA evidence backlog, says Lisa Foreman, deputy director of the Investigative & Forensic Sciences Division at the National Institute of Justice (NIJ), part of the Department of Justice. She says NIJ estimates put it at something like half a million DNA samples. Other experts say it is closer to three-quarters of a million samples, maybe more.

Whatever the exact number, Foreman says, the backlog at least shows that the DNA-database concept for fighting crime has caught on with state government officials. She says the states recognize the potential to solve crimes by comparing crime-scene DNA evidence with databases that contain DNA profiles of known offenders and/or DNA evidence collected from other crime scenes.

In the same way that fingerprints can identify suspects, DNA profiles can help to identify perpetrators or enhance investigative work, for example, by determining that an unknown offender is committing serial crimes when his or her DNA profile appears at more than one crime scene.

All of the DNA data collected by state and local governments are destined for the Combined DNA Index System (CODIS), operated by the Federal Bureau of Investigation and authorized by Congress. Ideally, the database will be used to stop criminals before their crimes escalate in terms of number and levels of violence—a well-documented phenomenon associated with many crimes such as rape and domestic violence.

In fact, the whole idea for creating DNA-profile databases grew out of efforts by the states to combat sexual assaults—crimes with a high rate of recidivism by convicted offenders. But as the power of this evidence became apparent, Foreman says, states began mandating that evidence from an ever-wider range of crimes be included in the profiling databases.

PHOTO BY GEORGE FREY

IDENTITY NEEDED **Myriad Genetics lab technician Tony Gaglio extracts DNA from vials, the first step in processing DNA evidence. New York State Police collected the DNA sample from the World Trade Center area.**

"That exponentially expanded the backlog," Foreman says. In addition to sex offenders, 40 states now require DNA samples in cases of murder and assault and battery, 32 states require that DNA samples be taken in burglary cases, and 12 states require DNA samples from all convicted felons.

Each piece of backlogged DNA evidence, then, is a link to the perpetrator of a violent crime who has not yet been identified or brought to justice. Given that stopping sex offenders was the starting point for the whole effort, it's a sad irony that the backlog today includes an estimated 180,000 unprocessed rape test kits—vaginal swabs and other forensic evidence collected from a victim in the aftermath of a rape. The DNA samples they contain may be the only evidence that could positively identify the rapist and prevent him from committing additional crimes.

Public safety advocates publicizing the backlog say evidence of rape and other sexual assaults is often designated "low priority" by law enforcement officials. Crime lab resources, stretched thin by other demands, such as the war on drugs, have often left crime lab workers with little choice but to stockpile the rape test kits and other DNA evidence.

Crime statistics and other research findings—about rape, especially—point out the urgency of solving the backlog problem. Justice Department-sponsored surveys reveal that one out of every six U.S. women has been the victim of a completed or attempted rape. More than 90,000 U.S. women were raped in 2000. And cases of rape are often accompanied by physical assault: 41% of women who were raped were also slapped, hit, kicked, bitten, choked, or hit with an object such as a gun or other weapon.

Justice statistics also reveal the plight of children: 67% of all victims of sexual assault that were reported to law enforcement between 1991 and 1996 were under the age of 18. Thirty-four percent of all sexual assault victims were under age 12, and one of every seven sexual assault victims was less than six years old.

"I'm actually quite negative about the situation," says Karen M. Berka Brewer, a forensic chemist who analyzes DNA evidence for the Indiana State Police Force in Fort Wayne. "The sexual assault of children is rampant," she says. "The evidence is there," but it's not being analyzed.

Berka Brewer says public crime labs are trying to do their part by concentrating on sex crimes with high recidivism rates, and on so-called gateway crimes like burglary and breaking and entering. Perpetrators of those crimes, she says, often go on to commit more serious offenses such as serial rapes and homicides.

"But we're underfunded now," Berka Brewer says, noting that most public crime labs are struggling with strained budgets at a time when they need to build better labs and to hire additional people.

Despite the pressure and constraints of her work, she says, "I still get that Nancy Drew feeling," referring to the fictional girl detective who inspired her pursuit of a career in forensic science. "I solve crimes with a microscope and a lab coat."

"Some work gets done," says Carl M. Selavka, director of Massachusetts State Police Crime Laboratory in Sudbury. "Drug analysis—in addition to bomb, arson, and toxicology cases—almost always gets done," he says. But "I have refrigerators filled with evidence from nonfatal stabbings and shootings."

Job seekers should be advised, therefore, that the majority of the work that will be done to reduce the DNA evidence backlog—and to tackle future needs for DNA forensic analysis—will likely not take place in public crime labs. Though NIJ will, in fact, soon begin distributing grants to the states aimed at eliminating the backlog, most of that money will be spent on outsourcing the work to biotechnology companies.

SO FAR, only a handful of private biotech labs meet FBI standards for processing DNA forensic evidence for deposit in CODIS. These include Bode Technology Group, Springfield, Va.; Cellmark Diagnostics, Rockville, Md.; ReliaGene Technologies, New Orleans; and Myriad Genetics, Salt Lake City. In fact, these companies have already started whittling down the backlog, working under contracts with a number of states. NIJ funding, expected to be released next month, can only expand the volume of this work.

Kevin C. McElfresh, senior vice president of Bode Technology Group, credits politicians such as New York City Mayor Rudolph Giuliani for calling attention to the backlog problem. He says Bode Technology Group—one of the first private labs to meet FBI standards for this work—began by tackling a backlog of some 10,000 rape test kits just for the borough of Manhattan. "What do the rest of the major cities have?" McElfresh asks, rhetorically.

McElfresh says private labs are tackling the backlog because they have the flexibility, in terms of hiring needed personnel and obtaining necessary lab equipment. He says the cost to process one rape test

"We're looking at a tsunami of physical evidence that will overwhelm the public sector."

kit can be $700 for his company. Spokesmen for other companies say the costs can range as high as $1,200 to separate and analyze DNA for a single case.

Cellmark, a recognized leader in forensic DNA analysis, is a familiar name to anyone who followed the compelling DNA evidence presented by one of its staff scientists in the 1994 O. J. Simpson murder trial. The company has also performed DNA analysis for investigators in the ongoing JonBenét Ramsey murder case in Boulder, Colo., and its services are sought in any number of less high-profile criminal investigations.

"We're growing like crazy," says Cellmark's Stolorow. "We have increased our staff by 50% in one year." The company now employs 65 scientists.

Another biotech company, Myriad Genetics, has been working with various state governments for two years, helping them process and eliminate their DNA-evidence backlogs. The company specializes in high-throughput DNA sequencing that allows it to handle approximately 2,000 forensic DNA samples per day.

"We're using this technology now to identify victims of the World Trade Center disaster," says William A. Hockett, Myriad's vice president for public relations. He explains that the company's DNA profiles of victims killed at the twin towers site will be compared with DNA samples collected from victims' relatives by New York state investigators.

At ReliaGene Technologies, chemist Sudhir K. Sinha, who is president and laboratory director, agrees that "there is tremendous opportunity here" as a result of the states' DNA evidence backlog. "I can't hire enough people."

The Y-chromosome DNA test he developed, Sinha says, can help solve complicated problems in both forensic and paternity/genealogic DNA analyses. For example, he says, in sexual assault cases that include multiple assailants, Y-chromosome testing can show that that was what happened, and the technology can then be used to identify individual assailants.

In cases where there is a mixture of male and female blood, saliva, or other biological samples, Sinha continues, Y-chromosome testing can be used to analyze only the male DNA, which in turn can be compared with a reference sample for purposes of suspect identification.

Most of the private labs contacted by C&EN say they will provide training to qualified scientists who want to specialize in forensic DNA testing. For example, they might start a new scientist in paternity or other DNA testing and then provide the specialized training—often including training in effective courtroom testimony—for work in forensics.

Of scientists who apply for work at his company, McElfresh says, "What I really want to know is, Do they perform in the lab? We have a six-month training program in place, but they won't make it through without a good set of hands in the lab."

The potential of forensic DNA evidence to solve and prevent crime is difficult to overstate. Stolorow, who was trained as a forensic chemist and who has worked in public crime labs, points to what he calls the "British model."

In the U.K., the National DNA Database was established in 1995. It currently holds the DNA profiles of more than 1.3 million suspects and convicted criminals as well as more than 117,000 profiles obtained from crime scenes. DNA samples can be taken from anyone in the U.K. who is suspected of, charged with, reported for, or convicted of a reportable offense. The sample is then checked against the database.

Each week in England and Wales, there are some 1,300 matches of suspects to crime scenes or matches of crime scenes to other crime scenes, according to the U.K. Forensic Science Service (FSS), which operates the database. The new chief executive of the service, Dave Werrett, who took office in October, was among the first forensic science investigators to present DNA profiling evidence in court.

It was a heartbreaking case. In 1983, 15-year-old Lynda Mann was found raped and murdered in the small town of Narborough in Leicestershire. A semen sample was taken from her body, but there were no other leads and the case wound down.

Three years later, 15-year-old Dawn Ashworth was found sexually assaulted and murdered in the same town. Semen samples from her body revealed that her attacker had the same blood type as Mann's murderer.

By that time, the first paper on DNA profiling had been published by Sir Alec J. Jeffreys, a professor of genetics at Leicester University. It included a method to sep-

INDIANA STATE POLICE PHOTO

DETECTIVE **Berka Brewer says she still "gets that Nancy Drew feeling" when solving crimes.**

VIRGINIA DIVISION OF FORENSIC SCIENCE PHOTO

FILLING THE DATA BANK **Blood samples from convicted felons being processed at the Virginia Division of Forensic Science.**

RELIAGENE TECHNOLOGIES PHOTO

ENOUGH FOR ALL **Sinha says states' DNA evidence backlog presents an opportunity for private labs.**

arate sperm from vaginal cells, which was used to exonerate the chief suspect in the Narborough crimes, a local schoolboy.

With the DNA evidence in hand, a detective on the case decided to undertake the world's first mass DNA screen. All adult males in three villages—some 5,000 men—were asked to provide samples of blood or saliva. DNA profiling was carried out on the 10% of men who had the same blood type as the killer.

Despite the exhaustive work, no DNA profiles matched the original samples. A year later, however, a woman overheard a colleague bragging that he had taken the test masquerading as his friend, Colin Pitchfork. The woman reported what she heard to the police and Pitchfork was arrested. His DNA was shown to match that from the murders, and in 1988 he was sentenced to life in prison.

PHOTO BY WILLIAM SCHULZ

Fisher

"When policymakers think forensics, they think DNA, but other areas could use some TLC."

"THE MARKET for jobs in forensic science is quite robust and driven by DNA analysis," says Peter DeForest, who heads one of the U.S.'s few Ph.D. programs in forensic science at John Jay College of Criminal Justice, part of the City College of New York, in New York City. He cites one New York state medical laboratory that recently expanded its scientific/technical staff from 75 to about 500 people to process forensic DNA evidence.

DeForest is not bothered too much by the numbers. "Kids take those jobs as a stepping stone to something else," he says.

"DNA is something the layperson can relate to," DeForest continues. "Prosecutors are demanding that it be done."

What does concern DeForest is the potential for myopia about DNA evidence to the exclusion of other crime-scene evidence. In a paper dealing with the perils of a shortsighted focus on DNA evidence, DeForest writes:

"There are no data but the situation appears to be getting worse. The focus on 'items' and 'tests' is increasing. The trends discerned include large-scale hiring of narrowly trained technicians coupled with reduced attention to the crime scene by scientists. Crime scene work is not trivial. It is 'rocket science.' There is a need for scientists at the scene defining the questions to be addressed. However, the reality is that this is rather rare."

"When policymakers think forensics, they think DNA," says Barry A. J. Fisher, who is director of the Scientific Services Bureau of the Los Angeles County Sheriff's Department. "But other areas could use some TLC." Those areas include blood stain analysis, trace analysis of various kinds of physical evidence, firearms identification, and fingerprint analysis, to name just a few.

"The scientific method and the human mind, not technologies, provide the solution," DeForest writes. "Technologies are the tools. We should be careful to understand the difference between science and technology. Science, not technology, provides the best means of seeking truth."

Ferrara agrees that there is more to crime-scene investigation than DNA evidence. "At a crime scene, there might be blood all over, weapons, bullets, fingerprints, extortion or suicide notes. There can be no undue emphasis on all forms of physical evidence.

"But sometimes," Ferrara continues, "we just want to know whose body fluid is there."

Forensic scientists, Ferrara says, now spend a lot of time looking at 20-year-old unsolved cases because of the possibility of producing new leads through the extraction of forensic DNA evidence. "We see case after case where the victims of unsolved crimes have lived in fear of their attackers."

Forensic DNA evidence, he says, "means we can provide closure" to crime victims and their loved ones. For example, he says, "the knowledge that the person who has killed someone's daughter has been brought to justice—you can't put a price tag on that."

"It's the most satisfying work you will ever do," McElfresh says. "You can go back and solve cases where there have been no leads. You give people back to their families, and you can get criminals off the streets." ■

DNA ANALYSIS

Finding Funds And Collating The Data

Next month, the Department of Justice's National Institute of Justice is expected to release the first round of grants underwriting efforts to eliminate the backlog of DNA evidence. This year's funding—some $15 million—is just the first blush of an anticipated $170 million in federal funding over four years as authorized by the DNA Analysis Backlog Elimination Act of 2000. Still to be determined is how much money Congress will actually appropriate for the work in fiscal 2002.

Another piece of legislation, the National Forensic Science Improvement Act, could provide public crime labs with more than $450 million over six years to improve "the quality, timeliness, and credibility of forensic science services for criminal justice purposes." At least some of that money is to be spent on improving their capacity for forensic DNA analysis. Again, fiscal 2002 appropriations will determine how much money is ultimately available to crime labs.

Eliminating the forensic DNA backlog in the U.S. will help build the FBI's Combined DNA Index System or CODIS database—Congress' officially designated national repository for DNA evidence. It enables federal, state, and local crime labs to exchange and compare DNA profiles electronically, thereby linking crimes to each other and to convicted offenders.

CODIS began as a pilot project in 1990, serving 14 state and local laboratories. The DNA Identification Act of 1994 formalized the bureau's authority to establish a national DNA index for law enforcement purposes.

In October 1998, the FBI's National DNA Index System became operational. It is the highest level of CODIS's three hierarchical levels or tiers—local, state, and national—and it enables participating laboratories to exchange and compare DNA profiles. All DNA profiles originate at the local level, then flow to the state and national levels.