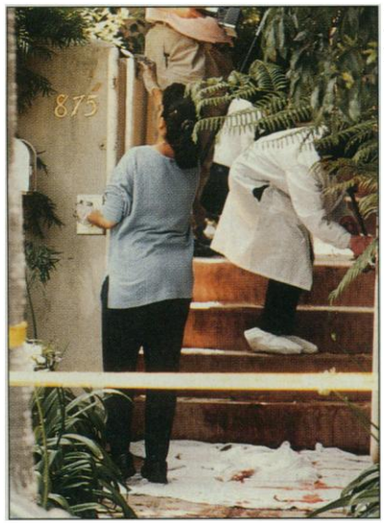
Forensic DNA Goes to Court With O.J.

The highly publicized murder trial of former football great O. J. Simpson provides one of the most strenuous tests yet for DNA fingerprinting, which has not been accepted by all U.S. courts

By the time the murder trial of American sports hero O. J. Simpson begins in earnest in the Los Angeles superior court, some of the most critical legal skirmishing will already have taken place. At issue: whether the jury impaneled to determine whether Simpson murdered his former wife, Nicole Brown Simpson, and her friend Ronald Goldman will get to hear what could be the key scientific evidence in the case. On 22 August, the prosecution announced that "preliminary" results of two different DNA tests (see box on next page) match Simpson's blood with blood found leading from the site where the victims were found stabbed to death. In the weeks leading up to the start of testimony, Simpson's lawyers are expected to mount a vigorous assault on the validity of forensic DNA evidence in an effort to convince Judge Lance Ito to keep it out of court.



T. THUENTE/SYGMA

DNA hunt. Investigators collect forensic samples from the bloody murder site.

Simpson's guilt or innocence won't be the only thing that could be at stake: Ito's rulings could affect the admissibility of DNA evidence in other cases in California, where appellate courts have been split on the issue. "Whatever the final outcome, [the Simpson case] is going to be very important for forensic DNA evidence," says Albert Scherr of Franklin Pierce Law Center in Concord, New Hampshire, a former defense lawyer who has appealed the use of DNA fingerprinting evidence in the New Hampshire Supreme Court. "It's the first nationally 'advertised' trial when DNA evidence can make a difference."

The prosecution has shown itself amply prepared to combat the expected onslaught. It's taken the unusual move of sending samples to two forensic laboratories for testing—Cellmark Diagnostics, a commercial DNA testing laboratory in Germantown, Maryland, and the California Department of Justice's own lab in Berkeley, California. If both labs reach the same conclusion, some of the arguments that have been used to keep DNA fingerprinting evidence out of court in other cases would be seriously undermined. Any ambiguities in the two labs' results could, however, give the defense a major opening.

The prosecution made its move after Simpson's defense team, led by Robert Shapiro, indicated in pretrial hearings that it will attack the DNA evidence on at least two technical points: The team will argue that the scientific community has failed to reach a consensus on how to calculate whether a match between two samples has occurred, and that there is insufficient assurance that incriminating errors do not occur in DNA fingerprinting laboratories.

Paradoxically, the defense may use attempts by the National Academy of Sciences (NAS) to ensure that DNA fingerprinting is accepted in court as a basis for arguing that it should not be. Indeed, NAS may have provided ammunition for Simpson's defense team by setting up a new committee last month to re-examine the statistical methods used to calculate the odds of a match—an issue that was supposedly settled 2 years ago by its committee on "DNA Technology in Forensic Science" (*Science*, 26 August, p. 1163). The Simpson defense team is expected to exploit this move by claiming that it indicates that there is no scientific consensus on the issue.

But by sending samples to two different labs to conduct a broader battery of tests than are usually employed in DNA fingerprinting, the prosecution is hoping to sidestep the statistical arguments entirely. "There are experts that hold that you can eliminate the statistical issue" if you conduct enough different tests, says Los Angeles prosecutor Lisa Kahn. And if you send samples to more than one laboratory, she says, "you can pretty much blow the possibility of a laboratory error out the window."

The prosecution is being guided in these tactics by a legal team with broad expertise in DNA testing. Kahn herself has handled more DNA admissibility hearings than any other prosecutor in California, and the prosecution has brought in deputy district attorney Rockne Harmon of California's Alameda County, an aggressive prosecutor famed for his high-pressure cross-examinations of expert witnesses seeking to cast doubt on DNA fingerprinting. The defense has also put together an impressive battery of experts. Shapiro has enlisted Peter Neufeld and Barry Scheck, two New York lawyers who specialize in defending suspects charged on the basis of DNA fingerprinting evidence, and Henry Lee, director of the Forensic Science Laboratory of the Connecticut State Police and a member of the first NAS committee on DNA Technology in Forensic Science. At this stage, neither side is revealing which expert witnesses will be called to testify, but they are expected to include the heavy hitters on both sides.

So far the prosecution team has won the preliminary court skirmishes. The defense has challenged the use of the two labs, accusing the prosecution of destroying evidence by conducting unnecessary tests and depriving the defense of the opportunity to conduct its own DNA analysis. But Judge Ito ruled on 26 August that the second set of tests could go ahead "in as conservative a manner as is scientifically reasonable."

Still, the war is just warming up. Judge Ito has also said that the formal DNA admissibility hearings will occur between jury selection—which starts on 19 September and is likely to take several weeks—and the start of testimony. And it is in those hearings that DNA fingerprinting is likely to undergo the most intense public scrutiny of its short history.

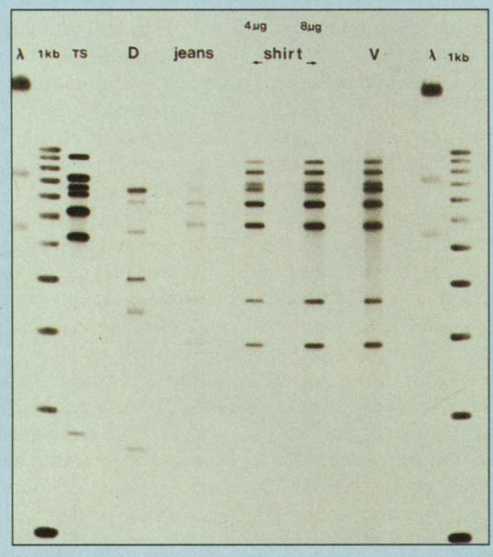
The statistical argument

The defense's first line of attack is expected to focus on the simmering dispute over how to calculate the frequency with which a particular DNA fingerprint occurs in the population. The issue is considered critical because it goes to the heart of the question of whether a match between a suspect's DNA and that found, say, in blood stains at a crime scene is just an innocent chance occurrence or hard proof of guilt.

Forensic scientists compare certain specific "markers" in DNA—the fingerprint—from crime-scene specimens and from the suspect. If they find a match, they then calculate the likelihood that it could have happened by chance. When DNA fingerprinting was first used in criminal casework 8 years

How DNA Fingerprinting Is Done

Forensic samples, such as those at the center of the dispute between prosecutors and defense lawyers in the O. J. Simpson case (see main text), can be submitted to at least two different types of DNA analysis. Most attention has focused on DNA fingerprinting; it detects DNA variations called restriction fragment length polymorphisms (RFLPs) that occur in the highly variable noncoding parts of the genome. The other analysis uses the polymerase chain reaction (PCR) to amplify specific gene segments that also vary, but to a lesser degree than RFLPs. Provided there is enough intact DNA, the RFLP method is preferred because it is far more sensitive, with each fingerprint occurring only in one person in every 100,000 to 100 million.



CELLMARK DIAGNOSTICS

Photo finish. DNA fingerprinting matches the blood on a defendant's shirt with that of a murder victim (V). The defendant was found guilty of murder.

To see if blood, semen, or other crime-scene samples contain enough DNA for RFLP analysis, a forensic technician first runs a tiny fraction of the sample on a "yield gel" which reveals how much DNA is present and how degraded it is. This step is necessary, says Mark Stolorow, director of operations at Cellmark, the commercial laboratory in Maryland that is testing some of the Simpson samples, because "there is no way you can look at a stain and make an estimation of what you have."

If the DNA in the sample passes muster, it is then digested with a restriction enzyme that chops the DNA at specific sites, creating fragments that vary in length between one person and the next. The fragments are separated on an electrophoresis gel (the short ones move faster than the long ones when a current is applied), and then blotted onto a nylon membrane that picks up the fragments while maintaining their relative positions. The membrane is then treated with a radioactive probe that binds to specific sites on the DNA fragments.

To visualize the positions of those fragments, and hence their lengths, the now radioactive membrane is placed in contact with a radiation-sensitive x-ray film. After several days, the exposed film is developed, creating an autoradiograph or "autorad." For a complete DNA fingerprint, the membrane must be treated sequentially with four or five radioactive probes, each recognizing a different DNA sequence. This requires that the previous probe be washed out before the next is applied. And because each x-ray exposure may take up to 14 days, the whole process can take weeks, even months.

If the forensic sample is too minuscule for RFLP testing, or if the fragile DNA has already started to fall apart because of exposure to sunlight, high temperatures, or excess humidity, DNA analysis with the aid of PCR can still be an option. Because PCR analysis detects variations in the actual genes, which show far less variation from one person to another than the noncoding regions of the genome, the results are less certain: Each profile occurs in one person in every few thousand. But PCR analysis has the edge in one regard: It can analyze tiny amounts of DNA in days.

–R.N.

ago, this was done by multiplying the frequency with which each of the three or four specific variations detected in a suspect's DNA occur in that person's ethnic group, which was broadly defined as Caucasian, Black, or Hispanic. Typically, the product was a minuscule number—indicating that a particular combination of markers would be expected to occur in perhaps one person in 100 million. But some critics, such as population geneticist Richard Lewontin and Daniel Hartl, both now at Harvard University in Cambridge, Massachusetts (*Science*, 20 December 1991, pp. 1721 and 1745), argued that simple multiplication ignored the possibility that some DNA variants might turn up far more frequently in unstudied subpopulations—among, say, immigrant Finns living in small country towns—raising the specter that chance mismatches could occur.

The NAS committee offered a solution: the ceiling principle. It recommended that DNA profiles of 100 or so individuals from 15 to 20 homogeneous reference populations—Vietnamese, German, West African, and so on—be rapidly assembled. These databases would be used to calculate the frequency of occurrence of different DNA markers in the various ethnic groups. The highest frequency found in any population, or 5%, whichever was the largest, would be used to calculate the odds of a match, ensuring that the answer would be conservative whatever the defendant's ethnic origins. Until the databases were established, the NAS committee recommended using the highest marker frequencies in at least three major ethnic groups—for example, Asian, Black, and Hispanic—or 10%, whichever is the larger. This temporary fix is still being used because construction of the reference databases has not yet happened.

BILL NATION/SYGMA

Smoking glove? Photo shows O.J. Simpson's cut middle finger, and one of two gloves linked to the crime.

The academy committee hoped that adoption of the ceiling principle would make DNA evidence more acceptable in court, and that has indeed happened in the vast majority of cases. "Since August 1992, in order to do our number crunching, we've used the ceiling method, and we've been successful in every case we've gone to [trial] court with," says Los Angeles prosecutor Kahn. The ceiling principle has yet to be definitively tested in California's appellate courts, however, and meanwhile the scientific arguments continue.

According to Joel E. Cohen, a population biologist at Rockefeller University in New York, "the ceiling principle can fail to be conservative in certain populations that are

Crime Bill May Improve Laboratory Regulation

If any errors are made in the DNA analysis used to support the murder charges against O. J. Simpson, they should come to light under the tough scrutiny of his high-powered legal and forensic defense team (see main text). Few defendants can afford such high-priced expertise, however, so many experts advocate another way to guard against errors in forensic DNA analysis: tougher regulation.

Currently, labs may undergo voluntary proficiency testing, and accreditation by the American Society of Crime Laboratory Directors—Laboratory Accreditation Board, but these measures are not required by law. Now, thanks to the crime bill Congress finally approved last week, oversight of forensic DNA labs may be stepped up. The bill authorizes expenditure of $40 million over a 5-year period by the Department of Justice (DOJ) to improve DNA testing. Some of that money will be used to establish a National DNA Advisory Board to assist the director of the Federal Bureau of Investigation (FBI) in developing standards for crime laboratories conducting DNA testing. Laboratories that comply with the standards—which are expected to cover training of forensic technicians, proficiency testing, and quality-control issues—would be eligible for DOJ funds to improve their DNA testing facilities.

That strings-attached funding, and the fact that the courts will expect laboratories to comply, will make the voluntary standards as good as mandatory ones, predicts John Hicks, who until June was director of the FBI's laboratories, and helped draft the DNA testing parts of the Crime Bill.

But not everyone is happy that the FBI will be responsible for oversight of forensic DNA testing. Some would prefer that this be done by an agency that is not itself involved in forensic DNA work, says criminologist William Thompson of the University of California, Irvine, a consultant to the Simpson defense. The National Academy of Sciences' 1992 committee on "DNA Technology in Forensic Science" suggested, for example, that the Department of Health and Human Services should initiate a mandatory accreditation program, but the recommendation was never put into practice.

Human geneticist Eric Lander of the Whitehead Institute for Biomedical Research in Cambridge, Massachusetts, a member of the 1992 academy committee, agrees that for appearance's sake it would be better if DNA testing oversight was conducted by a more neutral agency. But, he says, oversight by DOJ and FBI "is better than the alternative of not having any oversight at all."

–R.N.

very simple to [describe] mathematically." Hartl agrees that in theory the ceiling principle might overestimate the likelihood of a match being real, but believes it so unlikely that in practice the ceiling principle can be used. Still other geneticists and statisticians argue, however, that it is far too conservative (*Science*, 5 February 1993, p. 755). And many academic scientists hold that it makes no practical difference whether the ceiling principle is used. "The [difference in] numbers is typically in the order of one in 100 million versus a million," says Eric Lander, a human geneticist at the Whitehead Institute for Biomedical Research in Cambridge, Massachusetts, and a member of the 1992 NAS committee. "The [statistical] issues don't matter to a jury, but they do have academics worked up," he says. And that continuing scientific discord can have legal implications, because under California's Frye-Kelly standards (and similar criteria governing in many other states), evidence is admissible only if it is derived from methods that are supported by scientific consensus.

The new NAS committee is unlikely to resolve the statistics issue before the admissibility hearings in the Simpson case. But the Simpson prosecution is hoping to turn aside the defense's attack on statistical analyses with a hefty shield: the use of more DNA markers.

Currently, four or five markers or probes are employed in creating a DNA fingerprint (see box on p. 1353). However, a consensus is emerging that, if the number of markers is increased, statistics becomes a non-issue. If a match is made with eight or more markers, says Hartl, "the statistical issues recede into the background" because the odds of such a match occurring by chance would be minuscule. Geneticist-statistician Bruce Weir of North Carolina State University in Raleigh, who thinks the ceiling principle is too conservative, agrees: "Provided sufficient probes are looked at, someone can just stand up in court and say that these two profiles match, and that's a very unlikely event."

And this is the very tack the prosecution has taken. In a document filed with the Los Angeles court on 22 August, it stated that the DNA fingerprint test scheduled to be conducted at the Berkeley laboratory will not duplicate Cellmark's analysis. Instead, by using different restriction enzymes and markers, it will identify entirely different DNA variants, greatly diminishing the chance of a false match by doubling the number of markers from five to 10.

The lab error question

If the Los Angeles court accepts that the 10-probe approach removes any doubt about the chance of a false match, Shapiro, Neufeld, and Scheck are expected to shift their attack by focusing on the possibility that errors may have occurred in the testing labs. "The lab error is the most likely place to get a false incrimination of an innocent person or a guilty person going free," says William Thompson, a criminologist at the University of California, Irvine, who has submitted a declaration on errors in DNA testing to the Los Angeles courts for the Simpson defense.

The defense has already brought Cellmark's track record up in the courtroom. In a proficiency test conducted in the late 1980s, Cellmark incorrectly matched the DNA profiles of two samples from each of 50 batches of simulated forensic samples. Cellmark maintains that it has identified and rectified the problem, and has since passed several proficiency tests with flying colors. Now its official error rate is less than 0.5%, says Cellmark's director of operations Mark Stolorow. Thompson, however, contends that such tests don't reflect real-life situations in which samples may be mixed or DNA may be partially degraded. Stolorow responds that "so far in the history of Cellmark," no defense counsel has been able to prove that errors have occurred in actual casework.

Nonetheless, Stolorow acknowledges that "the only way we'd know if we'd made a mistake in actual casework [would be if] another sample was given to another laboratory and it was used to demonstrate that we'd made an error." That's far from routine procedure, but in the Simpson case it's exactly what the Los Angeles prosecutor intends to do—but to demonstrate that a mistake hasn't occurred. According to the prosecution's 22 August document, it's sending the DNA samples to the second lab to "refute any claim of laboratory error and provide greatly enhanced evidence of guilt."

The final verdict in the case of the State of California vs. Orenthal James Simpson may not be known for many months. Meanwhile, the DNA admissibility hearings may end up doing more to reach a verdict on how best to analyze DNA data, and to maintain standards in forensic laboratories, than did two NAS reports combined.

–Rachel Nowak