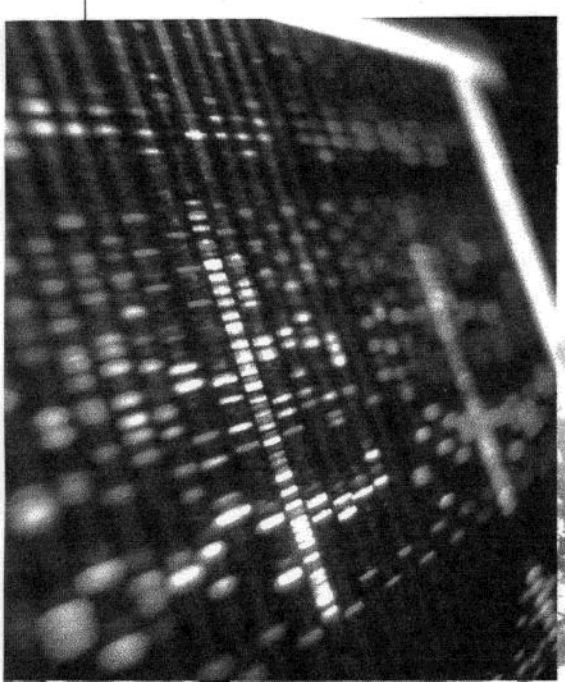
DNA matching

Hyped as a "magic bullet" for solving crime, DNA analysis has not disappointed. Samples taken from suspects are often compared with DNA databases to solve crimes committed years—sometimes decades—earlier. However, DNA matching has not escaped criticism, and convicting on DNA evidence alone makes for questionable justice.

In December 2000, Stephen Snowden was arrested for stealing a bottle of whiskey. Police swabbed his cheek for DNA and analyzed it. When they ran a routine comparison with a computer database of DNA taken from the scenes of unsolved crimes, they found a surprising match. The man they thought was just a petty criminal was actually a rapist. Ten years earlier he had attacked a woman whose car had broken down on a remote country road. Snowden received a 12-year jail sentence for the vicious assault.



Building databases

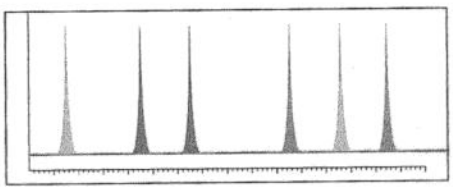
As Snowden's conviction demonstrated, the power of a DNA database stems from the ease with which it can be searched. A DNA profile encodes the identity of an individual in a series of digits no longer than four telephone numbers. Comparing such numbers to match criminal and crime-scene samples is straightforward and quick.

The first DNA databases were set up in the US in the 1980s, with the FBI's combined DNA index system (CODIS) now integrating the data nationally. Although advocates of DNA profiling argue that the innocent have nothing to fear from DNA databases, they do not enjoy universal support. Many people dispute the collecting and storing of the data, fearing that it erodes civil liberties. In addition, the validity of DNA evidence itself is constantly questioned in court due to the possibility of contamination—despite stringent precautions to prevent this.

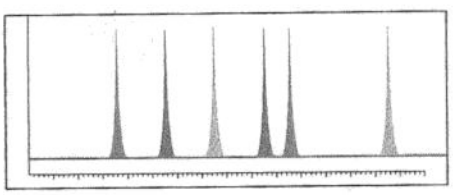
◀ **COMPUTER MATCHING**
DNA databases all maintain at least two indexes: one for crime-scene DNA and one for offenders. Some countries also store missing persons' DNA.

INDIVIDUALS IN A CROWD ▼
There is just a 200 billion:1 chance that the DNA of two randomly chosen individuals will match perfectly when 13 different sequences are counted.

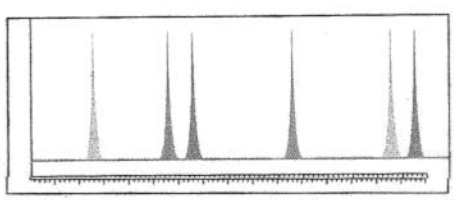
MATCHING ▼
Modern DNA scanners make it easy to compare DNA by plotting the short tandem repeats as peaks on a graph (see p. 60). This graphical representation shows the basic principle of how the samples are matched. There would be up to 13 different sequences (colors) to compare for each sample in a real-life case.



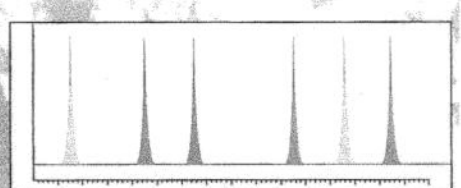
CRIME-SCENE SAMPLE ▲
A sperm stain found at a rape scene contains the assailant's DNA, which can be used for comparison.



VICTIM ▲
Peaks in the crime-scene sample that match peaks in the victim's DNA profile can be ignored.



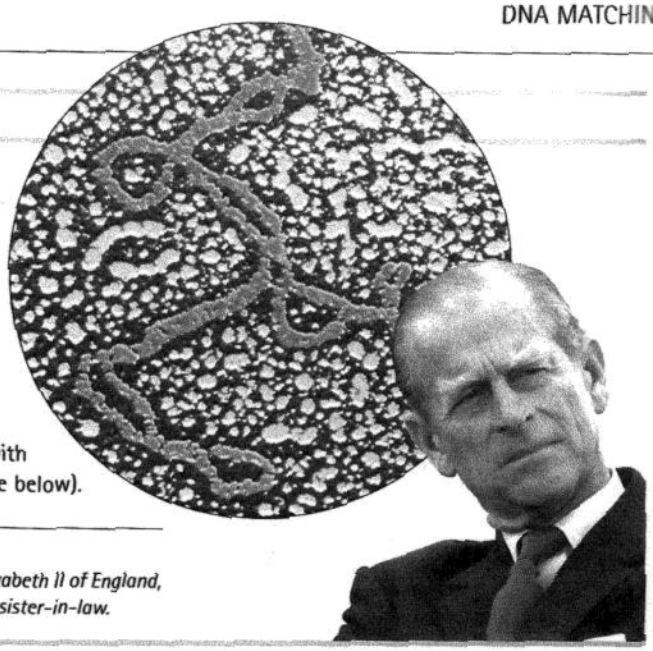
SUSPECT 1 (NO MATCH) ▲
Few of the peaks in this profile of an innocent suspect coincide with the peaks of the crime-scene sample.



SUSPECT 2 (MATCH) ▲
The profile of the suspect subsequently found guilty is an accurate match with the crime-scene sample.

MITOCHONDRIAL DNA

Most DNA analysis uses nuclear DNA, but this is not always present in a crime-scene sample, and deteriorates rapidly. An alternative is to analyze DNA from another part of the cell: the mitochondrion. Unlike nuclear DNA, where 50% is inherited from each parent, mitochondrial DNA (mtDNA) is passed on intact from just the mother, which makes it ideal for tracing ancestry. It is also more resistant to decay, surviving for many centuries in bone material. For these reasons, mtDNA was used in 1993 to analyze the suspected remains of Nicholas II. The last czar of Russia, Nicholas was executed along with his family by revolutionaries following the 1917 revolution that brought communist rule to the country. If the bones were genuine, mtDNA extracted from them would be similar to that of a direct descendant of the czar's family. Forensic scientists confirmed the identification by comparison with the mtDNA of Prince Philip (see below).



CZAR'S DESCENDANT ▶
Prince Philip, husband of Queen Elizabeth II of England, is a direct descendant of the czar's sister-in-law.

Will it stand up in court?

There are also concerns about the interpretation of DNA evidence in court, after guilty verdicts that relied heavily on it have been overturned on appeal. The so-called "prosecutor's fallacy" formed the grounds for many of these appeals. To understand this, imagine a case in which investigators find a stain at the scene of the crime in a country with a population of 10 million. DNA analysis suggests that the profiles of just 1% of the population would match the crime-scene sample. Police arrest a suspect, and a DNA test reveals a perfect match with the stain found at the scene. At the trial, the prosecution argues that, since only 1% of the population share the same DNA profile, there is just a 100:1 chance that the prisoner is innocent. But the defense successfully argues that this is a fallacy, and is true only if there is a presumption of guilt. If 1% of a population of 10 million share the same DNA profile, then there are 99,999 others who could be placed at the crime scene. If there is a presumption of innocence, then the odds are nearly 100,000:1 against the accused man being the man at the crime scene.

This theoretical example illustrates the danger of relying too heavily on DNA evidence. Effectively, a closely matching DNA profile multiplies the suspicion of guilt. If there is enough corroborating evidence, then a DNA match makes the prosecution case very compelling indeed. But if there is little or no other evidence, then matching DNA profiles prove little.

The future of DNA analysis

Identifying suspects potentially represents a small part of the utility of DNA analysis in the context of crime investigation. Scientists completed the task of sequencing the human genome in 2001, and subsequent analysis is revealing which parts of it are responsible for inherited traits. For example, DNA analysis of a crime-scene sample can already reveal whether or not a criminal has red hair. Just 6% of the British population have red hair, so this drastically narrows a search if a UK crime-scene sample is from a redhead. Many geneticists believe that further analysis will enable them to predict many more aspects of physical appearance, including race and height. The possibility of building a suspect's photofit picture from a single drop of blood is still a fantasy, but it is clear that the value of DNA analysis will continue to grow as researchers further unravel the genetic code.

ALEC JEFFREYS

DNA fingerprinting was the discovery of British geneticist Alec Jeffreys in 1984. The idea came to him in "a Eureka moment" one fall morning. By the afternoon he had worked out how to apply it forensically. The method was first used—to acquit a suspect—the following year.

Alec Jeffreys
b. 1950