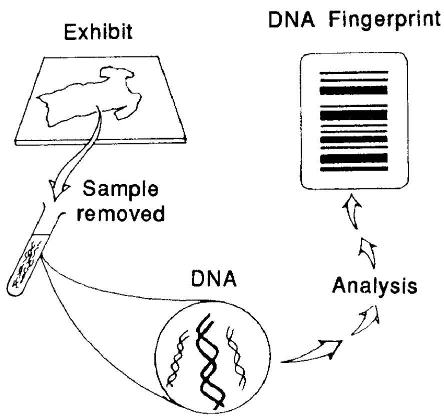
6 Genetic Fingerprinting

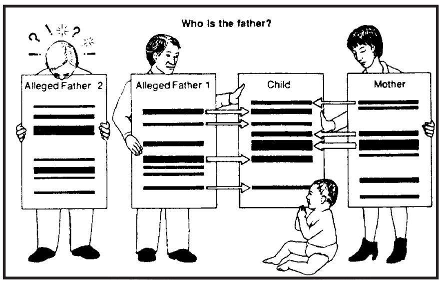
Genetic Fingerprinting was developed by *Professor Alan Jeffreys* at the University of Leicester in 1984.



The technique is based on the fact that each of us has a unique genetic make-up, contained in the molecule DNA (deoxy-ribonucleic acid), which is inherited from our natural parents, half from our mother and half from our father.

DNA can be extracted from cells and body fluids and analysed to produce a characteristic pattern of bands or genetic 'fingerprint'.

The sketch below shows how genetic fingerprinting can be used to identify a child's father.



Equally important has been the use of genetic fingerprinting in murder, assault or rape cases, where body fluids from the scene of the crime can be compared to those of a suspected assailant.

It is usual to compare between 10 and 20 bands. Experimental evidence has shown that in unrelated people the probability of *one* band matching is *one* in *four*, i.e. probability of $\frac{1}{4}$.

So, for example, the probability of *two* bands

$$\text{matching} = \left(\frac{1}{4}\right)^2$$

$$= \frac{1}{16} \text{ or a 1 in 16 chance.}$$

Activity 1

Find the probability of (a) 5 and (b) 10 bands matching. Express your answer in the form,

'1 in ? chance'.

Activity 2

Repeat Activity 1, but using 0.5 as the probability of any single band matching.

You will have noticed that the answers to Activities 1 and 2 change quite dramatically if the underlying probability changes. In fact, the value of 0.25 has been the subject of some speculation in a number of recent criminal trials.

Activity 3

Copy and complete the table below. Comment on the values found and suggest the number of bands which should be compared, to be confident of a match *not* happening by chance, when the probability is 0.25.

Probability (p)	*Number of bands compared* 5	10	15	20
0.2	1 in 3125	?	?	1 in 9.5 million million
0.25	?	?	?	?
0.3	?	?	?	?
0.5	?	?	?	?

Activity 4

(a) If $p = 0.25$ and we wish the probability of a complete match *not* happening by chance to be 1 in 50 million (approximately the population of Britain), how many bands need to be compared?

(b) The population of the USA is about 290 million. Assuming that $p = 0.25$, what advice would you now give for the number of bands that need to be compared if the full USA DNA data was available?

(c) The world population is estimated as 6.4 billion.
With $p = 0.25$, what advice would you now give for the number of bands that need to be compared if the world population DNA data was available.

We can also develop a general rule for the value of *n*, the number of bands to be compared.

Extension

Denoting the probability of a random match as *p*, the number of bands to be compared as *n* and the chance of a complete match as 1 in *r* million, show that

$$p^n = \frac{1}{r \times 10^6}$$

Hence deduce an appropriate formula for *n* in terms of $\ln r$, $\ln p$ and $\ln 10$.