Topical Applications of Mathematics

Genetic Fingerprinting — PUPIL TEXT

Genetic (or **DNA**) **fingerprinting** was developed by Professor Sir Alec Jeffreys at the University of Leicester in 1984. The technique is based on the fact that each of us has a unique sequence or code of genetic information, contained in our DNA (deoxyribonucleic acid) in the nucleus of every living human cell. This is inherited from our natural parents, half from our mother and half from our father.

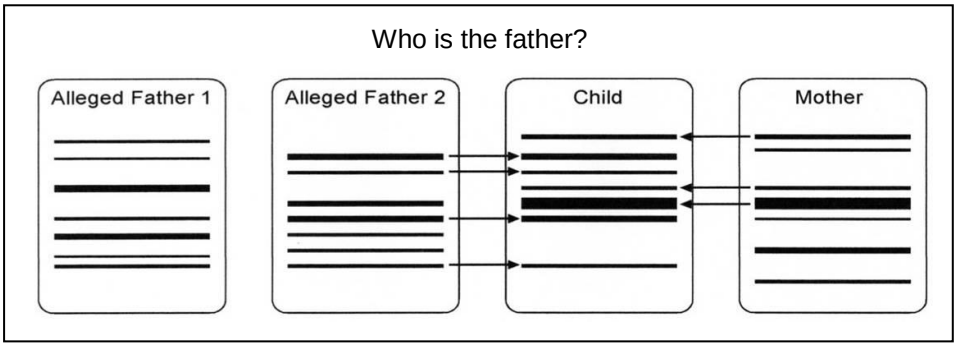
Although the majority of DNA doesn't differ from human to human, about 0.10 percent of a person's entire genome (the total set of genes carried by an individual or cell) varies from person to person. These areas of DNA, called **minisatellites** (short sequences of chemical building blocks) show variation in the numbers of repeat units (or stutters) unique to each person. These form the bands that are illustrated below.

DNA information can be recovered from human and animal remains as far back is Neanderthal man and has been used to solve a number of high profile mysteries from the past.

Apart from identification, paternity and immigration cases, the technique is also used in medical research including cancer and genetic conditions such as Huntington's disease.

Unless you have an identical twin, your DNA is unique to you. This is what makes DNA evidence so valuable in investigations - it's almost impossible for someone else to have DNA that is identical to yours.

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



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, a probability of 0.25.

So, for example, the probability of two bands out of two matching

$$= 0.25^{2}$$

$$= 0.0625 \text{ or a 1 in 16 chance.}$$

Activity 1

Find the probability of 10 bands out of 10 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 was the subject of some speculation in a number of criminal trials but it has been established now as an acceptable value to use.

Activity 3

Copy and complete the table below.

Probability	*Number of bands compared*			
(p)	5	10	15	20
0.2	1 in 3125	?	?	1 in 95 million million
0.25	?	?	?	?
0.5	?	?	?	?

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.

Activity 4

If $p = 0.25$ *and we wish the probability of a complete match* ***not*** *happening by chance to be 1 in 60 million (approximately the population of Britain), how many bands need to be compared?*