UNIT 6 *Genetic Fingerprinting* Teacher Resource Material

Key Stage: *4 (and A-level)*

Target: *GCSE and A-level Statistics*

Teaching Notes

This is an important topic which is now used in criminal cases to enable samples of DNA to be compared. Its use raises issues of what is taken for 'proof' in law, in comparison with mathematical proof. Although now used extensively, its validity continues to be a matter for discussion. In particular, the value to be taken for p, the probability of two bands matching at random and also the probability of a random chance of a complete match are the subjects of ongoing legal and moral debate.

Although the probability theory needed for this unit of work is not beyond GCSE level, some of the wider ethical issues are perhaps more appropriate for A-level students. Also, the final extension question requires the use of A-level concepts in Pure Mathematics, namely logarithms and indices.

Solutions and Notes

Activity 1 (a) $\left(\frac{1}{4}\right)^5 = \frac{1}{1024} \Rightarrow$ approximately 1 in 1000 chance

(b) $\left(\frac{1}{4}\right)^{10} = \frac{1}{1048576} \Rightarrow$ approximately 1 in 1 million chance

Activity 2 (a) $\left(\frac{1}{2}\right)^5 = \frac{1}{32} \Rightarrow$ 1 in 32 chance

(b) $\left(\frac{1}{2}\right)^{10} = \frac{1}{1024} \Rightarrow$ approximately 1 in 1000 chance

Activity 3

p	5	10	15	20
0.2	1 in 3125	1 in 10 million	1 in 30 thousand million	1 in 95 million million
0.25	1 in 1024	1 in 1 million	1 in 1 thousand million	1 in 1 million million
0.3	1 in 412	1 in 169351	1 in 70 million	1 in 28 thousand million
0.5	1 in 32	1 in 1024	1 in 32768	1 in 1 million

Activity 4 (a) $n = 13$ given probability of complete match as 1 in 67 million $\Rightarrow n = 13$

(b) $n = 14$ given probability of complete match as 1 in 268 million $\Rightarrow n = 14$, or $n = 15$ to be sure

(c) $n = 16$ given probability of 1 in 4.3 billion, so $n = 17$ needed.

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Extension Taking logs for the formula $p^n = \dfrac{1}{r \times 10^6}$

$$\begin{aligned} \ln p^n &= \ln\left(r \times 10^6\right)^{-1} \\ n \ln p &= -1 \ln\left(r \times 10^6\right) \\ &= -\left(\ln r + \ln 10^6\right) \\ \Rightarrow \quad n &= -\frac{\left(\ln r + 6 \ln 10\right)}{\ln p} \end{aligned}$$