DNA Profiling
Clue: The Real Thing

Background
The DNA of humans is more alike than different, but tiny differences make the DNA of each human unique. The technique of DNA profiling can be used to distinguish individual humans using regions of the genome where there is great variability among individuals. Typically these areas of the genome are not working genes and so over time, have been free to vary without selective pressures. These hypervariable parts of the genome are targeted to characterize individuals by their DNA.

The Scenario
Miss Scarlet was found murdered in the library in the middle of the night by Mrs. White, the maid. A candlestick lay near the body in a pool of blood. The list of suspects includes wealthy Mrs. Peacock, Professor Plum and even sweet Mrs. White. Mrs. Peacock, a wealthy middle-aged heiress, was known to hate Miss Scarlet for stealing the attentions of her ex-suitor, Colonel Mustard. Professor Plum, the noted con artist, may have had a reason to silence Miss Scarlet, as only she knew his true identity. Perhaps even Mrs. White had her own reasons. She despised Miss Scarlet and blamed Miss Scarlet for the death of her only son.

1. Make sure you have two pieces of DNA. The paper strip represents the DNA of only one strand in the molecule.
    a) Why do you have two pieces of DNA?

2. Imagine that we are digesting the DNA with restriction enzyme EcoRI, whose recognition sequence is 5'- GAATTC -3'. The enzyme makes a cut after the G. You might draw a line after the "G" to represent the cut and then count the number of letters (bases) in each "fragment." Remember that the recognition sequence might appear more than once in any piece of DNA.

3. Record the number of fragments you have and the size of each fragment in the class data table (Table 1a and Table 1b as appropriate).

4. Using the data from Table 1a, create a diagram of the gel that would result from the crime scene DNA and suspects' DNA. You can now see which fragments found at the crime scene match with victim's fragments and with a suspect's fragments. You eliminate the fragments that match with the victim. Looking at the remaining fragments from the crime scene, see if you can match the fragments to the pattern of one of the suspects. Every fragment remaining in the crime scene sample must be found in the suspect's sample or you do not have a match. At this point you should have a suspect that matches the crime scene sample.
    b) Why are there more bands in the crime scene lane than other lanes?
    c) Which suspect's DNA matches the crime scene DNA?
    d) Why is this match not sufficient to conclude guilt?
    e) How can we explain the presence of the 12 and 8 letter fragments in samples from both Mrs. Peacock and Mrs. White?

5. You now have to address the question of the probability of the crime scene sample match NOT coming from the suspect. To do this we will find the probability of finding the same fragments in another individual. The probability of finding any one pattern is equal to the number of times that a specific pattern is found divided by the sample size (*i.e.*, the number of people in the population sampled).

f) What is the sample size?

Determine the probability of finding each pattern and complete Table 2.

6. Use the product rule to calculate the probability of another person having the same combination of fragments as the suspect. Remember that the probability of events occurring simultaneously is found by multiplying the probabilities for the occurrence of each individual event.

g) What does the probability do for your confidence that the crime scene DNA is from the suspect?

h) Why is this still insufficient to conclude guilt?

i) The probability you calculated is based on a group of random individuals. Is it reasonable to assume that a random group of people would have been in library in the middle of the night? What does this suggest about the probability we calculated?

j) What could we do to increase the certainty of our conclusion?

7. In the case of Mrs. White, we might find that the restriction patterns for DNA regions, A, B, C, D, and E, found in her genome occur in the general population with the following frequencies, 1/60, 1/20, 1/100, 1/50, 1/40.

k) What is the probability of having the same set of restriction patterns as Mrs. White at these regions?

l) What does that probability suggest about the likelihood of the DNA belonging to her?

Table 1a Fragment sizes for crime scene and suspects (Class data)

	Crime scene	Miss Scarlet	Mrs. Peacock	Prof. Plum	Mrs. White
# fragments					
Size of fragments					

Table 1b Fragment sizes for general population (Class data)

	Gen Pop	Gen Pop	Gen Pop	Gen Pop	Gen Pop	Gen Pop	Gen Pop
# fragments							
Size of fragments							