

Use of DNA Fingerprinting in Forensic Science

A. The Crime

Late one night, the famous rock star, Rockina, returned to her luxurious apartment from an appearance at a concert. As she entered her apartment, she noticed that everything in her apartment was a mess—the drawers had been emptied out onto the floor; the cushions on the couch were ripped open; and the safe behind the picture wall had been opened. She then noticed the lights were on in the bedroom.

She stormed into the bedroom and surprised a burglar in the process of removing her magnificent (and expensive) jewelry from its hiding place beneath the mattress. Furious, she jumped on the burglar and tried to stab the person with her nail file. While she was able to inflict a small wound, she was no match for the assailant's knife. In the subsequent struggle, she was killed and the murderer escaped with her jewelry.

B. The Investigation

When the housekeeper, Casparina, entered the apartment the next day, she saw the body and immediately called the police. When they noted that there had been no signs of a forced entry, the investigation narrowed down to people who knew Rockina and who had a key to enable them to enter the apartment.

C. The Suspects

1. Casparina, the housekeeper, who just had a bitter argument with Rockina over a refused raise in salary.
2. Lucifer, her former boyfriend, who she had just left for another man.
3. Pinky, her personal trainer and current boyfriend. It was rumored that Pinky was insanely jealous of Rockina's fame.

When it was established that all three of the suspects had a key to the apartment, all had a motive for killing her, and no one had an alibi for the evening that she was killed, the police realized they had a problem. They consequently decided to hire a world famous forensic science team to use DNA Fingerprinting to prove one of the three suspects guilty of murder.

DNA Fingerprinting

Restriction enzymes

Forensic scientists make DNA fingerprints from DNA found in sperm cells, blood cells, or other human cells. They make use of a type of enzyme called "restriction endonucleases" or more commonly "restriction enzymes". When these enzymes recognize a certain area of a DNA molecule, they cut the DNA at that point. However, when they cut the DNA, they do so unevenly, making it a jagged cut.

For example, the restriction enzymes Ecor1 and HindIII cut the DNA at the following sequences.



So if Ecor 1 was used on the following segment of DNA

TTACGTAGAATTCCCTTAGAGATGAATTCCCTTA
AATGCATCTTAAGGGAATCTCTACTTAAGGGAAT

It would be cut in the following manner.

TTACGTAG	AATTCCCTTAGAGATG	AATTCCCTTA
AATGCATCTTAA	GGGAATCTCTACTTAA	GGGAAT

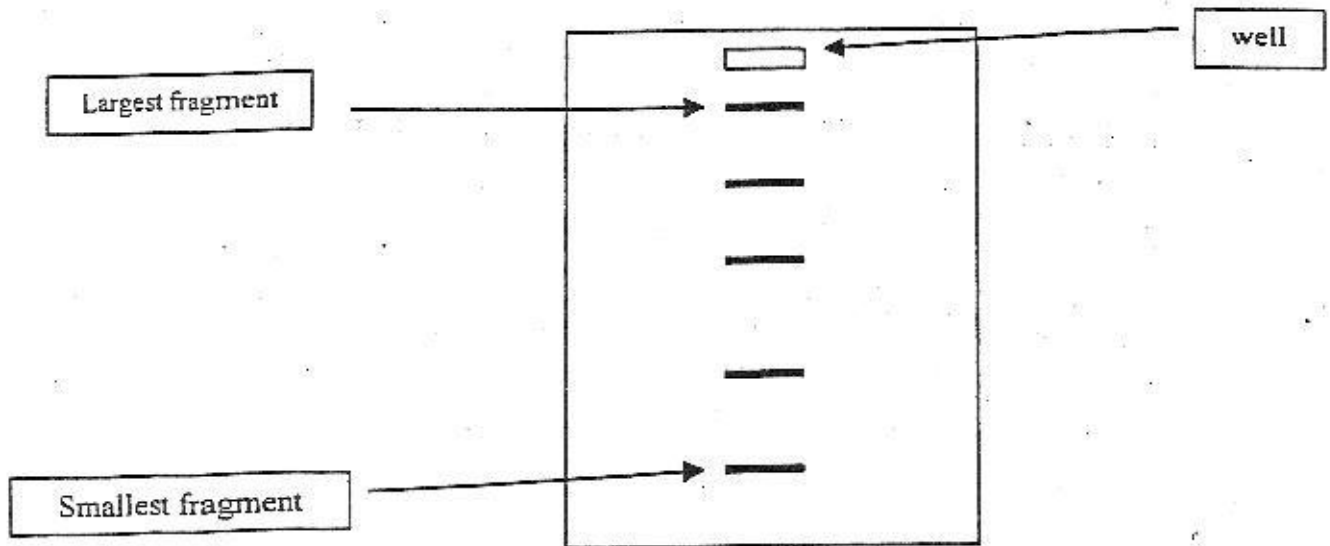
Use of this enzyme on the above segment would yield three different sized fragments.

Each restriction enzyme only cuts at one particular sequence of bases. To see how these fragments are made and used:

1. Obtain sheets showing the same portion of DNA from each of the three suspects and the DNA from the sample of blood taken from Rockina's nail file.
2. Analyze the DNA sequences at mark the positions in which the restriction enzyme Hind III would cut each DNA strand. Using a different color mark where the restriction enzyme Ecor 1 would cut the DNA..
3. Count the number of bases in each DNA fragment (use only the top strand of the fragment) and write the number down above each fragment.

Electrophoresis gel

After the restriction enzymes have cut the DNA, the fragments in each sample are separated by size using a technique called "gel electrophoresis". In this technique each sample is put into a "well". The "wells" are holes going part way into a block of agarose (This is similar to highly purified block of Jell-O). An electric current is passed through the agarose, which pulls the smaller fragments through the gel faster than the larger ones. The fragments will end up sorted by size.



To see how the electrophoresis creates the finger print of the suspect's DNA fragments, estimate the location of the bands in the agarose gel when the electrophoresis is completed.

Draw in the bands of DNA into the gels on the following page. Use the reference DNA bands in the first lane to estimate their proper location. Do this for each enzyme separately and then use both enzymes on the same gel.

EcoR I G|AATTC
 CTTAA|G

Hind III A|AGCTT
 TTCGA|A

DNA From the Nail File

TTGAGAATTC AAGCTTCCGATGGAATTCGAAATCAGAAGCTTATAGAATTCGCGCTAAGCTTCCC GGAATTCGTTCCATA
AACTCTTAAGTTCGAAGGCTACCTTAAGCTTTAGTCTTCGAATATCTTAAGCGCGATTTCGAAGGGCCTTAAGCAAGGTAT

Casperina's DNA

TTGAGTATTC AAGCTTCCGATGGAATTCGAGAATTC AAGCTTATAGAATTCGCGCTAAGCTTCCC GGAATTCGTTCCATA
AACTCATAAGTTCGAAGGCTACCTTAAGCTCTTAAGTTCGAATATCTTAAGCGCGATTTCGAAGGGCCTTAAGCAAGGTAT

Pinky's DNA

TTGAGAATTC AAGCTTCCGATGGAATTCGAAATCAGAAGCTTATAGAATTCGCGCTAAGCTTCCC GGAATTCGTTCCATA
AACTCTTAAGTTCGAAGGCTACCTTAAGCTTTAGTCTTCGAATATCTTAAGCGCGATTTCGAAGGGCCTTAAGCAAGGTAT

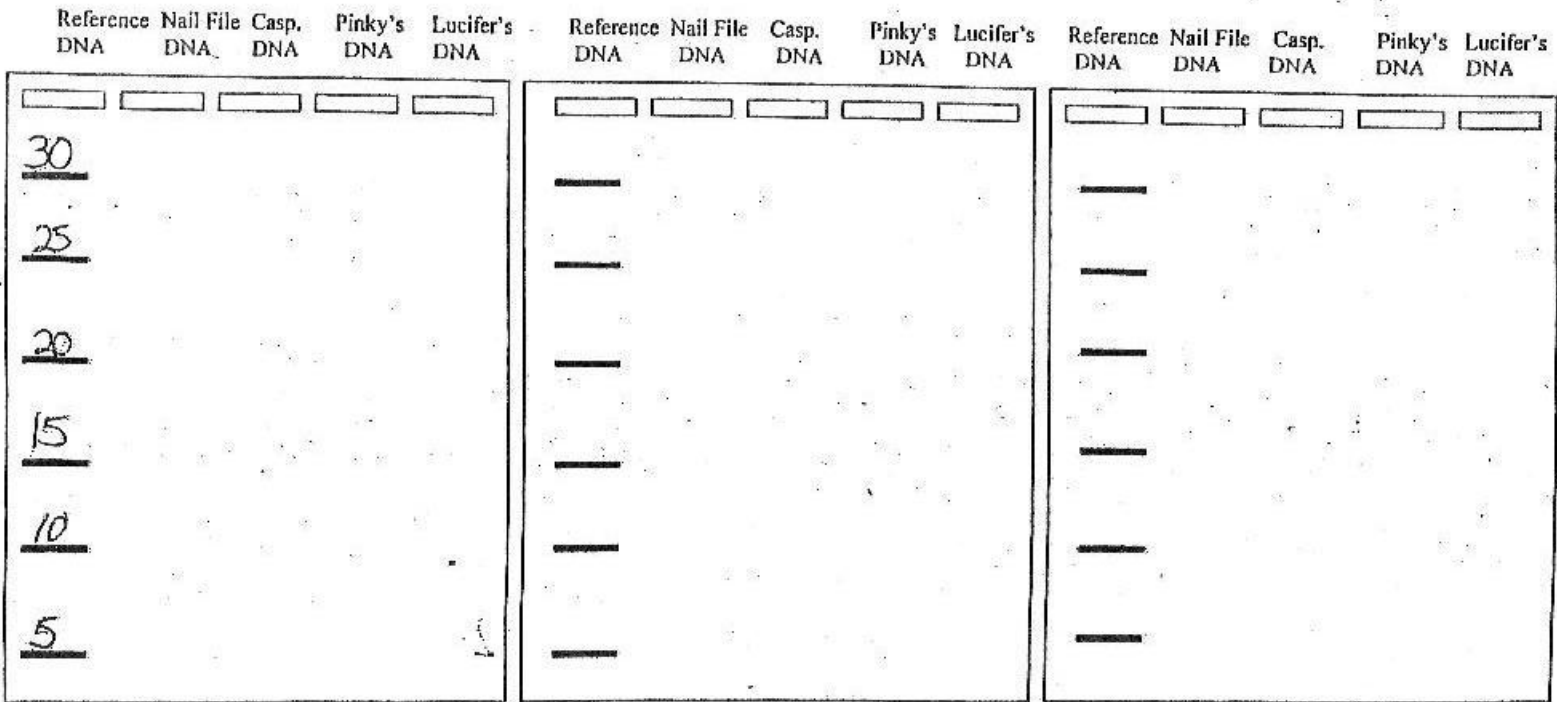
Lucifer's DNA

TTGAGAATTC AAGCTTCCGATGGAATTCGAAAGCTTGATCGTTATAGAATTCGAGATAAGCTTCCC GGAATTCGTTCCATA
AACTCTTAAGTTCGAAGGCTACCTTAAGCTTCGAACTAGCAATATCTTAAGCTCTATTCGAAGGGCCTTAAGCAAGGTAT

Ecor 1 Gel

Hind III Gel

Both Enzymes Gel



Questions

1. What do the Hind III results show? What do the Ecor I results show?
2. Who murdered Rockina?
3. Explain why scientists used a combination of restriction enzymes instead of just one?
4. Suppose the lab technician did a poor job of preparing the gels. The material was not dissolved well while making the agarose block. As a consequence, the gel was very thick in some areas and thinner in others. Explain how this might affect the results of the DNA fingerprint?