



Interpretation of DNA Profile Match by Mix STR Tool in Crime Scene Investigation

*Amaani Tasneem

Bio-Axis DNA Research Centre (P) Ltd, Hyderabad

E-mail id:actinium14@ymail.com

Received date: March 16th 2012, Accepted date: April 12th 2012, Published date: May 1st 2012

Abstract:

DNA evidence is being increasingly used in court cases. The first DNA typing methodology used forensically required comparatively large amounts of starting material. Now, with the use of the polymerase chain reaction (PCR) to amplify Short Tandem Repeat (STR) segments of DNA, laboratories are able to analyze DNA from samples as small as a single cell. The high levels of variability that exist at STR loci make them well-suited for use in human identification. There is a great deal that a defense lawyer can and must do in order to effectively represent a client who is incriminated by DNA evidence. Interpretation of multiple DNA profile matches was performed by mix STR tool where in the samples was collected from a homicide crime occurred at the construction site. Alleles of 15 different locus approved under CODIS namely FGA, TPOX, D8S1179, vWA, D2S1338, D19S433, D18S51, D21S11, THO1, D3S1358, AMEL, CSF1P0, D16S539, D7S820, were retrieved for each of the Victim, Suspect, and the Evidence involved in the crime. These samples with their known alleles were analyzed thoroughly by MIX STR TOOL with which we can trace out the culprits and mislabeling during sample collection involved in the crime by getting accurate information on the percentage of match by determining the presence or absence of alleles in the given data.

Introduction:

Forensic science is any science used for the purposes of the law, and therefore provides impartial scientific evidence for use in the courts of law, and in a criminal investigation and trial. Bioinformatics and forensic DNA are inherently interdisciplinary and draw their techniques from statistics and computer science bringing them to bear on problems in biology and law. Personal identification and relatedness to other individuals are the two major subjects of forensic DNA analysis. One of the most contentious issues in forensic use of DNA evidence is how to estimate the probability that two DNA profiles match by chance. In order to determine the probability that a particular genotype might occur at random in a

population, extensive population data must be gathered to make an estimate of the frequency of each possible allele and genotype. A sample size much larger than 100 samples is needed to make reliable projections about a genotype's frequency in a large population. Given allele frequencies, DNA profiles are screened automatically for matches between profiles of person to person(s), person to scene(s) and scene to scene(s). Although the most used set of STR loci are spread on all the chromosomes, they have different mutation rate. The adage "every contact leaves a trace" indicates the importance of a technique able to type trace amounts of genetic material left during the commission of a crime. This genetic information can then be used to include or exclude suspects as being the source of the genetic material. Forensic analysis involves the testing of regions of an individual's DNA. Databases have been compiled which list the abundance of a particular fragment of DNA in the population. From this information, an estimate of the abundance of combinations of DNA at several regions can be made and compared to the DNA of victims or suspects.

Short Tandem Repeat Profiling (STRs):

In this technique microsatellite repeating regions are examined. The technique is based on PCR- the cycle of reactions, in which DNA is split, replicated then split again for replication. This amplification gives an exponential increase in the number of copies of the original template. The reaction is under kinetic control, reaching a plateau which is dependent on competition, the ultimate inactivation of the catalytic enzyme and the original number of template molecules, primer and dNTPs. The DNA is denatured at approximately 94°C. Short strands of DNA, called primers, attach to the target DNA at a specific site. Bases are added enzymatically to the end of the primers to form a new complementary strand. Approximately thirty such cycles are carried out to produce many copies of the original material. Since the amount of original material is increased, this technique is particularly suited to the analysis of trace amounts of DNA. The amplified DNA is separated by electrophoresis through an ultra-thin denaturing polyacrylamide

gel. The number of repeats for a particular individual is determined at several loci.

CODIS (Combined DNA Index System):

It is the core of the national DNA database, established and funded by the FBI, and developed specifically to enable public forensic DNA laboratories to create searchable DNA databases of authorized DNA profiles. The CODIS software permits laboratories throughout the country to share and compare DNA data. In addition, it provides a central database of the DNA profiles from all user laboratories. A weekly search is conducted of the DNA profiles in this national database, known as the National DNA Index System (NDIS), and resulting matches are automatically returned by the software to the laboratory that originally submitted the DNA profile. In 1997, the FBI announced the selection of 13 STR loci to constitute the core of the United States national database, CODIS.

Profile: The 13 CODIS STR loci

Locus	D3S1358	vWA	FGA	D8S1179	D21S11	D18S51	D5S818
Genotype	15, 18	16, 16	19, 24	12, 13	29, 31	12, 13	11, 13
Frequency	8.2%	4.4%	1.7%	9.9%	2.3%	4.3%	13%
Locus	D13S317	D7S820	D16S539	THO1	TPOX	CSF1PO	AMEL
Genotype	11, 11	10, 10	11, 11	9, 9.3	8, 8	11, 11	X Y
Frequency	1.2%	6.3%	9.5%	9.6%	3.52%	7.2%	(Male)

Materials and method:

MIX STR TOOL- It is an excel based tool wherein we can determine the culprit by analyzing his/her STR on the genome. Mix STR tool has got different sets of files with different data inputs.

Data file: The raw data i.e., the alleles of the persons relating to the crime scene- the Victim, the Suspect and the Evidence are analyzed for the 13 CODIS or more regions. **RepSE:** This sheet provides detailed analysis of the number of alleles of each Standard (victim and suspect) that are common to other Evidences. **RepSS:** Provides detailed analysis of the number of alleles of each Standard that are shared with other Standards. **RepEE:** Provides detailed analysis of the number of alleles of each Evidence sample that are shared with other Evidence. **RepSummary:** The first set (Standard by Evidence) matches each Standard profile (Victim & Suspect), with all of the Evidences. It also gives the % of shared alleles and the % included loci. The second set (Evidence by Standard) matches each Evidence profile with the entire Standard (Victim & Suspect).

The third set (Standard by Standard) matches all the Standards among one another to give the % of shared alleles, and the % included loci. The fourth set (Evidence by Evidence) matches all the Evidences among one another to give the % of shared alleles and the % included loci. Within each block of each set, the results are sorted from "most included loci" to "least included loci". The % shared alleles is expressed in two slightly different ways: %A is the % shared alleles relative to the number of alleles "All" loci: $\%A = 100 * (\#+) / (\# \text{ in reference list})$

%P is the % shared alleles relative to the number of alleles in "present" loci: $\%P = 100 * (\#+) / (\#+ \& \#-)$

%P should always be equal to or larger than %A. The lists are sorted by decreasing %A. The % included loci is the % loci where all reference sample alleles are shared with the target sample: $\%in = 100 * (\# \text{ in}) / (\# \text{ Total})$

Case History:

Homicide at Construction Site

A civil engineer was found murdered at the construction site of his upcoming project. This gruesome murder was reported to the forensic investigators at 10:00hr by the local Police Department by laborers. The victim's body was found at the second floor. When the investigators started examining the crime scene, things were seen scattered all around which was due to the victim trying to defend himself against the attacker. Blood was spotted all over the place. Victim's face was seen covered by a plastic bag. Helmet and the right shoe of the victim were spotted some distance away from the body. Body posture was facing to the person's right. No physical evidence of the criminal was traced. No weapons were recovered. Trace amount of blood, hair, saliva and body tissues were found in the crime scene. Blood was collected from the floor, helmet of the victim, teeth of the victim, shirt of the victim, Iron pillars, plastic bag, PVC tubes, saw dust. Body tissues were recovered from the nails, teeth and key of the victim. Hair was collected from the nails of the victim and hands of the victim. Saliva was collected from both inside and outside of the plastic bag and also from the tie of the victim. Blood was found dark chocolate in colour and was coagulated, so the murder seems to be occurred at early evening before the body was recovered. Upon interrogation with the victim's relatives and witnesses 48 suspects were subjected for sample submission. All the samples collected as biological evidence from the crime scene as well as blood samples of all the suspects and victim were subjected for DNA profiling. The data thus obtained.

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Sample		Loci														
Type	Description	FGA	TPOX	D8S1179	vWA	D2S1338	D19S433	D18S51	D21S11	TH01	D3S1358	CSF1PO	D16S539	D7S820	D13S317	D5S818
Victim	Lane 1 victim	17,18	6,7	8,9	11,12	19,19	12,12	7,9	24,24	4,5	12,13	6,7	5,8	6,7	8,9	7,8
Suspect	Lane 2 Suspect 1	22,25	11,12	13,17	16,17	22,23	14,15	10,15	29,31	9,10	18,18	12,12	10,11	8,10	11,12	21,22
Suspect	Lane 3 Suspect 2	20,22	8,11	14,14	14,14	18,26	15,16	14,16	29,32	8,9	15,16	11,12	12,13	9,12	11,11	11,11
Suspect	Lane 4 Suspect 3	24,24	10,10	10,16	14,18	18,18	11,12	11,11	29,34	5,9	13,16	11,12	12,12	10,11	11,11	25,26
Suspect	Lane 5 Suspect 4	23,30	11,12	13,15	14,18	19,24	14,16	10,12	29,30	7,9	16,17	11,12	10,11	9,10	9,12	21,24
Suspect	Lane 6 Suspect 5	21,23	11,11	13,15	14,17	17,19	13,14	10,10	31,31	6,7	15,16	11,12	10,11	8,9	9,11	21,32
Suspect	Lane 7 Suspect 6	22,23	8,12	15,17	17,18	22,24	14,15	10,13	29,32	9,9	16,18	11,12	11,13	10,11	11,12	22,24
Suspect	Lane 8 Suspect 7	22,23	8,8	10,15	14,18	19,26	14,15	13,16	28,32	5,6	16,17	10,12	8,12	7,9	8,12	22,24
Suspect	Lane 9 Suspect 8	18,22	8,12	13,13	17,18	18,18	12,14	13,16	28,32	6,9	14,16	11,14	9,9	8,8	9,10	9,10
Suspect	Lane 10 Suspect 9	24,24	11,12	11,17	14,15	18,21	14,16	15,19	28,30	6,8	15,16	11,11	11,11	8,8	7,11	21,22
Suspect	Lane 11 Suspect 10	23,30	11,11	11,15	14,15	18,25	13,15	14,19	30,32	6,9	15,16	11,12	10,11	8,8	11,11	22,26
Suspect	Lane 12 Suspect 11	19,24	8,10	15,16	16,17	18,22	14,14	14,14	29,32	6,7	15,15	12,12	10,11	8,11	11,14	12,12
Suspect	Lane 13 Suspect 12	22,23	11,11	14,15	17,17	24,24	13,14	10,12	29,30	6,7	17,18	10,10	10,10	11,12	11,12	25,31
Suspect	Lane 14 Suspect 13	22,23	8,11	10,11	15,15	18,25	14,14	10,10	30,30	7,9	15,16	13,13	9,12	8,8	8,12	22,22
Suspect	Lane 15 Suspect 14	17,17	8,8	13,18	13,14	20,20	12,12	27,27	29,29	6,8	14,14	14,14	12,12	14,15	13,16	9,12
Suspect	Lane 16 Suspect 15	24,26	11,11	11,11	15,19	23,25	13,14	16,19	31,31	6,9	16,18	11,13	9,1	8,12	8,11	19,24
Suspect	Lane 17 Suspect 16	21,22	11,11	11,14	15,17	18,24	13,14	13,15	29,31	6,9	15,18	10,12	10,10	8,11	8,12	25,26
Suspect	Lane 18 Suspect 17	21,24	11,12	11,13	15,15	18,25	15,15	15,19	29,30	6,8	15,15	11,11	10,11	8,12	7,11	21,22
Suspect	Lane 19 Suspect 18	21,32	11,11	10,12	14,17	19,23	13,14	14,14	29,32	6,8	15,16	10,11	10,12	8,10	11,12	22,25
Suspect	Lane 20 Suspect 19	22,24	9,11	13,15	14,14	19,19	12,14	11,14	31,32	6,9	15,15	11,12	9,10	9,11	8,11	23,27
Suspect	Lane 21 Suspect 20	22,24	10,10	15,16	17,17	19,19	13,13	10,11	30,32	6,9	15,15	11,12	10,10	9,10	9,12	22,25
Suspect	Lane 22 Suspect 21	26,26	10,11	10,15	14,19	18,18	9,9	12,13	29,32	7,7	15,16	6,12	8,8	12,14	9,12	24,24
Suspect	Lane 23 Suspect 22	21,22	8,11	10,15	15,19	12,14	14,14	8,10	32,34	6,9	15,16	11,12	9,10	10,10	8,10	23,30
Suspect	Lane 24 Suspect 23	22,26	10,11	13,15	17,17	18,18	12,14	11,11	32,32	7,8	15,16	12,12	11,12	10,10	8,12	21,23
Suspect	Lane 25 Suspect 24	25,31	8,8	11,16	18,18	6,14	14,15	12,14	32,33	8,9	15,16	11,13	15,15	10,11	11,12	22,23
Suspect	Lane 26 Suspect 25	22,22	8,11	10,15	13,16	6,12	13,13	10,15	29,30	7,8	13,14	10,11	15,16	8,8	9,12	22,23
Suspect	Lane 27 Suspect 26	19,24	11,11	13,18	18,18	6,11	15,15	14,17	27,28	8,8	17,18	10,12	15,16	10,12	8,10	20,24
Suspect	Lane 28 Suspect 27	25,26	8,8	11,16	18,18	7,12	14,15	10,12	28,30	9,9	11,15	10,13	15,18	8,10	9,13	22,23
Suspect	Lane 29 Suspect 28	21,22	7,10	12,13	15,18	6,13	13,13	13,14	28,30	8,9	14,15	11,12	16,17	8,12	9,11	18,22
Suspect	Lane 30 Suspect 29	22,25	11,12	12,13	16,17	11,11	13,14	13,13	30,32	5,6	14,15	11,11	9,11	8,11	11,12	24,24
Suspect	Lane 31 Suspect 30	23,24	10,10	15,18	15,18	9,10	14,15	12,15	31,33	8,8	16,17	11,12	11,11	9,9	12,13	26,28
Suspect	Lane 32 Suspect 31	22,24	12,13	18,18	13,14	11,12	14,15	10,12	30,30	9,8	17,18	12,12	15,16	11,12	9,12	23,24
Suspect	Lane 33 Suspect 32	20,23	11,12	12,17	14,18	11,11	14,14	13,13	29,31	8,9	15,17	10,12	14,17	10,12	12,12	22,24
Suspect	Lane 34 Suspect 33	19,20	8,8	8,12	16,16	10,12	13,14	13,15	32,33	6,9	16,17	10,12	15,17	10,10	8,8	20,23
Suspect	Lane 35 Suspect 34	22,22	9,9	10,11	17,19	9,11	13,14	14,14	29,31	7,8	15,16	12,12	16,16	8,12	8,12	19,20
Suspect	Lane 36 Suspect 35	28,28	8,11	10,12	17,17	8,11	13,15	10,16	30,33	7,9	15,16	10,10	11,11	11,12	8,11	22,22
Suspect	Lane 37 Suspect 36	18,22	7,7	13,17	19,19	10,13	15,15	23,24	32,33	7,7	17,18	6,6	9,9	16,16	12,12	28,28
Suspect	Lane 38 Suspect 37	23,26	8,11	10,14	16,17	11,14	13,14	14,16	32,32	7,8	14,15	10,12	8,10	8,10	11,13	18,22
Suspect	Lane 39 Suspect 38	21,23	8,11	10,15	15,19	11,11	14,14	11,11	32,32	6,9	15,16	11,12	9,9	10,10	8,10	23,26
Suspect	Lane 40 Suspect 39	20,24	8,8	9,14	16,16	12,12	12,13	12,13	28,33	6,8	15,16	11,12	8,10	10,12	8,11	10,10
Suspect	Lane 41 Suspect 40	21,23	8,11	10,15	15,16	8,12	13,15	13,14	29,30	6,8	16,17	9,12	9,12	7,10	11,13	21,23
Suspect	Lane 42 Suspect 41	22,23	11,11	14,15	16,17	17,22	13,14	12,16	28,32	6,7	15,17	10,12	11,12	7,11	8,12	11,12
Suspect	Lane 43 Suspect 42	23,26	8,11	10,15	15,19	20,22	14,14	11,11	32,32	6,9	15,16	11,12	9,9	10,10	8,10	12,12
Suspect	Lane 44 Suspect 43	21,23	10,11	13,15	17,17	20,20	12,14	10,10	32,33	7,8	15,16	12,12	11,12	10,10	8,12	13,13
Suspect	Lane 45 Suspect 44	21,22	8,8	9,14	16,16	20,22	12,13	12,14	28,29	7,8	13,14	11,13	10,11	10,11	11,12	10,11
Suspect	Lane 46 Suspect 45	22,23	8,11	11,15	14,17	20,20	14,14	10,10	28,29	8,9	14,15	10,11	10,10	8,8	9,12	11,13
Suspect	Lane 47 Suspect 46	20,24	11,11	12,17	18,18	18,22	14,14	14,17	28,30	7,7	16,17	10,12	10,12	10,12	8,10	11,12
Suspect	Lane 48 Suspect 47	22,23	8,8	10,15	17,17	24,24	13,14	10,12	28,30	9,9	14,14	10,13	10,11	8,10	9,12	12,13
Suspect	Lane 49 Suspect 48	19,23	8,11	14,16	17,19	22,23	16,16	10,11	32,34	9,9	17,18	11,12	10,11	9,12	10,12	13,13
Evidence	Lane 50 Floor Blood	17,18	6,7	8,9	11,12	19,19	12,12	7,9	24,24	4,5	12,13	6,7	5,8	6,7	8,9	7,8
Evidence	Lane 51 Floor Blood	17,18	6,7	8,9	11,12	19,19	12,12	7,9	24,24	4,5	12,13	6,7	5,8	6,7	8,9	7,8
Evidence	Lane 52 Floor Blood	23,30	11,11	11,15	14,15	18,25	13,15	14,19	30,32	6,9	15,16	11,12	10,11	8,8	11,11	22,26
Evidence	Lane 53 Floor Blood	21,32	11,11	10,12	14,17	19,23	13,14	14,14	29,32	6,8	15,16	10,11	10,12	8,10	11,12	22,25
Evidence	Lane 54 Shirt Blood	17,18	6,7	8,9	11,12	19,19	12,12	7,9	24,24	4,5	12,13	6,7	5,8	6,7	8,9	7,8
Evidence	L 55 Helmet Blood	17,18	6,7	8,9	11,12	19,19	12,12	7,9	24,24	4,5	12,13	6,7	5,8	6,7	8,9	7,8
Evidence	L 56 Nails Blood	23,30	11,11	11,15	14,15	18,25	13,15	14,19	30,32	6,9	15,16	11,12	10,11	8,8	11,11	22,26
Evidence	L 57 Teeth Blood	21,32	11,11	10,12	14,17	19,23	13,14	14,14	29,32	6,8	15,16	10,11	10,12	8,10	11,12	22,25
Evidence	L 58 Iron Pillar Blood	23,30	11,11	11,15	14,15	18,25	13,15	14,19	30,32	6,9	15,16	11,12	10,11	8,8	11,11	22,26
Evidence	59 Plastic Bag Blood	17,18	6,7	8,9	11,12	19,19	12,12	7,9	24,24	4,5	12,13	6,7	5,8	6,7	8,9	7,8
Evidence	L60 PVC Tube Blood	24,24	9,9	13,14	17,18	23,24	14,15	12,13	29,30	6,7	15,16	11,11	12,12	8,11	9,11	10,11
Evidence	L 61 Saw Dust Blood	21,32	11,11	10,12	14,17	19,23	13,14	14,14	29,32	6,8	15,16	10,11	10,12	8,10	11,12	22,25
Evidence	L 62 Nails Body T	24,24	9,9	13,14	17,18	23,24	14,15	12,13	29,30	6,7	15,16	11,11	12,12	8,11	9,11	10,11
Evidence	L 63 Teeth Body T	23,30	11,11	11,15	14,15	18,25	13,15	14,19	30,32	6,9	15,16	11,12	10,11	8,8	11,11	22,26
Evidence	L 64 Key Body T	24,24	9,9	13,14	17,18	23,24	14,15	12,13	29,30	6,7	15,16	11,11	12,12	8,11	9,11	10,11
Evidence	L 65 Nails Hair	23,30	11,11	11,15	14,15	18,25	13,15	14,19	30,32	6,9	15,16	11,12	10,11	8,8	11,11	22,26
Evidence	L 66 Hands Hair	24,24	9,9	13,14	17,18	23,24	14,15	12,13	29,30	6,7	15,16	11,11	12,12	8,11	9,11	10,11
Evidence	L 67 PB i/s Saliva	17,18	6,7	8,9	11,12	19,19	12,12	7,9	24,24	4,5	12,13	6,7	5,8	6,7	8,9	7,8
Evidence	L 68 PB o/s Saliva	23,30	11,11	11,15	14,15	18,25	13,15	14,19	30,32	6,9	15,16	11,12	10,11	8,8	11,11	22,26
Evidence	L 69 Tie Saliva	21,32	11,11	10,12	14,17	19,23	13,14	14,14	29,32	6,8	15,16	10,11	10,12	8,10	11,12	22,25

Rep SE: Rep SE is the detailed breakdown of Standard alleles shared with Evidence.

Locus	Lane 11 Suspect 10	Lane 52 Floor Blood					
		Evidence #+ # -Alleles					
FGA	23,30	23,30 2 0	23,30 2 0	23,30 2 0	23,30 2 0	23,30 2 0	23,30 2 0
TPOX	11	11 1 0	11 1 0	11 1 0	11 1 0	11 1 0	11 1 0
D8S1179	11,15	11,15 2 0	11,15 2 0	11,15 2 0	11,15 2 0	11,15 2 0	11,15 2 0
vWA	14,15	14,15 2 0	14,15 2 0	14,15 2 0	14,15 2 0	14,15 2 0	14,15 2 0
D2S1338	18,25	18,25 2 0	18,25 2 0	18,25 2 0	18,25 2 0	18,25 2 0	18,25 2 0
D19S433	13,15	13,15 2 0	13,15 2 0	13,15 2 0	13,15 2 0	13,15 2 0	13,15 2 0
D18S51	14,19	14,19 2 0	14,19 2 0	14,19 2 0	14,19 2 0	14,19 2 0	14,19 2 0
D21S11	30,32	30,32 2 0	30,32 2 0	30,32 2 0	30,32 2 0	30,32 2 0	30,32 2 0
TH01	6,9	6,9 2 0	6,9 2 0	6,9 2 0	6,9 2 0	6,9 2 0	6,9 2 0
D3S1358	15,16	15,16 2 0	15,16 2 0	15,16 2 0	15,16 2 0	15,16 2 0	15,16 2 0
Amel	X,Y	X,Y 2 0					
CSF1PO	11,12	11,12 2 0	11,12 2 0	11,12 2 0	11,12 2 0	11,12 2 0	11,12 2 0
D16S539	10,11	10,11 2 0	10,11 2 0	10,11 2 0	10,11 2 0	10,11 2 0	10,11 2 0
D7S820	8	8 1 0	8 1 0	8 1 0	8 1 0	8 1 0	8 1 0
D13S317	11	11 1 0	11 1 0	11 1 0	11 1 0	11 1 0	11 1 0
D5S818	22,26	22,26 2 0	22,26 2 0	22,26 2 0	22,26 2 0	22,26 2 0	22,26 2 0
# Alleles	29	29 0	29 0	29 0	29 0	29 0	29 0
# Loci: In, Ex, Total		16 0 16	16 0 16	16 0 16	16 0 16	16 0 16	16 0 16

The last row provides the number of loci where all of the reference sample alleles are contained in the target sample (# In), the number of loci where at least one of the reference sample alleles are not contained in the target sample (# Ex), and the total number of loci where the reference and target samples have alleles (# Total). The second column (labeled "#+") is the number of alleles in the Standard that are common to the given Evidence. In this case both the alleles 23 and 30 are present in the evidence sample. The third column (Labeled "#-") is the number of alleles in the Standard that are absent from the given Evidence. Here as both the suspects and evidence allele matches there is no absent allele in the given evidence. The fourth column (labeled "-Alleles") is the list of alleles in the Evidence that are not shared with the given standard. As both the alleles match with the reference, the column is left blank.

Inference:

Since all of the alleles present in the reference sample exactly matches with that of the alleles present in the target sample, we can conclude that the suspect 10 profile is same as that of the evidence profile on lane 52. Similarly when the suspect 10 was analyzed with all the evidence samples it was found that the suspect 10 profile matched with other 5 evidences i.e., lane 56, 58, 65, 63, 68 along with L 52.

Locus	Lane 11 Suspect 10	Lane 50 Floor Blood			
		Evidence #+ # -Alleles	#	-Alleles	
FGA	23,30	17,18 0 2	2	17,18	
TPOX	11	6,7 0 1	1	6,7	
D8S1179	11,15	8,9 0 2	2	8,9	
vWA	14,15	11,12 0 2	2	11,12	
D2S1338	18,25	19 0 2	2	19	
D19S433	13,15	12 0 2	2	12	
D18S51	14,19	7,9 0 2	2	7,9	
D21S11	30,32	24 0 2	2	24	
TH01	6,9	4,5 0 2	2	4,5	
D3S1358	15,16	12,13 0 2	2	12,13	
Amel	X,Y	X,Y 2 0	0		
CSF1PO	11,12	6,7 0 2	2	6,7	
D16S539	10,11	5,8 0 2	2	5,8	
D7S820	8	6,7 0 1	1	6,7	
D13S317	11	8,9 0 1	1	8,9	
D5S818	22,26	7,8 0 2	2	7,8	
# Alleles	29		2	27	
# Loci: In, Ex, Total			1	15	16

This table of RepSE shows mismatch between suspect and evidence. In this case only the alleles from the locus AMEL matches with that of suspect sample. The alleles of remaining 15 loci do not match with that of suspect's loci. Hence we can conclude that the evidence sample on L50 is not of suspect 10.

Similarly tables were obtained from RepSE proving that the profile of suspect 18 was matching with the evidences run on Lanes 53, 57, 61, 69 respectively.

Rep SS: This sheet provides detailed analysis of alleles of each Standard that are shared with other Standards.

Locus	Lane 1 victim	Lane 2 Suspect 1		Lane 3 Suspect 2		Lane 4 Suspect 3		Lane 5 Suspect 4	
		Self #+ # -Alleles	Standard #+ # -Alleles						
FGA	17,18	17,18 2 0	22,25 0 2 22,25	20,22 0 2 20,22	24 0 2 24	23,30 0 2 23,30			
TPOX	6,7	6,7 2 0	11,12 0 2 11,12	8,11 0 2 8,11	10 0 2 10	11,12 0 2 11,12			
D8S1179	8,9	8,9 2 0	13,17 0 2 13,17	14 0 2 14	10,16 0 2 10,16	13,15 0 2 13,15			
vWA	11,12	11,12 2 0	16,17 0 2 16,17	14 0 2 14	14,18 0 2 14,18	14,18 0 2 14,18			
D2S1338	19	19 1 0	22,23 0 1 22,23	18,26 0 1 18,26	18 0 1 18	19,24 1 0 24			
D19S433	12	12 1 0	14,15 0 1 14,15	15,16 0 1 15,16	11,12 1 0 11	14,16 0 1 14,16			
D18S51	7,9	7,9 2 0	10,15 0 2 10,15	14,16 0 2 14,16	11 0 2 11	10,12 0 2 10,12			
D21S11	24	24 1 0	29,31 0 1 29,31	29,32 0 1 29,32	29,34 0 1 29,34	29,30 0 1 29,30			
TH01	4,5	4,5 2 0	9,10 0 2 9,10	8,9 0 2 8,9	5,9 1 1 9	7,9 0 2 7,9			
D3S1358	12,13	12,13 2 0	18 0 2 18	15,16 0 2 15,16	13,16 1 1 16	16,17 0 2 16,17			
Amel	X,Y	X,Y 2 0	X,Y 2 0	X,Y 2 0	X,Y 2 0	X,Y 2 0			
CSF1PO	6,7	6,7 2 0	12 0 2 12	11,12 0 2 11,12	11,12 0 2 11,12	11,12 0 2 11,12			
D16S539	5,8	5,8 2 0	10,11 0 2 10,11	12,13 0 2 12,13	12 0 2 12	10,11 0 2 10,11			
D7S820	6,7	6,7 2 0	8,10 0 2 8,10	9,12 0 2 9,12	10,11 0 2 10,11	9,10 0 2 9,10			
D13S317	8,9	8,9 2 0	11,12 0 2 11,12	11 0 2 11	11 0 2 11	9,12 1 1 12			
D5S818	7,8	7,8 2 0	21,22 0 2 21,22	11 0 2 11	25,26 0 2 25,26	21,24 0 2 21,24			
# Alleles	29	29 0	2 27	2 27	5 24	4 25			
# Loci: In, Ex, Total		16 0 16	1 15 16	1 15 16	2 14 16	2 14 16			

Inference:

The victim's sample was taken as reference sample and was compared with all the other standards i.e., here in this case with the victim himself and all the other 48 suspects. On doing

standard versus standard it was observed that there was no mislabeling while importing the data and all the DNA profiles imported were of different individuals. In the Rep SS report the match is found only when the reference sample is compared with itself. Hence in the above result there is only one similar match with that of the victim's profile that is the victim himself. So there was no mislabeling of the profiles or any same DNA profile repeated.

Rep EE: This sheet provides detailed analysis of alleles of each evidence that are shared with other evidence. The presentation format is identical to that of the RepSE and RepSS worksheets.

Locus	L 65 Nail Hair		L 52 Floor Blood		L 56 Nail Blood		L 50 Iron Pillar Blood		L 63 Teeth Body T		L 65 Nail Hair		L 60 PB o/s Saliva		L 69 Tie Saliva			
	Evidence #	% - Alleles	Evidence #	% - Alleles	Evidence #	% - Alleles	Evidence #	% - Alleles	Evidence #	% - Alleles	Evidence #	% - Alleles	Evidence #	% - Alleles	Evidence #	% - Alleles		
FGA	23,30	2, 0	23,30	2, 0	23,30	2, 0	23,30	2, 0	23,30	2, 0	23,30	2, 0	23,30	2, 0	21,32	0, 2	21,32	
TPCX	11	1, 1	0	0	11	1, 1	0	0	11	1, 1	0	0	11	1, 1	0	0	11	1, 1
D1S1179	11,15	2, 0	11,15	2, 0	11,15	2, 0	11,15	2, 0	11,15	2, 0	11,15	2, 0	11,15	2, 0	10,12	0, 2	10,12	
vWA	14,15	2, 0	14,15	2, 0	14,15	2, 0	14,15	2, 0	14,15	2, 0	14,15	2, 0	14,15	2, 0	14,17	1, 1	17	
D1S1338	18,25	2, 0	18,25	2, 0	18,25	2, 0	18,25	2, 0	18,25	2, 0	18,25	2, 0	18,25	2, 0	18,23	0, 2	18,23	
D1S4433	13,15	2, 0	13,15	2, 0	13,15	2, 0	13,15	2, 0	13,15	2, 0	13,15	2, 0	13,15	2, 0	13,14	1, 1	14	
D1S351	14,19	2, 0	14,19	2, 0	14,19	2, 0	14,19	2, 0	14,19	2, 0	14,19	2, 0	14,19	2, 0	14	1, 1		
D2S1311	30,32	2, 0	30,32	2, 0	30,32	2, 0	30,32	2, 0	30,32	2, 0	30,32	2, 0	30,32	2, 0	28,32	1, 1	28	
TH01	6,9	2, 0	6,9	2, 0	6,9	2, 0	6,9	2, 0	6,9	2, 0	6,9	2, 0	6,9	2, 0	6,8	1, 1	8	
D1S1338	15,16	2, 0	15,16	2, 0	15,16	2, 0	15,16	2, 0	15,16	2, 0	15,16	2, 0	15,16	2, 0	15,16	2, 0		
AmeI	X,Y	2, 0	X,Y	2, 0	X,Y	2, 0	X,Y	2, 0	X,Y	2, 0	X,Y	2, 0	X,Y	2, 0	X,Y	2, 0		
CSF1PO	11,12	2, 0	11,12	2, 0	11,12	2, 0	11,12	2, 0	11,12	2, 0	11,12	2, 0	11,12	2, 0	10,11	1, 1	10	
D1S3329	10,11	2, 0	10,11	2, 0	10,11	2, 0	10,11	2, 0	10,11	2, 0	10,11	2, 0	10,11	2, 0	10,12	1, 1	12	
D1S320	8	1, 0	8	1, 0	8	1, 0	8	1, 0	8	1, 0	8	1, 0	8	1, 0	8,10	1, 0	10	
D1S317	11	1, 1	0	0	11	1, 1	0	0	11	1, 1	0	0	11	1, 1	11,12	1, 0	12	
D1S318	22,26	2, 0	22,26	2, 0	22,26	2, 0	22,26	2, 0	22,26	2, 0	22,26	2, 0	22,26	2, 0	22,25	1, 1	25	
# Alleles	29		29		29		29		29		29		29		15		14	
# Loci In. Ex. Total	15	0	16		15	0	16		15	0	16		15	0	16		15	

Inference:

when all the profiles of evidences are compared among themselves it was found that body tissues evidence found on nails of the victim run in L65 matched with that of the evidence L52,56,58,63,65,68. As all the alleles present in the reference sample matches with that of alleles present in the target samples it is proved that all of these samples belong to one person that was involved in the crime. The last block is the sample of evidence which does not match with the reference sample. Here if we compare the reference sample and the last evidence sample L69 out of 29 alleles of the reference only 15 alleles are matching with the evidence across its 5 loci There are 11 such loci of the evidence that are different from reference which considers it to be a different DNA profile in comparison with the reference sample.

Rep Summary: The results of Rep SE, RepSS and RepEE are summarized in Rep Summary as follows:

Standard	Evidence	%A	%P	%In
Lane 1 victim	Lane 50 Floor Blood	100	100	100
Lane 1 victim	Lane 51 Floor Blood	100	100	100
Lane 1 victim	Lane 54 Shirt Blood	100	100	100
Lane 1 victim	L 55 Helmet Blood	100	100	100
Lane 1 victim	L59 Plastic Bag Blood	100	100	100
Lane 1 victim	L 67 PB i/s Saliva	100	100	100
Lane 1 victim	Lane 53 Floor Blood	10	10	13
Lane 1 victim	L 57 Teeth Blood	10	10	13
Lane 11 Suspect 10	Lane 52 Floor Blood	100	100	100
Lane 11 Suspect 10	L 56 Nails Blood	100	100	100
Lane 11 Suspect 10	L 58 Iron Pillar Blood	100	100	100
Lane 11 Suspect 10	L 63 Teeth Body T	100	100	100
Lane 11 Suspect 10	L 65 Nails Hair	100	100	100
Lane 11 Suspect 10	L 68 PB o/s Saliva	100	100	100
Lane 11 Suspect 10	Lane 53 Floor Blood	52	52	31
Lane 11 Suspect 10	L 57 Teeth Blood	52	52	31
Lane 19 Suspect 18	Lane 53 Floor Blood	100	100	100
Lane 19 Suspect 18	L 57 Teeth Blood	100	100	100
Lane 19 Suspect 18	L 61 Saw Dust Blood	100	100	100
Lane 19 Suspect 18	L 69 Tie Saliva	100	100	100
Lane 19 Suspect 18	Lane 53 Floor Blood	50	50	25
Lane 19 Suspect 18	L 56 Nails Blood	50	50	25

In the above block if we consider the first row of the sample Standard(L1) and Evidence(L59)as all the alleles of the victim is shared by evidence allele, %A=100. Since all the alleles are shared %P=100. Here all the reference loci alleles are shared with target loci alleles hence % In=100.

Inference:

As per the analysis done by Mix STR Tool where all the standards were taken as reference sample and compared with all the evidence samples, it was found that Victim's sample run on L1 matches to the extent of 100% values of A, P and In, with that of some of the evidence run on L 50 , 51, L 54,55,59,67,53,57 respectively. Yet another sample of blood collected from the floor teeth are the examples mentioned to find the difference inferring that those samples do not match with that of Victim's sample. Suspect 10 and suspect 18 were found to be the other two profiles that had 100%similarity with two different sets of the evidence samples, wherein the former sample matched with the evidence run on L 52, 56, 58,63,65,68 respectively. Samples run on L53 and 57 are the examples that do not belong to suspect 10. Suspect 18 samples matched with the evidence run on L53, 57, 61 and 69 respectively.L52 and 56 are the examples of the samples that do not belong to suspect 18.

Evidence	Standard	%A	%P	%In
Lane 50 Floor Blood	Lane 1 victim	100	100	100
Lane 51 Floor Blood	Lane 1 victim	100	100	100
Lane 52 Floor Blood	Lane 11 Suspect 10	100	100	100
Lane 53 Floor Blood	Lane 19 Suspect 18	100	100	100
Lane 54 Shirt Blood	Lane 1 victim	100	100	100
L 55 Helmet Blood	Lane 1 victim	100	100	100
L 56 Nails Blood	Lane 11 Suspect 10	100	100	100
L 57 Teeth Blood	Lane 19 Suspect 18	100	100	100
L 58 Iron Pillar Blood	Lane 11 Suspect 10	100	100	100
L59 Plastic Bag Blood	Lane 1 victim	100	100	100
L 61 Saw Dust Blood	Lane 19 Suspect 18	100	100	100
L 63 Teeth Body T	Lane 11 Suspect 10	100	100	100
L 65 Nails Hair	Lane 11 Suspect 10	100	100	100
L 67 PB i/s Saliva	Lane 1 victim	100	100	100
L 68 PB o/s Saliva	Lane 11 Suspect 10	100	100	100
L 69 Tie Saliva	Lane 19 Suspect 18	100	100	100

Inference:

The evidence samples were compared against all the standards and it was observed that samples run on L50, 51, 54, 55, 59 and 67 were found to be 100% match

with that of victim's alleles. Another sample run on L52, 56, 58,63,65,68 respectively were found to be 100% match with suspect number 10. Yet other evidences run on the L53, 57, 61, 69 respectively were found to be 100% match with suspect 18.

Evidence by Evidence					
Evidence	Evidence	%A	%P	%In	
Lane 50 Floor Blood	Lane 51 Floor Blood	100	100	100	
Lane 50 Floor Blood	Lane 54 Shirt Blood	100	100	100	
Lane 50 Floor Blood	L 55 Helmet Blood	100	100	100	
Lane 50 Floor Blood	L59 Plastic Bag Blood	100	100	100	
Lane 50 Floor Blood	L 67 PB i/s Saliva	100	100	100	
Lane 52 Floor Blood	L 56 Nails Blood	100	100	100	
Lane 52 Floor Blood	L 58 Iron Pillar Blood	100	100	100	
Lane 52 Floor Blood	L 63 Teeth Body T	100	100	100	
Lane 52 Floor Blood	L 65 Nails Hair	100	100	100	
Lane 52 Floor Blood	L 68 PB o/s Saliva	100	100	100	
Lane 53 Floor Blood	L 57 Teeth Blood	100	100	100	
Lane 53 Floor Blood	L 61 Saw Dust Blood	100	100	100	
Lane 53 Floor Blood	L 69 Tie Saliva	100	100	100	
L60 PVC Tube Blood	L 62 Nails Body T	100	100	100	
L60 PVC Tube Blood	L 64 Key Body T	100	100	100	
L60 PVC Tube Blood	L 66 Hands Hair	100	100	100	

Inference:

When evidence by evidence analysis was done it was found that there were samples of evidences that matched with other evidence samples. Evidence no. E2, E5, E6, E10 and E18 are matching with one another and hence belong to the same person. Similarly evidence no. E7, E9, E14, E16, E19 are matching with themselves and not with any other evidence and hence all of them belong to any other person. Similarly evidence samples E8, E12, E20 are matching with them and not with any other and hence belong to any third person. Similarly evidence no. E13, E15, and E17 match with them and not with any other evidence and hence belong to any fourth person.

Conclusion:

The given samples were analyzed and suspect number 10 whose sample was run on Lane 11 and Suspect number 18 whose sample was run on Lane 19 were found to be the prime culprits involved in the murder of the civil engineer at the construction site. The following interpretations were helpful in investigation and conclusion:

1. As per Rep EE Evidence no.E1, E2, E5,E6,E10,E18 are matching with one another and hence belong to one person, evidence no E3,E7,E9,E14,E16,E19 are matching with one another and not with any other evidence, hence they belong to any other person while evidence no E4,E8,E12,E20 are matching

with one another and not with any other evidence, hence they belong to any third person.

2. As per Rep SE victim's sample was matching with evidence E1,E2,E5,E6,E10,E18 Suspect 10 with evidence E3,E7,E9,E14,E16,E19 and suspect18 with evidence E4,E8,E12,E20.
3. When evidence by evidence analysis was done it was observed that there were four evidences E11, E13, E15, E17 that did not match with any of the Standard sample, hence belong to any Third culprit whose profile was absent from the suspects.

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