




FORENSIC EVIDENCE IN CIVIL & CRIMINAL TRIALS- DNA Profiling

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Evidence plays a crucial role in Civil & Criminal Cases

- 1. Evidence is divided into**
 1. Direct - Eyewitness statements / Confessions
 2. Circumstantial - Requires indirect judgment or inference about what happened. Eg. Presence of Hair, Fingerprint at the scene of crime
- 2. Circumstantial evidence** - Important in civil and criminal cases which lacks Direct Evidence.

FORENSIC SCIENCE

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- **FORENSIC** comes from the Latin word forensis, meaning “in open court”
 - **FORENSIC SCIENCE - USE OF SCIENCE & TECHNOLOGY FOR LEGAL PURPOSE** i.e Application of various Basic Sciences to provide scientific evidences to court of law

LOCARD'S PRINCIPLE OF EXCHANGE

1. “Whenever two objects come into contact, they always leave a trace on the other.”
2. Every criminal can be connected to the crime by contact traces carried from or left at the crime scene
3. Forensic science plays a **vital role** by providing **scientifically based information** through the analysis of **CIRCUMSTANTIAL EVIDENCE.**

Physical

Non-biological types of evidence like forms of fibers, paint chips, explosives

- **Questioned Document Examination**
- **Forensic Chemistry**
- **Forensic Ballistics**
- **Forensics Psychology**
- **Digital or Computer forensics**

Biological

Biological evidences include blood, semen, saliva, faecal material, urine, hair and bone.

- **Fingerprint Analysis**
- **Forensic Odontology**
- **Forensic Toxicology**
- **Forensic Anthropology**
- **Forensic Pathology**
- **Forensic DNA**



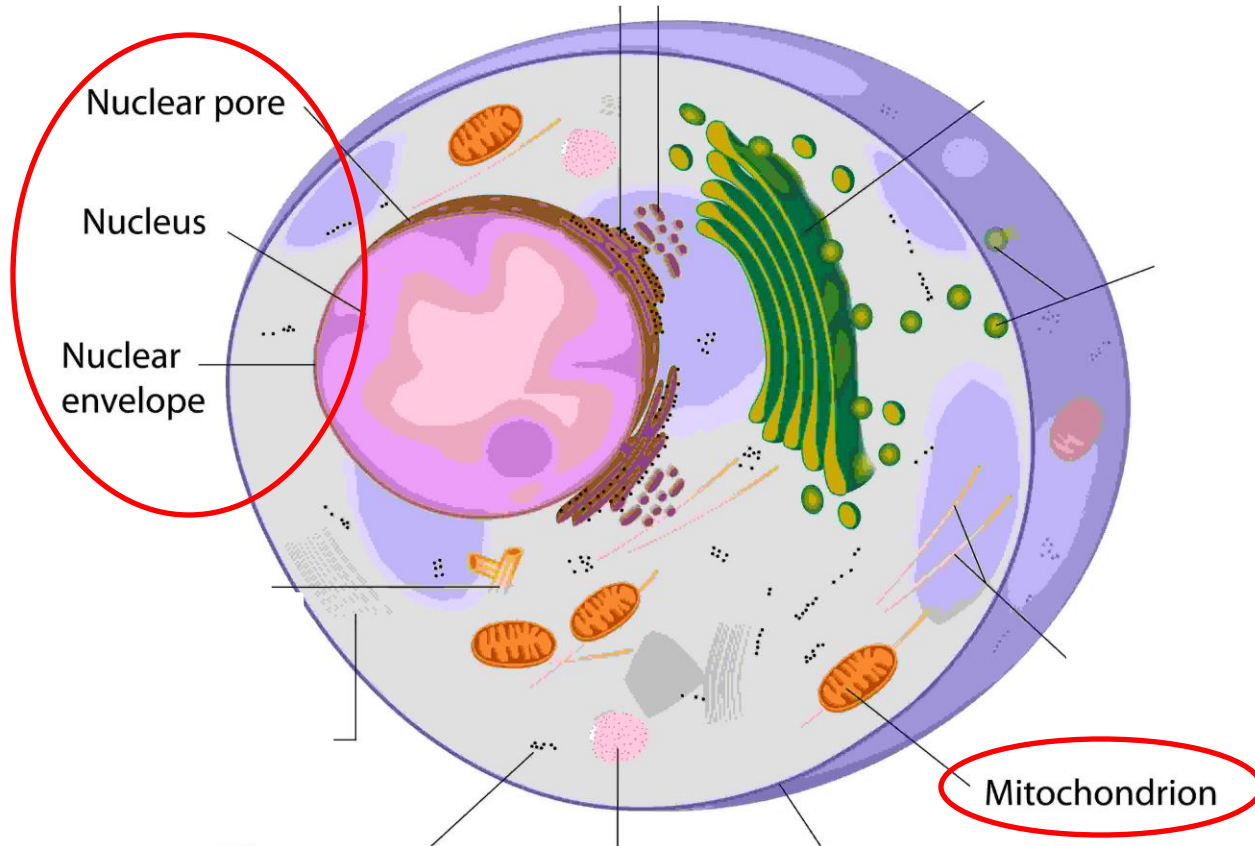
BIOLOGICAL FORENSIC EVIDENCE

DNA (Deoxyribonucleic Acid)

CELL



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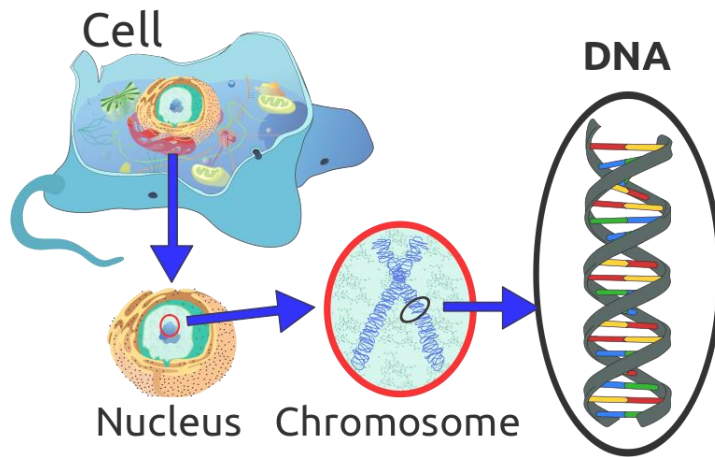


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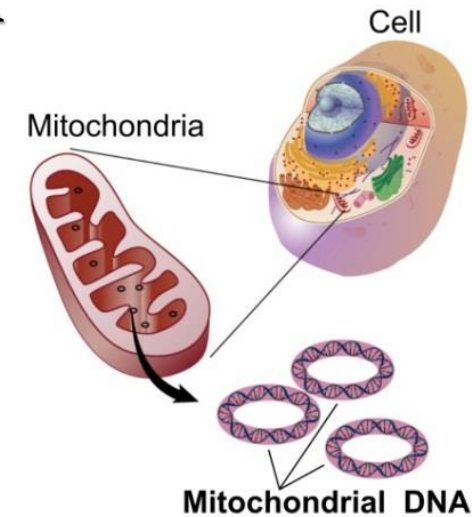
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DNA is mainly of two Types: Nuclear DNA & Mitochondrial DNA

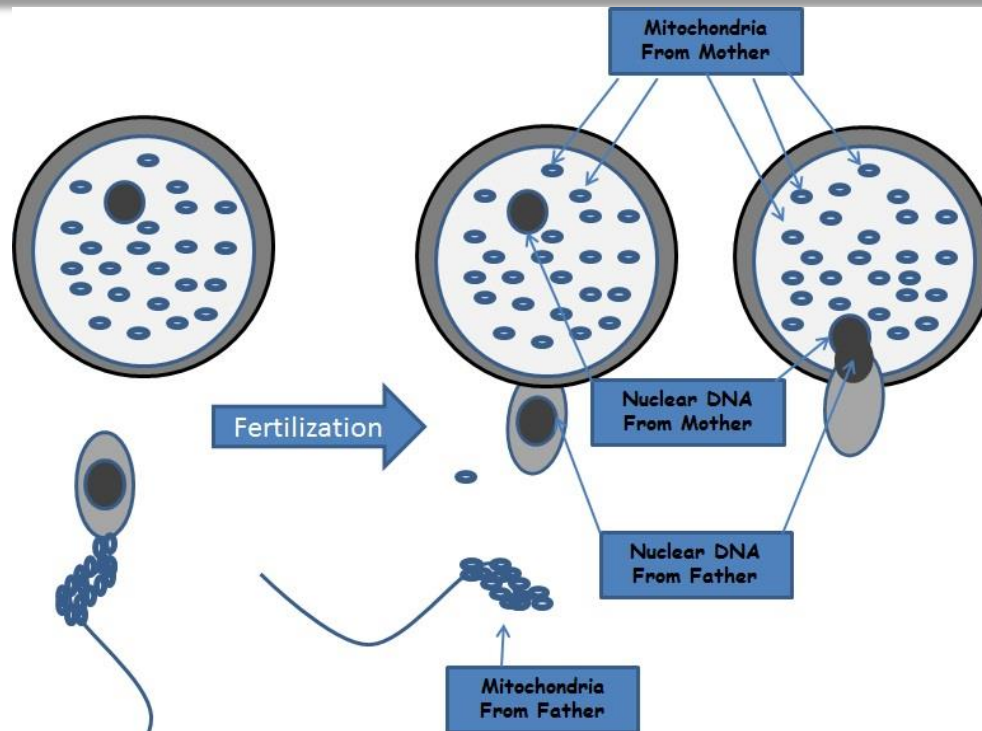


Nuclear DNA is inherited from parents (half from mother, half from father)



Mitochondrial DNA is inherited from the mother

All individuals same maternal lineage will be **indistinguishable** by mDNA analysis.



The mitochondria of a sperm are found in the tail and midsection

When **sperm** fertilizes an egg, the DNA-containing head of the sperm fuses with the egg, but the tail and midsection are left on the **outside of the egg.**

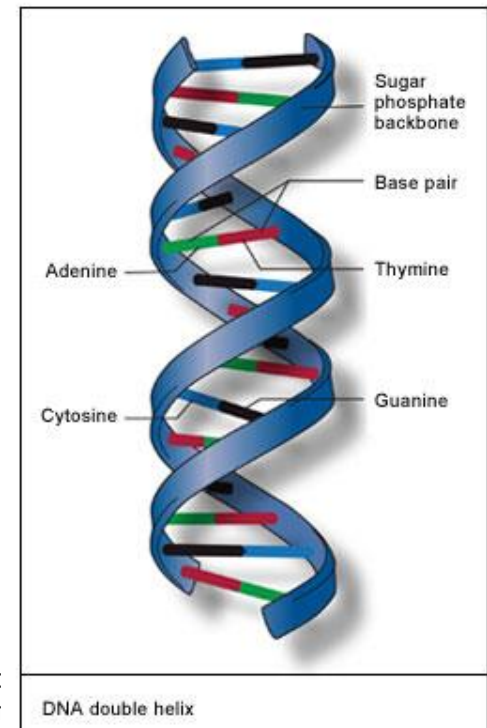
Mitochondria of the sperm never reach the inside of the egg, all the mitochondria in the embryo come from the egg.

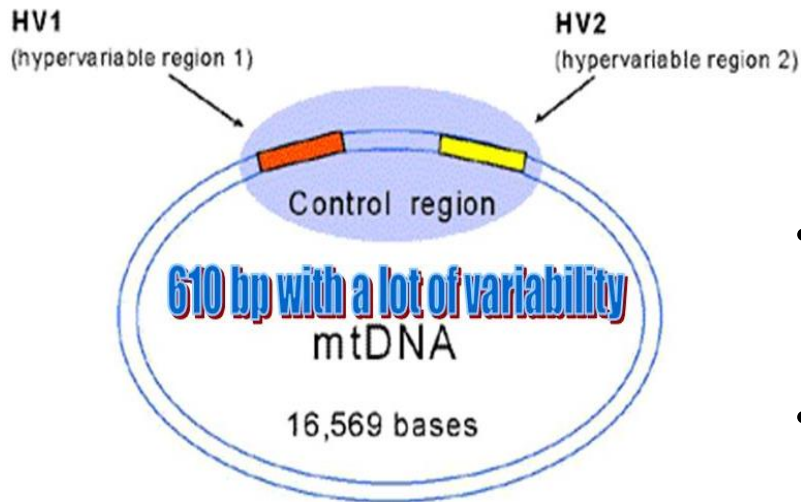
Mitochondrial DNA in a child is identical to that of the mother.

Used for proving maternal relationships in forensic investigations

DNA

- DNA (Deoxyribonucleic acid) main constituent of the chromosomes of all organisms and is found in the form of a **double helix** within the nucleus of cell and gives an individual a **PERSONAL GENETIC BLUE PRINT**.
- These chromosomes controls visible characteristics including such as eye, hair, and skin color and also invisible characteristics like blood groups and inherited diseases.
- In an individual's body, the DNA is the same in all cells.
- The chances of two people having exactly the same DNA profile is 30,000 million to 1 (except for identical twins).
- DNA is highly precise and scientific in nature and is a part of admissible expert evidence





- Mitochondrial DNA is found in ring like structure has two major parts **1. Coding region** **2. Control region**
 - The control region there are 2 regions where variations are found in humans.
 - These regions are called **Hypervariable Region 1(HV1)** & **Hypervariable Region 2 (HV2)**
- In mtDNA 3 regions namely: HVR1, HVR2 and Coding Regions are tested ; more regions tested gives more stringent comparison
 - mtDNA Mismatch - not full siblings but can still have the same father.
 - mtDNA match - strong possibility - related through the maternal line and they could be siblings but can have a different father.

TYPES OF SAMPLES

- Seminal stains
- Blood stains
- Loose/ Plucked Pubic hair
- Loose/ Plucked scalp hair
- Saliva from bite marks
- Teeth
- Bone
- Nail scrapings
- Trace material from genital areas
- Anywhere nucleated cells are, we might find DNA.



SOURCES FROM CRIME SCENE


Examples of sources from real cases:

- Saliva on the stamp of a stalker's threatening letter
- Skin cells shed on a ligature of a strangled victim
- Perspiration on a baseball cap discarded by a rapist was compared with the DNA in the saliva swabbed from a bite mark on a different rape victim
- DNA analysis of a single hair (without the root) found deep in a victim's throat

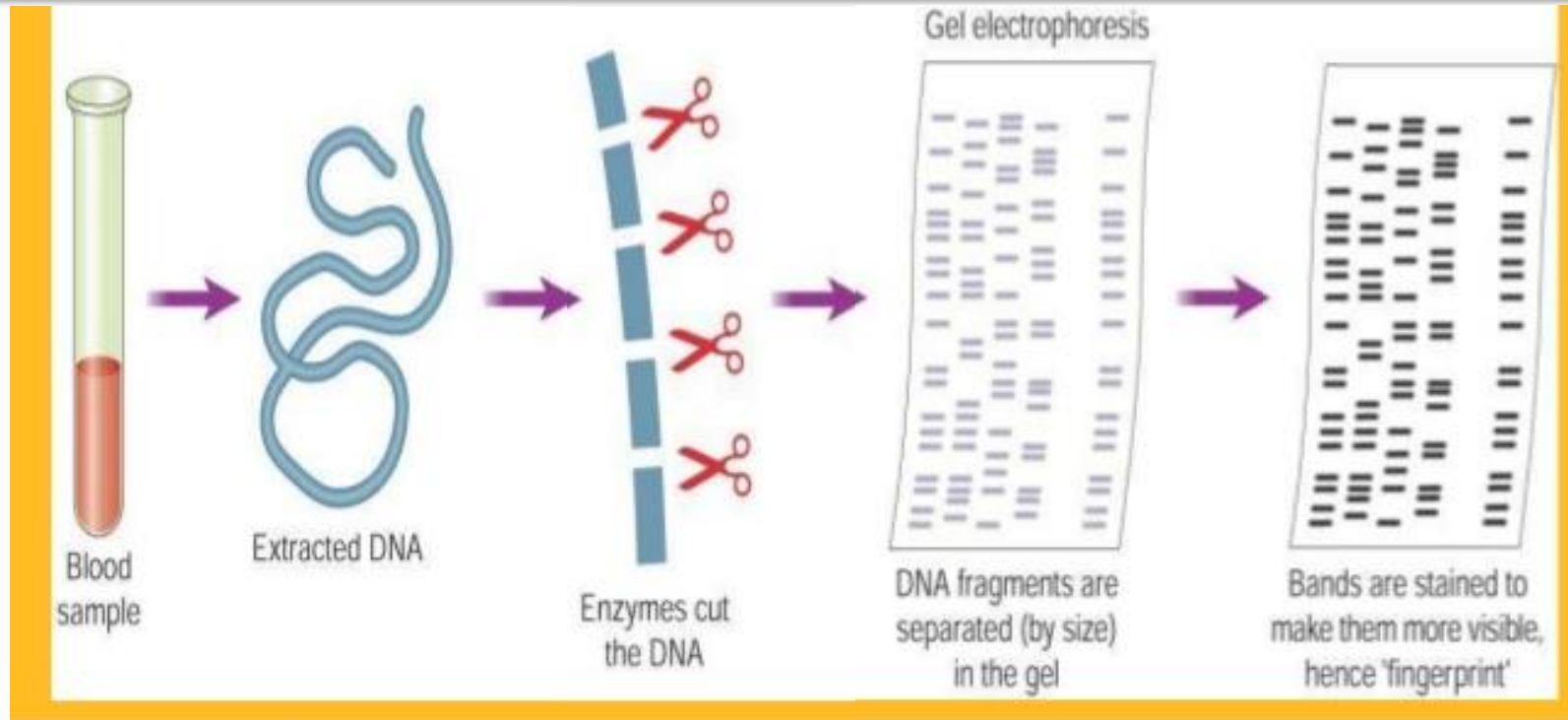
SAMPLE COLLECTION

- The biological material should be collected for use as evidence as soon as possible due to environmental conditions
- In sexual assault cases, it is important to obtain evidence samples from the victim preferably within 12-24 hours and max within 72 hours
- With appropriate storage, DNA evidence collected properly can be analysed after the passage of any amount of time.
- The DNA profiles acquired from the samples collected from the victim's body or crime scene is compared with
 - a. Reference Sample i.e the DNA profile of the victim itself to elimination
 - b. Suspect's Sample i.e the DNA profile of the suspect

PACKAGING OF EVIDENCE

- 
- Wearing disposable latex gloves while handling the evidence is required.
 - Clothing from victim and suspect must be collected.
 - The biological evidence should not be packed in plastic or airtight containers as moisture could contribute to the growth of DNA-destroying bacteria and fungi.
 - Enemies of evidence: sunlight, high temperatures, bacteria, moisture
 - Each article should be dried and packaged separately in a paper bag or in a well-ventilated box.
 - All biological evidence (blood samples) should be refrigerated or stored in a cool location
 - Standard/reference DNA specimens - such as blood or the buccal swab (swabbing the mouth and cheek).

STAGES OF DNA PROFILING



STAGE 1

Cells are broken down to release DNA.

STAGE 2

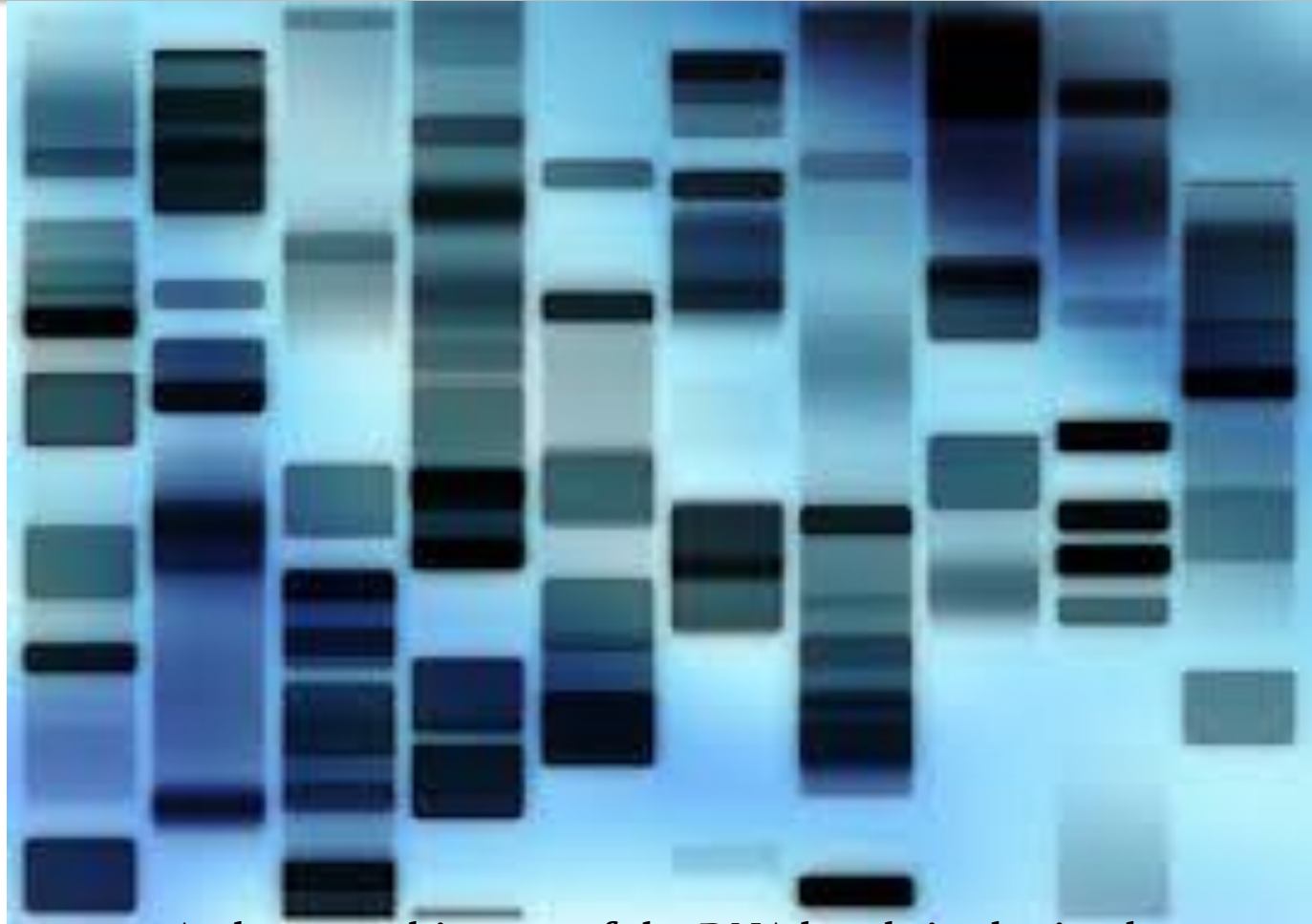
DNA is cut into fragments using restriction enzymes

STAGE 3

DNA Fragments are separated on the basis of size using Electric Current

STAGE 4

Radioactive material is added to produce a fluorescent image

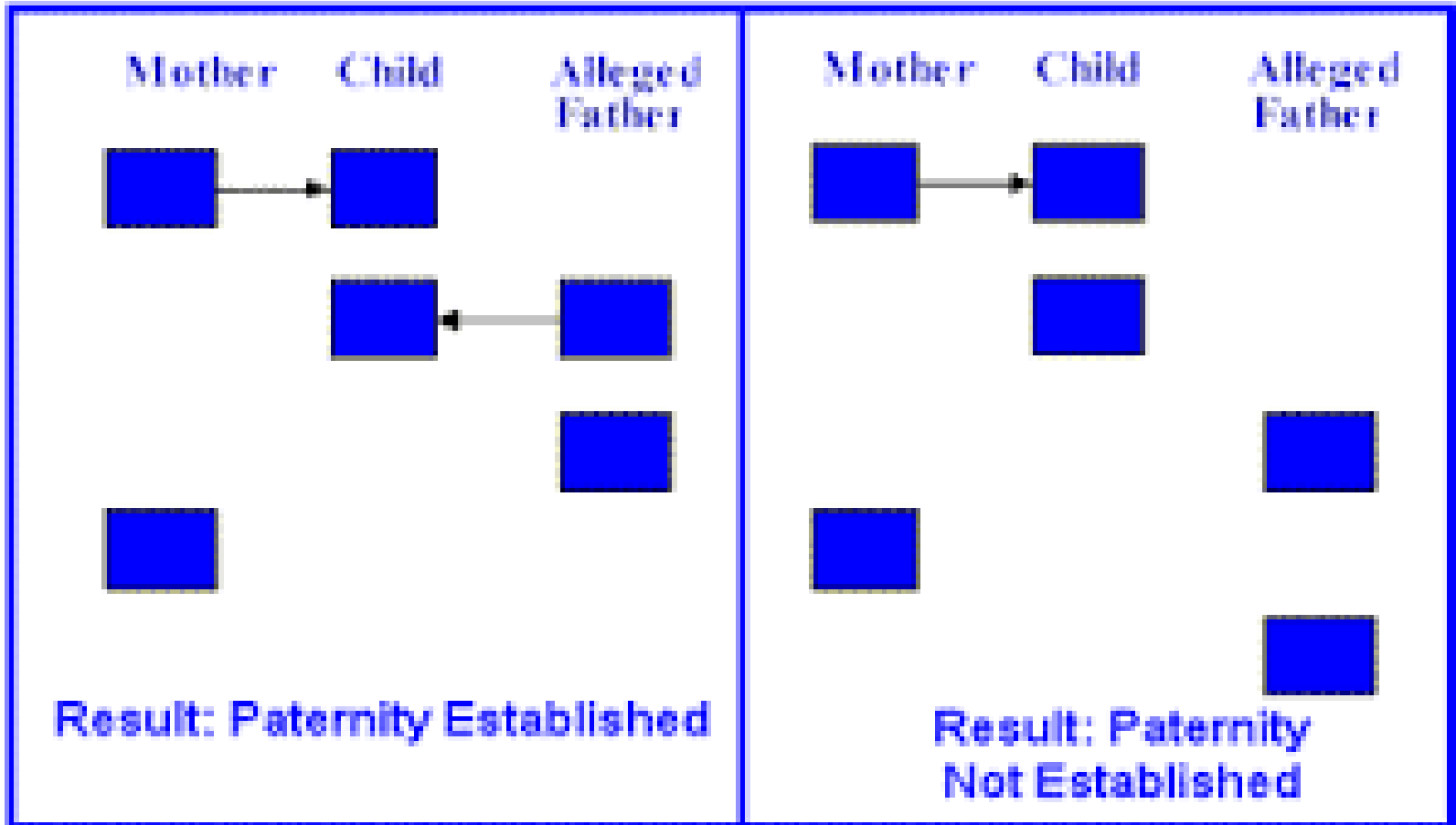


A photographic copy of the DNA bands is obtained.

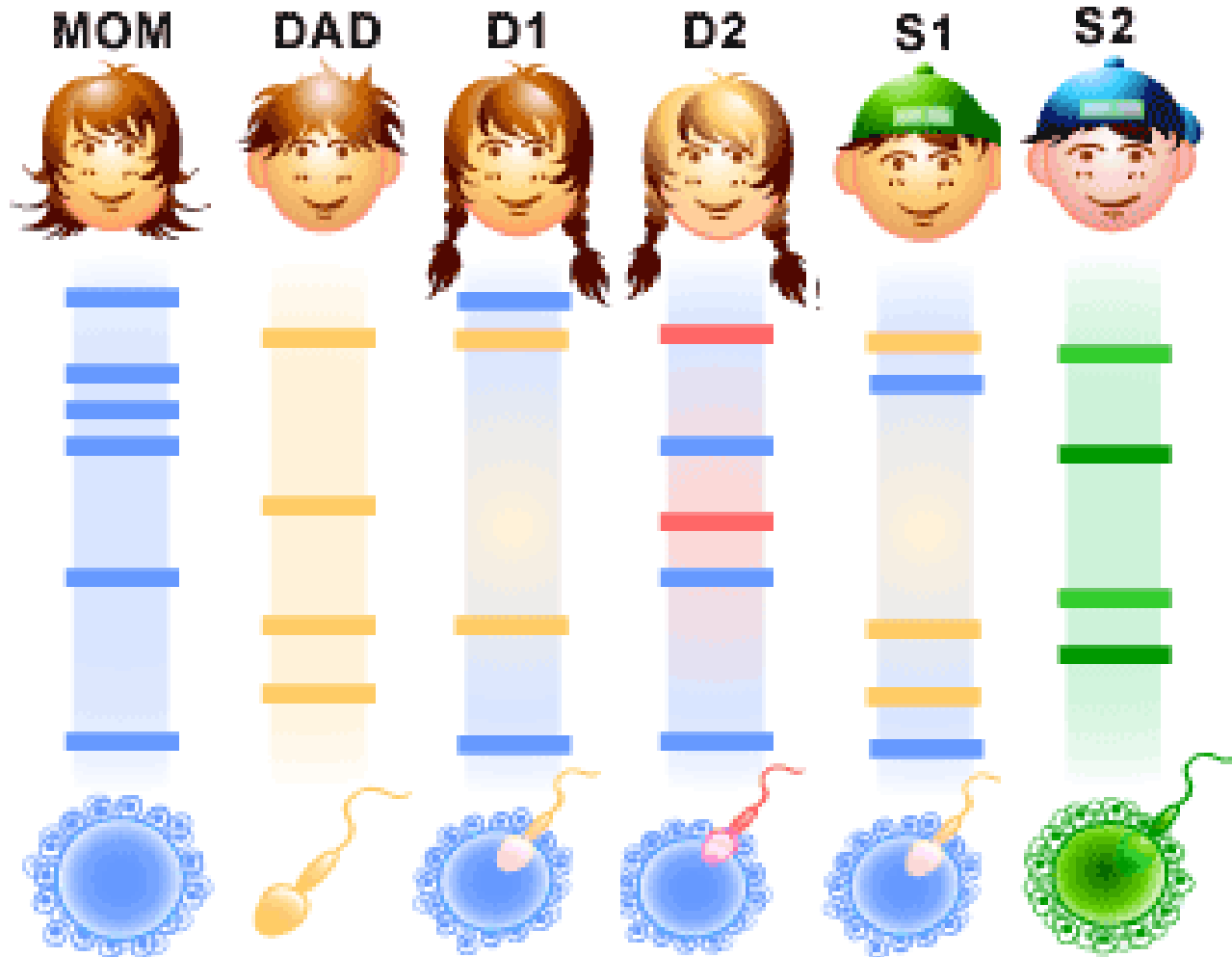
PATERNITY TEST



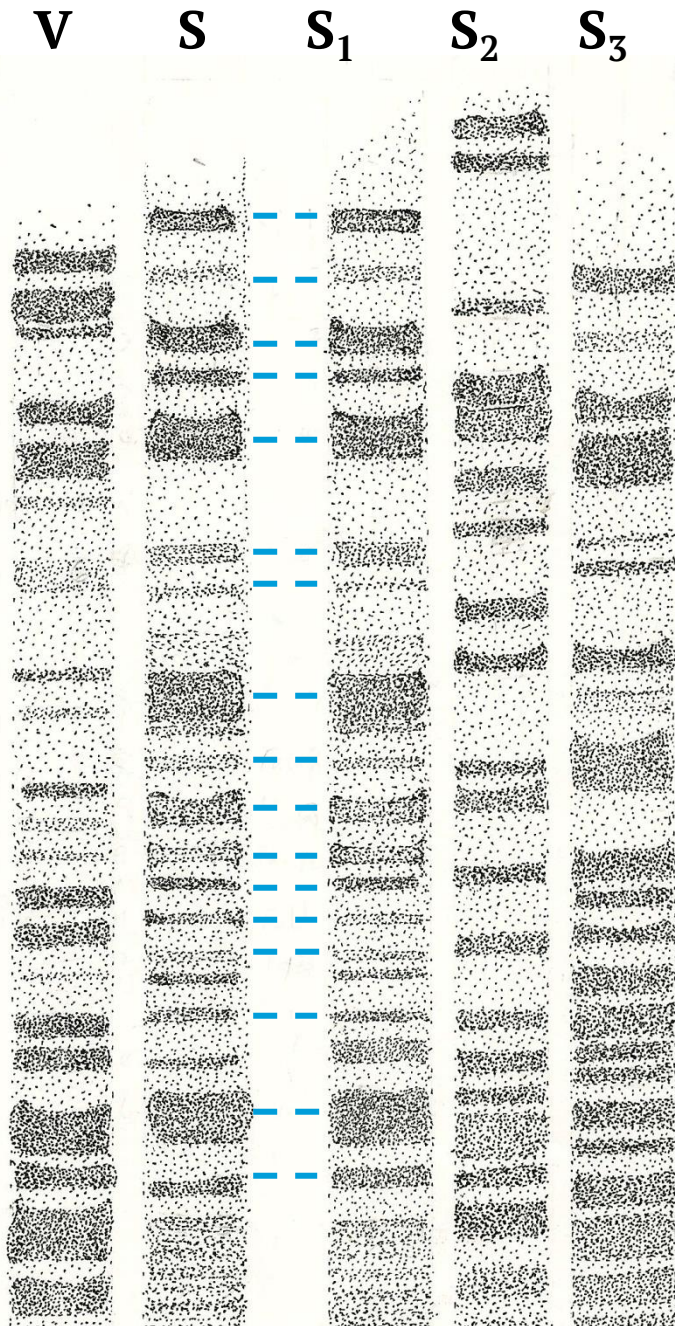
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Example



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V Victim

S Sample from crime scene

S₁ Suspect 1

S₂ Suspect 2

S₃ Suspect 3

Suspect 1 match those
taken from the crime scene

The center

STR / DNA MARKERS

- DNA has 15 universally specified DNA markers with specific combination of sizes.
- These markers are highly individualised
- D8S1179, D21S11, D7S820, CSF1PO, D3S11358, THO1, D13S317, D16S539, D2S1338, D19S433, VWA, TPOX, D18S51, D5S818, FGA
- The 16th marker is Amelogenin, which determines the sex of the sample
 - XX – Female
 - XY - Male



Case: 456789 Name		MOTHER Jane		CHILD Jenny		Alleged FATHER John	
Date Collected: Test No.		1/1/2010 456789-10		1/1/2010 456789-20		1/1/2010 456789-30	
Locus	PI	Allele Sizes		Allele Sizes		Allele Sizes	
D8S1179	1.55	10	14	13	14	11	13
D21S11	2.02	27	29	29	30	29	30
D7S820	1.17	8	10	8	10	10	11
CSF1PO	1.65	11	12	11		11	12
D3S1358	1.88	14	17	15	17	14	15
TH01	2.62	6	9.3	7	9.3	7	9
D13S317	3.43	13		11	13	11	
D16S539	3.32	9	12	11	12	11	
D2S1338	4.33	19	20	20	24	23	24
D19S433	2.23	13		13		13	14
vWA	3.62	14		14	17	17	
TPOX	1.86	11		8	11	8	
D18S51	3.06	15	17	14	17	13	14
D5S818	1.35	12	13	11	12	11	12
FGA	3.55	21	22	21	24	21	24
Amelogenin		X		X		X	Y

Interpretation:

RN: 76206

Combined Paternity Index: **323,769**

Probability of Paternity: **99.9996%**

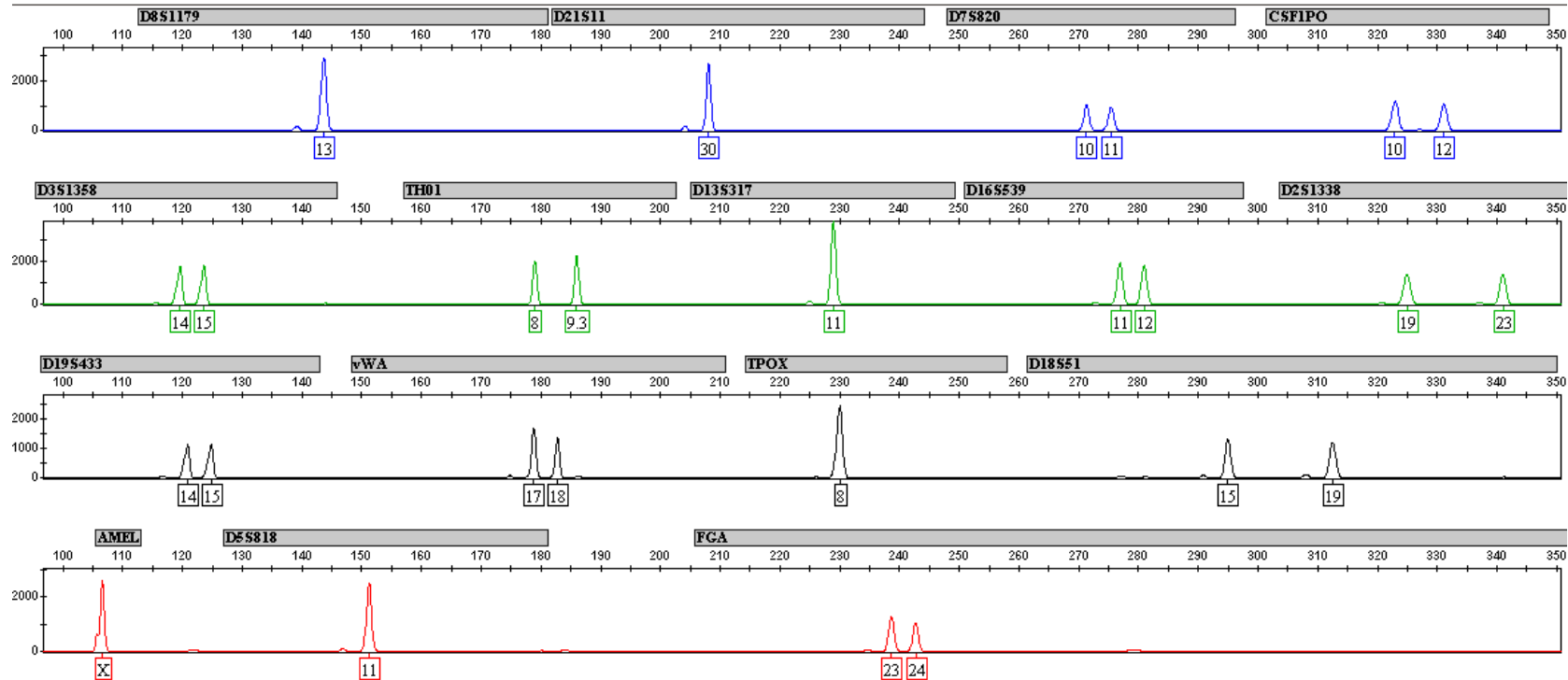
The alleged father is not excluded as the biological father of the tested child. Based on testing results obtained from analyses of the DNA loci listed, the probability of paternity is 99.9996%. This probability of paternity is calculated by comparing to an untested, unrelated, random individual of the Caucasian population (assumes prior probability equals 0.50).



Autosomal STR Loci/ DNA Markers	<u>Santosh Exh-1</u> Blood Sample	Blood Sample at the Crime Scene
D8S1179	13, 15	12, 11
D21S11	31, 32.2	23, 65
D7S820	10, 11	12, 8
CSF1PO	11	15
D3S11358	14, 15	12, 11
TH01	8	9
D13S317	9, 11	11
D16S539	11, 13	9, 12
D2S1338	20, 23	19, 20
D19S433	13	13
VWA	14, 16	14, 11
TPOX	9, 11	8, 10
D18S51	14, 15	12, 13
<u>Amelogenin</u>	X, Y	X, Y
D5S818	11	10
FGA	23, 25	21, 24

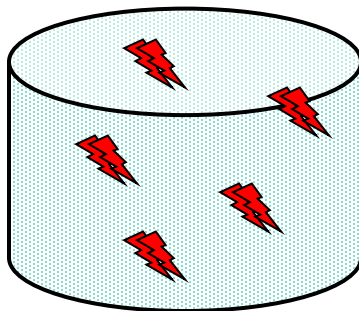
Full DNA Profile

Electropherogram data generated using Life Technologies® GeneMapper® software from Thermo Fisher Scientific Inc.

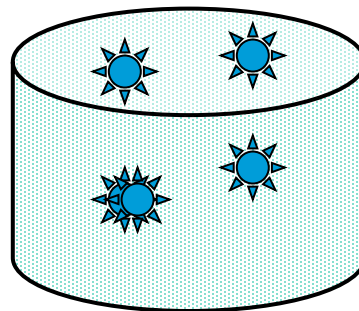


DNA MIXTURES

- Mixtures of victim & suspect(s)
 - How many people?
 - Previous consensual partners?
 - Contamination: scene, collection, lab?
- Mixture not always detected at all tests.



Profile A Detected



Profile B Detected



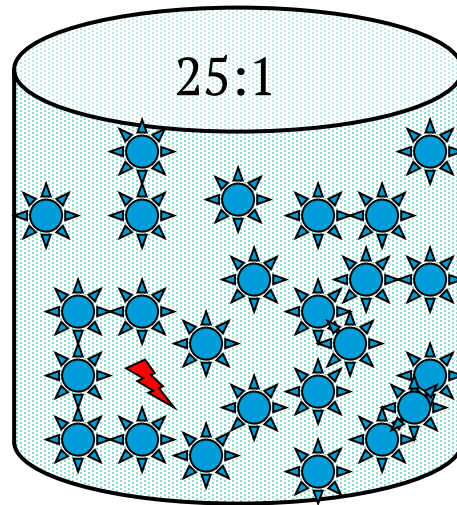
Factors:

1. Quantity of DNA
2. Quality of DNA

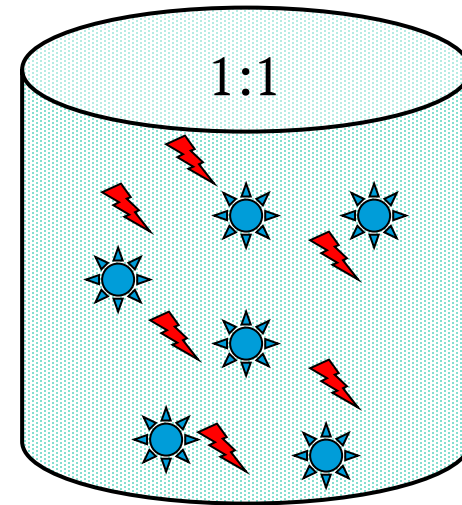
MIXTURE DETECTION



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Only Profile B Detected



Profiles A and B Detected

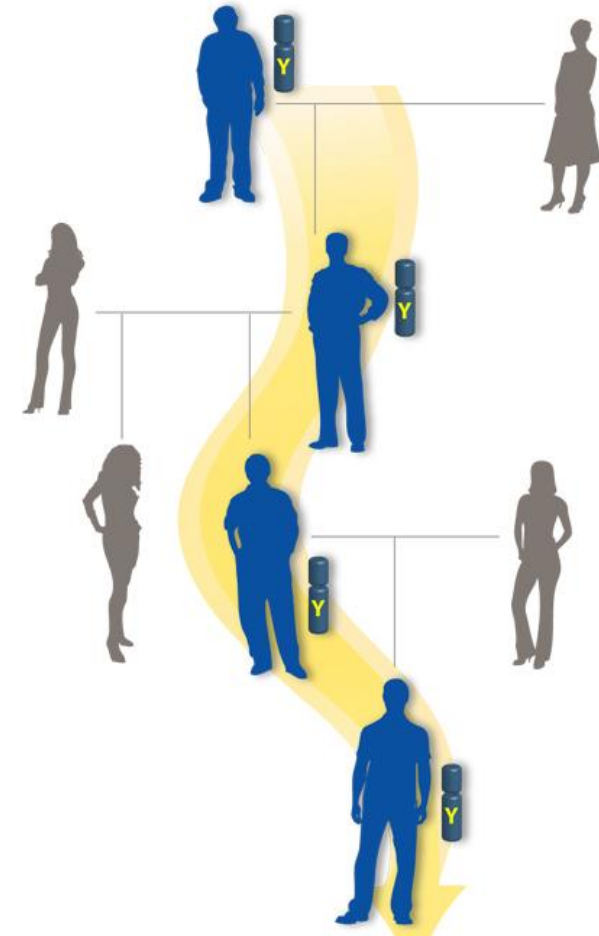


Factors:

1. Quantity
2. Quality
3. Ratio

Y-CHROMOSOME

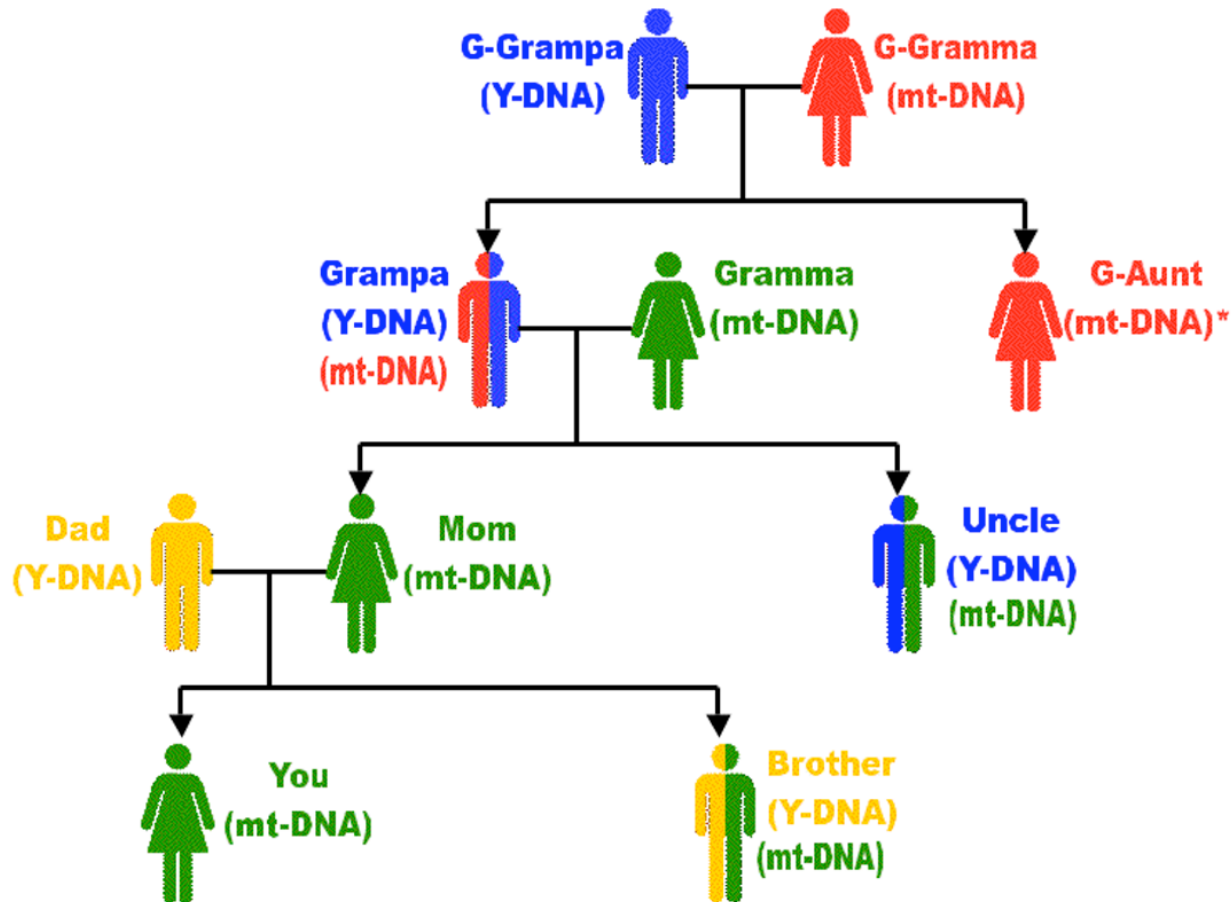
- Y chromosome analysis is a useful technique for analysing DNA of males.
- A son inherits a Y chromosome from his biological father and X chromosome from his biological mother.
- A female would inherit an X chromosome from her biological mother and an X chromosome from her biological father.
- Analysis of Y chromosomes- which is inherited over time through males in a familial line.



Y-STR ANALYSIS

- Analysis of designated areas of Y-Chromosomes
- Y-STR analysis is widely used in cases to segregate male samples
- Y-STR can
 - a. Separate male suspects from involvement in crime
 - b. Identify the paternal lineage of male perpetrators
 - c. Highlight multiple male contributors to a trace
 - d. Provide investigative leads for finding unknown male perpetrators.
- Two or more brothers - same combination of Y-STR types - same male lineage
- If their Y-STR is different – Father cannot be the same.
- All individuals same fraternal lineage will be **indistinguishable** by Y-STR analysis.

Inheritance of Y-DNA & mtDNA





NEW EMERGING TECHNOLOGIES IN DNA PROFILING

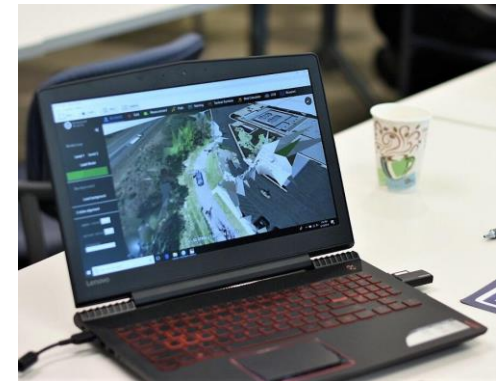
LCN DNA / TOUCH DNA

- Low Copy Number (LCN) DNA / Touch DNA is a profiling technique used by few countries, especially in cold cases.
- Touch DNA **is the next wave** of DNA testing that doesn't require blood or semen samples.
- It analyses skin cells or sweat from fingerprints left behind when assailants touch victims, weapons or anything else at a crime scene.
- This technique has dramatically increased the number of items of evidence that can be used for DNA detection.
- Usually very small amounts of DNA are deposited.
- LCN has been able to show results even 25 years after the crime

Common Sources of Touch DNA

From Hands:

- Gloves
- Knife handles
- Weapon handles
- Firearm grips
- Plastic bag handles
- Steering Wheels
- Rope
- Shoe laces
- Electrical cords
- Mobile
- Laptop
- Door Knob



TOUCH DNA EVIDENCE...


What does it mean

Shows linkage or association but....

- DNA recovered from an object may not be from the last person to touch it. Factors include:
 - Length of contact
 - Good cell shredded or not
 - Vigorous contact vs. Incidental
- DNA profiles recovered from touch evidence are often mixtures – multiple individuals
 - Elimination known(s)
 - Lawful owner
 - Crime scene personnel, officers

RAPID DNA

- New rapid DNA profiling technologies are emerging to help address the challenges like time and expertise.
- This is a system which automates DNA profiling from a simple cheek swab, generating results in about 90 minutes.
- The "swab in, profile out process" takes less than five minutes of hands-on time and performs all necessary steps of DNA analysis without human intervention.
- Reagents in disposable cartridges are loaded onto the system with up to seven buccal (cheek) swab samples.
- After a sample run is started, samples are processed with no further user interaction.
- The system extracts DNA and software analysis to generate full human identification profiles.

- 
- The findings are then used to search the linked DNA database or compared to swabs taken from suspects.
 - This integration enables law enforcement agencies to reduce the time it takes to generate a DNA profile and make decisions while arrestees are in custody.

CASE STUDY 1

Tandoor Murder Case

- This is the first case in India where DNA fingerprinting was used for investigation.
- Former Congress worker Mrs. Naina Sahni was shot dead by her husband Sushil Sharma.
- The body was tried to burn in the Tandoor at Bagiya Restaurant New Delhi on 2nd July 1995, with the help of restaurant manager Keshar Kumar
- Charred remains of a body in the tandoor kitchen were seized
- DNA from muscle pieces attached to her charred bone were compared with that of her parents and sister.



CASE STUDY 2

Rajiv Gandhi Assassination

- Establishing the identity of Dhanu, the suicide bomber who killed former prime minister Rajiv Gandhi
- The DNA found in the skull, charred muscle pieces on the suicide bomber's belt showed identical patterns, which proved that Dhanu was the bomber.



CASE STUDY 3 – Sheena Bora

4 Steps for DNA testing -

1st DAY: Part of Femur (thigh bone) of the skeletal remains was crushed. Bone cells were treated to remove calcium as it interferes with DNA testing (takes 24 hours)

2nd DAY: Nuclear DNA was extracted from bone and blood cells of Indrani Mukerjea (takes 24 hours)

4th DAY: 15 DNA markers of bone and blood samples were compared.

15 universally specified DNA markers on the bone of the unknown sample and the blood sample of Indrani matched.

The 16th marker is Amelogenin, determined the sex of the sample

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CASE STUDY 4

Nirbhaya Rape

DNA, fingerprints, analysis of bite marks sealed Nirbhaya rapists' fate: SC

- DNA investigation of blood stained clothes and body swabs linked all 5 men and a juvenile accused of the gang rape and murder of Nirbhaya
- DNA tests on bloodstains from undergarments worn by the main accused, Ram Singh, matched Nirbhaya's DNA
- A swab taken from Nirbhaya's body showed Ram Singh's DNA
- Bloodstains on clothes of all five accused, curtains and bus seats.
- Bloodstained dried leaves by the side of the highway where the pair said they were dumped.
- Bloodstains on the undergarments and flip-flops of Vinay Sharma
- Blood found on Vinay Sharma jacket matched with the woman's friend, who fought with the men before he was hit with iron rod.



DNA EVIDENCE

Abduction of journalist

Aug. 2014 - **Ahmed Rilwan Abdulla** who wrote pointed critiques of the government **was abducted.**

Alif Rauf and Mohamed Nooradeen, are accused of forcing Rilwan into a car at knifepoint outside his apartment building in Hulhumalé.



Apr. 2016 - Simultaneously around the same time an abduction was reported outside the same building which was linked with Rilwan's disappearance who was forced into a car at knife-point i.e after 2 years of denial

Eye-witnesses – The neighbours who saw a man being forced into a red car that sped off with its back door open.

Digital Forensic - CCTV Footage of Suaid tailing Rilwan before he was last seen entering the Hulhumalé ferry terminal in the capital.

DNA EVIDENCE

Abduction of journalist

- Mitochondrial DNA from hairs found inside a car owned by one of the accused matched Rilwan's mother,
- DNA Expert explained that mDNA is inherited solely from the mother.
- Defence questioned that mDNA could have come from someone other than Rilwan.
- The expert said it could match daughters of Rilwan's sisters.
- The DNA testing was conducted, noting that DNA found in Rilwan's apartment also matched his mothers.
- **The defence lawyer meanwhile objected to the prosecution's failure to submit a chain of custody report, which shows the transfer of evidence by the police through various investigative stages.**
- In response, the state prosecutor said the report is submitted only if the authenticity of the evidence is questioned
- Alif and Nooradeen were charged under the 1990 anti-terrorism law but were cleared of charges of abduction



EVIDENTIARY VALUE OF DNA PROFILING



**Pantangi Balarama Venkata Ganesh vs. State of A.P.
(Cr LJ, 2003, 4508):**

Court relied on an article by Dr. Lalji Singh & accepted DNA profile as conclusive evidence & observed “.....**the DNA test gives the perfect identity. It is a very advance science**”

NIRBHAYA CASE

“The DNA profiling, which has been done after taking due care for quality, proves to the hilt the presence of the accused persons in the bus and their involvement in the crime”

The bench referred to the statement of Dr. B.K Mohapatra, one of the prosecution witnesses in the case, and said he has testified that once a **DNA profile was generated, its accuracy is 100 per cent.**

DNA Technology potential “*genetic eyewitness*”

DNA Profiling is a complex scientific procedure, and its success lies in the skill and expertise of I.O., who is the first player to handle the “sample” and if he fails to do so the whole exercise of analysis goes waste.

The strange case of the 'time travel' murder

To avoid contamination in DNA samples the I.O. must use:

- Use clean hand with gloves
- Clean instruments to lift the sample
- Avoid sneezing or coughing over evidence
- Scene personnel can deposit their own tissues, hairs, fibers, or trace material from their clothing
- Wind can carry in contaminants
- Person touches their mouth, nose or other part of the face and then touches the area that may contain the DNA to be tested.

ISSUES BEFORE THE COURT



Defence challenges the “**scientific procedure**” adopted in DNA probe.

- Whether the testing procedure is reliable?
- Whether tests were performed properly?
- Whether the conclusion is acceptable?

&

CHAIN OF CUSTODY

Santosh K. Singh vs. CBI

- Priyadarshini Matoo, 23, was allegedly raped and strangulated to death in her house in N. Delhi in Jan 1996, by her fellow student S. K. Singh
- DNA test was conducted and test confirmed and connect the crime with criminal.
- But the Defence argued and challenged the “**scientific procedure**” adopted in DNA probe.



The Session Judge pronounced: **“Though I knew, he is the man (Santosh Singh), who committed the crime, I acquit him, giving him the benefit of doubt.”**

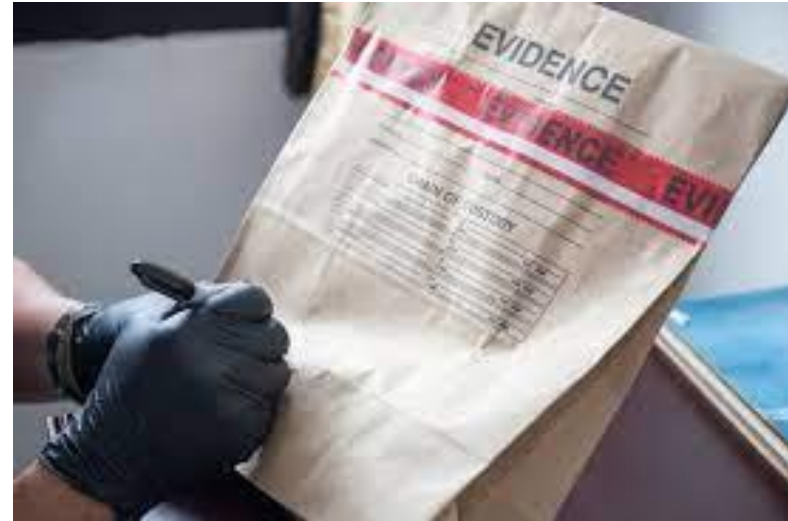
SUGGESTION - The Procedure adopted should be such that NO benefit of doubt is given to the accused.

- In Oct’2010 SC has sentenced him for life imprisonment.

CHAIN OF CUSTODY

This concept itself is of utmost importance.

- Forensic evidence to be admissible in the court of law must be beyond any doubt.



- It also refers to the **security** and **reliability** of the police and forensic/diagnostic labs handling DNA samples.

SUGGESTION - Ensuring that there should not be any break in the “**chain of custody**” (Proper docketing, documentation etc.) to have DNA as admissible evidence.

ISSUES BEFORE THE COURT IN CIVIL MATTERS

1. Privacy and Ethical Issues

S.C. observation in Gautam Kundu vs State of West Bengal regarding legitimacy: *“The court must examine carefully the consequences of ordering the blood test; whether it will have **the effect of branding a child as bastard and the mother as an unchaste woman**”*


2. Chances of misuse of DNA profile

3. Chances of genetic discrimination in marriage, education, social relations etc.

High Court verdict dismisses DNA evidence on paternity

- The High Court, in Dec. 2020, issued a verdict asserting that DNA evidence on paternity was inadmissible, despite section 411(c) of the Maldives Penal Code listing it as legitimate evidence.
- DNA analysis results are also accepted in other courts of law in Maldives, including during murder trial proceedings.
- The court also attributed the decision to dismiss the DNA evidence to the Maldivian Fatwa Committee's view that it was prohibited to conduct DNA tests to ascertain the paternity of children born out of wedlock.



- 
- As per the High Court, the charge of unlawful sexual intercourse could not be proven against the defendant, Mohamed Thaufeeq, on the basis of a woman's testimony and DNA evidence.
 - Thaufeeq denied committing adultery, Fathmath Shameema asserts that he is the father of the child she gave birth to on April 13, 2016.
 - Her claim was subsequently corroborated through a DNA analysis which found that the child's DNA is a match for Thaufeeq.
 - Highlighting that the child was born within a year of Shameema's divorce on December 21, 2015, the verdict noted that one year within divorce or the death of the husband was the maximum period within which a child's paternity can be confirmed.
 - Therefore, the High Court asserted that the child, confirmed via DNA analysis to be Thaufeeq's offspring, must instead be legally considered the child of Shameema's former husband.
 - The High Court's verdict prompted widespread public criticism and discourse.

CONCLUSION

The Hon'ble Supreme Court of India in the case of **Dharam Deo Yadav v. State of U.P.33**

“Criminal Judicial System in this country is at cross-roads, many a times, reliable, trustworthy, credible witnesses to the crime seldom come forward to depose before the court

Investigating agency has, therefore, to look for other ways and means to improve the quality of investigation, which can only be through the collection of scientific evidence.

In this age of science, we have to build legal foundations that are sound in science as well as in law.

.....Emerging new types of crimes and their level of sophistication, the traditional methods and tools have become outdated, hence the necessity to strengthen the forensic science for crime detection.



Judiciary should also be equipped to understand and deal with such scientific materials.

Constant interaction of Judges with scientists, engineers would promote and widen their knowledge to deal with such scientific evidence and to effectively deal with criminal cases based on scientific evidence.

We are not advocating that, in all cases, the scientific evidence is the sure test, but only emphasizing the **necessity of promoting scientific evidence also to detect and prove crimes over and above the other evidence.**



THANK YOU

FOR ANY QUERIES

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