DNA PROFILING IN JUSTICE DELIVERY SYSTEM

सत्यमेव जयते

DFS

"न्यायार्थे विज्ञानम्"

Central Forensic Science Laboratory

Directorate of Forensic Science

Ministry of Home Affairs, Govt. of India, Kolkata

DNA PROFILING IN JUSTICE DELIVERY SYSTEM

Central Forensic Science Laboratory
Directorate of Forensic Science
Ministry of Home Affairs, Govt. of India
30 Gorachand Road, Park Circus, Kolkata- 700014

2007

Central Forensic Science Laboratory, Kolkata

The first Central Forensic Science Laboratory (CFSL) in the country was established at Calcutta in 1957 under the aegis of Intelligence Bureau (IB). The laboratory was established under the able Directorship of Dr. N. K. Iyenger. It was shifted to newly formed Bureau of Police Research & Development (BPR&D) in 1973 and is being administered by the Directorate of Forensic Science (DFS), New Delhi since April 1st, 2002. Being the first central and premier forensic laboratory in the country, CFSL, Kolkata played a key role as in the development of forensic science and different forensic institutions in the country.

CFSL established "Neutron Activation Analysis" unit at Bhabha Atomic Research Centre (BARC), Trombay in 1974. The first DNA Profiling unit in the forensic set up was also established in this laboratory in 1997, which is credited with analysis of several important national crime cases along with few from neighbouring countries like Bhutan & Nepal. In 1998, Ministry of Home Affairs (MHA), Govt. of India reorganised CFSLs on the basis of scientific disciplines and CFSL, Kolkata was declared as Centre of Excellence in Biological Sciences. CFSL, Kolkata provides specialized forensic examination facilities as well as crime scene management to crime investigation agencies of Eastern, North Eastern states & UTs, NCT Delhi, CBI etc. Under special arrangement, CFSL, Kolkata is also accepting cases from Nepal & Bhutan for forensic examination. The laboratory presently provides state of the art facilities to different crime investigation agencies in i) Biology ii) DNA iii) Chemistry iv) Toxicology v) Explosives vi) Physics vii) Ballistics and ix) Computer Forensics. The laboratory is equipped with instrumentations iike Automated DNA Sequencers, Real-Time PCR, Scanning Electron Microscope- EDXA, Comparison Microscope, LC-MS-MS, GC-MS, GC-FTIR-IR Microscope, HPLC, HPTLC, GC-Head Space-Pyrolyzer, AAS, Ion Chromatogrph etc.

The laboratory provides consultancy to the State Govts., neighbouring and third world countries about the functioning and establishment of modern forensic facilities. CFSL, Kolkata also organizes specialized training programmes for the scientists, police officers, medico- legal experts, lawyers and judiciary. The laboratory is established as a seat of higher learning and DFS Research Fellows are working in the thrust areas of forensic molecular biology. Few hundered publications from the scientists of this laboratory have been published in the national as well as international journals. The laboratory is having active collaboration with academic institutions like Jadavpur University and WB National University of Juridical Sciences. The laboratory plans to have new facilities like Brain Fingerprinting, Narco- Analysis, and Shooter Identification etc in the proposed new campus in Rajarhat to serve the needs of Nation.

CONTENTS

DNA Profiling in Justice Delivery System

DNA Profiling or DNA Typing has proven to be the most powerful tool for identification of the source of biological specimen. It has tremendously helped in solving murders, sexual assaults and many other heinous crimes, which was not possible before the advent of this technology. All over world, DNA evidence has withstood legal scrutiny and revolutionized crime investigation. The term "DNA Fingerprinting" is often used to emphasize uniqueness of the technology to differentiate among individuals, even related ones, alike dermal fingerprints.

Advantages of DNA Profiling

Due to reliability of evidence, rapid and absolute elimination of innocents and identification of offenders, DNA Profiling has enormous advantages over the conventional means of personal identification.

1. Discrimination potential is very high. Individuals as close as siblings (except monozygotic twins) can be identified.
2. DNA Profiling can be done from any biological material and is not restricted to any specific organ/area of body, unlike dermal fingerprints.
3. DNA molecule being more stable than the blood groups and protein markers, typing is often possible where serological markers fail.
4. DNA Profiling is often feasible from degraded or very minute amount of biological material (at times invisible to the naked eye) because of high sensitivity.
5. Species of origin and gender can be determined.
6. Wild life and endangered species, biological warfare agents can also be identified.
7. DNA Profiling leads to better administration of justice, cost-effective in terms of investigation time & resources saved and enhance public confidence in the justice system.

Types of Cases Analysed

DNA Profiling can be employed in cases where the identity of an individual, suspect (s) or victims (s) needs to be established from biological clue materials present on the body of suspect(s)/victim(s), scene of crime, weapon etc. This technology is extremely useful in excluding innocents from the list of suspects. Some of the common scenarios in which it is being applied are:

Murder or Physical Assault: Assailant can be positively identified from his blood, or small piece of tissue present on clothing or body of victim and/or scene of crime. Similarly presence of blood or tissue of victim on the body of assailant, weapon or scene of crime provides a crucial link.

Rape or Sexual Offences: Offender can be positively identified from his semen, saliva, and tissue etc. left on the clothing or body of victim and/or scene during the commission of crime. Similarly presence of blood, vaginal smear or tissue of victim on the body of suspect provides a crucial link. Vasectomized males can also be identified by the presence of male epithelial cells in the semen.

Unidentified Bodies/Accidents/Mass Disasters: Identification of mutilated, exhumed, disfigured or burnt bodies, skeletal remnants can be accomplished by comparing the DNA profile with close blood relatives.

Parentage Disputes: Paternity or maternity of a child can be unequivocally established by DNA typing. Similarly, child swapping can be established by comparing DNA of the child with putative mother and father.

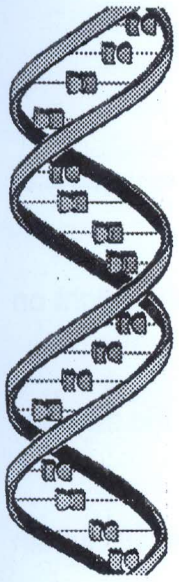
Organ Transplantation: Match organ donors with recipients in transplantation programmes.

Non- Human DNA Cases: Wildlife specimen used in trafficking like tiger skin & bones, rhino horn, bear bile, tortoise skin & shells, biological warfare agents etc can be identified.

Miscellaneous Cases: Cases for establishing identity of the fake blood donors, source of threatening letter from licked stamps, source of biopsy specimen etc have also been successfully analysed at CFSL, Kolkata.

DNA

Deoxyribonucleic acid (DNA) is genetic material present in the nuclei of cells of living organisms. An average human body is composed of about 100 trillion of cells. DNA is present in the nucleus of cell as double helix, supercoiled to form chromosomes along with intercalated proteins. Twenty- three pairs of chromosomes present in each nucleated cells and an individual inherits 23 chromosomes from mother and 23 from father transmitted through the ova and sperm respectively. At the time of each cell division, chromosomes replicate and one set goes to each daughter cell. All information about internal organisation, physical characteristics, and physiological functions of the body is encoded in DNA molecules in a language (sequence) of alphabets of four nucleotides or bases: Adenine (A), Guanine (G), Thymine (T) and Cytosine (C) along with sugar- phosphate backbone. A human haploid cell contains 3 billion bases approx. All cells of the body have exactly same DNA but it varies from individual to individual in the sequence of nucleotides.



Mitochondrial DNA (mtDNA) found in large number of copies in the mitochondria is circular, double stranded, 16,569 base pair in length and shows maternal inheritance. It is particularly useful in the study of people related through the maternal line. Also being in large number of copies than nuclear DNA, it can be used in the analysis of degraded samples. Similarly, the Y chromosome shows paternal inheritance and is employed to trace the male lineage and resolve DNA from males in sexual assault mixtures.

Only 0.1% of DNA (about 3 million bases) differs from one person to another. Forensic DNA Scientists analyse only few variable regions to generate a DNA profile of an individual to compare with biological clue materials or control samples.

Interesting Facts About DNA

1. The human genome has about 3 billion nucleotide bases (A, C, T, and G).
2. About 99.9% nucleotide bases are exactly same in all human beings.
3. Less than 2% of the genome codes for proteins.
4. The total number of genes in human genome is estimated at 30,000.
5. Chromosome 1 has the most genes while Y chromosome has the least.
6. Repeated sequences that do not code for proteins ("junk DNA") make at least 50% of the human genome.
7. Repetitive sequences are thought to have no direct functions, but they shed light on chromosome structure and dynamics.
8. The human genome has greater portion (50%) of repeat sequences than the mustard weed (11%), the worm (7%), and the fly (3%).
9. Short Tandem Repeats (STRs) occur average every 10,000 nucleotides of human genome.
10. mtDNA uses a different genetic code than the nuclear DNA.

Landmarks

- 1865- Gregor John Mendel, Father of Genetics, gave basic principles of heredity.
- 1869- Friedrich Miescher isolated nuclein from the nuclei of the white blood cell, presently known as nucleic acid.
- 1944- Oswald Avery and his colleagues' demonstrated DNA is the chemical element of heredity.
- 1953- James Watson, Maurice Wilkins and Francis Crick gave double helical structure of DNA molecule.
- 1956- Joe-Hin Tijo and Albert Levan showed that human DNA is densely packed in 46 chromosomes in the nucleus of the cell.
- 1968- Marshall Nirenberg, Har Gobind Khorana & Robert Holley won noble prize for cracking Genetic Code.
- 1983- Kary Mullis conceptualised Polymerase Chain Reaction (published in 1985).
- 1984- Alec J. Jeffreys developed probes for Human Identification (published in 1985).
- 1986 - Automated DNA sequencing with 4 dye colors was described.
- 1988- FBI begins DNA casework with single locus RFLP probes.
- 1990- Human Genome Project launched with goal to map all human genes.
  DNA evidence in a paternity case was accepted in India.
- 1991- FBI started casework with PCR based method using HLADQA1.
- 1993- Kary Mullis awarded Nobel Prize in Chemistry for invention of PCR method.
- 1995- Forensic Science Service starts UK DNA database.
- 1997- 13 CODIS STR loci defined.
  Y- chromosome STRs described.
- 1998- FBI launched Combined DNA Index System (CODIS) database.
- 2000- First copy of human genome submitted.
  PowerPlex 16 STR kit launched.
- 2001- Identifiler STR Kit launched.
- 2002- FBI released first mitochondrial database.
- 2003- Human Genome Project completed.
- 2007- Minifiler miniSTR kit introduced.

Important DNA Cases

S. No	International	National
1	Ghanian Boy Immigration Case	Rajiv Gandhi Assassination Case
2	Colin Pitchfork Case	Beant Singh Assassination Case
3	Romanov (Russian Czar family) Identification	Premananda Case
4	Identification of 9/11 Victims	Tandoor Murder Case
5	Identification of Tsunami Victims	Priyadarshini Mattooo Case
6	Bill Clinton - Monica Lewinsky Case	Pathribal, Anantnag Case
7	Dr. Sam Sheppard Case	Madhumati Shukla Murder Case
8	Titanic Baby Case	Pig Organ Transplantation Case
9	Mike Tyson Rape Case	Gumnami Baba Case
10	Thomas Jefferson Descendents Case	Salman Khan "Black Buck" Case
11	OJ Simpson Case	Nitish Katara Case
12	Identification of Saddam Hussein & sons	Shakira Khallili Case
13	Identity of Anastasia Romanov	Mumbai Corporator Identity Case
14	Mick Jagger Paternity Case	ISKCON Swami Case
15	Boris Becker Paternity Case	J&K Padder Identity Case
16	Anna Nicole Smith Case	Garbeta Case
17	Identity of Son of Louis XVI and Marie Antionette	Basmati- Texmati Patent Case

DNA Profiling Methodology

DNA profile is generated from the body fluids, stains, and other biological specimen recovered from evidence and the results are compared with the results obtained from reference samples. Thus, a link among victim(s) and/or suspect(s) with one another or with crime scene can be established.

DNA Profiling is a complex process of analyses of some highly variable regions of DNA. The variable areas of DNA are termed Genetic Markers. The current genetic markers of choice for forensic purposes are Short Tandem Repeats (STRs). Analysis of a set of 15 STRs employing Automated DNA Sequencer gives a DNA Profile unique to an individual (except monozygotic twin). Similarly, STRs present on Y chromosome (Y- STR) can also be used in sexual assault cases or determining paternal lineage. In cases of sexual assaults, Y-STRs are helpful in detection of male profile even in the presence of high level of female portion or in case of azoospermic or vasectomized male. Cases in which DNA had undergone environmental stress and biochemical degradation, miniSTRs can be used for over routine STR because of shorter amplicon size.

DNA Profiling is a complicated process and each sequential step involved in generating a profile can vary depending on the facilities available in the laboratory. The analysis principles, however, remain similar, which include:

1. isolation, purification & quantitation of DNA
2. amplification of selected genetic markers
3. visualising the fragments and genotyping
4. statistical analysis & interpretation.

In mtDNA analysis, variations in Hypervariable Region I & II (HVR I & II) are detected by sequencing and comparing results with control samples.

Forensic DNA Markers

Autosomal Short Tandem Repeats (STRs) :

D2S1338	D3S1358	D5S818	D7S820	D8S1179	D13S317	D16S539
D18S51	D19S433	D21S11	CSF1PO	THO1	TPOX	vWA
FGA	Penta D	Penta E	D2S441	D10S1248	D22S1045	

Sex Determining Marker : Amelogenin

Y- Chromosomal STRs :

DYS19	DYS385	DYS389I	DYS389II	DYS390	DYS391	DYS392
DYS393	DYS437	DYS438	DYS439	DYS448	DYS456	DYS458
DYS635	Y(GATA)H4					

Mitochondrial DNA (mtDNA)

Hypervariable Sequence I (16,024- 16,365bp)

Hypervariable Sequence II (73- 340bp)

DNA Markers for Species Identification :

Cytochrome b 12sRNA 16sRNA

Statistical Analysis

A typical DNA case involves comparison of evidence samples, such as semen from a rape, and known or reference samples, such as a blood sample from a suspect. Generally, there are three possible outcomes of profile comparison:

1) Match: If the DNA profiles obtained from the two samples are indistinguishable, they are said to have matched.

2) Exclusion: If the comparison of profiles shows differences, it can only be explained by the two samples originating from different sources.

3) Inconclusive: The data does not support a conclusion

Of the three possible outcomes, only the "match" between samples needs to be supported by statistical calculation. Statistics attempt to provide meaning to the match. The match statistics are usually provided as an estimate of the Random Match Probability (RMP) or in other words, the frequency of the particular DNA profile in a population.

In case of paternity/maternity testing, exclusion at more than two loci is considered exclusion. An allowance of 1 or 2 loci possible mutations should be taken into consideration while reporting a match. Paternity of Maternity Indices and Likelihood Ratios are calculated further to support the match.

DNA Databases

DNA Database is the computer repository of the genetic information of individuals for identification, comparison and sharing purposes. The different types of DNA databases are:

- **Convicted Offender's Databases** contain the DNA profiles of the convicted offenders as per prevalent law in the country. A habitual offender may indulge in crime after release from imprisonment and can be identified by comparing DNA profile of his biological specimen found at the scene with his genetic information already available in the database.
- **Suspect's Databases** are the recent trends in the crime investigation to further enlarge the scope of offender's databases.
- **Databases for Missing persons/Unidentified Bodies** contain the DNA profiles of the unidentified bodies, biological relatives of the missing or suspected deceased individuals for identification.
- **Population Databases** contain the allele frequencies and haplotypes of different genetic markers from unrelated individuals representing major population groups for calculating Random Match Probability (RMP) or Paternity/Maternity Index.
- **Elimination Databases** contain the DNA profiles of laboratory personnel for identification of contamination. Similarly, Police Elimination Databases contain profiles of police/scene of crime officers to detect the source of contamination if, any.

The National DNA Database (NDNAD) of UK is the most effective DNA database and contains DNA profiles of about 6% of population. The CODIS Database maintained by FBI contains DNA profiles information in three levels, the local level (Local DNA Index System), the state level (State DNA Index System) and the National level (National DNA Index System). Each local and state laboratory maintains its portion of CODIS while the FBI laboratory maintains the National database (NDIS). A number of European countries, Canada, Australia, South Africa have also developed successful DNA databases. Interpol has established International database of DNA profiles (both crime scene samples and reference samples) for use by its member states for comparing and tracking the international criminals effectively.

Excerpts from Acts Relating to DNA

The Transplantation of Human Organs Act, 1994
(Central Act 42 of 1994)

4. Duties of the Medical Practitioner

(1) A registered medical practitioner shall, before removing a human organ, from the body of a donor before his death satisfy himself

(a) that the donor has given his authorization in the Form 1

(b) that the donor is in proper state of health and is fit to donate the organ, and shall sign a certificate a specified in Form 2.

(c) that the donor is a near relative of the recipient and shall sign a certificate as specified in Form 3 after carrying out the following tests on the donor and the recipient, namely:-

(i) tests for the antigenic products of the Human Major Histo-compatibility system HLA-A, HLA-B and HLA-DR using conventional serological techniques;

(ii) tests to establish HLA-DR beta and HLA-DQ beta gene restriction fragment length polymorphism;

(iii) Where the tests referred to in sub-clause(i) and sub-clause(ii) do not establish a genetic relationship between the donor and the recipient further tests to establish DNA polymorphism using at least two multi locus gene probe;

(iv) Where the tests referred to in sub-clause (iii) do not establish a genetic relationship between the donor and the recepient further tests do establish DNA polymorphisms using atleast 5 single locus polymorphic probes.

(d) in case recipient is a spouse of the donor, record the statements of the recipient and the donor to the effect that they are so related and shall sign a certificate in Form 4

Excerpts from Acts Relating to DNA

The Code of Criminal Procedure (Amendment) Act, 2005

Amendment of Section 53.

(a) "examination" shall include the examination of blood, blood stains, semen, swabs in case of sexual offences, sputum and sweat, hair samples and finger nail clippings by the use of modern and scientific techniques including DNA profiling and such other tests which the registered medical practioner thinks necessary in a particular case;

Insertion of new Section 53A.

Examination of person accused of rape by medical practitioner.

(2) The registered medical practitioner conducting such examination shall, without delay, examine such person and prepare a report of his examination giving the following particulars, namely :-

- **(i)** the name and address of the accused and of the person by whom he was brought,
- **(ii)** the age of the accused,
- **(iii)** marks of injury, if any, on the person of the accused,
- **(iv)** the description of material taken from the person of the accused for DNA profiling, and
- **(v)** other material particulars in reasonable detail.

Excerpts from Judgements

First DNA Case Verdict in India

The first case of DNA profiling in India involved determination of paternity of son of Ms. E. Viasini in Thalassery (Telicherry), Kerala. The DNA analysis by Centre for Cellular & Molecular Biology, Hyderabad proved that suspect Mr. Kunhiraman was the biological father of the child. The chief Judicial Magistrate, Thalassery announced following verdict on April 24th, 1990:

"The Evidence of expert is admissible under Section 45 of the Indian Evidence Act. So also, the grounds on which the opinion is arrived at are also relevant U/S 51 of the Indian Evidence Act. PW4 is an expert in the matter of molecular biology and the evidence tendered by him is quite convincing and I have no reason why it should not be accepted. Just like the opinion of a chemical analyst or like the opinion of a fingerprint expert, opinion of PW4, who is also an expert in the matter of cellular and molecular biology, is also acceptable."

The verdict was challenged in the Kerala High Court, which upheld the verdict.

Excerpts from Supreme Court Judgements

Goutam Kundu vs. State of West Bengal and Another (1993)

1. "That courts in India cannot order blood test as a matter of course;
2. Wherever applications are made for such prayers in order to have roving inquiry, the prayer for blood test cannot be entertained.
3. There must be a strong prima facie case in that the husband must establish non-access in order to dispel the presumption arising under Section 112 of the Evidence Act.
4. The court must carefully examine as to what would be the consequence of ordering the blood test; whether it will have the effect of branding a child as a bastard and the mother as an unchaste woman.
5. No one can be compelled to give sample of blood for analysis. "

Sharda vs. Dharmpal (2003)

1. "A matrimonial court has the power to order a person to undergo medical test.
2. Passing of such an order by the court would not be in violation of the right to personal liberty under Article 21 of the Indian Constitution.
3. However, the court should exercise such a power if the applicant has a strong prima facie case and there is sufficient material before the court. If despite the order of the court, the respondent refuses to submit himself to medical examination, the court will be entitled to draw an adverse inference against him."

Excerpts from Supreme Court Judgements

Kamti Devi & Another vs. Poshi Ram (2001)
Amarjit Kaur vs. Harbhajan Singh & Another (2003)
Banarsi Dass vs. Teeku Dutta & Another (2005)

"We may remember that Section 112 of the Evidence Act was enacted at a time when the modern scientific advancements with Deoxyribonucleic Acid (DNA) as well as Ribonucleic Acid (RNA) tests were not even in contemplation of the legislature. The result of a genuine DNA test is said to be scientifically accurate. But even that is not enough to escape from the conclusiveness of Section 112 of the Act, e.g. if a husband and wife were living together during the time of conception but the DNA test revealed that the child was not born to the husband, the conclusiveness in law would remain unrebuttable. This may look hard from the point of view of the husband who would be compelled to bear the fatherhood of a child of which he may be innocent. But even in such a case the law leans in favour of the innocent child from being bastardized if his mother and her spouse were living together during the time of conception. Hence the question regarding the degree of proof of non-access for rebutting the conclusiveness must be answered in the light of what is meant by access or non-access as delineated above. "

Collection and Preservation of Evidence

If DNA evidence is not properly documented, collected, packaged, and preserved, it will not meet the legal and scientific requirements for admissibility in a court of law.

Because extremely small samples of DNA can be used as evidence, greater attention to contamination issues is necessary while locating, collecting, and preserving. DNA evidence can be contaminated when DNA from another source gets mixed with DNA relevant to the case. This can happen when someone sneezes or coughs over the evidence or touches his/her mouth, nose, or other part of the face and then touches the area that may contain the DNA to be tested.

The exhibits having biological specimen, which can establish link among victim(s), suspect(s), scene of crime for solving the case should be identified, preserved, packed and sent for DNA Profiling. Some of the possible locations of biological clue materials in cases of murders & sexual offences are as follow:

Possible Location of Evidence	Source of DNA
Pubic region	Semen, Hair
Bite mark or licked area	Saliva
Fingernail scrapings	Blood or Skin Cells
Condom	Semen (inside), Vaginal secretions (outside)
Clothings, blankets, sheets, pillows	Blood, Semen, Saliva, Hair
Hat, mask, gag	Sweat, Saliva, Hair
Cigarette butt	Saliva
Drinking vessels	Saliva
Weapon, bullet	Blood
Postage stamps/Envelope flaps	Saliva

Guidelines for Medico- Legal Experts

1. Soft tissue should be collected in suitable clean plastic container having saturated slat solution and frozen. Avoid using glass container as they may break. **Tissues should never be preserved in Formalin.**
2. In case of mass disasters, accidents, burnt or mutilated bodies, 2-3 tissues like deep muscle tissue, skin or other least affected tissue (about 5g) should be collected during autopsy in clean & sterilized containers and be transported in refrigerated condition.
3. When only skeletal remnants are available, teeth and long bones (femur or humerus) are good source of DNA.
4. Foetal tissues and maternal tissues must be separated at the time of collection.
5. The vaginal swabs or smear on slides in sexual assault cases should be properly dried & packed separately.
6. If hair is located, collect it with the forceps, avoid touching the hair root region and mount it on glass slide for preserving hair root.
7. If blood, semen or saliva stains are found on a body, moisten a cotton swab and swab the area thoroughly applying light pressure. Dry the swab properly and pack.

Guidelines for Investigating Officers

Important "Do's & Don'ts" to be kept in mind while collection, preservation or packaging of biological clue materials for DNA examination are as follow:

Do's

1. The exhibits should be collected, handled and stored to preserve their identity, integrity, condition and security.
2. A well-documented chain of custody should be maintained from the time the exhibit is first collected.
3. The Biological materials contain infectious agents. Direct contact with them should be avoided by wearing gloves, masks or other appropriate protective devices.
4. Wear gloves while collection of specimen and avoid contamination of the different specimen with one another. Change gloves after collection of every evidence to avoid cross contamination.
5. Each exhibit should be packed separately in paper envelopes and sealed properly.
6. Details regarding case no., date, P.S., name and signature of exhibit collector should be written over all packets.
7. Liquid blood, if found at the scene, should be collected on a piece of sterile filter paper, cotton or gauge, dried in sunshade, and then packed. Similarly wet garments should be properly dried and then packed.
8. Post- mortem blood should be transferred as dried stain on sterile gauge or filter paper.
9. Body fluid stains on objects too large to transport, fixed or non- absorbent surfaces should be either scrapped with a sterilized blade or scalpel. The scrapings should be collected in a clean sheet of paper and placed in an envelope.
10. If evidence is found on an absorbent surface, cut the area and pack.
11. Transfer fresh blood, tissues to laboratory in refrigerated conditions at the earliest to minimize degradation of DNA.
12. Swab the beverage containers with a moisten cotton swab, dry and pack.
13. The inner and outer surfaces of the condom should be swabbed separately, dried and packed.

14. Do inform about the claims made by victim(s) & suspect(s) regarding the source of the biological clue materials.
15. Please inform whether the exhibits bearing biological clue material were laundered or diluted with other body fluids.
16. Information regarding the victim(s)' and suspect(s)' health, such as AIDS, hepatitis etc. should be sent.
17. Details about the donor' blood transfusion or organ transplantation should be mentioned.
18. Always collect the control samples alongwith duly filled "Blood Sample Authentication Form" in duplicate.

Don'ts

1. Do not touch any exhibit with bare hands.
2. Do not collect different exhibits wearing same gloves.
3. Do not cough or sneeze over the area expected to carry biological clue material.
4. Do not pack biological exhibits in polythene envelopes or airtight containers. Use paper envelopes.
5. Do not expose the evidence material to heaters, fans or intense light sources.

How to forward a case for DNA Profiling ?

The request letter for forensic examination should contain and accompany following items:

1. A brief statement of facts relating to the history of case.
2. Duly sealed and marked exhibits and control blood samples.
3. Duly filled "Blood Sample Authentication Form" in duplicate for control samples.
4. Sample seal(s) in sealing wax with which exhibits have been sealed.
5. Attested copy of FIR, Post- mortem or medico- legal report of victim(s) & suspect(s).
6. A letter of authority in favour of The Director, Forensic Science Laboratory to examine the exhibits, and if necessary, to take them to pieces or remove portions for examination.
7. An officer not below the rank of Superintendent of Police or Judicial Magistrate should forward the case.

Control Samples

Since a person's DNA is same in all cells of his body, the DNA in a man's blood is the same as the DNA in his skin cells, semen, and saliva. Source of a biological clue material can be identified only by analysis of the authenticated control sample of that individual. Control biological sample like blood (about 2mL in EDTA tube or dried blood stain on sterile gauge, filter paper or FTA card) should be collected alongwith duly filled "Blood Sample Authentication Form" in duplicate. The case should always be forwarded with the control samples of individual whose biological clue material is suspected to be present on the exhibits.

In case of non- availability of an individual; exclusive items of the individual expected to carry his secretions or body cells like toothbrush or razor etc may be sent for analysis. Otherwise control samples of the close blood relatives are desired. In case of blood transfusion or organ transplantation, oral swab may be collected as control sample. Some of the probable scenarios are as follow:

Murder, physical assault, rape or sexual assault: Control samples of all suspects (s) & victim(s)

Unidentified bodies/accident/mass disaster:

a) Exclusive items of suspected deceased expected to carry his secretions or body cells

b) Control samples of suspected deceased's parents

c) In case, one of the parent is not available for testing, control samples of brothers or sisters of suspected deceased alongwith surviving parent, or

d) Control samples of the spouse of the suspected deceased with children.

Parentage Disputes: Control samples of child, putative mother and father.

Identity of Wildlife Exhibits: Control blood or tissue specimen of the suspected animal.

BLOOD SAMPLE AUTHENTICATION FORM

A. Particulars of donor/source

i) Name (in block letters):
ii) Father/Guardian's Name:
iii) Sex: iv) Date of Birth:
iv) Address:

Affix passport size photograph of the donor attested by Medical Officer.

v) Medical History:
Normal: Chronic Disease:
Genetic Disorder:
vi) Blood Transfusion, if any, in past three months:
vii) Organ Transplantation, if any:

B. Case Details:
Case No: Date: P.S.: U/S:

C. Purpose for conducting test:

D. Declaration by the Blood Donor:
I,..... hereby certify that the blood sample is being collected with my consent and acknowledge the above information to be true.

Left Thumb Impression | Right Thumb impression

Signature of Donor:
Name:
Date:

E. Sample Collection: Preferably 2mL blood should be collected in sterilized tubes using EDTA as anticoagulant. The tubes should be duly preserved in an ice container for transport. Alternatively, blood sample may be dried on clean sterilised gauge/filter paper/FTA card and sealed in paper envelope.
i) Nature of sample: Liquid Blood/Blood Stain ii) Date of collection:
iii) Volume: iv) Seal Impression: v) Collected by:

Signature, Name & Designation of Medical Officer with Stamp

F. Details of Investigating Officer/Solicitor/Witness:
Collection of Blood should be in presence of two witnesses.

Witness:	**Witness:**
Signature:	Signature:
Name:	Name:
Designation:	Address:
Address:	
Date:	Date:

For office use: **DNA Typing Unit, CFSL, Kolkata** **04/07**
Case No: CFSL(K)/EE/ Exhibit No.:

Forensic DNA Laboratories in India

Sl. No.	Name & Address of the Institution	Contact Information
1	Central Forensic Science Laboratory 30 Gorachand Road, Park Circus Kolkata-700014	Phone: (033)-22841638, 22843187 22841768, 22841753 22842240, 22840378 FAX: (033)-2284-9442 E- mail: dircfsl_kol@dfs.gov.in
2	Central Forensic Science Laboratory Plot No. 2, Sector 36A, Dakshin Marg Chandigarh-160036	Phone: (0172)-2615068 FAX: (0172)-2615068 E- mail: dircfsl_chd@dfs.gov.in
3	Central Forensic Science Laboratory Ramanthapur, Amberpet Post Office Hyderabad, Andhra Pradesh-500013	Phone (040)-27038429 FAX: (040)-27039281 E- mail: dircfsl_hyd@dfs.gov.in
4	Center for DNA Fingerprinting & Diagnostics. Gandipet, Hyderabad-500075 Andhra Pradesh	Phone 84132353/235463/235462 FAX: +91 843235462 E- mail: director@cdfd.org.in
5	Central Forensic Science Laboratory Central Bureau of Inve stigation, Block No- 4 CGO complex, Lodhi Road, New Delhi-110003	Phone: (011)-24361396 FAX: (011)- 24360742
6	Forensic Science Laboratory Govt. of NCT of Delhi, Mathura chowk Rohini, New Delhi-110085	Phone: (011) -2755890 FAX: (011) -27555890
7	Directorate of Forensic Science Sec-18A (behind Police Bhawan) Gandhinagar-382007, Gujarat	Phone: (079)- 23256250 FAX: (079) -23256251 (079) -23256393
8	Forensic Science Department 30A, Kamarajar Salai, Mylapore Chennai-600004, Tamilnadu	Phone: (044) -28447767 FAX: (044) -28447767 E- mail: forensic@tn.nic.in
9	Directorate of Forensic Science Laboratories Vidyanagari, Kalina, Santacruz (East) Mumbai-400098, Maharashtra	Phone: (022) -26670760 FAX: (022) -26670844
10	Forensic Science Laboratory Red Hills, Hyderabad-500004, Andhra Pradesh	Phone: (040)- 23390398 FAX: (040)- 23394449
11	Forensic Science Laboratory Kahilipara, Guwahati-781019, Assam	Phone: (0361)-2381305/385/696 FAX: (0361)- 2381305
12	Forensic Science Laboratory Civil Lines, Sagar -470001, Madhya Pradesh	Phone (07582) -267707 (07582) -267791 FAX: (07582) -267707

Glossary

Allele
Alternative form of a genetic locus; a single allele for each locus is inherited from each parent.

Amplification
An increase in the number of copies of a specific DNA fragment.

Autosome
A chromosome not involved in sex determination.

Base
One of the molecules that form DNA and RNA molecules.

Base pair (bp)
Two nitrogenous bases (adenine and thymine or guanine and cytosine) held by weak bonds.

Cell
The basic unit of any living organism that carries on the biochemical processes of life.

Chromosome
The self-replicating genetic structure of cells containing the cellular DNA that bears in its nucleotide sequence the linear array of genes.

Deoxyribose
A type of sugar that is one component of DNA (deoxyribonucleic acid).

Diploid
A full set of genetic material consisting of paired chromosomes, one from each parental set.

DNA (Deoxyribonucleic acid)
The molecule that encodes genetic information.

DNA bank
A service that stores DNA extracted from blood samples or other human tissue.

DNA sequence
The relative order of base pairs, whether in a DNA fragment, gene, chromosome, or an entire genome.

Double helix
The twisted-ladder shape that two linear strands of DNA assume when complementary nucleotides on opposing strands bond together.

Electrophoresis
A method of separating large molecules (such as DNA fragments or proteins) from a mixture of similar molecules with the help of electric current.

Gene
The fundamental physical and functional unit of heredity.

Genetic code
The sequence of nucleotides, coded in triplets (codons) along the mRNA, that determines the sequence of amino acids in protein synthesis.

Genetic marker
A gene or other identifiable portion of DNA whose inheritance can be followed.

Genetic polymorphism

Difference in DNA sequence among individuals, groups, or populations.

Genetics

The study of inheritance patterns of specific traits.

Genome

All the genetic material in the chromosomes of a particular organism.

Genotype

The genetic constitution of an organism, as distinguished from its physical appearance (its phenotype).

Haploid

A single set of chromosomes (half the full set of genetic material) present in the egg and sperm cells of animals and in the egg and pollen cells of plants.

Haplotype

A way of denoting the collective genotype of a number of closely linked loci on a chromosome.

Locus (pl. loci)

The position on a chromosome of a gene or other chromosome marker.

Mitochondrial DNA

The genetic material found in mitochondria, the organelles that generate energy for the cell.

Mutation

Any heritable change in DNA sequence.

Nitrogenous base

A nitrogen-containing molecule having the chemical properties of a base. DNA contains the nitrogenous bases adenine (A), guanine (G), cytosine (C), and thymine (T).

Nucleotide

A subunit of DNA or RNA consisting of a nitrogenous base (adenine, guanine, thymine, or cytosine in DNA; adenine, guanine, uracil, or cytosine in RNA), a phosphate molecule, and a sugar molecule (deoxyribose in DNA and ribose in RNA).

Nucleus

The cellular organelle in eukaryotes that contains most of the genetic material.

Polymerase chain reaction (PCR)

A method for amplifying a DNA base sequence using a heat-stable polymerase and two primers.

Polymorphism

Difference in DNA sequence among individuals that may underlie differences in health.

Sequencing

Determination of the order of nucleotides (base sequences) in a DNA or RNA molecule or the order of amino acids in a protein.

Sex chromosome

The X or Y chromosome in human beings that determines the sex of an individual. Females have two X chromosomes in diploid cells; males have an X and a Y chromosome.

GOLDEN JUBILEE CELEBRATIONS
(1957- 2007)

Central Forensic Science Laboratory
Directorate of Forensic Science
Ministry of Home Affairs, Govt. of India
30 Gorachand Road, Park Circus, Kolkata- 700014
Phone: 033- 22841638/22841768; FAX: 033- 22849442
E- mail: dircfsl_kol@dfs.gov.in