Chapter IV

DNA Profiling and its Efficacy: An Effective Tool of Crime Investigation
DNA PROFILING AND ITS EFFICACY: AN EFFECTIVE TOOL OF CRIME INVESTIGATION

4.1 Introduction

“To assert that the earth revolves around the sun is an erroneous as to claim that Jesus was not born of a virgin”

Cardinal Bellarmino¹

Law and science though joined hands to meet the ends of justice, have also been in uneasy alliances with each other. The fast development in the area of science and technology has resulted not only in solving the metaphysical problems but also many societal problem.² The scientific breakthrough in solving many intricate criminal as well as civil problems has raised the question for their acceptance as a part of our different legal studies on its probative value, as a piece of evidence and thus forcing for necessary amendment in the related law. The major scientific development in the area of DNA technology and its facts revelation has solved many intricating crime related mysteries specially in the area of rape, mass killing either because of natural or human agencies or in solving civil dispute specially related with the paternity of a child and in finding the identity of an individual. It has also been used in solving the cases of exchange of babies in hospital wards and also protection of farmers rights and biodiversity.³ The modern day biology is seeking new and better ways to enhance our quality of life through the application of technology (Biotechnology) and rapid progress in research on human genome. The currently developing technique of DNA promises a degree of accuracy greater even than current method of finger printing suspect. DNA profiling has been used extensively for paternity testing as well as for the criminal investigation. DNA profiling has particular application to the criminal law because of the possibility that it offers of determining whether blood or semen deposits located at the scene of a crime come from a person suspected of having committed the crime.⁴

¹ 17th Century Church Master Collegio Romano, who imprisoned and tortured Galileo for his astronomical work, during the trial of Galileo.
4.2 Meaning and concept of DNA: An Analysis

Life is based on earth cells; almost every cell has a nucleus and each nucleus carries a complete set of chromosomes. Human being has 23 pairs of chromosomes in each nucleus. These chromosomes carry linearly arranged genetics unit, which are materially referred as Deoxyribonucleic Acid (DNA).  

DNA is an organic substance i.e. the chemical basic of life, which is found in every cell found in every human body except red blood cells, which lose its with their maturity. This organic substance combining with protein forms the chromosomes, a thread like structure, responsible for carrying the genetic character from one person to its offspring. DNA is a double helical spiral structure.

The DNA is the genetic material that makes every individual different, except for genetically identical twins. A pattern of chemical signals i.e., genetic code, has been discovered within the DNA molecules, which is very unique to each individual, just like their actual fingerprint. The significance of the fast developing DNA technology and its impact on the rights of an human being and its societal effect have produced an vital require for getting familiar with and understanding the fundamentals of recent genetic science for an effectual role by all persons who are concerned with justice delivery system.\(^6\) In any informed discussion about the ethical legal and social implications of the “New Genetics”, fundamental scientific surroundings is an essential requirement which need not wait till an expert witness enters the witness-box to explain to the background. According to Article 51A (h) and (j) of the Constitution of India, it shall be the duty of every citizen of India “to develop the scientific temper, humanism and the spirit of inquiry and reform”; and “to strive towards excellence in all spheres of individual and collective activity so that the nation constantly rises to the higher levels of endeavour and achievement.”\(^7\) The Parliament is proficient to create laws with respect to the government agencies and institutions for specialized, professional or scientific training, encouragement of special studies or research, or scientific or technological help in the investigation or recognition of offense and with respect to coordination and determination of standards in institutions for higher education or research and development scientific and technical institutions (Entries 65 and 66 of the Union List). The Constitutional provisions of the country pay attention of the scientific developments that may have effect and might be place to use for the advantage of the nation The Constitution provides competent stability for balancing between public and private interests and the Courts have place to use its provisions for an effective social engineering to guard both the appreciated human rights accepted in the Constitution and the paramount public interest in a welfare State. The DNA of each gene is characterized by a unique sequence of bases that form the ‘genetic code’.\(^8\)

\(^6\) “Importance of DNA In Genetic Science”, available at: gujarathighcourt.nic.in (visited on date 21-04-2011).
\(^7\) Ibid.
\(^8\) Id.
These bases are arranged in groups of three, known as codons or phrases. The base sequence is the crucial feature of the gene. It is this sequence that carries the genetic information essential for the synthesis of an RNA molecule that may subsequently direct the synthesis of a protein molecule or may itself be functional in the cell. This process is called gene expression and it has two stages. The first stage in gene expression is transcription (the process by which RNA directs the synthesis of a protein). In a DNA molecule four nitrogen bases are present which are Adenine (A), Thymine (T), Cytosine (C) and Guanine (G), which are grouped together by a bond as A=T and C=G, and are joined together by a bond called nitrogen bond ⁹. The two chains link together in a ladder-like shape, twisted into the now famous double helix first described by James Watson and Francis Crick in 1953, who were awarded the Nobel Prize for their work “A Structure for Deoxyribose Nucleic Acid” (1953) 171 Nature 737. Linkage of the chains follows a strict rule, known as complementary base pairing, so that the base A can only pair with the base T, and vice versa and the base G can only pair with the base C, and vice versa. The human genome is comprised of about 3.2 billion of these base pairs. ¹⁰

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A genome is an organism’s entire genetic material. All living organisms contain genetic material or genomes. One of the most commonly accepted definition of gene is that a gene contains all of the information required to determine the expression of a specific protein or chain of amino acid (a polypeptide). Sometimes a polypeptide can form a complete protein on its own (as in the case of insulin), but in most cases a number of polypeptides combine to create a single protein (as in the case of collagen and globin). Proteins are critical components of all cells, determining colour, shape and function. Proteins can have a structural role (such as keratin, from which hair is made), or a functional role in regulating the chemical reactions that occur within each cell (such as the enzymes involved in producing energy for the cell). Proteins are themselves made up of a chain of amino acids. Within the DNA there is a code that determines which amino acids will come together to form that particular protein. The genetic code for each amino acid, consisting of three bases, is virtually identical across all living organisms. Different genes are switched on and off in different cells leading to different proteins being made or expressed with varying structures, appearances and functions leading to the production of brain cells, nerve cells, blood cells, and so on. Contemporary stem cell research is based on the idea that it should be possible to learn how to use gene switches to coax stem cells into developing into the specialized cells or tissue needed for therapeutic purposes. When the instructions in a gene are to be read, the DNA comprising that gene unwinds and the two strands of the double helix separate. An enzyme called RNA polymerase

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11 *Id.*
allows a complimentary copy of one strand of the DNA to be made.\textsuperscript{13} This copy is made from RNA nucleotides, and is called messenger RNA (or mRNA) because it carries the coded genetic information to the protein-producing units in the cell, called ribosome. This process of reading the message in the DNA is called transcription.

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{DNA_RNA_structure.png}
\caption{Structure of DNA and RNA}
\end{figure}

In the ribosome, the amino acids are assembled in the precise order coded for in the mRNA. The process of converting the message encoded in the RNA (mRNA) to protein using the ribosome is called translation. When the whole message has been translated, the long chain of amino acids folds itself up into a distinctive shape that depends upon its sequence – and is then known as a protein.\textsuperscript{14} Amongst humans, genes comprise only a small proportion of the DNA in a cell. Up to 98% of DNA consists of `non-coding’ regions popularly, but incorrectly, referred to as `junk DNA’ which are full of repeat sequences (micro-satellites), pseudo genes and retroviruses. By way of contrast, there are no non-coding portions of DNA in bacteria there are only genes, each one expressing a specific protein. In recent years, genetic scientists increasingly have come to believe that non-coding DNA may be the basis for the complexity and sophistication of the human genome, which permits only 30,000 or so genes to produce about 200,000 proteins. A pioneer in this field, Professor John Mattick, Director of the Institute for Molecular Biology at the University of Queensland, has surmised that non-coding DNA forms a massive parallel processing system producing secondary signals that integrate and regulate the activity of genes.

\textsuperscript{13} \textit{Ibid.}
\textsuperscript{14} \textit{Id.}
and proteins. In effect, they co-ordinate complex programmes involved in the development of complex organisms\textsuperscript{15}.

According to recent estimates\textsuperscript{16} all humans have the same basic set of about 30,000 – 35,000 genes, which is far lower than the early estimates of 200,000 (based on the number of proteins), and even the relatively recent estimates of 100,000 used at the start of Human Genome Project. Genes may come in different versions, known as alleles. These alleles arise when there is a change in the ordering of the bases (nucleotides) described above in effect, a ‘typographical error’ in the code, involving the change of a single letter, the inversion of two letters, the deletion or insertion of a codon or the repetition of a codon. This change in the sequence (a mutation) may cause no harm, merely resulting in a polymorphism, or it may make the gene faulty in the way it directs (expresses) the production of protein. In a very few cases the mutation is beneficial. Although any two human beings are at least 99.9% genetically identical, the precise DNA sequence of about 3.2 billion base pairs will differ slightly in each person’s genetic code. The 0.1% of difference is thought to compromise more than 10 million common single letter genetic variations (single nucleotide polymorphisms, or SNPs) as well as a larger number of rare variants. The rate of variation is very low in humans (one SNP per 1,300 bases) compared with other species, including other primates suggesting a population that has descended from a small ‘starter population’. This explains both the striking similarities among all people, which are the result of our common inheritance, and the many individual differences found even within a nuclear family.

Mutations are permanent and inheritable changes in the ability of a gene to encode its protein. Much like typographical errors, which can change the meaning of a word, or even render a sentence as gibberish, such changes in gene structure can have severe effects on the ability of a gene to encode its protein. Some mutations prevent any protein from being produced, some produce a non-functional or only partially functional protein, and some produce a faulty or poisonous version of the protein\textsuperscript{17}.

The unique combination of alleles found in a particular individual’s genetic make-up is said to constitute that person’s genotype. The observable physical characteristics of this genotype, as determined by the interaction of both genetic makeup and environmental factors, is said to constitute that person’s phenotype. This includes features such as colour of eye and hair, determined genetically, as well as height and weight determined by genetic factors as well as by diet, access to proper healthcare and other environmental influences. Because mutations can affect the functioning and expression of the alleles of genes, resulting in particular traits or characteristics, it is possible to follow the pattern of inheritance of the different alleles of a gene in a family. For most genes, two copies are found in an individual. If the two copies are the same allele, the individual is said to be homozygous. If two different alleles for that gene are present, the individual is referred to as heterozygous for that gene except for those traits coded for by genes that are found on the X chromosome. A dominant trait is the one that is manifested when a person has only one mutated allele in a particular gene pair. An affected person may have inherited the mutated allele from either parent or, as the result of a new mutation, may be the first person in the family to have it. There is one-in-two chance that a child will inherit a genetic trait if one parent has a dominant mutated allele. Examples of autosomal dominant traits include HD, myotonic dystrophy, hereditary non-polyposis colorectal cancer, Marfan syndrome, familial adenomatous polyposis, and early onset familial Alzheimer’s disease. Tendency to identify a specific gene as the cause of disease obscures the vital role of genes in human health. Any catalogue of the human genome would disclose the list of diseases giving an impression that genes are there to cause disease. “To define genes by the diseases they cause is about as absurd as defining organs of the body by the diseases they get: livers are there to cause cirrhosis, hearts to cause heart attacks and brains to cause strokes. It is a measure, not of our knowledge but of our ignorance, that this is the way the genome catalogues read. It is literally true that the only thing we know about some genes is that their malfunction causes a particular disease. This is a pitifully small thing to know about a gene, and a terribly misleading one. The sufferers have the mutation, not the gene.”¹⁸ Medical conditions or diseases linked to genes can be classified in a number of ways, including: monogenic (or single gene) disorders; polygenic (or multi-gene) disorders;

and multifactorial disorders. A monogenic disorder is one in which a mutation in one or both alleles of a single gene is the main factor in causing a genetic disease. Much of our early understanding about genetic influences on health is derived from the observation and study of monogenic disorders such as Huntington’s disease (a neurodegenerative disease which is inherited in an autosomal dominant pattern) – although such diseases are relatively rare. The vast majority of medical conditions with some genetic link involve either the complex interaction of a number of genes (polygenic) or the complex interaction between genes and the environment (multifactorial disorders). In the case of multifactorial disorders, inheriting a mutated allele for a particular condition means that a person is susceptible or predisposed to develop the condition. Other factors such as diet or exposure to certain environmental factors are necessary to bring about the expression of the trait or condition. Most of the important and common medical problems in humans are multifactor, including heart disease, hypertension, psychiatric illness (such as schizophrenia), dementia, diabetes, and cancers. According to the Human Genome Database, as on 29 December 2002, 14,014 genes had been mapped to individual chromosomes, of which 1,639 had been identified as being involved in a genetic disorder. It may be that most of the simple linkages have already been made, since the rate of discovery has slowed dramatically despite better technology; of the last 3,783 genes to have been mapped; only 17 have been identified with a genetic disorder.19

The arrangement of these bases of the helical structure is in a sequence and the variation in their sequence is different from another species, which helps the scientist to read this sequence and identify the gene and the person. DNA testing represents an extraordinary enhancement in solving many complicated crime relating mysteries with greater accuracies. This test can helps to determine whether a particular patch of blood, hair and wrapped cloths found from the scene of occurrence of crime or from the body of the criminal or the victim to the belong to the accused person or victim or not. Besides the above sample it can also be detected from the saliva, body fluids, bones, urine, body organs and even from charred damaged mutilated remain of a body20.

19 Supra 8.
20 Supra 3, 81.
4.3 Structure of DNA

The structure of DNA varies from individual to individual. DNA structure determines human character, behaviour and body characterisation. Each individual, consequently, is unique, different from all other. In monozygotic twins, DNA structure is same because they come forth by the division of a single fertilized egg. Monozygotic twin are genetically identified.21

DNA is a complex molecule. It has a double helix structure, which can be compared with a twisted rope ‘ladder’. The runs of the ‘ladders are made of two pair of four bodies.22

(1) Adenine and Thymine from one pair (and one rung of the ladder) each base emanating from either of the two arms and joining in-between.

(2) Cytosine and Guanine from the other pair and other rung of the ‘ladder’. The bases of one pair do not interchange with the bases of the other pair. The ladder thus formed, is twisted and each twist consist of ten pair –ten runs .One DNA molecule can have lakhs of these pairs.23

(3) These are four bases called AGCT by which DNA constituent of DNA are described. Urine bases are Adenine (A) and Guanine (G). Pyramidine bases are Cytosine (C) and Thymine (T). According to base pairing “rules of Chargaff” A always pair with T and G with C by hydrogen bond which is known as “Chargaff law”. Urine and Pyramidine base are joined with Deoxyribose sugar at 1st carbon position by B-glycoside bond. In this way Nitrogen base and sugar forms nucleoside. Nucleoside and phosphate acid join to form nucleotide. DNA can exit as a single –stranded from with two sugar – phosphate backbones.24 Nucleotides are linked serially by phosphate group each linking the C5 and C3 of the pentose of the successive nucleotide.25

21 Dr. B.R. Sharma, Forensic Science in Criminal Investigation & Trial 1123 (Universal Law Publication, IVth edn. 2011).
22 Ibid.1123.
23 Id., 1124.
25 Ibid. 108.
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The DNA molecule consists of double chain of nucleotide. One end of each strand is called 5' and the other 3'. Two strands are always complementary and antiparallel. The two strands of DNA are coiled around a common axis in “plactonemic coiling” manner like a spiral staircase. It is also known as right-handed coiling or clock-wise coiling or dextrose coiling. The dextrose sugar and phosphate group are like the railing and hydrogen bonded base pairs are as the steps and these are backbone of DNA. The attached base pairs are varied in each nucleoside unit.26

4.4 Historical Perspective of DNA

The following is a brief history of DNA discovery, analysis, and testing. The significant advances over the last 140 years that evolved into the DNA testing industry and the paternity testing information available today are discussed as follows:

1865

The theories of heredity are attributed to Gregor Mendel, based on his genetic profiles of pea plants, are well known to any biology student. However, his genetic profiles were so unprecedented at the time; it took almost 34 years for the rest of the scientific community to catch up. The short monograph, *Experiments with Plant Hybrids*, in which Mendel described how traits were inherited, has become one of the most enduring and influential publications in the history of science.

1900

The science of genetics was finally born when Mendel's work was rediscovered by three scientists - Hugo DeVries, Erich Von Tschermak, and Carl

Correns - each one independently researching scientific literature for precedents to their own "original" work.

1935

Andrei Nikolaevitch Belozersky isolated DNA in the pure state for the first time.

1953

James Watson and Francis Crick proposed the double-stranded, helical, complementary, anti-parallel model for DNA. *Nature* magazine published James Watson's and Francis Crick's manuscript describing the double helical structure of DNA.

1958

Coenberg discovered and isolated DNA polymerase, which became the first enzyme used to make DNA in a test tube.

1966

The genetic code was "cracked". Marshall Nierenberg, Heinrich Mathaei, and Severo Ochoa demonstrated that a sequence of three nucleotide bases (a codon) determines each of 20 amino acids.

1972

The first successful DNA cloning experiments were performed in California.

1973

For the first time, scientists successfully transferred deoxyribonucleic acid (DNA) from one life form into another. Stanley Cohen and Annie Chang of Stanford University and Herbert Boyer of UCSF "spliced" sections of viral DNA and bacterial DNA with the same restriction enzyme, creating a plasmid with dual antibiotic resistance. They then spliced this recombinant DNA molecule into the DNA of a bacterium, thereby producing the first recombinant DNA organism.

1976

The NIH released the first guidelines for recombinant DNA experimentation. The guidelines restricted many categories of experiments.

1978

Studies by David Botstein and others found that when a restrictive enzyme is applied to DNA from different individuals, the resulting sets of fragments sometimes
differ markedly from one person to the next. Such variations in DNA are called restriction fragment length polymorphisms (RFLPs), and they are extremely useful in genetic studies.

1980

Kary Mullis and others at Cetus Corporation in Berkeley, California, invented a technique for multiplying DNA sequences in vitro by, the polymerase chain reaction (PCR). PCR has been called the most revolutionary new technique in molecular biology in the 1980s. Cetus patented the process, and in the summer of 1991 sold the patent to Hoffman-La Roche, Inc. for $300 million.

1984

Alec Jeffreys introduced technique for DNA fingerprinting to identify individuals.

1985

Genetic fingerprinting entered the court room.

1989

Creation of the National Center for Human Genome Research, headed by James Watson, which will oversee the $3 billion U.S. effort to map and sequence all human DNA by 2005.

1990

The Human Genome Project, the international effort to map all of the genes in the human body, was launched. Estimated cost: $13 billion.

1992

The U.S. Army began collecting blood and tissue samples from all new recruits as part of a "genetic dog tag" program aimed at better identification of soldiers killed in combat.

1993

An international research team, led by Daniel Cohen, of the Center for the Study of Human Polymorphisms in Paris, produces a rough map of all 23 pairs of human chromosomes.

1995

Former football player O.J. Simpson was found not guilty in a high-profile double-murder trial in which PCR and DNA fingerprinting play prominent roles.

1997

Researchers at Scotland's Roslin Institute reported that they have cloned a
sheep--named Dolly--from the cell of an adult ewe. Polly, the first sheep cloned by nuclear transfer technology bearing a human gene, appears later. Also, leading geneticists expressed shock and dismay as word spread of the US Patent and Trademark Office announcement that it would allow patents on expressed sequence tags (ESTs), short sequences of human DNA that have proven useful in genome mapping.

1998

A rough draft of the human genome map was produced, showing the locations of more than 30,000 genes.

2000

Scientists announced that they have essentially cracked the human genetic code - a decade-long effort by over 1,000 researchers that could revolutionize the diagnosis and treatment of diseases once considered incurable. Decoding the 3 billion chemical "letters" in human DNA is seen as one of history's great scientific milestones - the biological equivalent of the moon landing.

4.5 Meaning & concept of DNA Testing

“Today we see enormous changes being brought about by science. The whole context of life is changing. As a matter of fact, looking back at least half century with which I have been more or less connected and some of you also see that enormous changes have been brought about chiefly by science and technology. This pace of change is growing and I have no doubt that another fifty year or even twenty-five hence, you will see even greater changes not merely in space research, but something affecting human life. In order to participate in this movement, you have to build yourself up in the Science and Technology.”

Jawaharlal Nehru

Modern day biology is seeking new and better ways to enhance our quality of life through application of technology (biotechnology) and rapid progress in research on human genome. The discovery of the structure of DNA (deoxyribonucleic acid)
in the 1950s, and the recognition that it is virtually the universal genetic material, made it imperative for the man to apply this knowledge towards unexpected ends.

The history of crime has started with the history of civilization. Every society has been enacting laws to combat crimes and criminals since long time. From times-Immemorial, the single quest of any legal system has been the Quest for truth. The phrase Satyamevajayate has assumed sacred proportions as regards to the Indian psyche. Crime is a social and economic phenomenon distressing the whole human community. With sweeping changes in society and in economic activities, the face of crime has also changed. Today the sophisticated technology in the hands of criminals is creating mayhem. The law enforcement agencies need to be a step ahead of the lawbreakers. Forensic science provides investigators or crime fighters that weapon, the most significant being DNA profiling or DNA test. DNA technology is one such tool, which upholds truth.  

The focus of most criminal investigations is on linking the evidence from the crime scene to suspects, and for more than a century, science has played an increasingly important role in this process. Fingerprinting, Genetic engineering, sequence of whole genome (be they of men, animal, plant or microorganism) or exploitation of the differences between the DNA of the male and the female (for example of the X and Y sperm) have thus all been historical imperative.  

Fingerprinting was applied to criminal investigation beginning in the 1880’s. Shortly after the principle of ABO blood group typing was reported in 1900. Its relevance to forensic investigation became apparent. In the 1960’s human leukocyte antigen (HLA) typing became the premier serologic tool for personal identification although in practice, it was useful for only a small percentage of sample. Finally, the 1980’s ushered in the age of DNA testing, which permits investigators to perform almost unbelievable feats of identification with current techniques. It is possible for a single person to be differentiated from all the people that have ever lived using DNA from a single hair root. The principles and techniques used for forensic DNA typing are also quit useful for other purpose. DNA profile are widely used in resolving issues of parentage in man and animal, and are rapidly replacing serologic analysis (i.e. blood

31 DNA Fingerprinting or profiling llows examination of human biological material at its most fundamental level-the DNA molecule. The molecule is smaller fundamental unit of a chemical compound that can take part in chemical reaction.
typing) for that purpose. Additionally, DNA testing is an indispensable tool for positional cloning, a technique by which a previously unknown gene is identified by finding association or links between DNA markers and the inheritance of a disease.

### 4.6 History of DNA Testing

A detailed summary of an interactive presentation that follows the history of DNA testing which began in the late 1800s. This timeline includes Mendel's genetic discoveries, many future DNA testing applications, along with interesting paternity cases that have made history.

If one has ever wondered what came between the discovery of eye color inheritance and paternity testing, he would want to follow the history of DNA testing in this flash media presentation created by DNA Diagnostics Center (DDC).

With simple explanations of complex discoveries ranging from Gregor Mendel's discovery of genetics to the most reliable DNA testing today, this interactive presentation is a great guide to the history of DNA testing for students and science enthusiasts of all ages.

One can follow along with history, each decade at a time from the 1890s to the present, and read about famous paternity cases involving high-profile cases like inheritance claims that called for DNA testing.

One such case involves Larry Hillblom, co-founder of a large shipping company, who died in a tragic plane crash in 1995. Women from several countries claimed that Hillblom had fathered their children, and made claims on his estate, estimated to be worth $90 million. Part of the estate was eventually awarded to four of his biological children, as proven by DNA testing. There are many more famous cases in the presentation, including the recent paternity testing case involving the famous actress/model Anna Nicole Smith32.

First established in 1985 by Sir Alec Jeffrey’s, DNA testing has become an increasingly popular method of identification and research. The applications of DNA testing, or DNA fingerprinting within forensic science is often what most people think of when they hear the phrase. Popularized by television and cinema, using DNA to match blood, hair or saliva to criminals is one purpose of testing DNA. It is also

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frequently used for other benefits, like wildlife studies, paternity testing, body identification, and in studies pertaining to human dispersion.

While most aspects of DNA are identical in samples from all human beings, concentrating on identifying patterns called micro satellites reveals qualities specific and unique to the individual. During the early stages of this science, a DNA test was performed using an analysis called restriction fragment length polymorphism. Because this process was extremely time consuming and required a great deal of DNA, new methods like polymerase chain reaction and amplified fragment length polymorphism have been employed.

The benefits of DNA testing are ample. In 1987, Colin Pitchfork became the first criminal to be caught as a result of DNA testing. The information provided with DNA tests has also helped wrongfully incarcerated people like Gary Dotson and Dennis Halstead reclaim their freedom\(^{33}\).

Thus it can be said with full attenticity that the invention of DNA Technology has surely revolutionized the crime detection. This technology has been found to be extremely useful in Civil as well as Criminal proceedings.

4.7 Discoveries and Development of DNA Technology- Discoveries in the field of Genetics –

- In 1865, Gregor J. Mandel gave the formula of “Law of Inheritance (In Austria).
- In 1869, Friedrich Miescher discovered DNA (in Switzerland).
- In 1901, Landsteiner developed blood grouping system (In Austria).
- In 1908 Hardy and Weinberg given the Hardy-Weinberg Law (From United Kingdom and Germany).
- In 1944, O.T.Avery mC Carthy and Mcc Leods described that DNA is a genetic material (In USA).
- In 1953, Watson –Crick and Wilkins-Fronklin indicated about double helical structure of DNA (In USA).
- In 1978, Kan and Dozy uses restriction enzymes for the purpose of elucidation of the polymorphism (In USA).

\(^{33}\) DNA Testing at Life Science- Com.htm.(visited on 21-12-2010).
4.7.1 Discoveries in the field of Forensic Science –

- In 1915, Beam and Feak described about advance blood test (In UK).
- In 1920, Locard gives the ‘principle of Exchange’ (in France).
- In 1966, Harris introduces “human allozymes polymorphism” (In UK).
- In 1980, Faulds described fingerprinting as the first source for individual identification (in Scotland).
- In 1985, Prof. Alec Jefferys developed first Forensic DNA analysis (In UK).
- In 1993, United States, F.B.I. started investigation working DNA Database (CODIS).
- In 1996, Second National Research Council Report was published in USA.
- In 1998, in United States, 13STR Loci were established for CODIS.
- In 1999, P.E. Bio-System and Promega of United States started multiplex kits marketing for DNA analysis.\(^{35}\)

4.7.2 First Uses of DNA evidence for the purpose of Law

- In 1986, Prof. Alec Jeffreys innovated and applied first DNA test of two teenage girl’s rape and murder case in USA.
- In 1987, Robert Melias was the first person got conviction on the basis of DNA evidence in UK.

\(^{34}\) Supra 15, 121-122.
\(^{35}\) Ibid.
• In 1987, DNA evidence was produced in first time in USA.
• In 1987, DNA test was first used in Tommy Lee Andrew of USA in a rape case.
• In 1989, DNA test had got legal validity in India.
• In 1989, DNA evidence was produced first in the Indian Courts (In Paternity disputed case in Kerala, India).
• In 1994, the ‘crime of century’ case of O.J.Simpson’s case produces in court.
• In 1996, mitochondrial DNA analysis was first used in the case of Tennessee in USA.
• In 1998, Canada has passed DNA Identification Act, 1998 and it is assented in 2000.
• In 2003, USA has passed Advancing Justice through DNA Technology Act, 2003.
• In 2005, in India, provision for DNA Profiling is included in the Code of Criminal Procedure by passing the Code of Criminal Procedure (Amendment) Act, 2005.36

4.8 Various Techniques of DNA Profiling

The aim and of DNA profiling is to detect the differences among DNA samples taken from different individual. DNA profiling uses advanced techniques developed by molecular biologist to ‘home in’ on the area of DNA where there are differences among individual DNA fingerprinting /profiling techniques is of greatest advantage as it helps in –

• Organ transplantation (in medical science)
• Establishment of biological relationship of two or more person
• Identifying missing children and in cases of child swapping
• Post conviction of DNA testing for exoneration
• To solve the paternity dispute
• To solve the other criminal cases
• The cases of inheritance or succession, adoption, maintenance of minor child, etc.37

36 Id.

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Lab for DNA testing

The original technique for performing DNA profiling and one that has been the subject of the most litigation till date is known commonly as Restriction Fragment Length Polymorphism (RELP) analysis. The more advanced technique is Polymer Chain Reaction (PCR) technique, Short Tandem repeat (STR), Variable Number of Tandem Repeat (VNTR) technique, etc.

4.8.1 Polymer Chain Reaction-

In 1983 a new technique discovered by Kary Mullis has been widely used to amplify a specific DNA fragment without the need of bacterial cell known as PCR. The Polymer Chain Reaction is a method by which specific segment of DNA which are of interest, can be replicated a million fold or more, so as to obtain sufficient DNA for analysis. The PCR process is analogous to cellular mechanism for DNA replication. The double stranded DNA extracted from the biological material is dissociated into single strands by incubation at high temperature. Each strand serves as a template for the replication of their complement of their complimentary sequences. The Polymer Chain Reaction (PCR) based testing method even very small biological evidence can be analyzed. This method replicated exact copies of DNA contained in sample without affecting the original one. The PCR process does not perform the work of DNA typing. It only increases the available DNA in a very large quantity and the number of copies can be increased to more than one million within a very short period time. It may be compared to a Xerox machine. But the comparison

37 *Supra* 15, 125.
38 The Indian Police Journal, 16(2001).
39 *Supra* 15,139.
is not totally true. In PCR DNA is copied copies and copied and so on. This can be done by Xerox machine. Virtually, PCR is a cloning process in which DNA or its fragment can be replicated and number of time.

PCR is also called Primer Extension Reaction. ‘Primer’ are those sequences of DNA which “flank” the region to be copied. Primers are the most important component of
PCR Reaction. The two other component of PCR are (1) “Template DNA “and (2) “DNA Polymerase”.\textsuperscript{40}

4.8.2 Restriction Fragment Length Polymorphism (RFLP)

Restriction Fragment Length Polymorphism analysis was the first Forensic DNA investigation technique which is used to analyze the forensic DNA sample, or evidentiary DNA or biological material to identify the individual. Bostein was the first person who suggested the use of RFLP method for mapping the human genome was discovered by Wyman and White. The significant discovery of 20\textsuperscript{th} century, i.e. RFLP analysis was introduced by a famous Criminalist Prof. Alec Jeffrey in 1985 while solving the rape-homicide cases of two teenaged school girl and afterwards it was used to detect a serial rapist of a crime in United Kingdom.\textsuperscript{41}

The technique focuses on the length of the various polymorphic repeated segments located between the common protein genes or coding regions because they have variable number of tandemly repeated (VNTR) units. The length of each of them repeated segments is directly associated to the number of times the sequence of the base pair is repeated. Recognizing and comparing the length of these segments between individual offer a way to discriminate one person’s DNA from another.\textsuperscript{42}

4.8.2.1 Steps of RFLP analysis

The RFLP is a complex procedure that can be subdivided into different steps which are performed sequentially thus error in any of the steps would invalidate the whole test rendering it inadmissible. These steps as follows-

(a) Isolation (or extraction) of DNA from biological material;
(b) Restriction enzymes cutting of DNA;
(c) Gel electrophoresis;
(d) Southern blotting;
(e) Hybridization;
(f) Visualization of DNA bonding pattern.\textsuperscript{43}

\textsuperscript{40} Mullis K.B. on The Unusual Origin of PCR, 1990 Ed.
\textsuperscript{41} Yaspal Singh, Mohd. Hasan Zaidi, DNA Test in Criminal Investigation, Trial and Criminal Trial and Paternity Dispute (Justice through Science ) 88,(Alia Publication ,edn.. 2006).
\textsuperscript{42} Abhijeet Sharma, Guide to DNA Test in Determination &Criminal Investigation 88 (edn.. 2007, Forwarded by Hon’ble Justice Arijit Pasayat ,Judge ,SC of India).
\textsuperscript{43} Supra 32, 89.
4.8.2.1 (a) Isolation (or Extraction) of DNA from biological material –

RFLP is a technique for analyzing the variable lengths of DNA fragments that result from digesting a DNA sample with a special kind of enzyme. This enzyme, a restriction endonuclease, cuts DNA at a specific sequence pattern known as a restriction endonuclease recognition site. The presence or absence of certain recognition sites in a DNA sample generates variable lengths of DNA fragments, which are separated using gel electrophoresis. They are then hybridized with DNA probes that bind to a complementary DNA sequence in the sample.

RFLP was one of the first applications of DNA analysis to forensic investigation. With the development of newer, more efficient DNA-analysis techniques, RFLP is not used as much as it once was because it requires relatively large amounts of DNA. In addition, samples degraded by environmental factors, such as dirt or mold, do not work well with RFLP. 44

At the first stage, DNA is isolated from the biological material submitted as forensic evidence such as blood or semen dried onto a solid surface, such as clothing. The primarily discovered material dried onto some surface which is then washed and DNA is released by treatment with chemical and enzymes. Occasionally, like in the cases of vaginal swabs from rapes, it becomes necessary to separate DNA from different cell type. In cases like them, sperm cells are separated from vaginal cells by centrifugation and differential analysis. Before DNA can be subjected to RELP analysis, it has to be free of any impurities that might affect the whole RELP process it is thus cleaned up using enzymes and organic solvent. At this stage, the amount of DNA is determined to ensure that sufficient quantity of DNA in interpretable test result. 45 The molecular weight is also determined to ensure that the DNA molecule have not been broken into shorter fragment by degradation through age or poor preservation .The quality of the DNA recovered can be easily evaluated by running the DNA ‘test-gel. Undigested DNA is run on an agarose gel and stained with ethidium bromide, which causes DNA to be fluorescent under Ultraviolet light .The size of the undigested DNA can be estimated by comparison with DNA molecules of known size ,usually known as markers. 46

44 “Structure of DNA,” available at: www.forensicsciencedna.com (last modified on the date 23-07-2010).
45 Supra 32, 10.
46 Supra 31, 90.
4.8.2.1 (b) Restriction enzymes cutting of DNA

After isolation and purifying DNA, the polymorphic repeating fragment sought from the rest of the strand. This is done through the special enzyme, which is called ‘restriction enzyme’. Restriction enzyme speed up the rate of chemical reaction. Specific restriction enzyme are used to break DNA at specific sites within the molecule and slide alone the helix until they recognize a sequence of base pairs that signal the enzyme to stop sliding. The enzymes then digest i.e. chemically out the DNA molecule at that sites, called a ‘restriction sites’, acting like molecular scissor, cutting DNA at a specific sequence of base pair.

If a specific restriction site occurs in more than one location on a DNA molecule, a restriction enzyme will make a cut at each of those sites, restricting in multiple fragment of different length.

4.8.2.1 (c) Gel electrophoresis

In this process, DNA fragment are separated on the basis of different of size. In this technique DNA is placed in a slap of agarose gel and then applying an electric current across the gel. DNA is negatively charged molecule so the fragment will move towards the positive electrode when the electric current is turned off, DNA fragments of different size have moved different distance. Long piece of DNA fragments remain near the top of the gel. Whereas sort piece are found near the bottom. The movement of bigger DNA fragment become very slow in comparison to small DNA fragment. When the DNA fragment are separated, size of restriction fragment length is determined by their movement in agarose gel. The disintegration of separated DNA fragment start after one or two days.

4.8.2.1 (d) Southern Blotting

In 1970, this technique was originally developed by Edward Southern. After the separation of DNA Fragment, DNA is transferred and permanently affixed to a nylon membrane by placing the membrane on the gel and soaking them overnight.
Nylon membrane is used because it has five times more binding capacity to bind up DNA than nitrocellulose membrane.

To covalently binding up of DNA molecules or cross linkage of single stranded DNA molecule (also called as-DNA molecule) to the Nylon membrane. It is treated with ultraviolet light. In this way the nylon membrane bound DNA molecule which called probe which become radioactive. After this process it is subjected to Hybridization.  

4.8.2.1 (e) Hybridization

After the process of southern transfer the DNA fragment attached to the membrane to identify the different length of the polymorphic fragment. To prevent the labeled probe from binding non-specifically to DNA fragment labeled probe is first prehybridized and then membrane is bathed in a solution containing labeled probe. The probe will recognize and hybridize to the target portion (VNTR) of single –stranded DNA molecule. The blot is mixed up in the concentration of detergent salt and urea with DNA which determines the DNA sequence or locus. The probe can be labeled with radioisotopes (P32 deoxyribonucleotide triphosphate) when this hybridization is over and all the specific polymorphic fragment have been bonded to the detecting probe, the membrane is washed to remove any unused probe molecule.

4.8.2.1 (f) Visualization of DNA Banding Pattern

The position of the polymorphic DNA can be visualized after they located by the probe through a photographic process, which is known as autoradiography. Autobiography means photographic recording of position of radio-labelled DNA probe on X-ray film. This process is done by covering the membrane with a sheet of unexposed X-rays film and storing this from one to seven days at a very low temperature. The radioactivity of the probes depicts the film at the exact location of the polymorphic fragment sites. The film is then developed and a pattern of bands is visualized each of which represent the location of the polymorphic segment on the membrane. This indicates the DNA fragment length by the distance traveled down the membrane. The band pattern produced depends on the DNA extracted from the

50 Supra 15, 138.
51 Variable Number Tandem Repeat.
52 Supra 15, 138.
forensic sample, and the donor’s individualized DNA structure. Every person’s DNA sequence is unvarying from cell and thus the pattern per-probe will be the same whether the DNA source is hair, root, WBC (White Blood Cell), sperm cell from semen or any other nucleated cell.

4.8.3 Short tandem repeat Analysis

Short tandem repeat (STR) technique is used to assess specific regions (loci) inside nuclear DNA. Changeability in Short tandem repeat (STR) regions can be applied to differentiate one DNA profile from another. The Federal Bureau of Investigation (FBI) applies a standard set of 13 specific STR regions for CODIS. CODIS is a software program that operates local, state, and national databases of DNA profiles from convicted criminals, unsolved offense scene proof, and missing persons. The unusual view is that two individuals will have the similar 13-loci DNA profile is about one in a billion.53

4.8.4 Mitochondrial DNA Analysis

Mitochondrial DNA analysis (mtDNA) can be applied to observe the Deoxyribonucleic Acid (DNA) from samples that cannot be examined by Restriction Fragment Length Polymorphism (RFLP) or Short tandem repeat (STR). Nuclear DNA must be extracted from samples for use in RFLP, PCR, and STR; however, mtDNA analysis uses DNA extracted from another cellular organelle called a mitochondrion. While older biological samples that lack nucleated cellular material, such as hair, bones, and teeth, cannot be analyzed with STR and RFLP, they can be analyzed with mtDNA. In the investigation of cases that have gone unsolved for many years, mtDNA is extremely valuable.54

All mothers have the identical mitochondrial DNA as their children. This is for the reason that the mitochondrion of each new embryo comes from the mother's egg cell. The father's sperm contributes only nuclear DNA. Comparing the mtDNA profile of unidentified remains with the profile of a possible motherly relative can be an significant method in missing-person investigations.

54 Ibid.
4.8.5 Y-Chromosome-Analysis

Y-Chromosome is inherited in uni-parental manner through paternal side into all male offspring DNA makers located in non-recombining section of Y-chromosomes (NRY) are inherited from generation to generation without exchange of genetic material between chromosome. Parentage linkage can be traced with Y chromosomes makers. Hence Y chromosomes specific STRs have prove as important tool in a male-specific forensic testing and thus can be utilized to prove relationship in paternity testing, sexual assault cases, historical evidence, missing person identification and helpful in evolutionary study to perform phylogenetic analysis.55

Additionally, Y-STR are also use investigation of sexual offence, which sample consist of a mixture of body fluids from different individual and detection of male fraction in male/Female mixture without differential DNA extraction. However, Y-STRs are useful when only distant relation on the parental side is present as donor of reference material.56

The Y chromosomes is passed directly from the father to son, so analysis of genetic markers on the Y chromosomes is particularly supportive for tracing connection among males or for analyzing biological proof involving multiple male contributors.57

4.8.6 Variable Number of Tandem Repeats (VNTR)

Friedrich Miescher discovered nucleic acid in 1869. He had also isolated Deoxyribo nucleic acid from fish sperm. VNTR was formerly used for DNA fingerprinting by the variation in tandem repeats.

4.9 Relevancy and Feasibility of DNA Testing In Crime Investigation

Deoxyribonucleic Acid (DNA) technique is increasingly very important to make sure correctness and fairness in the criminal justice system. News stories praising the triumphant application of DNA to resolve offence flourish all through the World. For instance, in 1999, New York authorities correlated a man through DNA proof to at least 22 sexual assaults and robberies that had terrorized the city. In 2002,

57 R. Usharani,”DNAevidence and the court” 1, Karnataka law Journal 2 (2008(1)).
authorities in Philadelphia, Pennsylvania, and Fort Collins, Colorado, used DNA evidence to link and solve a series of crimes (rapes and a murder) perpetrated by the same individual. In the 2001 “Green River” Killings, DNA proof made available a main breakthrough in a sequence of offences that had lingered unsolved for years in spite of a large law enforcement task force and a $15 million investigation. DNA is usually used to solve crimes in one of the two manner. In cases where a suspect is recognized, a sample of that person’s DNA can be contrasted to the proof which found from the crime scene. The findings of this comparison may assist to establish whether the suspect committed the offence or not. Crime scene proof can also be connected to other crime scenes through the use of DNA evidence.

There’s no doubt that discoveries in DNA analysis and DNA tests have definitely paved the ways to solve the mysteries of crime. DNA tests can connect a suspect to a crime scene and help detectives/experts come to a fast conclusion, but it’s not always so straightforward. In America, some criminals who have served over 20 years in prison or even those who faced death row for a crime they didn’t commit have now been finally exonerated, thanks to new DNA tests proving their innocence. The widespread use of DNA tests in forensics has proved worthy as to how to tackle the crimes. But according to a report in The Times newspaper, it’s thought that up to 2,000 cases of violent crimes in the UK could have been solved if DNA evidence had been discovered— the resulting DNA tests could have convicted dangerous criminals.

Investigation into Missed DNA Tests: An investigation is being undertaken across the UK to look into such cases where it was expected that the scientists would find DNA evidence at the crime scene— but failed. The investigation covers serious crimes between 2000 and 2005. It was launched after detectives found clues in DNA that was previously overlooked during the re-investigation into the murder of Rachel Nickel. Using different DNA technology, a new forensic agency undertook DNA tests on the same evidence from the original investigation. But they found vital information the new findings were brought forward and the result of their DNA tests led to a suspect being charged for Nickell’s murder. New DNA tests need investigation concerns have been raised over high profile crime cases such as that of Damilola Taylor, the 10 year-old who was stabbed in South London. Traces of blood that could

58 Importance of DNA testing in forensic science available at: www.whitehouse.gov (visited on 9-5-2011).
59 Supra 7.
have been used in DNA tests were missed during the initial investigation, but found after re-investigation four years later. It’s thought that about 2,000 violent crimes could have been solved through DNA tests were it not for the fact that vital DNA evidence had been missed. International Biosciences propose a wide range of DNA tests planned to make available unquestionable reply to emotional queries. “Whether you look for to prove paternity, establish relationship or seek pedigree, for legal definition or peace of mind, one is capable to make available the suitable DNA tests at, professionally and confidentially. Using state of this technique we are able to provide conclusive evidence on time”60.

4.10 Importance of DNA testing in Medical Science as well as in Legal Science

The term “Medico legal” comprises the fundamentals of two sister vocations i.e. Medicine and Law. Everyone talks about the law but a small number of persons have the right understanding as to what constitutes law. The normal layman frequently has about as much right information about the law as he has about medicine-or life on Venus. And, unluckily, two professional groups suffer from more ignorance of law and medicine than is good for them: lawyers, at least those who do not constantly deal with medical issues in their legal practice, know very little about the medical profession and its problems; physicians frequently comprehend too little about the law and how it affects them in the practice of their profession. Medico legal experts can provide a link between these two professions for their smooth & effective functioning in a scientific manner. The physician meets the law at every turn. He confronts it when, as the treating doctor, he is subpoenaed as a witness in a personal injury lawsuit; he meets it when his aid is sought as an expert in connection with a claim that another member of his profession has been negligent and when he is faced in his office or clinic by a narcotic addict, a man with a gunshot wound, or a young couple seeking a blood test. He is face-to-face with the law when he is required to render an aggravating array of governmental reports or to preserve physical evidence for the benefit of a law enforcement agency. The physician, in fact, finds a great deal of the law intensely irritating, often because he is not absolutely clear as to its purpose. The following subjects deal with all the above aspects of Law and medicine.

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60 Gwendolyn Carrp., K.D. 2007, North Western University, School of Law.
Benefits of Medical Jurisprudence:

The introduction of the medical jurisprudence has immensely benefited both the medical and the legal field of work. A better understanding and cooperation has resulted and has facilitated a smoother working of both disciplines. Previously unsolvable cases are now solved with ease with the development of the field of medical jurisprudence. It covers in its ambit the provision of evidence for a wide range and scope of cases. It can be used to determine the Paternity of a child and also be employed in determining the identity of human bodies, which have been mutilated beyond recognition in accidents like bomb blasts, factory explosions etc. In the field of Evidence Laws, it can be appropriated to solve cases involving murders, rapes etc. Medical jurisprudence techniques like autopsy can also be employed to discover important facts vital to the case after the person has died. However, despite their vast benefits to the field of law, medical jurisprudential techniques are not treated as primary evidence till date. The present Indian Evidence Act continues to treat technical findings, such as the results of DNA tests, as expert evidence. This situation will continue till legislation is drafted and enacted by the Parliament. Under Section 45 of the Indian Evidence Act, 1872, it has been, inter alia, provided that, when the court has to form an opinion upon a point of science, or art, or as to identity of handwriting or finger impression, the opinions on the point of science, of such persons who are specially skilled in science or art or any question as to identity of handwriting or finger impressions are relevant facts and such persons are called experts. The expression opinion upon a point of science of persons especially skilled in science is capable of application to all future advances in science which enable an expert opinion on a particular point. Due to the heavy misuse and lack of knowledge of the courts as regards the scientific evidence, they are hesitant in applying these techniques. In order to determine whether scientific evidence is admissible, the court may consider-

(1) Whether the principle or technique has been or can be reliably tested,

61 “Significance of DNA” available at: legalcellforall.blogspot.com (last modified on 23.july 20012).
(2) Whether it has been subjected to peer review or publication,

(3) Its known or potential rate of error,

(4) Whether there are standards or organizations controlling the procedures of the technique,

(5) Whether it is generally accepted by the community, and

(6) Whether the technique was created or conducted independently of the litigation.

The situation appears heartily only as regards autopsy reports, which have been given the status of documentary evidence under the Indian Evidence Act. The merit attached to them, however, remains subjective and varies from case to case. The complete benefit of these medical jurisprudential techniques can be enjoyed only by an enactment recognizing these techniques as primary evidence, giving it the credit it deserves.\textsuperscript{62}

4.10.1 Importance of DNA Testing In Medical Science

Medical jurisprudence is the application of medical science to legal problems. It is typically involved in cases concerning blood relationship, mental illness, injury, or death resulting from violence. Autopsy is often used to determine the cause of death, particularly in cases where foul play is suspected. Post-mortem examination can determine not only the immediate agent of death (e.g. gunshot wound, poison), but may also yield important contextual information, such as how long the person has been dead, which can help trace the killing. Forensic medicine has also become increasingly important in cases involving rapes. Modern techniques use such specimens as semen, blood, and hair samples of the criminals, found in the victim’s bodies, which can be compared to the defendant’s genetic makeup through a technique known as DNA fingerprinting; this technique may also be used to identify the body of a victim. The establishment of serious mental illness by a licensed psychologist can be used in demonstrating the incompetence to stand trial, a technique which may be used in the insanity defense, albeit infrequently.

\textsuperscript{62} Ibid.
4.10.2 Autopsy:

The systematic testing of a body for finding the reason of death is known as autopsy. In autopsy specially trained physician performed operation on a dead body. The basic object of autopsy is find out the actual cause of death and his health condition during his life. Autopsy is also known as post-mortem. It is perform only after taking the consent of the authorities in case of serious death cases and in other circumstances it perform only with the consent of the family members or with the consent of the deceased person before death. During post-mortem the non human tissue should be identified and discarded. The basic purpose of this testing is to acquire the tissue and organs for transplantation. With the help of autopsy, the cause of death is ascertained. In this test, pieces of scalp, skin, jaw, joint, spine, etc can be helpful to establish the number of the victim. Usually, the post-mortem is only done when there is some doubt regarding the reason of death etc. Post-mortem cannot be completed unless all parts of body are examined in detail. Valuable medical information can be learned from a post-mortem examination. Legionnaire’s disease was discovered as a consequence of autopsies, and improved safety standards have resulted from the examination of the bodies of crash victims. The autopsy deal with the particular illness as proved in one individual and is more than simply a statistical average. Each autopsy is significant to expose errors, to set the limits of innovative diseases and innovative patterns of disease, and to guide future studies. Morbidity and mortality statistics obtain correctness and importance when based on careful autopsies. The first step is a gross examination of the exterior for any deformity or trauma and an attentive description of the interior of the body and its organs. This is generally followed by additional studies, including microscopic examination of cells and tissues. Then the pathologist proceeds to the dissection, which consists of removing and examining carefully all the parts of the body.

4.10.3 DNA Fingerprinting:

The concept of DNA fingerprinting was introduced by Prof. Alec Jefferys in 1985 and general public has become more familiar with the power of DNA typing. Dr. Jefferys found that were repeated over the again next to each other which are

63  “Autopsy in Field of Forensic Science” available at: legalcellforall.blogspot.com (Visited on date 27-12-2013)
64  Ibid.
referred as VNTR. It was also found by him that the number of repeated sequences present in a sample could differ from individual to individual. It is considered as the most powerful tool to identify an individual. Earlier an individual was identified using some conventional techniques like ABO, MNS, Rh. Etc., blood group and serum protein etc but now DNA finger printing is preferred became DNA is much more resistant to the degradation caused by the environment condition. Moreover, DNA is somatically stable. This uniqueness of DNA forms the basis of DNA Fingerprinting which is based on Mandalian law of inheritance. 65

DNA fingerprinting profiles are unique to each person. It is used for analysing and comparing DNA from different sources and to recognize the suspect from blood, semen, hair or other biological material which found on crime scene. 66 DNA fingerprinting is also useful in cases of exchange of babies, rapes murder, assassination, dispute related with inheritance etc. After the development of DNA fingerprinting technique, the success rate of solving the case has been considerably increased. After the discovery of DNA fingerprinting many case laws relating with rape has been solved by the various courts in India.

It depends on the fact that no two people, except identical twins, have accurately the identical DNA sequence, and that although only limited part of a person’s DNA are analysed in the process, those parts will be statistically unique. The DNA samples of the offender can be obtained from the scene of crime itself. For instance blood samples from a scene of murder or samples of seminal fluids deposits on the clothes or furniture or in the body of the rape victim can be used to obtain a sample of the offender DNA. These samples can be matched with those taken from a possible suspect in the case. DNA evidence, apart from its use in criminal law to determine the killer or the rapist, is also employed for various other purposes. Amongst its varied applications, Paternity testing, Personal recognition, study of the evolution of the human population and study of inherited diseases like Alzheimer’s disease etc. are included. After the discovery and use of DNA proof technique the success rate in solving difficult cases in Criminal Law has very much increased. The

66 Modi’s *medical jurisprudence and toxicology* 337(Lexis Nexis, Butterworth publication, new Delhi,2008).
DNA evidence is undertaken by matching the DNA from the crime scene with DNA of suspects. These steps are involved in the -

- Collection of DNA at the crime scene and from the suspect.
- Analysing the DNA to create a DNA profile.
- Compare the profile to each other.\(^\text{67}\)

The introduction of DNA evidence in the field of Criminal law has particularly facilitated convictions in the matters involving the offence of Rape. In the earlier time it was only the circumstantial evidence which was based upon viable method of solving the rape related crime. It was extremely difficult for the victim of rape to establish the crime by any other means in the absence of circumstantial proof.

From the time of the beginning of the DNA proof, this has been greatly simplified. The investigating officer examined the primary samples of the seminal fluids which found at the crime scene. If this is unavailable, then samples of the seminal fluid are extracted from the victim’s body itself. The DNA from this sample is then matched with the DNA sample taken from the accused. If it is proved by the report that these samples match, then this acts as strong proof in the court for establishing rape. As regards the offence of murder, DNA samples that are gathered from the blood, mucous, saliva, skin; hair samples etc, which found on the offence site are applied to extract the DNA sample. DNA testing should be viewed against the fact that the growing citizen concern over crime is not merely about mounting statistics. It is also over the detectives’ inability to solve many gruesome crimes. Thus, this unique method becomes very effective to find out the offender. Regarding the authenticity of this modern DNA technique one of the most pertinent queries often made is regarding the handling of this type of technique by the police officer and law enforcement agencies in the process of crime investigation. It is mainly in this context that many critics of police performance raise the issue of DNA profiling frequently.\(^\text{68}\)

Apart from its use to nail the culprit, Post-conviction DNA Testing is also a very effective method to exonerate the innocent. The sophisticated technology makes it possible to obtain conclusive results in cases in which the previous testing had been inconclusive. Post-conviction testing will be requested not only in cases in which the DNA testing was never done but also in cases in which more refined technology may

\(^{67}\) R. Usharani,“DNA evidence and the court”1, Karnataka law Journal 2 (2008(1)).
\(^{68}\) DNA Fingerprinting available at wwwlegalservice.com(visited on date 14-07 2012)
result in an indisputable answer. The remarkable feature of DNA is that individuals leave at least its traces almost everywhere. A few of the everyday objects handled by us, such as pens, telephones, mugs and keys are some of the things that require attention from a crime investigator. A variety of offences such as murder, rape, armed robbery; extortion and drug trafficking yield themselves to the application of DNA collection and testing. According to a study by the National Institute of Justice (NIJ) of the United States’ Justice Department, there are many unusual sources of DNA evidence that need to be explored by an investigator. These include saliva found on the flap of an envelope containing a threat letter, spittle collected from the sidewalk where a suspect in a sexual assault case was under surveillance and blood collected from a bullet that had injured an assailant himself in a case of murder. Collection of samples at a scene of crime requires some skill and observance of basic rules of hygiene. There are two dangers here. One is that, as in the case of hand fingerprints, there is a distinct possibility of several persons having left their DNA behind in a scene of crime. The need, therefore, is to identify all visitors and collecting their samples also (apart from those of the victim/suspect). This assiduous process can try an officer’s patience. Secondly, DNA samples are extremely susceptible to contamination. It is essential that the technicians collecting the sample adopt all precautions that a surgeon would while performing a critical surgery. Any slackness could render the entire operation wasteful and susceptible to easy picking of holes by the defense counsel during a trial. Medical jurisprudence is the application of medical science to legal problems. It is typically involved in cases concerning blood relationship, mental illness, injury, or death resulting from violence. Autopsy is often used to determine the cause of death, particularly in cases where foul play is suspected. Post-mortem examination can determine not only the immediate agent of death (e.g. gunshot wound, poison), but may also yield important contextual information, such as how long the person has been dead, which can help trace the killing. Forensic medicine has also become increasingly important in cases involving rape. Modern techniques use such specimens as semen, blood, and hair samples of the criminal found in the victim’s bodies, which can be compared to the defendant’s genetic makeup through a technique known as DNA fingerprinting; this technique may also be used to identify the body of a victim. The establishment of serious mental

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69 Id.
illness by a licensed psychologist can be used in demonstrating incompetence to stand trial, a technique which may be used in the insanity defense, albeit infrequently.  

### 4.10.4 Genetic fingerprints

Genes are organised into chromosomes and it is through chromosomes that genetic information is transmitted. Genetic technology can be of great benefit to people. However, one of the most dangerous aspect of new technology is the danger to the genetic information becoming available to people who might be involved in making decision that effect every aspect of our lives, especially employer and health insurance company. Chromosomes are paired, and are made of deoxyribonucleic acid, often called DNA. It is the DNA which carries the “blueprint” (genes) from which “building orders” are obtained to direct the growth, maintenance, and activities that go on within our bodies. Except for identical twins, no two people have the same DNA. However, we all belong to the same species; consequently, large strands of DNA are the same in all of us. The segments that are different among us are often referred to as junk DNA by the biologists. It is these unique strands of DNA that are used by forensic scientists. Strands of DNA can be extracted from the cells and “cut” into shorter sections using enzymes. Through chemical techniques involving electrophoresis, radioactive DNA, and x-rays, a characteristic pattern can be established so-called genetic fingerprint. Because different people have different junk DNA, the prints obtained from different people will vary considerably; If there is a match between DNA extracted from semen found on the body of a rape victim and the DNA obtained from a rape suspect’s blood, the match is very convincing evidence-evidence that may well lead to a conviction. Although genetic fingerprinting can provide incriminating evidence, DNA analysis is not always possible because the amount of DNA extracted may not be sufficient for testing. Furthermore, there has been considerable controversy about the use of DNA, the statistical nature of the evidence it offers, and the validity of the testing. Genetic fingerprinting is not limited to DNA obtained from humans. In Arizona, a homicide detective found two seed pods from a palavered tree in the bed of a pickup truck owned by a man accused of murdering a young woman and disposing of her body. The accused man admitted giving the woman a ride in his truck but denied ever having been near the factory.
Chapter IV

where her body was found. The detective, after noting a scrape on a palavered tree near the factory, surmised that it was caused by the accused man’s truck. Using RAPD (Randomly Amplified Polymorphic DNA) markers—a technique developed by Du Pont scientists—forensic scientists were able to show that the seed pods found in the truck must have come from the scraped tree at the factory. DNA analysis is thus relatively new tool for forensic scientists, but already it has been used to free a number of people who were unjustly sent to prison for crimes that genetic fingerprinting has shown they could not have committed. Despite its success in freeing victims who were unfairly wrongfully convicted, many defense lawyers claim that the prosecutors have overestimated the value of DNA testing in identifying the defendants. They argue that because analysis of DNA molecules involves only a fraction of the DNA, a match does not establish the guilt, but only a probability of guilt. They also contend that there is a lack of quality control standards among laboratories, most of them private, where DNA testing is conducted. Lack of such controls, they argue, leads to so many errors in testing as to invalidate any statistical evidence. Many law officials argue that DNA analysis can provide statistical evidence.72

4.10.5 Gene Patents

Genetic Science and related technologies are important in medical research and in the development and provision of healthcare, and, their significance for human health is likely to increase as more becomes known about the biological functions of genes and the proteins they produce. The patentability of genetic material such as DNA sequence is an intricate and complex issue. The source or raw material for gene patent is human tissue, and some ethics claim that patent should not be given for human material.73

Human genetic research aims to enhance understanding of how genes and environmental factors operate and interact to influence the health of individuals and populations – and in so doing, to generate knowledge with the potential to improve individual and community health. Human genetic research may translate into the development and provision of new forms of healthcare involving, among other things,

medical genetic testing, pharmaco-genetics, gene therapy, and the use of therapeutic proteins or stem cells. There are many ways in which the potential subject matter of gene patents might usefully be categorized. The potential subject matter of gene patents can be grouped into the following four broad categories:-

(i) Genetic technologies – The methods and items used in genetic research and genetics – based healthcare, including those used in sequencing DNA, medical genetic testing, other diagnostic uses and gene therapy;

(ii) Natural genetic materials – These are the forms of genetic materials in their natural state, including DNA, RNA, genes and chromosomes;

(iii) Isolated genetic materials – These are the forms of genetic material isolated from nature, including genetic materials of whole genomes, single genes and gene fragments;

(iv) Genetic products – these are the item produced by the use of genetic materials, including proteins, nucleic acid probes, nucleic acid constructs such as vectors and plasmids, and anti-sense DNA.\(^{74}\)

Patenting of new and improved genetic technologies would ordinarily be the least controversial area of gene patenting, since the issues of “invention”, “novelty” and “usefulness” is clearer than they are in case of patents over genetic materials. There is a distinction between a gene or a gene fragment in situ i.e. in the human body or another organism and a gene or gene fragment that has been extracted from the body by a process of isolation and purification. In general, raw products of nature are not patentable. DNA products usually become patentable when they have been isolated, purified, or modified to produce a unique form not found in nature.\(^{75}\) The validity and scope of patent protection in the human genome is a question demanding a separate study. But the issue of gene patentability is analogous to the question of ownership of an individual’s genetic information can best be protected by law that treat genetic information as a kind of private property and not through a privacy regime. Genetic information can be protected by as personal property in many ways including as quasi property, as “jura in re propria”\(^{76}\) or what it may be called “quasi in


rem property. Genetic information is best protected as tangy non possent-an incorporeal thing – the subject matter of a right within the sphere of proprietary or valuable rights.  

4.10.6 DNA Parentage Testing

Parentage testing refers to testing done to confirm or deny biological parentage of a particular child or individual. Such testing may be conducted by blood group or DNA analysis. DNA parentage testing may exclude a person as the biological parent of a child with certainty but it cannot prove absolutely that a person is the child’s biological parent. The test result can, however, provide a probability that a person is the biological parent of a child and, if that probability is sufficiently high, an inference of parentage may be confidently drawn.

Parentage testing is the relationship testing and requires participation of two, sometimes three individuals in order to reveal useful information about the biological relationship between those persons. The context in which outcome of parentage testing is revealed is often highly emotionally charged. Where parentage has been misattributed, there may arise issues of “betrayal, revenge, truth and the search for resolution” for many years. This raises the question whether law should emphasize biological parentage over social parentage in matters of parental responsibility, guardianship and maintenance, succession and so on.

To determine child’s parentage, there is a statutory presumptions, such as, under Section 112 of the Indian Evidence Act, that the fact that any person was born during the continuance of a valid marriage between his / her mother and any man, or within two hundred and eighty days after its dissolution, the mother remaining unmarried, shall be conclusive proof that he is the legitimate child of that man, unless it can be shown that the parties had no access to each other at any time when that child could have been begotten.

DNA parentage testing may thus be used to rebut a presumption arising under the Act, or to establish evidence in the circumstances where no presumption arises. A man might seek DNA parentage testing in order to obtain evidence of non-paternity for the purpose of civil proceedings against the child’s mother to prove “paternity

77 Id.
79 Ibid.
fraud” and claim damages for emotional stress and financial loss that he suffered due to such fraud. DNA parentage testing may provide evidence to show that a person has a biological connection with a deceased person and can be a proof in support of a succession claim. In mass disasters, such as, aeroplane crashes and the famous World Trade Centre type collapses, DNA parentage and relationship testing is increasingly used in identifying human remains where the body of the deceased is no longer recognizable.80

The scientific accuracy of parentage testing is of vital importance, whether it is conducted by accredited or unaccredited laboratories. In a case where the family court ordered a man to undergo DNA parentage testing in relation to a child of whom he claimed to have no knowledge, the test result disclosed a 98.5% probability that he was the father of the child and was required to pay maintenance for the child.81 But years later, the man’s brother admitted having had a relationship with the child’s mother, and parentage testing showed a 99.5% probability that the brother was the child’s father.82 Thus, the social, psychological and economic consequences of unreliable testing point towards an imperative need to maintain the highest technical, scientific and professional standards in conducting parentage testing.83 It is suggested that parentage testing be done under supervision of courts to ensure both the accuracy and reliability of the evidence admitted. Possibility of ‘DNA fraud’ by laboratory staff in such tests is a matter of grave concern and there should be a proper mechanism to address issues arising from the test results and for safeguarding and protecting the integrity of samples against tampering or deliberate fraud. The option of using court supervision would make parentage testing subject to a court order and would enable the courts to provide independent oversight of testing, including in relation to the validity of consent.84

The question of disputed paternity or maternity may arise in the following circumstances-

80 Supra 4.
81 Dr. A.K. Srivastava”DNA Testing and Human Rights” IV CRLJ 82(2007).
82 This case was reported in G. Bearup, “The Doubt about Dad”, The Good Weekend (The Sydney Morning Herald), 3rd November 2001, 16, 20, and is referred in paragraph 31.42 of the ALRC Discussion Paper 66.
83 Vipul Dharmani,”DNA technology and its perspective “available at http://symlaw.ac.in(visited on date 03-09-2011).
84 Hardik Mehata and Rahul Desai,”Relevance of DNA as evidence from Indian perspective”2Gujarat Law Herald 21(2009).
• Alleged adultery and suits for nullity of marriage: when the child is born in lawful wedlock and the husband denies that he is not the father of the child and seeks divorce on this ground.

• Black mailing: when a child is born out of lawful wedlock and the mother accuses a certain man as the father of the child but the man denies the accusation.

• Suits for maintenance of illegitimate children.

• When there has been an allegation of interchanged of a child with another in the maternity home or hospital.

• In the case of kidnapped child, where the women who has kidnapped the child claims to be the mother she may name a friend as alleged father.

• In case supposition child, when a women pretend pregnancy and delivery and forth a suppositious child to pass it off as her own. 85

4.11 DNA testing Importance of in Legal Science

Advancement in science now provides law enforcement agencies with an unparalleled opportunity to conclusively identify those suspected of having committed the crime. DNA and other forensic testing have revolutionized investigation of crime in just 5 years. DNA, the common abbreviation for deoxyribonucleic acid is used with increasing frequency in the criminal justice system to determine the guilt or innocence. Improvement of DNA testing have also provided a powerful tool to the law enforcement to link suspect even to very old murders, provided that DNA evidence has been properly preserved. 86

In 1992, Barry Scheck ant Peter Neufeld the Innocence Project at the Benjamin N. Cardozo School of Law. 87 The project is a non profits law clinic that handles cases in which post conviction DNA testing of evidence can yield conclusive proof of innocence. As of June 2002, 100 people have been exonerated. 88 As a result

85 Kishan Vjj and Rajesh Biswas, Basic DNA and Evidentiary issue37(Jaypee Brother Medical Publisher (P) Ltd, New Delhi, 2004).
87 Actual Innocence by Scheck, Neufeld, and Dwyer.
88 As average of 7 years in prison was served by each exonerated prisoner identified in the 1996 government study titled "Convicted by Juries, Exonerated by Science ".

117
of this work, new Innocence Projects were created throughout the United States and now form an Innocence Network.

As of June 2002, 100 people have been exonerated from death row, and DNA has played a substantial role in exoneration in 11 of these cases. This prompted a trend for individual states to legislate post conviction DNA test for prisoners making claims of innocence. Some statutes apply only to the inmates on death row. Others enacted statutes requiring post conviction DNA tests for all convicted prisoners. However, these statutes are very restricted. After reading the 1966 government study titled “Convicted by Juries, Exonerated by Science,” the Attorney General directed the National Institute of Justice to establish the National Commission on the Future of DNA Evidence to provide recommendations for post conviction testing.

Since reinstatement of the death penalty in 1976, more than 765 people have been executed in the United States. The Innocence Protection Act of 2001 introduced in the Senate and House of Representatives will reduce the risk of wrongful convictions in capital cases. If passed, the bill will expand access to post conviction DNA testing and to establish federal standards in capital cases. It will make DNA testing available to the federal and state prisoners in capital and non capital cases, but with significant limitations.

4.11.1 Forensic DNA in Non criminal Cases

(a) Paternity Cases- Forensic DNA tests identical to those used in criminal cases are also used in paternity testing. Some of the commercial forensic laboratories that perform testing in criminal cases also perform paternity testing. The State courts rely on paternity testing to determine child support obligations.

(b) Questions may arise in immigration cases, particularly when immigrants claim family relationships to United States citizens. DNA tests to prove these biological relationships are recognized by the U.S. Immigration and Naturalization Service and by immigration courts.

(c) Identification of Decedents- Forensic DNA typing has long been used by AFDIL to identify the remains of war death. Using mitochondrial DNA testing,

90 H.R. 912 and S. , 486 Legislative Session.
the U.S. Armed Forces has identified the remains of soldiers from World War I, World War II, the Korean War, and Vietnam.

DNA typing is invaluable in mass disasters such as plane crashes. On September 11, 2001, the World Trade Centre in New York was destroyed when two jets high jacked by terrorists deliberately crashed into both the towers and killed thousand people. To identify the victim’s forensic DNA tests compared profiles of recovered bodies or body parts with profiles of victims’ personal items, such as toothbrushes and hairbrushes.

Several companies, private research institutes, and universities are working on programs employing new electronic DNA analysis technologies. These automated techniques are often developed in non-forensic fields, such as medical research, genetics, or biochemistry. Only after a time of hatching and incubation will the new technologies be sufficiently person to be reliable and widely accepted to permit forensic application.

DNA analysis is after all, used in medical identification and in the identification of disaster victims. Thus it is acceptable in these applications and it is acceptable in forensic applications as a good science.

The history of crime emanates with the history of civilization. Every society has been enacting laws to combat crimes and criminals since time immemorial; the single quest of any legal system has been the “quest for truth”.

Crime is a social and economic phenomenon distressing the whole human community. With sweeping changes in society and economic activities, the face and methodology of committing crime has also altered. Today, the sophisticated technology in the hands of criminals is creating mayhem. Thus the law enforcement agencies need to be a step ahead of the lawbreakers. Forensic science provides investigators or crime fighters that strong weapon, the most significant being DNA profiling or DNA technology to be one such tool, which upholds truth. DNA is an abbreviation of Deoxyribo Nucleic Acid, which is an organic substance, found in every cell and gives an individual a personal genetic blue print. It can be extracted from a whole variety of different materials like, blood, saliva, semen, hair, urine, body

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fluids, bones, body organs etc. DNA was in fact discovered in 1869 by a Swiss scientist Frederick Miescher, while Sir Alec. J. Jefferys discovered the use of DNA for forensic analysis in 1984 in England first used by the police in the famous Enderby case involving two girls who had been raped and murdered. Since then, different techniques have been developed by scientists, from time to time, the first being Restriction Fragment Length Polymerase or RFLP. Later, Polymerase chain reaction technique (PCR) was developed which has a great advantage over RFLP, and later on it takes lesser number of samples and replicates them manifolds. It is much quicker and cost effective. It also analyzes highly degraded samples and therefore it is the most widely followed method of DNA profiling. The various other methods of DNA profiling are short Tandem Repeat (STR) technology, Mitochondrial DNA analysis (MtDNA) and Y-Chromosome analysis. DNA tests are highly effective because every person’s DNA is unique except identical twins. The probability of DNA being same is about 1 in 3 billion. The greatest asset of DNA is that it is so specific to every individual that it cannot be tampered. DNA test can be used to establish parentage of a child, detect crimes, and identify mutilated dead corpses. They are of immense help in criminal justice administration and in some civil disputes like succession, inheritance etc.

The raison deter under the Indian Evidence Act of 1872 is against the illegitimacy of a child and the public policy that no child should suffer due to latches or lapses on the part of their parents. It is well established that when certain fact is considered as conclusive proof of another fact, the judiciary generally disables the party in disrupting such proof. The only exception occurs when the party contesting paternity shows that there was no access to the other party at the time when the conception of the child could have happened. Wherever paternity is contested, the burden of proof is on the party who pleads negative. Indian Courts have time and again held that the evidence for proving non-access must be strong, distinct,
satisfactory and conclusive\textsuperscript{98}. DNA test can be strong evidence as they are correct up to 99\% if positive and 100\% if negative. In the case of \textit{Gautam Kundu vs. State of West Bengal}\textsuperscript{99} the Apex Court has laid down certain guidelines regarding DNA tests and their admissibility to prove parentage-

(1) That Courts in India cannot order blood test as a matter of course.

(2) Whenever 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 that the husband must establish non-access in order to dispel the presumption arising under section 112 of the Indian 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.

Further the court said Blood-grouping test is a useful test to determine the question of disputed paternity. It can be relied upon by the courts as a circumstantial evidence, which ultimately excludes certain individual as a father of the child. However, it requires to be carefully noted that no person can be compelled to give sample of blood for analysis against his/her will and no adverse inference can be drawn against him/her for this refusal.

Later in the case of \textit{Kanti Devi v. Poshi Ram}\textsuperscript{100} the Supreme Court held that even a DNA test that indicated that the respondent was not the father of the child would not be enough to rebut the conclusiveness of the marriage as proof of legitimacy of the child. The Court held that the only way of rebutting the conclusive proof would be to adduce evidence of non-access.\textsuperscript{101} Justice K.T. Thomas while delivering the judgment said, "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 fathered by the

\textsuperscript{98} sec. 112 of the evidence act 1872.


\textsuperscript{100} AIR 2001 SC 2226: (2001) 5 SCC 311.

\textsuperscript{101} \textit{Ibid.}
husband, the conclusiveness in law would remain irrebuttable. 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.\textsuperscript{102}

The conclusive proof makes law not only static or standstill, but also rigid like an organised religion. It pronounce that ”whatever you may believe or whatever may be the fact, this forum will not consider your say, in fact you do not have any right to have your say”, it arrogantly throws out litigant. It is totally against the basic concept or rather requirement of justice that justice must also appear to be done.\textsuperscript{103}

In case of \textit{Bachubai Khasiya v. State of Gujarat & Another}\textsuperscript{104}, it was held by the court that the science of DNA is at a developing stage and when the Random occurrence Ratio is not available for Indian society, it would be risky act solely on a positive DNA report, because only if the DNA profile of the accused matches with the foetus, it cannot be considered as conclusive proof of paternity. Contrarily, if it is solitary piece of evidence with the possibility of involvement of the accused in the offence”.

In \textit{State of Karnataka v. M.V. Mahesh}, the applicant’s wife had disappeared and an investigation launched. Some human bones were recovered which were subjected to DNA of her close relatives, indicating that they may have belonged to her.

In \textit{Patingi Balaram Venkata Ganesh v. State of Andhra Pradesh}\textsuperscript{105}, it was alleged that the accused and the co-accused had fired at the deceased .Witnesses identified the assailant as wearing a pink shirt and testified that the accused had been injured during the firing. The pistol and the blood stained pink shirt were recovered and blood found on the shirt to match with the blood of the accused as per as DNA. The court relied on all the available evidence including the DNA evidence, found him guilty.

\textsuperscript{102} B. R. B V. J. B (1970) 2 All. ER 1023.
\textsuperscript{103} Dr. Rajeev Joshi,”Section 112 of Evidence Act, is conclusive proof intra vires”, CriLJ 145.
\textsuperscript{104} 2009(4) R.C.R. (criminal) 186.
The womanhood constitutes half of the population of the world but they are still an exploited lot. Inhuman treatment such as honour killing is being meted out to them rampantly suspecting their fidelity, which amounts to gross violation of human rights.\footnote{106 Famous Arushi Murder case of Noida is worth mentioning in this context.} The courts in the absence of any specific legislation or executive guidelines are helpless to order the parties to undergo DNA test. Sec.125 of the Code of Criminal Procedure, 1973 lays down the natural and fundamental duty of a man to maintain his legally wedded wife, children and parents so long as they are unable to maintain themselves. It provides a speedy remedy against starvation for a deserted wife, children and parents. Most of the times, in such cases parentage of children is in dispute. Therefore to establish paternity, apart from adding the oral and documentary evidence, the most warranted evidence is of medical proof in the form of DNA test.

In England, the Affiliation Proceeding Act was passed in 1957 whereby to establish paternity the mother’s evidence had to be corroborated by other facts such as blood test. The Family Reforms Act, 1969 granted powers to the courts to admit blood test reports in the proceedings of paternity. However, the English courts neither had the power to compel a person to submit for such a test, nor were able to draw any adverse inferences against refusal to do such a test.\footnote{107 http://www.legalservice.com (visited on date 12-09-2102).} Finally, the Family Reforms Act of 1987 enabled the English Courts to ask the parties to undergo blood tests. In United States of America, DNA tests have become a part of legislations like DNA Identification Act, 1994, Transplantation of Human Organs Act, 1994 and Advancement Of Justice through DNA Technology Act 2003 in our country though there is judicial acceptability of such tests, yet they can be exercised in case of ex debito justitiae and not on mere invocation of parties or on the mere volition of the courts. Unless the necessary laws are enacted at par with the laws of the developed nations the DNA technology would not be helpful in solving the disputed matters in India.

The Law Commission of India headed by Justice M. Jajannath Rao in its 185th report of the Union Ministry of law & justice in the year 2003, has suggested changes to the Section 112 of Indian Evidence Act 1872 for the inclusion of DNA test in the
part of the section by broadening the criteria. 108 On the changes suggested by the Law Commission the Indian Evidence Bill, 2003 is still pending before the Indian Parliament. The Bill had suggested the recasting of the language of Section 112 to include DNA test. While studying the comment of the law commission it becomes quite palpable that the Commission does not intend to apply the DNA test to positively prove that alleged person is not the father. The commission recommended that a person refusing to undergo DNA test should not be allowed to take a defensive stand that he is not the father. 109

4.12 Post Conviction DNA Testing: - An Over View

The phenomenon of exoneration as of wrongfully convicted prisoner through post conviction DNA Testing has received extensive and very positive media coverage. However, post conviction DNA Testing more often then not, provided either inconclusive result or in many cases confirmed the guilt of the prisoner seeking testing. 110

The fairy tale like story of the innocent men wrongly accused and convicted of a crime, later freed through post conviction DNA Testing, is told every week in magazines, newspaper comment, television shows and radio interviews. 111 DNA proof can be exercised to know the blamelessness of person. The ability of DNA proof to exclude a person conclusively has made DNA profiling a valuable tool in post conviction reviews. In case where the identity of the performer was at issue, and where the prosecution had relied on circumstantial evidence, DNA evidence can play a leading role in overturning a wrongful conviction. Post conviction request in which DNA evidence is available for testing and the testing results are likely to exonerate the convict, should be handled with great care when it becomes necessary to obtain samples from the victim and third party for the testing processes 112.

108 The language of the proposed sec.112 provides exception to DNA test to the prosecution of paternity by providing provision or the DNA printing test with the consent of the child by the permission of a court or finding out that a man is not father of a child.
111 Ibid.
112 See E.g. the aftermath of murder: daughter of victim, daughter of man convicted in Long ago murder clash over his fate, St. Louis Post-dispatch, Oct.23, 2005 at a to Stephanie booth, I fight for wrongfully convicted prisoner; hundred of innocent men have been locked up for violent crimes, they did not commit, cosmopolitans. 2005 at 232 ; Front line: what Jennifer saw(PBS
DNA technology is not only useful for strengthening cases against suspect but has become extremely helpful in proving innocence of suspect and even post convict. The National Institute of Justice under the guidance of Former Attorney General Janet Reno issued a report in 1996, entitled “Convicted by juries Exonerated by science” case studies where the uses of previously unavailable DNA technology proved the innocence of convicted felons. There Twenty-eight men in the study had served an average of seven years in prison before exoneration. Thereafter the initial report, the National Commission on the future use DNA evidence issued another report entitled “Post conviction DNA testing: Recommendation for Handling Requests”. This report was aimed at highlighting legal and scientific issues involved in post conviction testing and provided recommendation for prosecutors, defense counsel, the judiciary, victim assistance group, and laboratory and law enforcement personal. The post conviction cases highlight the importance of DNA technology and more specifically DNA database, as an investigative tool.

The DNA evidence is now a predominant forensic technique for identifying criminals when biological tissues are left at scene of crime. DNA testing on sample such as saliva, skin, blood, hair or semen not only helps to convict but also serves to exonerate. The sophisticated technology makes it possible to obtain conclusive result in case in which the previous testing has been inconclusive. The probative value of DNA testing has been steadily increasing to conduct their test advances\(^\text{113}\).

In the Indian context, the Constitution empowers the President of India under Art. 72 and the Governor of a State Article 161 to grant pardon, reprieves, respites, remission of punishment to suspend, remit or commute the sentence of any person convicted of the offences referred to their under.

4.13 Admissibility of DNA Evidence

The advancement of science had a great impact on law. The Govt. of India has taken note of the recent advancements in science and past appropriate legislations. Judges have to follow those enactments and apply the same whenever the need arise. As such legislators and Judges cannot remain aloof from the latest scientific advancement. Even in the absence of appropriate legislation, the Judges have applied

the scientific technique in solving disputes provided they did not expressly contravene
the existing law. The latest example is the use of DNA; though legislation has not
been passed in this regard even then it is used in appropriate cases.\textsuperscript{114}

In India, DNA evidence was first presented in 1991 in the Kerala High Court in
a paternity dispute (case of a well to do bus operator accused of fathering a child by
his typist).\textsuperscript{115}

The evidence to be admissible at trial must be relevant. The purpose of
evidence is aptly described by the witness. In other words, witness is the voice of
evidence. The courts from all over the world have recognized the importance of DNA
evidence. It is being used to solve and prove the old as well as new cases, either civil
or criminal and also the cases pertaining to paternity/ maternity disputes. It is
appreciated due to its extreme accuracy and reliability. In India the courts are also
relying on DNA technology but it appears that it is done reluctantly. The reasons are
many fold. Firstly, it is considered to be in a case rudimentary stage; secondly, it is
not a statutory recognition, and thirdly, that the presiding Judges of court themselves
do not have sufficient scientific knowledge to fully appreciate its technicalities. Since
DNA technology is recognized throughout the world and it is widely accepted in the
legal system in some of the countries of the world, the Indian courts should also have
the same attitude. Even in the absence of any statutory recognition, it is submitted that
DNA testing can be utilized in Indian cases.\textsuperscript{116}

In the of any absence specific legislation, in India regarding acceptability of
scientific evidence, the court has the discretion of admitting it under Section 45,
Indian Evidence Act, 1872. Before admitting it in evidence, the court may consider
following aspects \textit{viz}-

(a) Whether the technique is reliable or not?
(b) Whether it is supported by publication or peer review?
(c) What is the rate of error in such testing?
(d) Whether it is generally accepted by the Scientific Community?

\textsuperscript{114} The Gene Age- A legal Prospective, organize by centre for DNA Fingerprinting and Diagnostics,
Hyderabad and Nalsar university of law, Hyderabad, document prepared by Hon’ble Mr. Justice
\textsuperscript{115} Supra 69.
\textsuperscript{116} Ibid, .20.
(e) Whether it was necessary in this case to give the order for scientific examination?

(f) What are the standards of the procedure of testing etc?

In case of Geetha v. State of Kerala\textsuperscript{117}, the court held that the DNA testing report of CDFD, Hyderabad (A.P.), was inadmissible under Sec.293Cr.p.c.

In case of Vishal Motising vasava v. State of Gujarat\textsuperscript{118}, DNA test of husband was already carried out and wife was unaware of it, report of such DNA test was found negative. Wife moved application for second DNA test of husband at her choice of Forensic Science Library. On this application the court said that the session Judge had discretionary power to allow the second test and order for the same. Exercising such power is legal but the complainant cannot insist that such test be carried out at particular laboratory. Complainant had no such vested right and the state may carry out DNA test at the nearest FSL.

In case of Chandan Panalal Jaiswal v. State of Gujarat,\textsuperscript{119} the court considered that DNA analysis is a powerful identification technique and it should be used carefully. Therefore, case in collection, custody and manipulation by biological sample (s) is of great importance for the validity of this analysis. In case of Syed Mohd. Ghouse v. Noorunisa Begum\textsuperscript{120}, the wife and the minor girl filed a petition for maintenance against the appellant. In this case the marriage was not denied by the petitioner but the paternity was denied. Consequently, the petitioner refused to maintain his girl child. He demands for blood test of girl child so that it may be prove that he was not the father of that child. The apex court order for conducting the blood test for the benefit of the girl child. The court held that while considering an application seeking for DNA test, the court has to consider about the facts and circumstances and ramifications of such an order. In another case i.e. Banarsi Das v. Teeku Dutta\textsuperscript{121}, the court has held that DNA test orders is not allowed as a matter of routine.

\textsuperscript{117} (2005)2DMC286:2005(3) crimesto73 (ker.).
\textsuperscript{118} 2004CriLJ (3088) Guj.
\textsuperscript{119} 2004CriLJ 2992(2994). (Gujarat).
\textsuperscript{120} (2001)2DMC 454.
\textsuperscript{121} 2005 (52) A Cric 481 (S.C).
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In case of *Mahmood v. State U.P.*\(^{122}\), it was held that when an Inspector had not given any reason in support of his opinion, nor had it been shown that he has acquired special skill, knowledge and experience in the science of identification of fingerprint, it would be highly unsafe to convict one on a Capital charge without any independent corroboration, solely on the bold and dogmatic opinion of such a person, even in such opinion is assumed to be admissible under Sec. 45 of Indian Evidence Act.

In *Madhumita Shukla Murder Case* \(^{123}\) Amarmani Tripathi, who was then a minister in the Mayawati-led Bahujan Samaj Party-Bharatiya Janata Party coalition government, was accused of murdering the 24-year-old poetess because she allegedly refused to abort her child. Tripathi was arrested by the Central Bureau of Investigation on September 21, 2003 after a DNA test confirmed that the foetus matched with his DNA.

### 4.14 DNA Evidence – First Admissibility in India

The first Case on DNA test was from Kerala. The first case related with DNA test is *Kunihiraman v. Manoj Singh* \(^{124}\). This case was decided by Justice Tellicherry. In this case the parties were directed to undergo the DNA fingerprinting test, in order to establish the paternity of a child whose paternity was disputed. Both the parties were willing to undergo the test, which was conducted at the Centre of Cellular and Molecular Biology, Hyderabad. The fact of this case is as follows:-

Vilasini, a village girl from Kannur District in Kerala, had studied upto the tenth standard and was a deposit collector for a private financial institution. During the course of her business, she enrolled one Kunihiraman, a distant relative, as a depositor of the firm’s scheme. He was a bus operator with a sound financial background. She had to visit his house frequently, in order to collect the instalment. This resulted in an intimacy with him and an illegitimate child was born. Though the promise of marriage was given by Kunhiraman to Vilasini, he finally disowned her. In her distress, Vilasini abandoned the child, for which she had to face a prosecution. On acquittal, she requested Kunhiraman to pay for the maintenance of the child which he refused to do. Thereupon, a petition was filed by her before the Chief Judicial

\(^{122}\) 1976 CriLJ .10(13) (S.C.).  
\(^{123}\) AIR 2005 SC.  
\(^{124}\) (1991) 3 crimes 860 (ker.).
Magistrate, Tellicherry for maintenance. The claim was for a monthly allowance of Rs 500/- for the child.

Kunhiraman contended that he had no relationship whatsoever with the petitioner and stated that the child was not his progeny.

The lower court judgment 24-4-1990 was challenged in Kerala High Court but the judgment was upheld and court observed that DNA testing could by itself may be deciding factor for setting the paternity dispute. The court also held that it is admissible just like Ballistic and fingerprints expert opinion.125

**4.15 DNA and Criminal Justice Administrations**

The 21st century started with a very inauspicious note regarding the attack on World Trade Centre in New York which left us in no doubt that the new age, the criminals are no longer illiterate rogues but highly educated, qualified and motivated men. Therefore, the crime investigation trends too are undergoing rapid changes globally, depending increasingly upon the more reliable scientific evidence namely DNA fingerprinting.

Nowadays DNA fingerprinting is being used to identify mutilated dead bodies as was done in the WTC attack or after the earthquake in Gujarat. It is also used to gather relevant information about and to identify the terrorists killed in an encounter as was done in Akshardham attack or after the attack on Indian Parliament. After checking the DNA evidence found at the site of WTC, investigators could identify the leader of the terrorists and established his links with Al-Qaida. Unlike the Civil Proceedings or paternity disputes, the Criminal Courts in India have accepted DNA test. In Rajiv Gandhi Bomb Blast126 case, the DNA sample of the alleged assassin Dhanu were compared with her relatives, which gave concrete proof of her involvement in the crime and likewise in famous case Sushil Sharma V. The Delhi Administration 127(also known as Tandoor Murder Case) DNA sample of Naina Sahni were compared with the sample of her parents to conclusively establish her identity. Though no specific DNA legislation was enacted in India till date Sec53 & Sec.54 of the Code of Criminal Procedure, 1973 provided for DNA test impliedly and

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126 AIR 1999 SC 2640.
127 1996CriLJ 3944.
they were extensively used in determining the complex criminal problems. Sec. 53 deals with examination of the accused by medical practitioner at the request of police officer if there are reasonable grounds to believe that an examination of his person will afford evidence as to the commission of the offence.128

In Neeraj Sharma v. State of Punjab,129 the High Court observed that police power of taking samples of blood etc. could be exercised by the Magistrate and is not violative of article 20(3) of the Constitution.

Sec. 54 of the Cr.p.c.1973 further provides for the examination of the arrested person.130 The law commission of India in its 37th Report stated that to facilitate effective investigation, provision has been made authorizing an examination of arrested person by a medical practitioner, if from the nature of the alleged offence or the circumstances under which it is alleged to have been committed, there are reasonable grounds for believing that an examination of the person will afford evidence.131

Our country has been fighting vigorously against Terrorism for the last two decades. Thus our legislature had a compulsion to enact Prevention of Terrorism Act (POTA), 2002. According to Sec. 27(1) of POTA, When an investigating officer requests the court of CJM or the court of CMM in writing for obtaining sample of hand writing, finger prints, footprints, photographs, blood, saliva, semen, hair, voice of any accused person, a reasonable suspect to be involved in the commission of an offence under this Act, it shall be lawful for the court of CJM or the court of CMM to direct that such samples shall be given by the accused person to the police officer either through a medical practitioner or otherwise as the case may be. The phenomenon of terrorism is not unique to India. USA too has, after the attack of 9/11 has enacted the Patriot Act 2001, Sec. N503 of which provides for DNA identification of terrorists and other violent offenders. There are two other federal Acts too in the United States that provide for DNA tests namely The Innocence protection Act, 2003 and the advancement of justice through DNA Technology Act 2003. The first Act is in favour of a person wrongly convicted as he can ask for a DNA test to be done in order to prove his innocence and the second Act pertains to solve the pending cases with the help of DNA technology. In view of the recent

128 Ibid.
129 1953 CriLJ 2226 (Allah.).
130 Supra. 32.
development in the field of forensic science the Indian Government constituted a committee under the chairmanship of Justice V.S. Malimath in order to suggest effective reforms in the existing criminal justice system. The committee unanimously suggested comprehensive use of forensic science in crime investigation. An induction of DNA expert in the list of experts as provided under Section 293(4) of Cr.P.C, 1973.\(^{132}\)

The committee further recommended the amendment of Section 482 of Criminal Procedure Code dealing with the power of the high court. A recommendation regarding the amendments of Section 4 of The Identification of Prisoners Act, 1920, was also suggested by the committee which was on the lines of Section 27 of POTA, 2002. Moreover Section 313 of the Code of Criminal Procedure, 1973 was also recommended to be amended in order to draw adverse inference against the accused where he fails to answer regarding any important material against him. This would surely facilitate the law enforcement agencies and the police to employ DNA Profiling against the accused.

It must also be borne in the mind that the above mentioned submissions in the form of suggestions may not be misused by the enforcers of the law.\(^{133}\)

In Criminal Procedure Code by Code of Criminal Procedure (Amendment) Act, 2005 two new sections, Sec 53-A (2) (IV) and 164-A has been added, Sec 53 – A(2)(IV) provide that 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 : 53-A(2)(iv) the description of material taken from the person of the accused of DNA profiling, and Sec 164A (2) (iii) provides that the registered medical practitioner to whom such woman is sent shall, without delay, examine person and prepare a report of his examination giving the following particulars, namely:- 164A (2) (III) the description of materials taken from the person of the woman for DNA profiling.\(^{134}\)

In Bhatia Devi alias Babli & another V. State of Jharkhand & another\(^{135}\), a petition was filed for DNA test by petitioner no.1. Petitioner no.2 said that petitioner no.1 was legally married wife of opposite party. During maintenance proceedings,

\(^{132}\) Item 38, Malimath Committee report on reforms of criminal justice system 2003.
\(^{133}\) Ibid.
\(^{134}\) Code of Criminal Procedure (Amendment) Act, 2005, (w.e.f. of 23-6-2006).
\(^{135}\) 2011, CriLJ, 3643.
request for DNA test was made—the stand of opposite party that at no point of time he established sexual relation with petitioner no.1 after their marriage since he had no access to her -& petitioner no.2 was born to petitioner no.1 from earlier wedlock-no clear & satisfactory proof of no access-order passed by Family Court rejecting request for DNA test to establish the paternity.

**In Bhabani Prasad Jena v. Convener Secretary, Orissa State Commission for Woman and another**[^136], it was held DNA test is a matter relating to the paternity of a child, should not be directed by the court as a matter of course in a routine manner, whenever such a request is made. The court has to consider diverse aspects including presumption under Sec.112 of the Evidence Act pros and cons of such order and the test of eminent need, whether it is not possible for the court to reach the truth without the use of this test.

**In Halappa v. State of Karnataka,**[^137] it was held by the court that the blood sample of the accused of an offence of the rape can be taken without his consent for the purpose of DNA test. It is not the violation of Art. 20(3) because the offence of rape is very serious offence and it is an offence against the society at large.

**Rohit Shekar v. Shri Narayan Dutt Tiwari**[^138] in this case the Delhi High Court (in a paternity dispute case) examined the concept of DNA testing and the law pertaining to the same S. Ravindra Bhatt J. culled out the prevalent laws on the subject and examine them in the light of international decision, international human right instrument and national legislation and finally directed the defendant to undergo DNA test to ascertained the paternity of the claimant. In this case, the court having relied on international human right instrument and expressed the views that the right of the child to know (her or his) biological antecedent is now recognised internationally as being of crucial important. Major international instrument such as the UN Declaration on Human Rights have recognised the rights of a child irrespective of her or his legitimacy and article 7 of the Convention the Rights of the Child (CRC), 1989 has expressly specified a right to knowing of parenthood. In this case on the behalf of the DNA test it was proved that N D Tiwari the biological father of Rohit Agrawal.

[^136]: (2010), 8, SCC .633.
[^137]: 2010, Cri.L.J.4341.
[^138]: 2011 (121) dRJ562 (Delhi) .The SC refused to give in relief to the respondent.
Chapter IV

In *Anand Pasi v. State of U.P. &Another*\(^{139}\), it was observed by the court that under Section 293 of the Criminal procedure code, a report of scientific expert duly submitted by him for examination or analysis can be used as evidence without examine the expert under certain circumstances.

### 4.16 Conclusion

In India great importance has been attached to the technique of DNA Profiling. In fact various courts have also given their due recognitions to this modern technology. Thus with the help of DNA Profiling different complicated cases particularly relating to crimes and paternity have been easily solved. Keeping in view that today in the present society, the shrewd perpetrators of crimes are continuously engaged in the commission of highly sophisticated newer crimes with great impunity, using complicated modus operandi, there is an urgent need for a more rigorous, specific recent law on DNA Profiling to be enacted by the Government of India. Nonetheless in this regard a detailed comprehensive Bill entitled “*Human DNA Profiling Bill 2012*” has already been drafted in India. *(See Annexure I)*

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