CHAPTER: 9

APPLICATIONS OF DNA PROFILING

9.1 INTRODUCTION

DNA Fingerprinting, also known as Genetic Fingerprinting has recently come into vogue for establishing personal identification in criminal matters. Since time immemorial, various techniques for identification have been adopted; however DNA profiling has been proved to be the infallible one. Identification is the key question that needs to be answered in almost all the criminal cases and few civil matters. Traditionally, for identification, the investigating agencies relied upon Anthropometry, Dactylography, Portrait Parle, personality profiles, identification parades, identikit, photo-fit, or voice prints etc. On the basis of the theory of transfer given by Dr. Edmond Locard, Trace evidence was also used for identification purposes. Scientists even used body fluids for identification purposes. But, each mode had shortcomings of its own kind. Even Dactylography, once considered as infallible mode, is not achieving desired results as criminals have acquired modes of concealment. So, Scientists wanted a technique for identification with negligible shortcomings or use of such a marker that had an ability to survive and possessed large number of distinguishable alleles as compared to others. This need was fulfilled

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1 It was initiated by a French scientist, Bertillon who measured the various parts of body and described them so well that it became easy to apprehend them; however it had many flaws because of which, it ditched police officials quite a number of times.

2 Art of identification from the patterns of ridges on the fingers, firstly introduced in India in 1860 as a proof of identity for the payment of military pensions to illiterate ex-soldiers by a British administrator, William Herschel to stop widespread swindling. It is important to mention here that even the fingerprints of two twins are not similar.

3 Literally, the word means “picture”. It is the modified form of Anthropometrics. It involves following features of a person viz. name, alias; sex; colour; race; nationality; occupation; age; height; weight; built; complexion; hair; head; forehead and other parts of the body.

4 Each person has a personality that makes him distinct from others. The forensic psychologist can put together the idiosyncrasies of such criminals and predict their personality profiles.

5 Identification parade means and includes identification of the criminal by victim or eyewitness generally in the cases where the victim is earlier not acquainted with the criminal.

6 Reconstruction of facial features of fugitive criminals from the description by the victim or by the eyewitness helps to locate criminals. However, these can be defective and sometimes planted / fake. To overcome this lacuna, police department in USA has developed an identikit system. It is the kit carrying various facial features, drawn on transparent plastic sheets.

7 In photo-fit system of building a facial image of a culprit, photographic transparencies of different facial features are prepared in such a way that each transparency carries one feature only at a relevant site on the face.

8 There is no dispute over the point that each person has a unique voice pattern however, disputes may arise when the same is distorted, incompletely recorded, or mimicked.
post advent of DNA profiling for criminal investigations. DNA was introduced as evidence in a criminal proceeding in 1985 and played role in the outcome of a trial in 1988. However, it captured the fancy of the public in the infamous O.J. Simpson trial in 1995\(^9\) in Los Angeles Supreme Court, presided over by Judge Ito.

9.2 HUMAN IDENTIFICATION

Human identification is a method of identifying a particular individual. It may be identification of victims of criminal cases for e.g. rape, incest, bestiality, pedophily, etc; Identification of suspects in criminal cases; Identification of victims of mass disasters; Identification of babies in Baby swapping cases; Identification of the ancient remains; Identification of parents in adoption cases; Identification in Paternity\(^{10}\)/Maternity Disputes; identification for Authentication in immigration cases; Identification in Organ Transplant cases; Identification in Cold cases; Identification of skeletal remains/mutilated bodies through postmortem examination; Pedigree analysis in pets; Medical uses and identification for Post-conviction Exonerations.

Various techniques exist as of today for identification purposes. However, when identification is done through DNA, deoxyribonucleic acid, (human genetic material) of a sample such as semen, blood, or hair with a suspect sample, commonly

\(^9\) Available at http://en.wikipedia.org/wiki/O._J._Simpson_murder_case, (Last visited on march 18, 2015). O. J. Simpson was a Hall of Fame, football player, who became a running back for the Buffalo Bills after completing a storied college career at U.S.C. Other than his heroics on the field, Simpson gained fame subsequent to his football career by starring in many major motion pictures and in television commercials, especially for the Hertz Rent-A-Car Company. In June, 1994, Simpson was accused of murdering his ex-wife, Nicole Brown Simpson, and her companion, Ron Goldman. At the trial which took place a year after the deaths, DNA fingerprinting evidence was presented for the first time in a major case. Blood found of the door of Simpson’s Ford Bronco matched the blood found at the crime scene as established by DNA testing. The same blood was found adjacent to a shoe-print fitting Simpson’s shoe size and on other articles at the crime scene. The evidence was overwhelming and irrefutable, yet the jury incomprehensibly came back with an innocent verdict. It was apparent that the prosecution attorneys made some errors in their presentation of the DNA evidence. However, subsequent cases have been very successfully prosecuted in light of what was learned through the lacunae left during Simpson trial. It was a clear and cut case of laboratory negligence.

\(^{10}\) Available at http://en.wikipedia.org/wiki/anna_nicole_smith_case, (Last visited on march 18, 2015). Anna Nicole Smith was a star in Hollywood whose claim to fame was 1993 Playmate of the Year and a marriage to a fan, Texas oil tycoon and billionaire, Howard Marshall, who died soon after the marriage. Anna died in February, 2007 a few months after giving birth to her daughter, Dannielynn. At the time of Ms. Smith’s death, she was married to her lawyer, Howard Stern. A Los Angeles photographer by the name of Larry Birkhard claimed he was the father of Dannielynn. Since Danielynn is the heiress to millions of dollars, the paternity case received tremendous notoriety in the tabloids as well as on TV. The Court ordered that both men submit DNA samples. After laboratory testing, The DNA match was with Birkhard who subsequently took custody of the child. Modern DNA technology is assisting the law enforcement officers, the prosecutors, the judges and the Courts to make the rightful determinations in the outcome of criminal and civil cases.
used to prove the individual’s commission of a crime such as murder or rape,\footnote{Available at \url{http://law.yourdictionary.com/DNA-identification} (Last visited on March 18, 2015)} it is called as identification through DNA profiling. It may be complete (absolute) or incomplete (partial). Complete identification means the absolute fixation of individuality of a person whereas partial identification means ascertainment of only some facts about the identity of persons while others remain still unknown. Successful approaches include close co-operation between investigating officers and close relatives by pooling information and efforts. Experts those make contributions include pathologists, physicians, dentists, anatomists, physical anthropologists and experts of trace evidence. Identification may be of living person or the dead. Usually, identification of living is carried out by the police-officer whereas for identification of dead, a medical man is required. Identification of “Corpus Delicti\footnote{It is the body of offence or the body of crime as defined in the book "forensic science and toxicology:principles and practice" by Krishan Viz ; 3rd edition; pg 51}” is important for establishing the cause of death just linking the the accused to crime but its absence necessarily would not be fatal. However, it may provide an accused with an incentive to escape punishment\footnote{Ibid}.

Identification is a vital question, which needs to be answered in every investigating officer to solve the crime. Generally, in the criminal cases, the identity of victim is not at issue; however, there may be cases where the identity of the victim may be deliberately destroyed. In such cases, identity of victim needs to be established prior to the identity of suspect for revealing the motive\footnote{For example, where an accused wants that proceedings qua him may be dropped. He may choose a person with physical characteristics similar to his characteristics. Then he would disfigure him and plant his identification documents so that he is able to convince the authorities about his death those may result in dropping of proceedings against him}. In such cases, DNA profiling is the only mode to find out the truth as such an accused on enlarge may be a future threat to the society\footnote{Glaring example of the same is identification of the dead body through DNA profiling alleged to be that of Osama Bin Laden.}. This apart, the perpetrator may have \textit{n number} of reasons to conceal his identity\footnote{One of such reason may be to give hard time to investigating officials to reach him and in addition help him in securing time to flee.}. So, in the event of crime, an investigating officer has to answer various questions like who, why, when, how, and where the crime was committed? All these questions can be answered by aid of DNA profiling, which not only serves as an armamentarium for the investigating officers but may also help the innocent to be exonerated.\footnote{Assume that type O blood is found at the crime scene in the states of America. Type O occurs in about 177
9.3 RAPE CASES

Utility of DNA profiling in rape cases is a superior mode of identification. The traditional markers, don't have the ability to identify suspects in cases of admixture biological evidence. Moreover, sexual offences are done in secret and chances of eyewitness are rare. Not only this, now-a-days, rapists either muffle their faces or extremists may also kill their victims. Further, in cases of gang rape, there is a possibility that perpetrator may use condom or is a vasteconized male. The vaginal fluid is generally more as compared to the semen and when the sample is amplified, the victim sample along with semen will be amplified too. So, in such cases, Y-
Chromosomal\textsuperscript{18} analysis is extremely useful. In many other situations also, Y-Chromosomal Analysis may be helpful.\textsuperscript{19} for e.g. if there are mixed stains where the proportion of female DNA is higher than the male DNA present (which is frequently observed in vaginal swabs collected after sexual intercourse); In cases of alleged sexual assault where tests for seminal fluid or sperm are negative; In sexual assault cases where the evidence in question is positive for semen, but no DNA foreign to the victim can be detected, or potential male alleles are below the threshold for autosomal STR detection; In sexual assault cases where the evidence in question is amylase-positive and a male/female mixture is expected (e.g., traces of kisses or bites); In cases with very old semen stains, where the majority of sperm cells are suspected to be degraded and differential lysis is unsuccessful or risky; In sexual assault cases where a large number of semen or other stains have to be screened; In cases where the number of male donors in a stain needs to be determined; In cases where the evidence in question is expected to include cells of a male perpetrator (e.g., female fingernail hyponychium where male biological material may accumulate after violent attacks); In cases where the patri-linear relationship of a stain donor needs to be determined; In cases where the stain donor’s population of origin needs to be inferred\textsuperscript{20}.

9.3.1 Forensic Characterization of Semen\textsuperscript{21}

It is imperative for us to know that an average male's ejaculate contains 2 - 6 milliliters of seminal fluid and about 100 million sperm. First of all, it is to be ascertained that the collected body fluid is semen. This can be determined by

\begin{itemize}
  \item This is among the newest of the testing procedures. It’s fast and needs little DNA. Since this test is specific for only the male Y chromosome, it’s very useful for determining the number of male donors, in a mixed specimen, in sexual assault cases. It can be tested on sperm as well as epithelial cells. The potential utility of MPI and MPII in operational casework by their ability to dissect out the full 19 locus male haplotype in vaginal swabs taken up to 48 hours after intercourse has been exemplified. Partial profiles can be obtained 85 hours after intercourse. A judiciously chosen eleven-locus subset of our nineteen Y-STR loci is able to obtain a male donor profile 4 days after intercourse”.
  \item Article titled as “Y- chromosome STR Analysis in crime casework”, published online on May 20, 2009 by Lutz Roewer, head of department, Charité - Universitätsmedizin Berlin, Department of Forensic Genetics, Institute of Legal Medicine and Forensic Sciences.
  \item \textit{Ibid}
  \item Available at http://harfordmedlegal.typepad.com/forensics_talk/2006/12/DNA_ semen_analy.html, (Last visited on march 18, 2015).
\end{itemize}
quantification of Acid Phosphates in the sample or through Y-Chromosomal Testing (referred in the preceding Para).

The finding of seminal constituents from the crime scene sample is important evidence for substantiating sexual intercourse. However, absence does not necessarily mean that rape did not occur. Physical injuries such as bruises or bleeding confirm violent assault. Also, forceful contact between victim and assailant may result in a transfer of physical evidence. For this, analysis of all garments is necessary (may be victim or suspect) and evidence must be collected according to strict protocols. The presence of seminal constituents inside vagina is determining factor to ascertain the time of an alleged sexual attack as motile sperm lives only for 4-6 hours in the vaginal canal. The acidic environment of the vagina decreases the motile sperm count rapidly. Non motile sperm may normally be found up to 3 days after intercourse, and sometimes up to 6 days later in the cervix. Intact sperm (with tails) aren’t usually found 16 hours after intercourse but in some cases have been found up to 72 hours. Similarly, Seminal Acid Phosphatase substantially decreases with time in the vagina. It’s not usually found in the vagina after 48 hours. Another indicator of recent sexual activity is the P30 test. P30 is not usually found in the vagina after 8-9 hours post intercourse. If there was complete ejaculation, then there should be high levels of Acid Phosphatase and P30, and possibly motile sperm, left by the offenders, in the vagina and on the underwear.

Acid phosphates are an enzyme that secreted in seminal fluid, as well as other bodily fluids, such as vaginal secretions. However, the concentration of Acid Phosphates is up to 400 times greater in semen than in any other body fluid. It can be detected by its reaction to a special acidic chemical compound. A quick purple color is indicative of a positive acid phosphates reading. There are some fruit and vegetable juices which also have acid phosphates, but they will not react as quickly as Acid Phosphates in seminal fluid. A reaction time of less than 30 seconds indicates (+) semen. Another absolute indicator of semen is sperm. You can have semen without sperm, but you can’t have sperm without semen. When sperm are located under the microscope, a stain is definitely (+) for semen. Sperm are long, with both a head and a tail. The head carries the genetic material and the tail helps to spur it along upstream towards the cervix. Even with the large number of sperm in seminal fluid, it’s not unusual to have difficulty spotting them under the microscope. Not only are sperm bound tightly to cloth but, once dried, they become very brittle and easily disintegrate when washed or rubbed against something. Another reason is that sexual assaults often involve men with an abnormally low sperm count. This is known as Oligospermia. Some offenders have no sperm count at all. This is called Aspermia. A third reason is the increasing use of condoms by the offenders as they are getting smarter. If no sperm can be detected, yet the scientists still believe the evidence to be semen, a test known as the Prostate Specific Antigén (PSA or P30) can be carried out. This test is specific to seminal plasma. When it is isolated and injected into a rabbit, it produces antibodies (anti-P30). The serum is then used to check the semen stain. If it tests positive for P30, then the stain is seminal. Once the evidence is proven to be semen, the next step is to link the evidence to an individual through DNA fingerprinting.

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http://harfordmedlegal.typepad.com/forensics_talk/2006/12/DNA_semen_analy.html (last visited on 22/06/2014)


However for effective use of DNA profiling, the investigating officer has to be clever enough to look at all possible places from where DNA evidence can be found. Even in the absence of DNA from the sample, no haste conclusion should be taken and the investigating officer should carefully listen to what prosecutrix narrates and must do every endeavor to work on that theory without thinking about the results. Similar method can be employed for detecting the perpetrators committing unnatural offences against minor boys and males.

9.4 VICTIMS OF MASS DISASTERS

Identification of the victims of mass disasters is another complex area where DNA profiling can work wonders. DNA profiling was a tremendous aid in identification of the victims of World Trade Center Attack of September 11, 2001\textsuperscript{26}; the DNA Shoah project\textsuperscript{27}; disappeared children in Argentina.\textsuperscript{28} Mystery of son of

\textsuperscript{26} It was one of the gruesome terrorist attacks recorded in the history. The country had already faced such a difficult situation, but most difficult part had yet to come, that was of the identification of the victims from whatever was left behind. The near and dear ones were curious to know about the fate of their relatives and at-least wanted that ones who have met the tragic end should be bid farewell with all honour and after performing the last rituals. Identification of the victims of the September 11, 2001, World Trade Center attack presented a unique forensic challenge because the number and identity of the victims were unknown and many victims were represented only by bone and tissue fragments. At the time of the attack, no systems were in place for rapidly identifying victims in disasters with more than 500 fatalities. The National Institutes of Justice assembled a panel of experts from the National Institutes of Health and other institutions to develop processes to identify victims using DNA collected at the site. Panel members produced forms and kits needed to enable the medical examiner’s office to collect reference DNA from victims’ previously stored medical specimens. These specimens were collected and entered into a database. The medical examiner’s office also received about 20,000 pieces of human remains from the World Trade Center site, and a database of the victims’ DNA profiles was created. New information technology infrastructure was developed for data transfer between the state police and medical examiner’s office and to interconnect the databases and analytical tools used by panel members. In 2005 the search was declared at an end because many of the unidentified remains were too small or too damaged to be identified by the DNA extraction methods Available at that time. Remains of only 1585, of the 2792 people known to have died had been identified. In 2007, the medical examiner’s office reopened the search after the Bode Technology Group developed a new methodology of DNA extraction that required much less sample material than previously necessary. The victim DNA database and the new methods have allowed more victims to be identified, and further identifications will be possible as forensic DNA technology improves.

\textsuperscript{27} Available at http://www.DNAshoah.org/. (Last visited on July 19, 2014). DNA Shoah Project is building a database of genetic material from Holocaust survivors and their immediate descendants in hopes of reuniting families disrupted by the Shoah (“Holocaust” in Hebrew). The Project aims to match displaced relatives, provide Shoah orphans and lost children with information about their biological families and, eventually, assist in the forensic identification of Holocaust-era remains.

\textsuperscript{28} Numerous people (known as “the Disappeared”) were kidnapped and murdered in Argentina in the 1970s during the dirty war. Many women were pregnant. Their children took birth and, along with other kidnapped children, were raised by their kidnappers. The grandparents of these children have been looking for them for many years. Professor Mary-Claire King is performing the mitochondrial DNA analysis to help those who desire to unite with their dear ones.
Louis xvi and Marie Antoinette\textsuperscript{29}; tracing of Peruvian ice maiden\textsuperscript{30}; tracing lineage of African lemba tribesmen\textsuperscript{31}; ensuring authenticity of super bowl xxxiv footballs and 2000 summer Olympic souvenirs\textsuperscript{32} are also some of the glaring examples where the novel technology was used for the identification purposes.

9.5 COLD CASES

Cold case refers to that crime or an accident which has remained unsolved is not the subject of a recent criminal investigation. However, new information that could emerge from new witness testimony, re-examined archives, retained material evidence, as well as fresh activities of the suspect (e.g. repeated deaths of wives of a suspect, who marries a lady and then do away with her for insurance gain),\textsuperscript{33} upcoming technical methods, the surviving evidence can be re-analyzed, often with conclusive results. Law of Limitation doesn't apply to cold cases as such cases are violent or felony crimes, such as murder or rape. Sometimes disappearance of a

\textsuperscript{29} Paris, April 19, 2000 (\textit{Reuters}). Scientists cracked one of the great mysteries of European history by using DNA tests to prove that the son of executed French King Louis XVI and Marie-Antoinette died in prison as a child. Royalists have argued for 205 years over whether Louis-Charles de France perished in 1795 in a grim Paris prison or managed to escape the clutches of the French Revolution. In December, 1999, the presumed heart of the child king was removed from its resting place to enable scientists to compare its DNA makeup with samples from living and dead members of the royal family – including a lock of his mother Marie-Antoinette’s hair.

\textsuperscript{30} Available at http://www.ornl.gov/techresources/Human_Genome/project/benefits.shtml, (Last visited on July 19, 2014). The Ice Maiden was a 12 to 14 year old girl sacrificed by Inca priests 500 years ago to satisfy the mountain Gods of the Inca people. She was discovered in 1995 by climbers on Mt. Ampato in the Peruvian Andes. She is perhaps the best preserved mummy found in the Andes because she was in a frozen state. Analysis of the Ice Maiden’s DNA offers a wonderful opportunity for understanding her genetic origin. If mitochondrial DNA could be extracted from the Ice Maiden’s tissue and could be successfully amplified and sequenced, then trace her maternal line of descent could be possibly locate past and current relatives.

\textsuperscript{31} Available at http://www.pbs.org/wgbh/nova/transcripts/2706israel.html, (Last visited on July 19, 2014). In southern Africa, a people known as the Lemma heed the call of the shofar. They have believed for generations that they are Jews, direct descendants of the biblical patriarchs Abraham, Isaac, and Jacob. However unlikely the Lemba’s claims may seem, modern science is finding ways to test them. The ever-growing understanding of human genetics is revealing connections between peoples that have never been seen before.

\textsuperscript{32} The NFL used DNA technology to tag all the Super Bowl XXXIV balls, ensuring their authenticity for years to come and helping to combat the growing epidemic of sports memorabilia fraud. The footballs were marked with an invisible, yet permanent, strand of T synthetic DNA. The DNA strand is unique and is verifiable any time in the future using a specially calibrated laser. A Section of human genetic code taken from several unnamed Australian athletes was added to ink used to mark all official goods - everything from caps to socks - from the 2000 Summer Olympic Games. The technology is used as a way to mark artwork or one-of-a-kind sports souvenirs.

victim can also be considered cold case if, the victim has been not seen or heard since long\(^{34}\).

However, 35\% of cases, initially not cold, may become instantly so, when a seeming solved case is re-opened due to the discovery of new evidence pointing towards a person not actually a suspect. This happens in a surprising number of cases, and often is a result of a miscarriage of justice. Some become cold when "Corpus-delicti" is the human remain with no or negligible link evidence. Still some cases may be classified as cold when originally being ruled as an accident or suicide is re-designated as murder\(^{35}\).

A case is considered unsolved until suspect is identified, charged, and tried. A case that goes for trial but does not result in conviction can also be considered for re-opening purposes after discovery of new evidence. Generally, serial crimes are difficult to solve. For e.g. The BTK case\(^{36}\) and Original Night Stalker \(^{37}\)(still

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\(^{34}\) Natalee Ann Holloway (born October 21, 1986) disappeared on May 30, 2005, during a high school graduation trip to Aruba, a Caribbean country within the Kingdom of the Netherlands. An American student from Mountain Brook, Alabama, Holloway graduated from Mountain Brook High School on May 24, 2005, shortly before the trip. Her disappearance caused a media sensation in the United States. Holloway was scheduled to fly home later on May 30, but failed to appear for her flight. She was last seen by her classmates outside Carlon’s Charlie’s, a Caribbean chain restaurant and nightclub in Oranjestad, in a car with locals Joran van der Sloot and brothers Deepak and Satish Kalpoe. When questioned, the three men said they dropped her off at her hotel and denied knowing what became of Holloway. Upon further investigation by authorities, Van der Sloot was arrested twice on suspicion of involvement in her disappearance and the Kalpoes were each arrested three times. Due to lack of evidence the three men were released without charge after each arrest.

\(^{35}\) The John Christie murders are a classic case, when Timothy Evans was wrongly executed for the alleged murders of his wife and child. Many other bodies were later found in the house where they lived with Christie, and he in turn was executed for those crimes. The case helped a campaign against capital punishment in Britain.

\(^{36}\) Available at http://en.wikipedia.org/wiki/Dennis_Rader, (Last visited on July 19, 2014). Dennis Lynn Rader (born March 9, 1945) is an American serial killer who murdered ten people in Sedgwick County (in and around Wichita, Kansas), between 1974 and 1991. He was known as the BTK killer (or the BTK strangler). “BTK” stands for “Bind, Torture, Kill”, which was his famous signature. He sent letters describing the details of the killings to police and to local news outlets during the period of time in which the murders took place. After a long hiatus in the 1990s, though early 2000s, Rader resumed sending letters in 2004, leading to his 2005 arrest and subsequent conviction. He is currently serving 10 consecutive life sentences at El Dorado Correctional Facility, with an earliest possible release date of February 26, 2180.

\(^{37}\) Available at http://en.wikipedia.org/wiki/Original_Night_Stalker, (Last visited on July 19, 2014). The Original Night Stalker is the moniker for an unidentified serial killer and rapist who murdered at least ten people in Southern California from 1979 through 1986 and sexually assaulted at least fifty in Northern California from June, 1976 to July 1979. However, the connection to the Northern California assaults was not made until 2001, until which time the perpetrator was dubbed as The East Area Rapist. The Original Night Stalker/The East Area Rapist may be considered one of the worst and most prolific “un-apprehended” serial offenders in history since the Middle Ages. So far in the investigation, every named or investigated suspect has been cleared through DNA, alibi or other investigative means and methods.
unsolved) cases are such examples. The identity of Jack, the Ripper, is a notorious example of an outstanding cold case, with numerous suggestions as to the identity of the serial killer.\textsuperscript{38}

Every law enforcement department throughout the world has numerous unsolved cases where aid can be taken from DNA technology. Evidence invisible to the naked eye can be the key for solving a residential burglary, sexual assault, or murder. The saliva on the stamp of a stalker’s threatening letter, the perspiration on a rapist’s mask, or the skin cells shed on the ligature of a strangled child may hold the key for solving a crime. The successful review and investigation of unsolved cases require the same basic elements as the investigation of new cases including cooperation between law enforcement agency, crime laboratory and the prosecutor’s office. Investigators should be aware of technological advances in DNA testing that may yield profiles where previous testing was not performed or was unsuccessful. Recent advancements in DNA technology have improved law enforcement’s ability to use DNA to solve old cases. Original forensic applications of DNA analysis were developed using a technology called Restriction Fragment Length Polymorphism (RFLP) that required a relatively large quantity of DNA, so, at that time testing of a small sample or degraded sample was not possible. But now with the advent of advanced technology for DNA profiling, even a sample of minutest quantity can be amplified and degraded sample can also be tested. Further, newer DNA analysis techniques also enable laboratories to develop profiles from biological evidence invisible to the naked eye, such as skin cells left on ligatures or weapons. Unsolved cases should be evaluated by investigating agencies through both traditional and nontraditional sources of DNA. Valuable DNA evidence might get available that previously went undetected in the original investigation. If biological evidence is available for testing or retesting in unsolved case investigations, it is important that law enforcement and the crime laboratory work together to review evidence. Logistical issues regarding access to and the cost of DNA analysis will be another factor and an issue that relate to the discriminating power of each technology and that might affect the outcome of the results. Laboratory personnel can also provide a valuable perspective on the evidence that might yield

\textsuperscript{38} Available at murderpedia.org/male.R/r/r/ramirez-richard.htm (Last visited on July 19, 2014).
valuable and probative DNA results. Finally, if previously tested biological evidence produced a DNA profile but excluded the original suspect, revisiting those “exclusion” cases in the context of comparing them with DNA databases might prove to be very valuable in solving old cases. Some of the illustrative examples of cold cases are Murder of Elaine Graham\(^3\)\(^9\); Murder of 60-year-old John Orner\(^4\); Murder of 13-year-old Lizbeth Wilson in Prairie Village, Kansas\(^4\); murder of two El Segundo police officers.\(^4\)\(^2\) Also in 2011, 73-year-old Samuel Evans pleaded guilty to 1968 & 1972 cold cases after DNA evidence linked him to the slayings. The 1968 cold case solved by scientists at the Seattle Crime Lab is the oldest case ever solved using DNA Evidence.\(^4\)\(^3\)

\(^3\)Richard H. Walton, *Cold Case Homicides: A Practical Investigative Technique*, 432 (Taylor and Francis, 2006). In 2005 Edmond Jay Marr pleaded guilty to 2nd degree murder to the March 1983 kidnap and murder of Elaine Graham, 29, a nurse and student at California State University at Northridge. He became a suspect when acquaintances noted that he was in the immediate area of her disappearance and was seen at a sister’s home only a few blocks where the victim’s car was found. Her skeletal remains were found by hikers in a wooded area halfway between where she was last seen alive and where the car was found some six months later. A knife found in the suspect’s possession (when he was arrested for armed robbery a month later) was later proved to be the murder weapon when DNA evidence, unavailable in 1983, provided by Elaine’s daughter matched blood found in the knife’s crevices.

\(^4\)Ibid.; In 2002, Edward Freiburger was found guilty of 1st degree murder in the February, 1961 murder of 60-year-old John Orner, a cab driver in Columbia, South Carolina. Orner was robbed and murdered on the job with a .32 H & R pistol. Freiburger, then 19 and a soldier stationed at nearby Fort Jackson, became a suspect when it was discovered that he purchased such a pistol at a local pawnshop only hours before Orner received the dispatch call that was his last. It was bolstered by the fact he went AWOL that night. He was picked up by Tennessee State Police, a month later who found the gun in his possession. However ballistics tests were inconclusive and Freiburger was never charged. In 2002, a private firearms examiner working for the South Carolina Law Enforcement Division (or SLED) took the time to clean up the slugs and matched the bullets to the gun.

\(^4\)\(^2\)Available at [http://www.youtube.com/watch?v=GD8DOWiRH2o](http://www.youtube.com/watch?v=GD8DOWiRH2o), (Last visited on July 19, 2014). In 2003, John Henry Horton, 56, was arrested for the July, 1974 murder of 13-year-old Lizbeth Wilson in Prairie Village, Kansas. She had been last seen running across the field of the Shawnee Mission East High School by her brother John who was racing ahead of her about 7 p.m. Her remains were found in an empty field some six months later. Horton became a suspect when it became evident that she was last known to be alive at the school. He was the only known adult working on the school grounds that night. This was bolstered when other girls reported that he had tried to lure them into the school. Moreover, police found that he took an extended break from 8:30 p.m. until nearly midnight that night. They also searched his car and found a duffel bag and a bottle of chloroform. He explained it by saying that he used the chloroform to “get high”. However, the evidence was circumstantial and he went free until 2002 when investigators interviewed a witness overlooked in 1974. She, then 15, had been given chloroform by Horton and while unconscious had been sexually molested by him. This led to his arrest and conviction in 2003. However, the story did not end there. The Kansas State Supreme Court in 2005 overturned the conviction on the basis that the “prior bad act” had not been placed on public record so the witness’ testimony should not have been allowed. However they did grant leave to re-try and re-file the case. This time the evidence which was purely circumstantial, as well as the testimony of two of Horton’s fellow inmates, was enough for a second jury to declare him guilty.

\(^4\)\(^3\)In 2003, Gerald Mason was arrested and charged with the murder of two El Segundo police officers, as well as rape and robbery, dating back to 1957.
9.6 TUNNEL VISION

Sometimes a viable suspect has been overlooked or simply ignored due to flimsy circumstantial evidence, or due to the presence of a likelier suspect (who is later proven to be innocent), or due to tendency of investigators to zero in someone else to the exclusion of other possibilities (which goes back to the likelier suspect angle). This is called tunnel vision (wrong analysis). A notable example is the Peggy Hettrick murder case in Colorado.\textsuperscript{44} Another example is the Carol Hutto murder case \textsuperscript{45} in Florida. Similarly, the Zodiac Killer has been studied extensively for 40 years with numerous suspects discussed and debated. The perpetrators of the Wall Street bombing of 1920 have never been positively identified, though the Galleanists, a group of Italian anarchists, are widely believed to have planned the explosion. The burning of the Reichstag building in 1933, remains controversial and although Marinus van der Lubbe was tried, convicted and executed for arson, it is possible that the Reichstag fire was perpetrated by the Nazis to enhance their power and destroy democracy in Germany. A well-known cold case is the case of Judge Joseph Crater, a New York judge who stepped into a cab in 1930, and subsequently became the “missing man in New York”. In April 2005, police revealed that they had found some evidence in the 1950s which was related to the case: a handwritten note by Stella Ferrucci-Good, in an envelope reading “Do not open until my death”, claimed to give the location of Crater’s body. Another cold case is the unofficially unsolved murder of Hollywood director William Desmond Taylor, who was found, murdered in his home in 1922. In spite of several suspects and even a deathbed confession it is still considered unsolved\textsuperscript{46}.

\textsuperscript{44} Available at http://en.wikipedia.org/wiki/Peggy_Hettrick_murder_case, (Last visited on July 19, 2014). \textit{The Peggy Hettrick Murder} Case concerns the unsolved 1987 death of Peggy Hettrick in Fort Collins, Colorado. Timothy Lee Masters (born June 25, 1971) was charged and convicted of the crime in 1999, and sentenced to life imprisonment without parole. His sentence was vacated in 2008. Masters became the first convict in Colorado to be exonerated due to DNA evidence on June 29, 2011, although it was actually the absence of his DNA evidence on the body. Currently nobody is charged with the crime.

\textsuperscript{45} Available at http://www.livedash.com /transcript/ cold_case_files-the_calling_card %3B_carol’s_ diary, (Last visited on July 19, 2014). In December, 1976, the 16-year old’s body was found in a lake near an abandoned house in Largo, Florida. She was last seen alive the night before, when she received a call. Suspicion fell on her half-brother Jerry Irwin, then 17, who had stayed out all night and whose route home took him past the house and lake. Moreover, he had a long juvenile record of trouble-making and some violence. As a result, the police focused on him even though they could not make a case against him. This, however, allowed a better suspect to escape detection for nearly 18 years and even then four more were needed to bring the suspect, Carol’s boyfriend Jimmy Kuenn, to trial for the crime.

\textsuperscript{46} Ibid
Some of other notable international cold cases solved through DNA profiling are Aimee Willard's\(^{47}\) case; Barbara Ann Hackman Taylor's\(^{48}\) case; Altemio C. Sanchez's\(^{49}\) case; Chandra Ann Levy's\(^{50}\) case; Gary Leon Ridgway's\(^{51}\) case:

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\(^{47}\) Available at [http://en.wikipedia.org/wiki/Aimee_Willard](http://en.wikipedia.org/wiki/Aimee_Willard), (Last visited on July 29, 2014).. Aimee Willard (June 8, 1974 – June 20, 1996) was a star lacrosse player who was murdered on her way home during a night out with friends. Her car was left running and her body was found, but the killer was unknown. The unsolved crime was featured on Un solved Mysteries. With DNA evidence, her killer was identified as ex-convict Arthur Bomar, who was charged with and convicted of her murder. Bomar was sentenced to death. Many theories and suspects were investigated, but all were cleared when Bomar’s DNA matched DNA found during the investigation. It is theorized that Bomar hit Willard's car on purpose to pull her out. The story of her murder and investigation was also featured on an episode of Forensic Files.

\(^{48}\) Available at [http://en.wikipedia.org/wiki/Barbara_Ann_Hackman_Taylor](http://en.wikipedia.org/wiki/Barbara_Ann_Hackman_Taylor), (Last visited on July 29, 2014). Barbara Ann Hackman Taylor (b. December 1943 - d. 1968), also known as The Tent Girl, was an unidentified young woman (“Jane Doe”) found dead near Georgetown, Kentucky on May 17, 1968. Mr. Wilbur Riddle, who had been scavenging for glass insulators alongside Highway US-25, discovered the decomposing body wrapped in a heavy green canvas tarpaulin, that is generally used to wrap up a tent. A police investigation failed to identify the deceased woman, much less name any suspects in her apparent murder. She was buried in the Georgetown Cemetery with a donated headstone that bore her likeness as it appeared in a police sketch of how she might have looked in life. Decades later in 1998, the Tent Girl was positively identified as Barbara Ann Hackman Taylor as a result of the ongoing efforts of Mr. Todd Matthews. Matthews, the son-in-law of Wilbur Riddle, had maintained a longstanding interest in the case. He had collated information on the Tent Girl and combed through many missing persons reports on the internet. When he encountered a report from the family of a young woman who went missing in Lexington, Kentucky in late 1967, he forwarded information on the Tent Girl to the Hackman family. The family felt that this was likely their missing relative, and this led to the exhumation of the body and DNA testing, which confirmed her identity. The family opted to have Barbara’s remains re-interred in Georgetown, with an additional stone base placed under the original grave marker, bearing her real name. The prime suspect in the murder is Barbara’s husband, George Earl Taylor, who died of cancer in October 1987.

\(^{49}\) Available at [http://en.wikipedia.org/wiki/Altemio_Sanchez](http://en.wikipedia.org/wiki/Altemio_Sanchez), (Last visited on July 29, 2014).; Altemio C. Sanchez is an American serial killer who murdered at least three women and raped at least 14 others in and around Buffalo, New York, over a span of 25 years (1981–2006). He is also known as “The Bike Path Rapist”. His victims were: Linda Yalem, a sophomore at the University at Buffalo who was killed September 29, 1990; Majane Mazur, murdered in November, 1992; and Joan Diver, who was murdered on September 29, 2006, and whose body was found on a bike path in Newstead, New York, on October 1, 2006. The killer acquired the nickname because many of his crimes took place near secluded bike paths. On May 16, 2007, Sanchez pleaded guilty to the murders of Linda Yalem, Majane Mazur, and Joan Diver. On January 15, 2007, a police task force in Erie County, New York, arrested Sanchez and charged him with the murders. On January 19, 2007, an Erie County grand jury voted to indict Sanchez for the murders of Yalem and Mazur. Police say DNA found at eight crime scenes matches DNA secretly taken from Sanchez before his arrest.

\(^{50}\) Available at [http://en.wikipedia.org/wiki/Chandra_Levy](http://en.wikipedia.org/wiki/Chandra_Levy), (Last visited on July 29, 2014). Chandra Ann Levy (April 14, 1977 – May 1, 2001) was an American intern at the Federal Bureau of Prisons in Washington, D.C., who disappeared in May 2001. She was presumed murdered after her skeletal remains were found in Rock Creek Park in May, 2002. The case attracted attention from the American news media for years. The investigation led to media allegations of an extramarital affair with then-U.S. Representative Gary Condit, a five-term Democrat representing California’s 18th congressional district and a senior member of the House Permanent Select Committee on Intelligence. Condit was never named a suspect by police and was eventually cleared of involvement. However, the cloud of suspicion raised by the intense media focus on the missing intern and the later revelation of the affair led to his loss in his 2002 re-election campaign. The circumstances surrounding Levy’s death were unclear for eight years. On March 3, 2009, D.C. authorities obtained a warrant to arrest Ingmar Guandique, an illegal immigrant from El Salvador who had already been convicted of assaulting two other women in Rock Creek Park around the time of Levy’s disappearance. Prosecutors stated that Guandique had attacked and
tied up Levy in a remote area of the park, leaving her to die of dehydration or exposure. In November 2010, Guandique was convicted of murdering Levy; he was sentenced in February 2011 to 60 years in prison.

Available at http://en.wikipedia.org/wiki/Gary_Ridgway. (Last visited on July 29, 2014). Gary Leon Ridgway (born February 18, 1949), known as the Green River Killer, is an American serial killer. Ridgway murdered numerous women in Washington during the 1980s and 1990s, earning his nickname when the first five victims were found in the Green River. He strangled them, usually with his arm but sometimes using ligatures. After strangling the women, he would dump their bodies throughout forested and overgrown areas in King County. On November 30, 2001, as he was leaving the Renton, Washington Kenworth Truck factory where he worked, he was arrested for the murders of four women whose cases were linked to him through DNA evidence. As part of a plea bargain wherein he agreed to disclose the whereabouts of still “missing” women, he was spared the death penalty and received a sentence of life imprisonment without parole.

Available at http://en.wikipedia.org/wiki/Jessica_Keen (Last visited on July 29, 2014). Jessica Lyn Keen (September 24, 1975 - March 17, 1991) was a murder victim killed in Foster Chapel Cemetery in West Jefferson, Ohio. Her case was profiled on the television program Unsolved Mysteries. After being missing for two days, Jessica Keen’s body was found at the back of Foster Chapel Cemetery, 20 miles from the teen facility. She had been raped and badly beaten. She was still wearing her ring and watch, but a pendant with the word “taken” was nowhere to be found. Her boyfriend was the prime suspect, but DNA tests proved he was not responsible. Police theorized that she had escaped her abductors and ran to the cemetery. Evidence in the cemetery shows she tried to hide behind grave stones – one of her socks was found, and a knee imprint in the mud behind a grave stone was found with or near the sock. She was killed near a fence in the cemetery, presumably by her abductors, who had followed her. A cross with her name on it was placed where her body was discovered near the fence in the cemetery. On April 9, 2008, police in Burlington, North Carolina arrested Marvin Lee Smith, Jr. Smith was charged with unlawful sexual conduct on Keen, a felony. Smith had an extradition hearing set for April 30, 2008, to determine whether he would be turned over to Ohio authorities to face charges. In 2009, Smith admitted to a Madison county Courtroom that he had in fact raped and murdered Keen. According to The Columbus Dispatch, who reported the admission February 27, 2009, Smith told the Court that Keen had escaped Smith’s car and run into Foster Chapel Cemetery, where she collided with a fence post and fell. Smith confessed that he beat Keen to death with a tombstone, then discarded it over the fence nearby. Reports show that police had indeed found bloody pieces of a tombstone where Smith had indicated. In exchange for Smith’s confession, he avoided a death penalty trial that was set for March. Smith plead guilty to one charge of aggravated murder, with specifications of rape and murder, and was sentenced to 30 years to life in prison.

Available at http://en.wikipedia.org/wiki/Murder_of_Samantha_Runnion (Last visited on July 29, 2014). Jessica Lyn Keen’s case; The Lil’s Miss murder case; Samantha Bree Runnion’s case etc.

Jessica Lyn Keen’s case; The Lil’s Miss murder case; Samantha Bree Runnion’s case; Jessica Lyn Keen (September 24, 1975 - March 17, 1991) was a murder victim killed in Foster Chapel Cemetery in West Jefferson, Ohio. Her case was profiled on the television program Unsolved Mysteries. After being missing for two days, Jessica Keen’s body was found at the back of Foster Chapel Cemetery, 20 miles from the teen facility. She had been raped and badly beaten. She was still wearing her ring and watch, but a pendant with the word “taken” was nowhere to be found. Her boyfriend was the prime suspect, but DNA tests proved he was not responsible. Police theorized that she had escaped her abductors and ran to the cemetery. Evidence in the cemetery shows she tried to hide behind grave stones – one of her socks was found, and a knee imprint in the mud behind a grave stone was found with or near the sock. She was killed near a fence in the cemetery, presumably by her abductors, who had followed her. A cross with her name on it was placed where her body was discovered near the fence in the cemetery. On April 9, 2008, police in Burlington, North Carolina arrested Marvin Lee Smith, Jr. Smith was charged with unlawful sexual conduct on Keen, a felony. Smith had an extradition hearing set for April 30, 2008, to determine whether he would be turned over to Ohio authorities to face charges. In 2009, Smith admitted to a Madison county Courtroom that he had in fact raped and murdered Keen. According to The Columbus Dispatch, who reported the admission February 27, 2009, Smith told the Court that Keen had escaped Smith’s car and run into Foster Chapel Cemetery, where she collided with a fence post and fell. Smith confessed that he beat Keen to death with a tombstone, then discarded it over the fence nearby. Reports show that police had indeed found bloody pieces of a tombstone where Smith had indicated. In exchange for Smith’s confession, he avoided a death penalty trial that was set for March. Smith plead guilty to one charge of aggravated murder, with specifications of rape and murder, and was sentenced to 30 years to life in prison.

Available at http://en.wikipedia.org/wiki/Jessica_Keen (Last visited on July 29, 2014). “The Lil Miss murder” is the name given to the murder case of Lisa Marie Kimmell (July 18, 1969 - March 31, 1988), who disappeared while on a trip home from Colorado to Billings, Montana. Her murder would remain a cold case, until DNA profiling eventually linked a prison inmate to her kidnapping, rape and murder some fourteen years later, which led investigators to the most vital piece of evidence in the case: Kimmell’s missing car, which bore the distinctive personalized license plate that gave the case its name, “LIL MISS”.

Available at http://en.wikipedia.org/wiki/Murder_of_Samantha_Runnion (Last visited on July 29, 2014). Samantha Bree Runnion (July 26, 1996 - July 15, 2002) was an American murder victim. She was born in Massachusetts and was a resident of Stanton, California. Samantha was kidnapped, sexually abused and strangled by a man who lured her from her front yard by telling her he had lost his dog. Her body was found the next day by two men who were hang gliding off the mountainside near Ortega Highway in Riverside County, California. The autopsy revealed that she died from compression. A sample of the kidnapper’s DNA was found under her fingernail. The suspect, a Lake Elsinore, California, man named Alejandro Avila, was convicted of 1st degree murder with special circumstances in May 2005. His DNA matched that found on Samantha’s body, and a sample of her own DNA was found in his car. He was arrested three days after the abduction. Avila had previously been to the condominium complex where Samantha lived, because his ex-girlfriend had resided there and he had been previously acquitted of molesting her daughter and niece. On May 16, 2005, the jury recommended that he receive the death penalty. On July 22, 2005, the judge in the case formally sentenced Avila to death.
9.7 DNA PROFILING IN MINOR OFFENCES

Violent felonies like murders and rapes are the top priorities for investigating agencies whereas the scene of crime in case of minor offences like property crimes take the back seat mainly because of the assumption that the burglars would not leave DNA evidence behind or because departmental policies do not authorize the samples be taken from property crime scenes or because DNA profiling involves huge expenditure. DNA profiling cost of one sample comes around 10,000 TO 15,000 Rs/- per sample as per the information conveyed by Dr. Pandu, DNA forensic lab, Madhuban at Karnal, Haryana. But such a thought of investigating officers in case of property crimes qua collection of DNA evidence from property offences needs relegation as such crimes are not innocent crimes but intentional acts and the benefits of bringing to book, the property offenders, outnumber its disadvantages. So, these criminals pose a significant threat not just to those whose property they steal but to the community at large. The victims suffer from both psychological trauma and economic losses due to lowest clearance rate of any index crime. The analysis of DNA evidence from the property crime scenes not only will help to solve the said burglary but may also help to solve other crimes by linking those offenders to the other crimes which they might have perpetrated. So such samples should not only be collected but tested also. Refrain can result in recidivism of property crimes.

9.8 IMMIGRATION PURPOSES

DNA testing is used in many areas of life and its applications are expanding continuously. One of the booming areas for DNA testing is immigration. In fact, immigration is the one area for which, DNA analysis was conducted by Sir Alec Jeffery in 1983, for the first time. In this case, son of Ghanaian women was refused visa to U. K. of where his mother was the permanent resident. However, Sir Alec Jeffery was able to show that there was 1 in $6 \times 10^6$ probability that the boy was not the women’s son. At that point of time, the world population was 4 billion so; the boy was allowed to migrate. In US, authorities regularly use it to see whether residency application is genuine or not. General public should not panic during collection of

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DNA samples as most DNA samples today are collected using swabs from the cheek which, is a non-painful process. Only in rare cases will a blood sample need to be taken. Results are normally expected within 2-3 weeks, so, this much time would delay one’s application. Immigration DNA testing is necessary to prevent dishonest and fraudulent applications for residency to a country where one member of a family is already settled there. Passports and visas can be faked but DNA cannot be synthesized. A simple lineage DNA test can quickly establish biological family relationships and avoid having to find other ways to prove eligibility.\(^{56}\)

### 9.9 ORGAN TRANSPLANT

Transplanting living tissue from one person to another is a standard surgical procedure. Successful organ transplants between humans have created an increased demand for organ donors. This demand has vastly outgrown the supply of organs. Closing the gap between supply and demand is not easy. The tissue of the donor and the recipient need to be compatible, so that rejection does not occur. The tissue also needs to be collected in a strict medical environment. Around half of all people who need a transplant die while on waiting lists. This has given rise to a new type of crime, the organ thefts or organ transplants without consent. In such case if a person alleges such a crime, DNA profiling can prove the allegations.\(^{57}\)

### 9.10 SAMPLE SWAPPING CASES

History of sample swapping is as old as the use of DNA profiling in criminal cases. In the first criminal case analyzed by DNA testing, the blood sample of the rapist and murderer, Colin Pitchfork, was swapped. Any change in the reference samples or fudging will lead to erroneous results. If investigated properly, sample swapping can be identified. Unintentional swapping of samples at the time of collection by the authorities in a paternity case has been observed in this laboratory; the error was identified from the labels present on the samples and was later proved by DNA test.\(^{58}\)

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\(^{56}\) Ibid

\(^{57}\) Available at nuffieldbioethics.org/wp-content/uploads/2014/07/Human-tissue.pdf (Last visited on March 23, 2015)

9.11 CHILD SWAPPING

The application of DNA profiling in cases of paternity testing/maternity testing, in cases for establishing fatherhood for maintenance cases, mass disasters, victim identification, succession cases, child lost cases and cases of child swapping has been already discussed in detail in the preceding chapters. The process of DNA profiling is same then it may be for forensic investigation, identification or parentage. Earlier the maternity was never a point of dispute but now-a-days with advancement in technology and transformation of the cultural barriers, maternity is also been questioned especially in the cases of surrogate mothers and adultery though it may not be a offence against a women 59.

9.12 POST-CONVICTION TESTING

One way to view science is that it is a search for truth 60 and forensic science is no exception. The use of forensic science as a tool in the search for truth not only allows justice to be done by apprehending the guilty but also by exonerating the innocent”.61 Exoneration62 means to free somebody from blame or guilt i.e. to declare that somebody is not to blame or is not guilty of wrongdoing officially. DNA evidence is a relatively new instrument of exoneration. DNA technology has become one of the most powerful tools to ensure that justice is done through our criminal justice system. It not only helps identify offenders, get then convicted, but also, aids in getting innocent suspects and wrong convicts exonerated.63

Post-conviction relief proceeding is a federal criminal procedure prevalent in england whereby a convicted criminal can request that a conviction or sentence be corrected or vacated. This proceeding is designed as a partial substitute for habeas corpus, in which the Court reviews claims of a convicted offender that his/her constitutional rights were violated. Through a post-conviction relief proceeding, a

59 Ibid
60 Linus Pauling, “Science is the search for truth-it is not a game in which one tries to beat his opponent, to do harm to others”, 1958. Cited in Beck, Emily Morison (ed.), Familiar Quotations, (Brown and Company, Boston: Little, 1980).
62 The term “exoneration” is also used in criminal law to indicate that a surety bail bond has been discharged.
63 The first convicted defendant from a United States prison to be released on account of DNA testing was David Vasquez, in 1989.Available at http://en.wikipedia.org/wiki/Exoneration, (Last visited on July 29, 2014)
criminal defendant may challenge collaterally a judgment of conviction which has otherwise become final in the normal appellate review process. Post-conviction relief proceeding can be utile in the cases where at the time of institution or trial, DNA profiling was not existing, small or degraded sample testing was not possible or where the DNA evidence because of the admissibility issues was ignored over the ocular evidence. However, Attempts to exonerate convicts can be controversial in death penalty cases especially where new evidence is put forth post execution.

Recently, DNA evidence has been used to exonerate a number of persons either on death row or serving lengthy prison sentences. The number of states authorizing convicts to request post-conviction DNA testing since 1999 to October 2003 has increased from two to thirty. However, access to post-conviction testing is not easy. Organizations like the Innocence Project are particularly concerned with the exoneration of those who have been convicted on basis of weak evidence. Prefatory chapters also reveal that DNA evidence may not inculpate the perpetrator with certainty as manipulations may have to be ruled out. But, it can certainly exculpate a suspect provided all circumstances have been looked into before exoneration.

Post-conviction DNA profiling presents many challenges. One challenge is finding old biological evidence that may or may not have been retained. Although many jurisdictions have a policy of retaining old swabs and other biological evidence, many do not have. And, even in old cases in which biological evidence may still exist, actually locating can be difficult. Biological evidence remains stable when it is properly collected and stored. Scientific advances in DNA technology make it possible to reanalyze evidence in closed and cold cases. But proper maintenance and

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64 Available at http://definitions.uslegal.com/p/post-conviction-relief-proceeding, (Last visited on July 29, 2014). The federal statute pertaining to this proceeding is 28 U.S.C. §2255, enacted by Congress in 1948. Many states have adopted similar statutes that encompass all constitutional challenges to the judgment of conviction, but some statutes limit the scope of the remedy and the timeliness with which a motion for relief must be made. For e.g., some statutes stipulate a time frame of not more than five years after the conviction to invoke the proceeding. However, in India we do not have any statutory provision regarding post conviction relief proceeding.

65 Ibid

66 As of October 2003, prosecutors of criminal cases must approve the defendant’s request for DNA testing in certain cases. On April 23, 2007, Jerry Miller became the 200th person in the United States exonerated through the use of DNA evidence. Not only this, A 1995 survey of laboratories reported that DNA testing excluded suspects in about one-fourth to one-fifth of the cases. There is a national campaign in support of the formation of State Innocence Commissions, the statewide entities those would identify causes of wrongful convictions and develop state reforms that can improve the criminal justice system.

67 For example, hair - which previously only could be examined microscopically - can now be tested for DNA
storage of evidence can be a challenge for police agencies and forensic laboratories with limited space and even more limited budgets. Another challenge is backlog of DNA evidence.

9.12.1 ROLE OF THE PROSECUTOR

DNA testing can demonstrate actual innocence where both the prosecutors and the defense lawyers concur for such testing. As officers of justice, prosecutors should not only aim to get a verdict of conviction but real interest should be in bringing the actual guilty to justice. A groundless conviction means that the real perpetrator is still at large. DNA testing assists law enforcement because it may identify the true culprit in the case being challenged, clear up unsolved crimes, and prevent future criminal acts. Also, some prosecutors may not opt to take a traditional adversarial stance when their office receives a request for post-conviction DNA testing either due to lack of knowledge or particular case category or for the resources of their office. Prosecutors, who are knowledgeable about DNA testing and have ready access to laboratory facilities and expertise, may feel comfortable initiating DNA testing themselves instead of waiting for defense counsel to take the laboring oar. Except in the case of patently frivolous claims, following may be used as a guide:

- Prosecutors should not delay responding to a request for DNA testing. Immediate action may be required because the statute of limitations may bar future proceedings.

- Once a request for DNA testing is made, prosecutors should take affirmative steps to prevent the destruction of potentially relevant evidence (e.g., material from the crime scene or standards from victims or third parties) that may or may not have been tested. Immediate action may be needed when there is a policy authorizing the routine destruction of evidence.

- Prosecutors should use their best efforts to locate the crime scene samples. The prosecutor who handled the case originally may be the only person who knows where they are.

70 Ibid
71 Ibid
72 Ibid
Further, prosecutors should consider at the outset whether expeditious discussions with defense counsel would resolve the matter promptly or not? Defense counsel may be unaware of prior DNA testing that confirmed guilt and also the circumstances in which, the evidence was introduced and rejected. So, in such cases a need arises to convince the defense counsel objectively over the issue and seek his concurrence on the opinion of re-DNA testing.

9.12.2 ROLE OF DEFENSE COUNSEL

Defense counsel should appreciate that convictions are rarely reopened and that a non-contentious attitude may expedite the location of needed biological samples and accelerate the testing process that is an innocent client’s best hope for relief. On the other hand, defense counsel must also recognize and inform their clients that truth may have a price and that exculpatory results will have to be disclosed to the prosecution. Convicted felons are not entitled to testing without risking the consequences of false claims of innocence.\(^73\)

9.12.3 ROLE OF THE JUDICIARY

Judges may feel compelled to take a proactive position to protect the inmate seeking relief if the prosecution and defense are refusing to cooperate. A Court may exercise its discretion where it fears that the passage of time may make it impossible to ascertain the validity of a claim of actual innocence. The judge’s assistance may be sought in connection with matters such as locating and preserving evidence, obtaining discovery from laboratories, and compelling third parties to provide samples for elimination testing. The Court might also consider whether to exercise its discretion to appoint an expert to assist the Court in a case that presents a disputed, complex, technical issues relating to DNA testing or interpretation.\(^74\)

9.12.4 ROLE OF LAW ENFORCEMENT PERSONNEL

Cooperation on the part of law enforcement officials is crucial as materials needed for testing or retesting may be in their possession. Consequently, they can

\(^73\) Ibid
\(^74\) Ibid
assist in finding the evidence that was sent to the laboratory for testing; Identifying and locating other evidence that is now testable and in preservation of the evidence.\textsuperscript{75}

9.12.5 ROLE OF LABORATORY PERSONNEL

The public or private laboratory skilled in DNA testing can assist in the post-conviction process in a number of ways, including agreeing to conduct some pro-bono testing at the request of a judicial officer, prosecutor, defense counsel, or project and making its personnel available to assist participants in a post-conviction proceeding who lack adequate technical expertise.\textsuperscript{76}

9.12.6 ROLE OF THE VICTIMS’ ADVOCATE

The role of the victims’ advocate in post-conviction proceedings is essential and complex. The lawyer’s usual role is to provide support, which will likely be needed during a post-conviction proceeding as it may be extremely traumatic for surviving victims and their families to learn that a person found guilty is now attempting to vacate the conviction. The early involvement of victims’ advocates lessens the chance of victims and their families making this discovery through the media and ensures that they are kept informed and treated with appropriate concern and respect.\textsuperscript{77}

In cases where biological evidence was collected and still exists; and the evidence if subjected to DNA testing or retesting, it may exonerate the petitioner and it requires that the advocate prepare their clients for any possibility be that be exoneration. If this occurs, advocates face the difficult task of providing support for the person whose misidentification of the culprit may have been the chief evidence leading to the original guilty verdict.\textsuperscript{78}

Advocates will at times be called upon to persuade a victim to agree to DNA testing even though the victim is convinced of the accuracy of the identification he or she made at the inmate’s trial. For exclusionary purposes, samples may also have to

\textsuperscript{75} Ibid
\textsuperscript{76} Ibid
\textsuperscript{77} Ibid
\textsuperscript{78} Ibid
be tested from persons who were engaged in sexual relations with the victim at the relevant time. Victims may be reluctant to provide names or to urge these persons to cooperate. In order to expedite post-conviction proceedings, victims’ advocates must make victims appreciate the desirability of cooperating because DNA testing may lead to the apprehension of the person who was truly guilty and prevent future criminal acts. It is important to note that a number of States passed victims’ rights statutes that require notification of victims, including notification of appeals proceedings, prison release, and application for pardon or commutation of sentence. Agencies involved in post-conviction DNA cases should make certain they are complying with any applicable State statutes79.

9.12.7 BIOLOGICAL ISSUES

When DNA testing is done, several basic steps are performed regardless of the type of test. The general procedure includes interalia; isolation of the DNA; processing of the DNA so that test results may be obtained; determination of the DNA test results (or types), from specific regions of the DNA; and finally the comparison and interpretation of the test results from the unknown and known samples to determine whether the known individual is excluded as (is not) the source of the DNA or is included as a possible source of the DNA80.

Each additional test at a previously untested locus (location or site) in the DNA provides another opportunity for the result of “exclusion” if the known individual being used for comparison is not the source of the DNA from an evidence sample of unknown origin. If, however, the known individual is the source of the DNA on the evidence sample, additional testing will continue only to include that individual as a possible source of the DNA. When a sufficient number of tests have been performed in which an individual cannot be excluded as the source of the DNA by any of the tests, a point is reached at which the tests have excluded virtually the world’s population and the unique identification of that individual as the source of the DNA has been achieved81.

79 Ibid
80 Ibid
81 Ibid
9.12.8 LOCATION OF SAMPLES IN POST-CONVICTION CASES

It may not be out of place to refer here the various locations from where samples for testing in post-conviction cases may be found which, interalia includes Police department evidence or property rooms,\(^{82}\) Prosecutor’s office\(^{83}\); State and local crime laboratories often will retain slides or other pieces of evidence after conducting testing however, usually will return to the police department the clothing and vaginal swabs that are introduced as exhibits at trial; Hospitals, pathology departments, medical examiners’ offices, clinics, or doctors’ offices where sexual assault kits are prepared; Defense investigators; Courthouse property/evidence rooms; Offices of defense counsel in jurisdictions that require parties to preserve exhibits produced at trial; Independent crime laboratories; Clerks of Court; Court reporters\(^{84}\) etc.

9.12.9 POST CONVICTION IN AMERICA

9.12.9.1 THE INNOCENCE PROJECT, 2004

The Innocence Project is a non-profit legal organization in America (HQ at Newyork) committed for getting exonerated wrongly convicted people through DNA Profiling, and for reforming the criminal justice system to prevent further injustice. The Innocence Project was founded in 1992\(^{85}\) by Barry Scheck and Peter Neufeld. To date, the Innocence Project has freed 301 wrongfully convicted people, including 18 who spent time on death row. The strategy planned by the innocence project is first to find and target the causes responsible for wrongful convictions. As the pace of DNA exonerations has grown across the country in recent years, wrongful convictions have revealed disturbing fissures and trends in our criminal justice system. Together, these cases show us how the criminal justice system is broken – and how urgently it needs to be fixed. One should learn from the system’s failures. In each case where DNA has proven innocence beyond doubt, an overlapping array of causes has emerged – from mistakes to misconduct to factors of race and class. The common causes which have been identified are\(^{86}\) Eyewitness Misidentification / False testimonies; Invalidated or

\(^{82}\) Evidence is often found here if the evidence was never tested or it was sent to the State crime laboratory, which then returned it.

\(^{83}\) Evidence is often found here when it has been introduced at trial.

\(^{84}\) Available on https://www.ncjrs.gov/pdffiles1/nij/177626.pdf (last visited on 22/09/2014)

\(^{85}\) Available at http://en.wikipedia.org/wiki/Innocence_Project/ (last visited on 22/09/2014)

\(^{86}\) Available at http://www.innocenceproject.org/understand/ (last visited on 22/09/2014)
Improper Forensic Science; False Confessions / Admissions; Government Misconduct; Informants or Snitches; and Bad Lawyering. These factors don't contribute towards the exhaustive list of causes of wrongful conviction. Each case is unique and many include a combination of the above factors. Review of the case profiles would show how the common causes of wrongful convictions have affected real cases and that a sincere effort could have prevented\textsuperscript{87} the injustice.

\textbf{9.12.9.2 NATIONAL INSTITUTE OF JUSTICE}

The National Institute of Justice (hereinafter referred as NIJ) is the research, development, and evaluation government\textsuperscript{88} agency of the U.S. Department of Justice. It has been established with an objective of imparting knowledge and understanding how advances can be in the criminal justice system with the aid of science and technology and by adopting global perspective. NIJ provides funding to defray the costs for post-conviction DNA testing where actual innocence might be demonstrated. In initial stages, NIJ has funded 5 states in 2008 by grants\textsuperscript{89}. NIJ is seeking to help many more states. Last year, NIJ assembled a steering committee of criminal justice experts from the American Judicature Society, the Innocence Project, the National

\textsuperscript{87} For eg Kirk Bloods-worth was the first person to be exonerated by DNA profiling. Details Available at http://www.nij.gov/journals/262/post-conviction (last visited on 22/09/2014). Similarly a report titled as “Convicted by Juries, Exonerated By Science – Case Studies of DNA Evidence to Establish Innocence After Trial” was prepared by Edward J. Imwinkelried after the outcome of 28 cases. All the cases taken up for the report demonstrated that when DNA technology was subjected to admissibility rules, being novel, the Courts were compelled to rely upon the inferior kind of evidence, the eyewitnesses which in the 28 cases in hand turned to be inaccurate. In United States v. S Wade, Mr. Justice Brennan noted “the vagaries of eyewitness’s identification are well known; the annals of criminal law are rife with instances of mistaken identification. The sobering fact is that in all the 28 cases, the error was unmasked and justice finally served-only because of the novel scientific technique of DNA typing. The ‘junk science’ controversy has made it tempting to propose special restrictions for scientific evidence, especially testimony resting on new scientific techniques. The experts while preparing the report kept two questions in mind first, that the critics of scientific evidence did prove that the expert testimony presented a unique probative danger or they had merely made an assertion. Secondly, if we impose a unique restriction on scientific testimony, are the Courts more likely to reach at the just result or are we condemning the Courts to rely on suspected testimony that call into question the caliber of justice dispensed in our Courts? The conclusion framed through this report was that it served as an excellent example of the marriage between science and law and proving that DNA evidence has become invaluable resource in the forensic field. It was also held that justice can be served in such dramatic fashion and that it could actually facilitate to exonerate the wrongly guilty offenders while demonstrating the practical effect of science.

\textsuperscript{88} Government because, it is headed by the president rather than any scientist or a member of civil service. It is established under Omnibus Crime Control and Safe Streets Act, 1968.

\textsuperscript{89} In 2008, NIJ awarded nearly $8 million to five states - Arizona, Kentucky, Texas, Virginia and Washington - to identify eligible cases and help defray the costs of post-conviction DNA testing. States can use the money to review murder and rape cases, locate evidence, or analyze DNA in cases in which the innocence of a convicted person may be demonstrated through DNA. As these five states proceed with their work, NIJ will monitor their efforts and identify lessons learned for the rest of the country.
Association of Criminal Defense Lawyers, the National District Attorneys Association and other key stakeholders. The committee helped NIJ develop the agenda for a symposium to identify strategies to overcome challenges presented by post-conviction cases in state and local jurisdictions. The symposium was held in January, 2009 and was attended by prosecutors, defense lawyers, laboratory personnel and Innocence Project advocates from nearly all 50 states.\(^{90}\)

In another significant initiative, NIJ is funding the evaluation of post-conviction programs in Virginia and Arizona. The study will analyze the exonerations through DNA testing of retained forensic evidence of the people who were wrongly convicted of rape, murder and non-negligent manslaughter. The study will consider potential probative predictors of people who may have been wrongfully convicted such as coerced confession, eyewitness misidentification or ineffective assistance of counsel by examining cases that primarily occurred before DNA testing was readily available. One of the primary goals of the study will be to answer a critical policy question: What proportion of defendants with retained forensic evidence might be exonerated, if that evidence were tested? The study was designed to identify connections between case characteristics and the likelihood that DNA testing would produce results that could exonerate a convicted defendant. These finding could be particularly important if it turns out that there are statistical associations between case attributes and innocence, as this information could then be used by states to prioritize cases for post-conviction DNA analysis. Finally, NIJ is planning to fund an independent review of the exonerations of people who were wrongfully convicted to help the nation better understand how eyewitness testimony, false confessions, poor forensic examinations and investigative practices, and other issues relate to wrongful convictions. Therefore, NIJ intends to fund an analysis of Court records, police reports, newspapers and other published information to determine how people are wrongfully convicted, focusing particularly on cases of DNA exonerations in our country to date. The project is expected to look at data from three stages of cases of wrongful conviction: the investigation, the trial and post-conviction.\(^{91}\)

\(^{90}\) Ibid

\(^{91}\) *Investigation:* What happens during the early stages of what becomes a wrongful conviction? How did the investigators identify the suspect(s)? What forms of evidence did investigators collect? Had they identified the person who turned out to be the actual offender? Why did investigators focus on one person over another?

*Trial:* After the suspect who turned out to be not guilty was identified, what happened when the prosecutor became involved in the case? Was there a grand jury indictment or an information/complaint? What types of evidence were presented? Was there a jury trial or did the person
NIJ published Convicted by Juries, Exonerated by Science: Case Studies in the Use of DNA Evidence to Establish Innocence after Trial\textsuperscript{92} nearly 13 years ago. Many of the challenges discussed in that report are as relevant today as they were then, including Maintaining the highest standards for the collection and preservation of DNA evidence; Ensuring that the DNA testing methodology meets rigorous scientific criteria for reliability and accuracy; Ensuring the proficiency and credibility of forensic scientists so that their results and testimony are of the highest caliber and are capable of withstanding exacting scrutiny. Through its post-conviction research projects, NIJ is working to ensure that the standards of evidence collection and preservation; the reliability, the accuracy and the accessibility of DNA testing so as to enable our nation’s criminal justice practitioners to make appropriate use of this rapidly advancing and increasingly available technology\textsuperscript{93}.

\textbf{9.12.9.3 REMEDIES UNDER AMERICAN LAW} \hfill

As per Jail-house Lawyer’s Manual\textsuperscript{94}, 213 individuals have been exonerated in the United States through post-conviction DNA testing.\textsuperscript{95} Under the said manual, if a person believed that there is a biological evidence (like blood, semen, hair, or sweat) collected at the scene of crime of conviction that would exonerate him through DNA testing, he can make several motions to try to get this evidence tested, and the results admitted in Court. Finding evidence is one of the biggest obstacles for such a person. A big part of finding evidence is understanding the difference between biological evidence that was introduced at your trial (for instance, a bloody shirt) and evidence that was collected during the investigation, but not introduced at your trial

\footnotesize{\textit{plead guilty (false confession)? Did the wrongly convicted person testify? What type of representation did the person have? \hfill

\textit{Appeal and Remedy:} After a person was wrongfully convicted, what did he do, or what should he (or his counsel) have done? For example, what claims were raised during appeal? How was the wrongful conviction demonstrated? What happened, and how long did it take from the time the conviction was proven to be wrongful to the time of release? What release mechanisms were used (for example, retrial, Court order or pardon)? What compensation, if any, was given?} \hfill

\textsuperscript{92} This is a research report by National Institute for Justice that initiated a study in June 1995, to identify and review cases in which the convicted persons were released from prison as a result of post-trial DNA testing of evidence. As of early 1996, researchers had found 28 such cases. DNA test results obtained subsequently had proved that on basis of DNA testing, the possibility that the convicted persons could have committed the crimes was negligible and thus were incarcerated. The study involved study of 40 laboratories that had conducted DNA testing. \hfill

\textsuperscript{93} \textit{Ibid} \hfill

\textsuperscript{94} Dated March 1st, 1983 \hfill

\textsuperscript{95} “The Innocence Project”, Available http://www.innocenceproject.org/content/351.php#, ( last visited on 22/09/2014)
(for instance, a rape kit—the evidence collected from a rape victim when she was examined by a doctor). There is no need to actually locate the evidence to be tested. The only need is to prove that it was either collected during the course of the investigation or introduced into evidence at the trial (or both). While filing such a motion, it must be specified that what evidence ought to be tested, why that evidence is important, and the last known location of the evidence. It is very important to identify the last known location of the evidence. However, before filing a motion for post conviction testing, it is to checked whether the state has a post conviction DNA testing statute. In this regard the laws of Newyork are considered to be highly flexible.

The “reasonable probability” requirement is probably the most important. The Court will not order a DNA test if it believes there is no “reasonable probability” that the verdict would have been different, even if you are right about whatever you are trying to prove with the DNA test. This requirement does not mean that the Court must believe that the evidence will prove that you are completely innocent, but it does impose a significant burden on you. A Court can legally deny your request for testing if it believes that your conviction was justifiable, regardless of what a DNA test might show. The New York law is unusual in that it allows you to request DNA testing as part of your Article 440 motion to vacate judgment (request a new trial). Not all states allow you to combine the request for testing and motion for a new trial in the same motion, and it may be found that the law in other states is more difficult to use.  

In New York, the Court will order a test be done, if it satisfies certain pre-requisites namely:

- Requests has been made that a forensic test be performed on specific evidence, which you have clearly identified;
- The evidence upon which DNA test has to be performed is in connection with the trial (the trial which resulted in the conviction of suspect); and
- There is a “reasonable probability” that if the results of a DNA test had been admitted at the trial, the verdict would have been otherwise.

The text of that provision reads as follows:

Where the defendant’s motion requests the performance of a forensic DNA test on specified evidence, and upon the Court’s determination that any evidence containing deoxyribonucleic acid (“DNA”) was secured in connection with the trial resulting in the judgment, the Court shall grant the application for forensic DNA testing of such evidence upon its determination that if a DNA test had been conducted on such evidence, and if the results had been admitted in the trial resulting in the judgment, there exists a reasonable probability that the verdict would have been more favorable to the defendant. N.Y. Crim. Proc. Law, § 440.30(1-a(a)) (McKinney, 2005).


Article 440 of the New York Criminal Procedure Law to Attack Your Unfair Conviction or Illegal Sentence".

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For instance, some states have different deadlines, called “statutes of limitations”, for filing a motion for a new trial and for requesting post-conviction DNA testing. The opportunity to request a new trial may have passed the deadline even though the opportunity to request DNA testing is still technically available. Furthermore, some states may have stricter requirements for granting a request for testing than for granting a motion for a new trial (or vice versa).

9.12.9.4 REMEDIES IN ABSENCE OF LEGISLATION

Next question which needs to be answered is that whether offenders have constitutional right to seek post conviction testing in cases where there are no statutory laws. The law on this point is not settled, but recent Court decisions show that some Courts may support a constitutional right to testing. So, in America, where the state doesn’t have any specific statute, State Prisoners can file application under Section 1983. As far as Federal prisoners are concerned, they can apply under a new act called as the Justice for All Act, 2004. This law gives prisoners the right to request post-conviction DNA testing, but it applies only to federal prisoners. The Justice for All Act works exactly like a state post-conviction DNA statute if you are serving sentence for a federal crime. It lays out the standards states should have for

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100 In the case of Harvey v. Horan, 2002, Judge Luttig wrote an influential concurring opinion in which he opined that prisoners should have a right to testing because such a right would not necessarily allow a prisoner to attack his sentence (for example, if the DNA testing was not conclusive, the prisoner wouldn’t be able to attack his sentence) As for that the prisoner would have to file a separate petition based on a different violation of his constitutional rights. Several Courts have followed Judge Luttig’s reasoning, and have determined that prisoners do have a constitutional right to testing. The five main arguments often used to support the right to post-conviction DNA testing are:

- The procedural due process right to exculpatory evidence under the doctrine of Brady v. Maryland;
- The substantive due process right to be free from arbitrary government restrictions on his life, liberty, or property;
- The right to access the Courts and to petition the government;
- The unconstitutionality of continued confinement of an actually innocent person;
- The right a person has to seek executive clemency (for example, to ask the governor of a state to release a prisoner even without a new trial).

The Act requires that:

- The applicant must assert under penalty of perjury that he is “actually innocent” of the federal offense he is imprisoned or on death row for; or
- In death penalty cases, that he is “actually innocent” of another federal or state offense, if being exonerated of this offense would give him the right to a reduced sentence or a new sentencing hearing; and
- The specific evidence to be tested must not have been previously tested, except that testing using a newer and more reliable method of testing may be requested; and
- The proposed DNA testing may produce new evidence raising a reasonable probability that the applicant did not commit the offense; and
- The applicant must provide a current DNA sample for comparison with existing evidence.

post-conviction DNA testing, and it provides the rules and procedures for federal prisoners (serving a prison or death sentence) applying for DNA testing.\footnote{18 U.S.C. § 3600 (2000 & Supp. V 2005).}

Under this Act, the motion of DNA testing has to be made within five years after the Act was passed (so by October 30, 2009) or three years after your conviction—whichever comes first. If you don’t, your motion will be considered late, and you will have to show “good cause”, for condonation.\footnote{Ibid.} The government is not allowed to destroy DNA evidence from a federal criminal case while the defendant remains incarcerated, with certain exceptions, except where the defendant has waived his right to DNA testing; or where the defendant was notified about destruction of evidence post-conviction and he did not file a motion for testing; or where Court has denied a motion for testing at an earlier occasion; or where the evidence has already been tested and the results included the defendant as the source.\footnote{Ibid.}

It would not be out of place to mention here that If the evidence is large or bulky, the government may preserve a representative sample.\footnote{Ibid.} This apart, to discourage frivolous motions, there are provisions for the contemptuous. If innocence is asserted, and the DNA evidence does not show one to be innocent, the Court can hold one in contempt and if one is convicted of making false assertions, then term of imprisonment will be extended by at least three years.\footnote{18 U.S.C. § 3600 (2000 & Supp. V 2005).} However, if the evidence excludes one as the source of the DNA evidence, then he can petition for a new trial, which shall be granted when the test results, considered in light of another evidence available establish that a new trial would result in one’s acquittal.\footnote{Ibid.} Also, as a defendant, one may file a motion for a new sentencing hearing if, evidence of an offense was admitted during a federal death sentencing hearing and exoneration of that offense would entitle you to a reduced sentence or to a new sentencing proceeding.\footnote{Ibid.}

\footnote{Ibid.}  
\footnote{Ibid.}  
\footnote{Ibid.}  
\footnote{Ibid.}  
\footnote{Ibid.}  
\footnote{Ibid.}  
\footnote{Ibid.}  
\footnote{Ibid.}
In the federal system,\textsuperscript{111} Courts grant a motion for a new trial considering whether the evidence was available before the trial; Could it have been discovered before the trial through the exercise of due diligence; whether the evidence is relevant to the issue; whether the evidence is merely “cumulative” or “impeaching” or whether the evidence would probably change the result if a new trial were granted?\textsuperscript{112}

Also one may be able to file a motion for a new trial based on newly discovered evidence if biological evidence from the crime for which one was convicted still exists, and DNA testing was never performed on it; or DNA analysis was performed, but the results were not admitted in Court (because, for example, DNA testing was not regarded as reliable evidence at the time of your trial); or DNA analysis was performed, but the methods then used to analyze the evidence are now known to be unreliable\textsuperscript{113} (for example, microscopic hair comparison).

However, if one has pleaded guilty at trial, he may be denied motion for a new trial based on newly discovered evidence until and unless he could show that his act to plead guilty was involuntary. This may be so even if, the statute does not specifically say so.

9.12.9.5 HABEAS CORPUS

Post-conviction relief can be sought through petition for a writ of habeas corpus, though it is unlikely.\textsuperscript{114} A habeas corpus writ is a Court’s written order demanding a prisoner to be brought before the Court to see whether his imprisonment or detention is illegal. Unlike most post-conviction DNA cases, in which motions are made to find evidence, in habeas cases it is assumed you already have the evidence to exonerate you.\textsuperscript{115} So, this remedy is not available unless the biological evidence from the crime scene has already been subjected to DNA testing. Another aspect of habeas corpus petition is that it is a traditionally assumed relief which, cannot be granted

\textsuperscript{111} In federal Courts, Rule 33 of the Federal Rules of Criminal Procedure authorizes a request for a new trial. Rule 33 allows the Court to grant a new trial on defendant’s motion if “the interest of justice so requires”, Fed. R. Crim. p. 33.
\textsuperscript{113} \textit{Ibid}
\textsuperscript{114} Available at http://www3.law.columbia.edu/hrlr/JLM/Chapter_11.pdf (last visited on 22/09/2014)
unless a constitutional error occurred at trial. One may request access to crime scene evidence through the right to demonstrate actual innocence in habeas corpus review.\(^\text{116}\) Also, in a Supreme Court case called *House v. Bell*,\(^\text{117}\) the Court decided that in some cases where new evidence would have been likely to cast a reasonable doubt on a state prisoner’s conviction, that state prisoner may file for a federal habeas corpus writ, even if the laws of the state where he was convicted would have normally barred a federal habeas filing. In connection with habeas review, one may find success through the Brady obligation (also known as the Brady material doctrine).\(^\text{118}\)

The Supreme Court has interpreted Brady in such a way so as no compulsion is imposed on the state to perform DNA tests on evidence, or to preserve evidence being a constitutional duty, so, it can be tested.\(^\text{119}\) But, this rule changed when Congress passed the Justice for All Act of 2004.\(^\text{120}\) The Justice for All Act imposes uniform rules for the preservation of evidence for DNA testing in federal crimes but in its current form, any deviation from the rules does not give rise to damage actions.\(^\text{121}\) Also, there is no clarity of the fact whether violation of these procedures can be the basis for other relief claims, like under Section 1983.

### 9.12.10 POST-CONVICTION IN ENGLAND

In England case titled *Regina v. Michael Shirley*,\(^\text{122}\) was the First case in which, accused was exonerated on the basis of post-conviction DNA testing.\(^\text{123}\) The new

\(^{116}\) This idea is based on the judgment given in case titled *Herrera v. Collins*, in which the Supreme Court left open the possibility that “a truly persuasive post-trial demonstration of ‘actual innocence’” could lead to prisoner relief in the event there was not a state-sanctioned review of the evidence.

\(^{117}\) *547 U.S. 518, 126 S. Ct. 2064, 2076–77, 165 L. Ed. 2d 1, 21 (2006).*

\(^{118}\) *Brady v. Maryland, 373 U.S. 83, 87, 83 S. Ct. 1194, 1196–97, 10 L. Ed. 2d 215, 218 (1963).* Under this doctrine, the prosecution in a criminal case must reveal any evidence that may prove your innocence. However, the evidence referred to is the results from DNA testing, not the material being tested, so If,

- evidence was subjected to DNA testing;
- the prosecution withheld the results of that test from you; and

The results may have helped to prove your innocence, you may have a claim for habeas corpus relief. But, if no DNA analysis was performed on the material, you cannot allege a Brady violation based on the prosecution’s withholding of that evidence (since the “evidence” did not exist).


\(^{122}\) Available at [http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1351149/](http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1351149/), visited on August 1, 2011.

\(^{123}\) Michael Shirley was an 18 year old Royal Navy sailor when he was arrested in 1987 for the murder of Linda Cook - a young woman who had been raped and then killed by her assailant stamping violently on her head and neck. During this brutal assault, Linda Cook’s jaw and spine were broken and her larynx was crushed. One important aspect of the original trial evidence against Shirley was the result of analysis carried out on his semen extracted from Linda Cook’s body. As part of common procedure at
evidence which quashed Shirley’s conviction in the Court of Appeal is referred to throughout as ‘new DNA evidence’. However, the Court ruled that this evidence alone did not exonerate Shirley of the crime, so much as, make his original conviction unsafe. The emphasis is an important one because it highlights the way in which DNA evidence can be utilized in post-conviction cases and what it can achieve.

The case of Michael Shirley demonstrates that it is entirely problematic to suppose that post-conviction DNA profiling, in and of itself necessarily exonerates individuals. Even where it can be shown that DNA profiles obtained from victims cannot be associated with those convicted of a variety of assaults on them, such DNA evidence alone may prove inconclusive. What post-conviction DNA testing brings to an appellant’s case is, essentially evidence of the same value that is now routinely admitted to Courts in prosecution proceedings, that is, a statistically reasoned method for asserting the likelihood of a known individual being the originator of trace DNA found at a particular crime scene. It is the combination of that method of calculation, when combined with other forms of evidence, which is of the greatest value to our criminal justice systems.

Yet the crucial necessity to contextualize the significance of any particular instance of DNA profiling is often forgotten in the rhetorical constructions which

that time, blood group analysis was undertaken on semen swabbed from Cook’s vagina, vulva and anus. Evidence presented to the Court identified a blood group match between the semen and Shirley; the same blood group, it was asserted at the time, was shared by 23.3% of the British adult male population. Other physical evidence assumed to link Shirley to the victim included a distinctive shoe-mark logo imprinted on Cook’s stomach, which corresponded to the logo on shoes in his possession, along with cuts and scratches on his face and body and bloodstains on his trousers, all of which were supposed to have resulted from the attack.

Forensic DNA profiling was available to police investigators at the time of Michael Shirley’s trial in 1988. Alec Jeffrey’s ‘DNA fingerprinting’, based on multi-locus probes had already been employed initially to eliminate a prime suspect from investigation and, subsequently, to identify and link Colin Pitchfork to two murders. However, DNA profiling could not be undertaken upon Shirley’s semen found on swabs taken from Cook’s body as they were of insufficient volume so as to permit profiling with available techniques.

Subsequent scientific developments in DNA profiling technologies (most importantly the development of PCR amplification to allow smaller and more degraded samples to be used to generate full genetic profiles) allowed analysis to be carried out on samples obtained from Linda Cook’s body. In 1999, DNA analysis, using Low Copy Number technology (a process which uses increased PCR amplifications to analyze extremely small samples) was attempted on intimate swabs taken from Cook’s body and stored since 1986. However the mixed DNA profile derived from this analysis proved inconclusive in the absence of reference samples from Cook and Shirley. In 2001, the reference samples (mouth swabs) were obtained from both Cook and Shirley to obtain profiles for each of them. When Cook’s DNA bands were subtracted from those exhibited by the mixed profile there remained an array of “foreign” DNA bands which did not match either the victim or the appellant. The Appeal Court interpreted these ‘foreign bands’ to provide significant grounds for Shirley’s appeal against sentence and the Court quashed his conviction in July, 2003.

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surround its use. For instance, in Berger’s account of the capacity of this technology to exonerate individuals from involvement in crimes for which they have already been convicted, DNA profiling raises serious problems for criminal justice systems. Berger argues that unlike any previously available method for establishing new evidence, DNA profiling serves not only to re-open old cases, but also, forces us to re-think the assumptions we hold about our criminal justice system. For her, post-conviction DNA exoneration will not simply release convicted prisoners but will highlight ‘flawed assumptions and failing in our criminal justice system that will continue to require attention. In particular, she argues that the ‘infallibility of DNA’ introduces a level of certainty which shows the inadequacy of our trial system and the evidence types it relies upon. The DNA would expose the failings of the jury system because, by re-opening cases with post-conviction testing, it questions the adequacy of the evidence that had been used to convict. Eye witness testimony, she argues, may especially be called into question by DNA profiling though we have irrefutable proof of the fallibility of eyewitness testimony.

However, whilst Berger is correct in her claim that post-conviction DNA testing introduces new levels of certainty into specific aspects of criminal procedure, and raises legal issues yet; her view that it makes problematic all other forms of other evidence needs further examination. In the Shirley case, as we have seen, the Court of Appeal actually relied entirely on witness testimony, provided by Linda Cook’s friend, to establish a basis on which the significance of the DNA evidence could be interpreted. Without that testimony, it would have been open to contention that Cook had another sexual partner that day. Berger’s reliance on DNA as an ‘omnipresent witness’ that can be called upon to verify the certainty of a series of events is, at least, problematic and ignores the contextual complexity of evidence which pertains to all criminal cases.

It is problematic to claim that post-conviction DNA testing reveals flaws inherent to our criminal justice system. All new forms of evidence which exonerate the convicted point to mistakes in particular cases as they were originally prosecuted. In the Shirley case, it may be assumed that the jury relied on the standard scientific

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evidence available at that time to corroborate the other circumstantial evidence. Yet, the scientific credibility of accuracy and certainty on which DNA profiling is based, makes it a powerful source of evidence to admit as grounds for appeal. Whilst, it would be difficult to imagine a high volume of cases in UK, given that long-term prisoners constitute a small percentage of the prison population (and that many of them may have already been convicted with DNA evidence), it is nevertheless possible that more cases using post-conviction DNA evidence will appear. But at the present time, there is little reason to suppose that anything but a small percentage of those cases which should be heard will even reach the Court of Appeal. Without proper consideration by government, and resources made available to those who most need them, post-conviction testing in UK remains sporadic. For these reasons, it is difficult to imagine post-conviction exoneration cases developing along the USA model in UK. However, given that the collection, use and storage of genetic material by the police is, more than ever before, under scrutiny within UK, the provision of resources for such instances of forensic DNA profiling may be a necessary short-term investment by government. As noted above, USA post-conviction exoneration’s have served to promote the positive and beneficial aspects of DNA profiling in relation to debates about civil liberties. Whilst these debates have remained muted in the UK, there currently exist various critical challenges to the Government’s legislative provision and current arrangements for policing. The case of R v. Marper & ‘S’;125 which awaits a hearing in the House of Lords, will challenge the Government on the basis on Articles 8 and 14 of the European Convention of Human Rights, arguing that the retention of innocent persons’ DNA constitutes a breach of the right to privacy and constitutes a form of discrimination. It has been this case which has provided a focal point for many commentators’ view that an increasing imbalance between the state and individual citizens characterizes the current arrangements for DNA data basing. This is an imbalance which was recently recognized by the Parliamentary Joint Committee of Human Rights.126 The capability of DNA profiling to right the failures of past judicial mistakes may prove to be a crucial weapon in the government’s fight to maintain, or even extend further, the National DNA Database.

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126 Ibid.
The impact of DNA technology and its ability to prove innocence of a person has been recognized throughout the world; however, there are yet some countries that lack statutory provisions or more accurately a full code complete in all respects qua DNA profiling. Out of such countries India and Philippines are few to name. India, however, has recognized the impact of DNA-based exoneration’s as it moves toward passing legislation to establish an offender database. In remarks advocating for the passage of database laws, Dr. Seyed Hasnain, Director of the Center for DNA Fingerprinting and Diagnostics, and Member Secretary of the Indian DNA Profiling Advisory Council, stated, “The bill will allow us to store, retrieve, and use a DNA fingerprinting database of convicts and criminals. It is the need of the hour because the finality of Court judgments pertaining to criminal cases is being questioned.\textsuperscript{127}

“Ray De Villa was arrested on January 9, 1995\textsuperscript{128} and charged with the rape of his 13-year-old niece. Upon conviction, he was sentenced to death, but that sentence was later reduced to life in prison. Appellate decisions simply affirmed the trial Court’s decision and refused to order DNA testing. However, a review of the transcript and judge’s findings showed that the sole determining evidence relied on by the judge was the birth of a child, purportedly conceived by nature of the assault. This verdict was upheld in spite of evidence presented by the defense that the 76-year-old suffered a physical condition, making intercourse physically impossible. And, while certainly not dis positive of the issue, this was also a case in which the victim did not report the assault until confronted by her mother that the girl appeared to be gaining significant weight. Given the Court’s sole reliance on the birth of the child as the dis positive evidence of assault, this was clearly a case in which, if DNA paternity testing were performed and excluded the petitioner, that result would in fact be exonerative.

Similar to the experience of many petitioners in the US, one of the most difficult aspects of pursuing DNA analysis in a post conviction context in the Philippines was the task of gaining access to the Court to request testing. Given the final nature of De Villa’s sentence, there was no appellate mechanism for such analysis. De Villa’s lawyers were refused entry into the Court process to even ask for

permission to perform testing. They could not even get permission to get a sample of the petitioner’s blood for profiling. As such, Dr. de Ugrian and her team were forced to rely on their own ingenuity, the support of their lawyers, and the strength of their scientific expertise. The child’s family had refused to provide a sample of the child’s blood or saliva. Also, the prison refused to allow a sample to be taken from De Villa. Devising a well-supervised “spitting game” to get a saliva sample from the child at issue, the team was able to get a both a sample from the child, as well as samples from four other related children. The samples were preserved and stored in a manner that made the identity of the donors unknown to laboratory staff. A sample of the petitioner’s blood was also obtained, albeit without the assistance of the prison staff. Subsequent analysis, based on the pertinent genetic markers, showed that De Villa could not have fathered any of the children whose samples were tested. In other words, the sole basis of the judge’s decision had been completely refuted by DNA analysis. However, De Villa’s team of lawyers and scientists still faced a barrier to entry into the appellate system. Ultimately, De Villa’s attorneys sent a request for conditional parole to the President of the Philippines and Included in the packet forwarded to the President were the results of the DNA analysis performed by Dr. de Ugrian and her team. That parole was subsequently granted. This is now not a matter of doubt that DNA is uniquely capable of proving innocence in crimes where biological material was left by the perpetrator. Many people in prison were convicted before DNA testing was possible, or before it was considered reliable, and so they were not able to present evidence at their trial that might have helped prove their innocence. In the past, methods of testing evidence found at crime scenes were crude, and identifications or exoneration’s based on crime scene evidence were often inaccurate. DNA testing is much more accurate than older methods.

9.13 POST-CONVICTION TESTING IN INDIA

In India, we do not have any Post-conviction testing procedure. Neither, in India there is any legislation on DNA profiling nor do we have the means. In India, there are no DNA databanks or DNA databases. Neither, the sample is retained in the laboratories for any re-testing requests what to talk about post conviction testing.

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129 DNA (which stands for “deoxyribonucleic acid”) is a substance contained in every human cell. Each strand of DNA is encoded with information about the specific physical characteristics of the individual whom it comes from.
Earlier a bill DNA profiling bill, 2007 was drafted. But it could not receive assent from both the houses of parliament. Then, subsequently, DNA profiling bill, 2012 was also drafted. But it is still awaiting nod of the houses of parliament. The salient features of this bill are that it provides for a national database of DNA profiles. This DNA database will be used for crime detection and as evidence in judicial proceedings for admissibility of evidence. Bill legalises collection and analysis of the DNA samples for Repeat offenders, suspects, missing persons, unknown deceased persons and the “volunteers” for forensic purposes.

Using these profiles, Bill creates indexes within every databank including: crime scene indexes, suspects index, offender’s index, missing persons index, unknown deceased persons’ index, volunteers’ index etc. This will help searching particular entry very quickly. The DNA profile of an individual will be deleted if that person were to be acquitted after the trial. DNA profiles can be shared with other countries for cases related to terrorism, narcotics, illegal human organ sale etc. In a country like India which is densely populated there is huge requirement for these type of databases which may help in stopping different types of fraud like Ration card fraud, Voter ID Card fraud, Driving license fraud etc. The database also assists the Indian police to differentiate among criminals and non criminals. Or we can say that DNA database will differentiate between criminals and non-criminals, but DNA evidence is not useful in stopping ration card fraud etc. as it would require that DNA be extracted and authenticated for every instance of service. In 2012, the Department of Forensic Medicine and Toxicology at AFMC Pune proposed to establish a DNA data bank containing profiles of armed forces personnel. In Uttar Pradesh, the government ordered mandatory sampling for DNA fingerprinting of dead bodies. This reflects how much the government of India is concerned about the DNA profiling. It shows the scope of use, collection and storage of DNA profiles in databases that the Bill is silent on.

The preamble of the Bill states that, ‘DNA analysis of body substances is a powerful technology that makes it possible to determine whether the source of origin of one body substance is identical to that of another, and further to establish the biological relationship, if any, between two individuals, living or dead with any doubt.’

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130 Available at http://mrunal.org/2013/01/polity-dna-profiling-bill-feature-application-criticism.html (Last visited on march, 12, 2015)

131 Ibid
This statement ignores the possibility of false matches, cross-contamination, and laboratory error as DNA evidence is only as infallible as the humans collecting, analyzing, and marshalling the evidence. These mistakes are not purely speculative, as cases that have relied on DNA as evidence in India demonstrate that the reliability of DNA evidence is questionable due to collection, analysis, and chain of custody errors. For example, in the Aarushi murder case the forensic expert who testified failed to remember which samples were collected at the scene of the crime. In the French diplomat rape case, the DNA report came out with both negative and positive results; and in the Abhishek rape case the DNA sample had to be re-analyzed after initial analysis did not prove conclusive. Yet the Bill does not mandate a set of best practices that could help in minimizing these errors, such as defining what profiling system will be used nationally, and defining specific security measures that must be taken by DNA laboratories – all of which are currently left to be determined by the DNA board\textsuperscript{132}.

Many other problems and concerns that are raised with regard to the Bill are both intrinsic, including problems with effectiveness of achieving the set objectives, and extrinsic, including concerns with the fundamental principles of the Bill. For example, the use of DNA material as evidence and the subsequent creation of a DNA database can be useful for solving crimes when the database contains DNA profiles from the DNA samples only from crime scenes, and is restricted to DNA profiles from individual who might be repeat offenders. If a wide range of DNA profiles are added to the database, the effectiveness of the database decreases, and the likelihood of a false match increases as the ability to correctly identify a criminal depends on the number of crime scene DNA profiles on the database, and the number of false matches increases that occur is proportional to the number of comparisons made (more comparisons = more false matches). The DNA profile databases shall serve as useful tools in solving crime but on the other hand, the DNA profile of a person can reveal very personal information about the individual medical history, family history and so on. Therefore, a more comprehensive legislation regulating the collection, use, analysis and storage of DNA samples needs to be included in the draft Human DNA Profiling Bill\textsuperscript{133}.

The other main concerns with the Bill include access controls to the database and rights of the individual. To quote, the Bill does not require that a court order be

\textsuperscript{132} \textit{Ibid} \hfill \textsuperscript{133} \textit{Ibid}
issued for access to a DNA profile, and instead leaves it in the hand of the DNA bank manager to determine if communication of information relating to a match to a court, tribunal, law enforcement agency, or DNA laboratory is appropriate. Additionally, the Data Bank Manager is empowered to grant access to any information on the database to any person or class of persons that he/she considers appropriate for the purposes of proper operation and maintenance or for training purposes. The low standards for access that are found in the Bill are worrisome as the possibility for tampering of evidence and analysis is increased.

The Bill also lacks important provisions that would be necessary to protect the rights of an individual. For example, individuals are not permitted a private cause of action for the unlawful collection, use, or retention of DNA, and individuals do not have the right to access their own information stored on the database. These are significant gaps in the proposed legislation as it restricts the rights of the individual.

So we can easily analysis how much crucial the Human DNA profiling is at this present time for our society because it makes tracing the fugitives and criminals easier and allows DNA profiling for cases of culpable homicide, murder, etc. DNA analysis makes it feasible to determine whether the source if origin of one body substance is identical to that of another, and to establish the biological relationship, if any, b/w two individuals. DNA analysis is very important at least for the solution and problems of the cases where there is the strong need of the proper identification of the person. But at the other hand people don’t accept this because many found this as a threat to their privacy.\(^\text{134}\)

9.13 HUMAN GENOME PROJECT

The Human Genome Project (HGP) is an international scientific research project with a primary goal of determining the sequence of chemical base pairs which make up DNA, and of identifying and mapping the approximately 20,000–25,000 genes of the human genome from both a physical and functional standpoint.\(^\text{135}\) The

\(^\text{134}\) Available at http://lawmantra.co.in/the-draft-human-dna-profiling-bill-2012/( last visited on 3/01/15)
\(^\text{135}\) Available at http://www.pbs.org/wgbh/nova/body/cracking-the-code-of-life.html/( last visited on 3/01/15)
project began in 1989\textsuperscript{136} and was initially headed by Ari Patrinos, head of the Office of Biological and Environmental Research in the U.S. Department of Energy’s Office of Science. Francis Collins directed the National Institutes of Health National Human Genome Research Institute efforts. A working draft of the genome was announced in 2000 and a complete one in 2003, with further, more detailed analysis still being published. A parallel project was conducted outside of government by the Celera Corporation, which was formally launched in 1998. Most of the government-sponsored sequencing was performed in universities and research centers from the United States, the United Kingdom, Japan, France, Germany, China and Pakistan.\textsuperscript{137} The mapping of human genes is an important step in the development of medicines and other aspects of health care. While the objective of the Human Genome Project is to understand the genetic makeup of the human species, the project has also focused on several other nonhuman organisms such as E. coli, the fruit fly, and the laboratory mouse. It remains one of the largest single investigative projects in modern science. In May 2006, another milestone was passed on the way to completion of the project, when the sequence of the last chromosome was published in the journal Nature.\textsuperscript{138}

The sequence of the human DNA stored in databases available to anyone on the Internet. The U.S. National Center for Biotechnology Information (and sister organizations in Europe and Japan) house the gene sequence in a database known as Gene-Bank, along with sequences of known and hypothetical genes and proteins. Other organizations, such as the Genome Bio-informatics Group at the University of California, Santa Cruz,\textsuperscript{139} and Ensembl\textsuperscript{140} present additional data and annotation and powerful tools for visualizing and searching it. Computer programs have been developed to analyze the data, because the data itself is difficult to interpret without such programs. The process of identifying the boundaries between genes and other features in a raw DNA sequence is called genome annotation and is the domain of bio-informatics. While expert biologists make the best annotators, their work proceeds slowly, and computer programs are increasingly used to meet the high-throughput demands of genome sequencing projects. The best current technologies for annotation make use of statistical models that take advantage of parallels between DNA sequences and human language, using concepts from computer science such as formal

\textsuperscript{136} Available at http://www.economist.com/node/16349402 / (last visited on 3/01/15)
\textsuperscript{137} Available at http://www.dawn.com/2011/07/01/genome-mapping-of-first-pakistani-completed.html / (last visited on 3/01/15)
\textsuperscript{138} Available at http://wayback.archive.org/web/jsp/Interstitial.jsp / (last visited on 3/01/15)
\textsuperscript{139} Available at http://www.pbs.org/wgbh/nova/body/cracking-the-code-of-life.html / (last visited on 3/01/15)
\textsuperscript{140} Available at http://www.economist.com/node/16349402 / (last visited on 3/01/15)
grammars. Another, often overlooked, goal of the HGP is the study of its ethical, legal, and social implications. It is important to research these issues and find the most appropriate solutions before they become large dilemmas whose effect will manifest in the form of major political concerns. All humans have unique gene sequences. Therefore the data published by the HGP does not represent the exact sequence of every individual’s genome. It is the combined “reference genome” of a small number of anonymous donors. The HGP genome is a scaffold for future work in identifying differences among individuals. Most of the current effort in identifying differences among individuals involves single-nucleotide polymorphisms and the hap-map.

The International Hap-Map Project is an organization that aims to develop a haplotype map (Hap-Map) of the human genome, which will describe the common patterns of human genetic variation. Hap-Map is a key resource for researchers to find genetic variants affecting health, disease and responses to drugs and environmental factors. The information produced by the project is made freely available to researchers around the world. The International Hap-Map Project is collaboration among researchers at academic centers, non-profit biomedical research groups and private companies in Canada, China, Japan, Nigeria, the United Kingdom, and the United States. It officially started with a meeting on October 27 to 29, 2002, and was expected to take about three years. It comprises two phases; the complete data obtained in Phase I was published on 27 October 2005. The analysis of the Phase II dataset was published in October 2007. The Phase III dataset was released in spring 2009.

The project’s goals included not only identifying all of the approximately 24,000 genes in the human genome, but also to address the ethical, legal, and social issues (ELSI) that might arise from the availability of genetic information. Five percent of the annual budget was allocated to address the ELSI arising from the project. Debra Harry, Executive Director of the U.S group Indigenous Peoples Council on Bio-colonialism (IPCB), says that despite a decade of ELSI funding, the burden of genetics education has fallen on the tribes themselves to understand the motives of Human genome project and its potential impacts on their lives. Meanwhile, the government has been busily funding projects studying indigenous groups without any meaningful consultation with the groups. The main criticism of ELSI is the failure

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141 Ibid
142 Available at www.wikipedia.org/wiki/international_hapmap_project (last visited on January, 3, 2012)
143 Available at www.dnasequencing.org/sequencing_projects (last visited on January, 3, 2012)
144 Available at www.genome.gov/education/factsheets (last visited on January, 3, 2012)
145 Ibid
to address the conditions raised by population-based research, especially with regard to unique processes for group decision-making and cultural world views. Genetic variation research such as HGP is group population research, but most ethical guidelines, according to Harry, focus on individual rights instead of group rights. She says the research represents a clash of culture: indigenous people’s life revolves around collectivity and group decision making whereas the Western culture promotes individuality. Harry suggests that one of the challenges of ethical research is to include respect for collective review and decision making, while also upholding the Western model of individual rights\textsuperscript{146}.

9.14 SUMMARY

Parental testing and determination of legitimacy or illegitimacy of the child is not the only area where DNA profiling can be used as an infallible technology for identification. This apart it can prove very useful in numerous categories of human identification then it may be identification of victims of criminal cases for e.g. rape, incest, bestiality, pedophily, etc; Identification of suspects in criminal cases; Identification of victims of mass disasters; Identification of babies in Baby swapping cases; Identification of the ancient remains; Identification of parents in adoption cases; identification for Authentication in immigration cases; Identification in Organ Transplant cases; Identification in Cold cases; Identification of skeletal remains/mutilated bodies through postmortem examination; Pedigree analysis in pets; Medical uses and identification for Post-conviction Exonerations.

Innocence project, a national litigation and public policy organization aimed at getting exonerated wrongfully convicted persons is a glaring example to show how DNA technology has revolutionized forensic science and criminal justice system and has the potential to avert major miscarriages of justice. India doesn't have any legislation on post-conviction DNA testing but in the countries across the globe where it is being used tend to show from the statistical information that wrong convictions have resulted from concocted or faulty eyewitness testimony, false confessions, poor forensic examinations and investigative practices, and other issues related to wrongful convictions that may include poor lawyering, non examination of DNA samples being less in quantity or degraded for the want of specialized techniques of DNA profiling.

\textsuperscript{146} Ibid