MEDICO LEGAL VALUE OF DNA

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DNA is an abbreviation of Deoxyribonucleic Acid.

The cell is the tiniest unit, which can resemble an organism. It is bordered with plasma membranes. Cell is filled with protoplasm. Protoplasm can be divided as nucleus and cytoplasm.

Nucleus is the 'control centre' of the cell and it is surrounded by a double membrane called nuclear envelope. Inside the nucleolus chromosomes are found. Chromosomes are made of Deoxyribonucleic Acid.

Human body consists of about six thousand billion cells, which constitute tissues and organ systems. Each human cell has 46 chromosomes, of which 23 are derived from biological father and 23 from biological mother, due to fertilization of ovum with sperm.

Structure of DNA

Structure of DNA is described by its molecular structure which is called "Double Helix Model" which was first determined by James Watson and Francis Crick in 1953.

The primary unit of Deoxyribonucleic Acid is Nucleotide. Each nucleotide is composed of

1. Phosphate
2. Sugar

3. Nitrogen Base

The sugar variety in DNA nucleotide is Deoxyribose and the nitrogen bases present there are,

1. As Purines – Adenine, Guanine
2. As Pyrimidines – Thymine, Cytosine

They are usually referred in short hand version A, G, C, T.

These nitrogen bases always couples with their complementary partners as Adenine couples with Thymine and Guanine couples with Cytosine.

In a DNA molecule, two strands of polynucleotide have been linked together at the points of their nitrogen bases by hydrogen bonds according to their complementary patterns and they have been spiralled around each other making the 'Double Helix Model.'

Function of DNA

Genes have arranged along the length of chromosomes. A gene is a certain piece of DNA. Each gene carries instructions for the production of a particular protein which performs a particular function and also responsible for transmission of heredity.

DNA Fingerprinting

Quick identification of a criminal plays an essential role in the criminal justice system. The public and the media expect it. Various methods have been used to identify people since 1880`s such as anthropometry (the measurement of the human body), finger print identification etc.

DNA Fingerprinting can be explained as one of the most revolutionary advances in identification, which altered forensic investigation in recent years.

DNA fingerprinting is also called DNA typing, DNA identification, genetic typing or DNA profiling.

Professor Alec Jeffery a scientist at Leicester University in England discovered this new powerful tool in 1985.

DNA profile of an individual is a series of bars which represent different lengths of segments of DNA, which have been divided at predetermined points after a long chemical and technical process.

Methods used to obtain a DNA Profile

Various methods are used all over the world to obtain a DNA profile. They include PCR (Polymerase Chain Reaction), STR (Short Tandem Repeat) and Capillary electrophoresis.

PCR method is a great advancement of DNA profiling because the available DNA sample can be amplified by this method. It gives a great value at the instances of very small amount of DNA is available. It is also successful at times when a partially degraded biological material is available.

Biological Samples that can be used to obtain DNA profile

Almost any sample of the body other than sweat and bone without bone marrow can be used to extract DNA if they have been taken, preserved and sent to the laboratory in a DNA friendly manner.

In the 25 years since the technology was first discovered, it has been first tuned so that it can be used with ever smaller sample of DNA. Initially something of the size of a coin was required. But now a pinhead is enough,

These are the frequently used samples for DNA profiling

1. Blood.
2. Seminal fluid.
3. Vaginal aspirates.
4. Hair.
5. Tissues.

6. Saliva.
7. Tooth pulp.
8. Bone marrow.
9. Nasal secretions.
10. Buccal mucosa / buccal epithelial cells.
11. Body fluids.

How to collect, preserve and forward the samples

Blood

Blood can be obtained in liquid state or as blood stains. When liquid blood is drawn, it should be kept in sterile, leak proof tubes containing an anticoagulant to prevent clotting. Then the sample should be sealed and labelled with necessary information, and should be transported to laboratory at 20° Celsius under dry ice.

Blood drops should be collected in sterile conditions and spread on sterile bandage cloth folded several times so as to make it absorbed. This should be air dried in a shade and placed in a clean envelope, sealed, labelled and sent to the laboratory at room temperature. Blood stains on clothes also should be air dried and packed in paper bags, labelled and sent to the laboratory.

Seminal fluid

Seminal fluid, found in the vagina of the rape victim, can be collected by a pipette or as multiple swabs from vagina. Semen stains can be found on cloth, paper, furniture and floor tiles. Semen can also be found on anus of the victim as well. They should be sent to the laboratory.

Hair

Body hair and public hair can be sent for analysis. It is not essential to have the root of the hair to extract DNA after the modification of mitochondrial DNA analysis method. DNA pattern can be detected even in a sample from a single hair shaft.

Hair is a long lasting DNA container. When there is an exhumation long years after the burial, hair of the deceased may be the only available sample to extract DNA. Hair should be packed in clean paper. No preservative is required.

Tissues

Tissues may be found as mutilated remains, epidermal tags, fingernail scrapings fetal remains visceral samples, charred bodies, exhumation cases. Frequently they are connected with sexual offences, motor traffic accidents, mass disasters like bomb blasts.

In mutilated bodies, samples of 100 grammes of muscle should be collected using sterile instruments and placed in a sterile tube, containing normal saline as a preservative.

In cases of mass disasters, where several pieces of body are found, sufficient amount of muscle may be collected individually and sent as separate exhibits.

When a fetus is available the placenta should be removed and only fetus should be sent in normal saline.

For identification of fingernail scrapings, the palm of the victim should be placed on a clean polythene sheet and the inner portion of the finger nails should be scraped with a tooth pick and placed in a polythene sheet and sent it for identification after labelling with necessary information.

Saliva

Normally saliva can be found on the bite marks of suspects, on cigarette butts and food, which have been half eaten by the criminal. Saliva in liquid state or from a stained area should be sent in dried condition.

Teeth

Molar teeth are preferred for DNA identification. If skull containing teeth are found, molar teeth from upper and lower jaws should be detached and sent to the laboratory. If molar teeth

were not available other teeth may be sent. Teeth should be placed in a clean polythene cover.

Bones

DNA can be extracted from the bone marrow of the bones. Femur and humerus yield more bone marrow and are preferred. Bones should be packed in clean paper or cloth. No preservative is necessary.

Urine

About 10 ml of urine should be sent.

Medico-legal value of DNA PROFILING

DNA profiling can be used in many ways for identification in medico-legal cases. With the help of this new tool, some courts (e.g. In U.S.A.) changed their previous judgments and sometimes acquitted those who were convicted earlier.

These are some of the common applications of DNA profiling.

1. Paternity and maternity testing.
2. Crime investigation.
3. Identification of mutilated remains.
4. Diagnosis of inherited diseases.
5. Identification of dead bodies in exhumations.
6. Establishing family relationships.

Paternity Testing

This is one of the most widely used areas of DNA profiling. Normally paternity test is required when the paternity is disputed.

When it is needed to determine the father, coding is made from the child, mother and the father. The bars of the child's code are first matched with those of the mother's pattern. Then remaining bars are matched with the father`s pattern. When mother's pattern corresponds with the child's pattern and remaining bars do not correspond with the father's pattern, he is not the father of the child. If both of the father's pattern and the mother's pattern are not correspond with the child's pattern, it means, that child is not a production of the tested parents. At such instances a presumption can be made as the child has been exchanged somewhere without the knowledge of the parents.

DNA test can also be helpful to establish paternity when a victim is pregnant at a rape and the rapist denies the sexual intercourse with the victim, as it is late to obtain vaginal swabs. When the child is born, if the child`s pattern corresponds with both mother and the suspect, the suspect has to explain how it became his child.

But to obtain successful results, parents should not have had blood transfusions within three months before taking the blood samples. Paternity can be confirmed 100% by this method.

Maternity Testing

This may be needed at the instances of

1. Child is exchanged, is misplaced and found, is stolen and found and is kidnapped and found.
2. Woman is charged for infanticide.
3. Establish the connection between the fetus and the mother.

Children can be exchanged in hospitals by mistake or purposely. In such situations this method is the less time consuming and the most reliable method to recognize real parents.

When children are misplaced and found, several parents might claim the same child. In Sri Lanka, it happened at tsunami. Two parents claimed the same child and courts were able to decide the real parents without leaving any doubt with the help of the DNA profiling.

Sometimes children are stolen and when they are found after a long time, the accused defendant/s might say that the child is theirs.

DNA profile can bring justice to the real parents in such situations.

In infanticides, if a mother refuses to accept that she is the mother of the child, DNA profile can make the link between the mother and the child. At the same time, if a mother is charged for killing of her own child, which is a murder, mother can be charged for a lesser offence of manslaughter, if the death has occurred within the first year after the delivery.

A same kind of principle can be applied for the offence of criminal abortion as well.

No abortion can be performed except when it is necessary to save the mother's life. Because of the rigidness of the prevailing law in Sri Lanka, it is said that there are about one thousand illegal abortions are performed in a day. When fetal remains are discovered by the investigators and the suspected mothers are also found, with the help of DNA profiling the connection can be made between mother and the fetus.

Crime Investigation

This is also one another wide application of DNA profiling. Exoneration of a suspect or identification of a criminal can be done with genetic coding. Though this can be applied in a large number of crimes, I discuss few crimes to make it easy to understand.

Sexual Crimes

DNA technology is a remarkable advancement in investigation when sexual offences are been investigated.

These samples are usually tested for DNA profiling to identify the sexual offenders.

1. Vaginal aspirates
2. Vaginal, anal, buccal or penile swabs
3. Semen samples found on the skin or clothes of the victim, in a condom, on the floor, on the papers or on furniture.
4. Saliva from bite marks.
5. Any body fluid or somatic cells found at the scene of crime (e.g. Nasal mucosa).
6. Fingernail scrapings.

When there is a gang rape, if DNA profiling is done on mixed semen, the DNA pattern of all those who were engaged with the act of rape can be detected, because it provides a separate DNA profile for each person.

When a sexual offence is being committed or attempted to commit, often the victim tries to restrain the offender. At times it is done by scratching him. Fingernail scrapings of the victim can be tested to establish the contact of the assailant with the victim at such a time.

Murder and injuries

DNA profiling is useful in many ways finding those who have committed murders or caused injuries.

If a weapon is found, blood or tissue particles in the weapon can be matched with the DNA pattern of the deceased or injured. In the same manner, blood stains on the clothing or on the skin of the person of the accused can be matched. If hair roots are found on the weapon, they can be matched with the victim as well as the accused.

When there are injuries or deaths due to a hit and run accident, hair roots or tissue particles or blood stains found on the wheels or lower part of the suspect vehicle can be matched with the deceased.

Diagnosis of inherited diseases

The following inherited deceases can be identified by DNA fingerprinting.

Cystic fibrosis

Haemophilia

Huntington's disease

Familial Alzheimer's disease

Sickle cell anemia

Thalassaemia

Problems associated with DNA profiling

1. This kind of evidence completely taken on trust and faith. Sample to be tested can be changed by the investigator or the expert who conducts the process of DNA profiling. At times, when there are very small amounts of DNA are available, if there is a doubt about the test, there is no way of rechecking it.

2. Sometimes DNA source may be contaminated because of the improper handling and serious errors can be made when collecting samples.

3. When the laboratories do not maintain the international standards, they might come up with wrong interpretations.

4. When the bar code is brought before the courts, as the court is unlikely to understand in any detail the principles of the process, some kind of dissatisfaction might remain.

5. At times when a weak bar code is produced, its interpretation with comparisons might not be 100% correct.

6. Whatever the method of testing, high degree of expertise and possibility of technical error must be remembered at the time of testing.

7. Even if the DNA of an accused matches with the sample collected from the scene of crime, it might have been left by the accused sometime before and not when the crime was committed by him.

Case Law

1. A Ghanian boy living in UK migrated to Ghana to join his father. When he decided to return to UK, the immigration authorities suspecting a replacement or substitution refused entry. Conventional blood and genetic marker tests showed that the mother and the boy were related. DNA test carried out proved that the boy and the woman were in fact mother and son.

2. Loraine was murdered near Rangers Park station in London just before Christmas 1988. Several items were submitted including a man's handkerchief stained with blood. The blood stain proved to be Loraine's. A nasal mucosal stain was also found on the handkerchief was profiled. This was not Loraine's. Early in February 1989, a rape attempt occurred close to the same murder scene. A suspect John Dunne was arrested. After a chance fingerprint was found and tallied, police thought him to be the likely suspect. His blood sample was profiled. This matched with the profile obtained from the mucosal stain on the handkerchief. Dunne pleaded guilty.

3. Nine-year-old Imran's naked body was discovered in Avenham Park, Preston, on 13thJuly1985, two days after he went missing. Imran was raped then murdered as he walked home from his school. He had been strangled.

During the 1985 investigation, more than 6,000 people were spoken to, 2,500 statements were taken and hundreds of items of evidence were logged.

DNA from a relative, who was on the national database after committing a serious offence, led police to Morley. The scientists who conducted the DNA tests said there was a one in billion chance of the person responsible not being Morley, a father-of-seven.

4. DNA fingerprinting and mass DNA screening was first used as a police forensic test to identify the rapist and killer of two, 15-years-old, Lynda Mann and Dawn Ashwoth, who were murdered in Leicestershire, in 1983 and 1986 respectively. Colin Pitchfork was identified and convicted of murder after samples taken from him matched semen samples taken from the two dead girls. He was arrested in 1987 and sentenced to life imprisonment after admitting both murders. If not for the DNA, an innocent man who was earlier the main suspect, would have inevitably been convicted.

APPLICABILITY IN SRI LANKA

Identification by DNA profile first introduced to Sri Lanka in the investigation of Hokandara murder case. Six family members (the father, mother, three daughters and the son) were murdered in late nineties in Hokandara. One of the alleged murderers was also found dead at the scene of the crime and the other suspects were arrested on the same day.

Blood stains from the cloths of all these suspects were typed revealing an identical pattern indicating that the blood was from one individual. An identical DNA profile was also observed from the murdered son.

In Sri Lanka, identification by DNA coding is using in both civil disputes as well as in criminal investigations.

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