THE NATURE AND POWER OF GENETIC FINGERPRINTING
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Each of us has a pattern of information in our genetic makeup that is unique. The only exceptions to this are identical twins, each of whom has an identical genetic makeup. Just as fingerprints can be used to identify an individual, so can patterns in our genetic makeup, and with even greater accuracy. The genetic technique, known as genetic fingerprinting, is now in widespread use and frequently hits the headlines because of its applications in forensic science. Genetic fingerprinting is a far more powerful technique than classical fingerprinting because it can be used not only to identify a person, but it can also identify to whom that person is genetically related.

Our bodies are composed of trillions of fundamental units called cells. Each body (somatic) cell contains a complete copy of the individual's genetic makeup. The genetic material is organised into long threads called chromosomes. Humans have twenty-three pairs of chromosomes in each body cell. One member of each pair comes from the father and the other comes from the mother. The genetic material within each chromosome is DNA, which, of course, is also a long string. There are two strands in each DNA string. The two strands wind about each other in double helical fashion. Each strand is composed of successive units called nucleotides. There are only four kinds of nucleotides in DNA and they are denoted by the letters A, T, G and C. These are the letters of the genetic code alphabet.

The linear sequence of the genetic alphabet, in groups of three, specifies the genetic information. The two strands of DNA are linked together by loose bonds that form between the letters that make up each individual strand. The inter-letter bonding is very specific; A always binds to T and G always binds to C. Thus, the two strands of a DNA string have complementary sequences of nucleotide letters dictated by this bonding rule. For example the sequence A G T C on one strand would be bonded to the complementary sequence T C A G on the other strand. The most important information coded in the DNA is divided up into segments called genes. Each gene contains the information necessary to manufacture a specific protein in the cell. Apart from DNA, proteins are the most important chemicals in a cell and carry out most of the cell's activity.

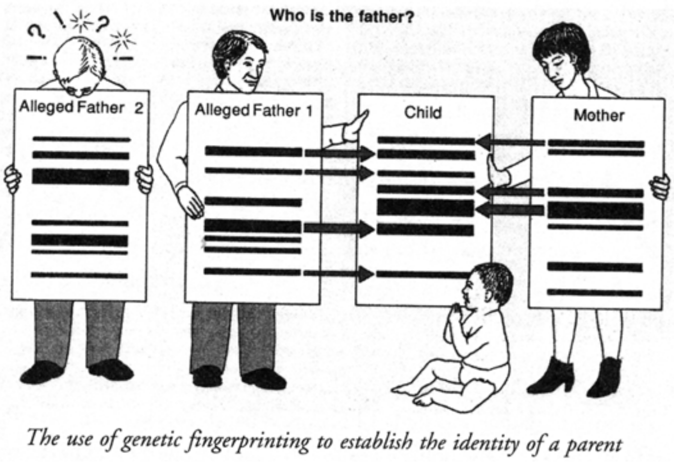
In addition to genes, chromosomal DNA also carries special regions of nucleotide repeat base sequences called minisatellites. These do not carry information codes for the manufacture of proteins. The number of locations of minisatellite regions is unique to the DNA of every particular individual. Half of this unique pattern is contributed by the father and half by the mother. The detection and identification of this minisatellite DNA pattern is the basis for genetic fingerprinting. The location of the minisatellite regions in DNA is detected using special probes (segments of DNA having complementary base sequences to the minisatellite regions) followed by selective staining and visualisation of the bound probe. The probes are not used against intact DNA molecules but against molecules that have been broken down into smaller pieces. This breaking of the DNA is not a random process but is carried out in a very specific fashion by the use of special enzymes (catalysts) called restriction enzymes that break DNA only at certain nucleotide sequences.

The full procedure for carrying out DNA fingerprinting on an individual would go as follows. First of all, a small sample of cells is taken and the DNA is isolated from them. The DNA is then fragmented using the restriction enzyme and the various bits of DNA are separated out from each other according to size on a special gel (a thin sheet of jelly-like consistency). The bits of DNA separate out from each other in the gel, stacked one over the other in size sequence, from the largest bits at the top of the gel to smallest at the bottom. The gel is now reacted with the minisatellite probe, which binds to the gel wherever it finds a complementary target. A special staining procedure is now employed to stain the gel everywhere the probe has reacted. The end product, the 'genetic fingerprint', is the stained gel. It is a sequence of darker and lighter horizontal bands, stacked one over the other from the top to the bottom of the gel. It looks quite similar to the bar code that is now printed on all product packaging. Just like the bar code, the genetic fingerprint uniquely identifies the subject from whom it was taken. About half the bands in an individuals genetic fingerprint have been inherited from the mother and the other half from the father.

The technique of genetic fingerprinting frequently hits the headlines in cases where it is used to establish the identify of a child's parent or to establish the identify of the perpetrator of some crime. Take the following hypothetical case. A woman gives birth to a baby. The father must be one of two men, but she cannot be sure which is the actual father. The matter can be readily decided by comparing the genetic fingerprints of the baby, the mother and the two potential fathers.

Very small samples of human tissue will suffice to allow a genetic fingerprint to be made, e.g. a few drops of blood, several hairs, some skin scrapings, etc. This is very useful in forensic science when small biological samples, collected from the scene of the crime, can be used to conclusively implicate or rule out a suspect. Genetic fingerprinting is a very powerful technique in incriminating or exonerating alleged rapists. A vaginal swab taken soon after the perpetration of a rape will contain samples of the victim's cells and also of the rapist's semen. When a genetic fingerprint of the victim's DNA is compared to a genetic fingerprint recovered from the swab, the bands corresponding to the rapist's semen can be easily identified. These bands can then be used to incriminate or exonerate suspects in rape cases by comparing them to genetic fingerprints prepared from suspects' semen samples.

One interesting and very useful application of genetic fingerprinting is the identification of children who 'disappeared' in Argentina during the military rule from 1976 to 1983, and their reunification with their grandparents. A genetic data bank of blood samples from relatives of children who went missing has been established and is used to check out the identities of people, now adults, suspected or known to have gone missing under the military regime.



The use of genetic fingerprinting to establish the identity of a parent

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