CL-AB. 9

The Portfolio Committee of Police (National Assembly)

Attention: The committee secretary, Mr. Jeremy Michaels

Per email: jmichaels@parliament.gov.za

16 October 2009

Dear Sir

B2-2009 Criminal Law (Forensic Procedures) Amendment Bill

This document serves to provide a short summary of the scientific principles behind DNA profiling and its benefits as an evidentiary tool for the criminal justice system. It also discusses relevant issues relating to ethical considerations regarding DNA profiling. As a geneticist, and South African citizen who fully supports the adoption of the Forensic Procedures Amendent Bill, I believe knowledge of this information is necessary for the interpretation of the above-mentioned Bill in regard to the use of DNA in forensic investigations.

I would like to request that I be allowed the opportunity to present this information at the public hearings to be held in Parliament.

I can be contacted per email: [redacted] or on my cell phone: [redacted].

Yours faithfully,
Dr. Carolyn Hancock (PhD Genetics)

SCIENTIFIC PRINCIPLES BEHIND DNA PROFILING

WHAT IS DNA?

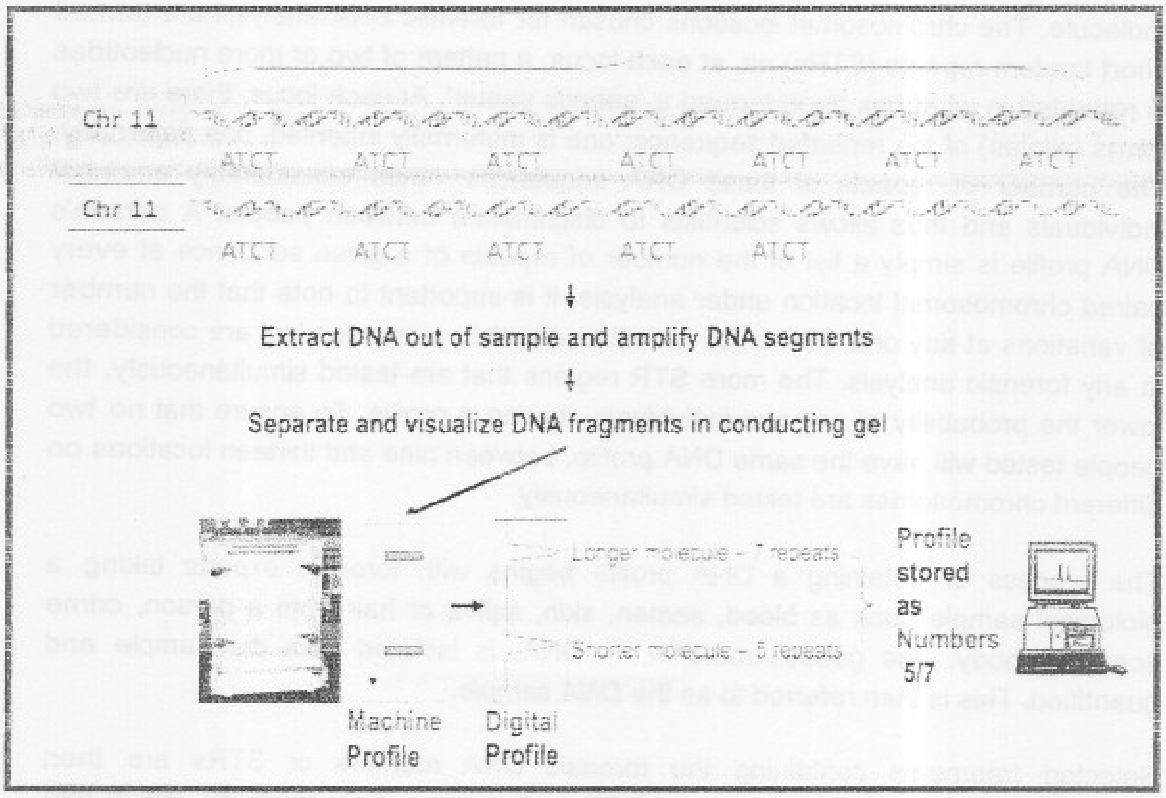
DNA stands for deoxyribonucleic acid. This is the name of the chemical which is found in virtually every cell in the human body and which carries genetic information from one generation to the next. Just like fingerprints, humans each have a unique DNA signature that remains unchanged throughout their lives. Whereas, fingerprints can only be found at a crime scene if a person touches a suitable surface with bare fingers, DNA can be extracted from hairs, skin cells, blood, fragments of bone, or teeth, as well as body fluids left after a crime. DNA testing, generally called DNA profiling, takes advantage of the fact that, with the exception of identical twins, the genetic material of each person is unique and is an omnipresent residue that trails us wherever we go. A DNA profile is simply a unique set of numbers obtained from a person's DNA that acts as a personal 'identification number'. In cases where traditional fingerprints are not found, DNA profiling may provide the answer to the question: Who was present at a crime scene? These physical properties of DNA have made it a critical tool in fighting crime.

WHAT IS A DNA PROFILE AND HOW IS IT OBTAINED?

All DNA consists of two long chains of subunits, twisted around each other to form a double helix. The subunits of each strand consist of nucleotides, each of which contains any one of four chemical constituents, attached to a phosphorylated molecule of the 5-carbon sugar deoxyribose. The four nucleotides in DNA are adenine (A), thymine (T), guanine (G) and cytosine (C). The specific sequence of nucleotides in the long chain of DNA identifies it as, for example, human, canine or a particular plant species. However, individuals within each group also have their own unique DNA sequences at other locations. At a chromosomal location where individual people differ, one person may have the sequence GATCGT and another GAACGT. These differences in nucleotide sequences allow individuals within a species to be identified.

A vast amount of genetic variation exists in human populations and, except for identical twins, all people are genetically different. Forensic typing is based upon this genetic variation. Analysis of genetic variation requires that such differences are traceable. We refer to such traceable features as markers. Millions of people share the same blood groups, so this is not very helpful for identification purposes. However, the discovery of DNA markers made it possible to effectively distinguish between people. From a genetic perspective, what differs between people is the sequence of the four nucleotides on the DNA molecule. Interestingly, only five percent of our DNA is made up of genes that code for all the proteins our body needs for growth and to function. Very little variation between people exists in these genes or coding regions. However, some regions in the other ninety-five percent of our DNA, that do not code for any proteins, are highly variable and may be used to regions are simultaneously analyzed and thus a sequence of up to 20 numbers will make up the DNA profile.

Figure 1: Process of obtaining a DNA profile



USES OF DNA PROFILING

DNA profiles may be used to:

- Identify potential suspects whose DNA matches evidence found at crime scenes.
- Exclude a suspect quickly, by demonstrating that a person was not involved in a particular crime scene or crime.
- Identify patterns of criminal behaviour through matching DNA profiles found at several crime scenes; this may help solve past, current and even future crimes. In other words, not only will DNA profiling increase the likelihood of identifying unknown perpetrators, but it will also increase the possibility of linking perpetrators to multiple crime scenes.
- Promote plea bargains, when suspects are confronted with real evidence in the form of a DNA match. For example, in Britain, 85 percent of suspects plead guilty when presented with a match of their DNA to the crime.
- Exonerate persons wrongly accused of crimes.
- Identify victims of disasters.
- Establish paternity and other family relationships.

distinguish people from one another. As the purpose of many of these non-coding chromosomal regions is unknown, they are loosely referred to as 'junk DNA'.

The DNA markers that are used for forensic purposes are found in a number of different chromosomal locations or loci within the non-coding regions of the DNA molecule. The chromosomal locations chosen for forensic DNA analysis are termed short tandem repeats (STRs) as, at each locus, a pattern of two or more nucleotides is repeated in what has been termed a 'genetic stutter'. At each locus, there are two forms (alleles) of the repeated sequence; one is maternally inherited, one paternally. The number of repeats of these DNA sequences varies considerably amongst individuals and thus allows scientists to discriminate between people. A person's DNA profile is simply a list of the number of repeats of a given sequence at every paired chromosomal location under analysis. It is important to note that the number of variations at any one STR locus is limited and thus numerous loci are considered in any forensic analysis. The more STR regions that are tested simultaneously, the lower the probability of any two individuals sharing a profile. To ensure that no two people tested will have the same DNA profile, between nine and thirteen locations on different chromosomes are tested simultaneously.

The process of obtaining a DNA profile begins with forensic experts taking a biological sample such as blood, semen, skin, saliva or hair from a person, crime scene or body. The genetic material, or DNA, is isolated from the sample and quantified. This is then referred to as the *DNA sample*.

Selected fragments containing the forensic DNA markers or STRs are then replicated, using a process known as PCR (polymerase chain reaction), which can be described as a form of molecular photocopying. After being placed in a special gel, the fragments are separated according to their length, using an electric current, a process called electrophoresis. A laser then lights up florescent tags on the fragments, so that the fragment length of each STR marker can be measured. The fragment length is determined by the number of repeats of a given sequence at every chromosomal location under analysis.

The resulting patterns, which resemble supermarket barcodes, are photographed and examined and converted into a digital profile. The fragment length of each STR marker is recorded as a series of numbers. This sequence of numbers is termed the '*DNA profile*'. The resultant DNA profile is, in other words, the electronic representation of the physical DNA sample.

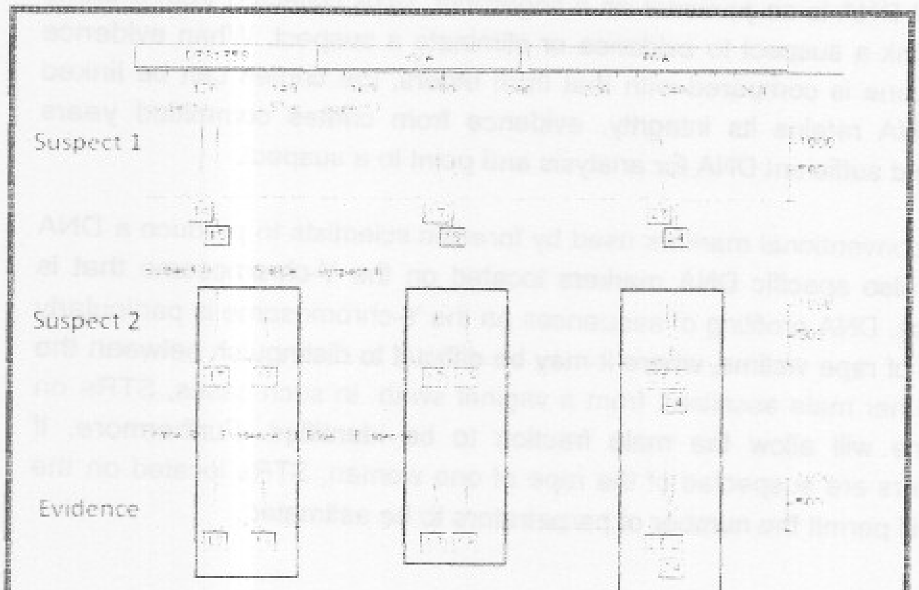
The process of obtaining a DNA profile is illustrated in Figure 1. The illustration refers to one STR marker (specific region on a chromosome) on chromosome 11. This STR consists of repeat units of the nucleotide sequence ATCT. On one DNA strand, there are seven repeats of the nucleotide sequence and on the other strand, there are five repeats. The DNA profile is recorded, and, if required, stored on a database as a sequence of numbers, in this case seven and five. In South Africa, ten marker

DNA PROFILING AND CRIME DETECTION

Forensic science provides the link between a crime scene and a suspect. Since 1901, fingerprinting has been used to track offenders. However, currently, the forensic tool of choice is DNA profiling, as evidence may be collected in many forms such as hair, blood, saliva, semen and perspiration. While blood, saliva and semen are still the main sources of DNA for forensic testing, trace amounts of DNA, for example from epithelial cells from the surface of the skin, can now be acquired from touched objects. Scientists can use the saliva on the rim of a glass, or the skin cells and hair shed on a cap, to compare with a suspect's blood or saliva sample. Similarly, DNA collected from the perspiration on a hat or scarf, discarded by a rapist, can be compared with DNA in the saliva swabbed from the bite mark on a different rape victim.

Figure 2 illustrates the comparison of three DNA profiles. Two are from suspects and one is the DNA profile obtained from evidence collected at a crime scene. It is clear that the evidence taken from the crime scene matches the DNA profile of Suspect 2, as the sequence of numbers (the DNA profile) is identical to the evidence.

Figure 2: Simplified example of the comparison between a crime scene sample and two suspects.



	D3	vWA	FGA
S1	14.15	17.18	23.24
S2	15.18	17.19	23.2.24
E	15.18	17.19	23.2.24

The designations D3, vWA and FGA represent three different chromosomal locations (STRs) under analysis.

In criminal investigations, the sequence of numbers from a DNA profile found at a crime scene may be compared to that of a known suspect. Alternatively, where there is no suspect for a particular crime, DNA samples collected at a crime scene may be compared with DNA profiles stored on a National DNA Database. This resource contains DNA profiles of people suspected and convicted of offences, as well as DNA profiles obtained from evidence left at crime scenes. A match or 'hit' between the crime scene evidence and a database profile may identify a new suspect. This can help to identify or rule out a potential suspect at an early stage thereby saving valuable police and other crime detection resources, leaving them free for other investigations. For this reason, a National DNA Database is considered to be one of the most powerful tools in crime prevention and detection used in the world today.

The time, effort and expense required to develop DNA databases are justified by the facts that:

- Criminals tend to re-offend. For example, 90 percent of rapists and 50 percent of armed robbers have a previous conviction.
- The severity of crimes committed by re-offenders often increases over time, with criminals committing their first offence between the ages of 16 and 19 years.
- A small number of criminals are often responsible for numerous crimes. DNA databases can assist in linking these crimes to one another.

Because individual DNA is as personal as a fingerprint, DNA collected from a crime scene can either link a suspect to evidence or eliminate a suspect. When evidence from one crime scene is compared with that from others, the crimes can be linked nationwide. As DNA retains its integrity, evidence from crimes committed years previously may yield sufficient DNA for analysis and point to a suspect.

In addition to the conventional markers used by forensic scientists to produce a DNA profile, there are also specific DNA markers located on the Y-chromosome that is found only in males. DNA profiling of sequences on the Y-chromosome is particularly useful in the case of rape victims, where it may be difficult to distinguish between the female victim and her male assailant, from a vaginal swab. In such cases, STRs on the Y-chromosome will allow the male fraction to be identified. Furthermore, if multiple perpetrators are suspected of the rape of one woman, STRs located on the Y-chromosome will permit the number of perpetrators to be estimated.

ETHICAL CONSIDERATIONS

With regard to obtaining and interpreting a DNA profile the following must be remembered:

(i) A DNA profile is stored on the DNA database as a sequence of numbers, which simply act as a unique identifier.

(ii) The DNA Profile is obtained from a set of only 9 to 13 markers located in the 'junk' or 'non-coded DNA', ensuring that no genetic disposition or other distinguishing feature may be read from the profile. Just as one cannot tell from looking at a fingerprint, whether the owner of that print has a pre-disposition to cancer, this principle applies equally to a DNA profile which has been processed for entry onto a DNA database. This is because the STR loci used in crime detection have no biological function, so this kind of information does not become available to the profiler. Furthermore, many genes and numerous environmental factors determine most diseases and behavioral tendencies. So it is very unlikely that a mere correlation between a non-coding region of DNA (STR) and a physical or behavioral characteristic will allow anyone to accurately predict these conditions.

(iii) The purpose for which a DNA profile may be used is limited to the detection of crime, the investigation of crime or the conduct of a prosecution and, most importantly, to the entry of the DNA profile onto the DNA database. The presence of a DNA profile on a National DNA database does not constitute nor signify a criminal record nor does it impact on the individual in any way, particularly if that individual has no intention of ever committing a crime.

The retention and further analysis of an *individual's DNA sample* is a more sensitive matter, as it is possible to sequence the entirety of a person's genetic make-up, obtaining information of a personal nature. It is for this reason that proposed new legislation in South Africa should not allow for the retention of samples taken from suspects, once a full DNA profile has been obtained and loaded onto the DNA Database. In contrast, a *crime scene sample* will form part of the evidence used to build a case and aid in an investigation, and, as such, it must be retained indefinitely in the same way as any other form of 'real' evidence such as a bullet casing or a weapon found at a crime scene.

Individuals have an expectation of privacy regarding their DNA information. However, in countries such as South Africa, where crime levels are unacceptably high, the state and human rights organizations have recognized that a person's right to privacy has to be weighed up against the public's right to safety. The protection of the public from criminals is an obligation of the state and the authority to take a DNA sample, from someone arrested on suspicion of a crime, should thus be warranted as it furthers the state's ability to detect and prevent criminal activity.

In general, the science and technology of DNA profiling is robust and reliable. However, there are always risks associated with the use of biological information. These include the deliberate or accidental contamination of samples; the misinterpretation of samples containing the profiles of more than one person (mixtures); the misinterpretation of partial profiles and the misuse or misinterpretation of statistics used to describe the probability of a match. It is thus imperative that regulatory bodies rigorously monitor quality assurance to ensure reliability and accuracy of collection, analysis and interpretation of DNA evidence. Also, there should be extensive education of the general public, police, emergency service personnel and the legal profession on the nature of biological evidence and its correct interpretation.

In conclusion, it can be stated that with regard to the use of STRs and privacy concerns, the information contained in the DNA profile (a list of numbers) itself is largely meaningless, except as a unique identifier. Furthermore, the proposed legislation clearly states that bio-information stored on the National DNA database may only be used for preventing, detecting and prosecuting crime or for identifying a deceased person or body part. Notwithstanding the fact that there will always be fears regarding the accuracy of profiling and the chances of error resulting in a wrongful conviction, this is counteracted by the far more common occurrence of the use of DNA evidence to exonerate innocent people, who have been convicted of crimes they did not commit, as well as the overwhelming number of suspects who plead guilty when confronted with DNA evidence.