The Department of Justice

Att: Lirette Louw

Per email: LiLouw@justice.gov.za

Tuesday, 27 January 2009

Dear Madam

B2-2009 Criminal Law (Forensic Procedures) Amendment Bill

This document serves to provide a short summary of the scientific principles behind 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 this month.

I can be contacted per email: cehancock@gmail.com or cell phone: 082 420 5152.

Yours faithfully,
Dr. Carolyn Hancock (PhD Genetics)

Summary of the Scientific Principles behind Forensic DNA Profiling

Forensic science provides the link between a crime scene and a suspect/s. Traditionally, (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. DNA has some useful characteristics for forensic analysis: (i) everyone has a unique DNA profile, (ii) the DNA in every cell of our body is identical and remains unchanged in one individual throughout their lifetime and (iii) half of our DNA comes from each of our parents. All DNA is made up of four components, known as nucleotides. These are the same in all organisms.

A vast amount of genetic variation exists in human populations. This can be appreciated when the appearance of a group of people are scrutinized. Except for identical twins, all the individuals will look different. All forensic typing is based upon is the genetic variation that exists between individuals. An analysis of genetic variation requires that such differences are traceable. We refer to such traceable features as markers. Blood groups and other protein markers all display low variability and are thus not very discriminating. It was with the discovery of DNA markers that it became possible to distinguish between all individuals, except for identical twins. From a genetic perspective, what differs between people is the sequence of the four nucleotides on the DNA molecule. Interestingly, only 5% 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 95% of the DNA, that do not code for any proteins, are highly variable and may be used to 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 information stored in a DNA Criminal Intelligence Database is taken from a number of different chromosomal locations or loci. These loci are located in non-coding regions of DNA. The chromosomal locations chosen for forensic DNA analysis are termed short tandem repeats (STR's) as at each locus, a pattern of two or more nucleotides is repeated. At each locus, people have 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 individuals. An individual's DNA profile is simply a list of the number of repeats of a given sequence at every 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 probably of any two individuals sharing a profile. To ensure that no two people tested will have the same DNA profile, between 9 and 13 locations on different chromosomes are tested simultaneously. To link a suspect to a crime scene the two DNA profiles analysed must be an exact match.

There are two primary benefits of DNA evidence:

1) Prove guilt by linking a suspect to a crime scene.
2) Exonerate innocent people.

A major benefit of a National DNA Database is when there is no suspect in a criminal case. In such a case the DNA obtained at a crime scene may be compared to all DNA profiles in a National Database. If all previously convicted criminals are recorded on the database many crimes may be solved as perprtrators of petty crimes often later commit more serious crimes.

With regard to the possible "sensitive" or personal information that may be contained in a DNA profile generated for forensics purposes, there is no research that indicates that any of the STR-based DNA loci currently utilised worldwide for forensic purposes have any biological *function*. However, this does not mean that these loci may not be of any biological significance. For example, any one of the STR loci may be shown to have a *correlation* with certain physical traits, such as susceptibility to a disease or a tendency to become violent. Thus knowledge of the DNA profile of an individual may help to predict whether an individual will contract a disease, even if the DNA sequence under analysis plays *no role whatsoever in causing* the physical trait.

One must bear in mind that many genes and numerous environmental factors determine most diseases and behavioural tendencies. It is thus very unlikely that a

mere correlation between a non-coding region of DNA (STR) and a physical or behavioural characteristic will allow anyone to attempt to accurately predict these conditions. Furthermore, the same types of correlations have been shown to exist between certain fingerprint patterns and physical traits. However, the research in this area is far less than in molecular genetics.

In conclusion, I think it can be stated that with regard to the use of STR's and privacy concerns, that the information contained in the DNA profile (a list of numbers) itself is largely meaningless, except as a unique identifier. If kept strictly for criminal intelligence purposes the retention of a person's DNA profile will be no more of an invasion of one's right to privacy than a fingerprint.

The scientific process of obtaining a DNA profile and of matching evidence collected at a crime scene with a suspect is illustrated in Figures 1 and 2.

Figure 1: The process followed in the production of a DNA Profile

With regard to the process of obtaining a DNA profile, forensic experts begin by taking blood, semen, skin, saliva or hair from the crime scene and a blood or buccal sample from a suspect. The genetic material, or DNA, is isolated from the sample and quantified. Certain fragments containing the forensic DNA markers or STR's are then replicated using a process known as PCR (polymerase chain reaction). After being placed in a special gel, the fragments are separated according to their length using an electric current, a process referred to as 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 a supermarket barcode, are photographed and examined. The fragment length of each STR marker is recorded as a series of numbers and entered onto the DNA database. The sequence of numbers from the DNA profile found at a crime scene is then compared against that of a known suspect. Alternatively, the DNA database is searched in order to attempt to identify a match between the crime scene evidence and an individual that had been previously arrested for another crime.

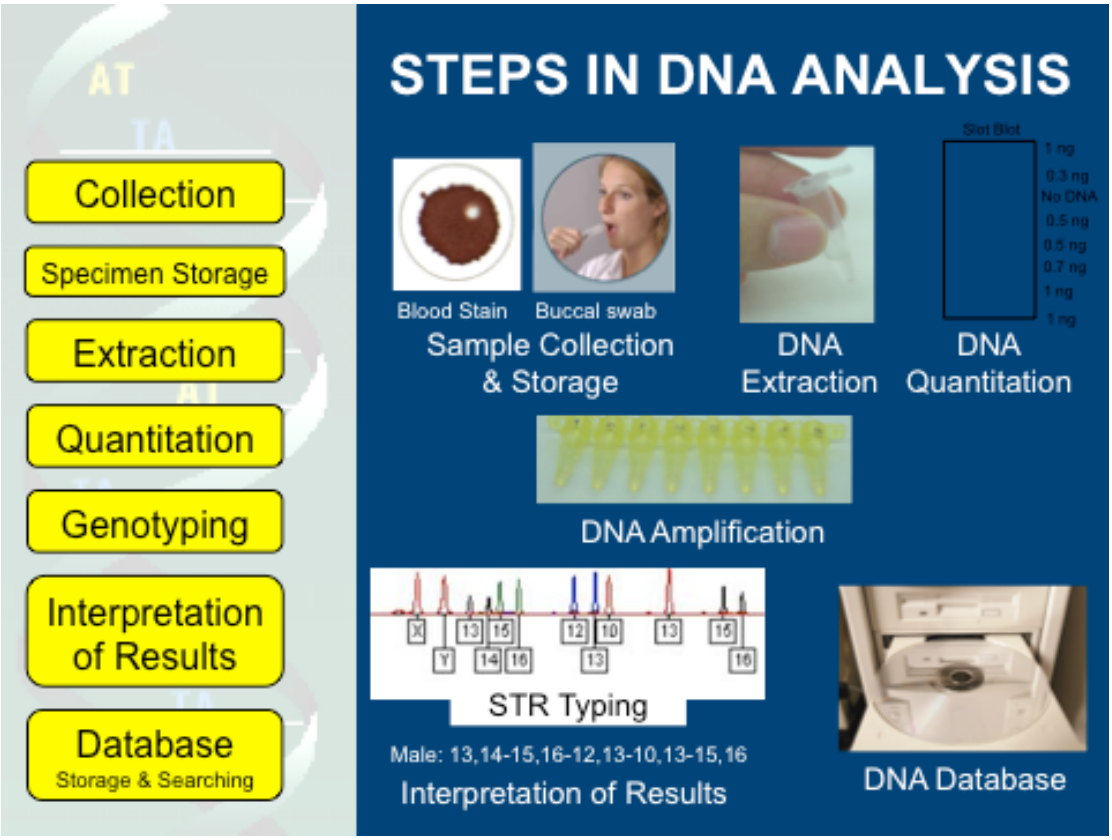

Figure 2: Simplified example of the comparison between a crime scene sample and two suspects.

The image created by the electrophoresis process is converted into a list of numbers that correspond to the fragment length or number of repeats of a given sequence at every chromosomal location under analysis (in yellow block). It is clear that the evidence taken from the crime scene matches the DNA profile of Suspect 2 as the sequence of numbers is identical.

The designations D3, vWA and FGA represent 3 different chromosomal locations (STR's) under analysis.