DNA evidence at crime scenes

This chapter contains these topics:

Overview

Summary of this chapter

This table summarises information outlined in this DNA section.

Topic	Information to note
[redacted]	
Preservation at scene	• Measures should be taken to avoid contamination. As a minimum gloves and masks should be worn.
Recovery techniques	• Liquids can be sampled using a clean swab • Dried stains can be scraped or swabbed • Items can be recovered to be examined in laboratory conditions.
Packaging	• Depends on item • Do not use plastic bags or staples • Seal packaging immediately.
Storage	• Dry, cool conditions – Not direct sunlight.
Special considerations	• The risk of contamination cannot be over-emphasised. Do not touch, talk over or sneeze over stains. Wear gloves and mask. Take controls first.
Factors affecting range of evidential significance	• Amount of DNA present • Condition of DNA (i.e. not degraded) • Location found and type of body fluid found.

Related information

For information about the law relating to DNA sampling (e.g. who can be required to give a DNA sample and when) DNA databases and the procedures for taking samples from individuals, refer to DNA sampling in the Police Manual.

Who to contact?

See Forensic contacts for information about who to contact for specialist advice about DNA evidence.

Describing DNA and profiling

What is DNA?

DNA stands for Deoxyribonucleic Acid.

This is the name of the complex chemical found in virtually every cell in the body. It contains the coded sequence that determines our physical characteristics and directs all the chemical processes in the body.

DNA is found in two different parts of each cell – the nucleus and the mitochondria. It is the nuclear DNA that is commonly analysed by ESR.

Nuclear DNA

Almost all cells in the body contain a nucleus. The genetic information coded for by nuclear DNA is carried in the chromosomes from one generation to the next. Half of a person's nuclear DNA is inherited from the mother and half from the father.

The nuclear DNA of identical twins is expected to be the same. Other siblings inherit different combinations of nuclear DNA from the same parents and their DNA is therefore different from one another. The DNA from unrelated individuals is likely to be even more different. Each generation of people is a new and different combination of genetic material from the previous generation.

Second generation multiplex plus

The second generation multiplex plus (SGM+) technique was introduced in New Zealand in 2001. ESR looks at a set of components of the DNA molecule. Each one of these components is known as a locus (plural loci). Ten loci have been selected because they are regions where there is known to be considerable variation between people caused by short pieces of DNA code being repeated over and over again, end to end (short tandem repeat loci (STR's)). Although any given set of components (the DNA profile) will not be unique to an individual, methods have been developed to calculate the probability of one person's DNA profile matching that of another just by chance.

As from November 2007, ESR uses Identifiler which selects 15 STR loci plus amelogenin.

LCN (Low Copy Number) DNA

Low Copy Number DNA (Deoxyribonucleic Acid) (LCN DNA) analysis was introduced in New Zealand in November 2006. It is a highly-sensitive DNA profiling technique and is an extension of the routine SGM Plus® profiling techniques. It enables scientists to produce DNA profiles from samples containing very few cells even if they are too small to be visible to the naked eye.

The increased sensitivity of this technique enables a DNA profile to be obtained from a very small original sample but presents a higher risk of contamination. LCN DNA profiles are more likely to be partial and/or mixtures. It may also not be possible to indicate the source (blood / semen / saliva / skin etc).

LCN profiles are compatible with the National DNA Database. This is because the same ten sites on the DNA are tested. The sensitivity of the technique occurs because more copies of the DNA are generated from a smaller amount of starting material, from samples previously too small.

LCN profiles have the same discriminating power as the routine SGM Plus technique - about one in a billion.

Using LCN analysis
LCN analysis should be considered for cases of a serious nature only. The main application of this technique is to target areas on items where it is believed an offender may have transferred DNA through touch (e.g. residue believed to have come from skin cells or sweat left in a fingerprint. Profiles can also be successfully generated from items such as discarded tools and weapons.

It is recommended that LCN DNA analysis is treated as an extension of the current DNA technique, second generation multiplex plus (SGM+) and used only when other forensic evidence sources are exhausted (i.e. from samples which have failed to provide a result using the conventional technique).

It is important that discussions are held between investigator and scientist to understanding the evaluation and evidential relevance of the findings.

Mitochondrial DNA
Mitochondrial DNA is maternally inherited – brothers, sisters and other maternally related individuals will have the same mtDNA type. This analysis is suitable for faeces, aged teeth or bones, hair shaft.

Using mitochondrial DNA
Mitochondrial DNA is only be used if conventional DNA analysis is not possible. It could be used for body identification if reference samples from maternal relatives are available. This would only be used for serious offences and in consultation with ESR.

Y chromosome DNA
Y chromosome DNA is paternally inherited - brothers and father will have the same type. This may be used where there is a large amount of female DNA present, (i.e. a rape case).

Familial DNA
Familial DNA searching (sometimes referred to as "Familial DNA" or "Familial DNA Database Searching") is the practice of creating new investigative leads in cases where DNA evidence found at the scene of a crime strongly resembles that of an existing DNA profile (offender profile) on the National DNA database (NDD) but there is not an exact match.

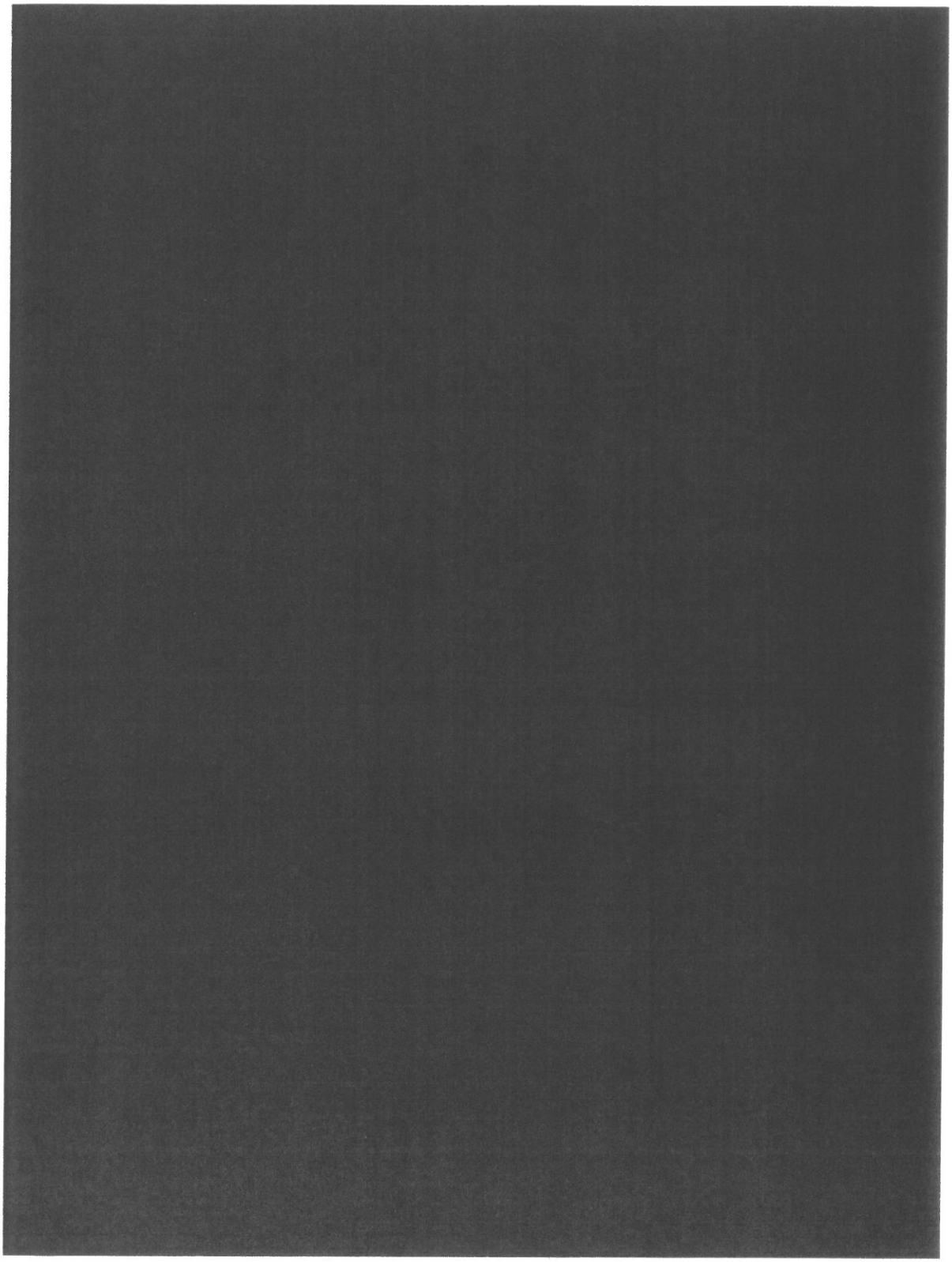
The Criminal Investigations (Bodily Samples) Act 1995 (CIBS Act) does not extend to providing a framework for forensic use of the NDD. In its absence, ESR and NZ Police have developed these agreed procedures for operational activities involving the NDD:

1	A familial search of the NDD may be considered for a serious offence where there is no DNA link resulting from a specific crime profile search.
2	Familial searching does not contravene the CIBS Act. However, it is recognised by both ESR and the NZ Police that this type of search has important ethical implications and should only be considered on a case-by-case basis.
3	As this type of search explores familial relatedness it shall only be undertaken where it is considered necessary and proportionate in a particular case.

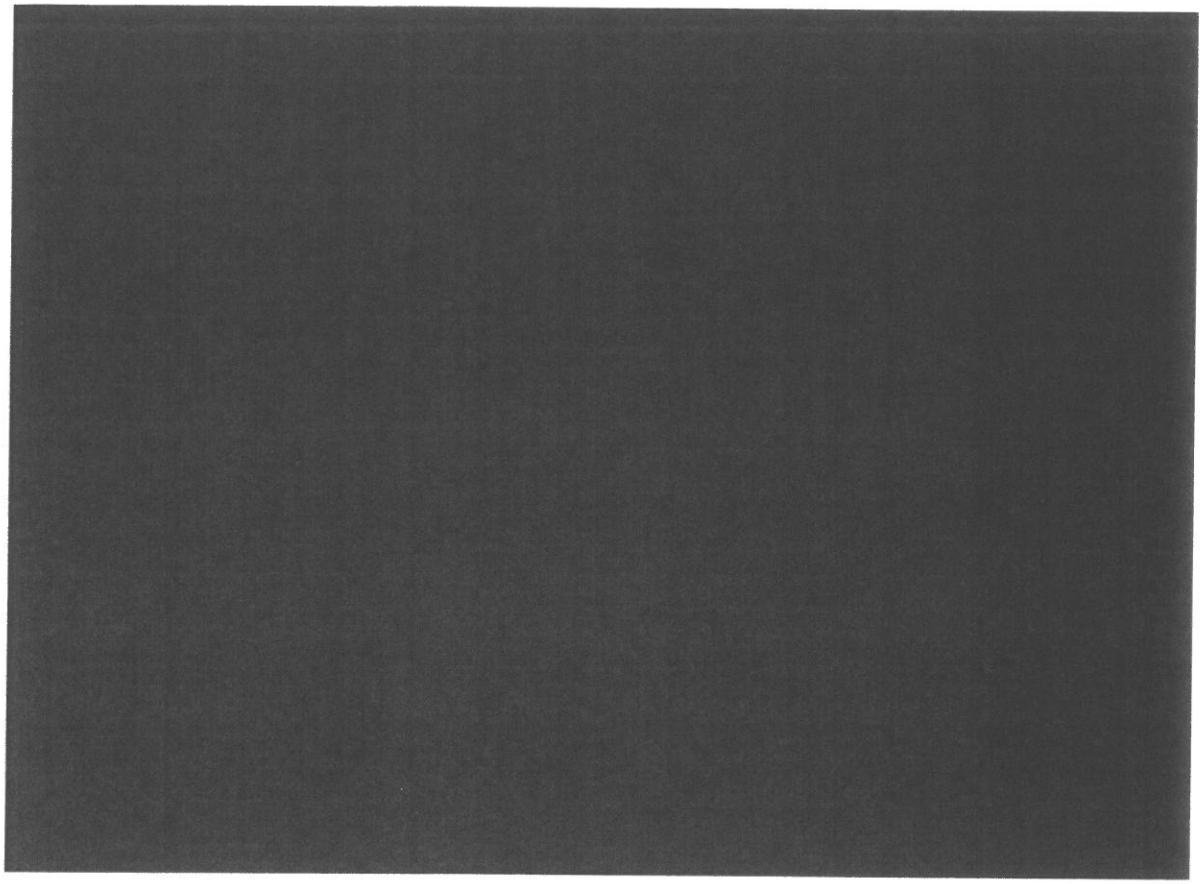
4	NZ Police shall have an authorisation process for familial search requests to ESR which considers the seriousness of the offence and whether a familial search is appropriate for the investigation.
5	NZ Police shall provide ESR with the necessary documentation which demonstrates the search has been authorised and should proceed. Authorisation shall be via completion of the proforma "NZ Police Request for a Familial Search" of the NDD. (Download a copy of the request form (word document, 350 KB)).
6	A familial search will result in a list of potential close relatives to the offender and will contain sensitive personal information.
7	The list is ranked statistically on the basis of how likely a person will be a relative of the offender. ESR shall assist NZ Police in the scientific interpretation of these results.
8	Access to this list shall be restricted to Police and ESR staff involved in the investigation.
9	ESR shall keep a record of familial search requests made by NZ Police and shall provide a summary of these in an annual NDD Report.

Further information
Download a copy of A Guide to the Familial Search Processes (word document, 54 KB).

DNA at crime scenes, Continued...



DNA at crime scenes, Continued...



Factors to consider at crime scenes

Understanding evidence

Advancements in forensic DNA technology have led to a significant increase in the number of samples collected during crime scene examinations.

Crime scene investigators need to:

- have a general understanding of how each item relates to the scene
- prioritise analysis according to the probability of yielding a DNA profile (depending on the sample's suitability) from an item and the evidential potential if the item provides a profile
- consider (particularly in volume crime cases) whether the forensic relevance outweighs the cost of analysis. If it does, submit it
- minimise contamination risk
- consider obtaining elimination DNA samples from investigators who through their involvement with the scene or exhibits could have left their DNA at the scene/on the exhibit - Staff / CIED(Crime Investigators Elimination database sampling form available on Police Forms on the Intranet.

Prioritising and sequencing sample analysis

[redacted]

There is not a straight answer to this issue. It depends on the circumstances of the case and the evidence available. Individual cases need to be discussed and the potential forensic evidence techniques and sequencing considered in the context of that case.

Fingerprinting usually appropriate before DNA profiling

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Samples should be submitted for processing as soon as possible after fingerprint treatment. Personnel conducting fingerprinting should use clean or new brushes and be aware there is a possibility that DNA can be transferred from one scene / exhibit to another on a dirty brush.

Elimination reference samples may be required from all officers involved in the collection or handling of samples for LCN.

See the Fingerprints Police Manual chapter for further information about fingerprint examination at crimes scenes.

Avoiding contamination

Contamination is a real risk.

The increased sensitivity of DNA extraction techniques enables a DNA profile to be obtained from a very small original sample but presents a higher risk of detecting inadvertent contamination. To avoid contamination **minimum protective clothing must include gloves and surgical facemasks**.

Actions to preserve the scene and avoid or minimise contamination include:

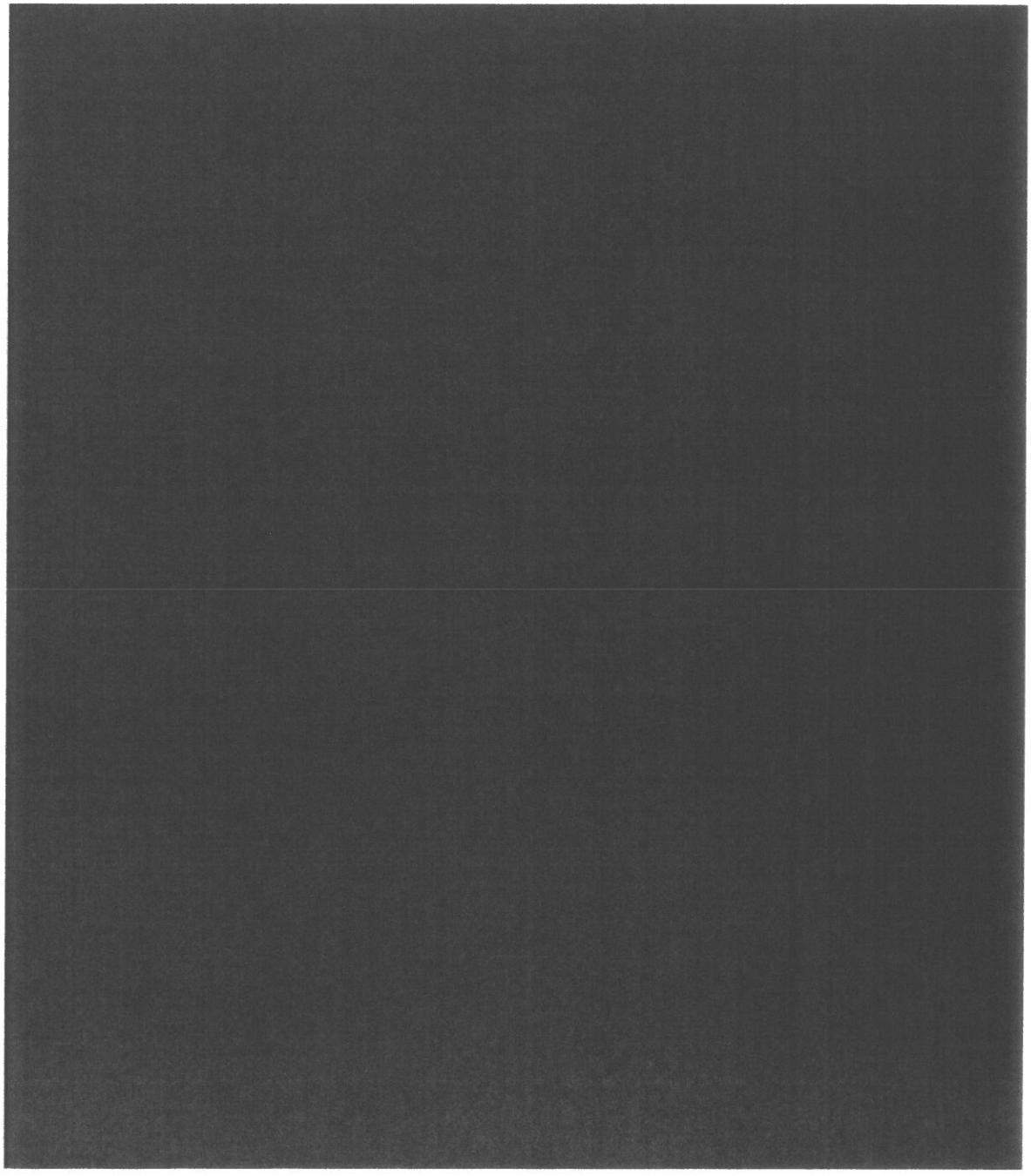
- controlling access and preventing unauthorised/unnecessary entry regardless of rank (consider who is in the scene and if they need to be in there)
- ensuring protective clothing is worn by **everybody** entering the scene (gloves and surgical masks at a minimum)
- using dedicated, sterile / disposable equipment (DNA kit)
- recording full details of people entering the scene
- avoiding sneezing, coughing or talking over exhibits /stained material
- photographing all evidential material in situ
- keeping handling to a minimum and only handling one item of evidential material at a time (change outer gloves between exhibits)
- erecting a cordon (ensuring it is extensive enough) and establishing a common approach path different to the route possibly taken by the offender.

For further information refer to the Crime scene examination chapter in the Police Manual.

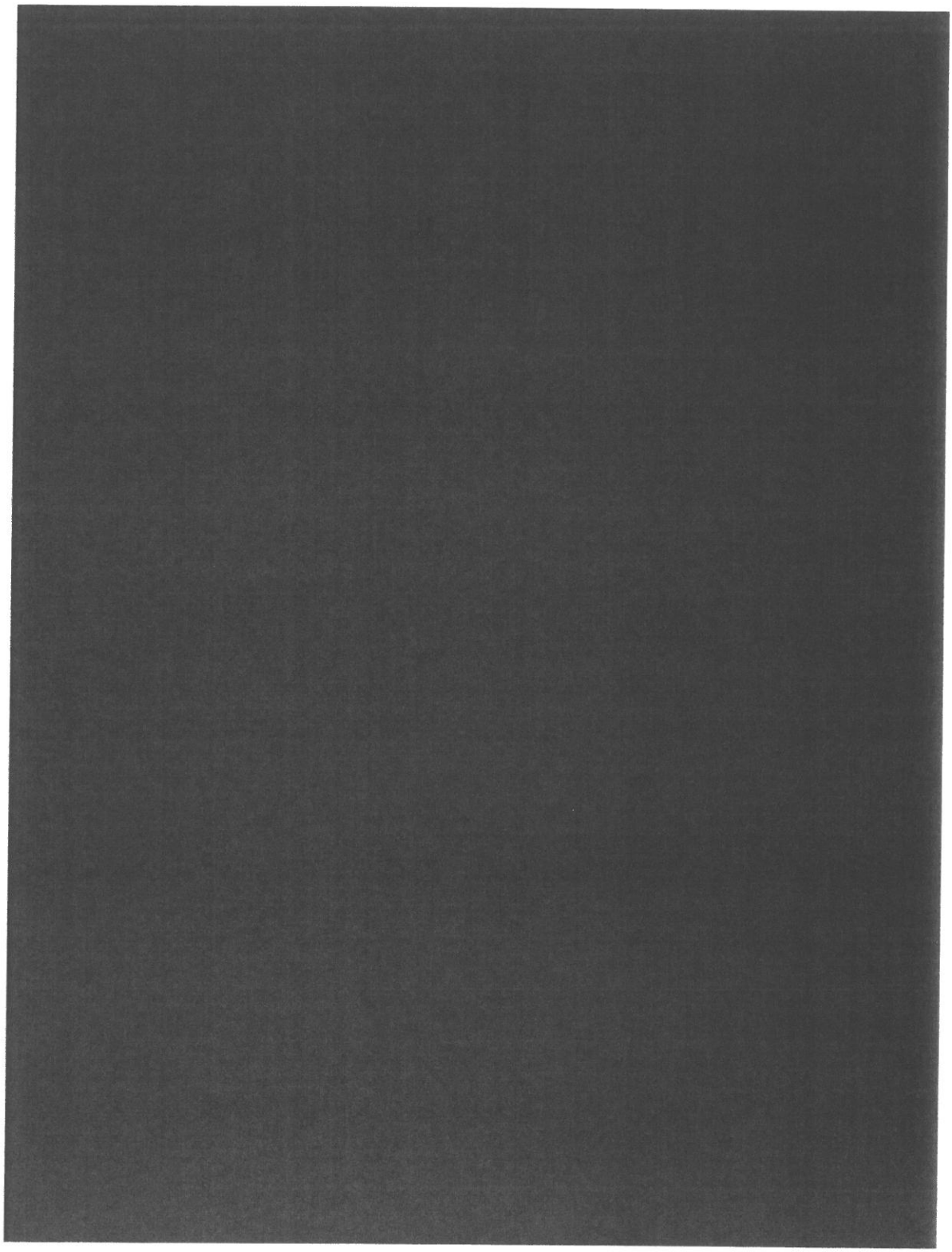
Recovery methods

Introduction

Careful recovery and packaging is essential to ensure exhibits are kept in the same condition as when they were found, unless wet. Packaging methods should prevent loss, leakage, damage and contamination.

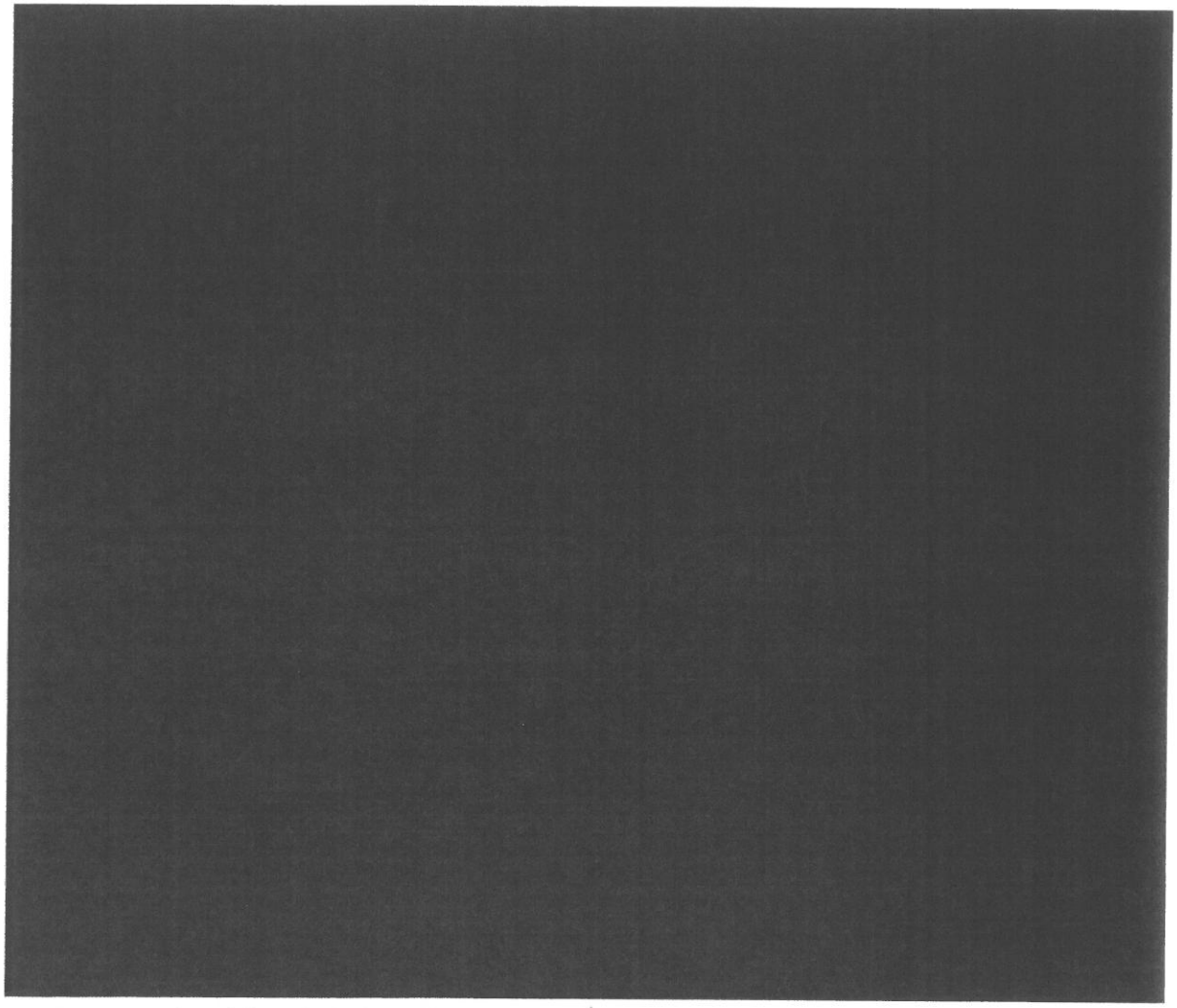


DNA at crime scenes, Continued...



Wet and dry swabbing method

Step	Action
1	Ensure swab seals are intact before use.
2	• Moisten sterile swab with sterile water (2-3 drops). • Swab area that may have saliva or blood stains by gently rubbing the dampened swab onto the selected area.
3	• Replace the swab in the plastic holder. • Label the swab base and holder with the exhibit number.
4	Cut about 5mm off the end of the swab holder tube with clean scissors. (This will allow the swab to dry).
5	Repeat the process using a dry swab to mop up any further liquid.
6	• Place the swabs in a clean paper envelope, seal, sign and label on the same side as the seal. (Both swabs can be packaged together). • Store at room temperature.
7	For dry blood and saliva, semen or vaginal fluid samples: • take a control swab of the unstained background surface as near as possible to where the blood swab was taken • place the control swab in a clean paper envelope, seal, sign and label on the same side as the seal • pack this swab separately.



Range of evidential significance

If it is found that the DNA profile of a suspect is different from that from a crime scene sample, then it is reasonable (processing errors excepted) and non-controversial to conclude that the DNA in the crime sample is not that of the suspect.

Specific DNA terminology

This table sets out the meanings of terminology used in relation to DNA matters.

Term	Meaning
Allele	Any of several alternative forms of a gene or STR locus found at the same point on a particular pair of chromosomes.
ASCLD/LAB	American Society of Crime Laboratory Directors / Laboratory Accreditation Board. An organisation providing accreditation and quality testing for forensic laboratories around the world. ESR is accredited under ASCLD/LAB to perform forensic DNA analysis as well as several other forensic analyses.
Aspermic or azoospermic	Semen that contains no or little sperm.
Bayesian	A statistical method of combining the likelihood ratio with additional information to produce an overall estimate of the strength.
Buccal sample/swab	A sample collected by rubbing a sterile swab on the inside of the mouth or cheek. This transfers loose skin cells onto the swab, cells which can then be used to generate a DNA profile.
Chromosome	A rod-shaped structure found inside most human cells. Consist mainly of long coils of DNA, and as such are the storage unit of DNA in the cell. Humans have 23 pairs of chromosomes; one set of 23 inherited from the father, the other set from the mother.
CI(BS) Act	Criminal Investigations (Bodily Samples) Act 1995. This was originally passed in 1995 as the Criminal Investigations (Blood Samples) Act and was amended to its current form in 2009. The Act deals with regulations regarding samples for use on the National DNA Database.
CSDU/CSD	Crime Sample Database Unit. This is the team at ESR that works on samples from volume crimes that have no specific suspect, such as burglaries. DNA profiles produced by the CSDU are loaded onto the Crime Sample Database (CSD) and are matched against the profiles from individuals on the National DNA Database (NDD).
Defence hypothesis	The defence hypothesis is assumed to be that the biological evidence seen in a case is not from the suspect, but from another unrelated person in the wider population. This assumption is used in the statistical calculations that evaluate a piece of evidence.
DNA	Deoxyribonucleic Acid. This is the name of the complex chemical found in virtually every cell in the body. It contains the coded sequence that determines our physical characteristics and directs all the chemical processes in the body.
Electrophoresis	A technique that separates DNA fragments on the basis or their size by running them through a viscous material. The fragments move through the material due to the application of

	an electric current which attracts the negatively charged DNA to the positive terminal, and the fragments are separated due to the fact that the smaller fragments will move through the matrix faster than the larger fragments and will thus arrive sooner at the positive terminal.
Familial searching	Familial searching is a useful tool in investigations where a full DNA profile has been obtained from a crime scene sample of a serious offence, but there are no matches when this profile is checked against the database. DNA profiles of individuals who are related to each other are more likely to contain similarities in their DNA profiles than two unrelated individuals. Familial searches of data stored on the database provide information for two lines of enquiry: the identity of individuals who could be a parent/child of the offender or the offender's sibling.
Fst	A statistical term used to measure the level of inbreeding in a subpopulation. This has an effect on the distribution of the alleles seen in DNA profiles and is used by forensic scientists to calculate how rare a certain DNA profile is.
Gene	A section of DNA that contains the genetic information contained in the DNA of an organism.
Genome	The complete set of genetic information contained in the DNA of an organism.
Heterozygote	A person who has two different alleles, one on each chromosome, at a single locus.
Identifiler	DNA analysis that tests 15 STR loci plus amelogenin. Provides more discrimination than SGM+.
LCN DNA	Low copy number DNA analysis was introduced in New Zealand in November 2006. It is an extension of the existing DNA technique; second generation multiplex plus (SGM+). The increased sensitivity of this technique enables a DNA profile to be obtained from a very small original sample but presents a higher risk of contamination.
Likelihood ratio	A statistical term that measures the value of a piece of evidence. Equal to the probability of seeing a piece of evidence given the prosecutor's hypothesis, divided by probability of seeing a piece of evidence given the defence hypothesis.
Locus	A specific area, or site, on a chromosome. DNA profiling looks at ten STR loci.
Mitochondrial DNA (mtDNA)	A relatively new method of DNA analysis that examines the DNA in mitochondria, which are small organelles responsible for producing the energy in cells. Mitochondrial DNA is maternally inherited – brothers, sisters and other maternally related individuals will have the same mtDNA type. It can be very useful in identifying badly burnt or decomposed samples because mitochondria are resistant to degradation. This analysis is suitable for faeces, aged teeth or bones, hair shaft. Mitochondrial DNA techniques are not as discriminating as traditional methods.
Multiplex	A form of DNA analysis that allows multiple loci to be analysed at the same time.
NDD	National DNA Database. A database of known DNA profiles

DNA at crime scenes, Continued...

	maintained by ESR. Profiles on the NDD are compared with those on the Crime Sample Database (CSD), which contains unknown DNA profiles from crime scenes.
Nucleotide	The base unit of DNA. Nucleotides make up the 'rungs' of the ladder-shaped DNA double helix. Nucleotides can be either A, G, C or T and different combinations of these are used to encode the information that DNA contains.
P30 / Prostate-specific antigen (PSA)	A glycoprotein produced by the prostate gland that has been well characterised and validated in the forensic science community as a marker for the presence of seminal fluid.
PCR Amplification	PCR stands for polymerase chain reaction, and refers to a method for increasing small amounts of DNA into an amount that can be more easily analysed. This is achieved through a copying process that is repeated many times, doubling the number of DNA molecules present at each stage.
PCT	Priority Casework Team. The team at ESR that deals with DNA cases where a suspect has been identified. This often involves work on high profile cases such as homicides, rapes, etc.
Polymorphism	Having multiple forms of an allele at a locus within a population. Forensic scientists look for areas of DNA that are polymorphic because these allow people to be told apart from each other by their DNA.
Prosecutor's hypothesis	The prosecutor's hypothesis is assumed to be that the biological evidence seen in a case originated from the suspect. This assumption is used in statistical calculations that evaluate the value of a piece of evidence.
RFLP	Restriction fragment length polymorphism. An old method of forensic DNA analysis based on the different sized fragments that can be produced when a piece of DNA is cut by certain enzymes. Replaced by STR analysis due to the large amount of DNA required for it to work, as well as the long time needed for analysis.
SGM Plus	The STR multiplex used by ESR to generate DNA profiles from biological samples. Contains ten different STR loci as well as the sex test Amelogenin. (Moving to Identifier November 2007, which tests 16 loci).
STR	Short tandem repeat. The form of forensic DNA analysis currently used by most forensic laboratories around the world. STRs are short sequences of nucleotides that repeat themselves multiple times at certain points in the genome. Different people tend to have different numbers of the repeat unit in their DNA, and this allows people to be told apart on the basis of their DNA.
Trace DNA	Extremely small amounts of DNA such as, for example, the few skin cells that may be left behind when a person touches something with their hands. In recent years it has become possible to obtain DNA profiles from trace levels of DNA.