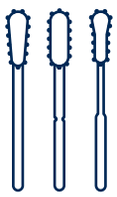
Forensic science

The diagnosis of a crime

Better forensic investigations begin with
a better sample collection.

Copan
innovating together



Collection

Transport

Processing

Artificial Intelligence

Our comprehensive approach to preanalytics

Background

The intersection of medicine and law

Forensic science aims to **identify, collect, and put together pieces of evidence** to prove or exclude a connection between individuals and objects, to understand what happened at the crime scene. **Investigators and forensics scientists can collect a wide range of physical or biological specimens** to assist the criminal investigation process; these specimens must be collected thoughtfully and with great care since the investigation findings affect court decisions and, consequently, the lives of all the individuals involved.

What's the Copan solution for forensics science?

- ***DNA collection and long-term storage of human DNA.***

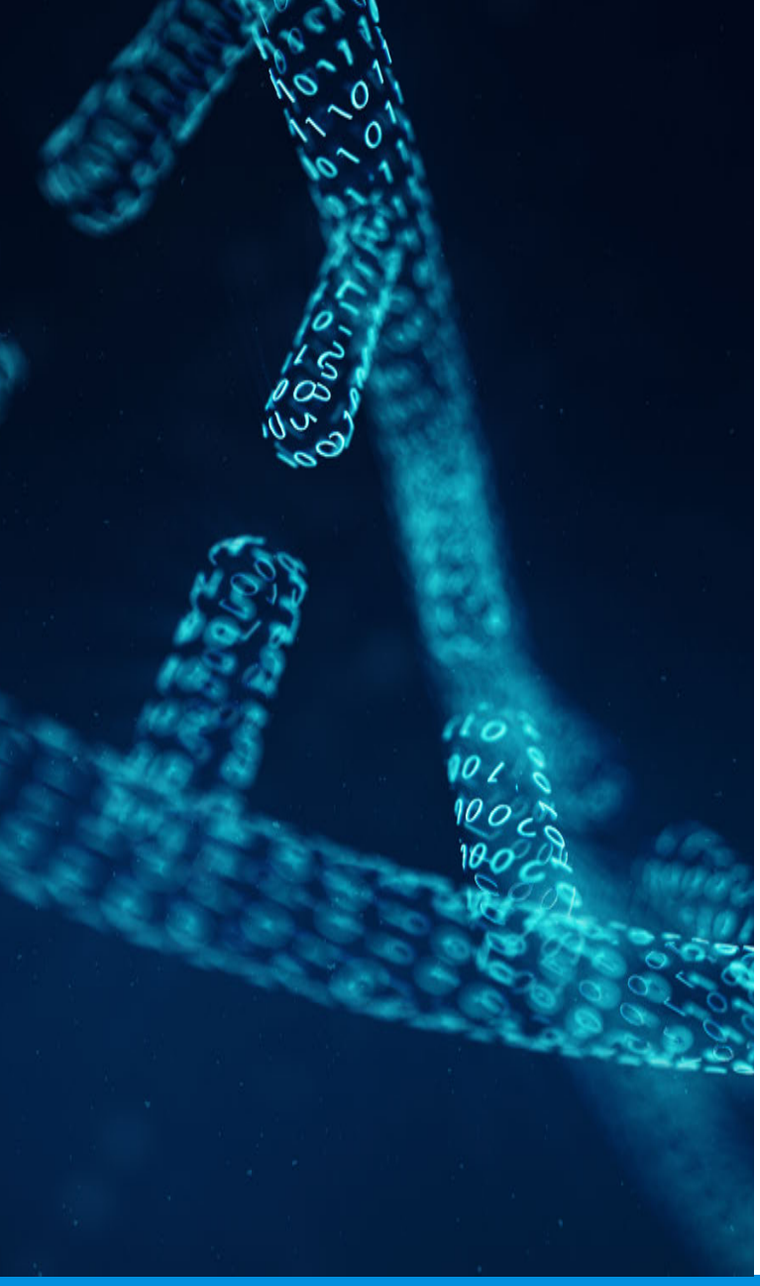
  NUCLEIC-CARD™, 4N6FLOQSwabs®

- ***Rapid DNA testing***

  microFLOQ®

- ***Sample preparation to improve human DNA recovery***

  NAO® Basket



DNA analysis in forensic science

The invisible witness

Despite only 0.1% of DNA differs from one person to the next, each human's DNA is unique, and **the chances of one individual's DNA profile matching another person are minimal.**

This uniqueness made DNA analysis a powerful tool to solve investigations since the mid-1980s, when Dr. Alec Jeffreys discovered repeated patterns in certain DNA areas; from that moment, **DNA profiling has become an integral part of police investigations[1].**

The concept behind the first profiling method developed – known as Restriction Fragment Length Polymorphism (RFLP) – is clever: since the number of these repetitions varies between individuals, measuring the variation in the length of these repetitions and **comparing samples of DNA found on the Scene with the one of the suspects is able to identify felons.**

Sources of DNA are usually easy to find (as biological fluids and bloodstains) but sometimes can be invisible to the naked eye (Touch DNA). Summarizing, typical sources of culprit's DNA can be found:

- On the victim's body: below the fingernails, in bitemarks, or perianal, vaginal, penile, rectal, or oral zones;
- On objects potentially used by the offender, as cigarette butts, tissues, bottles, or the murder weapon;
- Spread on the crime scene by stains of blood, semen, saliva, urine, or hair and skin cells.

Errors in the collection and handling of these biological samples or their contamination can result in their exclusion from the trial, highlighting the necessity of a proper sample collection and storage[2].

Modern techniques

Towards an unparalleled sensitivity

Although being accurate and reliable, RFLP requires a large amount of DNA to work. With the advent of PCR, it's now easier to obtain DNA profiles from minute amounts of a biological sample.

Modern DNA fingerprinting techniques analyze different types of highly variable sequences in the human genome: Variable Number Tandem Repeats (VNTR) and Short Tandem Repeats (STR). By combining the profile of more of these regions, it is possible to obtain the distinctive profile of a person and determine whether two DNA samples are from the same person, related people, or non-related people.

As impressive as the current DNA analysis systems are, **forensic scientists can nowadays develop a DNA profile from smaller and smaller biological samples**, such as the aforementioned "Touch DNA," which can be collected even from few invisible skin cells left behind on an object or the victim's body.

Case study

DNA solving a case, first take

Leicestershire, England, July 1986: the 15-year-old Dawn Ashworth is raped and murdered. The crime is weirdly similar to another murder, happened just three years before. At that time, Dr. Alec Jeffreys had discovered pattern repetitions in human DNA; so far, though, he applied his DNA pattern recognition technique only in paternity and immigration cases.

After the police requested him to help with the murders, Jeffreys profiled DNA samples found on the two crime scenes: the first DNA analysis acquitted the main suspect and forced the police to perform a genetic screening, collecting blood and saliva samples from more than four thousand men in the Leicestershire area. Although no DNA was found to match with the one on the crime scenes, a man was overheard saying he'd been paid to pose as someone else to provide fake samples.
The man trying to evade the DNA collection was Colin Pitchfork: when Dr. Jeffreys analyzed his DNA, it matched the crime scene samples. Pitchfork was arrested and sentenced to life prison[3].

Applications of DNA profiling

Guilty or not?

There are numerous ways to use DNA profiling in forensic identification. DNA fingerprinting can allow for a potential suspect in a crime to be identified, but it can also be used to prove innocence, which is life-changing in cases of individuals who have wrongfully been convicted. DNA profiles play an essential role in identifying victims who may be unrecognizable – due to the nature of the crime or to decomposition. Yet, another use for DNA profiling is to establish a familial connection in paternity cases.

Collection practices and issues

Preserving the evidence integrity

The relevance of any investigation is determined by the type and quality of the sample submitted to the forensic lab. DNA can easily be damaged from contamination, improper storage, or exposure to sunlight and heat, undermining its potential use as evidence. **Thus, reliable and reproducible preanalytical protocols** – collection, handling, preservation, and storage – **should be used for the pieces of evidence before they reach laboratory[4].**

- DNA evidence can be contaminated with DNA from another source.
  For this reason, investigators and laboratory personnel should always wear disposable gloves, avoid touching other objects, and use clean instruments when handling evidence.

- Biological evidence can be collected using dry or water moistured swabs[5]. After collection, environmental factors as heat and humidity can provide the growth environment for microbes, causing DNA degradation. Evidence should be then allowed to air dry before packaging in an evidence bag.

- Each sample must be carefully labeled with the crime scene info and patient or victim's identifying information to maintain accurate identification;

- Before reaching the lab, a strict chain of custody must be maintained so that the evidence can be appropriately analyzed and used later in legal proceedings[6].

ISO 18385:2016

Compliant with the latest standards

ISO 18385
Forensic DNA Grade

ISO 18385:2016 specifies requirements for manufacturing products used in the collection, storage, and analysis of biological material for forensic DNA purposes. To comply with this standard and minimize the risk of detectable human nuclear DNA contamination in products used by the global forensic community, we test all the forensic products' raw materials for the presence of amplifiable human DNA.
In addition, we dedicated restricted areas and staff to these products, and we created a DNA database of all the people working on the genetic production, including our suppliers.
Finally, we treat the finished products with EO and test them for hDNA contamination, releasing a CoA before their sale.

microFLOQ®

Rapid DNA testing made portable

MicroFLOQ® is our DNA collection tool featuring a **micro flocked swab-tip**, co-developed hand-to-hand with the French Gendarmerie Forensic Research Institute (IRCGN™). **microFLOQ® can collect minute amounts of DNA** and may be used as an alternative pre-screening methodology in forensic biology casework[7,8]. Moreover, the **lysing treatment on MicroFLOQ® fibers enables skipping the extraction step** and obtain a 24 DNA markers profile in less than 2 hours for multiple samples, even touch DNA[9]. This direct sample amplification consumes only a tiny portion of the specimen, preserving valuable evidence for re-analysis or additional testing.

4N6 FLOQSwabs® Genetics

DNA collection for human identification

4N6FLOQSwabs® Genetics **specifically designed and dedicated to DNA collection for forensic applications** such as human identification, databasing, sexual assault, paternity testing, evidence collection, genotyping, and skin[10]. **4N6FLOQSwabs® Genetics feature an active drying system to adsorb water molecules, preventing microbial growth and guaranteeing DNA stability.** Law enforcement agencies have extensively adopted 4N6FLOQSwabs® Genetics for an efficient evidence collection at a crime scene[11,12]. Like all our FLOQSwabs®, 4N6FLOQSwabs® Genetics **are available with different geometries**; Moreover, their short-length breaking point is compatible with 1.5/2 ml vials and facilitates laboratory workflow.

4N6FLOQSwabs® Crime Scene

Evidence collection devices with antimicrobial treatment for crime scene use

4N6FLOQSwabs® Crime Scene **guarantee that even minute amounts of DNA are collected and remain available for testing**. Their nylon fibers special coating allows nucleic acid preservation without any drying activity, while **their antimicrobial treatment minimizes environmental contamination** (not for use on living humans)[12]. 4N6FLOQSwabs® Crime Scene are suitable for all traces: sweat, semen, blood stains, skin, and any environmental traces found at a crime scene. As with the 4N6 Genetics line, they are **available with different geometries**, and their short length breaking point is compatible with 1.5/2 ml vials.

NUCLEIC-CARD™

For collection, stabilization, processing, transport, and archiving of nucleic acid samples

NUCLEIC-CARD™ is specifically designed to **collect, transport, and store human DNA from buccal cells, saliva, and blood. The lysing treatment on the NUCLEIC-CARD™ allows a direct PCR STR analysis on a small punch of the card without the need for the extraction step**. Furthermore, every NUCLEIC-CARD™ includes an area for cleaning strikes while punching with manual or automated punchers and is identified with a pre-printed barcode. Thanks to the unique chemical treatment, NUCLEIC-CARD™ preserves DNA for 20 years at room temperature. NUCLEIC-CARD™ is **available in various off-the-shelf configurations and in customizable sizes and layouts.**

NAO® Basket

For rapid and efficient DNA recovery

NAO® Basket is a semi-permeable system designed for releasing and concentrating human DNA from swab samples or other specimens during the extraction step. With simple centrifugation, NAO® Basket efficiently recovers the sample lysate containing the nucleic acids in the provided collection tube. As studies reported, the combination of NAO® Basket and FLOQSwabs® provides the recovery of more than 90% of the reference sample collected[8], 10. **NAO® Basket is compatible with the 20 mm breaking point designed on the 4N6FLOQSwabs® and is available in several formats.** NAO® Basket is compatible with commercial Nucleic Extraction Platforms.

Future perspectives

Forensics fiction becoming real

Forensic science is quickly evolving, and new detective tools – quicker, more specific, and sensitive – are expected to be soon validated, used, and accepted in the courtrooms[13]. **Scientists are in the early stages of evaluating Next-Gen DNA sequencing methods**, and by DNA phenotyping, they are already able to partially reconstruct how the perpetrator looks by searching for genes known to influence a person's physical traits – including eye, hair, and skin color[14], as well as height. Geneticists are also seeking new ways to identify what type of body fluids investigators are dealing with by exploiting microRNAs, small RNA sequences that vary between fluid types and allow their identification based on their unique RNA signature[15]. Other research groups are exploring how each person's microbiome – that can be left the crime scene surfaces or even in the crime scene air – can be used to identify a person[16]. Together with a stricter protocol and guideline standardization, these **near-sci-fi tools represent the future of genetic forensics investigation and could be soon applied to criminal cases**: that's why now, more than ever, **the importance of a neat evidence collection mustn't be undervalued.**

Scientific references

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Code: JMKC041R00

@copangroup

Copan Italia s.p.a.
Via Francesco Perotti 10,
25125 Brescia, Italy

t | f +030 2687211
@ | info@copangroup.com
www.copangroup.com