

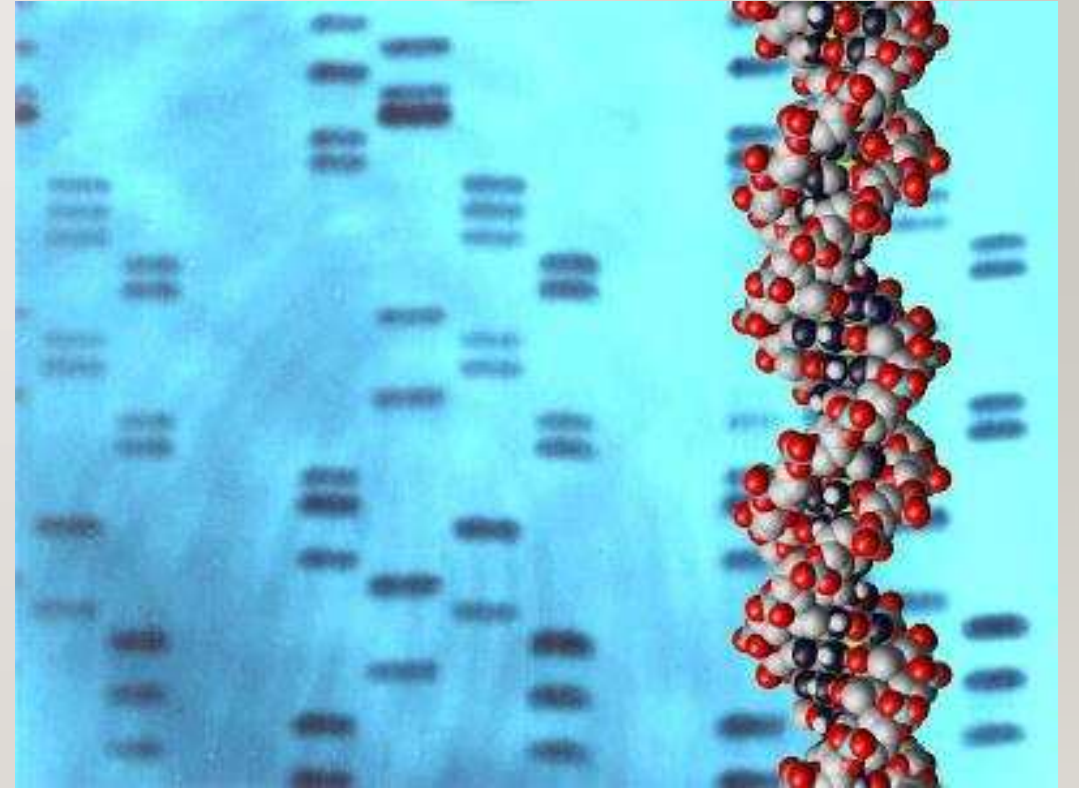
FORENSIC ASPECTS OF DNA ANALYSIS FOR BIOLOGICAL EVIDENCE

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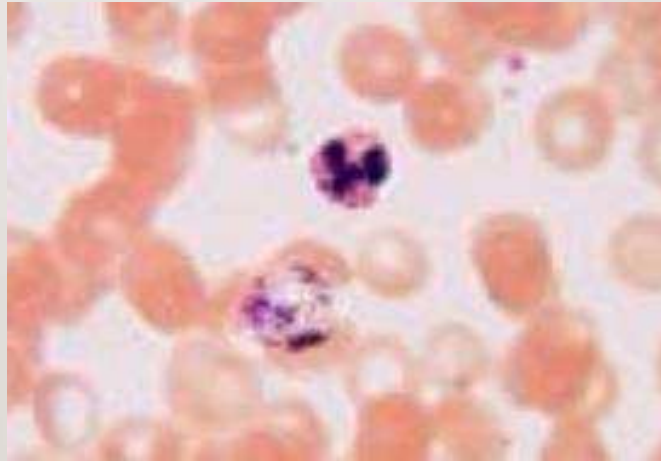
WHAT IS DNA EVIDENCE?

- DNA is a complex molecule that contains the instructions for building and maintaining the bodies of humans and other organisms.
- If someone leaves blood, semen or other biological material at a crime scene, scientists can use it as DNA evidence and create a DNA profile, or genetic fingerprint of that person.



WHERE IS DNA?

- All types of cells in our body contain a copy of the same DNA.
- The important cells for forensic testing are:

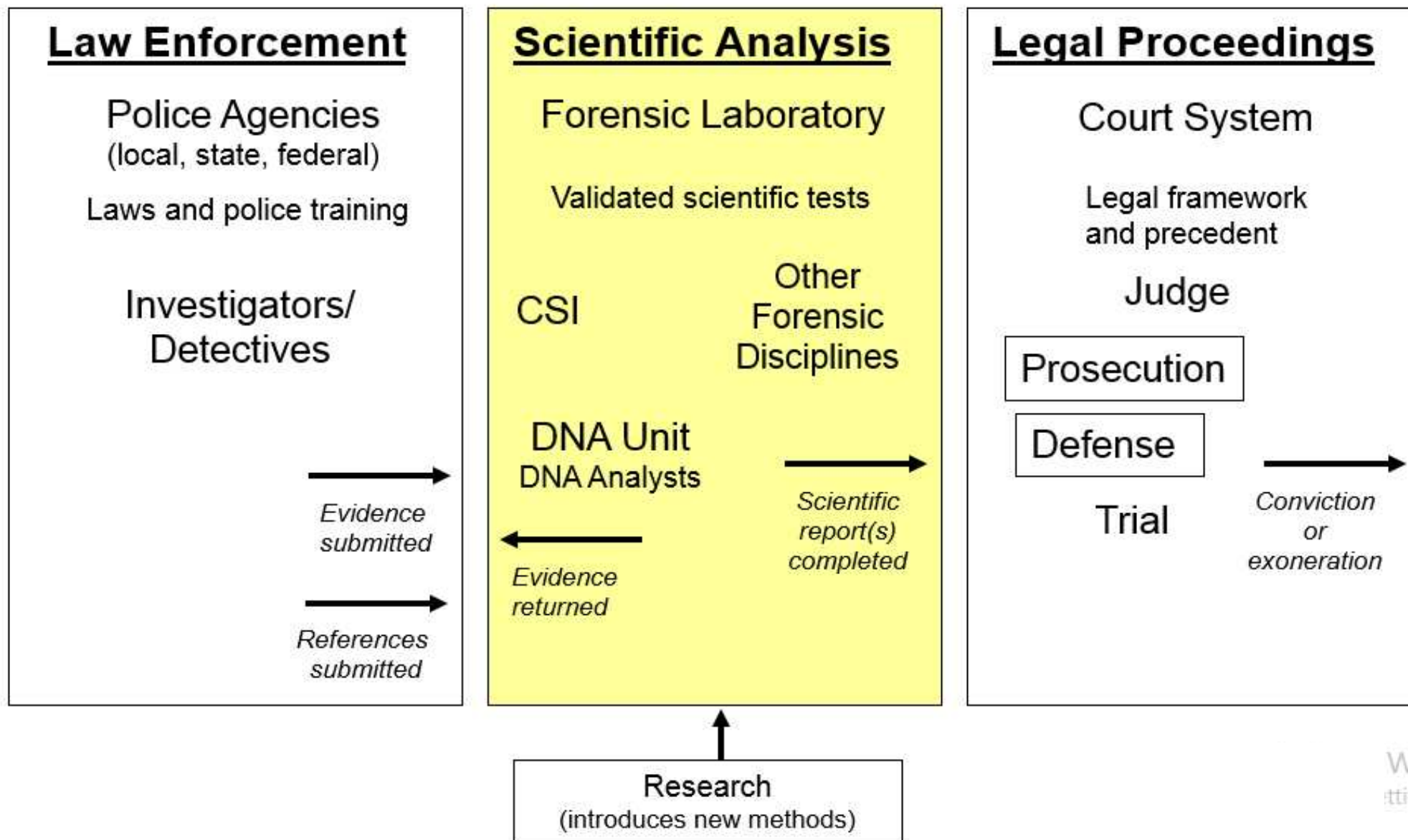


BASIS OF DNA PROFILING

- The genome of each individual is unique and has inherited genes and their genetic material from one's parents.
- DNA typing must be performed efficiently and reproducibly (information must hold up in court)
- Current standard DNA tests **DO NOT look at genes** – little/no information about race, predisposal to disease, or phenotypical information (eye color, height, hair color) is obtained



DNA fragments show unique patterns from one person to the next.



BASIS OF DNA PROFILING

- Forensic DNA analysis is an extremely powerful investigative technique that has become, in many ways, the standard by which other forensic sciences are measured.
- Every individual carries a unique set of genes
 - Chemical structure of DNA is same, but the order of the base pairs differs
- Every cell contains a complete set of DNA that identifies the organism as a whole
- Only one tenth of 1% of DNA differs from person to person



SOURCES OF DNA AT A CRIME SCENE



Saliva



Bone



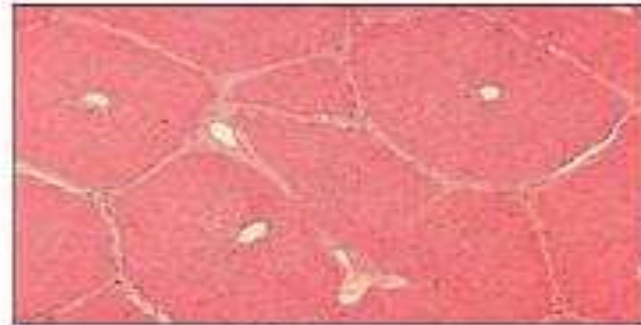
Blood on fabric



Tooth



Blood



Tissue



Hair



Semen

SOURCES OF DNA AT A CRIME SCENE

- Specimen Collection- Could be a licked envelope, dirty laundry, a cigarette butt, saliva
 - Special precautions in handling specimens: gloves, disposable instruments, avoid talking and sneezing, avoid touching sample with your skin, air-dry the evidence before packaging so mold does not grow
 - **Enemies of evidence: sunlight, high temperatures, bacteria, moisture**
 - **Ideal sample: 1 mL of fresh, whole blood (white blood cells) treated with EDTA**

DO'S & DON'TS

- **Avoid Contamination of DNA Evidence:**
- Use disposable gloves and disposable instruments for handling each sample.
- Avoid touching the area where you believe DNA may exist.
- Avoid talking, sneezing, and coughing over evidence.
- Avoid touching your face, nose, and mouth when collecting and packaging evidence.
- Air-dry evidence thoroughly before packaging as moisture destroys DNA.
- If wet evidence cannot be dried, it may be frozen.
- Put evidence into new paper bags or envelopes.
- Keep samples at room temperature and out of sun



FORENSIC DNA ANALYSIS

- Forensic DNA analysis involves Serology, Biology, Technology and Genetics.
- Forensic Science is the intersection of law and science
- DNA fingerprinting is a method used to identify an individual from a sample of DNA by looking at unique patterns in their DNA.
- DNA fingerprinting is mainly used for civil and criminal matters



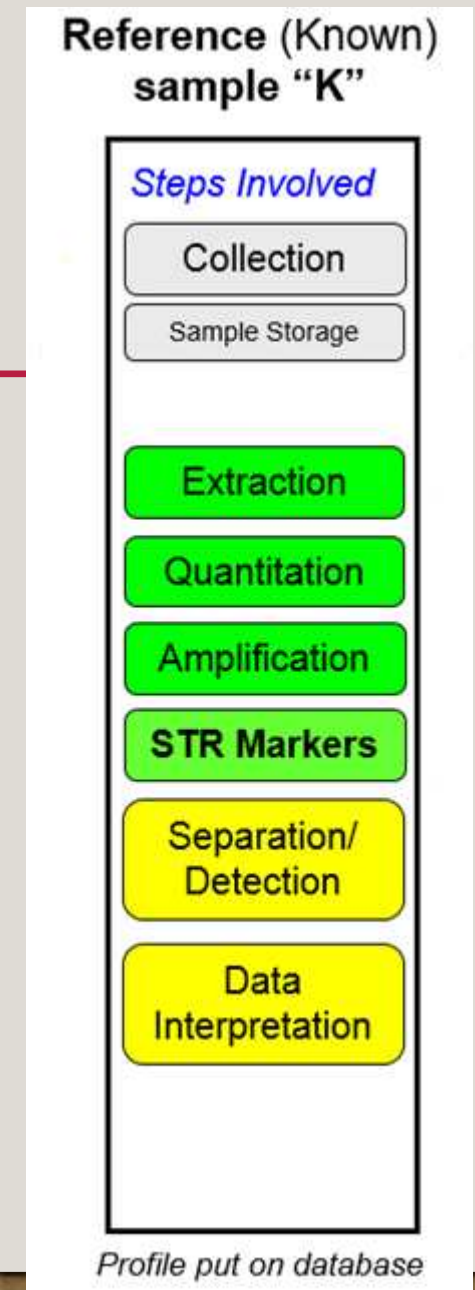
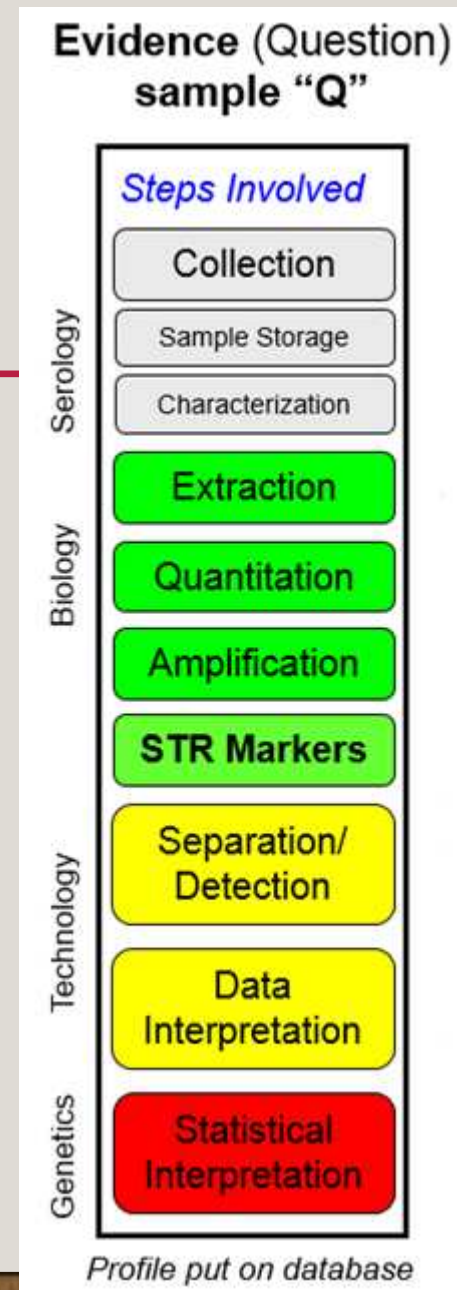
DNA TESTING REQUIRES A REFERENCE SAMPLE

- A DNA profile by itself is fairly useless because it has no context...
- DNA analysis for identity only works by comparison – **you need a reference sample**



EVIDENTIAL & REFERRAL SAMPLE VALUES

- Serology – Characterization of the evidence type
- Biology – DNA extraction, quantification, amplification and profiling
- Technology – Capillary Electrophoresis, Fluorescence capture/visualization, Data interpretation
- Genetics – Population genetics, allelic frequency, likelihood ratios



Sample Obtained from
Crime Scene or Paternity
Investigation

Biology



Technology



Genetics

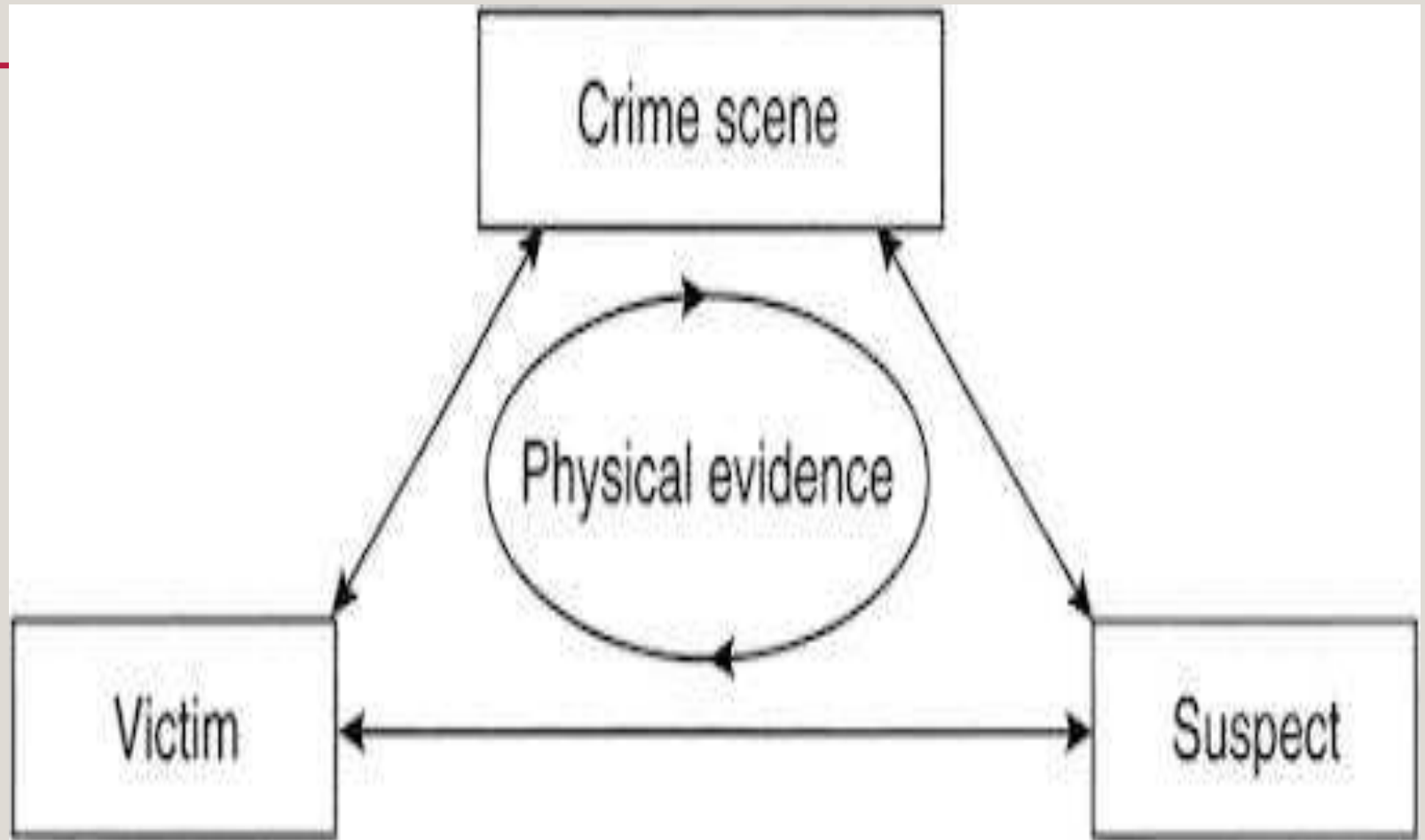


CONSERVATIVE NATURE OF FORENSIC DNA TYPING

- DNA fingerprinting is a comparative process
 - Looking for alignment of bands or dots in the fingerprint
 - All tests are based on exclusion
 - Testing continues only until a difference is found
 - If no difference is found after a statistically acceptable amount of testing, the probability of a match is high

LOCARD'S EXCHANGE PRINCIPLE

- When a person encounters an object or another person, a **cross-transfer** of physical evidence can occur.



Section of victim's DNA:



There are three regions of repetitive DNA.

Section of suspect's DNA:



The same three regions of repetitive DNA are present here, but some include different numbers of repeats. Now let's compare this sample to...

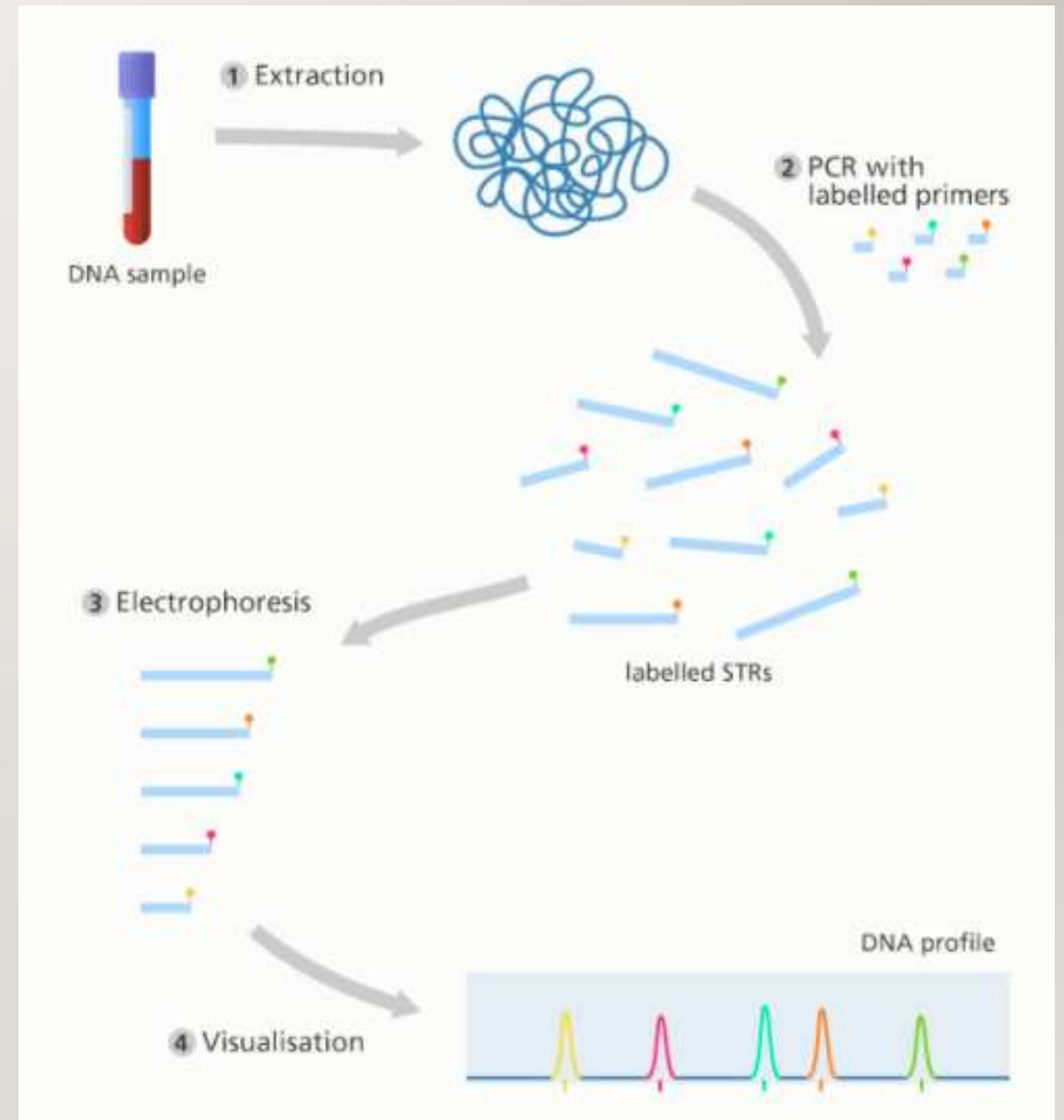
Section of DNA from crime scene hair:



The lengths of the repetitive sequences match the lengths in the suspect's DNA — so the DNA found at the crime scene belongs to the suspect.

DNA FINGERPRINT SUB-STEPS

- DNA Fingerprinting nowadays uses many small & large equipment to give distinct DNA profiles
- DNA Fingerprinting involves 4 sub-steps
 - DNA Isolation/Extraction
 - DNA Amplification
 - DNA Profiling
 - Visualization



DNA FINGERPRINT SUB-STEPS

- Most DNA samples submitted to a laboratory undergo the following process:
 1. **Extraction** is the process of releasing the DNA from the cell.
 2. **Quantitation** is the process of determining how much DNA you have.
 3. **Amplification** is the process of producing multiple copies of the DNA in order to characterize it.
 4. **Separation** is the process of separating amplified DNA product to permit subsequent identification.
 5. **Analysis & Interpretation** is the process of quantitatively and qualitatively comparing DNA evidence samples to known DNA profiles.
 6. **Quality Assurance** is the process of reviewing analyst reports for technical accuracy.

USES OF DNA PROFILING

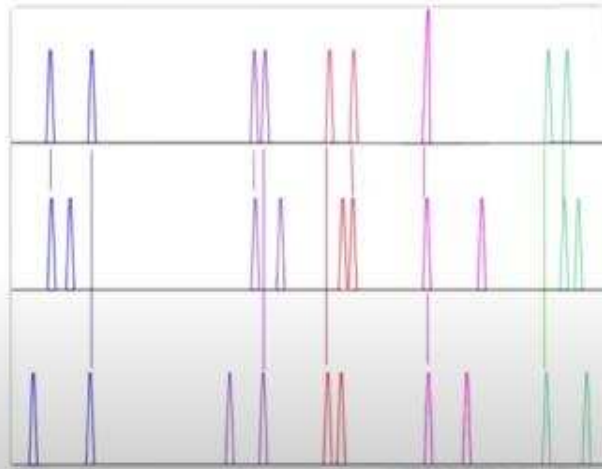
- Paternity/Maternity disputes resolution
- Relationship establishment for living donor organ transplantation
- Missing persons cases
- Homicide and sexual assault cases
- Identification of victims of mass disasters
- DNA tests for immigration/VISA purposes
- Ancient DNA profiling
- Child swapping cases
- Tissue or cell identification – in pathology labs

Paternity & Maternity Testing

Child

Mother

Father



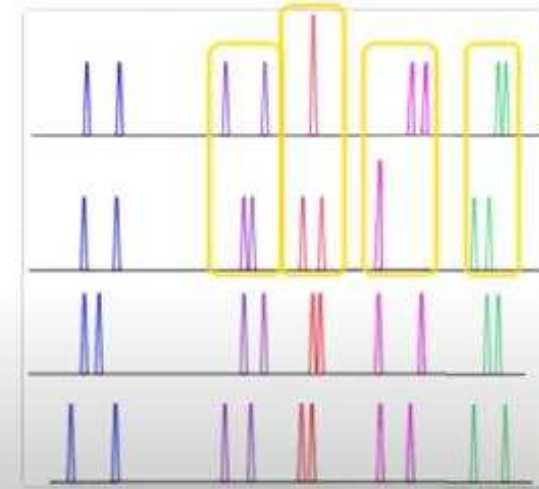
Sibling relationship

Sibling 1

Sibling 2

Mother

Father



Identification of Victims of Mass Disasters

