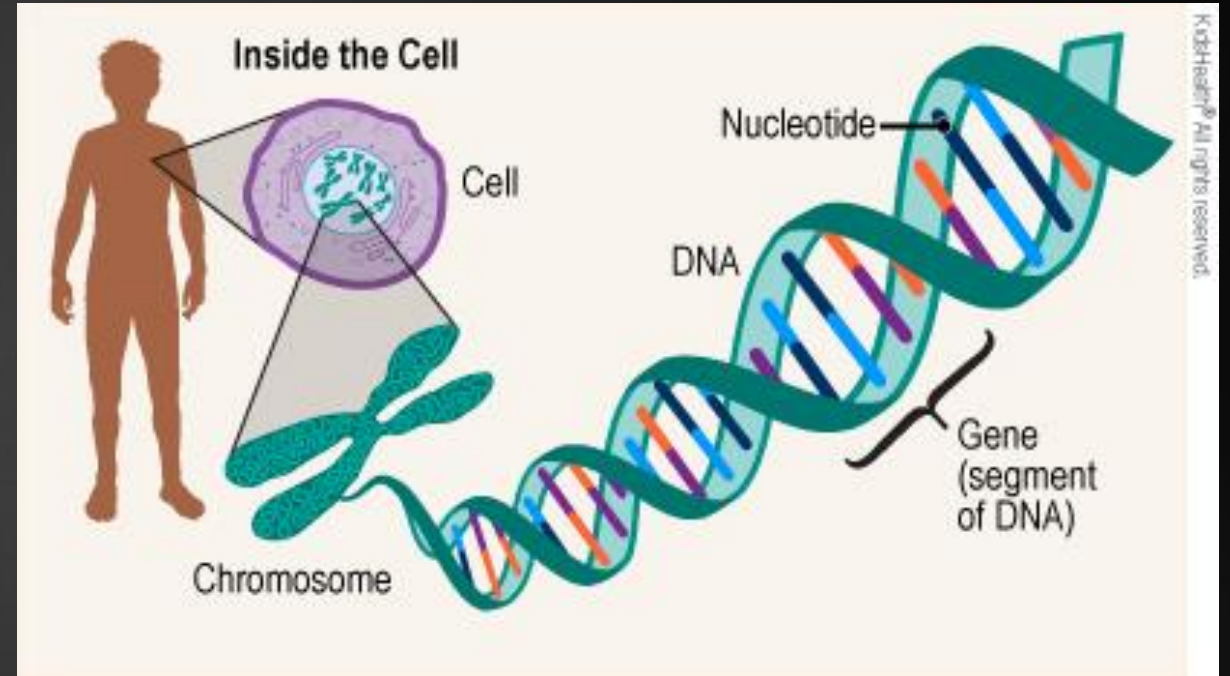


Forensic aspects of DNA analysis for Biological Evidence

GARGI DESHMUKH
SCIENTIST IN-CHARGE
GENOME FOUNDATION

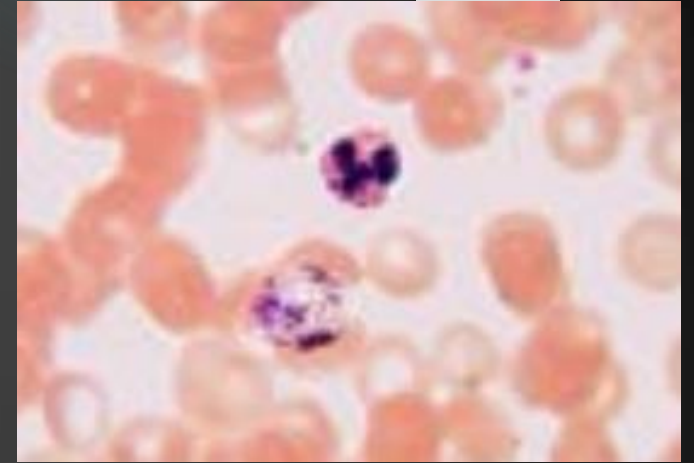
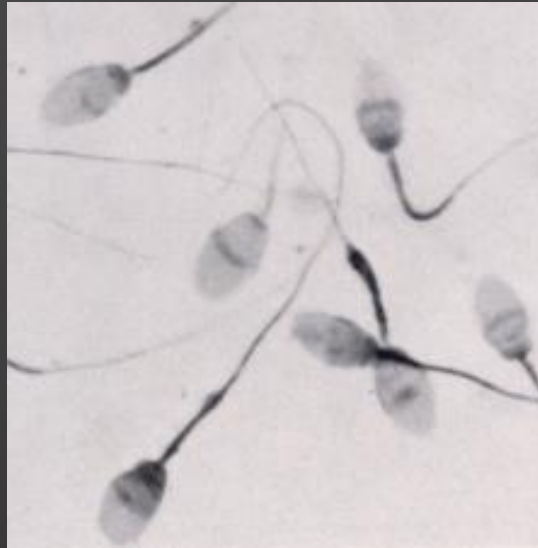
What is DNA?

- ▶ DNA = Deoxyribonucleic acid.
- ▶ Contains genetic information for cell growth, division and function.
- ▶ Hereditary material in humans and almost all other organisms.
- ▶ 50% inherited from each parent.



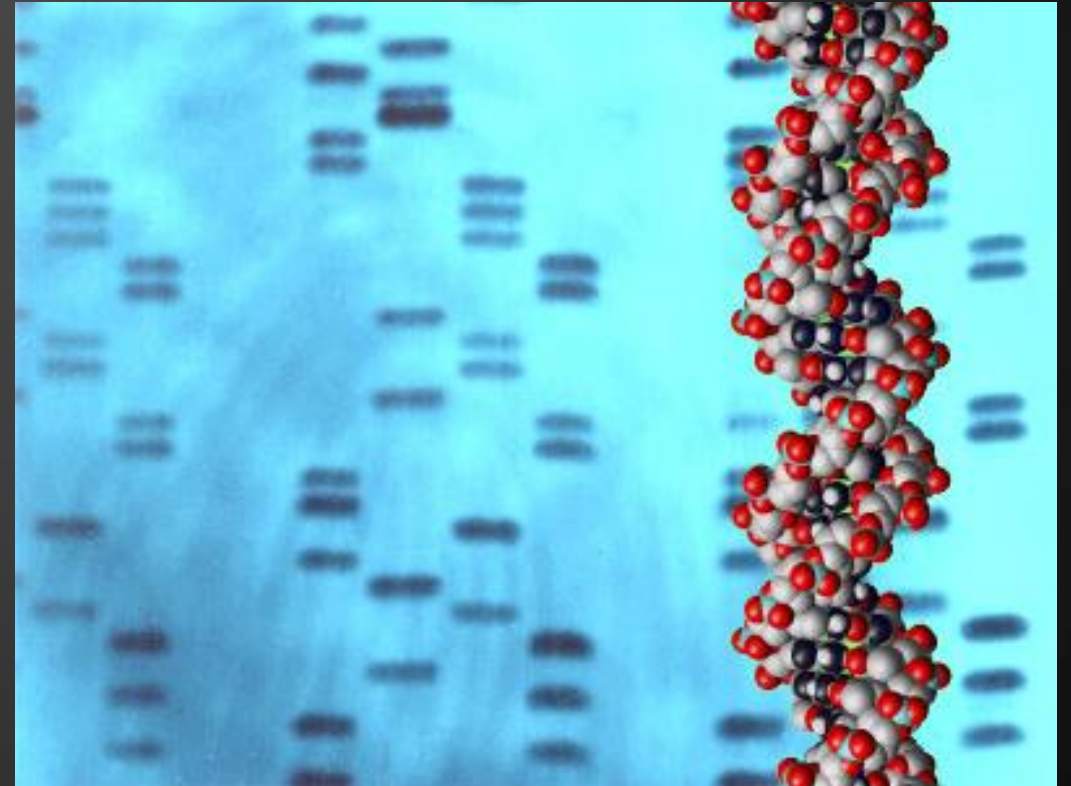
Where is DNA found?

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



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.



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

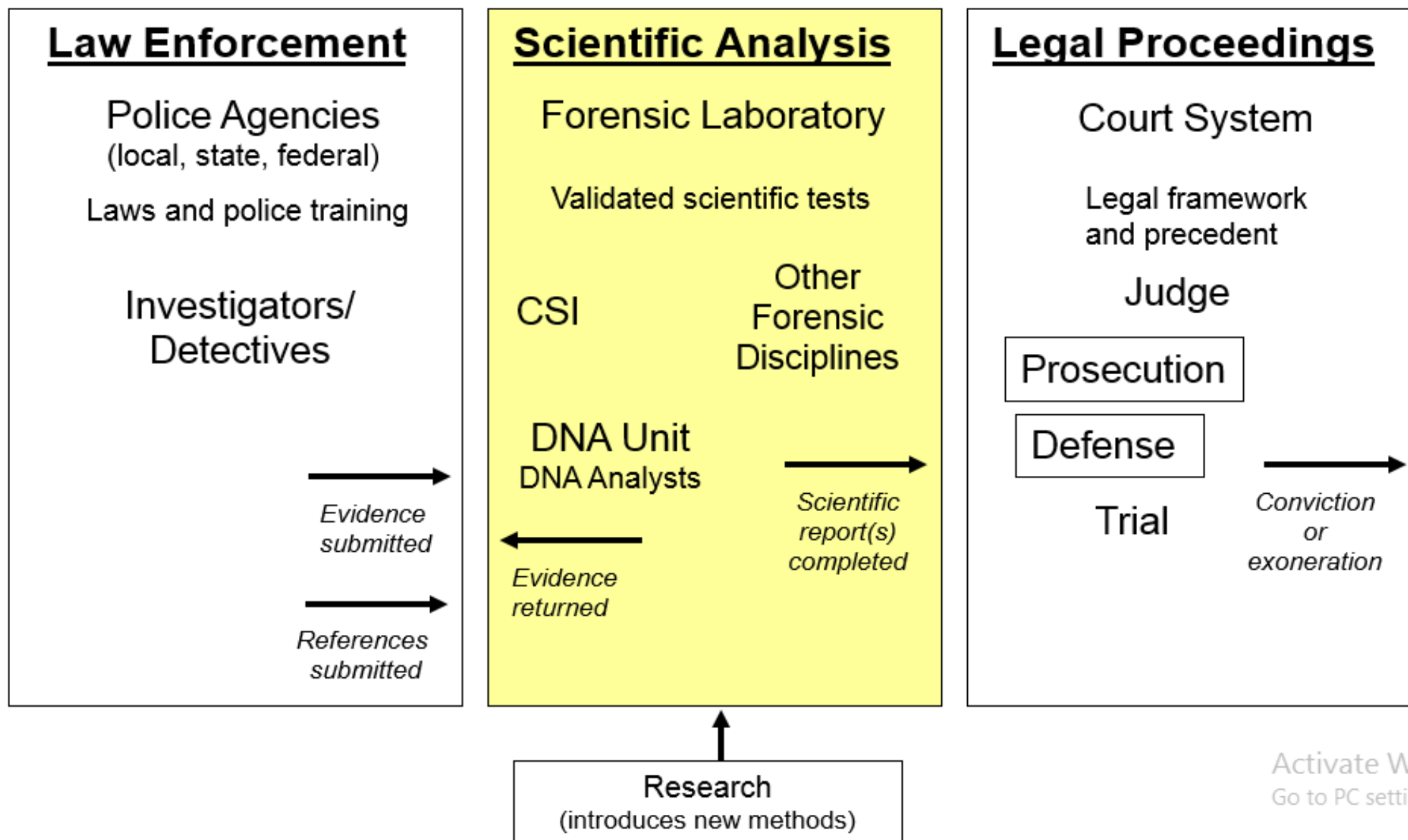
Basis of DNA Profiling

- ▶ **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



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



Sources of DNA at a Crime Scene



Saliva



Bone



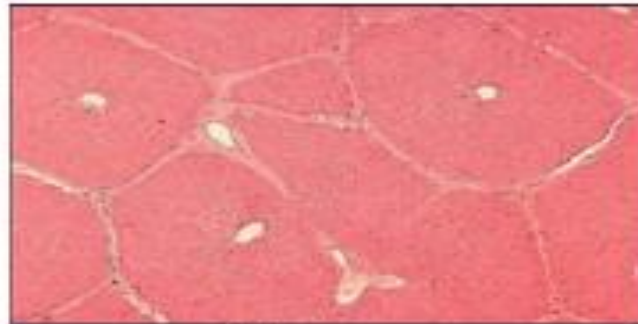
Blood on fabric



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
 - ▶ **Ideal sample: 1 mL of fresh, whole blood (white blood cells) treated with EDTA**
 - ▶ **Enemies of evidence: sunlight, high temperatures, bacteria, moisture**

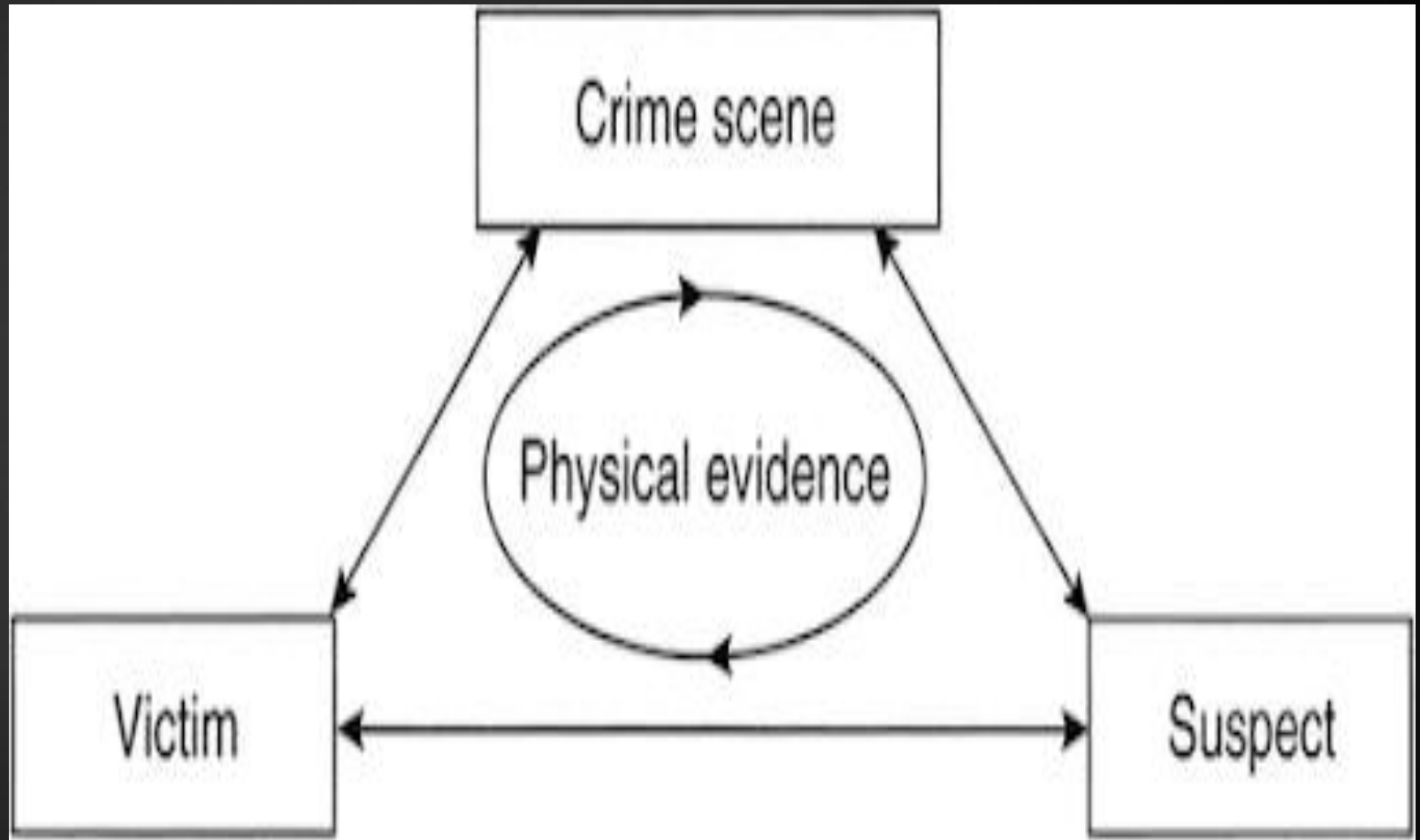
Do's & DON'TS

► **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

Locard's Exchange Principle

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

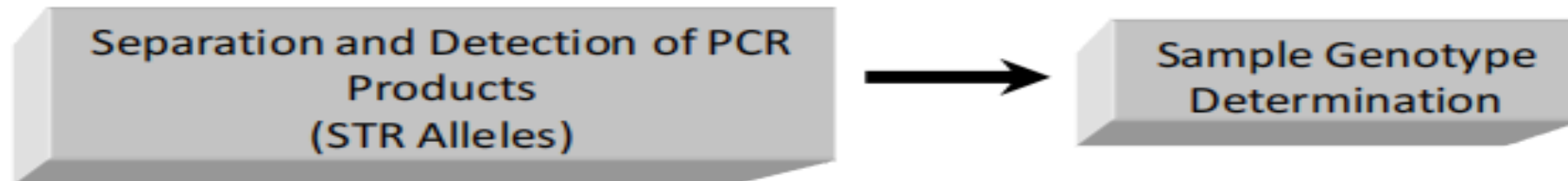


Sample Obtained from
Crime Scene or Paternity
Investigation

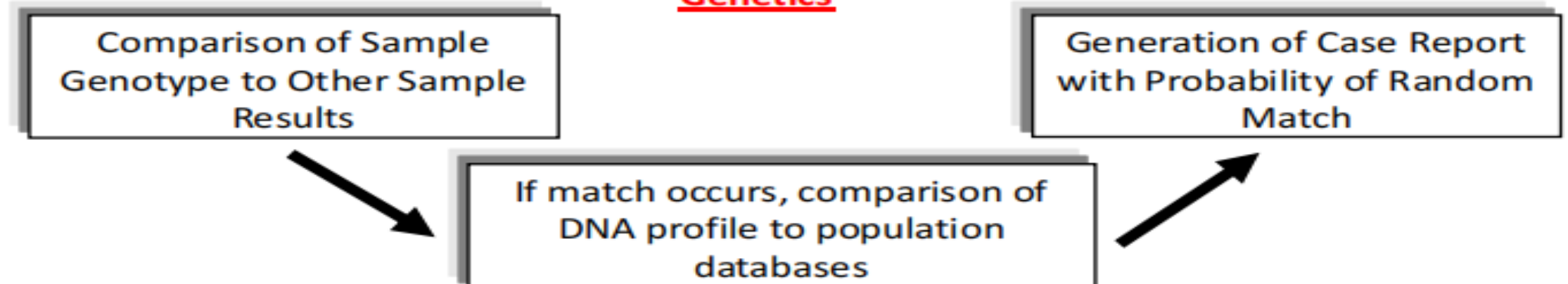
Biology



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

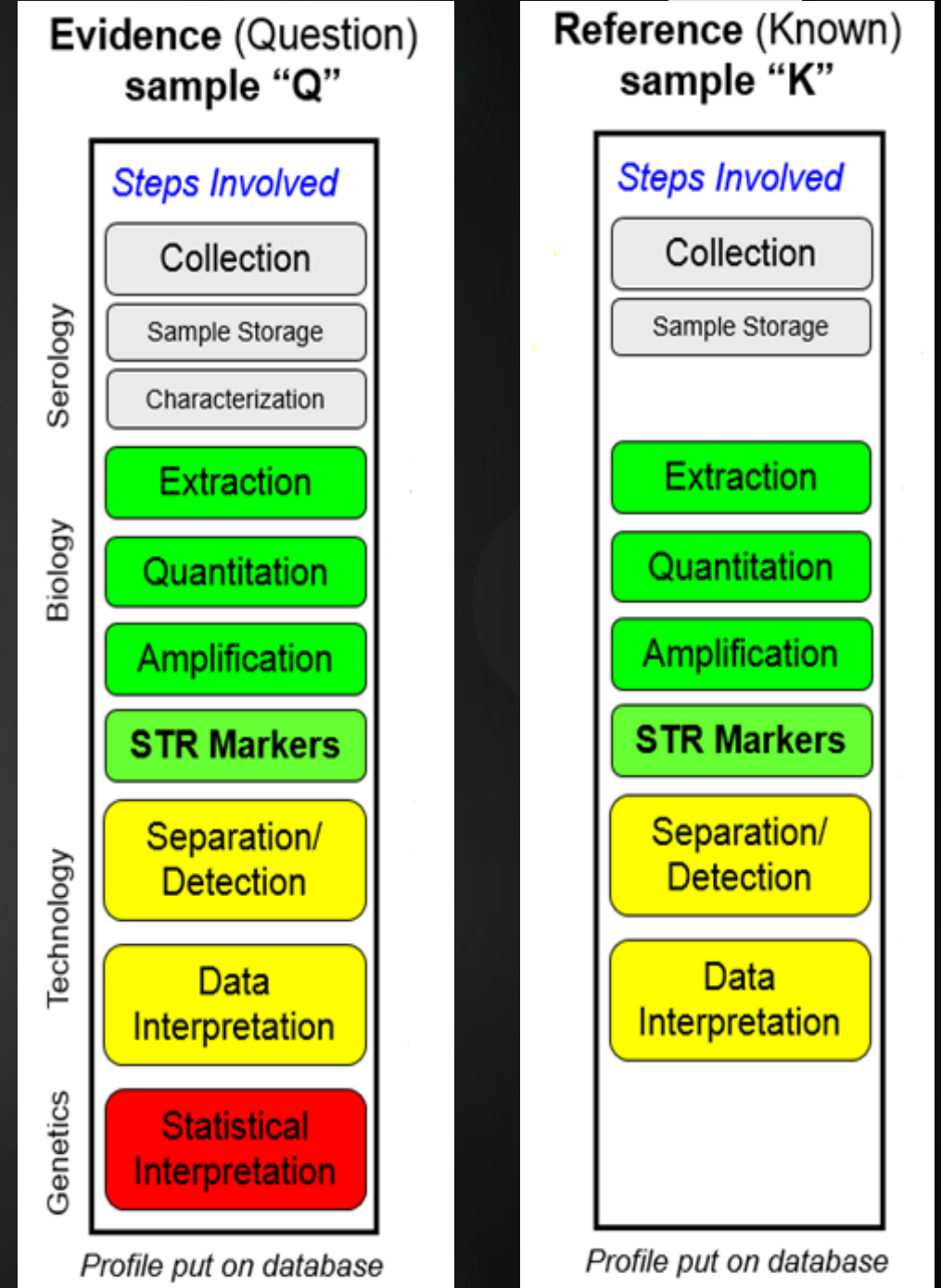
DNA Testing Requires A Reference Sample

- ▶ 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



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...

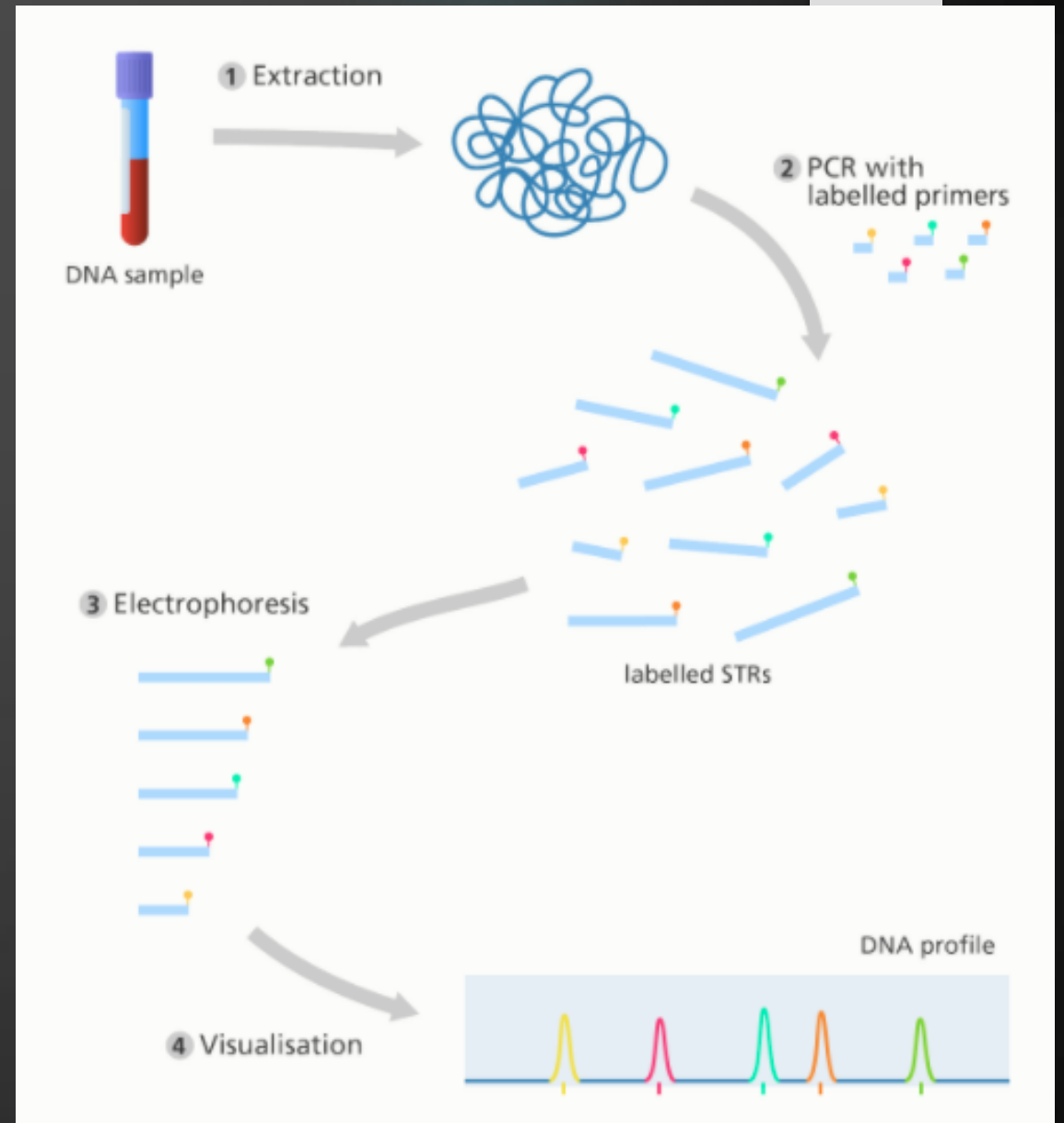
Section of DNA from crime scene hair:



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



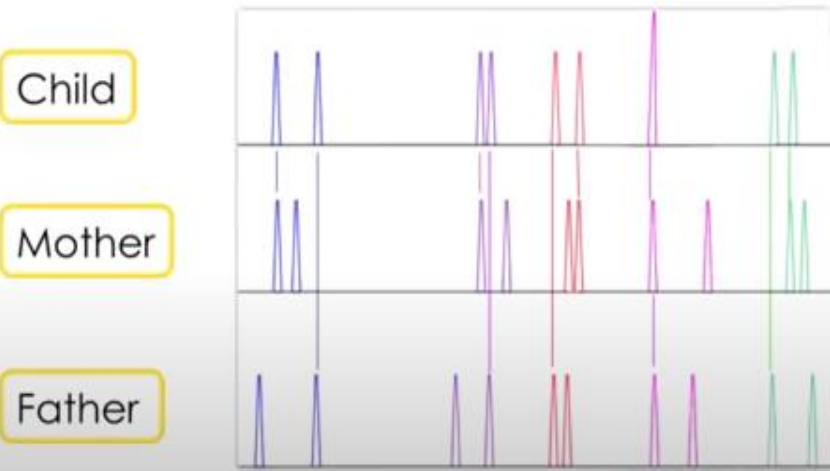
DNA Fingerprint Sub-steps

- ▶ 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.

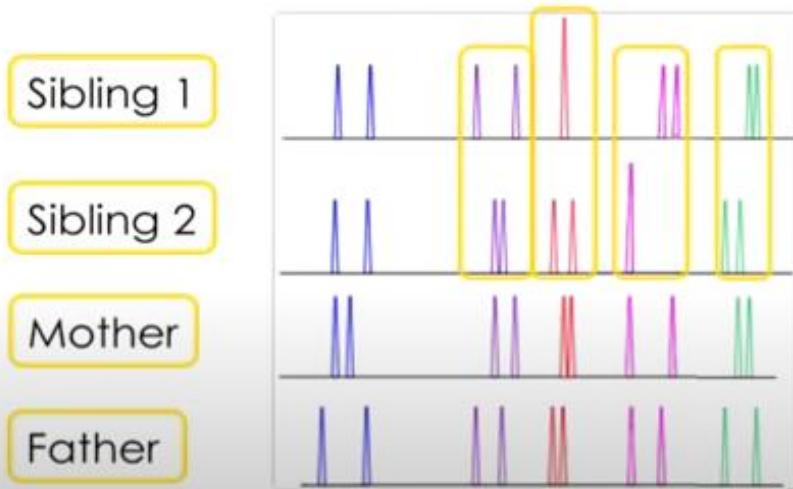
Uses of DNA PROFILING

- ▶ 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



Sibling relationship



Identification of Victims of Mass Disasters



*Thank
you*

