



FORENSIC ISSUES IN DNA PROFILING

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EXCEPTIONS TO DNA EVIDENCE

- With the exception of red blood cells, every cell in your body has DNA.



EXCEPTIONS TO DNA EVIDENCE

- And with the exception of identical twins, everyone's DNA is different.



STR PROFILES OF IDENTICAL TWINS

DNA Marker	Father	Mother	Identical Son 1	Identical Son 2
D7S820	9, 10	10, 11	10, 10	10, 10
D3S1358	16, 17.2	15, 15.2	15, 16	15, 16
D16S539	11, 11	9, 11	9, 11	9, 11
D8S1179	13, 15	15, 16	13, 16	13, 16
CSF1PO	10, 12	10, 10	10, 12	10, 12
SE33	25, 31.2	27, 33	25, 33	25, 33
TPOX	8, 12	9, 13	9, 12	9, 12
Amelogenin	X, Y	X, X	X, Y	X, Y

WHOLE DNA SEQUENCES OF IDENTICAL TWINS

Identical Son 1

....AATTGGGGGCATGCAATTCCGCATATACGGCAATGCATTTTCTCCTGATA....

Identical Son 2

....AATTGGGGGCATGCAATTCCGCATATACGGCAATGGATTTTCTCCTGATA....

WHOLE DNA SEQUENCES OF IDENTICAL TWINS

Identical Son 1

....AATTCCCCCATGCAATTCTGCATATACGGCAATGCATAATTCTCCTGATA....

Identical Son 2

....AATTCCCCCATGCAATTCTGCATATACGGCAATGGATAATTCTCCTGATA....

EXCEPTIONS TO DNA EVIDENCE

- DNA samples need to be collected properly. Immovable objects must be scrutinized completely, and evidence collection is crucial.



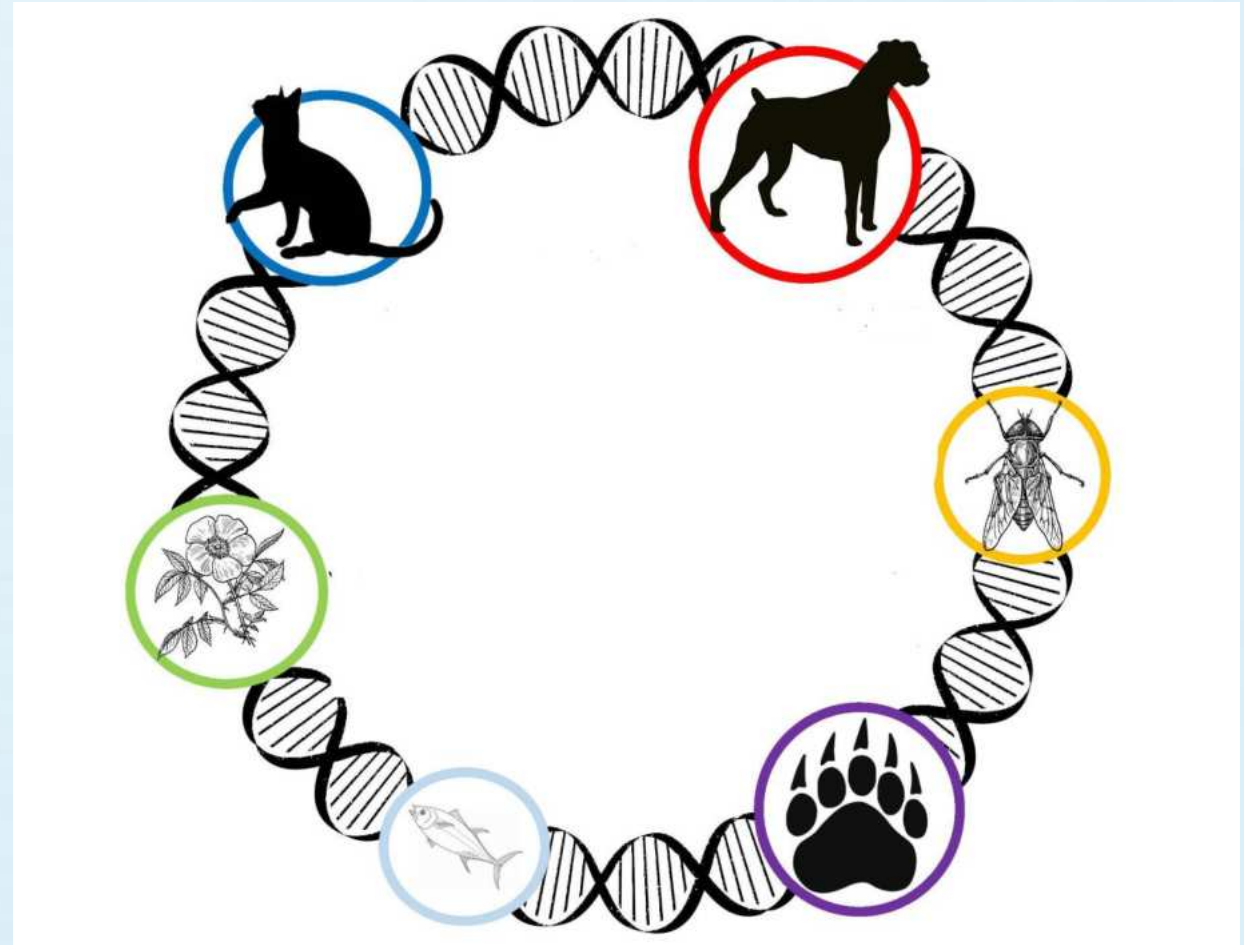
Evidence can be collected in the form of:

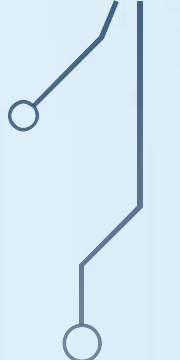
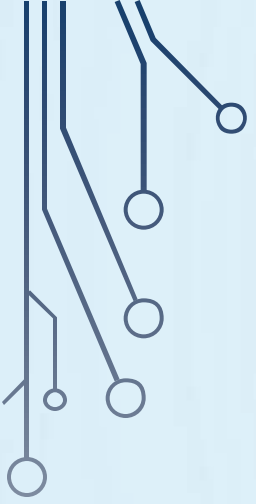
- Scrappings
- Saline swabs
- Cellotape lifts



EXCEPTIONS TO DNA EVIDENCE

- DNA extraction for animal/wildlife samples is not done in the same laboratory.





ANIMAL/WILDLIFE DNA TESTING

- If animal/wildlife DNA testing is done in the same laboratory, the rate of cross-contamination increases.
 - DNA may be extracted from a wide range of biological material such as blood, meat, urine, faeces, skin, hair, scales, bone, feathers, claws, teeth, shells, scales, venom and embryonic tissue, as well as processed products such furs, leather goods, and medicines
 - Preservation of wildlife samples need separate and highly specialized temperature conditions.
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EXCEPTIONS TO DNA EVIDENCE

- The target DNA template may not amplify due to the presence of PCR inhibitors in the extracted DNA.
- Labs can only clean/remove recorded/known PCR inhibitors

PCR inhibitors

Sodium dodecyl sulphate
KCl
Tannic acid
Urea
Bile
Salt
Phenol
Ethanol
Methanol
Polysaccharides
Melanin
Cell wall proteins
Immunoglobulins
Chaperon
Collagen
Haemoglobin
Protease
Nuclease

EXCEPTIONS TO DNA EVIDENCE

- Errors due to low DNA template - degraded exposure to the environment or harsh chemicals like acids and alkalis.

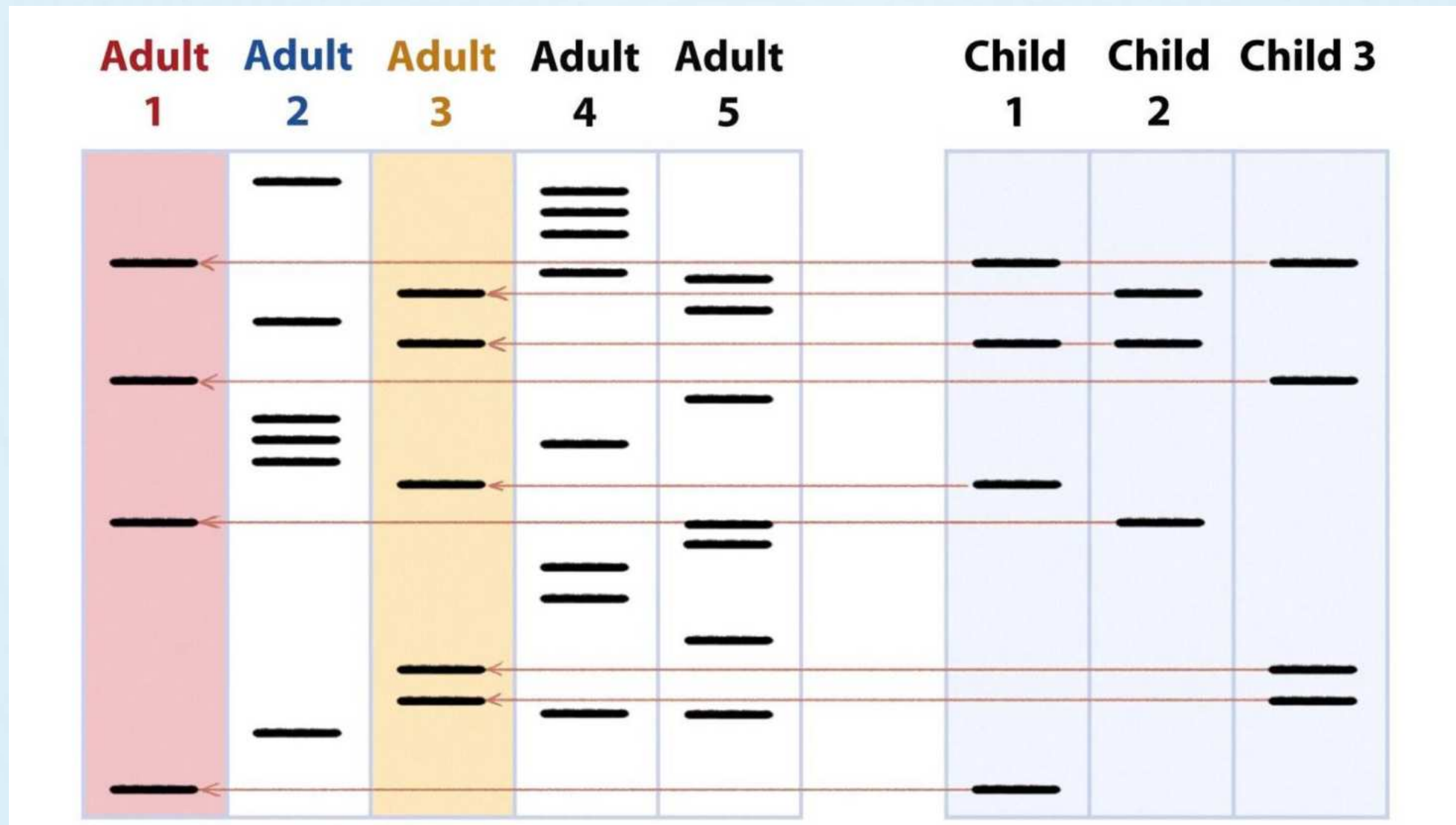


ISSUES WITH DNA PROFILING IN INDIA

- No centralized DNA database for tracking criminals or unrelated crimes
- Poor collection & preservation of evidence
- Inadequate and limited DNA fingerprinting facilities and resources
- Limited and inadequate experience in DNA profiling
- Lack of quality management



Manual comparison is time consuming and prone to errors of mixing.



Each bone fragment has to be individually typed and then segregated. Extremely time consuming process.

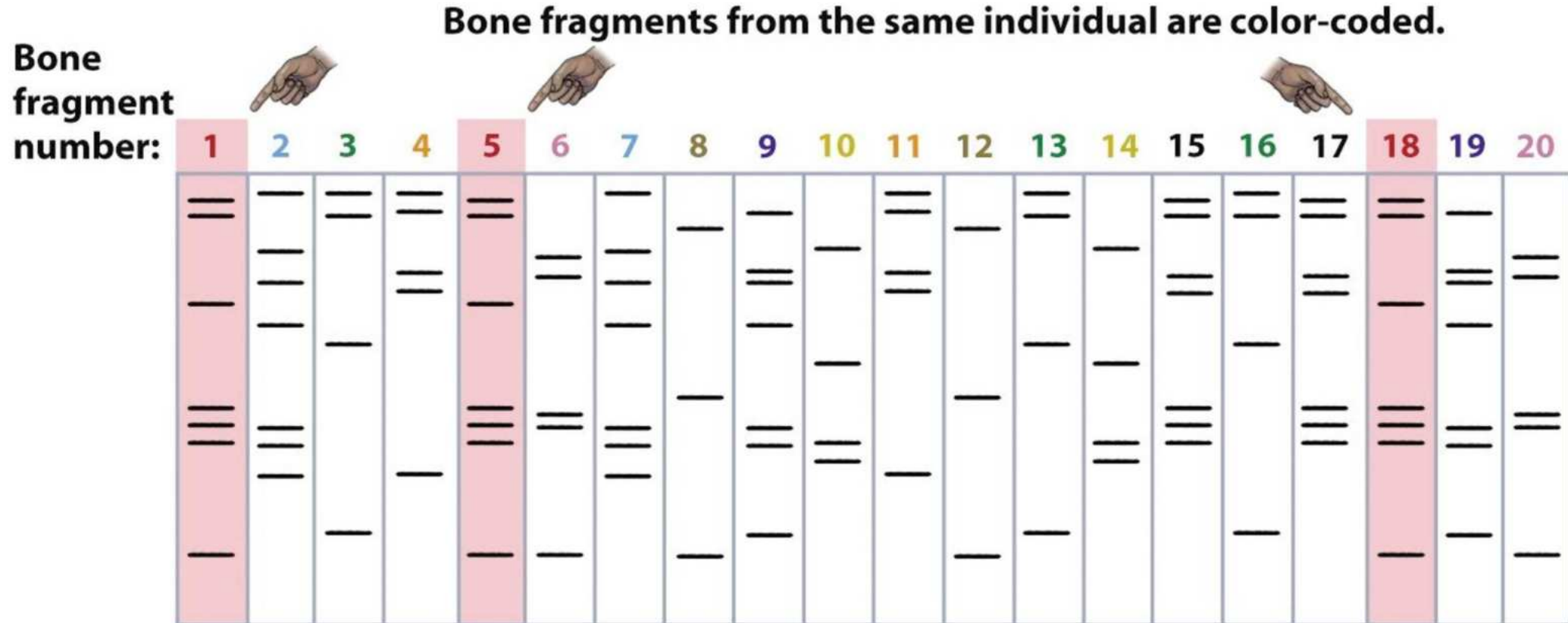
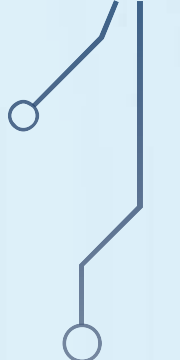
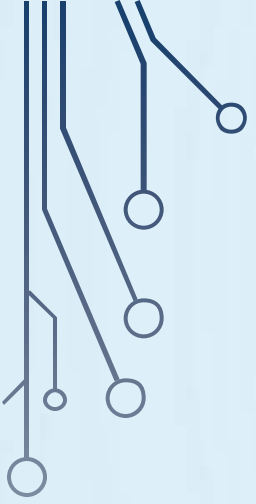


Figure 7-10 Biology: Science for Life, 2/e
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ISSUES WITH DNA PROFILING IN INDIA

- Lack of technology – slow implementation of improved in technology
 - Issues related to tampering of evidence or breaking of chain of custody.
 - Non-human DNA analysis is limited or negligible
 - People are unwilling to volunteer their blood/buccal samples for analysis
 - Misconceptions related DNA fingerprinting.
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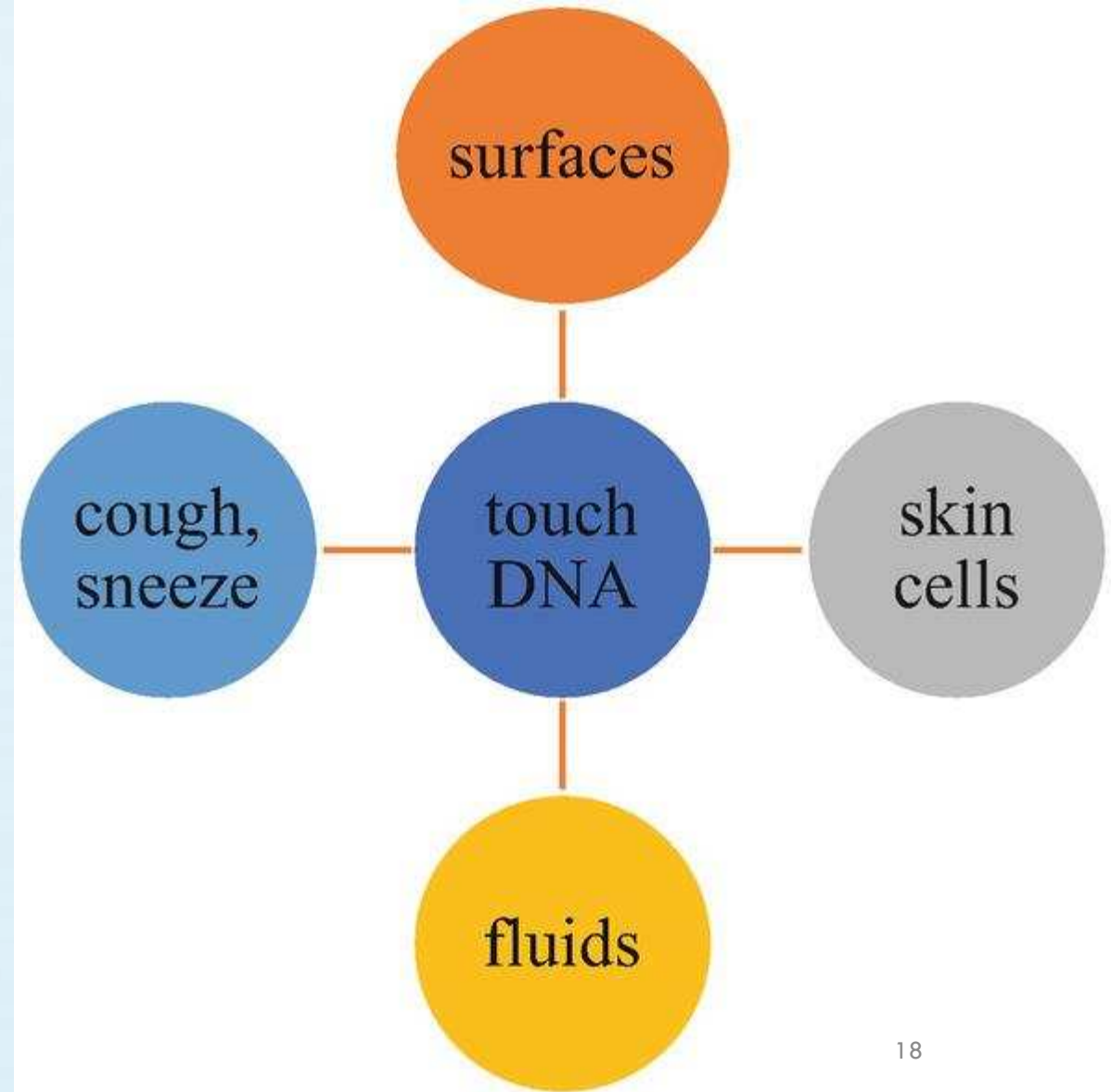


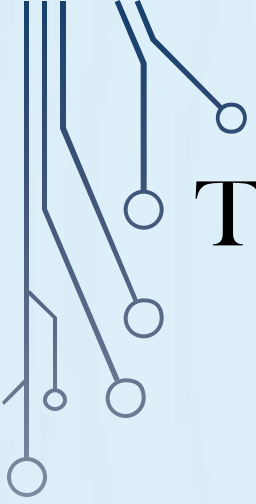
FUTURE OF DNA IN FORENSIC SCIENCE

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TOUCH DNA

- “Touch” DNA samples refer to samples where biological fluid cannot be detected, however there may be skin cells left behind due to contact with an item.





TOUCH DNA

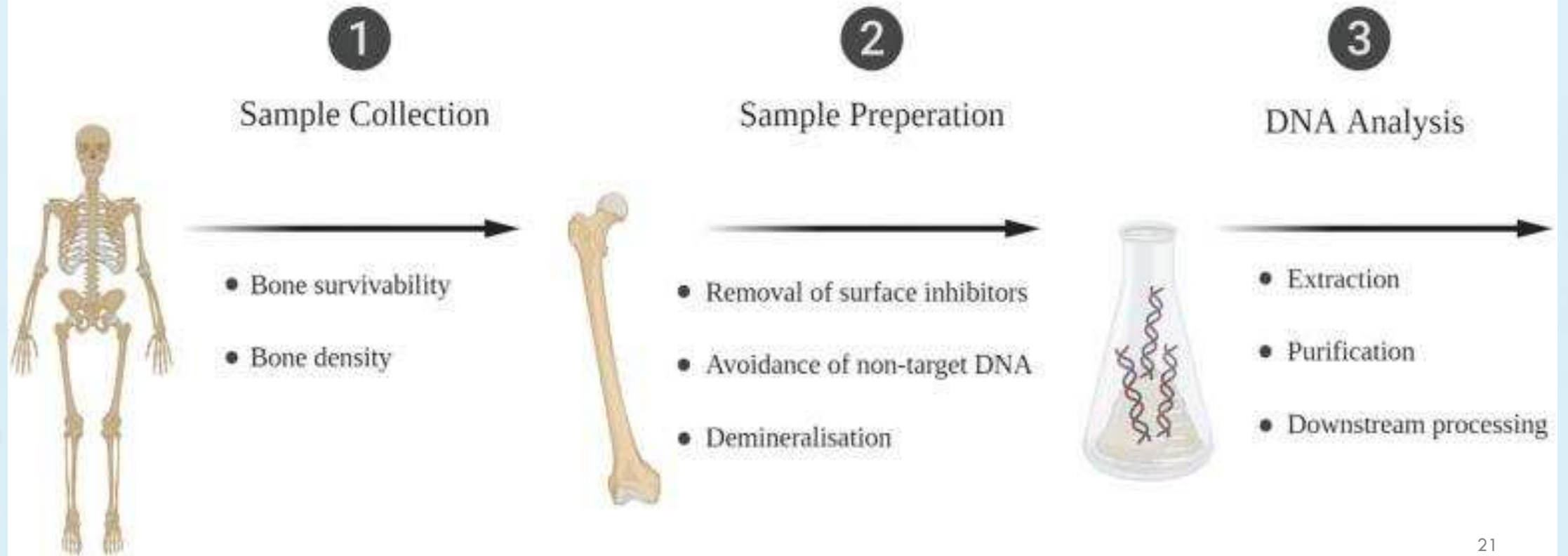
- In cases where the scientist is attempting to collect “touch” DNA for analysis, it is often difficult to collect a sufficient amount of DNA to generate a profile suitable for comparison.
- The accepted collection method has been to vigorously swab a sample with a cotton swab and forward the swab for DNA analysis.

- A few cases where touch DNA in the US has been used for getting convictions.

Item of Evidence	Type of case
Firearms, knife handles, weapon handles	any
Fired casing	any
Steering wheel and other vehicle swabs	carjacking, etc
Fingerprints on victim	any
Ligatures, hand cuffs, shoestrings	strangulation, kidnapping, rape, etc
Hand swabs from suspects	strangulation, rape
Face swabs from child victims (slapping, hitting)	child abuse
Swabs from limbs removed from animal carcasses	poaching
cell phones swabs	robbery, etc
victim neck swabs	strangulation
swabs from torn or forcibly removed clothing	rape, assault
airbag	DUI cases and others
tools	burglary
baggies	drug possession
paper demand notes	bank robberies
clothing items, hats, masks, gloves, glasses	any

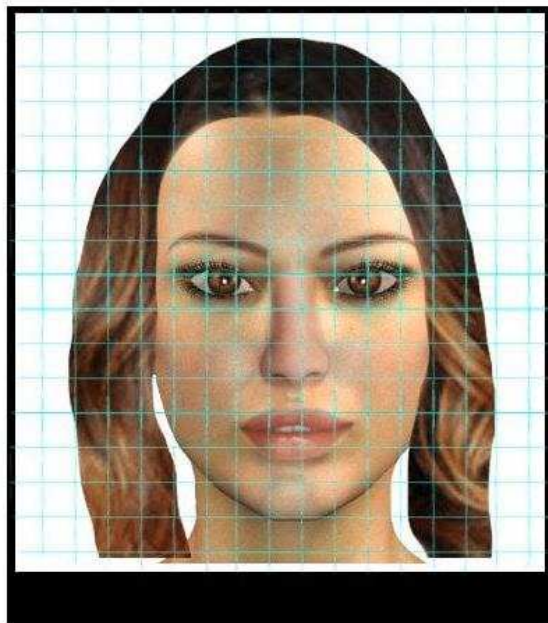
DNA RECOVERY FROM INCINERATED BONE

Considerations for DNA Recovery From Incinerated Bone

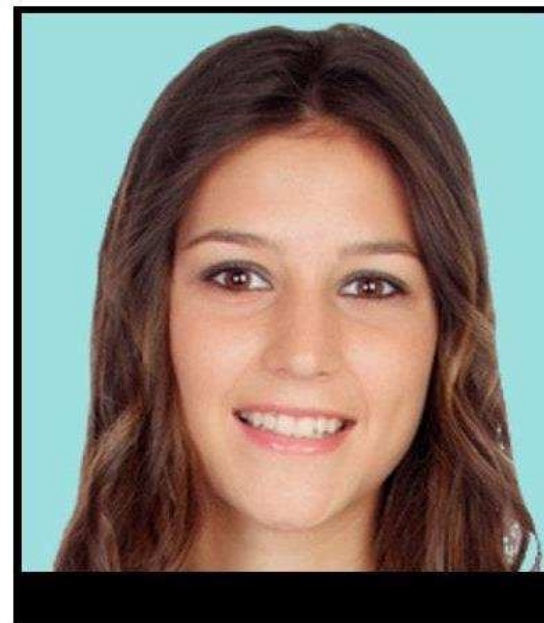


FORENSIC DNA PHENOTYPING

- “**Phenotype**” refers to the ensemble of all outwardly *observable* characteristics of an individual, including form and structural features, physical appearance, development and behavior.
- The genotype plays an important role in determining features of the phenotype but is not the sole contributor. Environment can also play an important role and can, for example, affect the expression of genes.



Predicted



Original

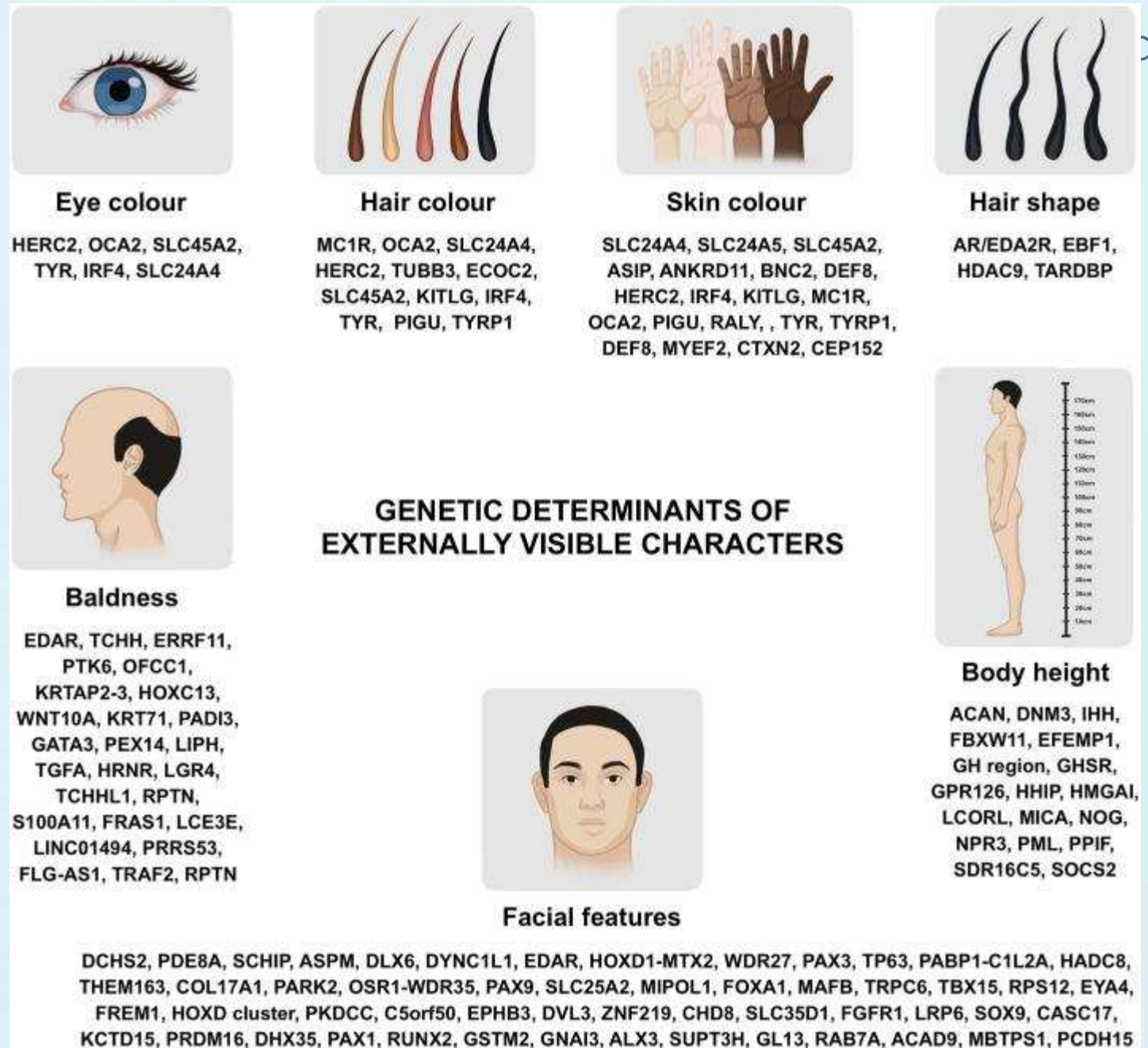
Envisaging the invisible woman!

Attempt to predict at least some features of an unknown suspect's phenotype from a small sample of DNA collected at a crime scene.

- A person's observable characteristics can be reconstructed from a small DNA sample or, in the relevant technical language, how much of a person's *phenotype* is determined from their *genotype*.
- This approach focuses not on STRs, but rather on single-nucleotide differences that occur at specific DNA locations, either within protein-coding genes or in DNA sections that affect gene expression.

PHYSICAL FEATURES WHICH CAN BE PREDICTED

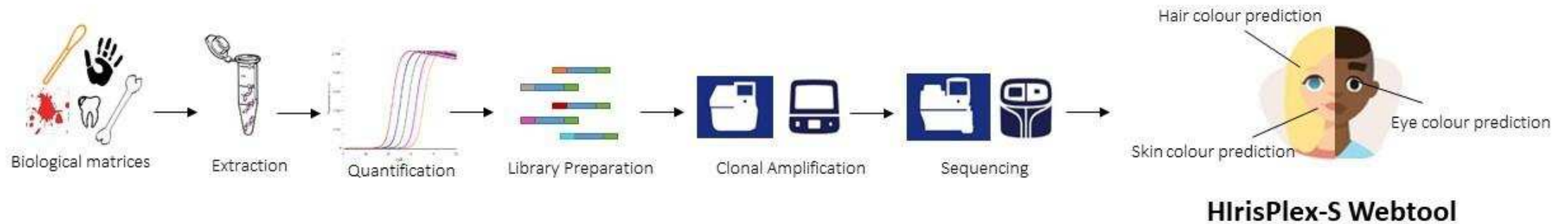
- Eye colour
- Hair colour (natural)
- Hair pattern
- Physical stature
- Skin tone/colour
- Eyebrow shape
- Male pattern baldness



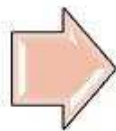
- ❌ NO MATCH WITH REFERENCE PROFILES
- ❌ NO MATCH WITH GENETIC PROFILES
ENTERED IN CRIMINAL DATABASES



FORENSIC DNA PHENOTYPING



Quick



Effective



High coverage



GUESS THE AGES!

A. 18;



B. 25;



C. 38;



D. 50;



E. 65



DNA PHENOTYPING USED IN CASEWORK

- The Idaho Falls case is worthy of note because a previous suspect had spent 20 years in jail for the crime, despite the fact that his DNA did not match that collected at the crime scene. He was finally released in 2017 after the DNA phenotyping was completed. And a new suspect identified with the aid of phenotyping was arrested, and confessed to the crime, in 2019. There were also two rape and murder cases in the 1990s in the Netherlands solved with the aid of DNA phenotyping. Snapshot composites have been released publicly in several other unsolved cases, including ones of sexual predation, in the hopes that they might lead to identification of suspects.

PROS & CONS OF DNA PHENOTYPING

- The accuracy is not great enough to be used in court proceedings, unless an indictment aided by DNA phenotyping has produced a subject whose DNA STR profile matches that of the crime scene sample.
- The composite generated might not match exactly due to chemical alterations to the observed characteristics.
- As an investigative aid, phenotypic composites should perhaps be compared to the more traditional composite subject sketches produced from eyewitness descriptions.
- The composite generated may be used an investigative tool to get confessions or answers from suspects/culprits.

DNA ON THE GO

- The vision looks like this: researchers, consumers, government employees—everyone—will be reading the DNA of their own bodies and the living things around them and streaming that data on the internet.
- DNA-reading sensors would be integrated into food production equipment, polluted waters, farms and phones. They would track the presence and movement of food pathogens and deadly viruses.



- **MinION** and **PromethION** are based on nanopore sequencing technology.
- An electrical potential is applied, causing ions to flow through nanopores. As individual strands of **DNA** pass through the pores, its presence causes specific changes in the currents.
- Software quickly translates the sequence of currents into the corresponding **DNA** components: nucleic acids represented by the letters **A, T, G** and **C**. The sequence of the four letters comprises the unique genetic code for every living thing.
- It tells users what species of microbes they've got by matching their **DNA** reads to the **DNA** sequences of known species in its database.

