

# Lecture 2: A brief history of forensics

Summer 2026

# Learning objectives



Understand how forensic science evolved over time



Describe genomic phenotyping



Describe the variable regions of the genome and how they are used in forensics



Understand the difference between common law and statutory law



Define individualization and its importance in evidence analysis



Explain how PCR revolutionized forensic analysis

# Forensic science is not a new field

- Crime has been around for as long as people have
- The field of forensic science has been developing for thousands of years in response to crime
- While the techniques of today may be very modern and innovative, this wasn't always the case
- Police had to work with the tools they had at the time to make convictions

*Let's take a brief tour of the history of forensic science!*

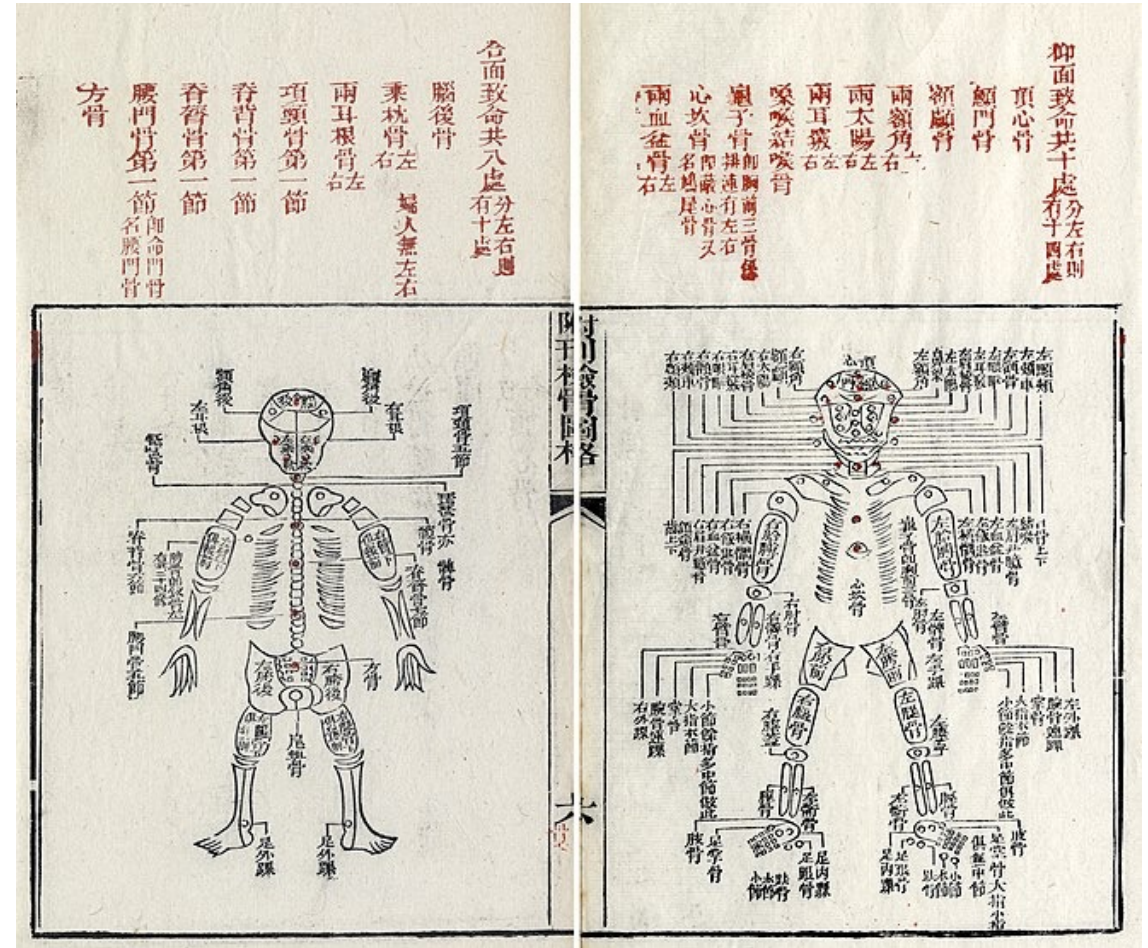
# The uniqueness of fingerprints



- Fingerprints were used by the ancient Babylonians to sign official documents on clay tablets
- Protected against forgery and falsification (we use signatures now)
- Theorised to have been used since 1900 BC
- References from the era of the Babylonian king Hammarubi (1791-1750 BC) indicate that fingerprints were taken from those that were arrested
- Also used by 246 BC in China as a seal (fingerprints and handprints)

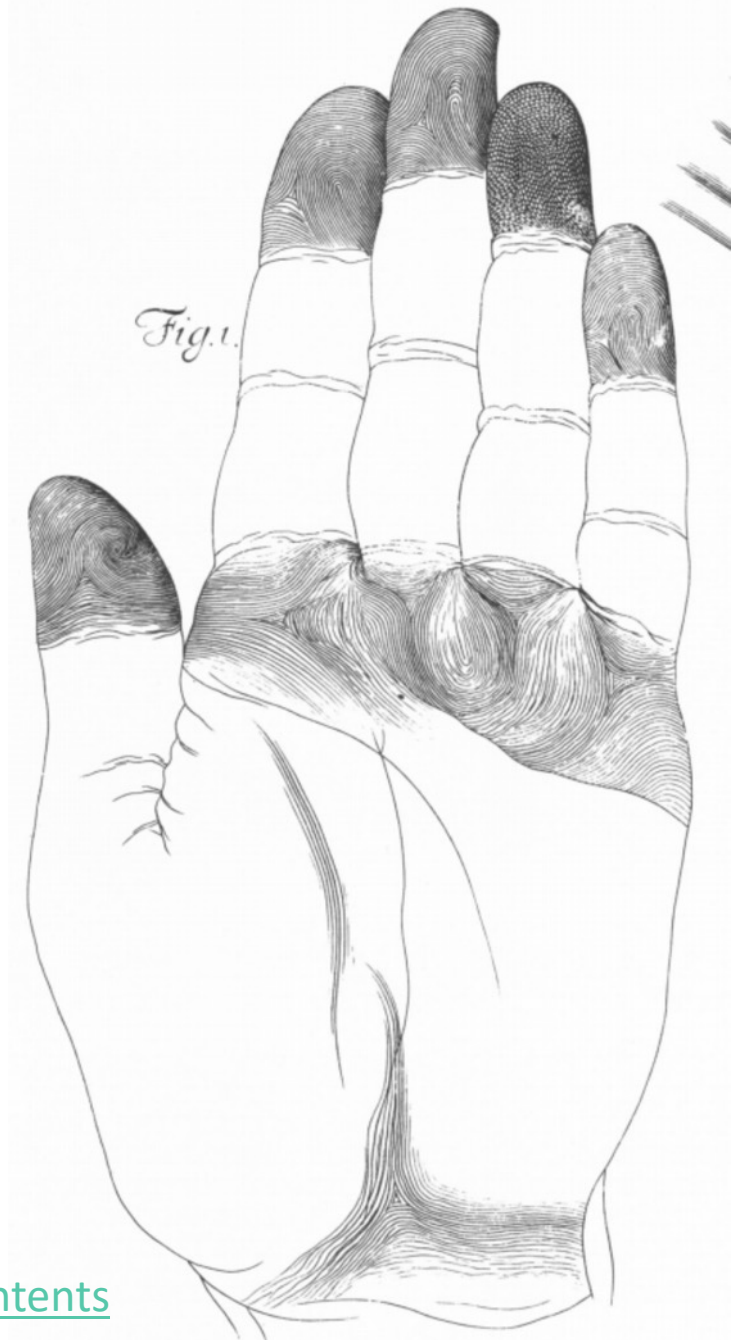
# The Washing Away of Wrongs - 1247

- The first book ever written on forensics
- Written in 1247 by Song Ci, with the earliest extant copy produced in the Yuan Dynasty
- 53 chapters, 5 volumes, serves as a guide to forensic autopsies
  - Volume 1: the inspection of bodies and injuries
  - Volume 2: methods on postmortem examinations
  - Volumes 3-5: detail the appearances of corpses from various causes of death and methods of treatment to certain injuries of a wounded person
- Documents the first case to use forensic entomology (bugs!)



# 1684: The Description and Use of the Pores in the Skin of the Hands and Feet, by the Learned and Ingenious Nehemiah Grew, M. D. Fellow of the College of Physicians and of the Royal Society

For if any one will but take the pains, with an indifferent *Glas*s, to survey the *Palm* of his *Hand* very well washed with a *Ball*; he may perceive (besides those great *Lines* to which some men have given Names, and those of a middle size call'd the *Grain* of the skin) innumerable *little Ridges*, of equal bigness and distance, and every where running parallel one with another. And especially, upon the ends and first *Joynts* of the *Fingers* and *Thumb*, upon the top of the *Ball*, and near the root of the *Thumb* a little above the *Wrist*. In all which places, they are very regularly disposed into *spherical Triangles*, and *Ellipticks*; as in the *Hand* I have caused to be drawn *Fig. 1.* Upon these *Ridges* stand the *Pores*, all in even *Rows*, and of that magnitude, as to be visible to a very good *Eye* without a *Glas*s. But being viewed with one,



# 1880: On the Skin-Furrows of the Hand, Henry Faulds, Nature

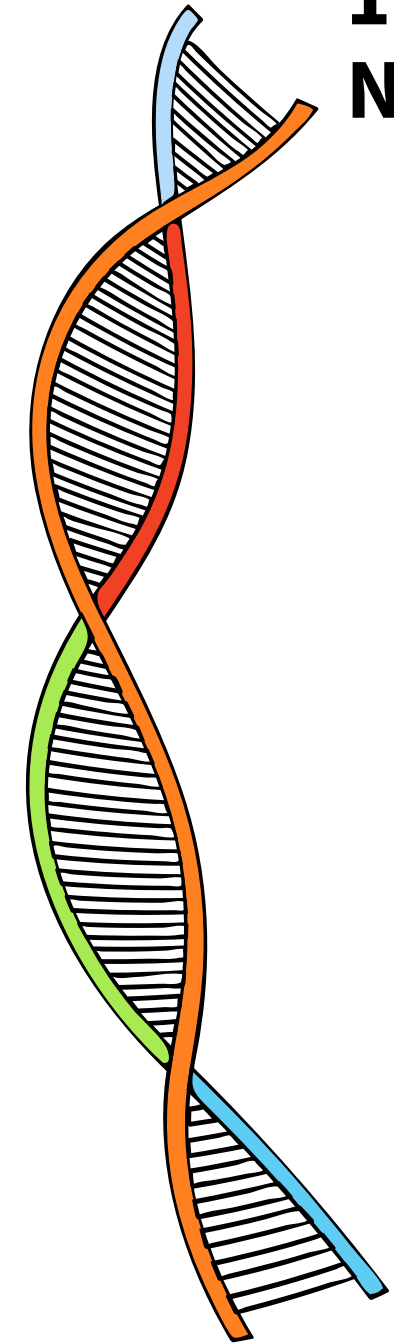
## On the Skin-furrows of the Hand

IN looking over some specimens of "prehistoric" pottery found in Japan I was led, about a year ago, to give some attention to the character of certain finger-marks which had been made on them while the clay was still soft. Unfortunately all of those which happened to come into my possession were too vague and ill-defined to be of much use, but a comparison of such finger-tip impressions made in recent pottery led me to observe the characters of the skin-furrows in human fingers generally. From these I passed to the study of the finger-tips of monkeys, and found at once that they presented very close analogies to those of human beings. I have here few opportunities of prosecuting the latter study to much advantage, but hope to present such results as I may attain in another letter. Meanwhile I would venture to suggest to others more favourably situated the careful study of the lemurs, &c., in this connection, as an additional means of throwing light on their interesting genetic relations.

Oct. 28, 1880]

*NATURE*

<https://www.nature.com/articles/022605a0>



# 1835: The first bullet comparison

- The Bow Street Runners were London's first official police force
- One of the last members, Henry Goddard, was the first to perform a bullet comparison when a homeowner was shot and killed
- **How?**
- Bullet taken from the body at autopsy
- Goddard identified a flaw in the bullet that **was not** made from firing the gun



Henry Goddard of the  
Bow Street Runners

# Arsenic: The Poison of Kings

- Widely found in the Earth's crust
- Odorless, tasteless, VERY potent
- Used by Nero to poison Britannica so that he could become the Emperor of Rome
- Became widely popular in Renaissance Europe as the murder weapon of choice
- Termed "inheritance powder"



# Symptoms of arsenic poisoning

- Drowsiness
- Headaches and confusion
- Diarrhea
- Metallic taste in the mouth
- Convulsions
- Stomach cramps
- Hair loss
- Death!



**Arsenic keratoses after long term exposure**

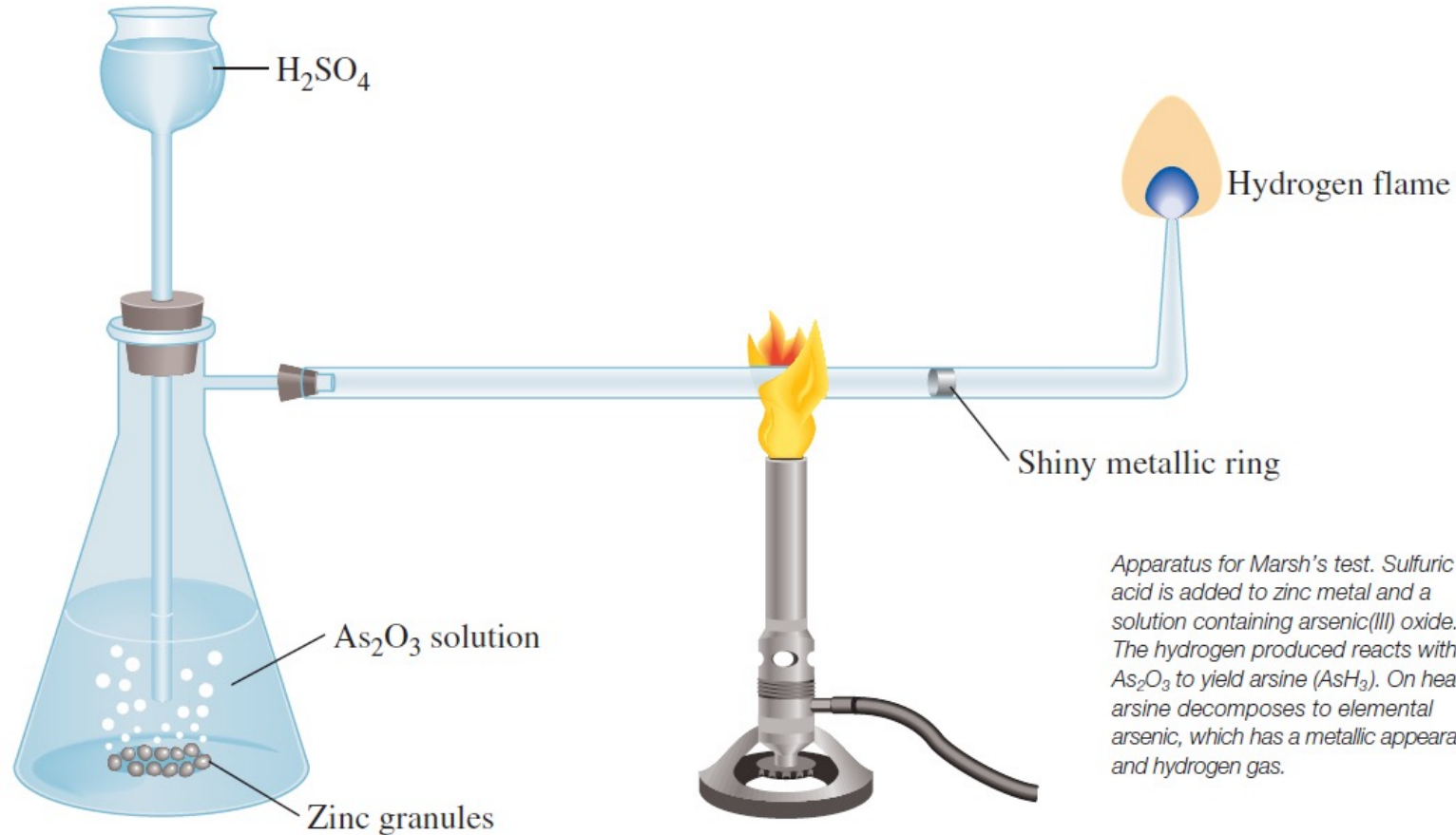
# 1832-1840: Testing for arsenic

- Despite the first conviction for murder using arsenic occurring in the 1700s, the standard test wasn't developed until 1832.
- Marsh Test:
  - John Bodie on trial in 1832, suspected of poisoning his grandfather by putting arsenic in his coffee
  - James Marsh performed a test by combining hydrogen sulfide with the coffee
  - Arsenic would precipitate upon contact
  - Precipitate broke down by the time the trial occurred, Bodie was acquitted even though he confessed!



# 1832-1840: Testing for arsenic

- Marsh decided a better test was needed



**Not only determines the presence, but the quantity of arsenic present.**

*Apparatus for Marsh's test. Sulfuric acid is added to zinc metal and a solution containing arsenic(III) oxide. The hydrogen produced reacts with  $\text{As}_2\text{O}_3$  to yield arsine ( $\text{AsH}_3$ ). On heating, arsine decomposes to elemental arsenic, which has a metallic appearance, and hydrogen gas.*

# 1840: Lafarge Case (France)

- First notable case using forensic toxicology to prove guilt
- Marie Lafarge poisoned her husband using arsenic that she said she bought to "kill rats"
- Marsh conducted test on the poisoned food, but the test at autopsy was negative
- Another toxicologist performed the same test, but this time it was positive, leading to a guilty verdict
- Highly publicized case that divided the French population



# 1863: Presumptive testing for blood

- Before 1863, we had no definitive way to determine that blood was, in fact, blood – except by just looking at it!
- Christian Friedrich Schönbein
  - Coined the term “ozone”
  - Also discovered that hydrogen peroxide foams on contact with blood!



# 1839: Measuring time of death

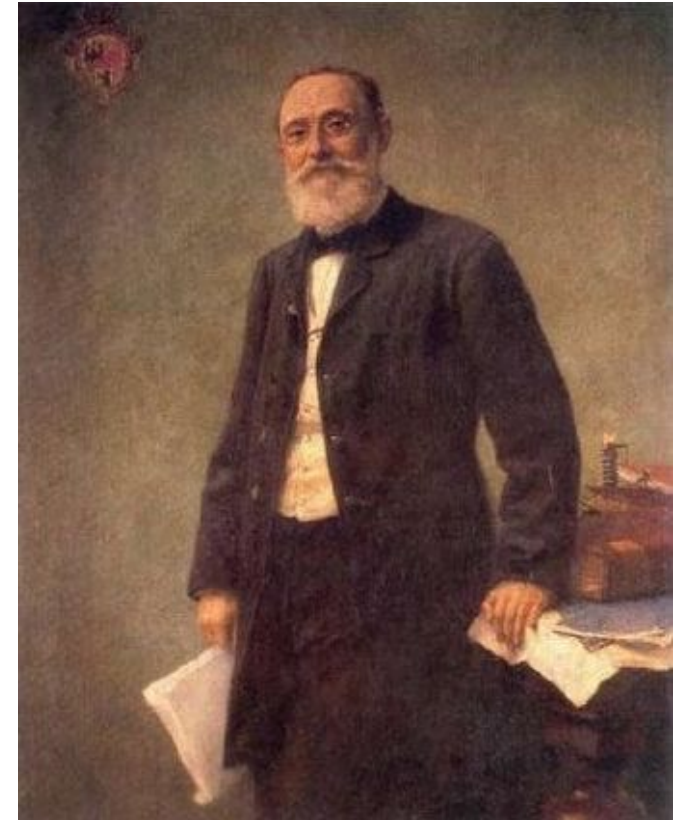
- Algor mortis – 2<sup>nd</sup> stage of death – post-mortem change in body temperature
- Discovery facilitated by John Davy, a doctor of the military in 1839 who measured the temperatures of bodies during autopsy
- Noticed that temperatures decreased shortly after death, but increased during decomposition

May not the temperature of the deeply seated parts, after death, give some insight into the manner in which death has occurred, or help to elucidate its cause? In example No. ix. the tempera-

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5495403/>

# 1857: Comparing strands of hair

- Rudolf Virchow, a German pathologist, wasn't sold on the idea of hair being used to convict a person of a crime
- 1861: First forensic report on hair as evidence
- “The hairs found on the defendant do not possess any so pronounced peculiarities or individualities so that no one with certainty has the right to assert that they must have originated from the head of the victim.”



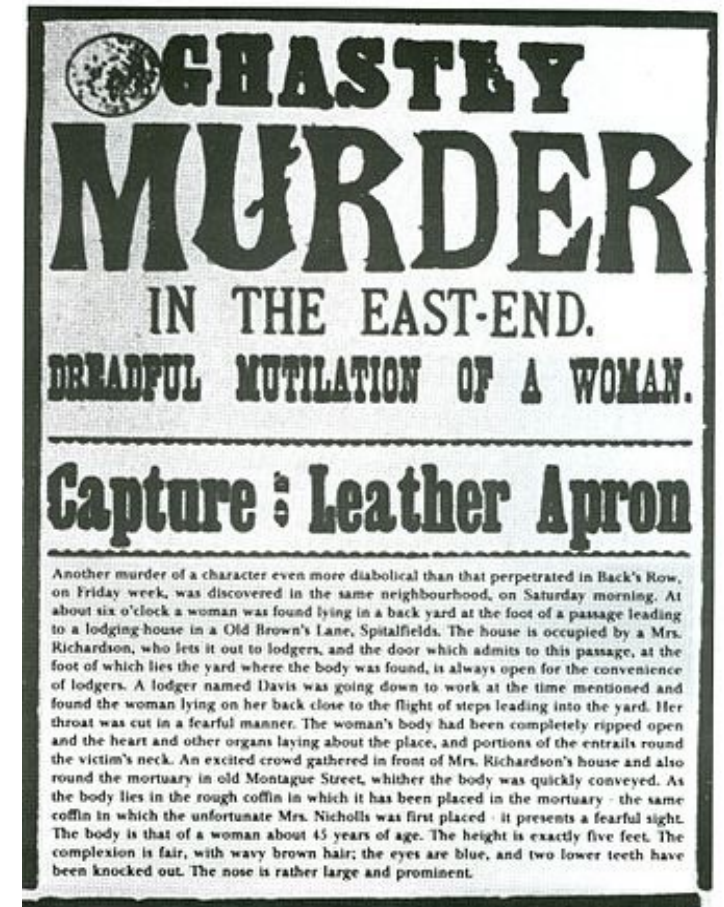
# 1888-1890: Crime scene photographs & criminal profiling

- Photographic documentation of criminals began in the 1840s-1850s in Denmark and Belgium
- Experimental and unregulated – taken by amateur photographers
- Are photographs a neutral source of evidence for crime scenes?



# Jack the Ripper

- 1888 – at least 5 prostitutes killed and mutilated in the streets of Whitechapel, London
- Mary Ann Nichols – 31 August 1888
- Annie Chapman – 8 September 1888
- Elizabeth Stride & Catherine Eddowes – 30 September 1888
- Mary Jane Kelly – 9 November 1888
- The murders created a media frenzy



# Jack the Ripper



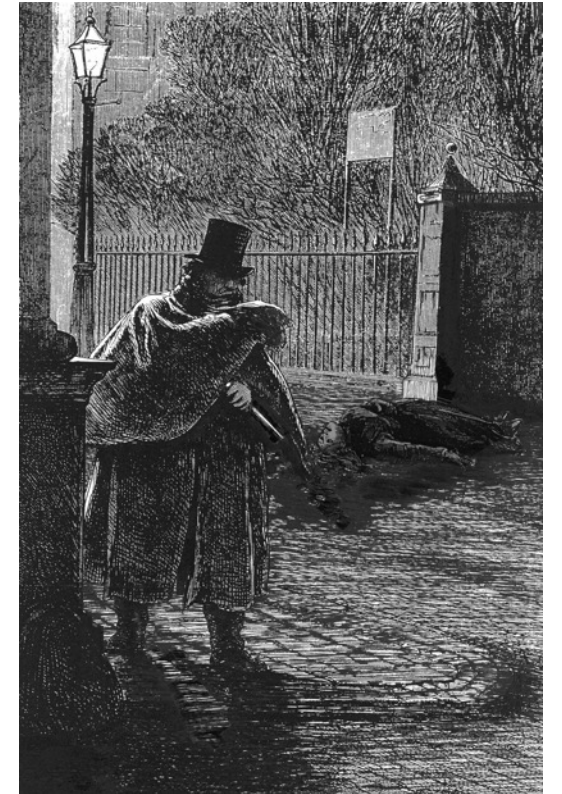
From hell  
Mrs. Surr  
Sorr I send you half the  
kidney I took from one woman  
preserved it for you tother piece  
flea and ate it was very nice I  
may send you the bloody knay that  
took it out if you only wate a whil  
longer.  
Signed Cateh me when  
you can  
Micheal Lusk -



# Jack the Ripper

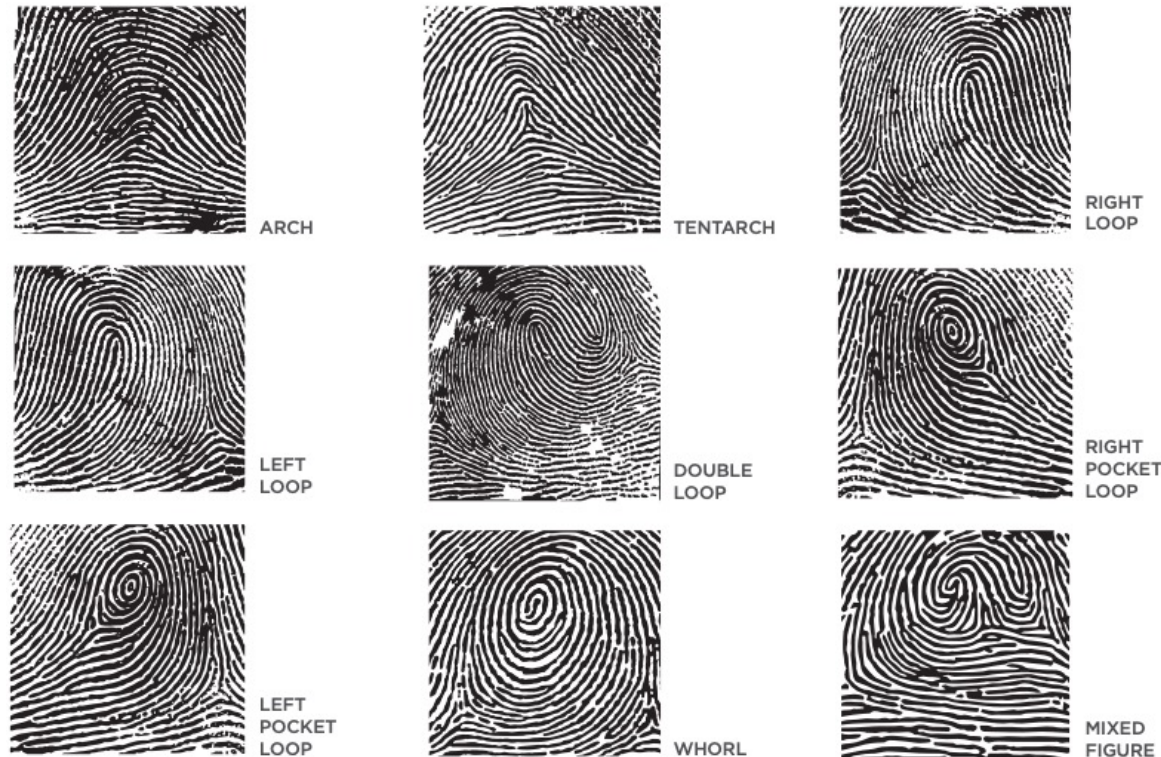
- Jack the Ripper never caught but a criminal profile was developed
- Thomas Bond – police surgeon who assisted with autopsies – gave the earliest recorded “offender profile”
  - Middle-aged
  - Living a solitary life
  - Wore a long coat
  - Unassuming in appearance

*“All five murders no doubt were committed by the same hand.”*



# 1896: Advances in fingerprint characterisation

- Sir Edward Henry devised a classification system for fingerprints
- Used to **exclude suspects**, not individualize prints
- Scores fingerprints based on ridge patterns





19 0 14 U 00I  
I 22 U 00M

<p>PO</p> <p>UMB W</p>	<p>19</p> <p>2. R. INDEX ✓</p>	<p>15</p> <p>3. R. MIDDLE ✓</p>	<p>PI</p> <p>4. R. RING W</p>	<p>PO</p> <p>5. R. LITTLE W</p>
<p>PI</p> <p>UMB W</p>	<p>21</p> <p>7. L. INDEX ✓</p>	<p>20</p> <p>8. L. MIDDLE ✓</p>	<p>PM</p> <p>9. L. RING W</p>	<p>P:</p> <p>10. L. LITTLE W</p>

**HENRY CLASSIFICATION**

# 1910: First police crime lab (France)

- Dr. Edmond Locard (1877 – 1966) – **Locard's Principle!**
- Studied medicine and law
- The father of modern forensic science
- Convinced the Police Department of Lyon to give him space and personnel to start a crime lab
- Nominated to the French Hall of Fame for criminalistics in 2012

***“The Sherlock Holmes of France”***



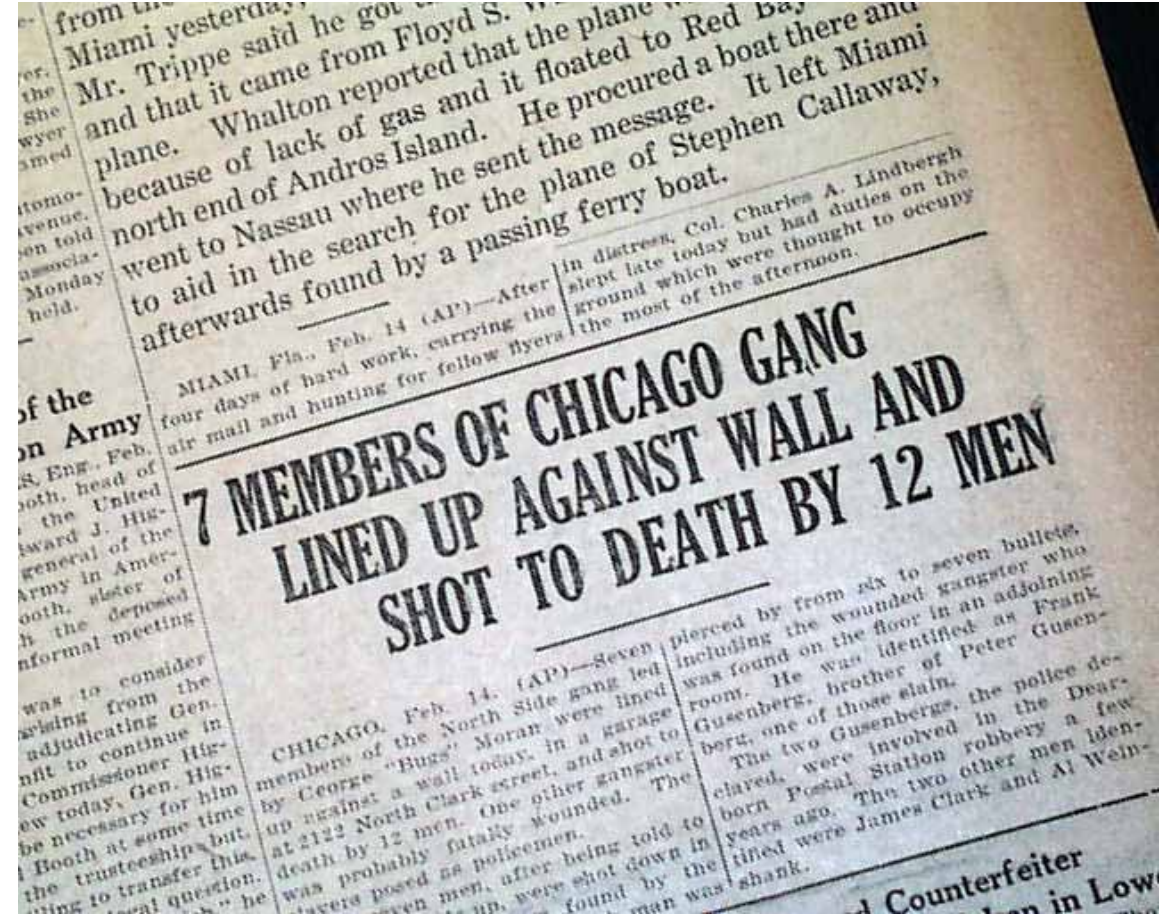
# 1924: First US crime lab (Los Angeles)

- LAPD's first criminalist – Officer Rex Welsh
- Wanted to apply scientific analysis to police work
- Developed scientific methods that could be applied to criminal investigations
- Joined by pharmacologist Ray Pinker in 1929
- Lab eventually became the Scientific Investigation Division of the police force



Ray Pinker, 1938

# St. Valentines Day Massacre - 1929



# St. Valentines Day Massacre - 1929

③

CORONER'S OFFICE.

NAME John May

ADDRESS \_\_\_\_\_

DATE Feb: 14, 1929

CONTENTS Bullet from trap #5  
steel capped bullet flattened  
on one side found in muscle  
over right side of sacrum

*A.D. Gunn.*

211 29025



⑦

RETURN TO  
OSCAR WOLFF  
CORONER COOK COUNTY  
500 COUNTY BUILDING  
CHICAGO, ILL.

*Bullet from leg  
#10.*

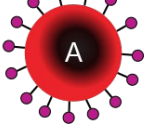
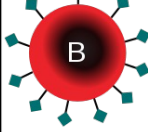
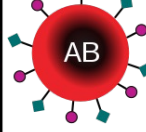
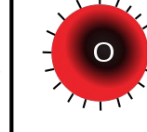






# 1929: Advances in bullet analysis

- Dr. Calvin Goddard hired to examine ballistic evidence from the massacre
- Bullets and casings gathered at the crime scene compared to test bullets
- Bullets matched two Tommy guns found during a raid of a local thug's house



# 1930s: Blood analysis

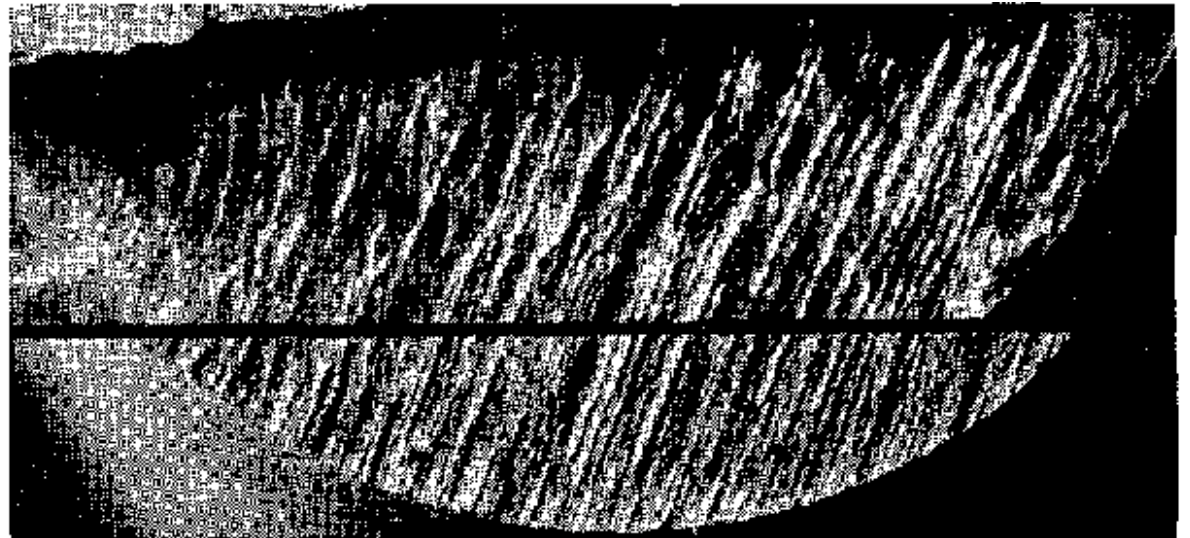
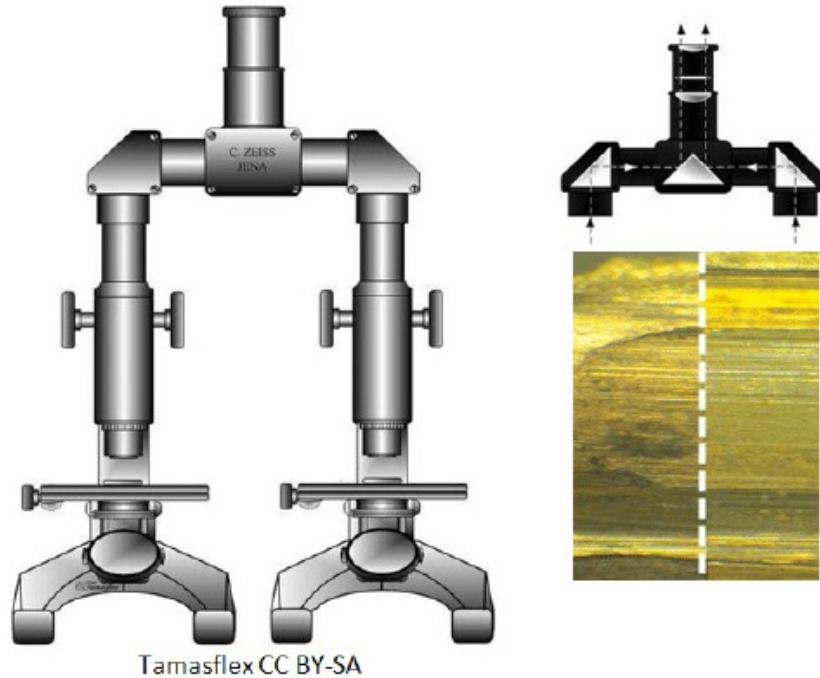
- In 1900, Karl Landsteiner discovered blood groups A, B and O
- Testing for blood group became common in the 1920s
- Power of exclusion for blood testing – 30%
- Serological testing for other antigens became common in the 1930s

	Group A	Group B	Group AB	Group O
Red blood cell type				
Antibodies in plasma	 Anti-B	 Anti-A	None	 Anti-A and Anti-B
Antigens in red blood cell	 A antigen	 B antigen	 A and B antigens	None

		Parent 1 (Rh+)	
		D	d
Parent 2 (Rh +)	D	DD (Rh +)	Dd (Rh +)
	d	Dd (Rh +)	dd (Rh -)

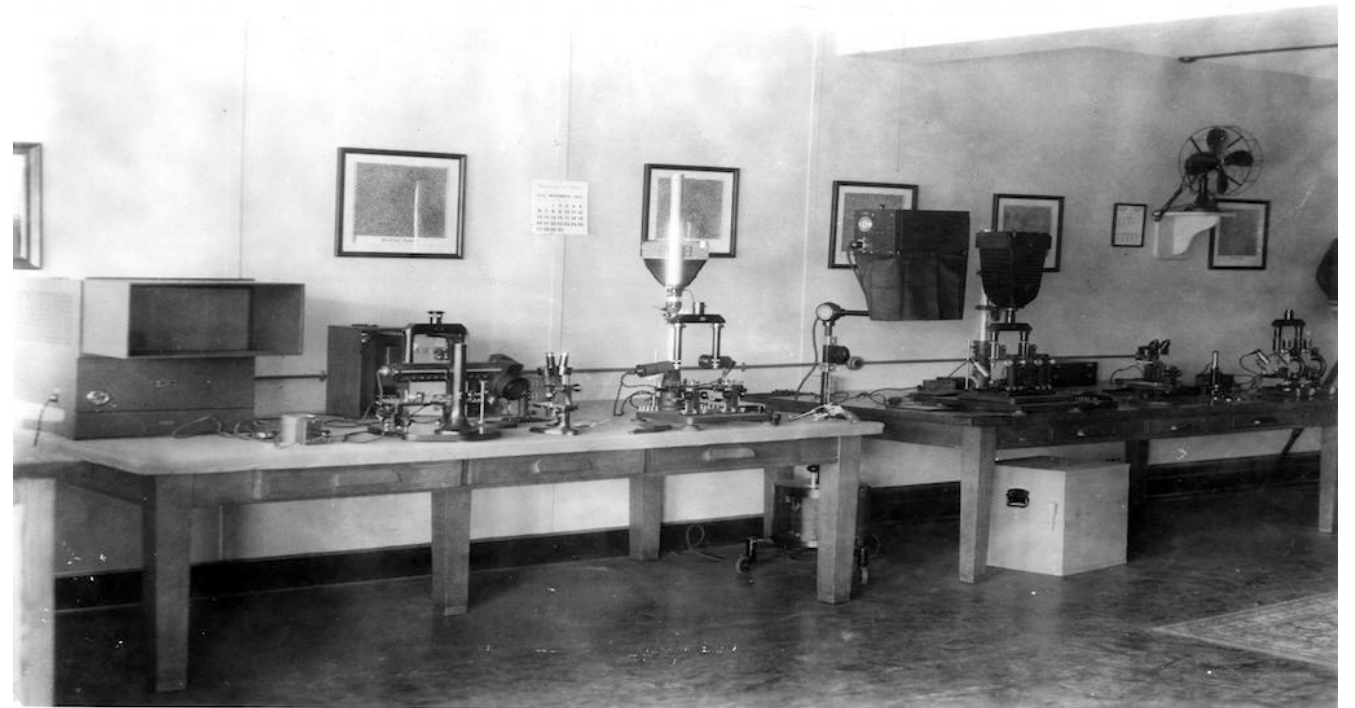
# 1930: Tool striation analysis

- Luke May – America's Sherlock Holmes
- Pioneered tool mark striation analysis
- Invented the Revelarescope in 1922



# 1932: FBI crime lab established

- 24 November 1932: FBI Crime Lab opened in Washington, DC
- Just a room with a sink and one employee!
- More of a public relations tool for J. Edgar Hoover
- 200 pieces of evidence/year
- In the first year, was responsible for helping solve one of the biggest crimes of American history



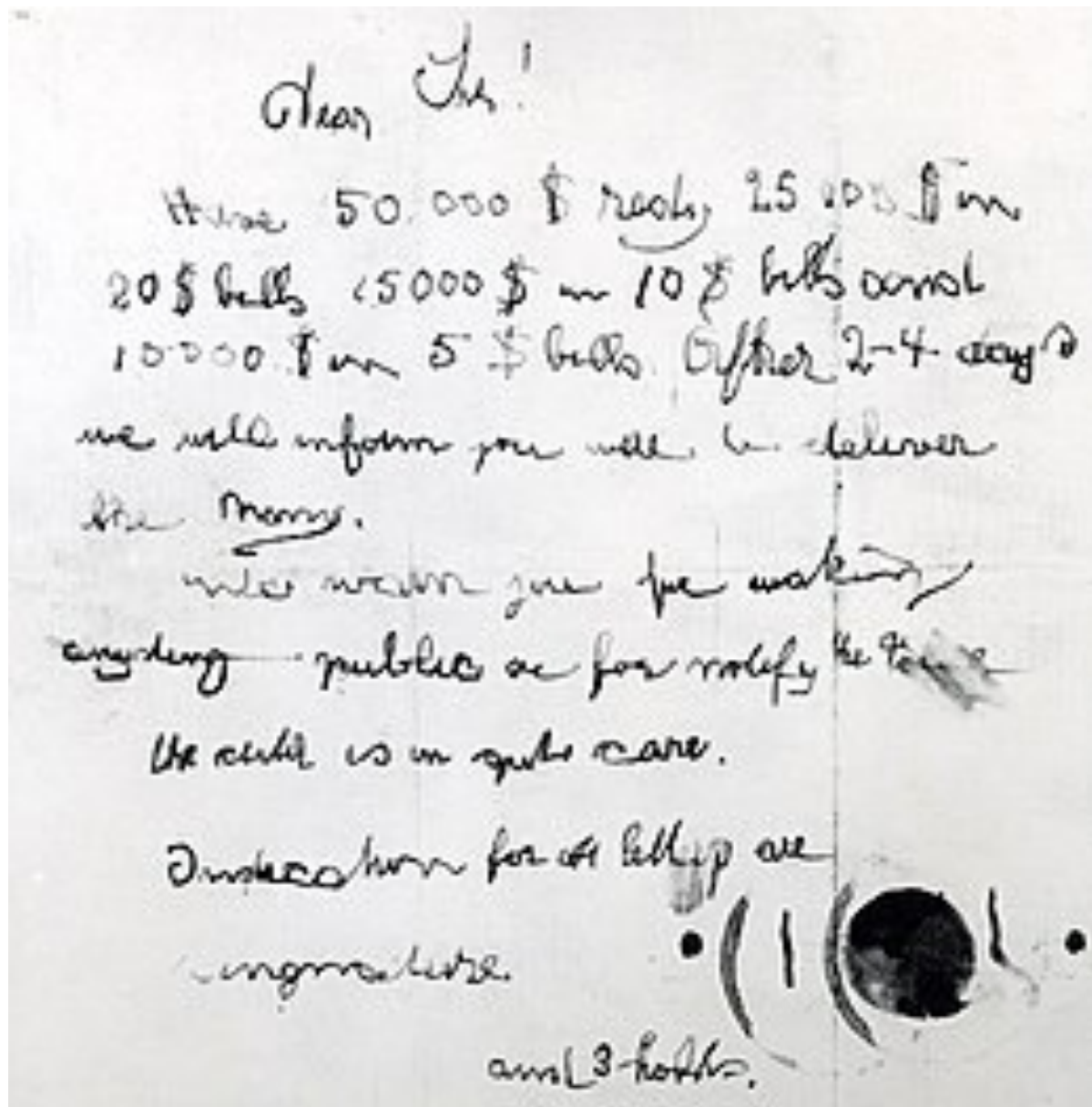
# The Lindbergh Baby

- Charles Lindbergh Jr. kidnapped 1 March 1932 in New Jersey
- 13 ransom notes sent to the family
- FBI crime lab responsible for document analysis



# Document analysis

- Ransom letters had terrible spelling and grammar
- Signed with a distinctive signature
- Contained a pattern of circles and hole punches
- First asked for \$50,000 then \$70,000



Dear Sir!

Here 50,000 \$ ready 25,000 \$ in  
20 \$ bills 15,000 \$ in 10 \$ bills and  
10,000 \$ in 5 \$ bills. After 2-4 days  
we will inform you will be deliver  
the money.

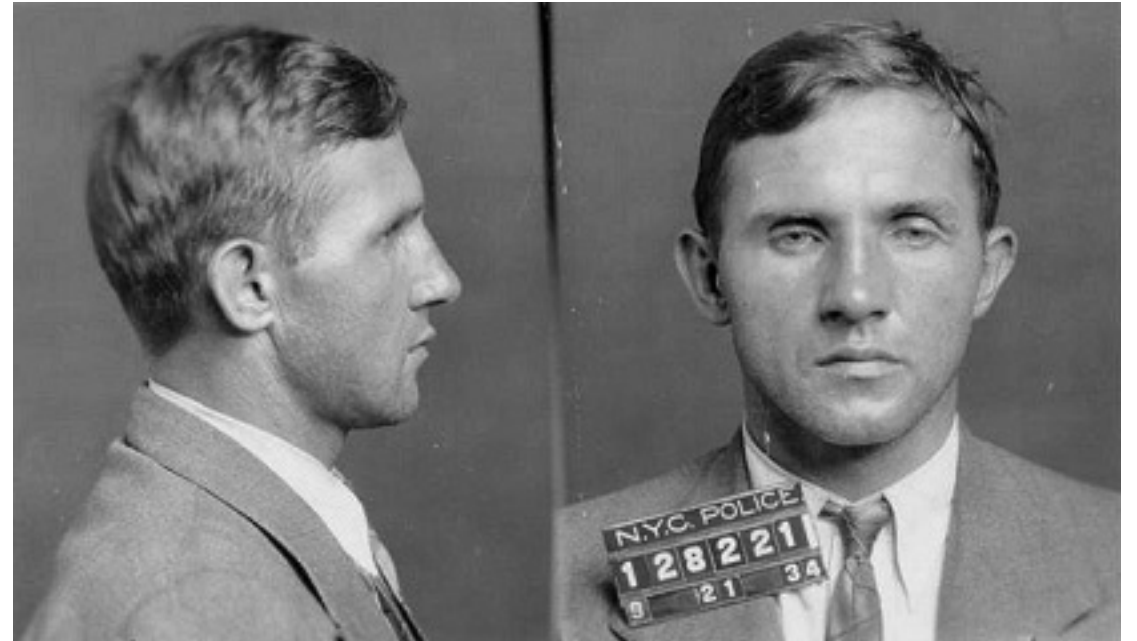
we want you for making  
anything public or for notify the police  
the child is in quite care.

Instructions for the kidnaper are  
incomplete.

and 3 holes.

# The Lindbergh Baby

- The body of Charles Lindbergh Jr. was found on May 12
- Ransom had been paid using money and gold certificates
- Money was found to be spent in Manhattan, NY over the following years
- Richard Hauptmann arrested after spending the money
- Handwriting and spelling was consistent with the ransom notes
- Convicted then executed for the crime



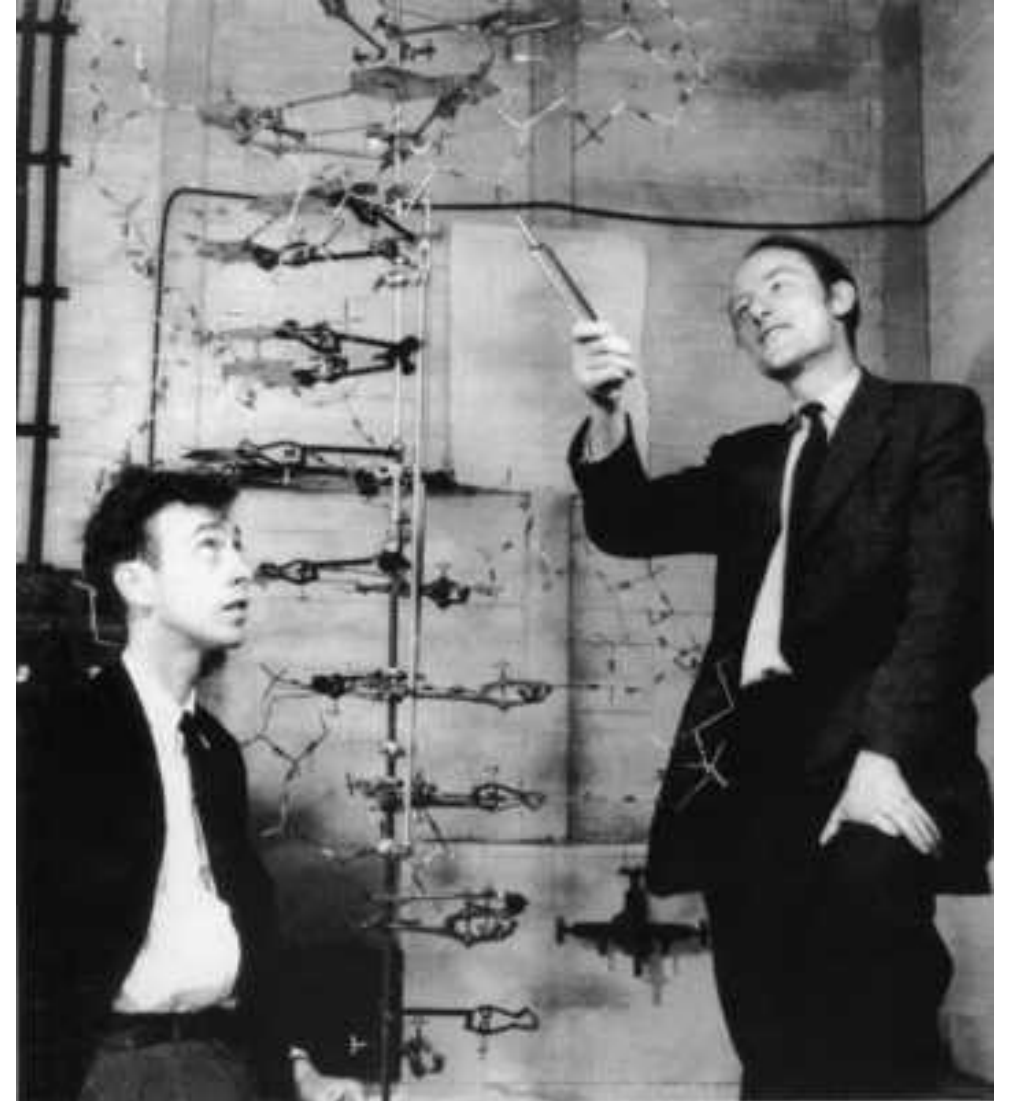
# 1937: Luminol – presumptive test for blood

- In 1928, German chemists found that certain substances enhanced the luminescence of luminol in a basic solution
- 1939: Walter Specht – forensic scientist
- Experimented with the use of luminol at crime scenes
- Found that it worked quickly, worked best with dried blood, and can be reproduced with the application of more luminol
- Still used today!



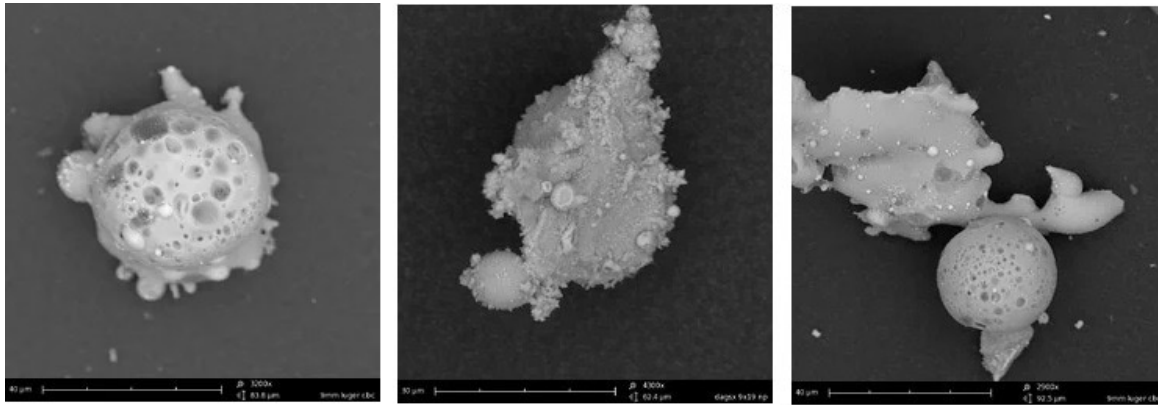
# 1953: Structure of DNA identified

- DNA had been identified in the 1860s, but the specific molecular structure wasn't identified until 1953 – Watson and Crick
- Not a forensic discovery, but formed the basis of modern forensics techniques and applications



# 1971: Gunshot residue analysis

- When a gun is discharged, more than just the bullet is shot
- Gunshot residue is comprised of gun powder, primer residues and projectile residues
- John Boehm analysed bullet entrance holes using scanning electron microscopy (SEM)



# 1975: Federal rules of evidence established (US)

- Up until now, evidence was not regulated in any way
- A committee was charged with the task of codifying all previously developed **common law** evidence rules
- Federal rules of evidence enacted as **statutory law**

## **Common Law:**

Derived from precedent set by previous judicial and tribunal decisions

## **Statutory Law:**

Written and passed by legislature and government and always supersedes common law

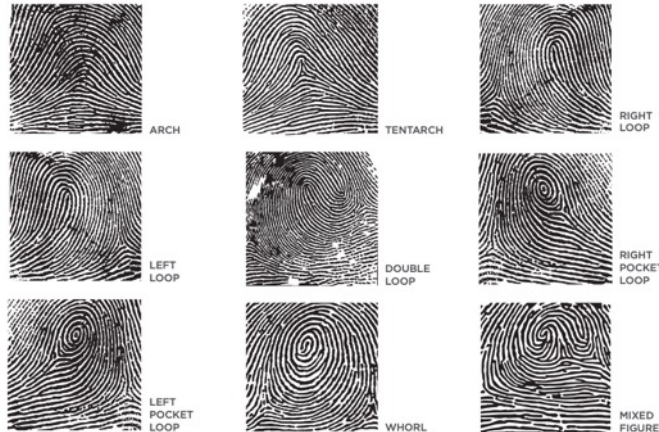
**Canada Evidence Act:** First developed in 1893, but firmly established in 1985

<https://laws-lois.justice.gc.ca/PDF/C-5.pdf>

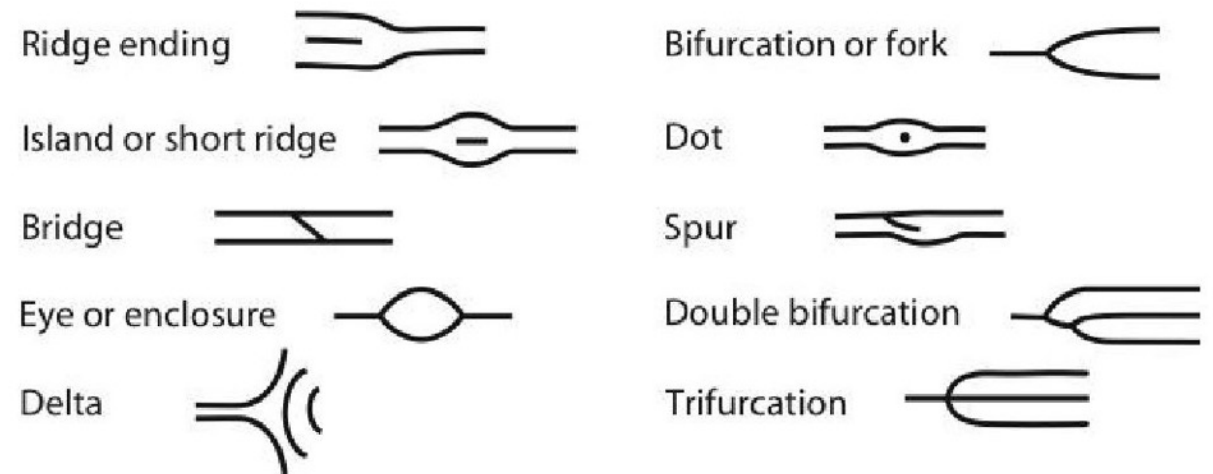
# 1977: Fingerprint database established (AFIS)

- In the 1970s, fingerprint analysis was routine but cumbersome
- Fingerprints now analysed in terms of their minutiae, not just the standard ridge patterns
- Odds of finding 2 people with the exact same fingerprint 1 in 64 billion

## Henry ridge patterns



## Minutiae



# 1977: Fingerprint database established (AFIS)

- AFIS: Automated Fingerprint Identification System
- Old process: 30-45 days to complete analysis
- AFIS – 30 minutes to scan 100,000 sets
- Now, holds over 120 million fingerprint sets
- **Canadian system:** Canadian Police Information Centre (CPIC) administered by the RCMP



# 1984: DNA fingerprinting

- 99.9% of DNA is shared between individuals
- DNA contains repetitive sequences that are highly variable – **variable number tandem repeats** (VNTRs)
- Alec Jeffreys developed DNA fingerprinting that uses **restriction enzymes** to cut DNA at these repeat sites to determine length of repeat regions

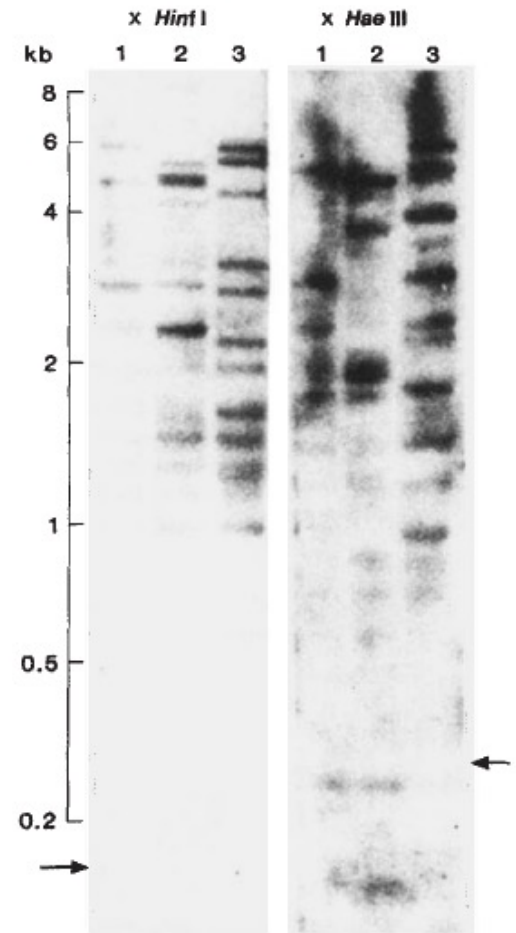
## Hypervariable ‘minisatellite’ regions in human DNA

Alec J. Jeffreys\*, Victoria Wilson\* & Swee Lay Thein†

NATURE VOL. 314 7 MARCH 1985

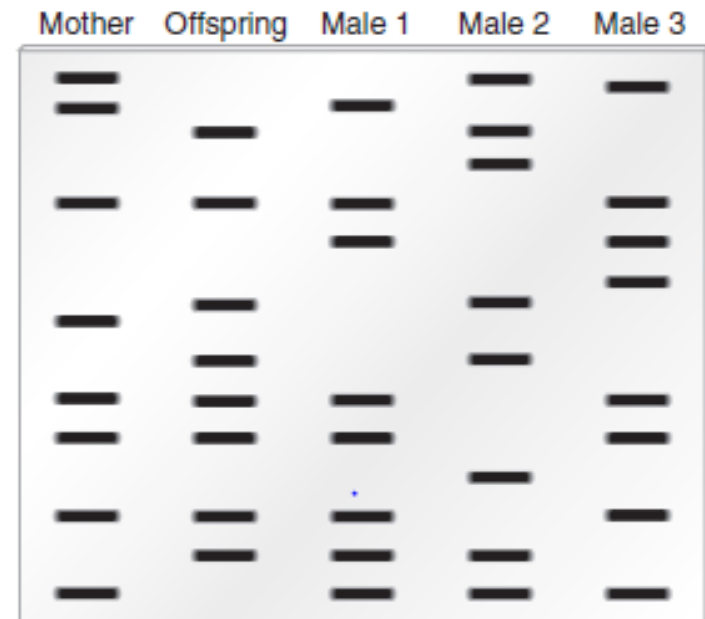
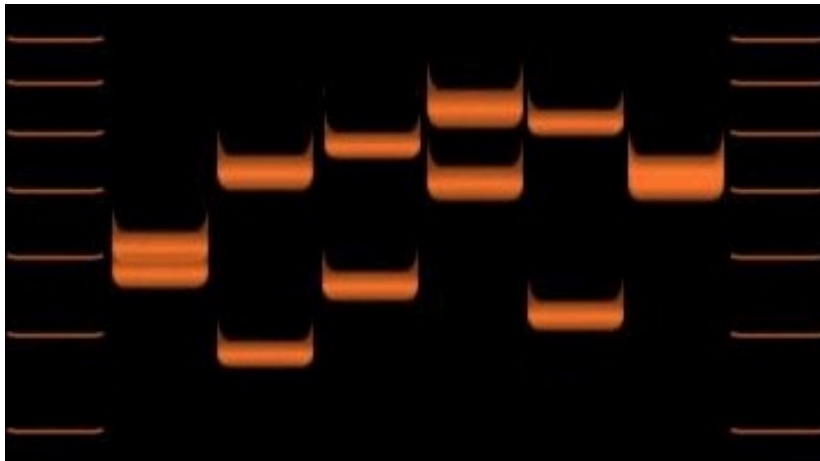
That's a lot of DNA!!!

Fig. 2 Detection of multiple 33-related sequences in human DNA. 10 µg samples of DNA from individual 1 (daughter), 2 (mother) and 3 (father) were digested with *Hinf*I or *Hae*III, electrophoresed through a 1% agarose gel and transferred by blotting<sup>35</sup> to a Pall Biodyne membrane to prevent the loss of small DNA fragments.



# 1986: Polymerase chain reaction

- PCR had been developed throughout the 80s so far
- Edward Blake and Henry Erlich collaborated to find a way to apply PCR to solving crime
- Amplification of the HLA DQ $\alpha$  locus allowed them to test trace amounts of evidence
- Alec Jeffreys used this method to amplify the VNTRs for more specific and sensitive fingerprinting



# 1987: First case prosecuted using DNA fingerprinting

- Jeffreys' fingerprinting technique was used to prosecute a case for the first time in 1987
- 21 November 1983: 15-year-old Lynda Mann raped and murdered in Narborough, UK
  - Semen evidence collected, blood typing and enzyme analysis performed
- 31 July 1986: 15-year-old Dawn Ashworth found raped and murdered in nearby Enderby
  - Semen evidence was consistent with the first murder
- DNA fingerprinting showed that the 2 girls were killed by the same person



# The investigation

- A local 17-year-old admitted to the 2<sup>nd</sup> murder but not the 1<sup>st</sup>
- DNA fingerprinting analyses showed that he was not the person who left the evidence
- Investigation asked 5,500 local men to volunteer blood/saliva samples
- DNA fingerprinting performed, but no matches!

# Colin Pitchfork

- Colin Pitchfork worked as a Baker's Apprentice in the area
- Colleague Ian Kelly revealed to fellow workers in a Leicester pub that he was paid £200 for giving a sample while masquerading as Pitchfork
- Pitchfork arrested and his DNA sample matched the semen samples
- He was sentenced to life imprisonment with a minimum term of 30 years before possible release
- Granted a conditional release in 2021
- Recalled back to prison for “not leaving young women alone”
- Granted parole again in 2023 but on challenge it was reversed
- Still in jail today



# Recognition



- The Blue Plaque scheme links important historical people with modern places
- Leicester pub The Clarendon has been suggested for a blue plaque in recognition of the moment the case turned and the DNA techniques that solved the crime

News ▶ Leicester News ▶ Crime

## Call for blue plaque on Leicester pub where police got their big break in Pitchfork murder hunt

A councillor says it should be recognised for the part it played in cracking the notorious case

SHARE    98 SHARES

 30 COMMENTS

By [Dan Martin](#) Politics Reporter  
11:28, 21 MAR 2020

NEWS

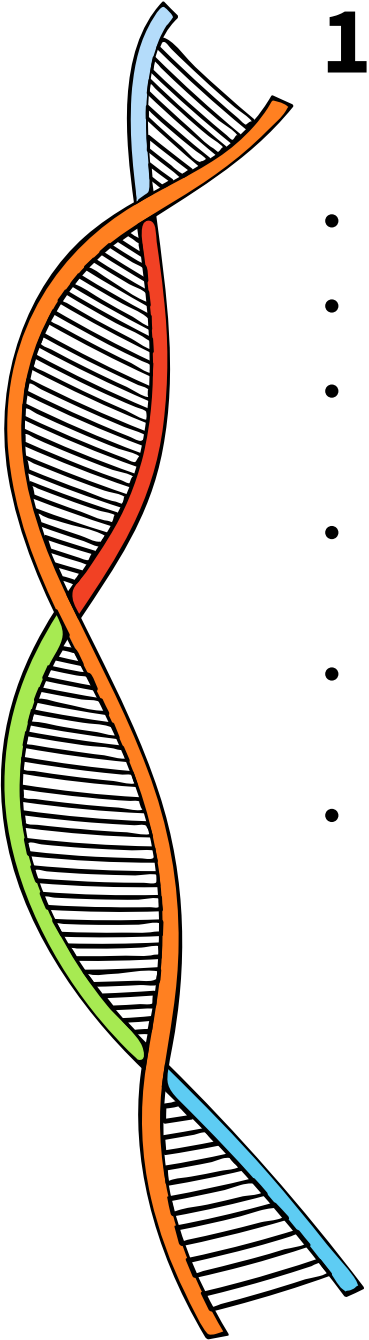
# 1989: First American convicted using DNA evidence

- In 1987, 4 women were viciously sexually assaulted and murdered in Richmond, Virginia
- Dubbed the Southside Strangler
- A known petty criminal was in the area when the murders occurred: Timothy Wilson Spencer
- Evidence taken from the crime scene
- DNA fingerprinting used – suspect was a match **AND** matched for a previous murder
- Spencer executed in 1994



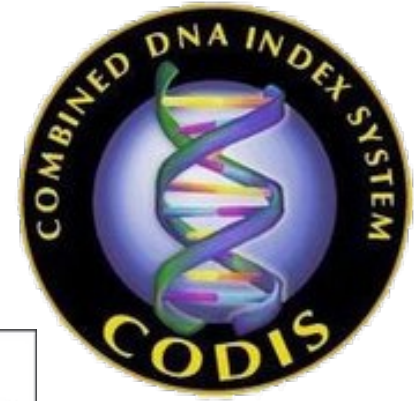
# 1995: First DNA database established (UK)

- In 1991, PCR combined with VNTRs allowed for numerical storage of DNA profiling results
- Profiling certain loci yielded results that approached individualization
- It was very cumbersome, so in 1992, a new technology called **short tandem repeat** (STR) profiling became more popular
- 2 loci were chosen as the basis for a standardized method of storing DNA profiles in a database
- April 10, 1995: First database created in the UK – *“the biggest breakthrough in the fight against crime since fingerprints”*
- By 1999, allowed over 700 matches each week

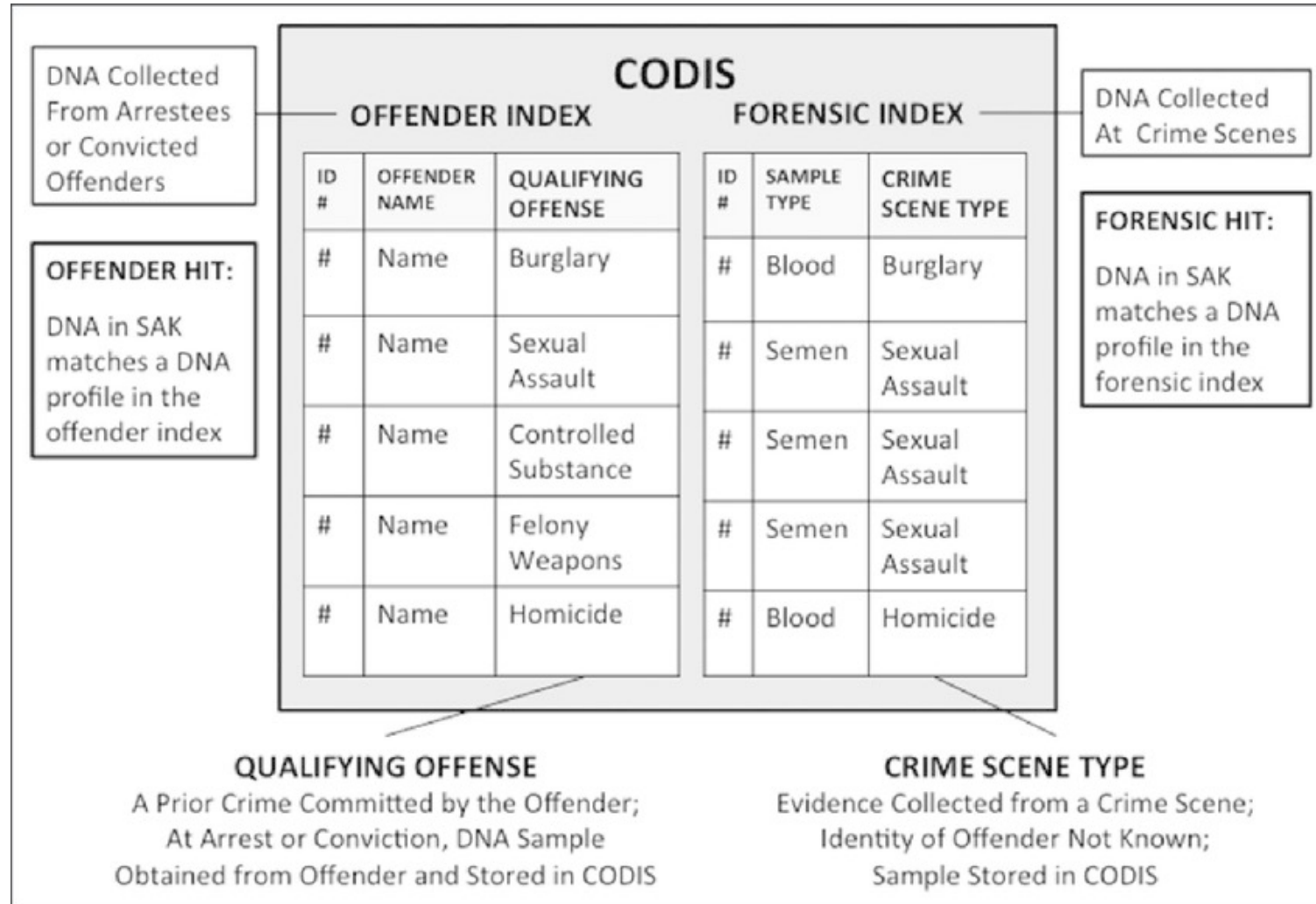


# 1998: National DNA Index (CODIS)

- Combined DNA Index System (CODIS) established in 1998 by the FBI



SAK – sexual assault kit



# Advances in DNA profiling technology

- 2001 onwards: single nucleotide polymorphism (SNP) analysis
  - Can test millions of positions in the genome for single base changes
  - Higher potential for individualization
  - Offers information about ancestry
  - Phenotyping – hair colour, eye colour
- 2009 onwards: exome, genome sequencing

[OPEN ACCESS](#) Freely available online



## A Genome-Wide Association Study Identifies Five Loci Influencing Facial Morphology in Europeans

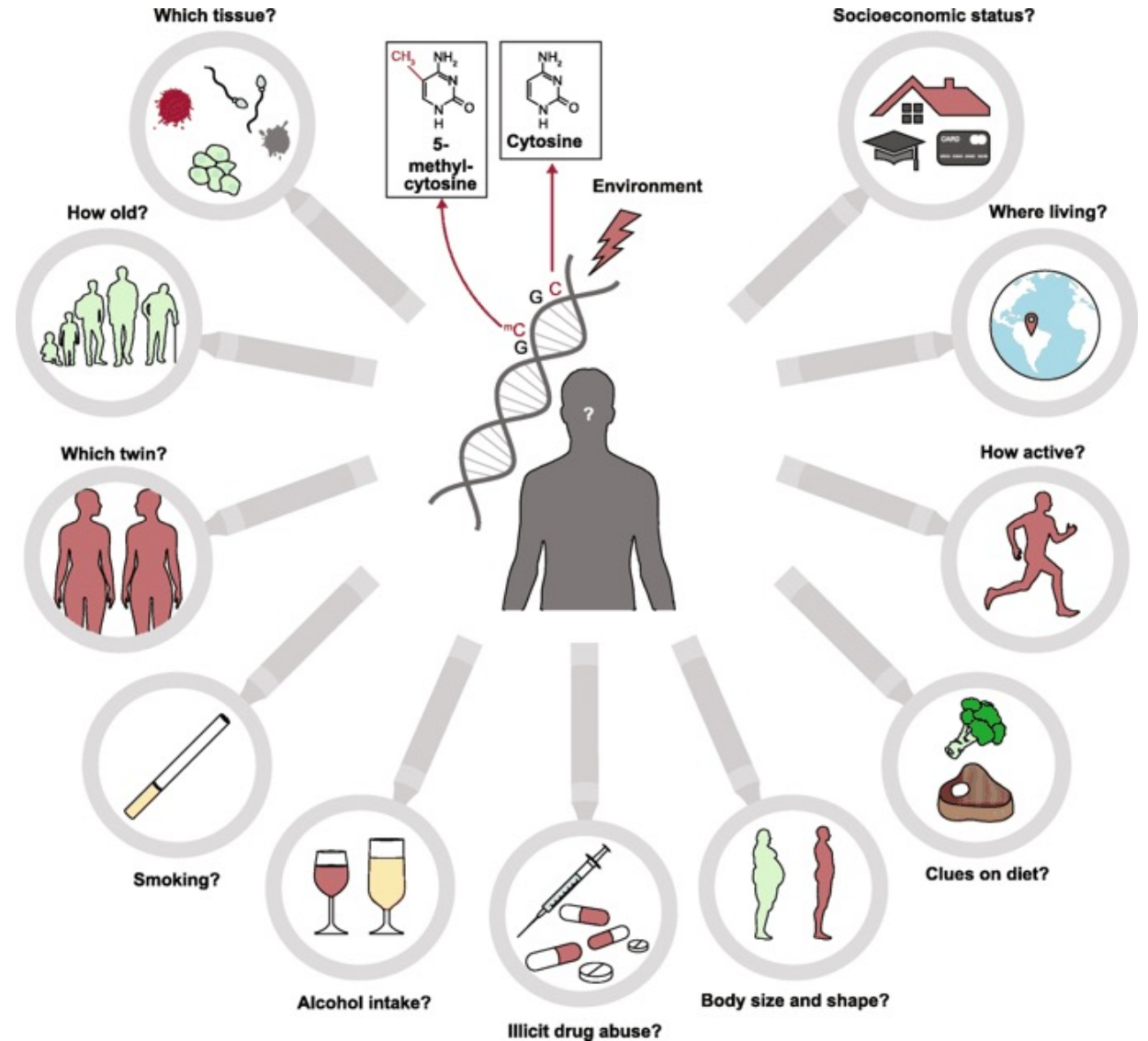
[OPEN ACCESS](#) Freely available online



## Modeling 3D Facial Shape from DNA

# Advances in DNA profiling technology

- Epigenetics – changes to the DNA that do not involve the sequence
- Result from environmental factors
- Can forensic genomics be useful for:
  - Aging?
  - Twin identification?
  - Tissue identification?



# Visual summary



## 1900s

Advances in bullet analysis, blood typing and tool striations.

## 1800s

Significant advances in forensic techniques made.

## 1950s

Double helix structure of DNA identified by Watson & Crick.

## 1980s

DNA fingerprinting developed and improved using PCR.

## 1990s

Digitalized DNA databases created around the world.

## 2000s

NGS allows us to perform forensic DNA analysis at scale.

# Optional further reading

- History of Forensic Science article (available on Canvas)

