

# FORENSIC EVIDENCE IN CIVIL AND CRIMINAL TRIALS & DNA PROFILING

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*AIIMS Bhopal*

# FORENSICS

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- ▶ Definition –Application of scientific methods and techniques to the investigation of crime.
- ▶ Forensic medicine – Application of knowledge of **medicine** in administration of justice.
- ▶ Forensic Science- – Application of knowledge of **science** in administration of justice.



## Criminal trial

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- ▶ Homicides
- ▶ Sexual assaults
- ▶ Dowry deaths
- ▶ Narcotics & Psychotropic substances use
- ▶ Assault/ accident cases
- ▶ Cases of poisoning including alcohol



# Civil trial

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- ▶ Insurance
- ▶ Paternity tests
- ▶ Negligence – Documentation/consent
- ▶ Accident causation
- ▶ Age estimation( for consent, retirement Etc )



# Role of Forensic evidence

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- ▶ When no eyewitness is present
- ▶ To prove beyond reasonable doubt

Scientific facts cannot be denied.

DNA – conclusive of presence of culprit ...



# Locard's Exchange Principle



- The Locard Exchange Principle states that whenever two objects come into contact, a mutual exchange of matter will take place between them.



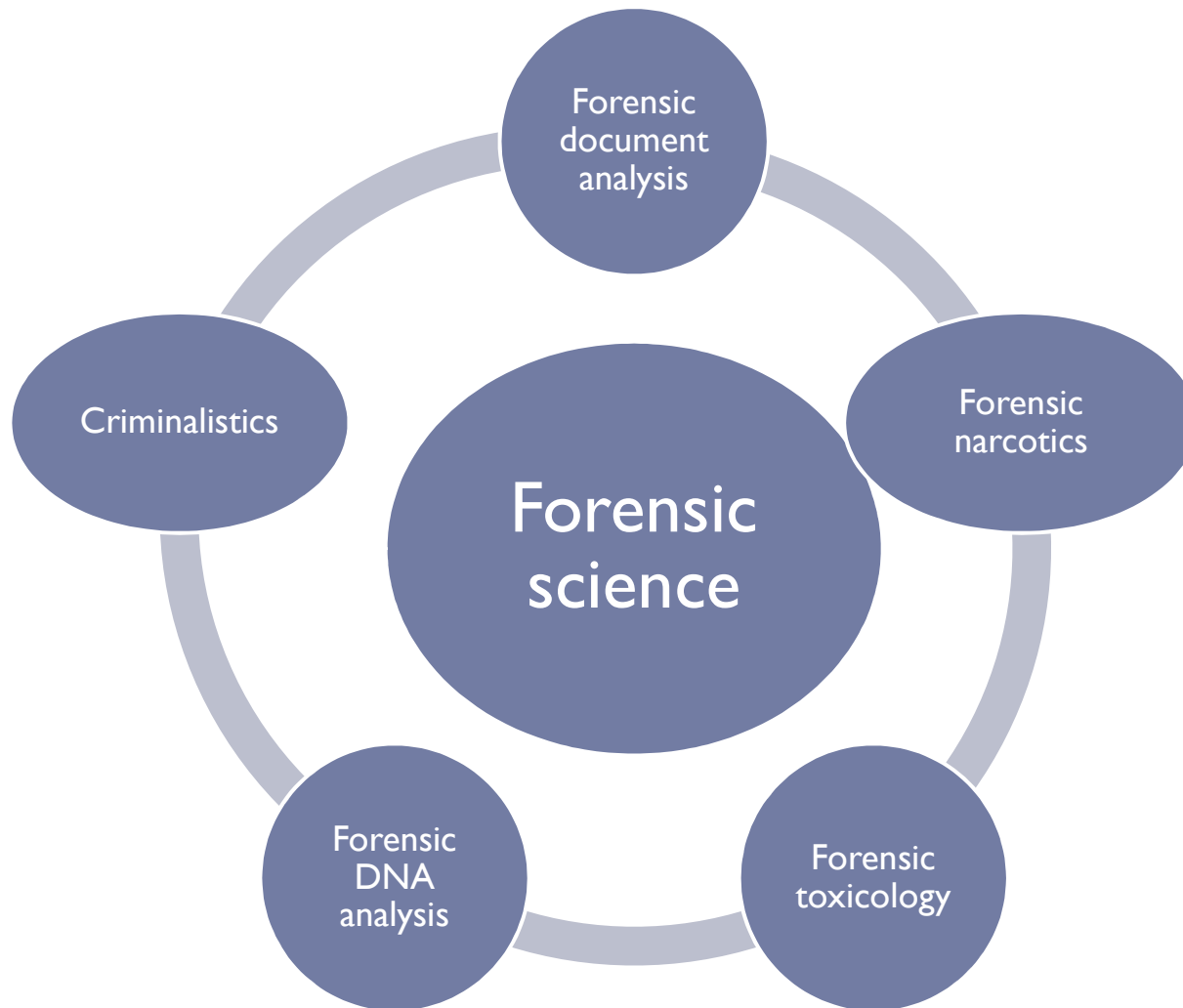
**POLICE LINE - - DO NOT CROSS - - POLICE LINE - - DO NOT CROSS**

# LOCARDs Principle of Exchange

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- ▶ **Locard's exchange principle** holds that the perpetrator of a crime will bring something into the crime scene and leave with something from it, and that both can be used as forensic evidence.
- ▶ *"every contact leaves a trace"*





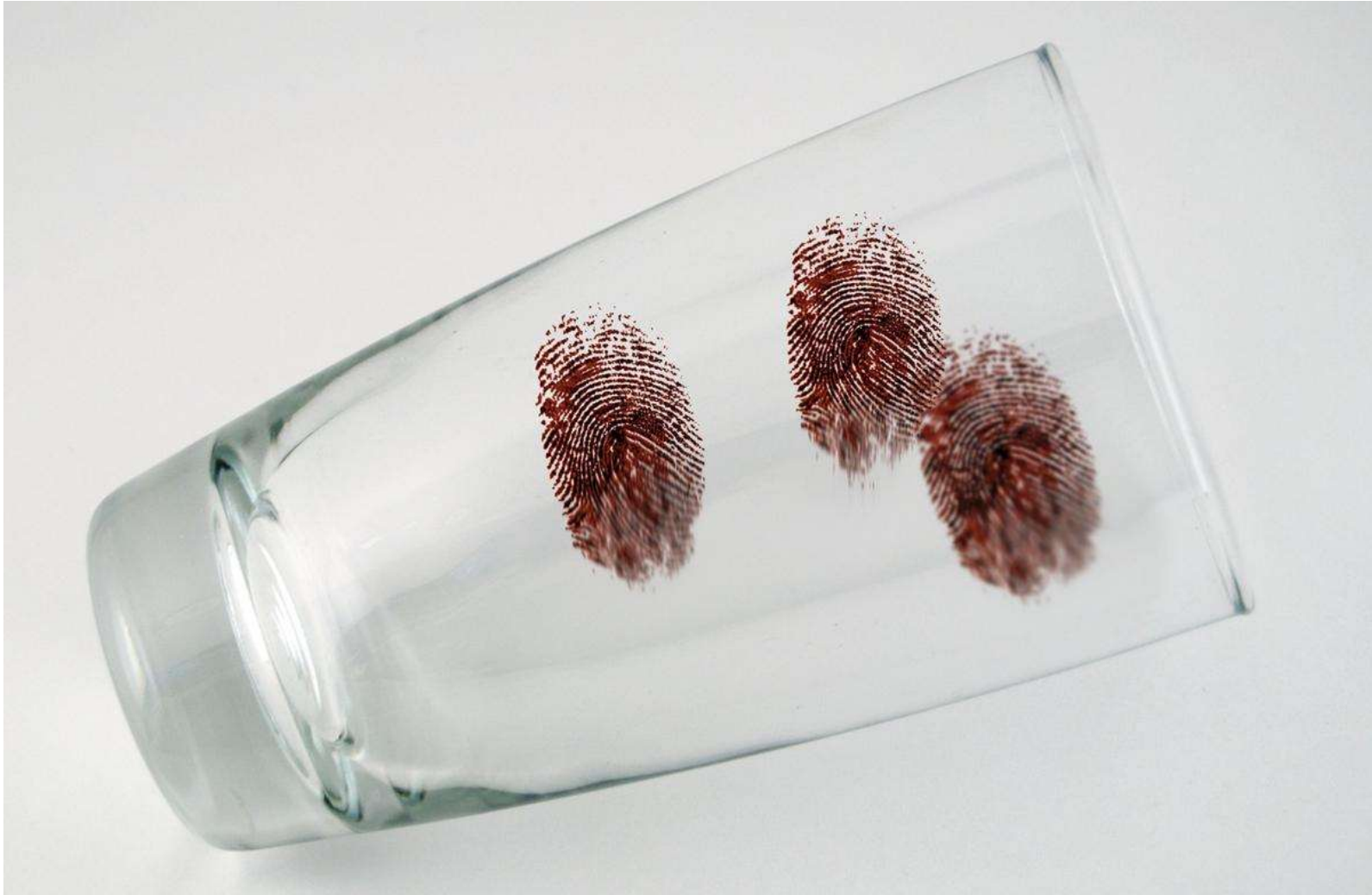
# Forensic Ballistics

- Forensic Ballistics is the science of analyzing firearms, bullets and bullet impacts.
- Ballistic fingerprinting is analyzing firearm evidence to determine if that particular firearm was used in the crime.

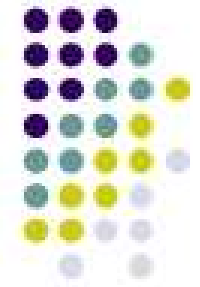


# Finger printing

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# Forensic Serology



Forensic serology deals with the scientific study of blood and other bodily fluids that are found at crime scenes. This is primarily performed for the detection and identification of biological material (i.e., blood, semen, saliva, and urine) on physical evidence in order to:

1. Link suspect(s) and victim(s) to each other and/or to the scene(s)
2. Include or exclude potential suspect(s) or victim(s)
3. Establish crime scene(s)
4. Identify weapon(s)
5. Corroborate case circumstances
6. Narrow down the samples for further analysis



# Examination of Clothings

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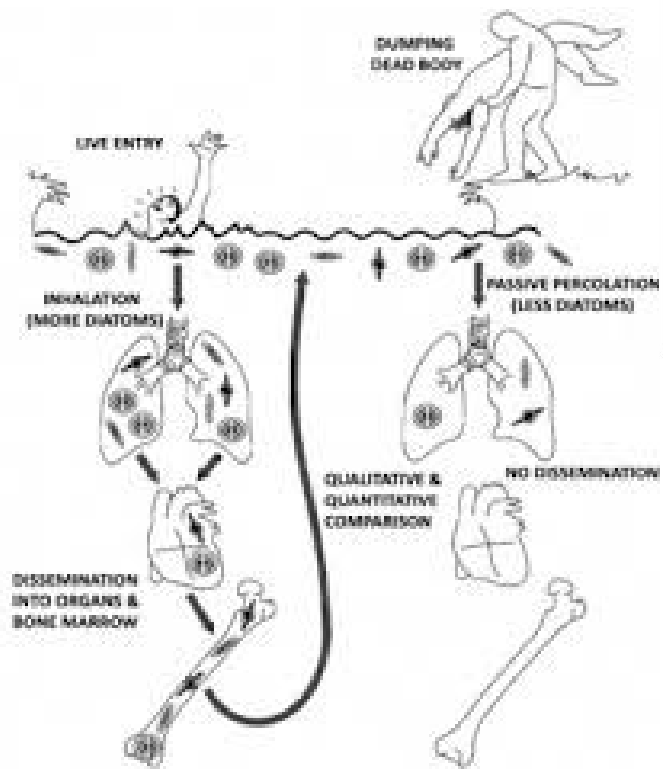
- ▶ Injury/ tear
- ▶ Identification
- ▶ Sexual assault
- ▶ Firearm
- ▶ Homicide
- ▶ Hanging

The clothings are examined for

- ▶ Blood
- ▶ Stains-mud, grease etc
- ▶ Semen stains
- ▶ Tears to correlate injury.



# Diatoms



*Eunocybellarania vandana*



*Amphora ovalis*



*Denticula tenuis*



*Opephora pacifica*

Figure 4: Few Seasonal diatoms.

# FORENSIC ENTOMOLOGY



## The life cycle of a blowfly

It never takes these insects long to make their way to a decomposing body, and the first thing they do when they get there is lay eggs. This timeline is based on a constant temperature of 70 degrees.



## DAY 1

Adult fly  
lays eggs  
on leaf.

## TWO WEEKS

Emergence of  
adult fly

Their measured life cycle allows forensic entomologists — bug specialists — to roughly calculate when a victim died based on the developmental stage of the blowflies when the body is discovered.

## DAY 2

Eggs hatch and larvae emerge.

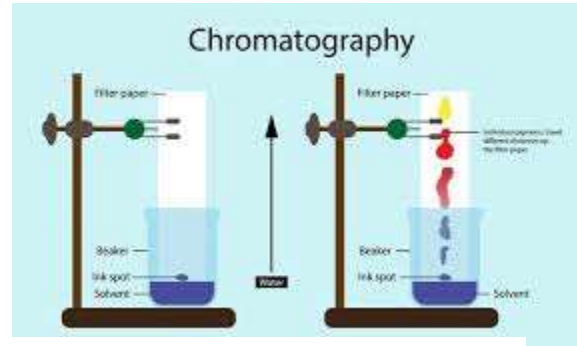
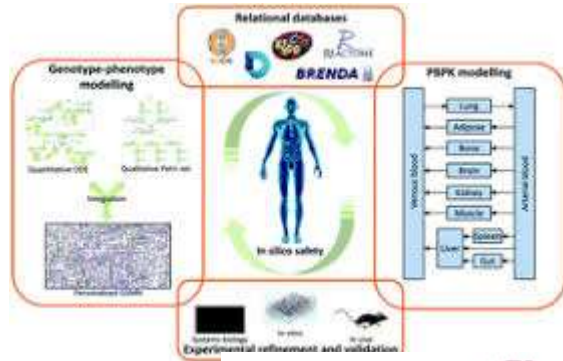
DAYS 8-9

**Prepupation.** Larva forms a hard, cocoonlike shell and begins developing adult features.

**DAYS 3-7**

Director, Michigan State University  
Dept. of Education

## THE FLUX-MODEL



poisons  
toxicology  
investigation  
Toxicology  
determining  
alcohol  
legal  
crime  
forensic  
analysis  
Read  
levels  
laboratories  
drugs  
applications  
medicine

# Forensic DNA

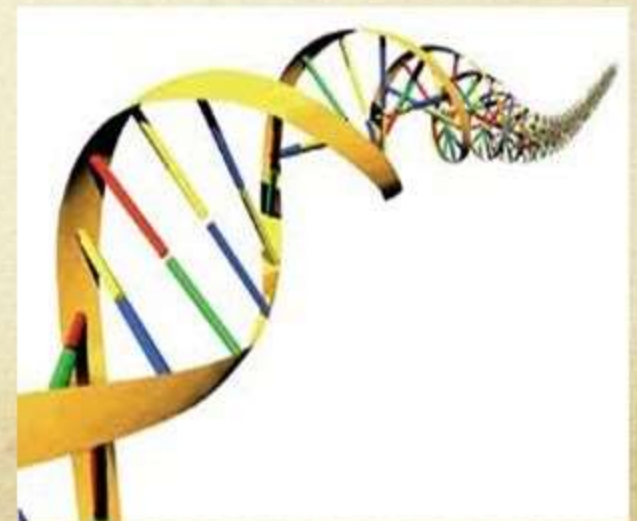
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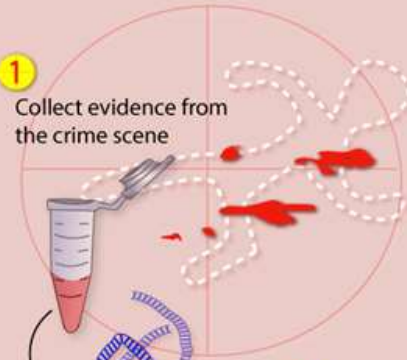
# DNA Evidence

How can DNA be used to solve Crimes?



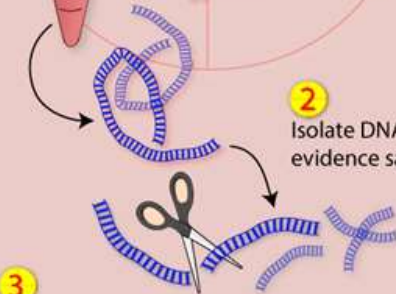
1

Collect evidence from the crime scene



2

Isolate DNA from an evidence sample

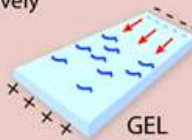


3

Cut the DNA into fragments using specialized protein "scissors" called restriction enzymes. For every person, the sizes of the cut fragments are unique - except for identical twins.

4

Separate the negatively charged DNA fragments in a gel by passing an electric current through it.



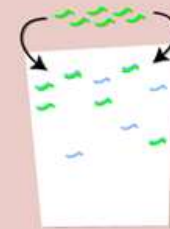
5

Transfer the DNA fragments from the gel to a sheet of membrane



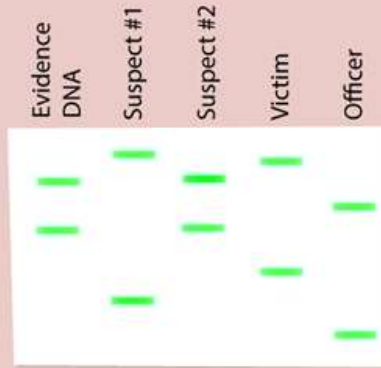
6

Probe the membrane with DNA fragments that complement the DNA sequence of the fragments of interest.



7

Compare the fragment profile of the evidence DNA with those of the suspects, detective and victim to see if they match.



8

Re-probe the membrane up to 10 more times to identify different fragments.

If the profiles from the evidence DNA and a suspect match multiple times, then it is very likely that the evidence DNA came from the suspect.

# **MISCELLANEOUS CRIME SCENE SAMPLES**

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- ▶ Clothing's, pillows, sheets- blood, semen, saliva, hair
- ▶ Bullet- blood
- ▶ Cigarette butt- saliva
- ▶ Condom- semen, vaginal secretions
- ▶ Envelope-saliva
- ▶ Fetal and maternal tissue- separate at the time of collection
- ▶ Urine
- ▶ Sweat
- ▶ Nasal secretions
- ▶ Faecal stains
- ▶ Vomitus
- ▶ Tissue ( bone marrow, muscle, spleen, fingernail scrapings)
- ▶ Mouth swabs

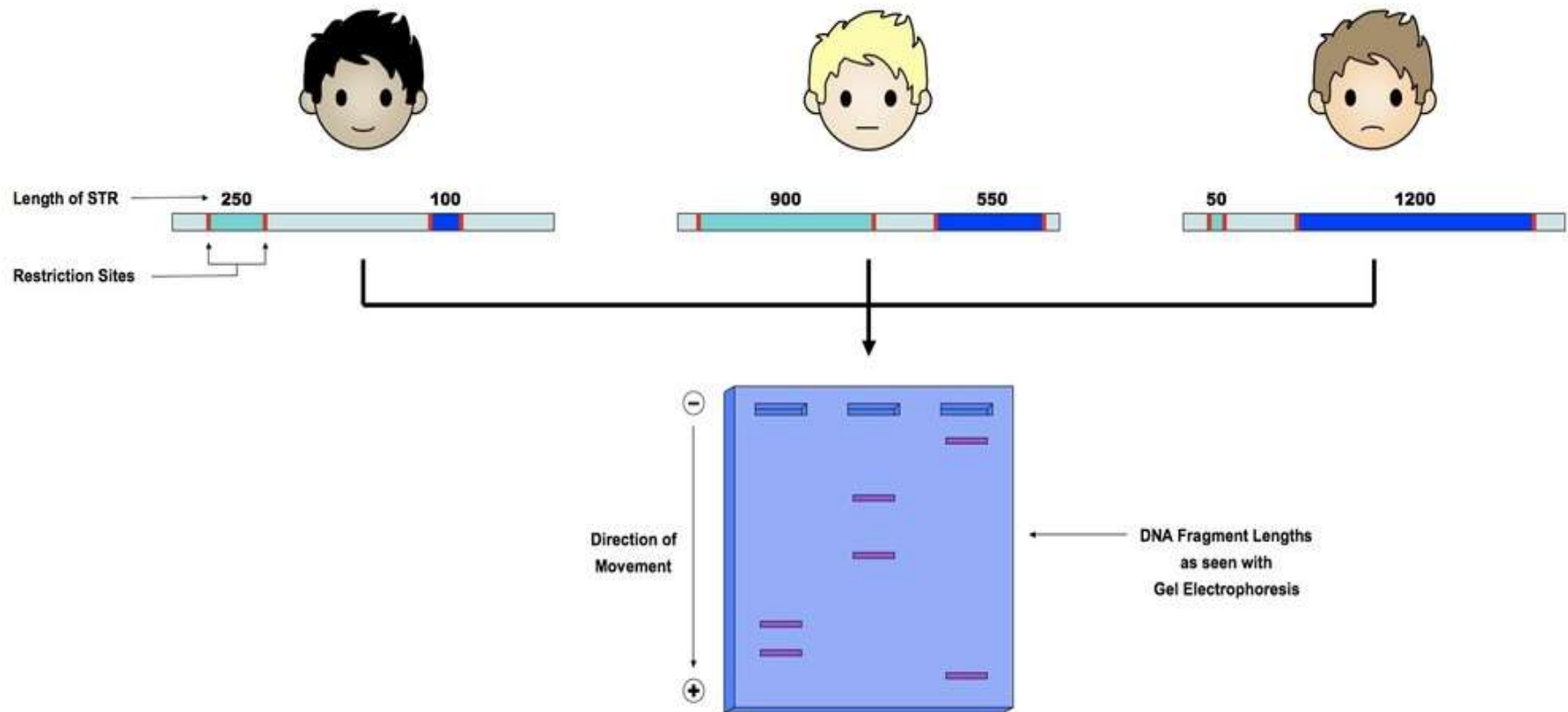


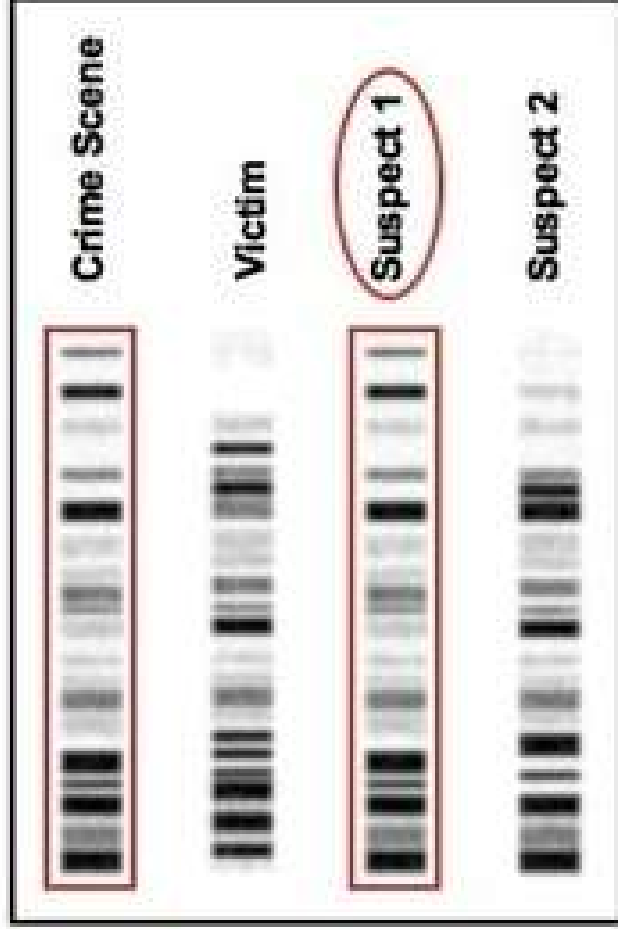
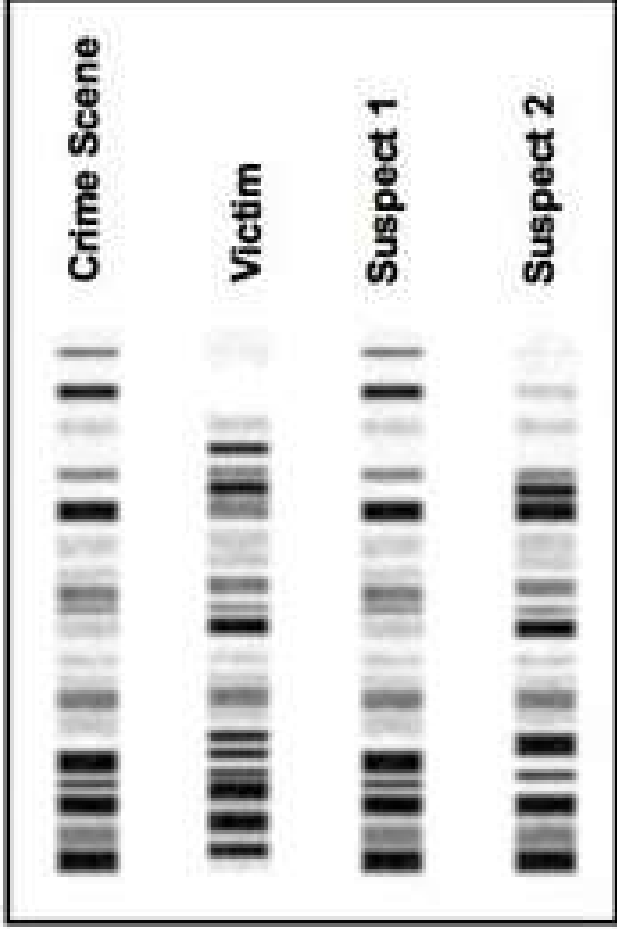
- 
- ▶ Within the non-coding region of an individual's genome, there exists satellite DNA - long stretches of DNA made up of repeating elements called short tandem repeats (STRs)
  - ▶ These repeating sequences can be excised to form fragments, by cutting with a variety of restriction endonucleases (which cut DNA at specific sites)
  - ▶ As individuals all have a different number of repeats in a given sequence of satellite DNA, they will all generate unique fragment profiles
  - ▶ These different profiles can be compared using gel electrophoresis



# UNIQUE

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# Comparison of DNA samples from crime scene to that of different suspects

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**DNA  
sample  
from  
the  
crime  
scene**



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**matches**

Case: 456789 Name	MOTHER Jane	CHILD Jenny	Alleged FATHER John
Date Collected: Test No.	1/1/2010 456789-10	1/1/2010 456789-20	1/1/2010 456789-30
Locus	PI	Allele Sizes	Allele Sizes
D8S1179	1.55	10 14	11 13
D21S11	2.02	27 29	29 30
D7S820	1.17	8 10	10 11
CSF1PO	1.65	11 12	11 12
D3S1358	1.88	14 17	14 15
TH01	2.62	6 9.3	7 9
D13S317	3.43	13	11 13
D16S539	3.32	9 12	11 12
D2S1338	4.33	19 20	23 24
D19S433	2.23	13	13 14
vWA	3.62	14	14 17
TPOX	1.86	11	8 11
D18S51	3.06	15 17	13 14
D5S818	1.35	12 13	11 12
FGA	3.55	21 22	21 24
Amelogenin		X	X Y

Interpretation: Combined Paternity Index: **323,769** Probability of Paternity: **99.9996%**

The alleged father is not excluded as the biological father of the tested child. Based on testing results obtained from analyses of the DNA loci listed, the probability of paternity is 99.9996%. This probability of paternity is calculated by comparing to an untested, unrelated, random individual of the Caucasian population (assumes prior probability equals 0.50).

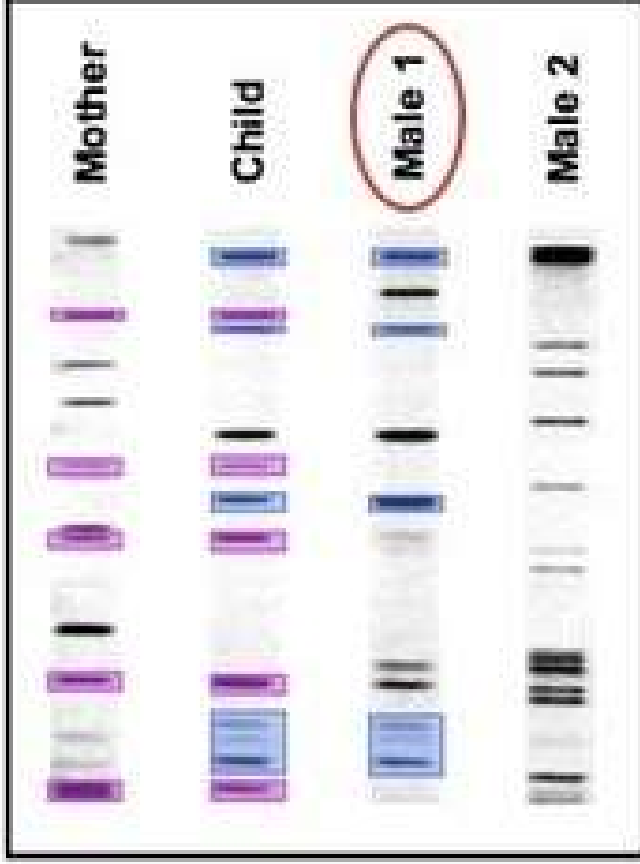
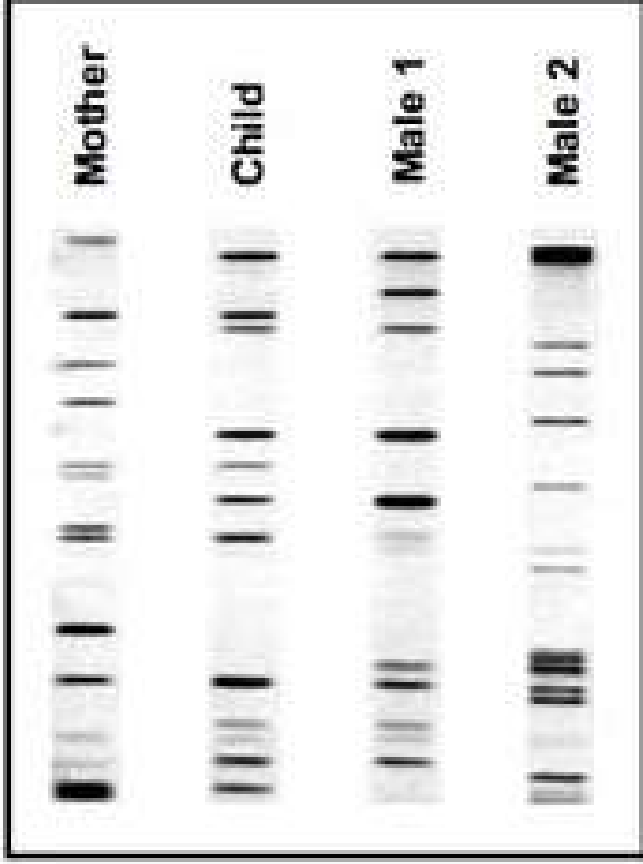
		CHILD	Alleged FATHER
Locus	PI	Allele Sizes	Allele Sizes
D3S1358	2.02	16	15 16
vWA	2.89	14 19	18 19
D16S539	0.83	9 11	11 12
CSF1PO	0.78	10 12	11 12
TPOX	1.44	8 11	8 11
D8S1179	4.04	10 14	10 14
D21S11	1.58	28 29	28 30
D18S51	3.39	15 19	15 19
D2S441	2.48	10 11	10 11
D19S433	2.23	13 14	13 14
TH01	0.82	6 9.3	7 9.3
FGA	1.39	22 27	21 22
D22S1045	1.42	16 17	16 17
D5S818	1.38	11 12	12 12
D13S317	0.86	8 11	11 12
D7S820	1.56	8 9	8 12
SE33	2.63	24.2 28.2	28.2 29.2
D10S1248	7.31	16 17	14 17
D1S1656	3.21	12 14	14 15
D2S1338	4.47	19 24	19 24
Amelogenin		X Y	X Y

Interpretation:

Combined Paternity Index: **533,475**

Probability of Paternity: **99.9998%**

The alleged father is not excluded as the biological father of the tested child. Based on testing results obtained from analyses of the DNA loci listed, the probability of paternity is 99.9998%. This probability of paternity is calculated by comparing to an untested, unrelated, random individual of the Caucasian population (assumes prior probability equals 0.50).



# COLLECTION OF SAMPLES COMMONLY USED for DNA IN FORENSIC PRACTICE

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- ▶ **Liquid blood:** 2-5 ml of iv drawn blood in sterile, leak-proof, screw capped bottles containing heparin or EDTA along with an identification card.
- ▶ **Semen samples:** sterile cotton ear buds moistened with sterile water should be used to take swabs (from genital and other body parts) completely air dried, placed in sterile tubes, sealed and labelled.
- ▶ **Stains from crime scenes:** stains should be swabbed with cotton buds moistened with sterile water.



- 
- ▶ **Blood/semen from individuals under field conditions:** can be collected in a sterile tube and same should be spread on a sterile bandage cloth folded several times so as to absorb all the fluid, air dried, placed in a clean envelope, sealed labelled and sent to DNA lab at room temperature.
  - ▶ **Bones:** long and intact bones, e.g. femur /humerus are most suitable.
  - ▶ **Visceral samples:** Muscle is the most ideal source. Approx 100 gms in wt should be dissected out and placed in sterile glass tube containing normal saline as preservative. (Dimethyl sulphoxide/DMSO is a better preservative)



- 
- ▶ **In exhumation cases:** if dry tissue is present, should be placed in sterile bottle without preservative and sent to lab at room temperature.
  - ▶ **Teeth:** molar teeth are generally used. If not available, any other teeth may be used. For teeth and bones no preservative is required.
  - ▶ **Hair:** preferably with roots, to be packed in clean paper, sealed and sent at room temperature.
  - ▶ **Finger nail scrapings:** sterile needle or tooth pick to be used to scrape the inside of finger nails. Material should be collected in clean paper envelopes and sent to lab without preservatives.



# Benefit OF DNA AS AN EVIDENCE

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- ▶ Reliable
- ▶ Scientific
- ▶ Unbiased

*A man can lie but science doesn't.*



# Interpreting Results of DNA Analysis in Criminal Investigation

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- ▶ 1) Inclusion: When the DNA profile of a known individual (A victim or suspect) **matches** the DNA profile from the crime scene evidence, the individual is “included” as a potential source of that evidence.
  - ▶ 2) Exclusion: When the DNA profile from an individual (A victim or suspect) **does not match** the DNA profile generated from the crime scene evidence, the referenced individual is “excluded” as the donor of the evidence.
  - ▶ 3) Inconclusive: Inconclusive results indicate that DNA testing **did not produce information** that would allow an individual to be either included or excluded as the source of the biological evidence.
-

# Touch DNA

- ▶ **Touch DNA** is a forensic method for analysing DNA left at the scene of a crime.
- ▶ It is called "**touch DNA**" because it only requires very small samples, for example from skin cells left on an object after it has been touched or casually handled.
- ▶ The technique has dramatically increased the number of items of evidence that can be used for DNA detection.
- ▶ Touch DNA doesn't require you to see anything, or any blood or semen at all. It only requires seven or eight cells from the outermost layer of our skin.



# DNA AS AN EVIDENCE

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- ▶ Presence of an individual's DNA on an item does not prove their guilt;
- ▶ conversely, a lack of DNA does not necessarily prove their innocence.



# **ISSUES and LIMITATIONS Cons of DNA profiling as a Forensic Tool**

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- ▶ Tests unreliable if quantity is less or the sample is degraded.
- ▶ Cost effectiveness.
- ▶ Lack of qualified experts.
- ▶ New techniques of DP can give incorrect results due to errors like cross contamination




# DNA BILL PASSED In INDIA

Lok Sabha passes DNA tech...  
From thehindu.com – delivered by Goog

THE HINDU

NATIONAL


Lok Sabha passes DNA technology Bill



The Bill would allow use of DNA technology for establishing identity of persons like victims, offenders, suspects, undertrials, missing persons and unknown deceased persons. | Photo Credit: Reuters


Special Correspondent

NEW DELHI 08 JANUARY 2019 17:46 IST  
UPDATED: 08 JANUARY 2019 22:38 IST




Lok Sabha passes “The DNA Technology (Use and Application) Regulation Bill - 2019”

08 January 2019 | News



The purpose of this Bill is to expand the application of DNA-based forensic technologies to support and strengthen the justice delivery system of the country



The Lok Sabha has passed “The DNA Technology (Use and Application) Regulation Bill - 2019”. The Bill has been formulated recognizing the need for regulation of the use and application of Deoxyribonucleic Acid (DNA) technology, for establishing identity of missing persons, victims, offenders, under trials and unknown deceased persons.

The purpose of this Bill is to expand the application of DNA-based forensic technologies to support and strengthen the justice delivery system of the country. The

Lok Sabha gives consent to ...  
From m.economictimes.com – delivered

< Politics and Nation

Lok Sabha gives consent to DNA bill

By PTI | Updated: Jan 08, 2019, 04.06 PM IST





According to the government, the bill seeks to expand the application of DNA based forensic technologies to support and strengthen justice delivery system.

NEW DELHI: The Bill that provides for regulation of use and application of Deoxyribonucleic Acid (DNA) technology for establishing the identity of certain categories of persons, including offenders, victims, suspects and undertrials was passed in Lok Sabha Tuesday.

# FORENSIC MEDICINE

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- ▶ Deals with medical aspects of law

Everything to do with HUMAN BODY & Psyche( Living or Dead) By a medical man

- ▶ Injuries
- ▶ Sexual Assault
- ▶ Age estimation
- ▶ Clinical toxicology
- ▶ Dying declaration
- ▶ Certification for disability, mental illness etc
- ▶ AUTOPSY.





Sampling of body fluids



AUTOPSY



Medical documentation



Toxicology



Medical records



Injury Exam



Sexual assault Exam



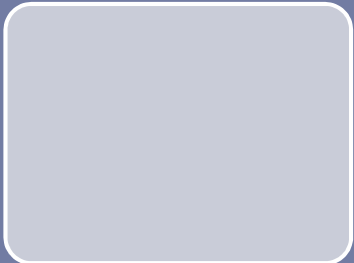
Drug abuse

# FORENSICS IN LIVING

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Injury examination



Examination of sexual  
assault cases



Age estimation



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# INJURY EXAMINATION

The Injury report is useful in investigation

- ▶ To know the type of weapon used
- ▶ To know the no. of assailants
- ▶ To know the type of hurt
- ▶ To match the injury with suspected weapon
- ▶ In cases involving sec 320-326 IPC.



# Examination of injury cases

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- ▶ Number
- ▶ Type of injury
- ▶ Site/location
- ▶ Size
- ▶ Any foreign body present
- ▶ Age of injury
- ▶ Manner of infliction
- ▶ Simple or grievous
- ▶ Antemortem/postmortem











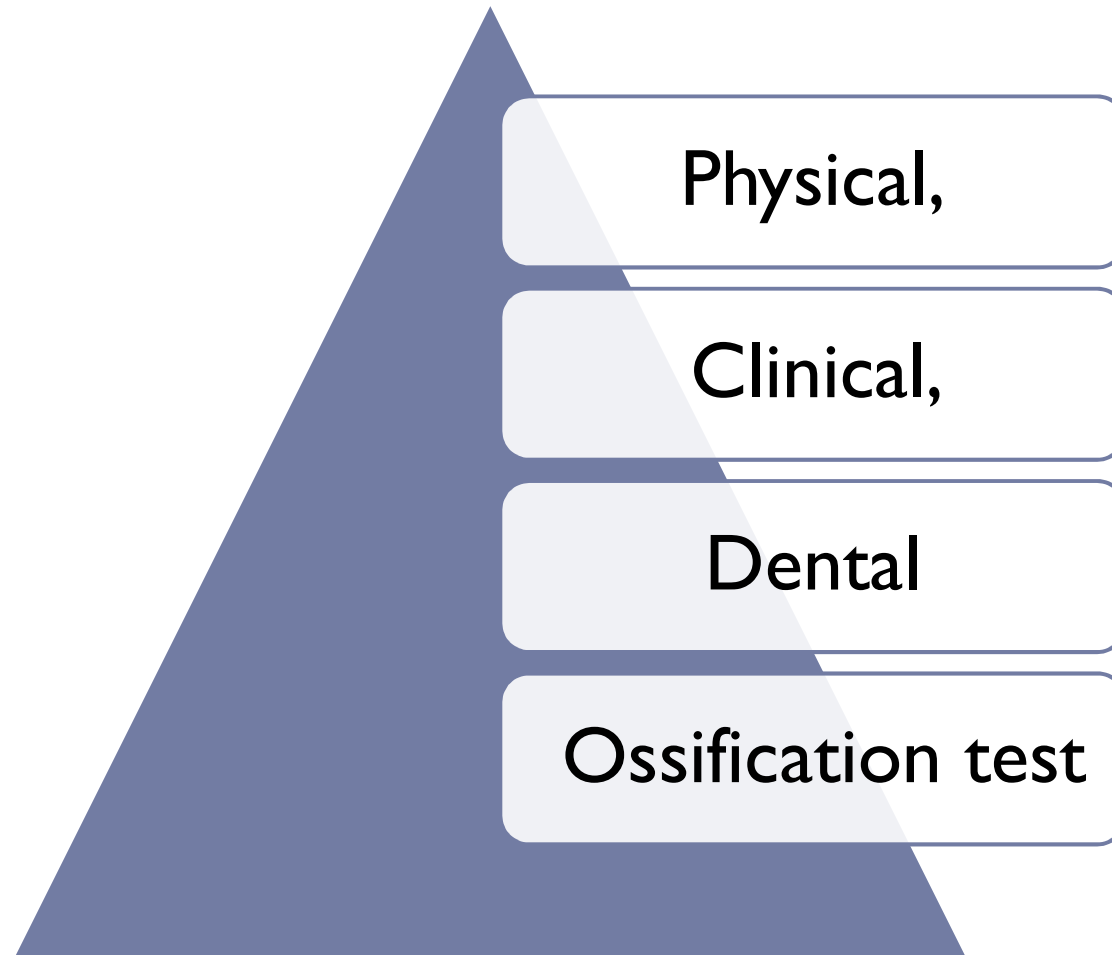






# AGE ESTIMATION

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# Dental

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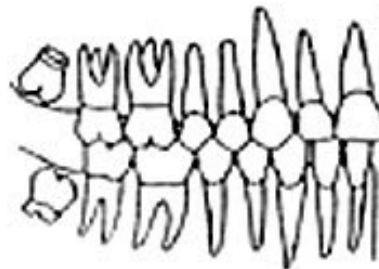
10 Years  
( $\pm 30$  months)



12 Years  
( $\pm 36$  months)



11 Years  
( $\pm 30$  months)



15 Years  
( $\pm 36$  months)



# Ossification Test

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**X-ray Shoulder Joint**



X-Ray showing non-fusion (Degree-0) of the epiphyses at the elbow joint.

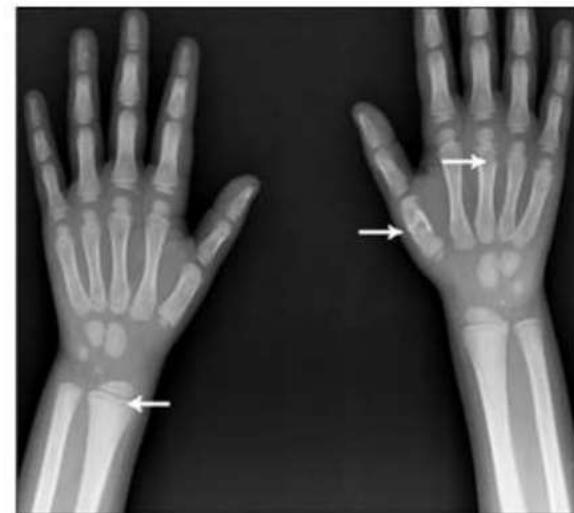


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**Hip Joint (X-ray AP View)**

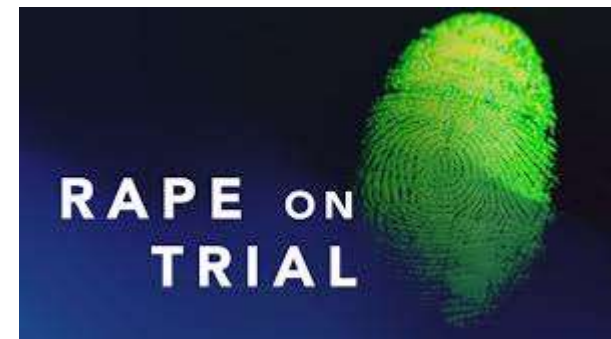
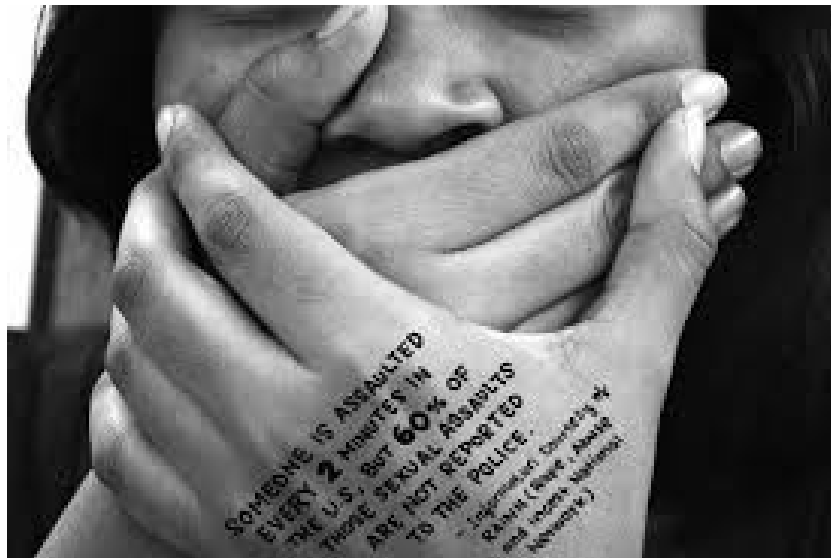


**Wrist Joint and Hand**



# EXAMINATION OF SEXUAL ASSAULT

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# AUTOPSY



# Examination of bones

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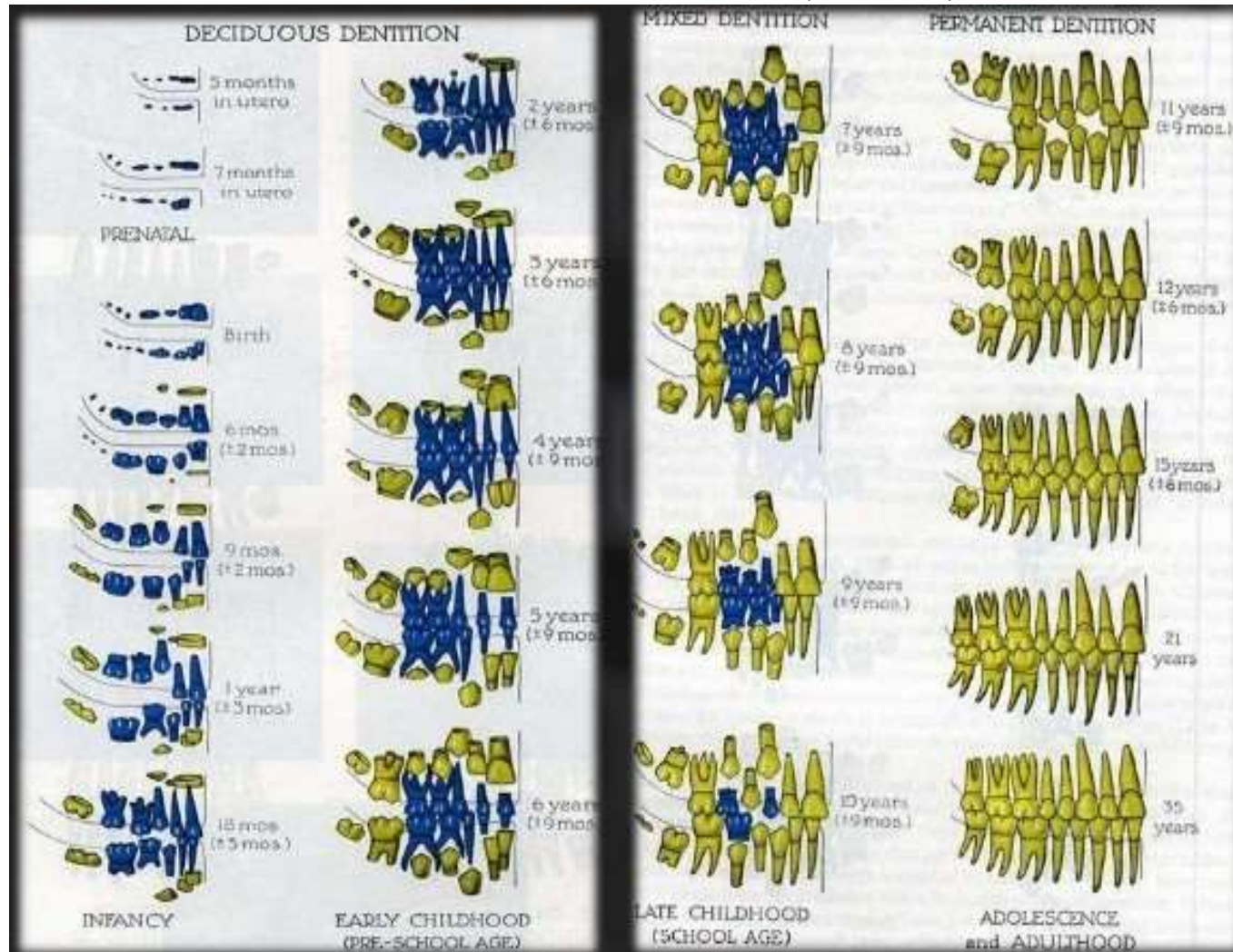
- ▶ Are they really bones?
- ▶ Are the remains human or animal?
- ▶ How many individual?
- ▶ How long dead? -Recent or old
- ▶ Cause of death?
- ▶ Time since death?



- ▶ What is the race of the individual?
- ▶ What is the sex of the individual?
- ▶ What is the age of the individual?
- ▶ What is the stature of the individual?
- ▶ What traumas did the individual have?
- ▶ What individual traits did the individual have?



# SCHOUR AND MASSLER METHOD (1941)



They studied the development of deciduous and permanent dentition describing 21 chronological steps from 4 months to 21 years of age.

The chart do not have separate survey for male and female.

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# GUSTAFSON'S METHOD

Gustafson (1950) and Thoma (1944)

- ▶ He described the age changes occurring in the dental tissues and recorded six changes.





**A** - Attrition of incisal/occlusal surface



**P** – Periodontitis

**S** – Secondary dentin

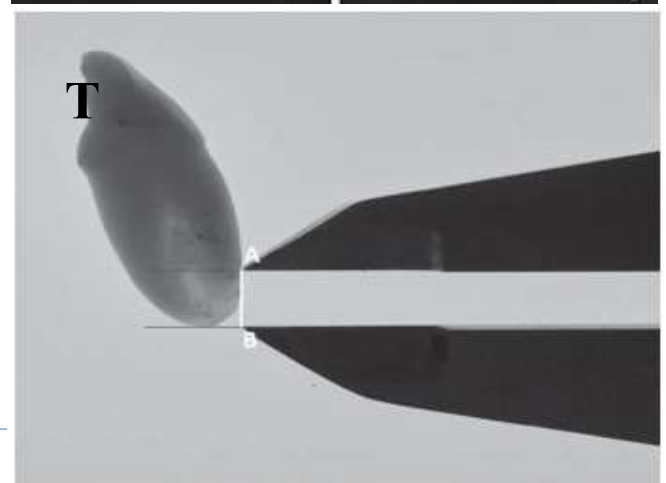
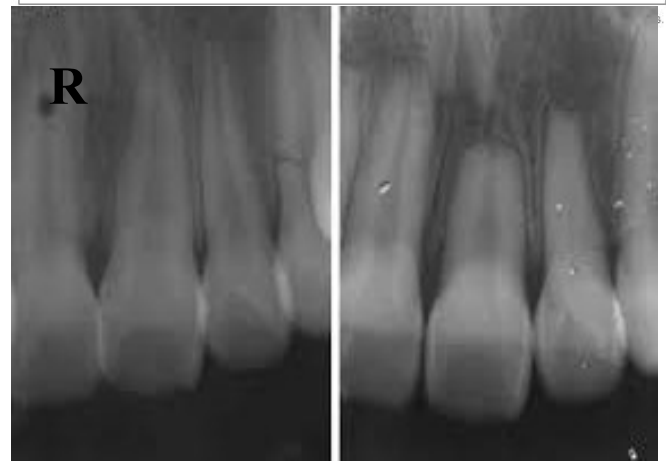
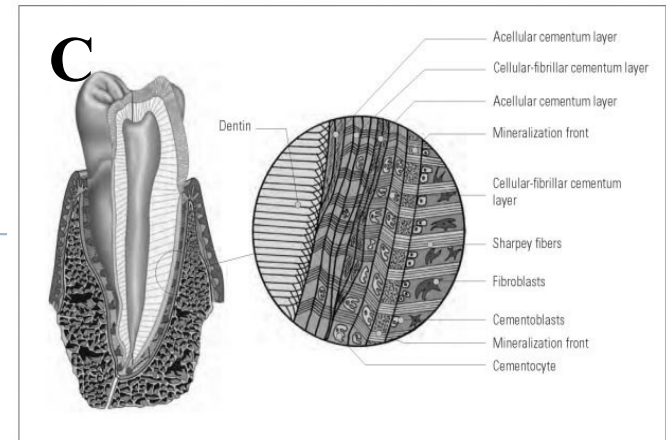
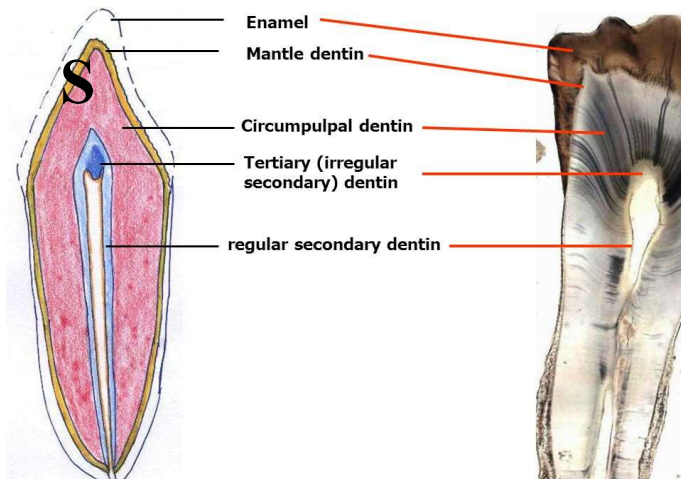
**C** – Cementum apposition

**R** – Root resorption

**C** – Cementum apposition

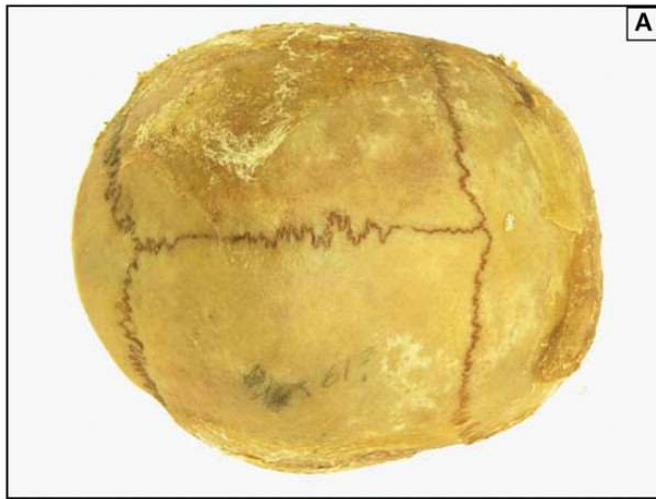
**R** – Root resorption

**T** – Root transparency



# Age from skull sutures

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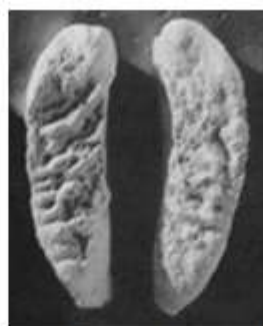




Stage 1: 18-19 years old



Stage 2: 20-21 years old



Stage 3: 22-24 years old



Stage 4: 25-26 years old



Stage 5: 27-30 years old



Stage 6: 30-35 years old



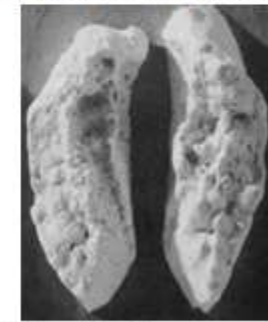
Stage 7: 35-39 years old



Stage 8: 39-44 years old



Stage 9: 44-50 years old



Stage 10: 50+ years old

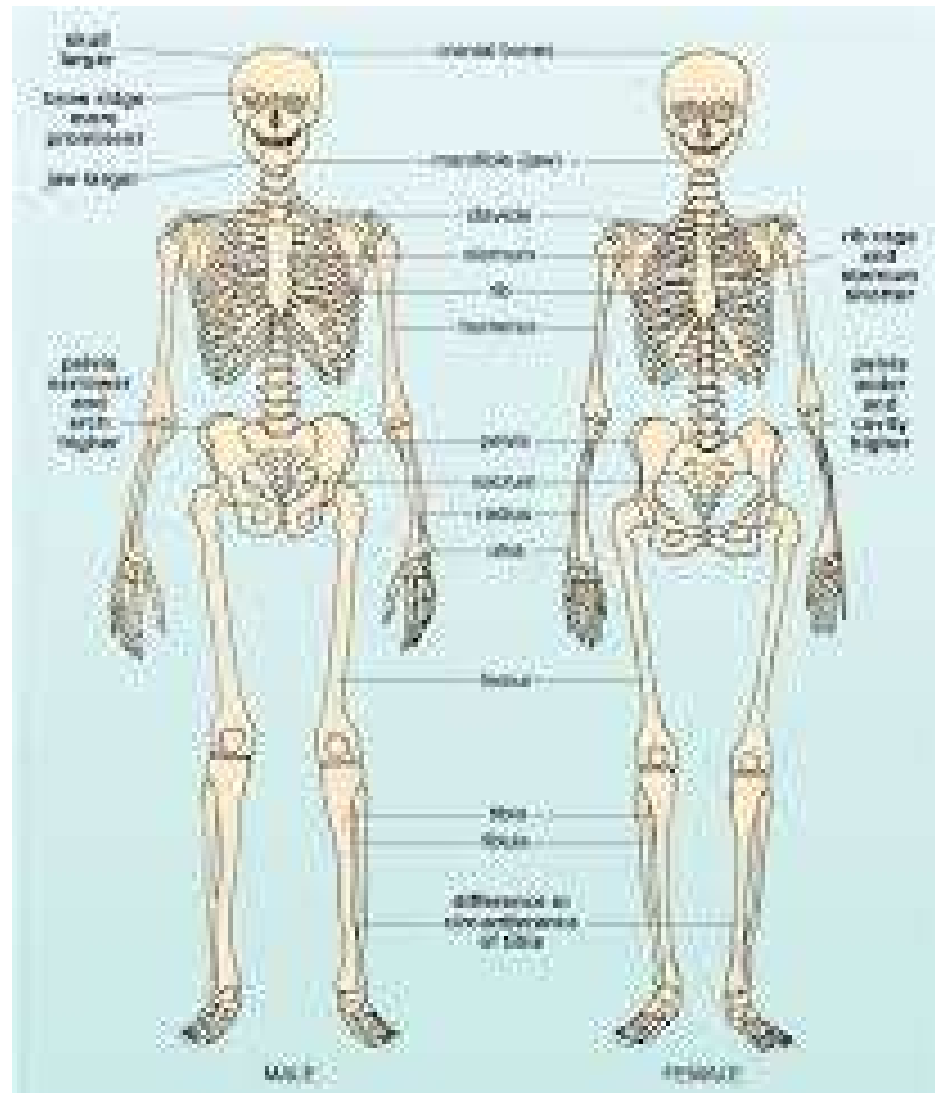
Todd's (1920) ten age phases of pubic symphysis modification in adult white males.

© Pieter Folkens

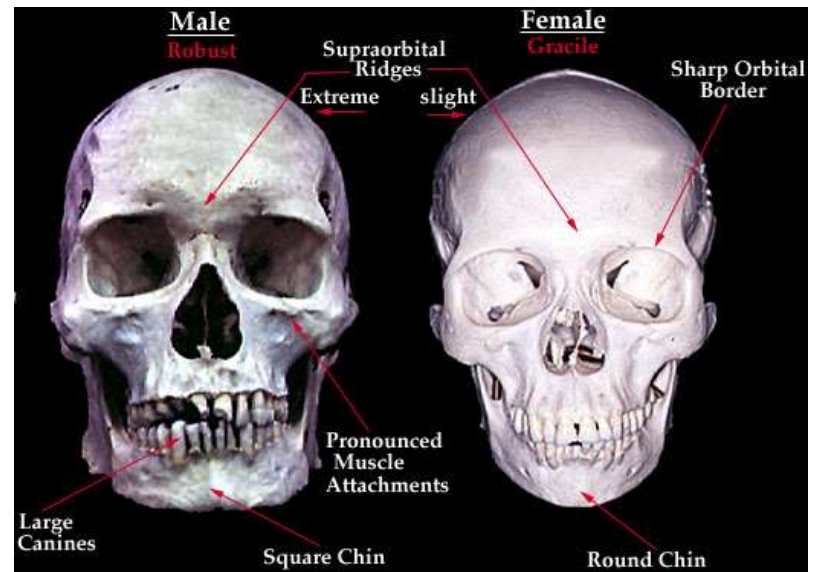
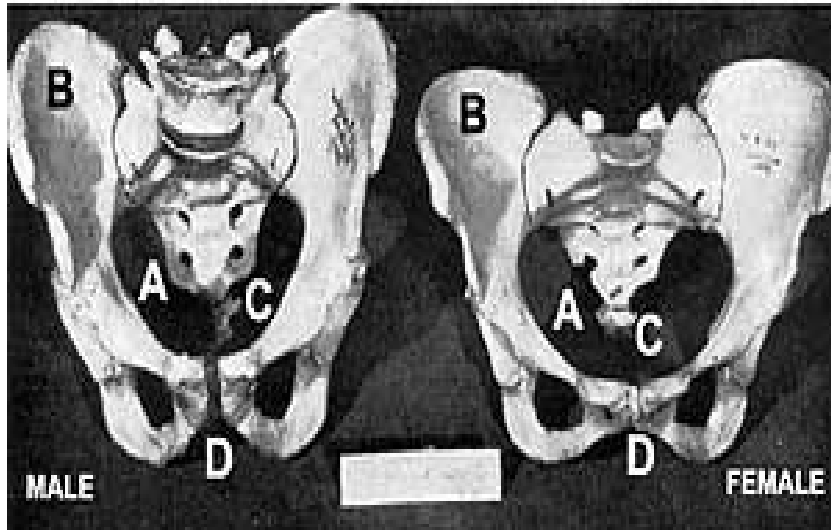


© Pieter Folkens

## ► DETERMINATION OF SEX



# Sex

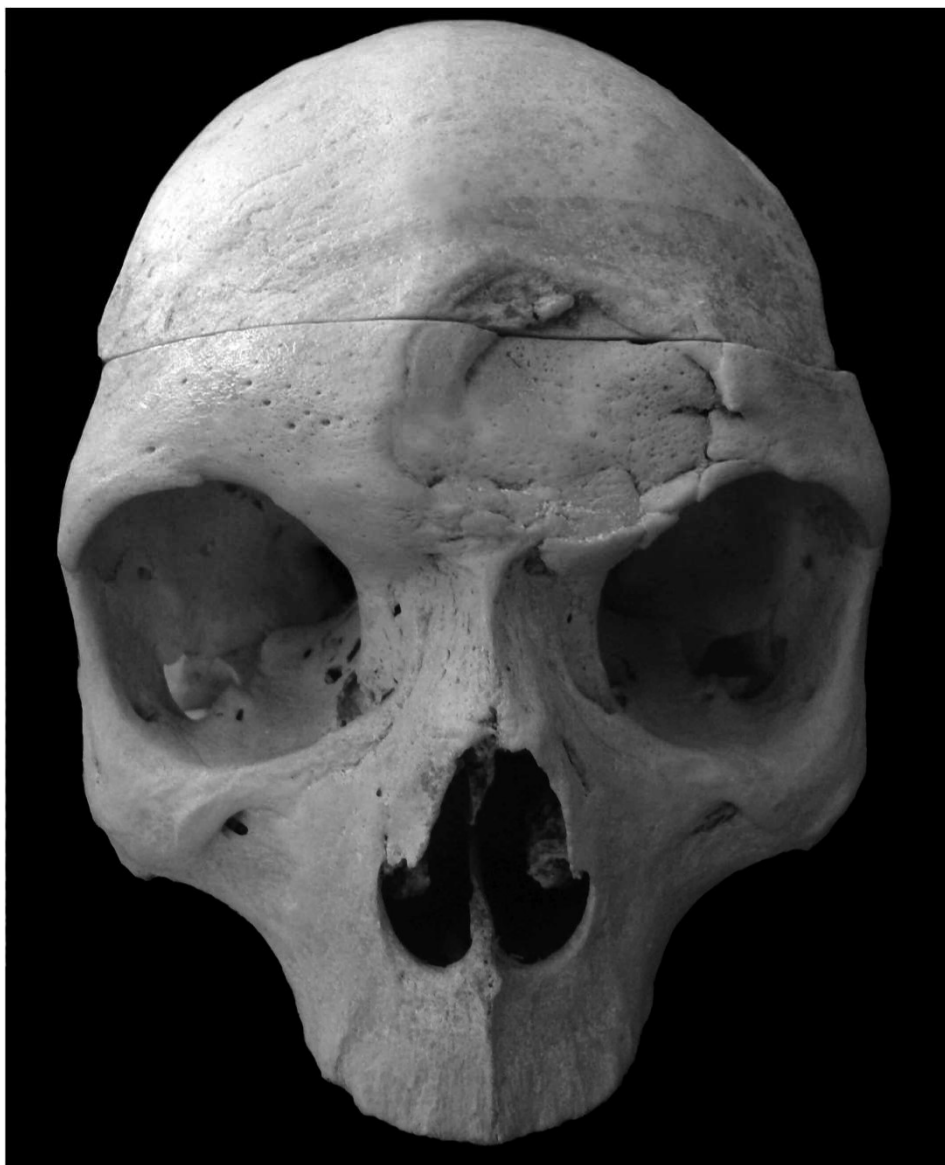


# Perimortem Injuries

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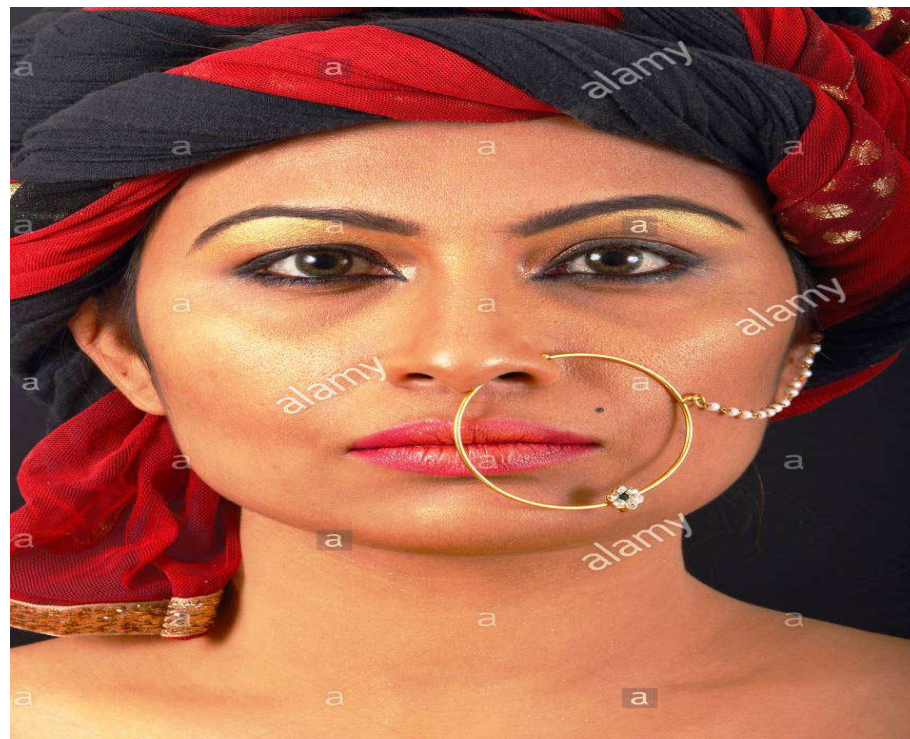
Injury occurred at or around the time of death and may have even caused the death



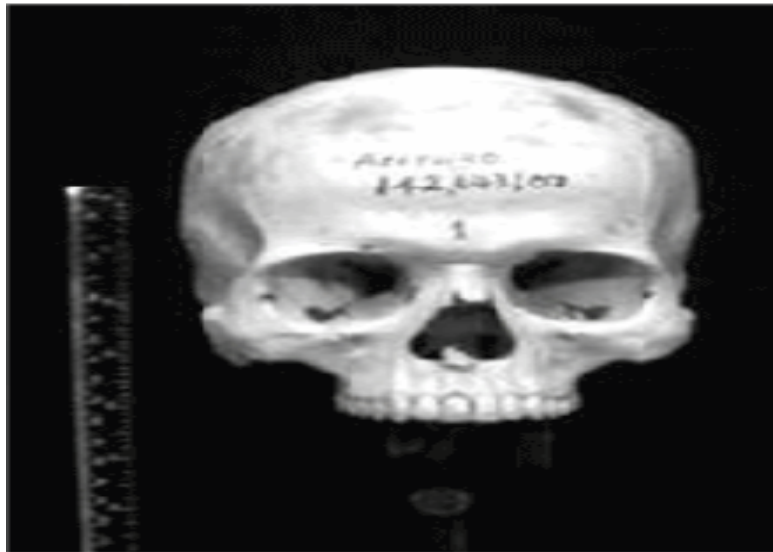




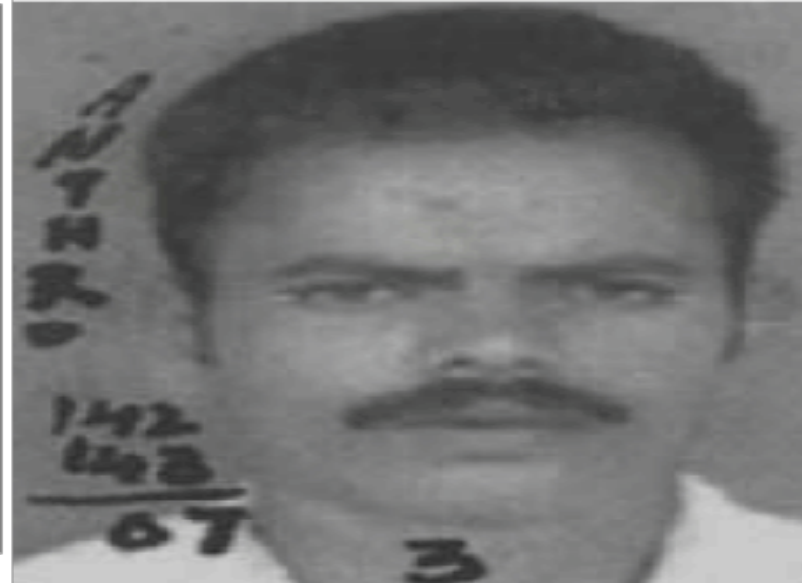
Enlarge



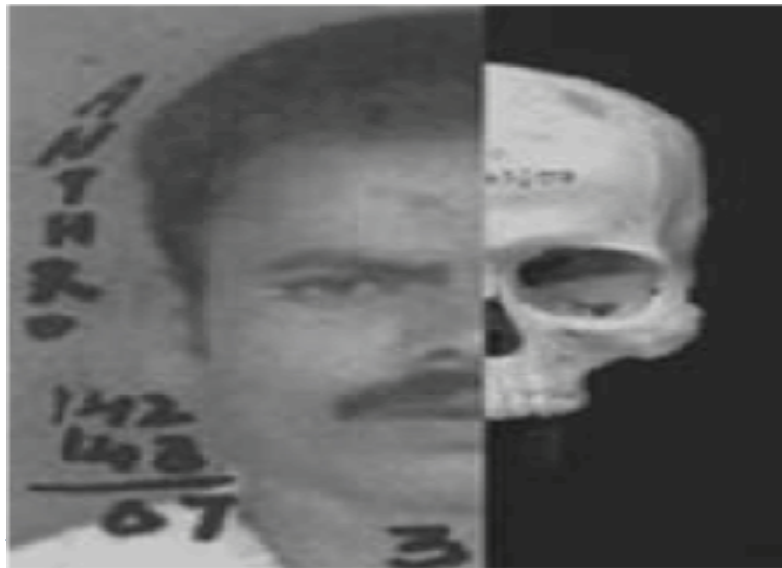
## Skull-Photograph Superimposition



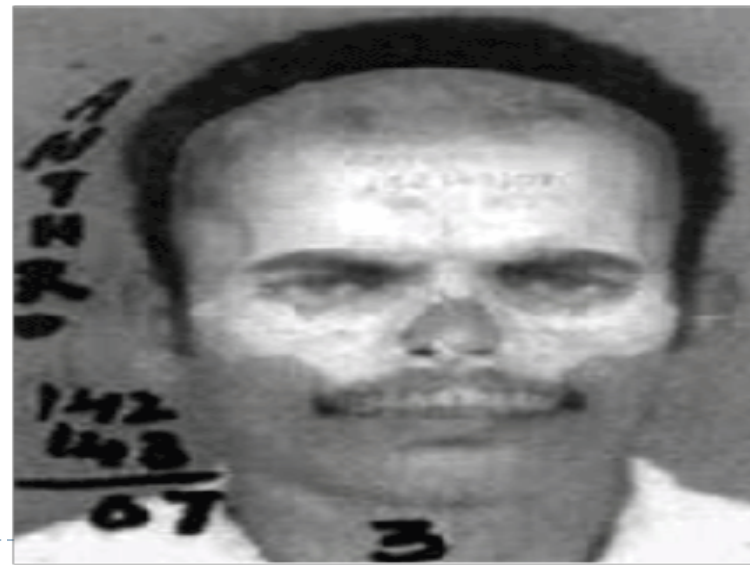
1. (a) Skull



1.(b) Photograph



1.(c) Wiped image



1.(d) Mixed image

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**DEAD MEN TELL TALES .....  
YOU NEED AN EAR TO HEAR  
THEM!**



# Reasons for reluctance of courts to use Forensic evidence

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## 1. Mismanagement of Forensic evidence

- Ignorance
- Improper collection
- Improper preservation
- Non collection of clue evidence
- Non maintenance of chain of custody
- Delayed dispatch for analysis



## **2. Not sending the accused for Medico-legal examination**

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- ▶ Non lifting of fingerprints or evidences (especially biological) by I.O.
- ▶ Non preservation of seized material.

## **3. Technical lacunae in scientific evidence**

- ▶ Test not done meticulously.
- ▶ No supportive data provided by expert
- ▶ Delayed examination by the expert.
- ▶ Delayed Report writing



## Limitations of Forensic evidences

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- ▶ Probative value is more rather than corroborative value in crime in dealing with circumstantial evidence
- ▶ More often comparative rather than absolute...
- ▶ Based on facts and its interpretation.



# To Summarise

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Forensic evidence is either dealt by scientist or medical person depending on type of evidence.

Forensic evidence is based on Locard's principal of exchange

Forensic evidence is factual and is thus unbiased.

Forensic evidences have their limitations as it is scientific .....



Thank  
you

