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Review of FORENSIC MEDICINE

Authors

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Highlights

- Most of the questions in each section are new and self-designed
- "The Quick Pills" in each chapter
- Flowchart presentation of the chapters at the end of section for Quick Revision
- "Mnemonics" in the appropriate places of each chapter to help retain the "volatile content" for longer duration
- Golden points with images
- "Recent changes in law"- not updated in textbooks. The contents of recent laws are depicted in concise manner.

Latest Exam Pattern Questions Upto 2019

AIIMS (Nov 2018–2000)

PGI Chandigarh (Nov 2018–2000)

NEET-AIPGMEE (2019–1991)

DNB (2018–2000)

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Most Important ★★★★★
Very Important ★★★★
Important ★★★

4

CHAPTER

Identification



Fixing the identity of a person has an immense medico-legal importance both in living as well as dead individuals. The different identification data which are taken into consideration for exact fixation of an Individual are:

- Age, sex
- Race and religion
- External peculiarities like moles, scars, tattoo mark, wounds, occupation marks.
- General development, complexion and stature
- Anthropometric measurements (**Bertillion system**)
- Finger prints (**Galton system**) and foot prints (**podogram**)
- Teeth
- Extra data for living individuals only are handwriting, speech & voice, gait, memory.

RACE

Race can be determined by:

- **Complexion:** Black (negro), white (caucasoids), yellow (mongoloid)
- **Eyes:** Blue color in caucasoids
- Different features in **skull** as described below:
  - **Palate**: Triangular (caucasoid), rounded (mongoloid), rectangular (negro)
  - **Orbit**: Triangular (caucasoid), rounded (mongol), square (negro)
  - **Nasal aperture**: Elongated (caucasoid), rounded (mongol), broad (negro)
  - **Cephalic index** (CI)= Maximum breadth of skull/ maximum length of skull × 100. Based on cephalic index, three types of skull (**DUMB**) are found:

    Dolicho-cephalic: CI is 70–74.9%. It is seen in early fusion of **sagittal suture**, e.g. Negro and pure Aryans

    Mesaticephalic: CI is 75–79.9%. **Indians are mesaticephalic.**

    Brachycephalic: CI is 80-85%. It is seen in mongoloids (**maximum C.I**). It is because of early fusion of **coronal suture**, e.g. Americans and Japanese

Other indices from long bones helpful in determination of race are:

Brachial index: Radius/Humerus × 100

Crural index: Tibia/Femur × 100

Humerofemoral: Humerus/femur × 100

Intermembral index: (Length of humerus +Radius)/ (Length of Femur + Tibia) × 100

Race from Hairs

Mongoloids

- Round in cross-section with thick cuticle
- Medulla is non-fragmented

Caucasoids

- Oval shaped in cross-section with medium cuticle
- Medulla is fragmented

Negroids

- Kidney shaped in cross-section and cuticle is absent
- Medulla is fragmented.

Race from Teeth

- **Caucasoids:** Carabelli's cusps (small nodules at lingual surface of maxillary molars).
- **Mongoloids:** Shovel shaped teeth (central depression with marginal ridges on posterior surface of upper central incisors)

  Congenital lack of upper 3rd molars
  Enamel pearls on premolars
  Taurodontism (Bull Tooth)
  Long pointed canine
- **Negroid:**

  Large teeth with more cusps in their molars
  Two lingual cusps on first premolars of lower jaw.

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SEXUAL DIFFERENTIATION

Sex of a person can be determined on the basis of:

- External morphology
- Sex chromatin
- Sexing of skeletal remains in dead.
- Gonadal biopsy (**confirmatory method**).

External Morphology

- Hairs on face and chest, greater muscular built, presence of penis are suggestive of male sex.
- Absence of hairs on face and chest with long and thin scalp hairs, well developed breast, presence of vaginal and uterus are suggestive of female sex.
- More conclusive is presence of testis in male and ovaries in female.

In normal cases the sex determination is easy from external examination only, but it is difficult in cases of (1) hermaphroditism (2) concealed sex (3) advanced decomposition and (4) skeleton.

Intersex

It is the condition of intermingling of sexual characteristics, such as physical, reproductive and sexual behaviors, in varying degree in one individual. Some defect during embryonic stage leads to development of intersex. It is of 4 types:

- **Gonadal agenesis**: Gonads are not developed, nuclear sex is negative.
- **Gonadal dysgenesis**: External sexual structures are present but gonads fail to develop at puberty, e.g. Klinefelter's syndrome, Turner's syndrome.
- **True hermaphroditism**: Bisexuality in which an ovary and a testis or two ovo-testis are present with the external genitalia of both sexes.
- **Pseudohermaphroditism**: Here gonadal tissue is of one sex and external appearance is of the opposite sex.

It is of 2 types:

1. **Male pseudohermaphroditism** (nuclear sex is XY, anatomical sex is female) e.g. 5-alpha-reductase inhibitors, testicular feminization.
2. **Female pseudohermaphroditism** (nuclear sex is XX, anatomical sex is male). e.g. congenital adrenal hyperplasia(**CAH**).

Sex chromatin: sex from the chromatin can be determined by:

- **Barr body**: It is the inactivated X-chromosome, present in female sex. Buccal smear, saliva, hair follicles are used in detection of Barr body. It is present in 20–80% cells of buccal smear in female and 0 to 4% cells in male. This Barr body is a planoconvex mass lying near nuclear membrane.
- **Davidson-Smith body**: Small nuclear appendage present in Neutrophils in the female in about 6% cases. Appeared as a small nuclear **drumstick shaped** lobe in the nucleus.
- **Feulgen reaction**: This reaction using a stain called **acriflavin Schiff reagent** which stain **X- chromosome**, seen as a bright yellow fluorescent bodies found in 50 to 70% of cells in female, and 0 to 2% in males.
- **Quinacrine staining**: quinacrine dihydrochloride is a dye used to **stain Y chromosome**. The percentage of quinacrine positive bodies ranges from 45 to 80% in male, and 0 to 4% in female.

Sexing from skeletal remains: According to **Krogman**, the degree of accuracy in sexing adult skeletal remains is:

- Entire skeleton: 100%
- Pelvis and skull: 98%
- Pelvis alone: 95%
- Skull alone: 90%
- Long bones alone: 80% (medullary index of long bones can be used for determination of sex. Diameter of medulla/diameter of whole bones × 100)

Sexual Dimorphism of Skeletal Remains (From Head to Toe)

Trait	*Male*	*Female*
Gross	Prominent muscular marking and heavy	Less prominent and light
Forehead	Slopping and less rounded	Vertical and more rounded
Glabella	More prominent	Smooth or absent
Supraorbital ridge	More prominent	Not marked
Orbits	Square	Rounded
Fronto-nasal angulation	Distinct	Smoothly curved
Zygomatic arch	More prominent	Less prominent

Contd...

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Trait	*Male*	*Female*
Palate	Large, U–shaped	Small, parabola
Frontal and parietal eminences	Small	Large
Frontal sinuses	Much developed	Less developed
Mastoid process and diagastric groove	Large, deep	Small, less deep
Occipital condyle	Large	Small
Mandible		
Chin	Square	Rounded
Anatomical angle	Less obtuse and everted	More obtuse and inverted
Mental tubercle	Large and prominent	Insignificant
Ascending ramus	Greater breadth	Smaller breadth
Condyles	Larger	Smaller
Sternum		
Ashley's rule	Length of sternum is >149 mm	<149 mm
Hyrtl's law	Body is longer and more than twice the length of manubium	Body is shorter and less than twice the length of manubrium
Sternal index (length of manubrium/length of body)	46.2	54.3
Pelvis		
Shape	Deep funnel shaped with heart shaped inlet	Flat bowl shaped with circular inlet
Subpubic angle	Acute (70-75^0)	Obtuse (90- 100^0)
Obturator foramen	Oval	Triangular
Greater sciatic notch	Smaller, narrow, deeper	Large, wider, shallow
Sciatic notch index(width/depth) × 100	145	166
Acetabulum	Larger (52 mm)	Small (46 mm)
Ischial tuberosity	Inverted	Everted
Ischiopubic index (pubis length/ischium length) × 100	73 to 94	91 to 115
Preauricular sulcus	Not frequent	Frequent
Chilotic line	Sacral part is more	Pelvic part is more
Chilotic line index: (sacral part/pelvic part) × 100	>100	<100
Sacrum		
Shape	Long and narrow	Short and broad
Articulation	2.5 and 3 vertebrae	2 to 2.5 vertebrae
Corporobasal index (breadth of 1st sacral vertebra/breadth of base of sacrum) x 100	45	40.5

- Best bone for determination of sex is **pelvis**
- **Chilotic line** is useful in determination of sex (Male—Sacral part of chilotic Line more prominent (**MS**), Female —Pelvis part of Chilotic line more prominent)
- **Greater sciatic notch** in the pelvis is the ideal feature to determine sex of a female child.
- Pre-auricular Sulcus is a Tertiary sexual characteristic.
- **Corpo-basal index** is more in males.[Q]

AGE

It can be determined from:

- General development and secondary sexual characteristics
- Teeth
- Ossification of bones

Greater importance should be given to ossification of bones, followed by teeth and then physical findings while calculating the age of a person.

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1. Secondary Sex Characters (Marshal and Tanner Criteria)

In males— The sequence is increase size of testis and penis followed by pubic hairs, then growth spurt, then mustache, axillary hairs.

Sequence of development of secondary sexual character (**TPGMA—Sequence to remember)**

- Size of testes and penis[Q]
- Appearance of pubic hairs
- Growth spurt
- Moustache
- Axillary hairs/beard

In females—Thelarche (breast development), pubarche, growth spurt, menarache, finally axillary hairs.

In Females

- At 13-14 years—breast begins to develop, hair on mons veneris. Sequence of development of secondary sexual characters in females.
- **TPGMA—Sequence to remember[Q]**
  - Thelarche (Beginning of breast development)
  - Pubarche
  - Growth spur
  - Menarache
  - Axillary hairs

2. Teeth

Useful for age estimation by:

- Stage of development
- Secondary changes
- Aspartic acid racemization

Stage of Development

- Temporary or deciduous teeth are 20 in number—4 incisors, 2 canines and 4 molars in each jaw.
- Sequence of eruption of temporary teeth are **IMCM (Incisor, molar, canine and Molar-first lower central incisor** at 6 month and all 20 teeth by 2.5—3 years)
- In ill-nourished children and in rickets, dentition may be delayed but in Syphilis, dentition appears early or, even present at birth (**Hutchinson-Boeck Teeth**)

Mama	*Molar, 1st*
Is	Incisor, 1st
In	Incisor, 2nd
Pain	Premolar, 1st

Papa	*Premolar, 2nd*
Can	Canine
Make	Molar, 2nd
Medicine	Molar, 3rd

- The first temporary tooth to erupt is **lower central incisor**.
- All teeth erupt first in the lower jaw except **lateral incisor** which erupts first in upper jaw.
- The eruption of temporary teeth is completed by **2 to 2.5 years** and temporary teeth begins to be replaced by permanent teeth at about 6 to 7 years after the eruption of first permanent molar.
- **Last temporary tooth to fall is canine.**

Age	*Total number of teeth*
2.5–5 years	20
6–11 years	24 (addition of first molar in each quadrant)
12–17 years	28 (addition of second molar in each quadrant)
Above 18 years	32 (addition of third molar in each quadrant)

Temporary Dentition

Dentition	*Average age of eruption (months)*	*Age in ranges (months)*
Lower central incisor	6	6–8
Upper central incisor	7	7–9
Upper lateral incisor	8	7–9
Lower lateral incisor	9	10–12
First molar	12	12–14
Canine	18	17–19
Second molar	24	20–30

The **replacement of temporary teeth** by permanent teeth is **completed** at the age of 11 years after the eruption of **canines**. Hence, during the age between **6 to 11 years**, both temporary and permanent teeth are present in jaws called age of **mixed dentition**. During this age of mixed dentition the **total number of teeth remains 24**.

Formula to calculate total number of permanent teeth in oral cavity from age in mixed dentition period: No of permanent teeth= **(Age in years – 5) × 4**.

Based on development and eruption, the permanent teeth are of two types, i.e. successional and superadded.

- **Superadded teeth** don't have deciduous predecessors and six in each jaw, e.g. all permanent molars.
- **Successional teeth** are erupted in place of deciduous teeth and ten in each jaw, e.g. all other teeth except permanent molars.

Difference between temporary and permanent teeth are

Trait	*Temporary teeth*	*Permanent teeth*
Size	Smaller and lighter	Heavier and stronger
Crown	China white in color	Ivory-white
Neck	More constricted	Less constricted
Root	Smaller and more divergent	Larger and less divergent
Ridge	At the junction of crown with fangs present	No ridge

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Permanent Dentition

Dentition	Average age of eruption (years)	Age in ranges (years)
First molar (first to erupt)	6	6–7
Lower central incisor	7	6–8
Upper central incisor	8	7–9
Upper lateral incisor	9	9–11
Lower lateral incisor	10	10–12
First molar	11	11–12
Canine	12	12–14
Second molar	18	17–25

(DEMIRJIAN METHOD is the most suitable method for estimating age using third molar)

Secondary Changes in Teeth

Based on the physiological changes in the dental tissue, age of a person can be determined. For this **anterior teeth are preferred over posterior teeth,** i.e preference decreases from incisors to premolars, **3rd molar is least preferred tooth**. The method is:

Gustafson's Method

It is helpful for age estimation of adult over 25 years. Anterior teeth are more reliable than posterior in this method. **(incisors are mostly suitable, 3rd molar is unsuitable).** The various criteria are:

- **Attrition**: wear and tear
- **Periodontosis:** regression of gum margin
- **Secondary dentin:** deposition of dentin in the pulp cavity (**2nd most reliable criteria**)
- **Cementum apposition:** apposition of cementum at and around the root of teeth.
- **Root resorption:** resorption due to aging
- **Transparency of root:** transparency of dentin at root level. (**Most reliable criteria**, seen **after 30 years** of age. **Error increases after 50 years)**

Mnemonics

SCRIPT
S= Secondary dentine,
C= Cementum apposition,
R= Root resorption,
I= attrition,
P= Parodontosis,
T= Translucency (most reliable)

Boyde's Method

- It is useful to estimate the age of a **dead infant** by **counting the number of incremental lines** from neonatal lines onwards in the enamel of tooth.
- Neonatal line is noted in **about 3 weeks**.
- Age determined in terms of days.

Stack's Method

- Age of a child is calculated by measuring the weight and height of the erupting teeth.

Daliz method: It is a modification of Gustafson's method.

Miles' method: By assessing the wear and tear on all three permanent molars.

Lamendin method: Gum regression and transparency of root are taken to consideration for age estimation. It is also a postmortem procedure.

Methods of Dental Charting

Different methods are used to represent the teeth in both jaws in an individual. The methods are:

a. Universal

Right	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Left
	32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	

b. Palmer's notation (each quadrant number to 1 to 8)

Right	8	7	6	5	4	3	2	1	1	2	3	4	5	6	7	8	Left
	8	7	6	5	4	3	2	1	1	2	3	4	5	6	7	8	

c. Haderup system [(+) sign for upper jawteeth), (–) sign for lower jaw teeth.]

Right	+8	+7	+6	+5	+4	+3	+2	+1	+1	+2	+3	+4	+5	+6	+7	+8	Left
	+8	+7	+6	+5	+4	+3	+2	+1	+1	+2	+3	+4	+5	+6	+7	+8	

d. FDI (Put quadrant number before teeth number)

Right	1	2	Left
	4	3	

Right	18	17	16	15	14	13	12	11	21	22	23	24	25	26	27	38	Left
	48	47	46	45	44	43	42	41	31	32	33	34	35	36	37	38	

e. Modified FDI (put quadrant number before teeth number)

Quadrant

Right	1	2	Left
	3	4	

Right	18	17	16	15	14	13	12	11	21	22	23	24	25	26	27	28	Left
	38	37	36	35	34	33	32	31	41	42	43	44	45	46	47	48	

f. Diagrammatic or anatomical charting

3. Ossification of Bones

Age estimation from bones can be possible by studying the appearance of centers of ossification as well as their

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fusions. The numbers of ossification centers present with respect to age are:

Age	Bone centers
11th week IUL	806
Birth	450
Adults	206

- The **earliest centers** of ossification appear at the end of 2nd month of pregnancy for clavicle and mandible.

Mnemonics for Ossification center:

CaSt Takes SaFe Cushion—Intrauterine life
- Clavicle (5 to 6 weeks)—first month
- Calcaneum—5 months
- sternum (2nd and 3rd piece of body)—7 months
- Talus—7 months
- Sacrum—8 months
- Lower end of femur—9 months
- Cuboid—10 months

- Between **2 to 6 years**, the number of carpal bones present on X-ray indicates the approximate age in years. The earliest carpal bone to ossify is capitate (2 months) and last one is pisiform (9 to 12 years).
- Epiphyseal fusion in cartilaginous bone occurs by about one year earlier in female than male except suture closure of the skull bones which is earlier in male.
- **Pubic symphysis** is the single best criterion for determining age from third to fifth decades of life.
- All sacral vertebrae fused and the sacrum becomes a single bone between 21 and 25 years.

Different methods for determination of bone age
- **Quantitative methods**: are very penetrating; so not often used
- **Qualitative methods**: Greulich and Pyle Atlas (most commonly used) and Taner- whitehouse (Most accurate) methods.
- **Index method**: Numerical scoring is given for each step of ossification.

- **Sternum**: Four pieces of the body of sternum fuses with one another from below upwards between 14 to 25 years. Xiphoid unites with body at about 40 years and manubrium with body at about 60 years.
- **Hyoid**: Greater cornu of hyoid with body in between 40 to 60 years. Hence hyoid bone fracture in throttling is more common in old age person.
- **Sacrum**: Five segments of sacrum becomes a single bone between 20 to 25 years.
- **Mandible**: Two halves of the mandible unites at center at the age of 2 years.
- **Skull**:
  - Posterior fontanelles closes at birth while anterior fontanelles at 18 months.
  - Inner tables of the skull fuse 5 to 10 years earlier than outer tables.
  - Metopic suture, separating two halves of frontal bones, closes at 2 to 4 years which may extend to 6 years.
  - The basiocciput fuses with basisphenoid at about 18–21 years.
  - The cranial sutures most successfully estimate the age of an individual is sagittal suture, followed by lambdoid and then coronal sutures.
  - Closure of all sutures indicates an age more than 60 years.
  - **Masto-occipital suture** is the last to close.
  - **Lateral head skiagram** is used to observe skull sutures.
  - Ages of closure of various sutures.

Suture	*Commencement*	*Halfway closed*	*Termination*
Spino-occipital	20	40	65 years
Coronal	25	30	40 years
Sagittal	25	30	40 years
Lambdoid	25	30	45 years
Pterion	40		65 years
Masto-occipital	45		80 years

AGE OF THE FETUS

Rule of Haase

A rough method of calculating the age of the fetus:
- **Up to 5 months** age of fetus = √ length (in cm)
- **>5 months:** (length (in cm)/5) = months

It is also known as - **(Morrison's modification of Hasse's Rule)**

Weeks of gestation	*Features*
4 weeks	Length: 1 cm, weight: 2.5 g Eyes are seen as 2 dark spots and mouth as cleft
8 weeks	Length: 4 cm, weight: 10 g Eyes and nose recognizable, hands and feet are webbed. Anus is seen as dark spot. Placenta is formed.
12 weeks	Length: 9 cm, weight: 30 g Eyes are closed and pupillary membrane appears, nails appear, neck is formed
16 weeks	Length: 16 cm, weight: 120 g **Sex can be recognized**; lanugo hair is visible on body; pupillary membrane is visible and meconium is seen in the upper part of small intestine
20 weeks	Length: 25 cm, weight: 400 g

Contd...

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Weeks of gestation	Features
	Nails are distinct and soft, vemix caseosa appears on the body. Fine hair on scalp, meconium at the beginning of large intestine
	Center of ossification for calcaneum appears
24 weeks	Length: 30 cm weight: 700 g, foot length: 4.5 cm
	Eyebrow and eyelashes appear, eyelids are adherent and papillary membrane is still present; skin is red and wrinkled for want of fact; testes are close to kidneys and scrotum is empty; meconium is seen in upper part of large intestine.
28 weeks	Length: 35 cm, weight: 900-1200 g, crown-rump: 23–25 cm, foot length: 5.4 cm
	Eyelids are open, pupillary membrane disappears; nails are thick, but do not extend to the tips of fingers and toes; skin is dusky-red, thick and fibrous; meconium present in entire large intestine.
	Center of ossification for talus appears
32 weeks	Length: 40 cm, weight: 1–15 kg, foot length: 6.4 cm
	Scalp hair is thick; nail's reach the tips of fingers, skin is not wrinkled; lanugo hair on face; left testes in scrotum, right tests near the external inguinal ring
36 weeks	Length: 45 cm, weight: 2.5-3 kg, foot length: 7 cm

Contd...

Contd...

Weeks of gestation	Features
	Scalp is covered with dark hair; lanugo hair is seen only in shoulders; vernix caseosa is present over the flexures of joints and neck folds; scrotum is wrinkled and contains both testes. In females, vulval labia close vaginal opening. Meconium is near the end of large intestine.
	Ossification centers for lower end of femur (36-37 weeks), cuboid and capitate appear
40 weeks (full term)	Length: 50-53 cm, weight: 3-3.5 kg crown-rump: 28-32 cm, foot length: 8.25 cm
	Lanugo hair is seen only in shoulders; nails project beyond fignertips, but reach only the tip to toes; rectum contains dark green or black meconium; six fontanelles are present. Umbilicus is midway between xiphisternum and symphysis pubis.
	Center of ossification for upper end of tibia appears (38-40 weeks)

Joints	Approximate age of fusion
Shoulder joint	18 years
Elbow joint	16 years
Wrist joint	18 years
Hip joint	17–18 years
Knee joint	18 years
Ankle joint	16–17 years

Medicolegal Importance of Age

Sr No.	Age	Medicolegal	IPC/importance	Explanation
1	>5 years	Criminal responsibility	Railway Act	Punishability
2	< 12 years	Consent	Sec 89 IPC[Q]	Parents/guardian give consent for non-invasive procedure
3	<14 years	Employment	Factory Act [Q]	Cannot be employed
4	14–15	Do	Do	Employment with fitness certificate
5	<15 years (girls)	Rape[Q]	Sec 375 IPC	Sex with wife with consent
6	<18 years	Statutory rape[Q]	Sec 375 IPC	Sex with or without consent with girl
7	<16 years (boy)	Kidnapping	Sec 361	Taking away without the consent from lawful guardian
8	<18 years (girls)	Kidnapping[Q]	Sec 361	Do
9	<18 years (girls)	Kidnapping	Sec 366-A IPC	Procuring a girl for sexual intercourse
10	>18 years	Consent	87 IPC	Consent for invasive procedure
11	>18 years	Majority attainment	Sec 3 Indian majority Act 1875	Valid will, adult franchise
12	>18 years	Marriage	Child marriage and restraint Act	
13	> 18 years juvenile court-female magistrate	Juvenile punishment (MCQ) Magistrate is 1st class JM or MM 16–18 maximum punishment —7 years	Juvenile justice Act 2000 now for henious crime juvenile between 16–18 faces normal trial	Both boy and girl below 18 are juvenile

Contd...

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Sr No.	Age	Medicolegal	IPC/importance	Explanation
14.	<21 years (girls)	Kidnapping	366–B IPC	
15.	>21 years	Attainment of majority	Sec. 3 Indian majority	Under guardianship
16.	>21 years (boys)	Marriage	Child marriage and restraint Act 1978–79	
17.	>25 years	Lok Sabha election and consuming alcohol in restaurant and bars		
18.	>30 years	Rajya Sabha		

Age (years)	Medicolegal importance
<7	Criminally not responsible (82 IPC)
7-12	Criminally responsible if he knows the nature and consequence of Act (83 IPC)

STATURE

Stature of a person from long bones can be estimated using regression formulae of:

- Karl Pearson
- Trotter & Glessor
- Dupertius and Hadden
- Jit and singh

Geneva Agreement

It deals with the reconstruction of the stature with the aid of the long bones.

Multiplication factors for different bones are:

Bone	Multiplication factor
Radius	6.5 (6.1 + 8/2)
Ulna	6.1 (5.3 + 8)
Humerus	5.3 (4.5 + 8)
Tibia/fibula	4.5 (3.7 + 8)
Femur	3.7

TATTOO MARKS

These are coloring patterns on the skin effected by multiple small puncture marks made through the skin with needle dipped in coloring matter. Color pigments penetrating to the depth of dermis make the patterns permanent. Pigment can be detected in draining lymph nodes by histopathology.

Different coloring dyes used for tattooing are:

- Finely divided carbon
- Indian ink
- Prussian blue
- Cinnabar
- Vermilion

Methods of removal of tattoo: Surgical ablation, electrolysis, carbon dioxide snow application, dermabrasion.

Faded Tattoo mark become visible by **ultraviolet lamp** and **Infrared photography** makes **old tattoo** visible.

Medicolegal Importance

- Identification (name), race, religion, can be determined. **Sydney Shark Arm case** identification was done by Tattoo Marks.
- Intravenous drug addicts conceal the site of injection by tattoo.
- Personality of a person, such as blue bird design on the dorsum of 1st web space of hand in some homosexual, can be determined.

HAIRS

Trichology is the study of hairs. The differences between animal and human hairs are:

Features	Human	Animal
Texture	Fine/thin	Coarse/thick
Scales	Large	Small
Medulla	Absent/ fragmented	Broad
Cortex	Thick	Thin
Medullary index(diameter of medulla/shaft)	<0.3	>0.5
Precipitin test	Specific to human	Specific to animal

Growth of hairs: 0.4 mm/day

Hairs becomes loosen after 72 hours of death.

MLI of hairs: Determination of age, sex, race, chronic metallic poisoning, time since death, scene of crime, victim and assailant.

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DACTYLOGRAPHY

Fingerprint system, **Galton-Henry system**, Dermatoglyphics:

- It is the study of ridge patterns in the skin, which was first used in India in 1858 by sir W. Herschel of Bengal.
- It is considered as **most reliable method** of identification of a person as the patterns are not inherited and is different even in identical twins.
- The ridge pattern of fingers appears between **12 to 16 weeks** of intrauterine life and the formation is completed by **24 weeks**.
- It is classified primarily as
  - **Loop** (m/c type),
  - Arches,
  - Whorls,
  - Composite (least common type)
- In practice **10 to 12 points** of fine comparison are accepted as proof of identity. The fingerprint patterns are distinctive and permanent in every individual.
- Histological section up to **6 mm** from the skin surface yield satisfactory result.
- Types of fingerprints are:
  - **Latent print (chance print)**: Invisible or barely visible impression left on a smooth surface
  - **Visible prints**: Prints from blood stained or ink stained fingers.
  - **Plastic print**: Impression made on a soft surface such as soap, cheese, mud, thick died blood etc.
- Latent prints are invisible prints which are made visible by dusting the area with color powders, examined the area by oblique lightening, treating with 5% silver nitrate solution especially when the prints are on the fabrics, exposing with vapours of iodine or osmium tetroxide when the prints are on papers. Latent print on the glass and rods can be made visible by scanning electron microscope.
- Impression of all the ten fingers are taken in criminals, but only left thumb impression for civil purposes.
- **FINDER**: Computerised automatic fingerprint reading system which recorded the print of eight fingers of both hands excluding little fingers.
- Permanent impairment of fingerprint pattern occurs in leprosy, electric injury, and after exposure to radiation.
- **O-FTIR**: (Optical frustrated Total Internal Reflection) is most commonly used to capture live scan fingerprints.

OTHER IMPORTANT METHODS USED IN IDENTIFICATION

Poroscopy

- It is described by **Edmond Locard (Locard also is famous for Exchange Principle)**
- This is the further study of fingerprints utilizing study of pores.
- It is useful when only fragments of fingerprints are available in which there is no specific pattern.
- Each milimeter of ridge contains 9–18 pores. Pore charcteristics are unique to each individual and permanent.

Palatoprints

- Taken from the **anterior part of palate** having rugae which are individual specific and permanent.
- Used even in advanced decomposition.

Cheiloscopy (Lip Prints)

- Study of fissures and grooves on the lips which are individual specific.
- Suzuki classified the lip print into 7 types.
- Aquaprint and cyanoacrylate may be used for developing the print.

Retina Scan in Identification

It appears to be the **most precise and reliable biometrics** for identification of an individual. It is unique, permanent and different even in identical twins.

Skull Photo Superimposition

- A method of identification in which photograph of skull found after death is superimposed on photo of his face of the person.
- This test is of **more negative value** because it can definitely concluded that the photograph and skull are not those of the same person.

Bertillion System (Portrate Parle)

Anthropometric system based on the physical measurement of specified part of body, even if there are no biological specimens.

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The Quick Pills

- X-ray of frontal sinus is useful in individual > 15 years when antemortem X-rays are available[Q]
- Sydney shark arm case identification was done by tattoo marks[Q]
- Methods to erase tattoo are[Q]

Mnemonics

BCDE

- Burning and scarring, Beam (laser beam)
- Corrosive and Caustic chemicals
- Dry ice
- Electrolysis, Excision and graft, Enzyme (Papain)

- Identification of human remains
  - Blood grouping
  - DNA analysis
  - Mg/Zn ratio
  - Incremental line in second molar (maple)
  - Amino acid racemization (aspartic acid)
- Sex of the fetus can be determined after end of **4th month**[Q]
- Age estimation by using scar is a very important tool.

Duration	*Features*
5–6 days	Reddish blue, firm, union (Angry)
2 weeks – 2 months	Pale, soft, tenderness present
2–6 month	Brown, tough, glistening, tenderness mild
>6 months	White tough, non-tender.

- In Turner's syndrome the anatomical structure is female but the nuclear sexing is male[Q]→Mn→TNM
- In Klinefelter syndrome, the anatomical structure is male but the nuclear sexing is female[Q]
- Stature
  - Karl-Pearson
  - Trotter and Glessor
  - Dupertius and Hadden
  - Jit and Singh
- **Male pseudohermaphrodite**—nuclear sex male, anatomical sex – female **(testicular feminization)**
- **Female pseudohermaphrodite—** nuclear sex female, anatomical sex— male (commonest cause adrenal hyperplasia)[Q]
- **Colonel victor barker** case was a famous case of concealed sex
- **Barr body—**The number of Barr bodies present is correlated with the (B is the number of Barr Bodies, X is the number of X chromosome)
  - Is a small Plano convex mass lying near nuclear membrane
  - Barr body was first demonstrated by Barr and Bertam
  - In buccal mucosa, it is present in 20 to 80% of cells in the female and 0 to 4% in males
- **Davidson-Smith Body** [Q]—Present in **Neutrophils** in the female (6% of cells) but is absent in males
- **Feulgen reaction**[Q]**:** It is used to stain. **X-chromosome**, which is seen as bright yellow spot.
- Asterion closes by the age of 50 years[Q]
- **Stack** method is used to determine the age of fetus by using teeth (infant age)
- **Center of cuboid appears at 10th month of intrauterine life**
- Frontal sinus—used in identification, absent in 5% cases, unilateral in 1% cases, not even identical twins have the same frontal sinus pattern.
- Skull of male- glabella prominent, orbits and mastoid are round and digastrics groove is deeper.
- **Cross-section of human hair:** Mongoloid-circular, caucasoid-oval, negro-kidney shape
- **Scar**—vascularity of scar remains for 2 months and **scar is completely non-tender by 6 months.**
- Human hairs are generally fragmented (medulla) except Negro – non-fragmented
- Pigment of hairs—evenly distributed in cortex (mongol)- cuticle is thick, cortex (outside concentrated)- Negros (cuticle is absent) and Caucasoid (cuticle is medium)

- Anthropometry – 11 points needed.
- Stature from fragmentary long bones—**steele's formula**
- Indian railway Act—age for criminal responsibility is 5 years.
- Hair order in appearance for male—pubis-axilla-face (14-15-16 years)
- Coronal and sagittal sutures obliterates: 40 years
- Pterion fuses—65 years
- Masto-occipital suture fuses at around 80 years
- Anterior frontanelle closes by 2 years
- Post. Frontanelle fuses by 2 months
- Two half of mandible fuses—2nd year
- Obtuse angle of mandible in old and infants
- Weight of human skeleton- (4.5 kg in male and 3 kg in female)

- Capacity of male skull is 10% more in male
- Cross dressing a psychiatric disorder in Transvestism and it is with evil intention in concealed sex
- Race from teeth
  - **Shovel shaped incisor, enamel pearl on premolars**, congenital lack of third molar and **taurodontism (blue tooth)**[Q] **seen among mongoloids**.
  - **Carbelli's cusps**[Q] seen in white races (small nodule at lingual surface of molar in upper jaw).
- **Trigonocephaly—**Early fusion of the **metopic** suture [Q]
- **Scaphocephaly—**Early fusion of the **sagittal** suture. Most common type of craniosynostosis.
- **Posterior plagiocephaly—**Early fusion **of lambdoid** suture[Q]
- Anterior plagiocephaly—Early fusion of one coronal suture.
- **Turica = multiple sutures**
- **Alzarin red** is used as a marker to stain centers of ossification.
- **Risser test**: it is based on a study of the iliac crest points of ossification from a frontal view of the pelvis.

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Multiple Choice Questions

1. **Corpus delicti means:** *(AIIMS May 07)*
   a. Dead body
   b. Essence of crime
   c. Decompositional changes
   d. Dereliction of duty

2. **Corpus delicti includes:**
   a. Body of victim
   b. Weapons of offence found near or in the body
   c. Photographs of deceased showing fatal injuries
   d. All of the above

3. **Cephalic index (C.I) is important for determination of:** *(NBE 13, 14, 15)*
   a. Age b. Sex
   c. Race d. Stature

4. **Cephalic index of an Indian skull belong to:** *(AI 04)*
   a. Dolichocephalic b. Mesaticephalic
   c. Brachycephalic d. Mixed variant

5. **Brachycephaly is due to early fusion of which of the following suture:**
   a. Metopic suture b. Coronal suture
   c. Sagittal suture d. Lamdoid suture

6. **Breadth and length of skull are measured using:**
   a. Calipers b. Osteometric board
   c. Scales d. Measuring tape

7. **A skull which is narrow and elongated having square shaped orbit, rectangular palate, and cephalic index between 70 to 75, belongs to which of the following race:**
   a. Negroes b. Mongoloid
   c. Caucasian d. Aryans

8. **In which of the following method photograph of the face of a suspected person is required to compare with an unknown skull:** *(AI 04, DNB 08)*
   a. Gustafson's method
   b. Galton's system
   c. DNA Profiling
   d. Superimposition technique

9. **Krogman formula is helpful for determination of:**
   a. Age b. Sex
   c. Religion d. Race

10. **The accuracy of sex determination from skull is:** *(CET 16)*
    a. 90% b. 95%
    c. 98% d. 100%

11. **Davidson body (a small nuclear attachment in neutrophil) is helpful for determination of:** *(CET 14)*
    a. Age b. Sex
    c. Race d. Religion

12. **5-α reductase deficiency occurs in:**
    a. Male pseudohermaphroditism
    b. Female pseudohermaphroditism
    c. Concealed sex
    d. True hermaphroditism.

13. **Steeper forehead with distinct frontonasal angulation and square shaped orbit of a skull belongs to:**
    a. Male sex b. Female sex
    c. Intersex d. Concealed sex

14. **From a bundle of bones, the accuracy of sex determination is maximum by which of the following bone:** *(All India Dec 14)*
    a. Skull b. Pelvis
    c. Femur d. Sternum

15. **In female pelvis the obturator foramen is?**
    a. Round b. Triangular
    c. Oval d. Squarish

16. **Preauricular sulcus (attachment of anterior sacroiliac ligament) is useful for determination of:** *(AI Dec 15)*
    a. Age b. Sex
    c. Race d. Stature

17. **For determination of sex in child single most reliable feature of pelvis is:**
    a. Preauricular sulcus b. Obturator foramen
    c. Subpubic angle d. Greater sciatic notch

18. **Which of the following index is more in male compared to female:**
    a. Ischiopubic index b. Sciatic notch index
    c. Chilotic line index d. Sacral index

19. **Square shaped chin with everted angle of mandible is a feature of:**
    a. Female sex b. Male sex
    c. Intersex d. Concealed sex

20. **Medico-legal angle of mandible is helpful for determination of:**
    a. Age b. Sex
    c. Race d. Stature

21. **Corporo basal index is more in which sex:** *(AI 08)*
    a. Male b. Female
    c. Intersex d. Concealed sex

22. **Ashley's rule is helpful in determination of:** *(AIIMS Nov 15)*
    a. Sex b. Age
    c. Race d. Stature

23. **Which of the following rule states that the body is longer and more than the twice the length of the manubrium:**
    a. Puppe's rule b. Ashley's rule
    c. Hyrtl's rule d. Young's rule

24. **Medullary index (diameter of long bone/diameter of whole bone × 100) is used for determination of:**
    a. Age b. Sex
    c. Race d. Stature

25. **Ossification center of medial end (inner end) of clavicle appears at what age:**
    a. 12 to 14 years b. 15 to 17 years
    c. 20 to 22 years d. 23 to 25 years

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Answer with Explanations

1. **Ans. (b) Essence of crime**

   The corpus delicti: (delicti=fault; offence) (the body of offence; the essence of crime) means, the facts of any criminal offence, e.g. murder. The corpus delicti of murder is the fact that a person died from unlawful violence. The main part of corpus delicti is the establishment of identity of the dead body, and infliction of violence in a particular way, at a particular time and place, by the person or persons charged with the crime and none other.

2. **Ans. (d) All of the above**

   Corpus delicti includes body of the victim and other facts which are conclusive of death by foul play, such as a bullet or a broken knife-blade found in the body and responsible for death. Clothing showing marks of the weapon, and drawings and photographs of the deceased showing fatal injuries are also included in this term.

3. **Ans. (c) Race**

   The Cephalic Index (C.I.) or Index of Breadth is important for determination of race.

Type of skull	*Cephalic index*	*Race*
1. Dolico-cephalic (long-headed)	70 to 75	Pure Aryans, Aborigines and Negroes
2. Mesaticephalic (medium-headed)	75 to 80	Europeans Chinese and Indians
3. Brachycephalic (short-headed)	80 to 85	Mongolian

4. **Ans. (b) Mesaticephalic**

   See the table above.

5. **Ans. (b) Coronal suture**

   Brachycephaly is due to fusion of coronal suture and Dolichocephaly is sagittal suture.

6. **Ans. (a) Calipers**

   The breadth and length of skull are measured by calipers between both parietal eminences, and between glabella and external occipital protuberance respectively, and not by measuring tape.

7. **Ans. (a) Negroes**

Type of skull	*Cephalic index*	*Race*
1. Dolichocephalic (long-headed)	70 to 75	Pure Aryans, Aborigines and Negroes
2. Measticephalic (medium-headed)	75 to 80	Europeans, Chinese and Indians
3. Brachycephalic (short-headed)	80 to 85	Mongolian

8. **Ans. (d) Superimposition technique**

   Superimposition: Applied by Glaister and Brash in 1935 in Ruxton case. Superimposition is applied to determine whether the skull is of the person in the photograph. Photograph need not be front view of the face; even lateral and semi-lateral view of face can be used. A recent photograph is better. If the negative of photograph is not available, negative of the available photograph is prepared by recopying it. The photograph is enlarged to natural size from the presence of some standard thing in the photograph of the missing person to indicate the scale. In the absence of a standard, photographs of the skull and face are superimposed by adjusting the magnifications until the interpupillary distances correspond.

   Points for comparison: (1) Eyes (2) Nasion. (3) Prosthion (4) The nasal spine (5) The lower border of the nose. (6) The lower border of the upper jaw (7) The zygomas below the eyes (8) Supraorbital ridges. (9) Angle of the jaw. (10) External auditory meatus. (11) Angle of the jaw. (12) Teeth.

9. **Ans. (b) Sex**

   According to Krogman, the degree of accuracy in sexing adult skeletal remains is:
   - Entire skeleton—100%
   - Pelvis alone—95%
   - Skull alone—90%
   - Pelvis plus skull—98%
   - Long bones alone—80%

10. **Ans. (a) 90%**

    According to Krogman, the degree of accuracy in sexing adult skeletal remains is:
    - Entire skeleton—100%
    - Pelvis alone—95%
    - Skull alone—90%
    - Pelvis plus skull—98%
    - Long bones alone—80%

11. **Ans. (b) Sex**

    In females, neutrophil leucocytes contain a small nuclear attachment of drumstick form called Davidson body in up to six percent of cells. This is absent in males.

12. **Ans. (a) Male pseudohermaphroditism**

    Pseudohermaphroditism: In this condition gonadal tissue of only one sex is seen internally, but external appearance is of the opposite sex.
    - **Male pseudohermaphroditism:** Nuclear sex is XY, but sex organs and sexual characteristics deviate to female form, because of testicular feminization. It is characterized by primary amenorrhea, female external genitalia, normal size breasts, scanty or absent axillary and pubic hair. Testes are in the abdomen or inguinal canal; 5-α reductase deficiency occurs.
    - **Female pseudohermaphroditism:** Nuclear sex is XX, but deviation of sex organs and sexual characters towards male are seen, due to adrenal hyperplasia. 21 hydroxylase deficiency is most common.

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Review of
FORENSIC MEDICINE

Salient Features

- Clear and concise content in chapters with a flow to make better understanding and interesting for the students
- Multiple times review by different faculties to minimize the errors and repetitions of contents
- Most of the questions in each section are new and self-designed. There is high probability of repetition of these questions in future exams
- "The Quick Pills" will help the students to emphasize more on the facts and getting new information
- Flowchart presentation of the chapters at the end of section will help to revise the chapters at a single shot
- The best part of the book is "Mnemonics" in the appropriate places of each chapter will definitely help to retain the "volatile content" for longer duration
- "Golden points with images" will help to deal with image-based questions in competitive exams and spotter in UG exams
- The most important salient feature of this book is the last chapter "Recent changes in law"- not updated in textbooks. The contents of recent laws are depicted in concise manner.

Akhilesh Raj Jhamad MD (Forensic Medicine from AIIMS, New Delhi) is a leading faculty with more than 10 years of teaching experience in India and Abroad. He is famous for his made easy classes and has many international publications to his credit.



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