



DELHI ACADEMY OF MEDICAL SCIENCES (P) LTD.

Delhi Academy of Medical Sciences (DAMS) is a well-established name in the field of PG Medical Entrance Education since 1999. We are recognized for our impeccable foresight, enviable expertise and innate acumen. Over this long period, DAMS has evolved into a unique fraternity of educators and students striving together, year after year, in pursuit of a single goal. DAMS is dedicated to make a difference in your journey to success in Post Graduate Medical Entrance Examination. Our famous CRS series are a benchmark for objective based examination.



eMedicoz

**One Stop Solution to
Licensing Exam, PG
Entrance, NEXT, USMLE,
PLAB & DM/MCh
Entrance examinations**

All You Need to Study Is
Available On One Platform



Head Office:- 4-B, Grovers Chamber, Pusa Road, New Delhi-110005
Helpline No :- 011-4009 4009
Website: www.damsdelhi.com, E-mail: info@damsdelhi.com

CONCEPT BOOK

FORENSIC MEDICINE & TOXICOLOGY



**REDEFINING MEDICAL EDUCATION
VIDEO COMPANION WITH EACH CHAPTER**

NEXT GENERATION CONCEPT BOOK

FORENSIC MEDICINE & TOXICOLOGY



**ACTIVE RECALL BASED
INTEGRATED EDITION**



CONCEPT BASED LEARNING

Video companion on each Chapter

NEXT GENERATION



COMPREHENSIVE REVIEW SERIES

“FORENSIC MEDICINE AND TOXICOLOGY”

ACTIVE RECALL BASED

Integrated Edition





Published by Delhi Academy of Medical Sciences (P) Ltd.

HEAD OFFICE

Delhi Academy of Medical Sciences (P.) Ltd.

4-B, Grovers Chamber, Pusa Road,

Near Karol Bagh Metro Station,

New Delhi-110 005

Phone : 011-4009 4009

<http://www.damsdelhi.com>

Email: info@damsdelhi.com

ISBN : 978-93-89309-26-3

First Published 1999, Delhi Academy of Medical Sciences

© 2021 DAMS Publication

All rights reserved. No part of this book may be reproduced or transmitted in any form or by any means, electronic, mechanical, including photocopying, recording, or any information storage and retrieval system without permission, in writing, from the author and the publishers.

This book contains information obtained from authentic and highly regarded sources. Reprinted material is quoted with permission. Reasonable efforts have been made to publish reliable data and information, but the authors and the publishers cannot assume responsibility for the validity of all materials. Neither the authors nor the publishers, nor anyone else associated with this publication, shall be liable for any loss, damage or liability directly or indirectly caused or alleged to be caused by this book.

Neither this book nor any part may be reproduced or transmitted in any form or by any means, electronic or mechanical, including photocopying, microfilming and recording, or by any information storage or retrieval system, without permission in writing from Delhi Academy of Medical Sciences. The consent of Delhi Academy of Medical Sciences does not extend to copying for general distribution, for promotion, for creating new works, or for resale. Specific permission must be obtained in writing from Delhi Academy of Medical Sciences for such copying.

Trademark notice: Product or corporate names may be trademarks or registered trademarks, and are used only for identification and explanation, without intent to infringe.

Typeset by Delhi Academy of Medical Sciences Pvt. Ltd., New Delhi (India).

Contents

Chapter 1	Introduction and Legal Procedure	1 – 12
Chapter 2	Medical Law and Ethics	13 – 33
Chapter 3	Identification	34 – 66
Chapter 4	Medico-Legal Autopsy	67 – 77
Chapter 5	Thanatology	78 – 101
Chapter 6	Injuries, Starvation & Torture	102 – 151
Chapter 7	Mechanical Asphyxia	152 – 173
Chapter 8	Sexual Jurisprudence	174 – 203
Chapter 9	Forensic Psychiatry	204 – 210
Chapter 10	Forensic Science	211 – 225
Chapter 11	Toxicology	226 – 295
Chapter 12	LAW	296 – 307

1

Introduction & Legal Procedure

CONCEPTS

- **Concept 1.1 Definitions and History**
- **Concept 1.2 Inquest**
- **Concept 1.3 Criminal Courts in India and its Powers**
- **Concept 1.4 Summons, Evidence and Witness**
- **Concept 1.5 Recording of Evidence in a Court of Law**



Concept 1.1 : Definitions and History

Learning objective: To know the various definitions and the history of Forensic medicine.

Time needed

1 st reading	30 minutes
2 nd look	15 minutes

Forensic medicine or legal medicine

- Deals with application of medical knowledge for the solution of legal problems, e.g., in deciding cases of injuries, murder, sexual offences, poisoning, etc.

Medical jurisprudence

- Deals with legal responsibilities of the doctor concerned with the practice of medicine, e.g., medical negligence cases, consent, medical ethics, rights and duties of doctors etc.

Medical ethics

- Deals with the moral principles, which should guide members of the medical profession in their dealings with each other, their patients and the state.

Principles of medical ethics

1. Respect for autonomy: Respect the decisions made by other people concerning their own lives.
2. Beneficence: Action done for the benefit of others.
3. Non-maleficence: "Do no harm."
4. Justice: Treat all people equally, fairly, and impartially.

Medical etiquette

- Deals with the conventional laws of courtesy to be observed between members of the medical profession (Doctor – Doctor Relationship)

Cognizable offence

- An offence in which a police officer can arrest a person without warrant from the Magistrate. Examples – Rape, murder, dowry death, ragging etc.

Non-cognizable offence

- An offence in which a police officer cannot arrest a person without warrant from the Magistrate.

Summons case

- Offences for which imprisonment is less than 2 years.

Warrant case

- Offences for which imprisonment is more than 2 years.



Criminal offence

- These are offences against public interest, property, person, public safety and security, e.g., Murder, Rape, Robbery, theft etc. These are taken as offences against the state. In this, State is a party and represented by the Public Prosecutor.

Civil offence

- It deals with dispute between two persons or parties, e.g., Land dispute, Divorce, Compensation etc. Plaintiff is the party bringing the action and the Defendant is the accused.

Indian Penal Code (I.P.C.)

- Deals with criminal laws in India. It describes offences and their punishments. There are 23 Chapters and 511 sections of I.P.C.

Criminal Procedure Code (Cr.P.C.)

- Deals with the legal procedures in various criminal matters. There are 37 chapters and 484 sections of Cr.P.C.

Indian Evidence Act (I.E.A.)

- Deals with the laws of evidence and applies in judicial proceedings. It contains a set of rules and allied issues governing admissibility of evidence in the Indian courts of law. There are 11 chapters and 167 sections of I.E.A.

First Medico legal autopsy was done by	Bartolomeo Varignana, in Italy in 1302
First book of Forensic Medicine was written by	Furtunato Fedele, an Italian in 1602
First Postmortem in India was done by	Dr. Buckley in Madras in 1663, a case of suspected Arsenic poisoning
The oldest medico-legal Code is	Code of Hammurabi
The father of Toxicology is	Paracelsus
The father of Forensic Medicine	Paolo Zacchia
The father of Modern Toxicology	Mathieu Orfila
The father of Modern Forensic Medicine	Bernard Spilsbury



Concept 1.2 : Inquest

Learning objective: To know the different types of inquest held in India

Time needed

1 st reading	20 minutes
2 nd look	10 minutes

Inquest means legal or judicial inquiry to ascertain a matter of fact. In forensic work, an inquest implies an **inquiry into the cause of death** that is apparently not due to natural causes. It is conducted in cases such as homicide, suicide, sudden, accidental, unexpected and unexplained deaths, killing by an animal or machinery etc.

1. Police inquest

- This is done by Officer-in-charge of a police station (Station House Officer).
- The officer conducting the inquest is called as "Investigating Officer" (IO).
- On receipt of information about any sudden, suspicious or unnatural death of any person, the IO forwards the information to the nearest Magistrate and proceeds to the place where the dead body is lying.
- At that place, the IO in presence of two or more responsible persons of the area (called as Panchas) makes an investigation and prepares a report called as Panchanama.
- The police officer visits scene of crime and prepares a report which includes description of wounds, the nature of weapon used and the apparent cause of death.
- The inquest report (panchanama) is then signed by the police officer and two witnesses.
- If foul play is suspected, body is sent for autopsy.

2. Magistrate's inquest

- Magistrate's Inquest to be conducted by District Magistrate/Sub-divisional Magistrate/Executive Magistrate/Judicial Magistrate.
- **The Magistrate can conduct an inquest instead of police inquest or in addition to the police inquest in any case.**
- This is done especially in cases of – Death in police custody, Death due to police firing, Death while under police interrogation, Death in prison, Death in psychiatric hospital, Dowry death, Exhumation etc.

3. Coroner's inquest

- It was held at Kolkata (Calcutta) and Mumbai (Bombay).
- A Coroner was an officer of the rank of First-Class Magistrate, appointed by
- State government.



- The Coroner may be a doctor or a lawyer or both.
- When the accused was not found, the Coroner returns an open verdict.
- Open verdict means an announcement of the commission of crime without information regarding the accused.
- It is held in U.K., some states in America and some other countries.

4. Medical examiner's inquest

- This is a type of inquest conducted in **most of the states of U.S.A., Japan, and Canada etc.**
- As the name suggests, under this system, a medical person is appointed to hold an inquest.



Concept 1.3 : Criminal Courts in India and its Powers

Learning objective: To know the different criminal courts in India and its powers

Time needed

1 st reading	20 minutes
2 nd look	10 minutes

Supreme court:

- Highest judicial tribunal of India situated in New Delhi. Can pass any sentence.
- Usually considers appeals from lower courts.
- It can sustain or alter the punishment approved or awarded by the High Court.

High court:

- Highest judicial tribunal of the State usually situated in the capital of the State.
- Can pass any sentence. Usually exercises appellate jurisdiction.

Sessions court:

- Highest judicial tribunal of the District usually situated at the district headquarters.
- Can pass any sentence. However, death sentence must be confirmed by the High Court.

Assistant session court:

- High Court may also appoint Assistant Session Judges depending upon the demands. Such court may be situated at district headquarters or any other place considered suitable.
- Can pass any sentence except death sentence, life imprisonment or imprisonment exceeding 10 years.

Chief Judicial Magistrate (CJM)/Chief metropolitan magistrate:

- In every district, High Court shall appoint a Judicial Magistrate of first class having sufficient experience to be the Chief Judicial Magistrate (in the Metropolitan area, it is called as Chief Metropolitan Magistrate).
- Can pass any sentence except a sentence of death or of imprisonment for life or of imprisonment exceeding 7 years. Fine without limit.

Judicial Magistrate of First Class (JMFC) / Metropolitan Magistrate:

- Can pass sentence of imprisonment for a term not exceeding 3 years or of fine not exceeding Rs.10,000 or both.

Judicial Magistrate of Second Class (JMSC):

- Can pass sentence of imprisonment for a term not exceeding 1 year or of fine not exceeding Rs. 5,000 or both.



Juvenile justice board

- As per Juvenile Justice (Care and Protection of Children) Act, 2000., a 'juvenile' or a 'child' means a person who has not completed eighteenth year of age, and a 'Juvenile in conflict with law' means a juvenile who is alleged to have committed an offense.
- The juvenile offenders are produced before the Juvenile Justice Board. Every such Bench shall have the powers conferred by the code of Criminal Procedure.
- The Metropolitan Magistrate or a Judicial Magistrate of the first class, as the case may be, shall be designated as the Principal Magistrate.



Concept 1.4 : Summons, Evidence and Witness

Learning objective: To know the procedure of serving summons, different types of evidence and witnesses

Time needed

1 st reading	30 minutes
2 nd look	15 minutes

Subpoena / Summons (Sec. 61 to 69 of Cr.P.C.)

- It is written document issued by the court and served on the witness under a penalty in all cases by the Police officer to attend the court for giving evidence on a particular day and time.
- Where a person summoned cannot, by exercise of due diligence, be found, the summons may be served by leaving one of the duplicates with some adult male member of his family residing with him and obtaining signatures on the other copy in the form of a receipt.
- If, however, service of summons cannot be effected by any of the above means, one copy of the summons should be **fixed on some conspicuous part of the house or homestead** in which the person summoned ordinarily resides.
- Court issuing summons to a witness may, in addition to and simultaneous with the issue of such summons, direct a copy of the summons to be **served by the registered post** addressed to the witness or his agent empowered to accept the service at the place where he/agent ordinarily resides or carries on business or personally works for gain.
- In the event of receiving a refusal of the witness to take delivery of the summons (whether through the acknowledgement purporting to be signed by the witness or through an endorsement purporting to be made by a postal employee), the court may declare that the summons has duly been served.
- If witness fails to attend the court, he may be fined or imprisoned in all types of summons, but he will be **excused if he has a valid and urgent reason**.
- In criminal cases, if court issues notice to witness under section **350 of Cr.P.C.** and if court finds that witness has neglected or refused to attend, the court may sentence him to fine not exceeding one hundred rupees.
- Higher courts have priority over lower courts and criminal courts have priority over civil courts. If the summon is from two courts of same level, preference is to be given to the summon received first.

Evidence

As per **Sec.3 of IEA**, "Evidence" means and includes—

- (1) all statements which the Court permits or requires to be made before it by witnesses, in relation to matters of fact under inquiry, such statements are called oral evidence;
- (2) all documents including electronic records produced for the inspection of the Court, such documents are called documentary evidence.



Oral evidence

- This means and includes all statements that the court permits or requires to be made in relation to matters of fact under inquiry.
- According to Section 60 Indian Evidence Act (IEA), the oral evidence whenever possible must be direct.
- Exceptions to oral evidence:
 1. Dying declaration.
 2. Expert opinion expressed in treatise.
 3. Evidence of a doctor recorded in a lower court.
 4. Evidence given by a witness in a previous judicial proceeding.
 5. Evidence of Mint officer or any officer of India Security Press.
 6. Reports of certain Govt. Scientific experts, such as Chemical examiner, **Chief** Inspector of Explosives, Director of Fingerprint bureau, Director of Central Forensic Science Laboratory, serologist etc.
 7. Public records
 8. Hospital Records: Routine entries such as DOA, DOD, Pulse, Temp. etc.
 9. When the certificate or document is acceptable to the counsels (lawyer of accused) without cross-examination etc.

Documentary evidence:

1. Medical Certificates

- They refer to disease, death, birth, vaccination, insanity, etc.
- Only a registered medical practitioner can give a valid certificate.
- If the patient dies due to natural causes, the doctor is legally bound to give death certificate without charging fees.
- If the doctor is not sure of the cause of death or, in cases of suspicion of foul play, the doctor should not give death certificate and the police should be informed.

2. Medicolegal Reports

- It is required by the Law enforcing agencies such as Police and Courts of Law and are prepared by the doctor, usually in criminal cases, e.g. murder, assault, rape, poisoning, etc.

3. Dying declaration

- It is a written or oral statement of a person, who is dying due to some unlawful act, relating to the cause of his death.
- A magistrate should be called to record statement.
- If the condition of the patient is serious, the doctor or any other person can record the statement in the presence of two witnesses.
- Before recording the statement, doctor should certify that the person is conscious and have sound mind (compos mentis).
- The person need not take oath because it is believed that a dying person will not tell lies.
- Leading questions should not be asked.



- The signature of the declarant should be taken, and it should also be signed by the doctor and the witnesses.
- A dying declaration can also be written in ink on hand also.
- If the declarant survives, the declaration loses its legal validity and is not admitted as dying declaration, but the declaration has corroborative value.

4. Dying deposition

- It is not practiced in India (Only Hypothetical situation).
- It is the statement given by the dying person to the Magistrate under oath in the presence of the accused and may be his lawyer.
- It is superior to dying declaration because the accused has an opportunity of cross examination the dying person, the person is under oath, the accused is present.
- Even if the declarant survives it retains its legal validity.

Witnesses

1. Common / Ordinary Witness

- He is a person who gives evidence about the facts observed by himself.
- Doctor is an ordinary as well as expert witness. He/She can volunteer the statement only if ordered to do so.

2. Expert Witness

- He is one who is qualified or experienced in a scientific or technical subject and can give opinion from the facts observed by himself or others e.g. doctor, fingerprint expert, handwriting expert, firearm expert etc.

3. Hostile Witness

- A hostile witness is one who purposely makes statements contrary to facts or does not give his evidence fairly and with a desire to tell the truth to the court, or
- A hostile witness is one, who cites the evidence against the interest of the part by whom he has been summoned.
- The common or expert witness may turn hostile.
- While examining a hostile witness, leading questions are permitted even during examination-in-chief.



Concept 1.5 : Recording of Evidence in a Court of Law

Learning objective: To know the procedure of recording evidence of a witness in a court of law

Time needed

1 st reading	20 minutes
2 nd look	10 minutes

As per Section 138 I.E.A. the evidence of a witness is recorded in following sequence:

1. Oath / Solemn Affirmation

- Before giving evidence, the witness has to swear in the name of God or solemnly affirm that he will tell the truth, the whole truth and nothing but the truth.
- It is compulsory and holds the witness responsible for consequence of his evidence.
- In oath-taking the witness must keep his hand on a holy book.
- Telling lies by a witness under oath/solemn affirmation or failure to tell what he knows or believes to be true is known as perjury (Sec.191 of I.P.C.)
- The witness can be prosecuted and punished for perjury under Sec. 193 of I.P.C.

2. Examination-In-Chief

- Questions are put to the witness by the lawyer who has summoned him.
- The object is to elicit from the witness the principal salient facts bearing on the case, and if the witness happens to be an expert, then interpretation of these facts.
- A medical witness in his examination-in-chief narrates his findings on examination of the case under consideration.
- He testifies the report to be prepared by him after the examination and was also duly signed by him.
- He must answer queries of the prosecution counsel for clarification of points in connection with the case.
- At this stage of the examination, no leading questions are allowed except in those cases in which the presiding officer is satisfied that a witness has turned hostile.

3. Cross-Examination

- The witness is questioned by the lawyer for the opposite party, i.e. lawyer for the accused (defence lawyer).
- The purpose of cross-examination is to weaken, qualify or destroy the case of opponent and to establish the contention of defence through the witness of the prosecution.
- Leading questions are allowed. (Section 143 I.E.A.).
- There is no time limit for cross examination.



4. Re-Examination

- This is done by the lawyer, who has conducted examination-in-chief.
- Re-examination is allowed only when the presiding officer thinks it proper.
- Leading questions are not allowed.

5. Re-Cross Examination

- If new subject has been introduced in re-examination, the lawyer of opposing party has the right to re-cross examine a witness on the new matter.
- Leading questions are allowed.

6. Questions by Judge:

- Can be asked at any time to clear his doubts.
- On conclusion of the evidence, the witness should read over his own deposition very carefully before he signs it.
- He should draw the attention of the court for correction or any inaccuracy or discrepancy in recording of the evidence.

CONCEPTS

- ➔ **Concept 2.1 Medical Council of India and State Medical Council**
- ➔ **Concept 2.2 Professional Misconduct and Red Cross Emblem**
- ➔ **Concept 2.3 Professional Negligence**
- ➔ **Concept 2.4 Vicarious Liability**
- ➔ **Concept 2.5 Professional Secrecy**
- ➔ **Concept 2.6 Consent**
- ➔ **Concept 2.7 Euthanasia**
- ➔ **Concept 2.8 Health Related Declarations of World Medical Association**



Concept 2.1 : Medical Council of India and State Medical Council

Learning objective: To know the Functions of Medical council of India and state Medical council

Time needed

1 st reading	30 minutes
2 nd look	15 minutes

Medical Council of India

In the year 1933, the Indian Legislative Assembly passed an Act known as the Indian Medical Council Act 1933.

This Act stands repealed and, in its place, the **Indian Medical Council Act 1956** is enacted with following.

1. To give recognition for representation of the licentiate medical practitioners.
2. To provide registration of foreign medical qualifications.
3. To provide for formation of a committee to help in reorganizing postgraduate medical education in the country.
4. To maintain an "All India Medical Register" containing names of Registered Medical Practitioners all over India.

The Act was amended in 1964 to reconstitute Medical Council of India and reorganize medical education of the country.

National Medical Commission Act 2019

- The Commission shall be the successor in interest to the Medical Council of India including its subsidiaries or owned trusts and all the assets and liabilities of the Medical Council of India shall be deemed to have been transferred to the Commission.
- Notwithstanding the repeal of the Indian Medical Council Act, 1956, the educational standards, requirements and other provisions of the Indian Medical Council Act, 1956 and the rules and regulations made thereunder shall continue to be in force and operate till new standards or requirements are specified under this Act or the rules and regulations made thereunder.

Provided that anything done or any action taken as regards the educational standards and requirements under the enactment under repeal and the rules and regulations made thereunder shall be deemed to have been done or taken under the corresponding provisions of this Act and shall continue in force accordingly unless and until superseded by anything done or by any action taken under this Act.

Functions of Medical Council of India:

1. Medical Register:

It maintains Indian Medical Register, in which names of all doctors who are enrolled on any State Medical Register are entered.

The register is considered as a public document within the meaning of Indian Evidence Act 1872.

Erasure of Name: The doctor's name is removed from the Medical Register in case of death and if the entry is made wrongly or entered as a result of fraud.



2. Medical Education:

M.C.I. regulates the standards of medical education in the country.

3. Recognition of Medical Qualifications.

- The First Schedule: Contains the recognized medical qualification granted by Universities in India.
- The Second schedule: Contains the recognized medical qualifications granted outside India.
- Third schedule has two parts;
- Part I: Contains medical qualifications granted by Indian Universities which are not included in First schedule.
- Part II: Contains medical qualifications granted by Foreign Universities which are not included in Second schedule.

4. Appeal against disciplinary action:

If the name of any doctor is removed from the State Medical Register, he can appeal to the Central Government (Health Ministry), which consults the MCI and gives decision, which is binding on the State Medical Council.

5. Warning notice:

MCI can issue Warning Notice containing certain practices which are regarded as falling within the meaning of the term "Professional Misconduct".

6. Disciplinary action against doctors.

7. Maintenance of Indian Pharmacopoeia.

Functions of State Medical Council:

1. Medical Register: It maintains Indian Medical Register, in which names of all doctors who are enrolled in that State Medical Council.
2. Disciplinary action against doctors.
3. Issuing Warning notice.



Concept 2.2 : Professional Misconduct and Red Cross Emblem

Learning objective: To know the definition and what constitutes professional misconduct

Time needed

1 st reading	40 minutes
2 nd look	20 minutes

Professional misconduct (Infamous conduct in professional respect)

It is any conduct of the doctor, which is considered as disgraceful or dishonorable judged by medical practitioners of good repute and competence.

The MISCONDUCT is listed under CHAPTER 7 of Indian Medical Council (Professional conduct, Etiquette and Ethics/Regulations, 2002) as follows.

The following acts of commission or omission on the part of a physician shall constitute professional misconduct rendering him/her liable for disciplinary action:

1. **Violation of the regulations:** If he/she commits any violation of these regulations.
2. If he/she does **not maintain the medical records** of his/ her indoor patients for a period of 3 years as per regulation 1.3 and refuses to provide the same within 72 hours when the patient or his/her authorized representative makes a request for it as per the regulation
3. If he/she does **not display the registration number** accorded to him/her by the State Medical Council or the Medical Council of India in his clinic, prescriptions and certificates, etc. issued by him or violates the provisions of regulation
4. **Adultery or improper conduct:** Abuse of professional position by committing adultery or improper conduct with a patient or by maintaining an improper association with a patient will render a physician liable for disciplinary action as provided under the Indian Medical Council Act, 1956 or the concerned State Medical Council Act.
5. **Conviction by Court of Law:** Conviction by a Court of Law for offences involving moral turpitude/criminal acts.
6. **Sex determination tests:** On no account sex determination test shall be undertaken with the intent to terminate the life of a female foetus developing in her mother's womb, unless there are other absolute indications for termination of pregnancy as specified in the Medical Termination of Pregnancy Act, 1971. Any act of termination of pregnancy of normal female foetus amounting to female foeticide shall be regarded as professional misconduct on the part of the physician leading to penal erasure besides rendering him liable to criminal proceeding as per the provisions of this Act.
7. **Signing professional certificates, reports and other documents:** Registered medical practitioners are in certain cases bound by law to give, or may from time to time be called upon or requested to give certificates, notification, reports and other documents of similar character signed by them in their professional capacity for subsequent use in the courts or for administrative purposes, etc. **Any registered practitioner who is shown to have signed or given under his name and**



authority any such certificate, notification, report or document of a similar character that is untrue, misleading or improper is liable to have his name deleted from the Register.

8. A registered medical practitioner shall not contravene the provisions of the Drugs and Cosmetics Act and regulations made thereunder. Accordingly: (a) Prescribing steroids/psychotropic drugs when there is no absolute medical indication; (b) Selling schedule 'H' & 'L' drugs and poisons to the public except to his patient. Contravention of the above provisions shall constitute gross professional misconduct on the part of the physician.
9. **Performing or enabling unqualified person to perform an abortion or any illegal operation** for which there is no medical, surgical or psychological indication.
10. **A registered medical practitioner shall not issue certificates of efficiency in modern medicine to unqualified or nonmedical persons.** (Note: The foregoing does not restrict the proper training and instruction of bona fide students, midwives, dispensers, surgical attendants, or skilled mechanical and technical assistants and therapy assistants under the personal supervision of physicians.)
11. A physician **should not contribute to the lay press articles and give interviews regarding diseases and treatments that may have the effect of advertising himself** or soliciting practices; but is open to write to the lay press under his own name on matters of public health, hygienic living or to deliver public lectures, give talks on the radio/TV/ Internet chat for the same purpose and send announcement of the same to lay press.
12. An institution run by a physician for a particular purpose such as a maternity home, nursing home, private hospital, rehabilitation centre or any type of training institution, etc. may be advertised in the lay press, but such **advertisements** should not contain anything more than the name of the institution, type of patients admitted, type of training and other facilities offered and the fees.
13. It is improper for a physician to use an **unusually large sign board** and write on it anything other than his name, qualifications obtained from a University or a statutory body, titles and name of his specialty, registration number including the name of the State Medical Council under which registered. The same should be the contents of his prescription papers. It is improper to affix a sign board on a chemist's shop or in places where he does not reside or work.
14. The registered medical practitioner **shall not disclose the secrets of a patient** that have been learnt in the exercise of his/her profession except: (i) in a court of law under orders of the Presiding judge; (ii) in circumstances where there is a serious and identified risk to a specific person and/or community and (iii) notifiable diseases. In case of communicable/notifiable diseases, concerned public health authorities should be informed immediately.
15. The registered medical practitioner **shall not refuse on religious grounds** alone to give assistance in or conduct of sterility, birth control, circumcision and medical termination of pregnancy where there is medical indication, unless the medical practitioner feels himself/herself incompetent to do so.



16. **Before performing an operation, the physician should obtain in writing the consent** from the husband or wife, parent or guardian in the case of minor or the patient himself as the case may be. In an operation that may result in sterility, the consent of both husband and wife is needed.
17. **A registered medical practitioner shall not publish photographs or case reports of his/her patients without their permission** in any medical or other journal in a manner by which their identity could be made out. If the identity is not to be disclosed, the consent is not needed.
18. In the case of running of a nursing home by a physician and employing assistants to help him/her, the ultimate responsibility rests on the physician.
19. **A physician shall not use touts or agents for procuring patients.**
20. A physician shall not claim to be specialist unless he has a special qualification in that branch.
21. **No act of in vitro fertilization or artificial insemination shall be undertaken without the informed consent** of the female patient and her spouse as well as the donor. Such consent shall be obtained in writing only after the patient is provided, at her own level of comprehension, with sufficient information about the purpose, methods, risks, inconveniences, disappointments of the procedure and possible risks and hazards.
22. **Research: Clinical drug trials or other research involving patients or volunteers as per the guidelines of ICMR can be undertaken**, provided ethical considerations are borne in mind. Violation of existing ICMR guidelines in this regard shall constitute misconduct. Consent taken from the patient for trial of drug or therapy which is not as per the guidelines shall also be construed as misconduct.

The following are some of the ingredients contained in the misconduct: (6 'A's)

1. Adultery: Abuse of professional position by committing adultery or improper conduct with a patient or by maintaining an improper association with a patient.
2. Association with unqualified persons.
3. Alcohol: Treating a person under the influence of alcohol.
4. Addiction: Treating a person under the influence of drugs.
5. Abortion: Performing an illegal abortion

Advertisement: Repeated advertisement in a newspaper by a medical practitioner is an example of ethical negligence.

Dichotomy or fee-splitting: Receiving or giving commission to professional colleague or a manufacturer or trader in drugs or appliances, or to a chemist, dentist etc.

Covering: Having relations with unqualified persons, which enable them to practice midwifery, or issuing certificates which enable such practices to occur etc.

Red Cross Emblem

- Geneva Convention (1949) regulates the use of the Red Cross emblem. India being signatory to the convention also adopted these emblems.



- The Indian Red Cross Society Act specifies that the Red Cross sign can only be used by **Military Medical Services**, their personal units, installations and means of transport and by International Committee of the Red Cross, etc.
- **Abuse of emblem can lead to a fine of Rs. 500 besides the provision of forfeiture of the goods or vehicles on which the emblem has been used without authorization.**
- Doctors need to use the symbol of a rod entwined by two snakes, decorated with wings on the top of the rod.
- Hospitals have a symbol with an 'H' written in white color over a grey background.
- Red Cross Emblem is used by those belonging to the Red Cross movement & Army medical services, who are involved in times of armed conflicts and natural disasters.
- Ambulances must use a symbol with a needle and thread inscribed in white over the central part of fanned out petals.
- Medical stores to use a symbol of 'green cross' over white background.



Concept 2.3 : Professional Negligence (Medical Negligence)

Learning objective: To know what professional negligence is, the types of professional negligence, Res ipsa loquitur, defenses for a doctor against medical negligence and the differences between professional negligence and professional misconduct.

Time needed

1 st reading	40 minutes
2 nd look	20 minutes

Definition: Professional negligence (**Malpractice**) is the absence of reasonable care and skill (Act of commission and/or Act of Omission), or negligence of a doctor in the treatment of a patient, which may result in injury or death.

The burden of proving negligence lies on the plaintiff (i.e. patient).

1. Civil Negligence:

- **A civil wrong is known as 'Tort'.**
- In civil negligence a patient brings charges of negligence against doctor for monetary compensation (damages) for the damage (harm) suffered by him.

Two types of compensatory damages have generally been recognized:

1. **General damages** being awarded for noneconomic losses like pain, sufferings, mental anguish, grief and other related complaints.
2. **Special damages** include past and future medical, surgical, hospital and other related costs, past and future loss of income, expenses for the cremation in case of death and unusual consequences of the alleged injury such as where there is aggravation of a pre-existing state of disease.

***Punitive or exemplary damages** may occasionally be awarded in addition to those that are intended to set an example for the future or to punish the egregious behaviour of the defendant.

- If the court has taken decision on a particular case, the same case cannot be reopened in any other court of same rank (**Res judicata**).

2. Criminal Negligence:

- It occurs when the doctor shows gross lack of competency, **gross** inattention, and criminal interference to the patient's safety, or gross negligence in the selection and application of remedies.
- The doctor may be prosecuted by the police in a criminal court.
- **As per Sec. 357 Cr.P.C.**, there is provision for award of compensation in addition to imprisonment or other penalty prescribed by the IPC, compensation may also have to be paid to the victim in criminal negligence.



Examples of Criminal Negligence:

1. Operation on wrong limb
2. Removal of wrong organ
3. Wrong blood transfusion
4. Leaving instruments in abdomen
5. Performing criminal abortion etc.

Differentiating Features Between Civil and Criminal Negligence

Civil negligence	Criminal negligence
Lack of reasonable care and skill in the professional behavior.	Gross carelessness and scant regard for patient's welfare.
A dispute between two parties in their individual capacity.	A case between the State and the accused doctor.
The injured party has an option to sue specific person or those falling in the chain of events.	Every person is responsible for his own act. And, there must be some personal act.
There can be no civil action for negligence if the negligent act or omission has not been attended by an injury/harm/damage to the patient.	Bare negligence involving the risk of injury is punishable criminally, though nobody is actually hurt.
Contributory negligence can be cited as a defence.	Contributory negligence does not constitute defence.
The standard of proof rests upon the balance of probabilities, i.e. was it more likely than not that the condition/damage/harm was caused by negligence rather than by some complication.	The standard of proof requires establishment of guilt 'beyond reasonable doubt'.
Accused doctor is liable to pay damages.	Accused doctor is punishable with imprisonment or fine or both as per provisions of the IPC.

Res Ipsa Loquitur

- It means, the thing speaks for itself.
- **This doctrine is applied both in civil and criminal negligence.**
- The legal and procedural effect of the Court's acceptance of res ipsa loquitur in a negligence action is to shift the burden of proof from the plaintiff (patient) to one of disproof by the defendant (Doctor).
- This doctrine cannot be applied against several defendants (i.e. doctors).
- To prove Doctrine of Res ipsa loquitur, the following conditions should be satisfied:
 1. **That in absence of negligence, the injury would not have occurred.**
 2. **Patient has not contributed to negligence.**
 3. **Doctor had exclusive control of the circumstances or injury producing instruments or treatment.**

E.g.: Amputation of wrong digit or limb, leaving a swab or instrument in abdomen of patient after operation etc.



Defences for a Doctor Against Medical Negligence

Contributory negligence

- This refers to any conduct or negligence on the part of the patient which has contributed to the damage alleged, although the doctor has also been negligent.
- In other words, here both doctor as well as patient is negligent.
- **The burden of proof lies on the doctor that the patient was negligent.**
- If proved the compensation payable will be reduced. (PARTIAL DEFENCE)

Products liability

- During the treatment, a doctor may use various products such as tablets, capsules, injections, stents, intramedullary nails, etc.
- If at all, damage occurs to the patient by the faulty/ defective/ adulterated/ contaminated products used by the doctor, then the manufacturer of the products will be held liable and not the doctor.

Corporate negligence

- It is the duty of the hospital to provide best care.
- Sometimes a patient may suffer from injury, arising as a result of inadequate accommodation, defective equipment, unsterile operation theatres, incompetent staff etc.
- In these cases, hospital becomes liable for negligence.

Misadventure

- Injury or death of an individual due to some inadvertent or unintentional act by a doctor, or his agent or hospital.
- But the doctor has to draw the patient attention to such potential risks and also should take possible steps to avoid such mishaps.

Medical maloccurrence.

- In some cases, despite good medical attention and care, an individual may fail to respond properly. This is called Medical mal occurrence.

Novus actus intervenience

- It means an unrelated action intervening.
- A person is responsible not only for his actions, but also for the logical consequences.
- This principle usually applies to cases of assault and accidental injury.
- It is applicable in a situation where the cause of disability or death passes from the original incident for which the doctor was responsible, to the later negligent action of some other person.

Doctrine of calculated risk

- In certain treatment procedures or operations, there is inherent risk or unavoidable risk.
- In such cases, the charge of negligence cannot be proved or stand against doctor.



Doctrine of error of judgment

- A doctor is not held responsible for negligence caused due to error of judgment in making diagnosis or judgment despite proper medical examination and appropriate investigations.

Difference Between Professional Negligence and Infamous Conduct:

Trait	Professional negligence	Infamous conduct
1. Offence	Absence of care and skill	Violation of code of medical ethics
2. Damage to person	Should be present	Need not be present
3. Duty of care	Should be present	Need not be present
4. Trial court	Civil and/or Criminal	State Medical Council
5. Punishment	Fine or imprisonment	Erasure of name or Warning
6. Appeal	To higher Court	To State or Central government



Concept 2.4 : Vicarious Liability

Learning objective: To know the meaning of vicarious liability, respondeat superior and borrowed servant doctrine

Time needed

1 st reading	10 minutes
2 nd look	5 minutes

Vicarious liability is a legal doctrine that assigns liability for an injury to a person who did not cause the injury but who has a particular legal relationship to the person who did act negligently. It is also referred to as imputed negligence.

- Legal relationships that can lead to imputed negligence include the relationship between parent and child, husband and wife, owner of a vehicle and driver, and employer and employee.

It has got two components, namely:

1. **Respondeat superior** (Latin=Let the master answer)

The conditions to be satisfied are

- i. There must be an employer-employee relationship.
- ii. The employee's conduct must occur within the scope of his employment.
- iii. While on the job.

2. **Borrowed servant doctrine**

When a visiting surgeon (not employed by that particular hospital) operates in a hospital, he uses the services of the paramedical staff of that hospital (employed by the hospital) during surgery. During this time, the visiting surgeon is responsible for the damages for any negligent actions of these paramedical staff.



Concept 2.5 : Professional Secrecy

Learning objective: To know the secrets of the patient to be kept by the doctor and privileged communication

Time needed

1 st reading	20 minutes
2 nd look	10 minutes

Professional Secrecy

- The doctor is obliged to keep secret of all the things about his patients, which he comes to know during his professional work.
- The rights of the patient are given by “**The Declaration of Lisbon 1995**”.
- Professional secrecy may be divulged by demand of the court.
- The secrets regarding a patient can be revealed for:
 1. Protection of individual
 2. Protection of the country
 3. Interest of justice.

Privileged Communication

- It is defined as “a bonafide statement made by doctor upon any subject matter to the appropriate authority to protect the interests of the community or of the State”.
- In other words, it is a statement made by a doctor, under legal, social, ethical or moral obligation to protect the interest of society to other authority concerned though such communication may, under normal conditions, amount to defamation or slander.
- While making a privileged communication, the communication should:
 - Be Made to Proper authority
 - Be Bonafede
 - Be without malice
 - Contain the facts alone regarding the issue.

Examples of privileged communication:

1. A syphilitic patient swimming in a public pool.
2. Engine or bus driver found to be color blind.
3. A person with infectious disease working as a cook.
4. A doctor’s duty is to notify birth, death, and infectious disease to public health authority.
 - Exceptions to the General rule of Professional Secrecy (“**CIVIC SIN**”)
 - C** - Crime
 - I** - Infections Disease
 - V** - Venereal Disease
 - I** - Interest (Self)



C - Courts of Law

S - Servant and Employee

I - Interest (Patient's)

N - Negligence suits/Notifiable diseases.

The doctor, when examining an under-trial prisoner in police custody, is not permitted to disclose the nature of illness of the patient to the authorities, unless expressly so desired by the patient himself. But convicted person has no such right to prevent the doctor from disclosing the nature of illness or result of the examination to the authorities.



Concept 2.6 : Consent

Learning objectives: To know the different types of consent and the rules and regulations of consent.

Time needed

1 st reading	40 minutes
2 nd look	20 minutes

Definition: Consent means voluntary agreement, compliance or permission. Two or more persons are said to consent when they agree upon the same thing in the same sense (**Section 13 of Indian Contract Act**)

Types of consent:

I. **Implied consent:** Consent is said to be implied when it is not expressed and when it results from the circumstances of the particular case or the status of the patient. Implied consent presents itself in three different manners in the field.

1. **Circumstantial consent:** Consent may be implied from the conduct of the patient. e.g., Patient extends his arm when told by the provider that he wanted to start an IV; patient lifts his shirt when told that it was necessary to listen to his lung sounds.

2. **Incompetent patients:** Implied consent also arises in emergency situations when the patient is unconscious or his ability to make a rational judgement about treatment is severely impaired by illness, injury, shock, drugs, alcohol or mental disease. The legal theory underlying this form of consent is that it would be reasonable for a provider to assume that the patient would consent to treatment if conscious and competent to do so. This is often referred as the emergency doctrine.

3. **Minor patients:** Where an emergency exists, emergency personnel may also provide treatment to a minor using the principle of implied consent. Under such circumstances, it is presumed that the parent or guardian, if available, would have wanted care to be provided and would have granted consent.

II. **Express consent** is one, the terms of which are stated in distinct & explicit language. It may be oral or written.

Validity of oral consent is as valid as written consent, if properly witnessed.

Unintentional act towards a person without consent amounts to trespass.

Intentional act towards a person without consent amounts to assault.

There are seven basic ingredients that go to form a valid consent.

Firstly, the person giving the consent must be competent to give consent. Generally, when a patient attains the age of 18 years complete and above he is competent to give consent.

Secondly, he should be of sound mind.

Thirdly, consent should be given of free will. There should not be any force, fear, fraud, coercion or favor.

Fourthly, consent should be an intelligent consent. The doctor should tell the patient in his own language and make sure that he has understood completely.



Fifthly, the consent should be specific. The doctor should not exceed the limit of authorization except while performing the procedure he discovers a pathology, which if not removed at that time would put the patient's life in imminent danger.

Sixthly, consent should be an informed consent (the most important ingredient). Failure to inform amounts to negligence. The ingredients of informed consent are

- a) Diagnosis.
- b) Nature of treatment or procedure.
- c) Risks involved
- d) Prospects of success.
- e) Prognosis if the procedure is not performed, and
- f) Alternative method of treatment.

Definition of informed consent: It is the consent given by a competent individual, who are received the necessary information, and adequately understood the information, and who after considering the information, has arrived at a decision without having been subjected to coercion, undue influence, inducement or intimidation.

Therapeutic Exceptions (Therapeutic Privilege)

The doctor can withhold certain pieces of information, which may be determined to the patient's state. However, **"If the risk untoward result is statistically high, the patient should be informed regardless of the effect on his morale. If the risk is statistically low, but the consequences of a rare untoward occurrence may be severe, the patient should likewise be informed. On the other hand, if the statistical risk is low or the severity of the risk is not great, the physician may safely tailor his warning so as not to excite the patient's fears"**.

Seventhly, the consent should be expressed better in writing, signed by the patient, and witnessed by two independent witnesses. One of them should be patients near relative.

Consent may not be necessary in cases of:

1. **Emergency:** An unconscious patient/a child/mentally ill patient in an emergency.
2. When a **Medico-legal case** is referred by a court of Law for examination.
3. **Waiver:**
 - An example for waiver of consent can be found in a state law regarding an abortion facility or physician obtaining written consent of the parent or legal guardian of the minor prior to performing abortion on that minor. However, if the minor does not wish to seek the consent of the parents or legal guardian, the minor can petition the juvenile court for waiver of consent requirement.
 - Public benefit or service programme.

Doctrine of Loco parentis

- In an emergency involving children, when parents are not available or legal guardians are not available, consent from the person-in-charge of that child can be taken.

Section 90 of IPC:

Consent known to be given under fear or misconception.— A consent is not such a consent as it intended by any section of this Code, if the consent is given by a person under fear of injury, or under a misconception of fact, and if the person doing the act



knows, or has reason to believe, that the consent was given in consequence of such fear or misconception; or Consent of insane person.—if the consent is given by a person who, from unsoundness of mind, or intoxication, is unable to understand the nature and consequence of that to which he gives his consent; or Consent of child.—unless the contrary appears from the context, if the consent is given by a person who is under twelve years of age.

Section 90 I.P.C. defines consent in **negative** terms.

As per this section, any consent given under the following five circumstances will not be a true consent. The consent becomes invalid if given by a person:

1. Under fear of injury or
2. Under a misconception of the fact or
3. Who from intoxication is unable to understand the nature and consequences or
4. Who from unsound mind is unable to understand the nature and consequences or
5. Who is below the age of 12 years.

Important Rules of Consent

- Doctrine of **NON-FIT-INJURIA**- If an individual gives consent to suffer any harm or injury, he cannot claim damages for the same.
- While taking consent of a patient, if doctor fails to provide the patient the required information regarding the disease or operation or treatment modality, the doctor may be charged for negligence.
- Not taking consent is considered as a deficiency in medical services **under the Section 2(1) of the Consumer Protection Act**
- A woman should not be examined without her consent in medico-legal cases such as rape, pregnancy, abortion etc.
- **Doctor can examine without consent even by using reasonable force, if a person is arrested on a charge of committing an offence and a sub-inspector of police gives requisition [Sec.53 (1) Cr.P.C.].**
- A prisoner can be treated without his consent.
- Consent for an illegal act such as criminal abortion is not valid.
- A consent given by a person under fear of injury or an intoxicated person is not valid.
- Any harm caused to a person in good faith even without that person's consent is not an offence if the person cannot signify consent.
- Consent must be taken just before the surgical procedure, but not during/after/long before the surgical procedure.
- It is the duty of treating physician to take the consent, not any other person like assistants, residents, interns, nurses etc.
- The people who are doing hunger strike, as well as prisoners can be fed forcibly without consent.
- If a victim of rape refuses to give consent, she cannot be compelled to undergo physical examination.



Concept 2.7 : Euthanasia (Mercy Killing)

Learning objective: To know the rules of euthanasia, different types of euthanasia and law in relation to euthanasia.

Time needed

1 st reading	30 minutes
2 nd look	15 minutes

Definition: Putting a person to painless death, who is suffering from hopelessly incurable and painful disease or when life becomes purposeless as a result of mental or physical handicap.

- Euthanasia advocates the administration of lethal doses of opium or other narcotic drugs.
- First country to legalize euthanasia is Netherlands.** Now it is legalized in Belgium, Luxemburg, Switzerland, Thailand etc.
- Dr. Jack Kevorkian is known as "Dr. Death", who has assisted in the death of 130 people.
- In March 2018, the Supreme Court of India, passed a historic judgement-law permitting Passive Euthanasia in the country. The Supreme Court specified two irreversible conditions to permit Passive Euthanasia Law in its 2011 Law: (I) The brain-dead for whom the ventilator can be switched off (II) Those in a Persistent Vegetative State (PVS) for whom the feed can be tapered out and pain-managing palliatives be added, according to laid-down international specifications.
- The Supreme Court on Friday, March 09, 2018 delivered a landmark judgment allowing "living will" where, an adult in his conscious mind, is permitted to refuse medical treatment or voluntarily decide not to take medical treatment to embrace death in a natural way. In the 538-page judgment, the court laid down a set of guidelines for "living will" and defined passive euthanasia and euthanasia as well.
- The court stated the rights of a patient would not fall out of the purview of Article 21 (right to life and liberty) of the Indian Constitution.
- The Bench comprising Chief Justice of India Dipak Misra and Justice A M Khanwilkar defined advance medical directive. In case where an individual may not be in a position to specify his wishes, an advance medical directive can be pursued by the individual exercising his autonomy on the subject of the extent of medical intervention that he wishes to allow upon his own body at a future date.
- Defining advance medical directive, the bench said, "The purpose and object of advance medical directive is to express the choice of a person regarding medical treatment in an event when he loses the capacity to take a decision. The right to execute an advance medical directive is nothing but a step towards protection of aforesaid right by an individual."

Guidelines Laid Down by The Top Court:

1. Who can execute the advance directive and how?

The advance medical directive can only be executed by an adult who is of a sound and healthy state of mind and in a position to communicate, relate and comprehend the purpose and consequences of executing the document.



It must be voluntarily executed and without any coercion or inducement or compulsion and after having full knowledge or information. Consent of the individual is necessary and it shall be in writing "stating as to when medical treatment may be withdrawn or no specific medical treatment shall be given which will only have the effect of delaying the process of death that may otherwise cause him/her pain, anguish and suffering and further put him/her in a state of indignity."

2. What should the written document contain?

It should clearly indicate the decision relating to the circumstances in which withholding, or withdrawal of medical treatment can be resorted to. Specific terms should be mentioned, and instructions must be absolutely clear and unambiguous. It should have a clause stating that the executor may revoke the instructions/authority at any time.

The document should further disclose that the executor has understood the consequences of executing such a document. Name of a guardian or a close relative should be specified in the event where the executor becomes incapable of taking a decision. The said guardian or close relative will be authorized to give consent to refuse or withdraw medical treatment in a manner consistent with the Advance Directive.

The guidelines further direct to record and preserve the document. Signed by the executor in the presence of two attesting witnesses and countersigned by the jurisdictional Judicial Magistrate of First Class (JMFC) appointed by the District judge. Adding on, one copy of the document would be preserved by the JMFC in his office, in hard copy and digital form, another would be forwarded to the Registry of the jurisdictional District Court, another copy would be handed over to the competent officer of the local Government or the Municipal Corporation or Municipality or Panchayat and the fourth copy would be given to a family physician, if any.

Detailed pointers have been set in case the executor becomes terminally ill, in which case, the instructions in the document must be given due weight by the doctors. A Medical Board would be constituted by the hospital or the physician where, the executor is admitted.

In case permission to withdraw medical treatment is refused by the Medical Board, it would be open to the executor of the Advance Directive or his family members or even the treating doctor or the hospital staff to approach the High Court by way of writ petition under Article 226 of the Constitution.

The individual has been provided with the right to withdraw or alter the Advance Directive as well. The court also drew a scenario in the event of the absence of an Advance Directive. In such a case, a Hospital Medical Board would be constituted where the individual is admitted.

If the patient is terminally ill and undergoing prolonged treatment in respect of ailment which is incurable or where there is no hope of being cured, the physician may inform the hospital which, in turn, shall constitute a Hospital Medical Board.

On the subject of administration of a lethal drug, the court held that "no one is permitted to cause death of another person including a physician by administering any lethal drug even if the objective is to relieve the patient from pain and suffering".

The top court also reiterated from Gian Kaur's case that the right to life does include right to live with human dignity which would mean, "the existence of such right up to the end of natural life, which also includes the right to a dignified life upto the point of death including a dignified procedure of death."



Classification:

1. **Active Euthanasia:** Inflicting painless death by an act of commission e.g. injecting large doses of barbiturates/KCl/curare etc.
2. **Passive Euthanasia:** Inflicting painless death by an act of omission e.g. withdrawal of life saving measures/life support.
3. **Voluntary Euthanasia:** With the consent of the dying person.
4. **Involuntary (Compulsory) Euthanasia:** Without/against the consent of the person.
5. **Non voluntary Euthanasia:** The person is incapable of making their wishes known, e.g. irreversibly comatose patient, severely defective patients.
6. **Battlefield Euthanasia:** Killing of a severely wounded individual.



Concept 2.8 : Health Related Declarations of World Medical Association

Learning objectives: To know the various health declarations of WMA

Time needed

1 st reading	20 minutes
2 nd look	10 minutes

Name	Subject
Declaration of Geneva	Modernized Version of Hippocratic Oath
Declaration of Hamburg	Support for doctors refusing to participate in torture or other forms of cruel, inhuman or degrading treatment
Declaration of Helsinki	Human Experimentations and Clinical Trials
Declaration of Istambul (Istambul Protocol)	Organ Trafficking and Transplant Tourism First set of International guidelines for documentation of torture and its Consequences.
Declaration of Lisbon	The rights of the patient
Declaration of Malta	Role of Doctors in Hunger strike
Declaration of Munich	Racial, political discrimination etc. in medicine
Declaration of Oslo	Therapeutic Abortion
Declaration of Sydney	Definition of Death (Brain death)
Declaration of Tokyo	Torture and other cruel and degrading treatment or punishment
Declaration of Venice	Terminal illness
Declaration of London	International code of Medical Ethics
Declaration of Madrid	Professional Autonomy and Self-regulation

CONCEPTS

- ⇒ Concept 3.1 **Corpus Delecti**
- ⇒ Concept 3.2 **Determination of Race**
- ⇒ Concept 3.3 **Indices to Differentiate Sex from Bones**
- ⇒ Concept 3.4 **Determination of Sex by Nuclear Sexing**
- ⇒ Concept 3.5 **Intersex States**
- ⇒ Concept 3.6 **Sex Determination by Bones**
- ⇒ Concept 3.7 **Age Determination by Teeth**
- ⇒ Concept 3.8 **Age Determination by Ossification Centres**
- ⇒ Concept 3.9 **Age Determination by Sutural Closure**
- ⇒ Concept 3.10 **Height and Weight of a Child**
- ⇒ Concept 3.11 **Medicolegal Importance of Age**
- ⇒ Concept 3.12 **Estimation of Stature from Long Bones**
- ⇒ Concept 3.13 **Developmental Changes in a Foetus**
- ⇒ Concept 3.14 **Dactylography**
- ⇒ Concept 3.15 **Other Methods of Identification of a Person**
- ⇒ Concept 3.16 **Scars**



Concept 3.1 : Corpus Delicti

Learning objective: To know what is corpus delicti

Time needed

1 st reading	5 minutes
2 nd look	2 minutes

- **Corpus Delicti: Corpus delicti (body of offence, essence of crime*) means, the facts (elements) of any criminal offence e.g. murder.**
- In a charge of homicide, the two essential requirements are
 - positive identification of the victim and
 - the proof of death by the criminal act of the accused.
- The main part of corpus delicti is the establishment of identity of the dead body.



Concept 3.2 : Determination of Race

Learning objective: To know the indices and other various features to differentiate between races.

Time needed

1 st reading	30 minutes
2 nd look	15 minutes

Cephalic Index (C.I.)

Helps to determine the race of an individual

C.I. = (Maximum breadth of skull / Maximum length of skull) x 100

Type of skull	C.I.	Race
Dolico-cephalic(long-headed)	70-75	Pure Aryans, Aborigines and Negroes.
Mesaticephalic (medium headed)	75-80	Europeans, Chinese and Indians
Brachycephalic (short headed)	>80	Mongoloids

Other Indices to Differentiate Race

By measuring the length of different long bones:

- 1. Brachial index** (Radio-humeral index) = Length of Radius / Length of Humerus x 100
- 2. Crural index** (Tibio-femoral index) = Length of Tibia / Length of Femur x 100
- 3. Intra-membral index** (Humero-femoral index) = Length of Humerus / Length of Femur x 100
- 4. Inter-membral index** = Length of Humerus + length of Radius / Length of Femur + length of Tibia x 100

Differentiating features of hairs in different races			
Characters	Caucasians	Mongolian	Negro
Feature:	Straight or wavy, blondes brown or fair.	Coarse, straight or wavy, black or brown	Thick, woolly, curly and self spiraled
Diameter	70-100 µm	90-120 µm Round	60-90 µm Flattened
Cross-section	Oval	Round	Flattend
Pigmentation	Uniform distribution	Dense abundant through the cross-section	Dense and clumped towards the periphery
Cuticle	Medium	Thick	–
Undulation	Uncommon	Rare	Prevalent



Differentiating points between races			
Features	Caucasians	Mongolian	Negro
Complexion	Fair	Yellowish	Black
Eye: (Iris colour)	Gray or blue	Black	Black
Forehead	Raised	Inclined backward	Small and compressed
Nasal aperture	Narrow and elongated	Rounded	Broad
Nose	Sharp	Flattened	Blunt
Face	Small	Large and flattened	Jaw projecting, malar bone prominent, teeth set obliquely
Hard palate	Triangular	Large and flattened	Rectangular
Upper extremity	Normal	Small	Large in proportion to body Forearm large in proportion to arms Hand small
Lower extremity	Normal	Small	Leg large in proportion to thigh Feet wide and flat Heel bone projecting backward



Concept 3.3 : Indices to Differentiate Sex from Bones

Learning objective: To know the different indices to differentiate sex from bones.

Time needed

1 st reading	10 minutes
2 nd look	5 minutes

- 1. Sternal index:** Length of Manubrium/Length of Body x 100,
Males: 46.2, Females: 54.3
- 2. Ischio-pubic index** (Washburn index): Length of Pubis/Length of Ischium x100
Males: 73-94, Females: 91-115
- 3. Sciatic notch index:** Width of Sciatic notch/Depth of Sciatic notch x 100
Males: 4-5, Females: 5-6
- 4. Sacral Index:** Width of Sacrum/Length of Sacrum x 100,
Males: < 114, Females: > 114
- 5. Corporo-basal index:** Length of Body of S1/Length of Base of Sacrum x 100
Males:45, F: 40.5 (Only index, which is more in Males)
- 6. Medullary Index** (Also to differentiate human hair from animal hair):
Diameter of Whole bone/Diameter of Medulla x 100
Ideal bones for Medullary index are: Tibia, Humerus, Radius, Ulna (HURT)

Concept 3.4 : Determination of Sex by Nuclear Sexing

Learning objective: Determination of sex by Barr bodies, Davidson body and Y chromosome

Time needed

1 st reading	20 minutes
2 nd look	10 minutes

1. Barr Bodies (Sex Chromatin):

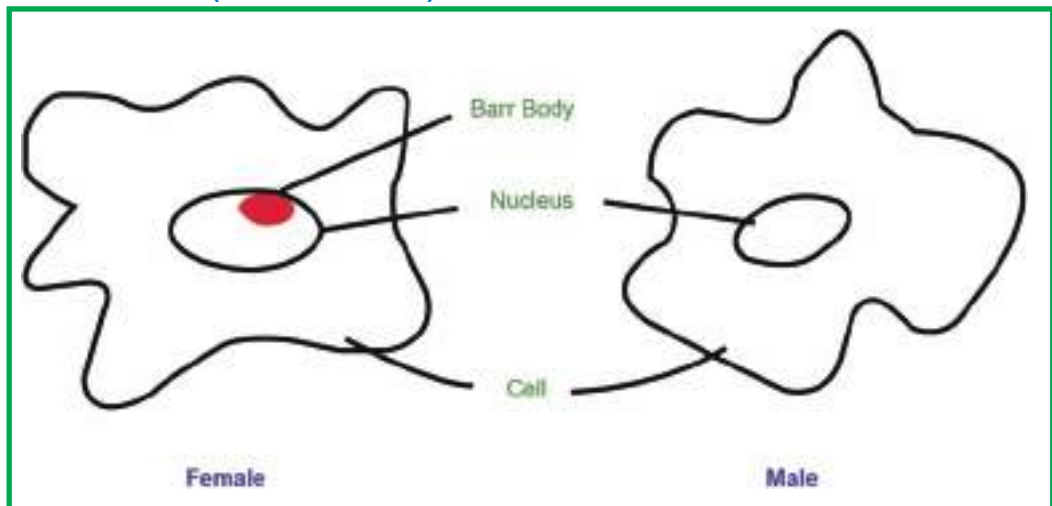


Fig. 3.1

- According to Lyon's hypothesis, this nodule is nothing but an inactivated X-chromosome.
- Barr bodies are demonstrated in the cells of buccal mucosa, skin, cartilage, nerve, amniotic fluid, polymorphs and lymphocytes (Memorizer: B.S.c. Nurses Are Predominantly Ladies).
- In a buccal smear, the Barr bodies are seen in 20-80% of cells in females, and in 0-4% of cells in males.
- In human head hair, Barr bodies are found in hair follicles in a proportion of $29 \pm 5\%$ in females and $6 \pm 2\%$ in males
- To diagnose sex as female, buccal smear must show at least 20-30% Barr bodies.
- The females are known as Chromatin positive and males as Chromatin negative.
- Feulgen reaction is the best staining technique for demonstration of Barr bodies, though the hemotoxic eosin method can also be used.

Staining for X chromosomes

- Schiff reagent: Fluorescent Feulgen reaction using acriflavin;
Chromatin positivity: 50-70% in females and 0-2% in males.
- FISH (Fluorescent in situ hybridization)



2. Davidson-Smith Body

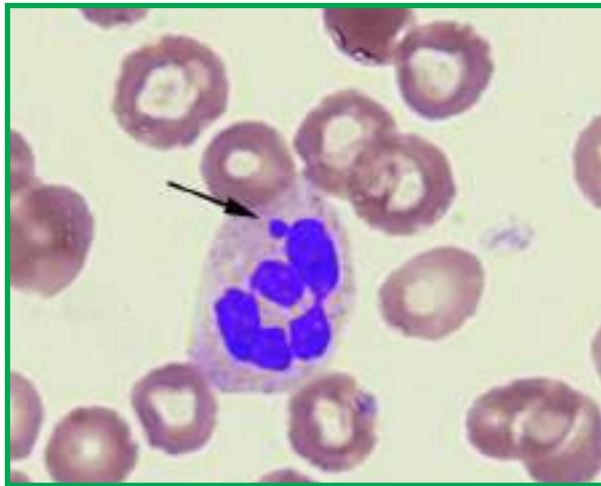


Fig. 3.2

- In females, neutrophil leucocytes contain a small nuclear attachment in the form of thin stalked drumstick, known as Davidson body.
- To diagnose sex by Davidson body, the peripheral smear must show minimum of 6% counts.
- Davidson bodies are not seen in males.

3. Y- Chromosomes

- The 'Y' Chromosomes present in males are fluorescent for the dye Quinacrine dihydrochloride.
- Chromatin positivity: 45-80% in males and 0-4% in females.
- Blood stains, cartilage, bone marrow, teeth pulp and hair root pulp can be used as specimens.
 - Sex chromatin cannot be made out in decomposed bodies; but by using fluorescent dyes, **Y chromosomes can be demonstrated up to 1 year after death in dental pulp tissue**, the F-bodies are seen in 30-70% of cells in males and 0-4% in females.



Concept 3.5 : Intersex States

Learning objective: To know the congenital and developmental anomalies in sex.

Time needed

1 st reading	20 minutes
2 nd look	10 minutes

These are the conditions wherein both male and female characters coexist in varying degrees in the same individual. It can be divided into 4 groups:

i. Gonadal Agenesis

- Gonads (either ovaries or testes) fail to develop. The nuclear sex is chromatin negative.

ii. Gonadal Dysgenesis

- External genital organs are present, but the testes or ovaries fail to develop at puberty.

E.g. Klinefelter's syndrome & Turner's syndrome.

Klinefelter's Syndrome

- Anatomical structure is male, but the nuclear sexing is female (chromatin positive).
- There are 2 or more X chromosomes and 1 or more Y chromosomes; but the classical pattern is associated with **47XXY** karyotype.
- Intelligence is usually normal; however, reading difficulties and problems with speech are more common.
- Symptoms are typically more severe if three or more X chromosomes are present.
- It is usually diagnosed when there is a delay in onset of puberty. The boy grows and develops normally until puberty. Later 1 or more of the 3 classical features become apparent.

1. **Gynecomastia (usual finding).**

2. Testes are small & firm in consistency, associated with a small penis, aspermia and **hyalinised testis** (histologically).
3. Sexual Eunuchoidism: The person is usually tall with long arms & legs, scanty pubic hair, axillary hair, chest hair, beard & moustache and thin voice.

Turner's syndrome

- Anatomical structure is female and nuclear sexing is male (chromatin negative).
- The chromosomal pattern is **45 XO**.
- This syndrome is characterized by 3 principal features:
 1. Short stature.
 2. Congenital anomalies like web neck, shield chest, wide-set nipples, cubitus valgus, **bicuspid aortic valve (Most common heart defect – 30%)**, coarctation of aorta (5-10%), septal defect, aortic dissection, osteoporosis, renal abnormalities, red green color blindness, pigmented naevi, short 4th metatarsal, dyslexia, high-arched palate, low-set ears, spina bifida, low posterior hairline, etc.



3. **Sexual infantilism:** Primary amenorrhea, sterility, grossly undeveloped breast, scanty pubic & axillary hair, infantile vagina, infantile fallopian tubes and ovaries containing fibrous tissue without ovarian follicles (**streak ovaries**).

iii. True Hermaphroditism

- It is a very rare condition of bisexuality in which both an ovary and a testicle, or 2 ovo-testes are present with external genitalia of both sexes.
- There may be presence of uterus.
- Phallus may be penile or clitoral.
- The labia may be bifid as in female or fused resembling the scrotum of males. Neither gonad is completely functional.
- The sex chromatin may be male or female

iv. Pseudo-Hermaphroditism

There are two types of pseudo-hermaphroditism:

a. Male pseudo-hermaphroditism

- ▶ Nuclear sex is XY
- ▶ **There is presence of testis** in the abdomen or inguinal canal, but the external genitalia is of female form.
- ▶ Characterized by **female external genitalia**, primary amenorrhea, normal sized breasts, scanty or absent axillary or pubic hair, **due to testicular feminization**.
- ▶ **5-a reductase deficiency occurs.**

b. Female pseudo-hermaphroditism

- ▶ Nuclear sex is XX
- ▶ **External genitalia are male form due to adrenal hyperplasia.**
- ▶ **21 hydroxylase deficiency is most common**

Gonadal Biopsy: This is a confirmatory method of determining sex. In all the disputed sexual identity cases, gonadal biopsy is called for. Biopsy from primary gonads, i.e. testes in case of male and ovaries in case of female, can indicate definitely about the actual sex of an individual.



Concept 3.6 : Sex Determination by Bones

Learning objective: To know the features in bones to differentiate between male and female

Time needed

1 st reading	30 minutes
2 nd look	15 minutes

MALE	FEMALE
PELVIS (HIPBONE + SACRUM)	
1. Subpubic arch narrow, 'V' shaped 70° to 75°	Subpubic arch wide, 'U' shaped 90° to 100°
2. Greater sciatic notch narrow, deep and less than right angle	Greater sciatic notch wide, shallow and almost a right angle or even more
3. Body of the pubis triangular	Body of the pubis square
4. Preauricular sulcus narrow, shallow and without marked edges	Preauricular sulcus broad and deep in parous women.
5. Ischial tuberosities inverted	Ischial tuberosities everted
6. Sacrum long and narrow	Sacrum wide and short
7. Sacral promontory prominent	Sacral promontory not prominent
8. Auricular surface of the sacrum extends 2.5 to 3 vertebral bodies	Auricular surface of the sacrum extends 2 to 2.5 vertebral bodies
FEMUR	
1. Neck-shaft angle more obtuse	Neck-shaft angle less obtuse
2. Auricular surface of the head forms more than 2/3 of the sphere	Auricular surface of the head forms less than 2/3 of the sphere
3. Outer angle of the femur is around 80°	Outer angle of the femur is around 76°
4. Bicondylar width more (74-89mm)	Bicondylar width less (67-76mm)
MANDIBLE	
1. Chin (Symphysis menti) is square	Chin is pointed or rounded
2. Angle region everted	Angle region not everted
3. Symphyseal height more	Symphyseal height less
4. Ramus more broad	Ramus less broad
CRANIUM	
1. Glabella, supra-orbital ridges, mastoid process, occipital protuberance, occipital condyles and muscular attachments more pronounced	Glabella, supra-orbital ridges, mastoid process, occipital protuberance, occipital condyles and muscular attachments less pronounced
2. Fronto-nasal angulation distinct	Fronto-nasal angulation not well marked
3. Frontal & parietal eminences less prominent	Frontal & parietal eminences more prominent
4. Orbital opening comparatively big and rectangular	Orbital opening comparatively small and rounded



Krogman's Table

Percentage of accuracy in determination of sex from bones

Pelvis	95%
Skull	90-92%
Long Bones	80%
Pelvis + Skull	98%
All 206 bones	100%

Chilotic Line

It is useful in determination of sex

- Males - Sacral part of chilotic line more prominent
- Females - Pelvic part of chilotic line more prominent

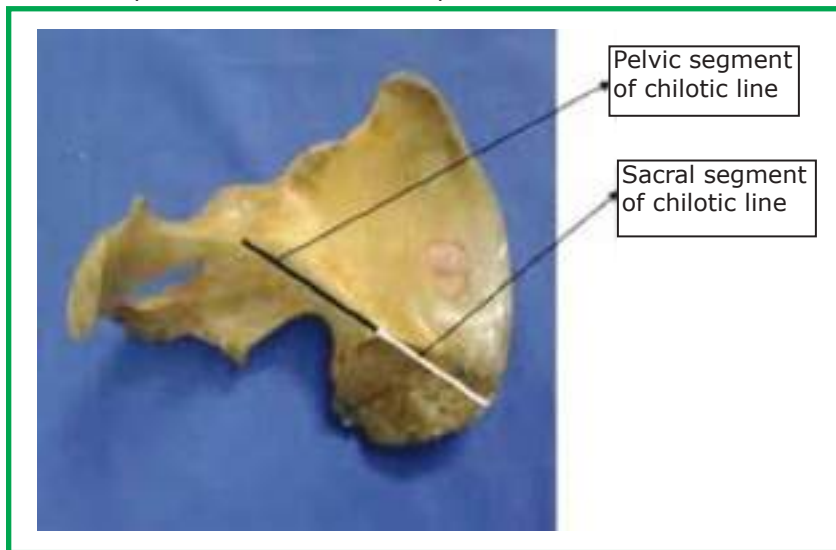


Fig. 3.3

Sex differentiation from bones can be done only before puberty; but sex can be differentiated by the greater sciatic notch, even in fetus.

Best criteria in pelvis to determine sex is Sciatic notch index.

Pre-Auricular Sulcus is a Tertiary sexual characteristic.

Perforated olecranon fossa is more common in females on the left side.



Concept 3.7 : Age Determination by Teeth

Learning objective: To know the determination of the age of an individual by the eruption of temporary and permanent teeth

Time needed

1 st reading	40 minutes
2 nd look	20 minutes

- There are two sets of teeth
 1. Temporary / Milk / Deciduous teeth.
 2. Permanent teeth.

Temporary Teeth

- There are 5 teeth in each quadrant. Total number of the teeth $5 \times 4 = 20$.
- From medial to lateral - central incisor, lateral incisor, canine, first molar and second molar.

Age of Eruption of Temporary Teeth:

Lower central incisors	6 – 8 months
Upper central incisors	7 – 9 months
Upper lateral incisors	7 – 9 months
Lower lateral incisors	10 – 12 months
First molars	12 – 14 months
Canines	17 – 18 months
Second molars	20 – 30 months

*Complete root calcification occurs at about $1-1\frac{1}{2}$ years after the eruption of teeth.

Permanent Teeth:

- There are 8 teeth in each quadrant. Total number of the teeth are 32.
- From medial to lateral -> central incisor, lateral incisor, canine, first premolar/ bicuspid, second premolar/ bicuspid and third molar/tricuspid.
- Complete root calcification occurs at about 2-4 years after the eruption of the teeth.
- Calcification of first molar begins at birth and calcification of third molar at 8-10 years.

Age of Eruption of Permanent Teeth:

First molars	6 years
Central incisors	7 years
Lateral incisors	8 years
First bicuspid	9 years



Second bicuspid	10 years
Canines	11 years
Second molars	12 years
Third molars	18 – 25 years

Early tooth eruption is seen in Syphilis, may be at birth.

Delayed tooth eruption is seen in Hypothyroidism (Commonest cause),

Hypopituitarism, and Rickets, Down's syndrome, Cleido-cranial dysplasia, Cysts and Supernumerary teeth.

Different Methods of Age Estimation

1. Gustafson's Method

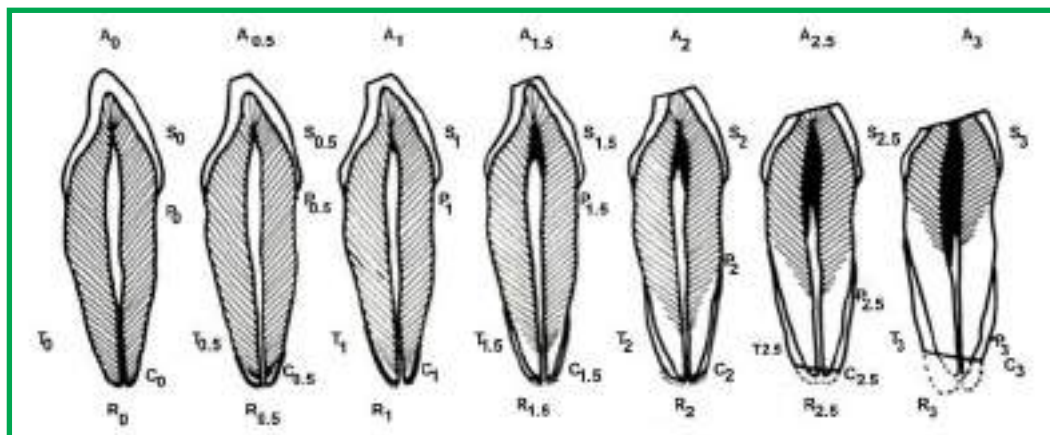


Fig. 3.4

The age estimation of adults over 25 years depends on the physiological age changes in each of the dental tissue. The various criteria used in Gustafson's method is:

A – Attrition (Wear and tear)

P – Periodontosis (Loosening of teeth)

S – Secondary dentine formation (Infilling of root cavity)

R – Root resorption

T – Translucency of the root

C – Cementum apposition (Increase in the tissue holding the tooth in position)

Arbitrarily, 0 to 3 points are allotted to indicate the degree of any of these changes.

Stage 0 indicates no change.

Stage 1 indicates beginning of change.

Stage 2 indicates obvious change.

Stage 3 indicates maximum change, occurring in the dental tissue.

Total score points = $A_n + P_n + S_n + C_n + R_n + T_n$.



The total score obtained from this formula is applied to a regression formula:

Estimated age (years) = $11.43 + 4.56 \times (\text{total points}) \pm 3.63$ years.

The error is said to be ± 4 to 7 years.

1. The limit of **error increases above 50 years** of age.
2. **All changes are absent at 15 years.**
3. It is applicable in dead persons only (**It is a post-mortem procedure**).
4. Some adjustment in final calculation may be done in case of people with bad oral hygiene.
5. The tooth is ground down on glass slabs from both the sides to about 1mm, which allows the estimation of transparency. Then the section is ground further down to 1/4th mm for microscopic examination.
6. **Translucency is seen after 30 years of age.**

2. Boyde's Method

- Cross striations in the enamel and dentine of deciduous teeth and permanent first molars represent daily **incremental lines**.
- Studied by histological sections.
- The age of an individual can be calculated by counting the number of lines from neonatal line onwards. Neonatal line is considered as an indicator of birth
- This method is applicable mainly to infants.
- The age so calculated is accurate with an error of around 20 days.

3. Stack's Method

- Estimation of the age of infants from the **weight and height of the erupting teeth** of child. It is used on both deciduous and permanent during their erupting phase.

4. Mile's Method

- **This is used by studying only the root transparency of a tooth after the age of 30 years.**

5. Lamendil's Method:

- Estimation of age from using only 2 criteria namely,
 1. Gingival Recession and
 2. Root Transparency



Concept 3.8 : Age Determination by Ossification Centres

Learning objective: To know the estimation of the age of an individual by appearance and fusion of ossification centres.

Time needed

1 st reading	60 minutes
2 nd look	30 minutes

The appearances and fusions of ossification centres depends on geographic, hereditary, nutritional and other factors.

(There are variations in the appearance and fusion of ossification centres in different books. This is as per TB of FMT by Dr. Anil Aggrawal)

Wrist Joint

Ossification Centre	Appearance	Fusion
Capitate	2 months	–
Hamate	3 months	–
Triquetral	3 years	–
Lunate	4 years	–
Scaphoid, Trapezium, Trapezoid	4 – 5 years	–
Pisiform	9 – 12 years	–
Lower end of Ulna	6 years	19 years
Lower end of Radius	2 years	19 Years

Elbow Joint

Ossification Centre	Appearance	Fusion
Capitulum	1 year	-
Medial Epicondyle	5-7 years	15 years (F) 16 years (M)
Trochlea	10 years	–
Lateral Epicondyle	11 years	–
Conjoint Epiphysis (By the fusion of Lateral epicondyle, Trochlea and Capitulum)	Formed at 12 years (F) and 13 years (M)	14 years (F) 15 years (M)
Upper end of radius	5 years	16 years
Upper end of ulna	9 years	16 years



Shoulder Joint

Ossification Centre	Appearance	Fusion
Head	1 year	–
Greater Tubercle	3 years	–
Lesser Tubercle	5 years	–
Conjoint Epiphysis	6 years	18 years
Acromion Process	16 years	20 years

Hip Joint

Ossification Centre	Appearance	Fusion
Head of femur	1 year	17 years
Greater trochanter	4 years	17 years
Lesser trochanter	14 years	17 years
Tri-radiate Cartilage	13 years	15 years
Iliac crest	14 years	20 years
Ischial Tuberosity	16 years	20 years

Knee Joint

Ossification Centre	Appearance	Fusion
Lower end of Femur	9 th month of IUL	18 years
Upper end of Tibia	10 th month (At birth)	18 years
Upper end of Fibula	4 years	18 years

Ankle Joint

Ossification Centre	Appearance	Fusion
Lower end of Tibia	1 year	17 years
Lower end of Fibula	1 year	17 years

Growth in Individual Bones (Ossification of Bones)

Number of Ossification Centers at 8th week of IUL are 806 and at birth are 450

First ossification centre to appear is shaft of clavicle at 5-6 weeks of I.U.L. Second centre in lower jaw (6th week of I.U.L.)

The inner end of clavicle is the last ossification centre to appear (18-20 years) and last to fuse (25 years) – Gray's anatomy

Patella ossifies from multiple centers at 3 to 6 years and becomes a single bone at puberty.

Calcification of hyoid bone and thyroid cartilage occur after the age of 40 years



The two halves of the mandible unite at the 2nd year

Hyoid Bone- The greater cornu unites with the body between 40 and 60 years.

Sacrum: The five pieces of sacrum start fusing from below upwards at the age of puberty and becomes a single bone between 21 and 25 years

Mandible: Angle of Mandible -> In old age and children, ramus of mandible makes obtuse angle with the body about 140°. Mental Foramen moves towards alveolar margin with age

"GREULICH AND PYLE" METHOD:

It is a technique for evaluating the bone age of children by using a single x-ray of the left hand, fingers, and wrist. The bones in the x-ray are compared to the bones of a standard atlas.

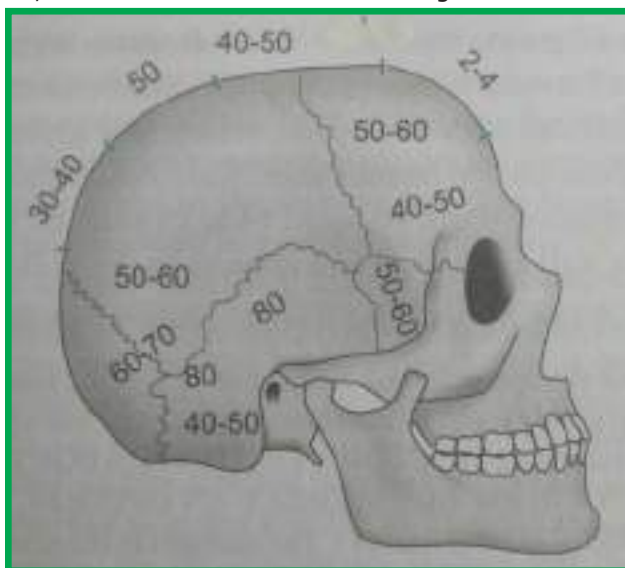
Concept 3.9 : Age Determination By Sutural Closure

Learning objective: To know age estimation by the cranial sutural closure and details on sutures

Time needed

1 st reading	20 minutes
2 nd look	10 minutes

- Endo-cranial sutures close 5-10 years earlier than ectocranial sutures.
- Endocranially, sutural closure is more uniform and more complete.
- In many skulls, fusion of sutures at the ectocranial surface may remain incomplete. This is called 'lapsed union' and occurs most often in the sagittal suture.
- On the outer side, the fusion occurs in the following order:



- Metopic suture at 2-4 years, may extend to 6 years.
- Posterior one-third of sagittal suture at about 30-40 years.
- Anterior one-third of sagittal and lower half of coronal at about 40-50 years.
- Middle sagittal and upper half of coronal at about 50-60 years.
- Lower half of coronal suture at 40-50 years.
- Upper half of coronal suture at 50-60 years.
- Inner half of lambdoid suture at 50-60 years.
- Outer half of lambdoid suture at 60-70 years.
- Temporo-parietal suture at 80 years.
- The basi-occiput fuses with the basi-sphenoid at 18 to 21 years.
- In the lambdoid suture, fusion activity starts late, and the progress is also slow.



- The closure starts around 25–30 years near the asterion, and the peak or maximum closure occurs at about 55 years.
- Estimation of age by sutural closure of skull is not reliable. It can be given only in the range of a decade.
- Cranial sutures close later in females than males.
- Out of all cranial sutural closures, sagittal suture is more reliable than lambdoid, and lambdoid is more reliable than coronal (Ss.L.C.).
- Closure of sagittal suture starts at the age of 20-25 years
- Closure of coronal suture starts at the age of 30-35 years
- Closure of lambdoid suture starts at the age of 40-45 years
- Masto-occipital suture is the last to fuse
- Closure of all sutures indicates age more than 60 years
- Lateral and occipital fontanelles usually close within the first 2 months
- The posterior fontanelle closes in 6-8 months, anterior fontanelle closes between 18-24 months, anterolateral & posterolateral fontanelle fuse before 2 months
- Lateral view of x-ray is used to observe the skull sutures



Concept 3.10 : Height and Weight of a Child

Learning objective: To know the height and weight of a child at various ages

Time needed

1 st reading	10 minutes
2 nd look	5 minutes

Height of a Child:

- Full term child : About 50 cm.
- At 6 months : About 60cm.
- At 1 year : About 68cm.
- At 4 years : 90 to 100cm (Twice the birth height).

Weight of a Child

- Full term child at birth : About 3 to 3.5kg.
- At the end of 6 months : Doubles (6 to 7 kg)
- At the end of 1 year : Triples (9 to 10 kg).



Concept 3.11 : Medicolegal Importance of Age

Learning objective: To know the medicolegal importance at various ages of a person

Time needed

1 st reading	30 minutes
2 nd look	15 minutes

5 years

- Custody of minor who has not completed the age of 5 years shall ordinarily rest with the mother.

7–12 years

- A child below 7 years of age is exempted from criminal liability because he is incapable of having a criminal intent (82 I.P.C.).
- A child above 7 years and below 12 years may/may not be held guilty depending upon presence/absence of maturity and understanding (83 I.P.C.).
- A child under 12 years cannot give valid consent to suffer any harm that may result from any act done in good faith for the benefit of the child [consent of guardian or the person having lawful charge of the child is required (89 I.P.C.)].
- Consent given by a person who by reason of immaturity of age (i.e., a child below 12 years) is incapable of understanding nature and consequences of the act is not valid in the eyes of law (90 I.P.C.).
- Exposure and abandonment of a child below 12 years of age by the parent or the person having care of the child is punishable (317 I.P.C.).
- Kidnapping or abducting a child below 10 years of age with intention of robbing any moveable property from the person/body of such a child is punishable (369 I.P.C.).

14 years

- A child less than 14 years cannot be employed in a factory.
- Between 14 and 15 years of age, a person can be engaged in non-hazardous factory jobs for a limited period during day hours.

15 years

- Above 15 years of age, one can be employed in a factory like an adult subject to the production of fitness certificate for the particular employment.
- A police officer cannot compel attendance of a male person below 15 years (or any woman) at any place other than the place in which such male person (or woman) resides (160 Cr.P.C.).
- A decree of divorce can be procured by the wife if her marriage (whether consummated or not) had been solemnized before she attained the age of 15 years, and she repudiates the marriage after attaining that age but before attaining the age of 18 years—Section 13(2) (IV) of Hindu Marriage Act (HMA).



16 years

- Kidnapping of a minor under 16 years of age (if male) and under 18 years (if female) is punishable (361 I.P.C.).
- Kidnapping or obtaining custody of a minor below 16 years (if male) and below 18 years (if female) and the maiming of a minor for employing him/her for begging are punishable (363-A I.P.C.).

17 years

- A candidate seeking admission to MBBS course must complete the age of 17 years on or before 31st of December of the year of admission (MCI regulation on graduate medical education).

18 years

- Sexual intercourse with a girl below 18 years of age is termed as 'statutory rape', i.e., consenting age for sexual intercourse for a girl has been prescribed as 18 years and above (375 I.P.C.).
- Qualifying age for marriage has been prescribed as, "The bridegroom should have completed the age of 21 years and the bride, the age of 18 years"—Section 5(iii) HMA.
- On completion of 18 years of age one becomes 'major'.
- No pregnancy of a woman who has not attained the age of 18 years shall be terminated except with the consent of her guardian in writing—MTP Act Section 4(a).
- A person under 18 years of age cannot give valid consent to suffer any harm that may result from an act not intended or not known to cause death or grievous hurt, e.g. consent for an operation.
- Abetment of suicide of a child below 18 years of age is punishable to the extent of life imprisonment or imprisonment up to 10 years and fine.
- Inducing a minor girl under 18 years of age to go to any place, or to do any act, with the intention or knowledge that such minor may be forced or seduced to have illicit intercourse with another person is punishable under 366-A I.P.C.
- A person (boy or a girl) who has not completed 18 years of age is a juvenile and in case of any offense, Juvenile Justice Board may advise or warn the juvenile, or to be released on probation for good conduct, or to pay fine, or to make an order directing the juvenile to be sent to reformatory/correctional school.
- A person of and above 18 years of age can authorise the removal of organ from his/her body for therapeutic purposes [Transplantation of Human Organs Act, 1994; Section 2 (f)].
- A person of and above 18 years of age can exercise the right to cast vote.
- A person of and above 18 years of age and having a sound disposing mind can make a 'valid will'.
- No court shall take cognizance of an offence under Section 376 IPC where such offence consists of sexual intercourse by a man with his own wife, the wife being under 18 years of age, if more than 1 year has elapsed from the date of the commission of the offense—CrPC (Amendment) Act, 2008 (w.e.f. 31.12.2009).



20 years

- A person selling, letting to hire, distributing, exhibiting or circulating obscene objects to any person under 20 years of age has been made punishable (293 I.P.C.).

21 years

- Qualifying age for the marriage has been prescribed as, “The bride groom should have completed the age of 21 years and the bride, the age of 18 years”—Section 5(iii) HMA.
- Procuring girl(s) from outside the country or from Jammu and Kashmir for illicit intercourse with another person is punishable under 366-B IPC.
- For those under guardianship of court, one is not deemed to attain majority until completion of 21 years of age.

25 years

- Minimum age for contesting for the membership for the parliament or other legislative bodies.
- Maximum age for entering into some government services.

35 years

- Minimum age for appointment as the President, Vice President of India and Governor of a State.
- No prenatal diagnostic technique shall be used or conducted unless the age of pregnant woman is above 35 years—PC and PNDT Act Section 4(3)(i).

55–60 years

- Age for retirement from service under some government, statutory, or autonomous bodies.

60–70 years

- 60 years is the usual age of retirement for the Central Govt. employees.
- A member of the District Forum can hold office for a term of 5 years or up to the age of 65 years, whichever is earlier.
- A member of the State Commission can hold office for a term of 5 years or up to the age of 67 years, whichever is earlier.
- A member of the National Commission can hold office for a term of 5 years or up to the age of 70 years, whichever is earlier.
- MCI allows a medical teacher to work in a private institution till completion of 70 years of age.



Concept 3.12 : Estimation of Stature from Long Bones

Learning objective: To know the estimation of stature when long bones are available, the variation in statures and estimation of stature in mutilated bodies

Time needed

1 st reading	20 minutes
2 nd look	10 minutes

Stature from long bones can be estimated by measuring the length of long bones and by using regression formulae, such as:

- Jit and Sing formula (Indian)
- Trotter and Glesser's formula
- Karl-Pearson's formula
- Dupertuis and Hadden's formula
- Steele and McKern's Formula: From fragmented bones
- Smith and Fidge's Formula: From fetal bones (F for F)
- Multiplication Factors: Invented by Indian workers

Variation in stature:

- Stature or height of a person increases progressively and becomes maximum at the age between 21 and 25 years.
- Later, for every 25 years, it is shortened by 2.5 cm due to thinning of intervertebral discs and some stooping posture as a result of decreased tone of muscles.
- The height varies in the various hours of the day, being maximum in the morning and less by 1.5 to 2.00 cm in the evening due to reduction of elasticity of intervertebral discs.
- In a dead body, soon after death due to primary relaxation of the muscles, the body length may be more by 2–2.5 cm. Later, when rigor mortis develops, it may be shortened. With the passage of rigor mortis and onset of putrefaction, the length may change due to secondary relaxation.

Estimation of stature in mutilated bodies:

- When both side arms are outstretched in a straight line, the distance between the tips of the two middle fingers of the hands is approximately equal to the stature of the person.
- Stature is approximately equal to twice the length from vertex to symphysis pubis or equal to twice the length from symphysis pubis to one side heel, with the hip and knee extended and ankle dorsiflexed.
- Stature is about 3.3 times the length from the sternal notch to the symphysis pubis.
- Stature is about 3.7 times the distance between the tip of olecranon and tip of middle finger of the same side.



- The height of the head measured by the vertical distance from the top of the head to the tip of the chin is about $1/7^{\text{th}}$ and the length of the skull is about $1/8^{\text{th}}$ of the total height.
- The distance between the sternal notch to the pubic symphysis is $1/3^{\text{rd}}$ of the total height.
- The length of the vertebral column is $35/100$ of the total height.
- Maximum foot length divided by 0.15 gives stature.



Concept 3.13 : Developmental Changes in a Foetus

Learning objective: To know the changes in a fetus at various gestational age

Time needed

1 st reading	40 minutes
2 nd look	20 minutes

Features in the Foetus	Age at the end of month
Length: 1 cm, Weight: 2.5g. Eyes seen as two dark spots, mouth seen as cleft.	1
Length: 2.54 cm, Weight: 10 g. Mouth and nose are separated, anus appears as dark spot. Ossification centres in clavicle and maxilla. Placenta begins to form	2
Length: 9 cm, Weight: 30g. Eyes are closed, pupillary membrane appears. Neck is formed. Early fingernails development. Intestines in abdomen.	3
Length: 16 cm, Weight: 120g. The sex can be differentiated , skin covered by appearing downy lanugo hairs. Skin is rosy and firmer; the head is one-fourth of the length of body. Umbilicus is situated near the pubic symphysis. Brain convolutions begin to appear. Gall bladder is formed, and meconium is found in duodenum. Pupillary membrane appears. The fetus can be detected on X-ray.	4
Length: 25 cm, Weight: 400 g. Light hairs appear at scalp, the head is larger and about 1/3rd of crown-rump length of fetus. Lanugo distinct, nails are distinct and soft, the position of umbilicus recedes upwards, skin covered with vernix caseosa. Bile begins to form, meconium found in beginning of colon (ascending colon).	5
Length: 30 cm, Weight: 700 g. The skin has wrinkled appearance due to less fat in body, reddish in color. Eyelash and eyebrows appear, eyelids are adherent. The umbilicus is situated farther from pubic symphysis. Brain – cerebral hemispheres cover the cerebellum, Sylvian fissure formed. Meconium present in transverse colon and testis near kidneys (on psoas muscle).	6
Length: 35 cm, Crown–rump length: 23 cm, Foot length: 8 cm, Weight: 900-1200 gram. Skin is dusky red, thick and fibrous and covered with vernix. The eyelids are separated, and pupillary membrane disappeared. Scalp hairs are about 1 cm long. Fingernails present and thick. Meconium in descending colon. Left testes near the external inguinal ring and right near the internal inguinal ring.	7
Length: 40 cm, Weight: 1.5 to 2 Kg. The skin is rosy, not wrinkled, covered with soft hairs. Lanugo has disappeared from face, and the hairs of scalp are denser and longer (1.5 cm). The nails reach up to tip of fingers but not up to tip of toes. Left testis is in scrotum. Right testis near the external inguinal ring. Scrotum corrugated. Meconium reaches up to rectum.	8
Length: 45 cm, Weight: 2.2 to 3 Kg. Placenta: 500 gm. Scalp hairs longer and is about 2-4 cm, lanugo has disappeared from body except on shoulder, vernix found in flexures of joints. Nail grows beyond the tips of fingers and up to tip of toes. Both testes in scrotum. Meconium found in rectum.	9
Length: 48-52 cm, Crown–rump length: 28 - 32 cm, Weight: 2.5 to 4 Kg. Head circumference: 33-38 cm. Scalp covered with 3-5 cm hairs. Lanugo absent from body except at shoulders. Face not wrinkled. Skin pale and covered with vernix caseosa. Umbilicus is mid-way between pubis symphysis and xiphisternum. Nails projected beyond tips. The rectum contains meconium. Vulva closed; labia majora cover labia minora and clitoris.	10



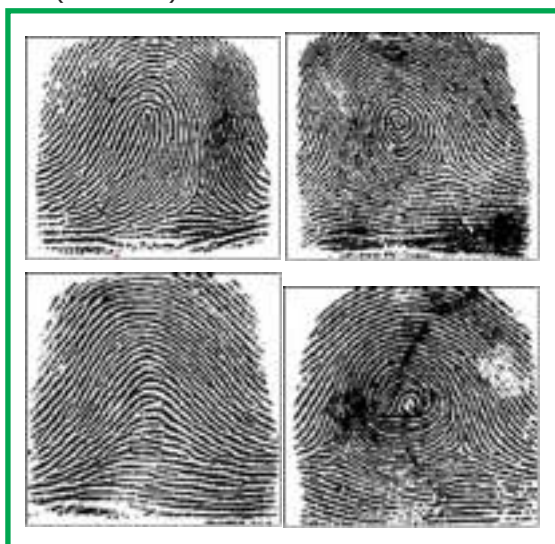
Concept 3.14 : Dactylography

Learning objective: To know the various types of fingerprints and its application in forensic practice.

Time needed

1 st reading	30 minutes
2 nd look	15 minutes

- It is also known as **Fingerprint system, Galton system, Dermatoglyphics**
- It is based on the principle that skin of the balls of the fingers and thumbs is covered with characteristic ridges, the arrangement and distribution of which remains constant and persists throughout life and that the patterns of no two hands resemble each other.
- Even the fingerprints of the twins are not similar.
- It has been estimated that the chances of two persons having identical fingerprints is about one in sixty four thousand millions. (Quetelet's rule that every nature-made object shows infinite variations of forms, and in the world's crime records no two identical fingerprint patterns have been reported.)
- Fingerprints are discovered by Sir William J Herschel (1877)
- Systematized by Sir Francis Galton (1892)
- It is further improved by Sir Edward Henry.
- The First fingerprint bureau was established at Writer's Building, at Kolkata
- The fingerprints develop at 12-16 weeks of I.U.L.; the patterns are not inherited.
- The minimum points of comparison in fingerprints for positive identification as per Supreme Court ruling is 8.
- Fingerprints are classified primarily as
 - Loops (about 67%) - most common
 - Whorls (about 25%)
 - Arches (about 7%)
 - Composite forms (about %)





Recording of Fingerprints

- Plain impression: Is obtained by gently pressing the inked surface of the tip of the finger or thumb on the paper.
- Rolled impression: Is taken by rolling the inked finger or thumb from side to side.

A Rolled impression recording the complete pattern of the whole ball of the finger or thumb is much completer and more desirable than a plain one, which is only partial.

Development of Latent Fingerprints:

1. Physical method: Dusting the area with colored powders. Commonly used powder is Grey powder-chalk and mercury. On dark surfaces white powder (Lead carbonate or French chalk) is used.
2. Chemical method: The amino acid in the sweat is identified by chemicals, such as Ninhydrin, Silver nitrate, osmium tetroxide or Iodine fumes.
3. Autoradiography: After spraying lead carbonate or barium sulphate.
4. Laser: BEST method. Show luminescence; Even 10 years old fingerprints can be developed.
5. Scanning electron microscope visualizes latent fingerprints on metal and glass.

Conditions Altering Fingerprints:

- Criminals may at times, tries to hide the identity by destroying the fingerprints by applying burns or corrosive agents. But the prints are not destroyed unless the skin is destroyed completely.
- Permanent impairment: Leprosy, Charring, Radiation, Electrical injuries, Corrosives:
- Ridge alteration: Eczema, acanthosis nigricans, scleroderma, dry and atrophic skin:
- Temporarily modification: Coeliac disease
- Change in the distance between ridges but without change in pattern: Rickets and acromegaly.
- Circumvention: Dermabrasion.

Fingerprints in case of Decomposed Bodies:

- The degloved skin of a putrefied body is kept in 10% formalin.
- If the fingers are shriveled: Immersed in 20% ACETIC ACID for 1-2 days
- If the skin is dehydrated: The finger is soaked in 3% solution of POTASSIUM HYDROXIDE.
- Histological sections up to 0.6 mm. from the surface of the skin give satisfactory fingerprints.

Computerisation:

Fingerprint reader (FINDER), is a computerized automatic fingerprint reading system which can record each fingerprint data in half a second.

- Prints of 8 fingers are recorded except little finger.



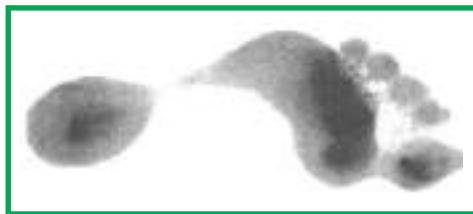
Concept 3.15 : Other Methods of Identification of a Person

Learning objective: To know the other methods of identification of a person such as podogram, poroscopy, cheiloscopy, Bertillon system, retinal scan, veins on the back of the hand, superimposition, tattoo marks and rugoscopy

Time needed

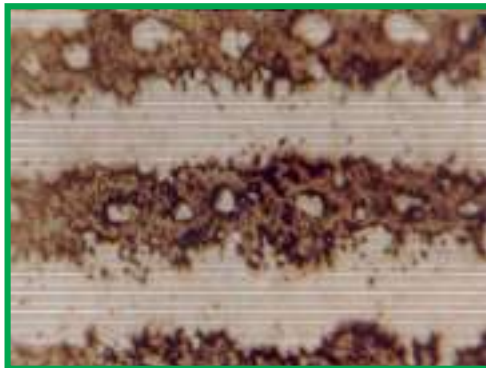
1 st reading	30 minutes
2 nd look	15 minutes

Podogram: Study of footprints.



Poroscopy (Locard's Method):

- Discovered by Sir Edmund Locard.
- The ridges on the fingers and hands are studded with microscopic pores, formed by mouths of ducts of subepidermal sweat glands.
- Each mm of ridge contains 9-18 pores (Thousands per square cm).
- These pores are permanent and unchanged during life and vary in size, shape, number and situation over a given length of ridge in each individual.
- Study of these pores is known as Poroscopy.

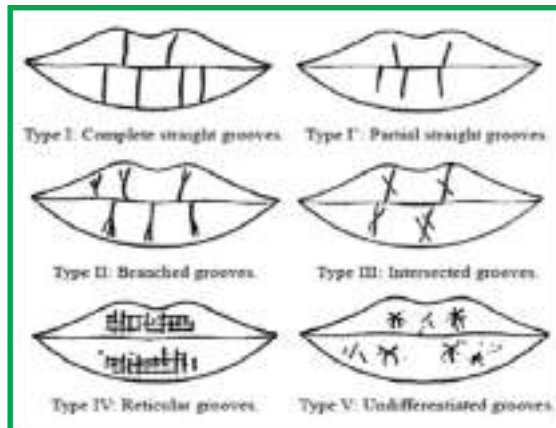


- Useful when only fragments of fingerprints are available.
- Locard is also famous for Exchange Principle, or 'Locard's principle of mutual exchange' which states that, whenever two objects come in contact with each other, always there is transfer of material from one object to the other).

Cheiloscopy (Lip prints):

The study of furrows and grooves present in human lips.

Lip prints are originally classified by SUZUKI & TSUCHIHASHI as follows:



1. Type I: A clear-cut groove running vertically across the lip.
 2. Type I': Partial-length groove of Type I.
 3. Type II: A Branched groove.
 4. Type III: An intersected groove.
 5. Type IV: A Reticular pattern
 6. Type V: Other patterns.
- Establishment of 7 to 9 characteristics lead to positive identification.

Bertillon System or Anthropometry (Portrate Parle)

Anthropometric system based on the physical measurement of specified parts of body, even if there are no biological Specimens

Three important criteria of this system is

- 1) Descriptive data: Includes full description of a person such as complexion, colour of the hair, colour of the iris, shape of the nose, lips, chin, etc.
- 2) Body marks such as moles, birth marks, scars, etc.
- 3) Body measurements: 11 in number, namely,
 1. Standing height
 2. Sitting height
 3. Length of the head
 4. Breadth of the head
 5. Breadth of the face
 6. Distance between two outstretched upper limbs
 7. Length of left forearm and hand
 8. Length of left middle finger
 9. Length of left little finger
 10. Length of left foot and
 11. Length of right ear



Retina Scan:

- The pattern of retina is unique and is not changed from birth to death.
- The pattern is different even in identical twins.
- It is the most precise and reliable biometric.
- The pattern may be altered in cataracts, glaucoma, retinal degeneration and diabetes.

Veins on the Back of the Hand:

- It is suggested by the Tamassia that there is complete individuality in the arrangement of the veins of the back of the hand.

Superimposition:

- A technique in identifying a person by superimposing the X-ray of skull found after death on the photo of the face of the suspected person.
- This was first applied by Glaister and Brash in 1935 in Isabella Ruxton's case.
- The 'TIARA' was used to enlarge the photo to life size
- A negative result having more credibility because it can definitely be stated that the skull and the photograph are not those of the same person.



Tattoo Marks

- These are the designs made in the skin by multiple small puncture wounds with needles or an electric vibrator dipped in coloring matter (dye).
- The different dyes used are
 - Black: Indian ink, Carbon (soot)
 - Red: Cinnabar, Vermillion (Mercuric Sulfide)
 - Green: Chromic Acid
 - Blue: Indian ink, China ink, Indigo, Cobalt, Prussian blue, Ultramarine
- **Latent tattoos:** Are invisible tattoo marks
 - These invisible tattoo marks can be made visible by ultraviolet rays.
 - Infrared photography makes old tattoos readily visible.
 - In a dead body, previous application of tattoo mark can be determined by regional lymph node biopsy where there will be presence of dye.
- **Ideal depth for tattoo is superficial layer of dermis.**
- **LASER is the best method to remove tattoo.**

Rugoscopy (Palatoprints):



- Palatal rugae are used as a method of identification
- Discovered by Harrison Allen.
- Anterior palate (1/3rd) is preferred over posterior part.
- Palatoprints do not change during growth.
- Primary rugae : 5mm or more.
- Secondary rugae : 3-5 mm.
- Fragmentary rugae: Less than 3mm.



Concept 3.16 : Scars

Learning objective: To know the changes takes place in a scar

Time needed

1 st reading	10 minutes
2 nd look	5 minutes

- Scars helps in Identification of a person, identification of causative weapon (by the shape), previous pregnancy etc.
- Disfiguration due to scars amounts to grievous hurt.

Age of a Scar:

Duration	Features
5-6 days	Firm union with Reddish or bluish 'angry' scar
2 weeks – 2 months	Pale, Soft, tender and Sensitive
2 months – 6 months	White, glistening and mild tenderness
>6 months	Tough, non-tender

CONCEPTS

- ⇒ **Concept 4.1 Types, Rules and Objectives of Autopsy**
- ⇒ **Concept 4.2 Incisions used at Autopsy**
- ⇒ **Concept 4.3 Tests and Findings in Motuary**
- ⇒ **Concept 4.4 Emblaming**
- ⇒ **Concept 4.5 Preservation of Viscera in Cases of Suspected Poisoning**
- ⇒ **Concept 4.6 Artefacts**
- ⇒ **Concept 4.7 Second Autopsy and Exhumation**



Concept 4.1 : Types, Rules and Objectives of Autopsy

Learning objective: To know the definition, different types of autopsy and rules & objectives of autopsy.

Time needed

1 st reading	30 minutes
2 nd look	15 minutes

Autopsy implies examination of the dead body (post-mortem examination) with a view to searching **primarily for the cause of death**.

Though conventions and legal provisions vary from country to country, there are generally two types of autopsies:

1. **The Clinical or Academic Autopsy**, which is performed **with the consent of the relatives** of the deceased to arrive at the diagnosis of cause of death where diagnosis could not be reached during the treatment or to confirm diagnosis where it was doubtful.
2. **The Medicolegal or Forensic Autopsy**, which is performed on the instructions of the legal authority in circumstances relating to suspicious, sudden, obscure, unnatural, litigious or criminal deaths, and the information so derived is applied for legal purposes to assist the course of justice.

In the medicolegal autopsy, the body belongs to the State (Consent of the party is not required) for the protection of public interest until such time as a complete and thorough investigation into the circumstances attending the death has been completed. Any or all portions of the body may be taken and kept for detailed examination as well as preserved for later trial purposes

Objectives of Autopsy

1. To determine the identity of the deceased.
2. To determine the cause of death.
3. To determine mode of dying and time since death wherever possible.
4. To demonstrate the details of all the external and internal abnormalities, malformations, disease, etc.
5. To describe in detail all the external as well as internal injuries.
6. To obtain samples of tissues/body fluids for examination/analysis wherever necessary.
7. In case of newborn infants, to determine the issue of live birth and viability.
8. To obtain photographs and video films wherever necessary.

Rules of Medico-Legal Autopsy

- A medicolegal autopsy is to be carried out at the **behest of the appropriate legal authority**.
- The request/order may move from the **police officer** (usually the station house officer or sub-inspector of police) or from **magistrate** or from **Coroner** under whose jurisdiction the incidence/ event leading to death occurred. Ordinarily, this protocol is not disturbed unless under compelling circumstances.



- Medicolegal postmortem examination can **be performed only at the authorised centre.**
- However, **occasionally, the autopsy may have to be conducted at the site, particularly when the body is in advanced stage of putrefaction and materials of evidentiary value may be lost during its transportation or where the District Magistrate desires it to be conducted at the site due to some law and order problem.**
- **All Registered Medical Practitioners in Government Service are authorised** to conduct the medicolegal autopsy.
- However, even the **private medical institutions** can undertake the medicolegal examination of the living as well as of the dead, provided they possess resources and **approval of the government concerned.**
- The examination should preferably be conducted **under natural sunlight.** However, under **circumstances of urgency,** it may have to be carried out at night with the help of the adequate quantity and quality of **artificial light.**
- Before beginning the autopsy, the formal **identification of the dead body must be done** by a police officer or by the relatives/friends of the deceased whose names and signatures should be recorded.
- In case of unknown bodies, photographs in the mortuary be obtained (it may well have already been photographed at the scene) and skin from the finger tips should be removed and given to the police preserved in 10% formalin in separate vials. Fingerprints are taken by the police in cases of unknown bodies. Doctor must scrutinise the body for features of identification under such situations, including clothing and other articles/ documents/ornaments, etc., on the person of the deceased.
- Avoid delay as far as possible.
- **No unauthorised person should be permitted to enter the mortuary.**
- **No police official should be present while the autopsy is being conducted.**
- All the details should be noted there and then in the postmortem register.
- If there is an assistant, it may be better to dictate the notes to him as the autopsy proceeds step by step and then to read, verify and attest the report.
- All corrections should be initialed.
- Nothing should be erased or mutilated or left to memory.
- Always hand over the report and other specimens/tissues/ articles, etc., immediately after conducting the postmortem.
- Never indulge in delaying the things.

A doctor should better not take up the autopsy, which he does not feel competent to carry out.



Concept 4.2 : Incisions used at Autopsy

Learning objective: To know the different types of incisions used at autopsy to open the body cavities.

Time needed

1 st reading	20 minutes
2 nd look	10 minutes

'I'-shaped incision:

- Extending from symphysis menti (chin) to symphysis pubis, avoiding the umbilicus.

'Y'-shaped incision:

- Two incisions commence on either side of the neck from the angle of the jaw to meet at manubrium sterni, then continue as a single incision down to pubic symphysis.

Modified 'Y'- shaped incision:

- Incision commence from either side of the chest from anterior axillary fold, curve under the breast to meet at xiphisternum and continue as a single vertical incision down to pubic symphysis.

Incision to open the skull:

- A coronal incision is placed extending from one mastoid process to another mastoid process.
 - The choice of opening the skull or the other body cavity first is left to the dissector.
 - In cases of head injury, it is a common practice to open the skull first and then the thorax and the abdomen.
 - In deaths due to compression of neck, it is preferable to open the skull first. The draining out of blood from neck vessels due to prior removal of skull and brain provides a comparatively clearer field for the study of neck structures and will avoid congestive-artefactual haemorrhages in the neck structures as cautioned by Prinsloo and Gordon.
 - Remove the pituitary by chiseling the posterior clinoid processes and incising the diaphragm of the sella turcica around its periphery.
 - The middle ears and the mastoid processes can be examined by chiseling out wedge-shaped portions of petrous temporal bone.
 - The orbits may be examined by removing the orbital plates in case of skull.
 - Cut the brain in serial coronal sections at regular intervals from front to back or cut obliquely at the intracerebral fissures exposing basal ganglia, lateral ventricles and white matter.
 - Cut the cerebellum through the vermis to expose the fourth ventricle.



Concept 4.3 : Tests and Findings in Motuary

Learning objective: To know Alkaline pyrogallol test, differences between antemortem and postmortem clots, conditions giving rise to adrenal & subendocardial hemorrhages and fixation of brain.

Time needed

1 st reading	20 minutes
2 nd look	10 minutes

Alkaline pyrogallol test:

- **This test helps to differentiate air embolism from putrefactive gases.**
- 4 mL of alkaline pyrogallol is taken in a 10mL syringe and air is aspirated from right side of the heart.
- The needle is removed and replaced by a stopper.
- If air (Oxygen) is present, the mixture turns brown on shaking.
- In a second syringe, some air is introduced by the atmosphere and the test is repeated as a control.
- In case of putrefactive gases, the colour doesn't change.

Differentiation between Ante-mortem and Post-mortem clots:

- The ante mortem clots are firm, rubbery and attached to the vessel wall by lines of Zahn.
- Post mortem clots are soft, friable, having appearance of red currant jelly (red cells)/ yellow chicken fat (serum) and not attached to the vessel wall by lines of Zahn.
- Post-mortem fibrinous clots in the heart are known as Cardiac Polyps.

Adrenal Haemorrhages seen in :	Sub endocardial haemorrhages seen in:
Burns	Acute haemorrhage
Trauma	Shock
Poisoning	Brain tumours
Head injury	Ectopic pregnancy
Fetal anoxia	Abortion
Meningococcal septicemia (Waterhouse Fredrickson syndrome)	Stress
Thrombosis of central vein	Asphyxial deaths
Hypertension.	Head injury
	Poisoning : Arsenic & Aluminium Phosphide

Fixation of brain for complete examination of brain:

- It is fixed with Formalin for 1 week.
- **The weight of the brain is increased by about 10% in children and about 15% in adults due to fixation in formalin.**



Concept 4.4 : Embalming

Learning objective: To know about embalming, the different methods of embalming and embalming fluid.

Time needed

1 st reading	20 minutes
2 nd look	10 minutes

It is the treatment of the dead body with antiseptics and preservatives to prevent putrefaction and preserve the body:

- In this, the contents of the body cavities are removed, and the vascular system is injected with an embalming fluid containing 40% formaldehyde and 10% methyl alcohol.
- Embalming is never done before postmortem because it alters the appearance of the body, tissues and organs, making it difficult to interpret any injury or disease.
- Embalming destroys cyanide, alcohol and many other substances. Determination of the presence of many of the alkaloids and organic poisons becomes very difficult.
- **The main composition of embalming fluid is Formalin**, which is a 37% (by weight) or 40% (by volume) aqueous (water) solution of formaldehyde, with the chemical formula HCHO , used as an antiseptic, disinfectant, and especially today as a fixative for histology (the study of tissues under the microscope).
- The embalming fluid may be injected by Hand/Foot pump, Stirrup pump, Bulb Syringe, Gravity Injector or **motorized Injection (best)**.
- There are different methods of injection namely,
 1. Continuous Injection and Drainage
 2. Continuous Injection with disrupted Drainage
 3. Alternate Injection and Drainage
- **4. Discontinuous Injection and Drainage (BEST METHOD)**
- **There are several embalming fluids, but typical embalming fluid is the best.**

Typical Embalming Fluid

Contents	Use	Proportion
Formalin (40%)	Preservative	1.5 L
Methanol	Preservative	500mL
Phenol	Germicide	50mL
Thymol	Fungicide	5g
Glycerine	Wetting agent	600 mL
Sodium borate	Buffer	600 g
Sodium citrate	Anticoagulant	900 g
Sodium chloride	Controls pH	800 g
Eosin (1%)	Cosmetic	30 mL
Soluble wintergreen	Perfume	90 mL
Water	Vehicle	Upto 10 L



Concept 4.5 : Preservation of Viscera in Cases of Suspected Poisoning

Learning objective: To know the viscera to be preserved at autopsy and the preservatives used for viscera.

Time needed

1 st reading	40 minutes
2 nd look	20 minutes

Viscera to be Preserved in all Fatal Cases of Suspected Poisoning

1. Stomach and its contents
2. Upper part of small intestine (About 30 cm) and its contents
3. Liver (200-300 gm)
4. Kidney (½ of each, as one kidney may be dysfunctional)
5. Blood (30 ml) (Minimum 10 mL)
6. Urine (30 ml)

Additional Viscera to be Selected at Autopsy

Lung (One)	Gaseous poisons, Alcohol, chloroform, cyanide.(Ligate the trachea and collect bronchial air and preserved in heat sealed nylon bag)
Heart	Cardiac poisons, Strychnine
Brain (100g)	Neurotoxic poisons, CO, Cyanide, Strychnine, Anaesthetics and Volatile poisons
Uterus	Criminal abortion
Muscle (3cm × 3cm)	If the internal organs are badly putrefied, especially from the thigh. In a embalmed body, the best specimen may be skeletal muscle from the buttock.
Skin	Injected poisons and corrosives on the skin
Fat	Pesticides (Abdominal or Perinephric fat), Anaesthetics (Mesenteric)
V. Humor	Alcohol, chloroform, Cocaine, Morphine, Tricyclic Antidepressants
Bile	Narcotic drugs, cocaine, Barbiturates, Methadone, glutathione, some tranquilizers
Hair, Nail, Bone, Skin, Muscle	Heavy Metals (20-30 head hair; all 20 nails; 10 cm of shaft of femur; 1 sq inch of skin from back; and one cubic inch of muscle-quadriceps)

Preservatives used at Autopsy

Viscera	Supersaturated solution of NaCl* / Rectified spirit**
Blood	Sodium / Potassium fluoride, 10 mg/mL (prevents glycolysis, inhibits enzymatic activity and bacterial growth) + K oxalate
Urine	HCl/Thymol/NaF, Toluene is best (NaF is used in case of poisoning by Alcohol, CO, Cocaine and Cyanide)
Enzymes	Liquid Nitrogen in Thermos flask



Virological studies	80% glycerol in buffered saline
Brain for Negri bodies	50% glycerol in saline
Blood for DNA	EDTA / Heparin
Vitreous	NaF
Muscle for DNA	Dimethyl sulphoxide (DMSO)
Maggots	Acetic alcohol (Killed by dropping into boiling absolute alcohol, so that it dies in extended position)
Blood for culture	Sodium polyanethole sulfonate (SPS) - Anticoagulant

Contraindications for NaCl	Contraindications for Rectified spirit
Mineral acids except carbolic acid Alkalis Corrosive sublimate Aconite	Phenol Kerosene Formic acid Acetic acid Formaldehyde Paraldehyde Chloroform Ether Chloral hydrate Alcohol Phosphorus

Preservatives are not necessary in cases of

- Lung for inhaled poison (Packed in Nylon bag which is heat sealed)
- Bone, Hair, Nail
- When refrigeration is available and
- In cases where analysis is done within 24 hours.



Concept 4.6 : Artefacts

Learning objective: To know the definition and different types artefacts.

Time needed

1 st reading	10 minutes
2 nd look	5 minutes

Definition:

It is a change in the natural state of the body that is likely to be misinterpreted at autopsy.

Types:

- 1. Therapeutic Artifact:** Introduced before the death due to therapy. E.g.: Sternal and multiple rib fractures due to cardiac massage, injection marks in the cardiac region, bruise caused by a defibrillator, etc.
- 2. Agonal Artifacts:** Artifacts introduced at the time of death (**Perimortem**). E.g.: Regurgitation and aspiration of gastric contents- It may be seen in natural death as a terminal event due to medullary anoxia.
- 3. Postmortem Artifacts:** These may be due to improper handling of the dead body, improper autopsy procedure, by arthropods and rodents, etc.

Prinsloo and Gordon artifact:

- Apparent “bruising” of the neck musculature does not always indicate compression of or trauma to the neck.
- In any autopsy, **substantial hemorrhage** may be seen over the **posterior surface of the esophagus** and the anterior longitudinal ligament of the cervical spine.
- This is a common postmortem artifact described fully by Prinsloo and Gordon, sometimes known by their name.



Concept 4.7 : Second Autopsy and Exhumation

Learning objective: To know the requirement of second autopsy and rules and regulations of exhumation.

Time needed

1 st reading	30 minutes
2 nd look	15 minutes

Second Autopsy:

- Second autopsy is performed in cases of circumstances where the body is buried after due autopsy but discrepancy arose after sometime, may be due to public hue and cry or some political overtones.
- Before performing second autopsy, the doctor must obtain all the available documents relating to the case especially the first autopsy report, photographs of the scene of death and of the body taken during the first autopsy, hospital records in case of hospital-death and police investigative reports/papers, etc.
- The interpretation of findings of a second autopsy, performed on a previously autopsied exhumed body, is extremely difficult due to various artefacts of burial and exhumation and the alterations resulting from the first autopsy.
- The findings should be documented meticulously with photography.
- It is possible that valuable results may be discovered.
- Even if no new information is unearthed from the second autopsy, it will help in putting an end to rumours or suspicions and will go a long way in maintaining public tranquility.

Exhumation (Disinterment)

- Exhumation means lawful disinterment or digging out of a buried body from the grave.

Objectives

1. Identification, i.e. confirming the individuality for any criminal or civil purpose arising after the burial.
2. Establishing cause of death: When any foul play is suspected, exhumation may be ordered depending upon the public demand or request by the relatives, to determine the cause of death.
3. Second autopsy: When the first autopsy report is being challenged or is ambiguous.

Rules and procedure

- Exhumation is to be carried out under the orders of the appropriate authority. **District Magistrate/Sub-Divisional Magistrate/Executive Magistrate are empowered to order for the exhumation.**
- **There is no time limit for exhumation in India**, whereas in France the time limit is 10 years, and in Germany the time limit is 30 years.
- The grave is identified properly, with the help of relatives and the official in charge of the graveyard.



- **It is done under the direct supervision of a medical officer in the presence of magistrate.**
- **It is usually done in the early morning.**
- In case of suspected poisoning,
 - **6 soil samples of 500 g** each should be taken from each side of the body, i.e., above, below, both sides, head end and foot end of the body.
 - In addition, at least **two samples** must be taken from some distance (control soil) - say around 25 to 30 yards from the grave.
- **Disinfectants should not be sprinkled on the body.**
- In suspected mineral poisoning, hair, nails, and long bone e.g., femur should be preserved for chemical analysis.

CONCEPTS

- ⇒ **Concept 5.1** **Definitions, Terms and Tests**
- ⇒ **Concept 5.2** **Brain Death**
- ⇒ **Concept 5.3** **Organ Transplantation**
- ⇒ **Concept 5.4** **Apparent Death
(Suspended Animation)**
- ⇒ **Concept 5.5** **List of Postmortem Changes:**
- ⇒ **Concept 5.6** **Postmortem Changes in the Skin
and Eye**
- ⇒ **Concept 5.7** **Body Temperature Changes after
Death**
- ⇒ **Concept 5.8** **Postmortem Lividity**
- ⇒ **Concept 5.9** **Changes in Muscles**
- ⇒ **Concept 5.10** **Decomposition**
- ⇒ **Concept 5.11** **Postmortem Chemistry**
- ⇒ **Concept 5.12** **Modification of Putrefaction**



Concept 5.1 : Definitions, Terms and Tests

Learning objective: To know the different definitions, the meaning of various terms and different types of tests.

Time needed

1 st reading	30 minutes
2 nd look	15 minutes

- **Thanatology** deals with study of death and the changes takes place after death.
- **Atria Mortis** (Gateways of Death): Also known as Modes of Death.
- **Three modes of death according to Bichat are:**
 1. Coma –death from failure of functioning of brain
 2. Syncope –death from failure of functioning of heart
 3. Asphyxia –death from failure of functioning of lung
- **“Tripod of life”** are Brain, Lungs and Heart.
- **Gorden’s (Barcroft’s) modes of death** are
 1. Anoxic Anoxia - No oxygen available to the body, e.g, High altitude, Hanging, Strangulation etc.
 2. Anaemic Anoxia - anoxia resulting from a decreased concentration of haemoglobin, e.g, Acute haemorrhage, Severe anaemia, poisoning by Carbon monoxide (Chemical anoxia), nitrates, chlorates, coal tar derivatives etc.
 3. Histotoxic /Cellular Anoxia - Poisoning of the respiratory enzyme systems of the tissues, as in the inhibition of cytochrome oxidase by cyanides because of the inability of tissue cells to use oxygen, its tension in arterial and capillary blood is usually greater than normal.
 4. Stagnant Anoxia - a condition in which there is inadequate blood flow in the capillaries, causing low tissue oxygen tension and reduced oxygen exchange. The condition is associated with shock, cardiac standstill, and thrombosis.
- **Somatic death:** Loss of functions of the brain, heart and lungs with certain individual cells still functional. As per Law, somatic death is enough to declare that the person is dead.
- **Cellular/Molecular death:** Means the death of cells and tissues individually, which takes place usually 1-2 hours (depends on cells).
- **Supra-Vital Interval** (Intermediary life): Period between somatic and cellular death.
- **Presumption of death:** A person is presumed to be dead if he has not been seen or heard for a minimum period of 7 years (108 IEA).
- **Sudden death:** As per WHO, death is said to be sudden or unexpected when a person not known to have been suffering from a dangerous disease, injury or poisoning is found dead or dies within 24 hours after the onset of terminal illness.
- After stoppage of circulation muscles can live up to 1-2 hours.
- **Zasko’s phenomenon:** Striking the lower third of the quadriceps femoris muscle about 10 cm. above the patella with a reflex hammer causes an upward movement of the patella because of contraction of the whole muscle. This can be seen up to 1-2 hours after death.



- **Idiomuscular contraction or bulge:** Striking at the biceps brachii muscle with the back of a knife causes a muscular bulge at the point of contact due to local contraction of the muscle.
- Named tests for detection of breathing and circulation:
 1. **Diaphanus test:** Finger webs lose luster, a circulation test.
 2. **Icard's dye test:** Dye is injected intravenously; color does not change in dead. It is a test for circulation.
 3. **Magnus test:** Ligature applied to finger. It swells and becomes blue if the person is alive, it is a test for circulation.
 4. **Winslow's test:** Reflections from mirror over chest move with respirations if alive.



Concept 5.2 : Brain Death

Learning objective: To know the definition of brain death and diagnosis of brain death.

Time needed

1 st reading	30 minutes
2 nd look	15 minutes

Ad Hoc Committee of Harvard Medical School recommended three criteria for determining permanent non-function of the brain:

1. Unreceptivity and unresponsivity
2. No movements or breathing
3. No reflexes

And an added confirmatory test proposed was 'a flat' or isoelectric EEG.

The fact that EEG is an objective test, while all other require subjective clinical judgements by the doctors, substantiates its strength.

The criteria of Harvard Ad Hoc Committee have since been generally accepted throughout the world.

- Currently, brainstem has been the focus of attention where vital centres are situated because various strata of brain behave differently in their response to oxygen deprivation.
- Therefore, circumstances may be there, where cortex has been damaged but the lower brain including brainstem is still functioning.
- In such a state, the victim will exist in a '**vegetative state**', the so-called 'living cadaver'.
- The victim can remain in deep coma for a considerable period, may be for years.
- However, when brain death spreads below the tentorium, i.e. when base of the brain including midbrain, pons and medulla suffer damage, the loss of vital centers and consciousness will cause the victim not only to be irreversibly comatose but also to be incapable of spontaneous breathing.
- Without medical intervention, the cardiac arrest invariably follows within minutes and then the usual process of 'cellular death' progresses.
- Once irreversible damage to the brainstem has been established, the victim is dead in the somatic sense, though not yet dead in the cellular sense.
- It is through this 'physiological gap' that the advances in removing the organs from the cadavers for the transplantation purposes have broken through.
 - With the passage of Transplantation of Human Organs Act, 1994 (the Act was enacted in July 1994 and notification was issued in Gazette of India on 4th February 1995), India has also given statutory sanction to the concept of brain-stem death.
 - The Act defines a 'deceased person' as one in whom permanent disappearance of all evidence of life has occurred by reason of brain-stem death or in the cardio-pulmonary sense, at any time after the live-birth.
 - Brain-stem death has been defined as the stage at which all the functions of brainstem have permanently and irreversibly ceased.



Certain preconditions to be fulfilled before certifying the brain-stem death:

- The cause of irreversible brain-stem damage (either from a period of hypoxia, trauma, illness or toxic insult) producing non-responsive coma, must be clearly established.
- Following reversible causes must be excluded:
 - Intoxication
 - Depressant drugs
 - Muscle relaxants
 - Primary hypothermia
 - Hypovolemic shock
 - Metabolic or endocrinal disturbances
- The patient must be examined by a team of doctors at least twice, with a reasonable gap of time in between (say about 6 hours or so).
- None of the doctors who participate in the diagnosis of brain-stem death should have any interest in the transplantation of an organ being removed from the cadaver.

The structural and functional damage of brainstem may be diagnosed depending upon the following observations:

- Dilated fixed pupils, not responding to sharp changes in intensity of incident light.
- Absence of motor responses within the cranial nerve distribution on painful stimulation.
- Absence of corneal reflexes.
- Absence of vestibulo-ocular reflexes.
- Absence of gag reflex or reflex response to bronchial stimulation by a suction-catheter passed down the trachea.
- Absence of spontaneous breathing.



Concept 5.3 : Organ Transplantation

Learning objective: To know the different terms related to organ transplantation and certification of brain death for organ transplantation

Time needed

1 st reading	10 minutes
2 nd look	5 minutes

- **Homologous donation:** Grafting of the tissue from one part of the body to another in the same patient, such as skin and bone.
- **Live donation:** It includes blood and bone marrow transfusion.
- **Live organ donation:** It includes kidney and parts of the liver.
- **Cadaveric donation:** Organs taken from a person who is declared dead.
- **Xenograft:** Grafting of animal tissue into humans).
- Cornea can be removed from a dead body within 6 hours, skin in 24 hours, bone in 48 hours and blood vessels in 72 hours for transplantation.
- Kidneys, heart, lungs, pancreas, intestine and liver must be obtained soon after circulation has stopped as they deteriorate rapidly.

As per 'The transplantation of human organs Act', the brainstem death needs to be certified by a board of doctors consisting of the following:

1. The **registered medical practitioner in charge of hospital** in which brain-stem death has occurred.
2. **An independent registered medical practitioner**
3. **A neurologist or a neurosurgeon**
4. **The registered medical practitioner treating the person** whose brain-stem death has occurred.



Concept 5.4 : Apparent Death (Suspended Animation)

Learning objective: To know the definition of apparent death and the causes of this condition.

Time needed

1 st reading	10 minutes
2 nd look	5 minutes

- It is defined as “a state of body in which the vital functions are at such a low pitch that the body functions cannot be determined by ordinary methods of clinical examination”.
- Suspended animation may last for few seconds to half an hour or more.
- In this condition the circulation, respiration etc. do not completely stop but is being maintained in their minimum.
- Prompt resuscitation can revive the state.
- Apparent death is of two types as:
 - 1. Voluntary** – Produced voluntarily. Yogis or ‘sadhus’ or ‘sanyasi’ may practice this method.
 - 2. Involuntary** – Person lands in apparent death spontaneously. Involuntary suspension of animation lasting from a few seconds to half an-hour or more may be found in:
 - ▶ A: After Anesthesia
 - ▶ B: in newborn Babies
 - ▶ C: Cholera/Cerebral concussion
 - ▶ D: Drowning.
 - ▶ E: Electrocution
 - ▶ Shock, sunstroke, syncopal attack, insanity, hypothermia, narcotic poisoning, vagal inhibition etc.



Concept 5.5 : List of Postmortem Changes:

Learning objective: To know the changes takes place after death

Time needed

1 st reading	10 minutes
2 nd look	5 minutes

Following death, signs of death appear in the following order:

1. Immediate (somatic death):

- Insensibility and loss of voluntary power- earliest sign at death
- Cessation of respiration
- Cessation of circulation

2. Early (cellular death):

- Changes in the skin
- Changes in the eye
- Primary flaccidity of muscles
- Cooling of the body
- Postmortem lividity
- Rigor mortis

3. Late (decomposition and decay):

- Putrefaction
- Adipocere formation
- Mummification



Concept 5.6 : Postmortem Changes in the Skin and Eye

Learning objective: To know the changes that takes place in skin and eye after death.

Time needed

1 st reading	20 minutes
2 nd look	10 minutes

Changes in the Skin:

- Skin becomes pale and ashy white and loses elasticity within a few minutes of death.

Changes in the Eye

- Loss of corneal reflex is not a reliable sign, as it is seen in all cases of deep insensibility, e.g, epilepsy, narcotic poisoning, general anesthesia etc.
- **Cornea** loses its glistening appearance and becomes opaque.
 - Glistening of cornea remains even after death in case of CO and Cyanide poisoning.
 - Dimness of cornea before death occurs in cholera, uraemia, narcotic poisoning and wasting disease.
- **Taches Noire De La Sclerotique:**
 - This is deposition of cellular debris and foreign bodies in the eye, if the eye remains opened.



- **Railroad phenomenon:** Fragmentation or segmentation of the blood columns in the retinal vessels appears within minutes after death and persists for about an hour after death.
- **Flaccidity of eyeball:** Sunken eyes due to decreased intraocular tension. Value of IOT is

▪ During life	:	14-25 gm.
▪ Soon after death	:	< 12 gm.
▪ Within half an hour	:	< 3gm.
▪ End of 2 hours	:	NIL
- **Pupils:** Soon after death pupils are slightly dilated, because of primary relaxation of muscles of iris. Later it constricts because of rigor mortis.
The pupils react to atropine and eserine for about an hour after death.



Concept 5.7 : Body Temperature Changes after Death

Learning objective: To know cooling of the body and increase in temperature after death.

Time needed

1 st reading	20 minutes
2 nd look	10 minutes

Cooling of the Body

- Also known as algor mortis or 'Chill of death'
- Body loses heat by conduction, convection and radiation.
- Internal organs cool primarily by conduction.
- The core temperature is more than the surface temperature.
- Body starts cooling after establishment of temperature gradient.
- For about half to one hour after death the rectal temperature falls a little or not at all followed by a linear rate of cooling (0.4 to 0.6°C per hour) for the next 12 to 16 hours. Then it gradually becomes slower. When putrefaction starts, it may rise slightly due to bacterial activity.
- Rectal temperature is usually recorded. Alternative sites are the axilla, deep nasal passage and sub-hepatic region.
- Internal organs take about 24 hours to cool.
- Sub-normal temperature occurs in cases of:
 - Collapse
 - Congestive cardiac failure
 - Massive hemorrhage etc.

Factors affecting the rate of cooling:

- The rate of fall of temperature is rapid when the difference between body and environmental temperature is great. In tropical climates, the heat loss is on an average 0.5°C, whereas in temperate countries 1°C per hour.
- Children and older people cool more rapidly than adults due to larger surface area.
- Fat is a bad conductor of the heat. Fat bodies cool slowly and lean bodies rapidly.
- The environment of the body:
 - Cooling is rapid in bodies kept in well ventilated room than kept in closed room'.
 - Cooling is rapid in humid atmosphere than in dry atmosphere.
 - Cooling in still water is twice as fast as in air and in flowing water, it is about three times as fast.

Postmortem Caloricity:

The temperature of the body remains raised for the first two hours, up to 1.5° to 2°C.

**Conditions resulting in postmortem caloricity:****i. Disturbance of heat regulation**

- Sunstroke
- Pontine haemorrhage

ii. Increased production of heat due to muscular activity

- Tetanus
- Strychnine
- Violent asphyxial deaths (Struggle prior to death)

iii. Excessive bacterial activity

- Septicemia
- Cholera
- Influenza etc.

iv. Miscellaneous

- Alcohol, heroin, cocaine, CO poisoning

High atmospheric temperature Drug reactions, Fat/Air embolism

Concept 5.8 : Postmortem Lividity

Learning objective: To know the definition, development, disappearance, color changes of postmortem lividity, medicolegal importance, differences between postmortem staining and bruising and differences between postmortem staining and congestion

Time needed

1 st reading	40 minutes
2 nd look	20 minutes



- Postmortem lividity is also known as Hypostasis, Postmortem staining, Livor mortis, Vibices)
- Postmortem hypostasis is bluish purple or purplish red discoloration, which appears under the skin (rete mucosum) of the dependent parts of the body after death due to capillo-venous distention.
- Postmortem lividity begins shortly after death.
- Postmortem Lividity is not seen at the areas of contact flattening of dependent parts.
- Any pressure prevents the capillaries from filling, such as the collar band, waist band, belts, wrinkles in the clothes etc. and such areas remain free from color and are seen as strips or bands called **vibices**.
- If the position of the body is changed before fixation, the hypostasis appears in the new areas of dependent parts; but once fixed it does not get shifted.
- Postmortem hypostasis persists till it merges with discoloration of putrefaction.
- It is more marked in asphyxia and is less marked in death from hemorrhage (> 65% of blood loss in adults and > 45% of blood loss in infants), anemia, lobar pneumonia (coagulation of blood) and wasting disease.
- Hypostatic congestion resembling postmortem hypostasis may be seen even before death in case of a person slowly dying with circulatory failure e.g cholera, typhus, TB, uraemia, morphine and barbiturate poisoning, CCF, deep coma and asphyxial deaths.
- P.M. Lividity is not seen in bodies found in running water.
- As decomposition progresses, the lividity becomes dusky in colour and turns brown and green before finally disappearing with destruction of the blood.



- In case of Hanging: Hypostasis is more marked in lower limbs, external genitalia, lower part of arms and forearms (Glove and stocking pattern)

Medicolegal significance:

1. The principal value lies in ascertaining whether a body has been moved from the position in which it originally lay when the life ceased.
2. Degree of development may help in ascertaining the postmortem interval.
3. Color may impart clues towards cause of death.
4. A good indicator of occurrence of death.

Color Changes in Postmortem Lividity

Normal	Bluish-purple
Cherry Red	CO (COHb)
Bright Red	Cyanide (OxyHb)
Bright Pink	Hypothermia, Refrigerated body
Dark Brown	Phosphorus, Phosphate
Chocolate/Copper /Reddish brown	Nitrites, Aniline, Potassium chlorate, Nitrobenzene, Potassium bichromate, acetanilide, Bromates
Deep blue	Aniline (in some cases)
Bluish Green	H ₂ S (SulphHb)
Black	Opium
Bronze	Cl. perfringens

Differences between Postmortem Staining and Bruising

Features	Postmortem Staining	Bruise
Situation	On the dependant parts of the dead body	Anywhere
Surface	Not elevated	May be slightly elevated
Margins	Well-defined	Diffused/ill-defined
Color	Bluish or reddish purple normally. Specific colour in some specific poisoning death cases.	Reddish when fresh, which changes in colour with time.
Cause	Due to capillovenous distension with blood.	Due to extravasation of blood from capillaries.
Effect of pressure	Pressed spot appears pale.	No change on application of pressure.
Cut section	Cut surface shows blood confined within the vessels, and minute drops of blood may be seen exuding from the divided ends of the distended capillaries/venules, which do not stain the tissues.	Cut surface shows evidence of haemorrhage in the tissues with coagulated or fluid blood from the ruptured blood vessels.



Microscopic study	Blood elements found within the blood vessels and no evidence of inflammation.	Blood elements are found outside the blood vessels, and there may be evidence of inflammation.
Enzymatic study	No change.	Change in the level of certain enzymes in the affected area.
Medicolegal importance	Suggests about the time of death and position of the dead body.	Suggests about the nature of injury, weapon used etc.

Differences between Postmortem Staining and Congestion

Features	Postmortem staining	Congestion
Situation	Dependent part of the organ.	Whole or any part of the organ, affected with the pathology.
Cause	Passive capillo-venous distension.	Due to some pathology in the organ.
Swelling	Nil.	May be appreciable.
Cut surface	Oozing of blood from the distended capillaries.	Exudation of fluid, mixed with blood, from the cut surface.
Hollow viscus	Hollow viscus such as stomach and intestines when stretched shows alternate stained and unstained areas.	Hollow viscus such as stomach and intestines when stretched shows uniform staining.



Concept 5.9 : Changes in Muscles

Learning objective: To know the changes in muscles which takes place after death such as primary relaxation, rigor mortis and secondary relaxation.

Time needed

1 st reading	30 minutes
2 nd look	15 minutes

After death, the muscles of the body pass through three stages:

1. Stage of Primary relaxation or flaccidity.
2. Stage of Rigor mortis.
3. Stage of Secondary relaxation or flaccidity.

1. PRIMARY FLACCIDITY:

During the stage, death is only somatic and it lasts for one to three hours. All the sphincters relax and there may be incontinence of urine, semen and feces.

2. RIGOR MORTIS:

- This is the stage of stiffening and shortening of muscles fibers.
- Individual cell death takes place at this stage.
- Mechanism: When the ATP is reduced, the overlapping portions of myosin and action filaments combine as rigid links of actomyosin, which is viscous and inextensible and causes hardness and rigidity of muscle rigor.
- When lactic acid concentration reaches a level of 0.5%, muscles go into rigor mortis (pH level falls) and the rigidity is maximum when the lactic acid level is 0.3%.
- Rigor persists until decomposition of the proteins of the muscle fibers makes them incapable of any further contraction.
- Whole body becomes stiff, once the rigor mortis is completely established.
- All muscles of the body, both voluntary and involuntary, are affected.
- Rigor mortis sets in very early in the heart, generally within the first hour, and always earlier than in skeletal muscle.
- It first appears in involuntary muscles.
- It progresses proximo-distally.
- Rigor mortis disappears also proximo-distally.

Duration of Rigor mortis:

- In India, it lasts for 18-36 hours in summer and 24-48 hours in winter.
- In temperate areas, it lasts for 2-3 days.
- When rigor sets in early, it passes off quickly and vice versa.

Conditions altering the onset and duration:

- The onset of rigor is early, and duration is short in death from diseases causing great exhaustion and wasting e.g. cholera, typhoid, tuberculosis, cancer etc. and in violent deaths as cut-throat, firearm, electrocution, lightening, heat stroke.



- Rigor mortis is frequently absent in septicemia.
- The rigor mortis sets faster in children, elderly, malnourished individuals.
- Causes delaying the onset of rigor mortis are severe haemorrhage, pneumonia, apoplexy, deaths from asphyxia, nervous diseases causing paralysis of muscles.

Cadaveric Spasm:

- In this condition, the muscles that are contracted during life, become stiff and rigid immediately after death, without the stage of primary relaxation.
- It occurs especially in cases of:
 - A - Sudden Asphyxial death
 - B - Injury to the Brain
 - C - Cerebral hemorrhage
 - D - Drowning, Di- nitro-Ortho Cresol poisoning
 - E - Exhaustion
 - F - Fear, Firearm injury
- This is usually limited to a single group of muscles and frequently involves hands.
- It mainly occurs in voluntary muscles.
- It cannot be produced by any method after death.
- It may be explained on the basis of diminished or exhausted ATP in the affected muscles.

Medico-legal Importance:

- In case of suicide, the weapon e.g. pistol or knife is seen firmly grasped in victim's hand which is a strong presumptive evidence of suicide.
- In cases of drowning, material such as grass, weeds etc. may be found firmly grasped in the hand, which shows antemortem drowning.
- In case of homicide, the buttons or piece of cloth of the assailant may be found in the grip of the hand, which helps in identification etc.

3. SECONDARY RELAXATION:

- Muscles become soft and flaccid due to breaking down of check due to putrefaction.

Differences Between Rigor Mortis and Cadaveric Spasm

Features	Rigor mortis	Cadaveric spasm
Onset	This is due to changes in the muscles after the molecular death of their cells and is preceded by primary flaccidity of muscles. 2–3 hours are therefore usually necessary before stiffening occurs.	This is continuation of state of contraction of the muscles after death in which the muscles were at the instance of death. The stage of primary flaccidity is absent. The stiffening is therefore instantaneous.
Muscles involved	All muscles of the body are affected gradually.	Selected muscles, which were in a state of contraction at the time of death.
Intensity	Comparatively moderate	Comparatively very strong.
Duration of stay	About 12–24 hours.	A few hours, until replaced by rigor mortis.



Predisposing factor(s)	Nil.	Excitement, fear, fatigue, exhaustion, nervous tension along with contraction of muscles during death.
Mechanism of formation	Breakdown of ATP below critical level.	Not exactly known.
Medicolegal bearing	Mostly helps to know the time since death.	It helps to suggest the manner of death i.e. whether suicide, accident or homicide.



Concept 5.10 : Decomposition

Learning objective: To know the various changes that takes place as a result of decomposition.

Time needed

1 st reading	40 minutes
2 nd look	20 minutes

It involves 2 processes:

1. Autolysis: Self-digestion of tissues by enzymatic activity.
2. Putrefaction: Due to bacterial activity. It is the final stage following death, in which destruction of the soft tissue of the body occurs.
 - Organisms enter the tissues shortly after death, mainly from the alimentary canal, and less often through the respiratory tract or through the external wounds.
 - Multiplication of bacteria begins within 4 hours and peak is reached within 24-30 hours.
 - Because protective agencies of the body are absent, the bacteria spread through the blood vessels using the proteins and carbohydrates of the blood as culture media.
 - Destruction is mainly caused by the action of bacterial enzymes, mostly anaerobic organisms derived from the intestine.
 - The bacteria produce a large variety of enzymes and these breakdowns the various tissues of the body.
 - The bacteria involved are clostridium welchii, Streptococci, Staphylococci, Bacteroid's, anaerobic lactobacilli, Diphtheroides, B. proteus, B. coli, B. aerogenes capsulatus etc.
 - Putrefaction is the final stage following death, produced mainly by the action of bacterial enzymes, mostly anaerobic organisms derived from the bowel.
 - The characteristic features of putrefaction are:
 - Changes in the colour of the tissue.
 - Collection of gases in the tissues.
 - Liquefaction of tissues.

Changes in the color of the tissue:

- The first external sign of putrefaction in a body lying in air is greenish discoloration of skin over caecum i.e. right iliac fossa.
- The color appears in 12 to 18 hours in summer and 1 to 2 days in winter.
- The green discoloration then spreads over the entire abdomen, external genitals and then patches appear over the chest, neck, face, arms and legs.
- Internally, decomposition proceeds more slowly than the surface.
- But the color varies from dark red to black, rather than green.
- With this color change the viscera becomes softer and greasy to touch. Finally they break down into a soft disintegrating mass.



Development of foul-smelling gases:

- The chemical processes liberate ammonia, carbon monoxide, carbon dioxide, hydrogen sulphide, phosphorated hydrogen, methane and mercaptans.
- Gases collect in the intestines in 12-18 hours in summer and 1-2 days in winter and the abdomen becomes tense and distended.
- The gas formation in the blood vessels may force the blood stained fluid, air or liquid fat between the epidermis and dermis forming small blisters in 18-24 hours.
- From 18-36 hours after death, the gases collect in the tissues, cavities and hollow viscera under considerable pressure and the features become bloated and distorted.

Pressure effects of gases:

- Due to the presence of the gas in the abdomen, the diaphragm is forced upwards compressing the lungs and heart, and the blood stained froth exudes from the mouth and nostrils (POST-MORTEM PURGE), which can be mistaken for the bleeding following ante-mortem injury.
- Pressure of the gases may force food from the stomach into the fauces and this may fall into the larynx.
- Swelling due to gases is most marked in the face, genitalia and abdomen.
- In 24-48 hours, the subcutaneous tissues become emphysematous. The breast and penis is greatly distended, the eyes bulge from the sockets, and the tongue is forced out between the swollen and discolored lips.
- After 3 days, the face is so discolored and bloated that identification becomes very difficult. The hair becomes loose and is easily pulled out. The nails are also loose.
- In 3-5 days or more,
 - The sutures of the skull especially of the children are separated and liquid brain comes out.
 - Teeth (anterior teeth and often premolars) become loose and may fallout.
 - The skin shows "slippage" and the skin of the hands and feet may come off in a "glove and stocking" fashion.





Liquefaction of tissues:

- Colliquative putrefaction begins from 5-10 days or more after death.
- The abdomen burst and the stomach and intestine protrude.
- In children thorax also bursts.
- The tissue become soft, loose and are converted into a thick, semi-fluid, black mass and are separated from the bones and fall off.
- The cartilages and ligaments are softened in the final stage.

External order of putrefaction:

In Air: Abdomen -> Chest -> Face and Neck -> Lower limbs -> Upper limbs

In water: Face and Neck -> Chest -> Upper limbs -> Abdomen -> Lower limbs

Postmortem Purge:



- Due to the presence of gases in the abdomen, the diaphragm is forced upwards resulting in expulsion of blood-stained froth/gastric contents from the mouth and nostrils.

Postmortem luminescence:

- It is mainly due to contamination by *Photobacterium fischeri*.
- Luminescent fungi *Armillaria mellea* is another source of light.

Putrefaction and temperature factor

- Putrefaction begins above 10°C and is optimum between 21°C and 38°C.
- Putrefaction is arrested below 0°C and above 48°C.

Putrefaction sets in rapidly in cases of:

- Septicemia, peritonitis, inflammatory and septic conditions, anasarca and asphyxia.

Conditions which retard/delays putrefaction

- Wasting disease: Anaemia, severe hemorrhage (decreased blood) and Debility (atrophy of tissue)
- Poisons: Arsenic, antimony and other heavy metals, carbolic acid, zinc chloride, strychnine.

**Poisons which resist putrefaction:**

- CO, cyanide, fluoride, barbiturates, P, OP, endrin, strychnine, yellow oleander, nicotine etc.
- Heavy metals like Arsenic, antimony, mercury, lead, thallium etc.

Casper's dictum:

- If the environmental factors are same, a body decomposes in air twice as rapidly as in water and eight times as rapidly as in earth. A:W:E = 1:2:8

Decomposition of bone:

- Bones decompose after death in 3-10 years.
- Less than 7 amino acids in bone mean time since death is more than 100 years.
- First amino acid to disappear is proline and hydroxy-Proline. *
- Last amino acid to disappear is glycine. *
- Total ultraviolet fluorescence of cut surface of bones is seen in 35-100 years.



Concept 5.11 : Postmortem Chemistry

Learning objective: To know the parameters in body fluids after death

Time needed

1 st reading	10 minutes
2 nd look	5 minutes

Blood: Decrease in Glucose, Na^+ , Cl^- .

C.S.F.: Decrease in Glucose. No change in Urea, Creatinine, Na^+ , Ca^{++} and Mg^{++} .

V. Humor: Decrease in Glucose, Na^+ , Pyruvic acid.

All other parameters increase after death.

Time since death by K^+ concentration is calculated by

Madea and Henssge formula and

Sturner's equation.



Concept 5.12 : Modification of Putrefaction

Learning objective: To know the modification of putrefaction such as adipocere and mummification.

Time needed

1 st reading	20 minutes
2 nd look	10 minutes

Adipocere (saponification or grave wax):



- It is a modified form of putrefaction, where the body fat is converted into higher fatty acids.
- The change is due to gradual hydrolysis and hydrogenation of fat.
- It is seen in body immersed in water or in damp warm environment.
- Adipocere is delayed by cold and formed rapidly by warm humid climate.
- The conditions required are warm temperature, moisture, and relative diminution of air.
- It is found first in the face, buttocks, breast and abdomen (fatty depots).
- In temperate countries, the shortest time for its formation is about 3 weeks in summer.
- Process begins in 3 days and completes in 3months. In cold water it may take up to 1 year.
- Fresh adipocere is soft, moist, whitish and translucent, resembles RANCID BUTTER but old samples are dry, hard, cracked, yellowish and brittle.
- It is formed first in subcutaneous tissue.
- Medicolegal Importance:
 - Identification - The facial features are well preserved.
 - Cause of death - Injuries is recognized.
 - Time since death.
 - Place of death.



Mummification:

- It is a modified form of putrefaction where drying and desiccation of the tissues occur.



- Mummification occurs when body is buried in dry sandy shallow graves.
- The conditions required are high temperature, free flow of air and absence of moisture.
- Medico-legal Importance:
 - Identification – The general facial features are preserved.
 - Cause of death - Injuries is recognized.
 - Time since death.
 - Place of death.
- The time required is same as for adipocere.
- The entire body loses weight up to 60-70%.

Chronic arsenic and antimony poisoning favor the process of mummification.

6

Injuries, Starvation & Torture

CONCEPTS

- Concept 6.1 Mechanical Injuries
- Concept 6.2 Fractures of Skull
- Concept 6.3 Intracranial Lesions
- Concept 6.4 Other Regional Injuries
- Concept 6.5 Road Traffic Accidents
- Concept 6.6 Basic Principles of Ballistics
- Concept 6.7 Cartridges
- Concept 6.8 Rifled Firearm Injuries
- Concept 6.9 Smooth Bored Firearm Injuries
- Concept 6.10 Range of Firearms
- Concept 6.11 Terminologies in Ballistics
- Concept 6.12 Bomb Explosion
- Concept 6.13 Temperature Related Events
- Concept 6.14 Burns
- Concept 6.15 Scalds
- Concept 6.16 Electrical Injuries
- Concept 6.17 Lightening
- Concept 6.18 Starvation
- Concept 6.19 Torture



Concept 6.1 : Mechanical Injuries

Learning objective: To know classification of mechanical injuries, enzyme histochemistry, the definition and features of abrasions, contusions, lacerations, incised wounds, chop wounds and defence wounds.

Time needed

1 st reading	90 minutes
2 nd look	45 minutes

Classification of Mechanical/Physical Injuries

1. Those caused by blunt force
 - Abrasions
 - Contusions (bruise)
 - Lacerations
2. Those caused by sharp force
 - Incisions
 - Chop wounds
3. Those caused by pointed weapons
 - Stab wounds
4. Those caused firearms
 - By rifled firearms
 - By smooth bored firearms
5. Blast injuries
6. Undetermined

Sequence of Enzymes/Biochemical Markers Rising after Injury

- Calpains, cathepsin, Serotonin (10 min)
- Histamines (30 min)
- Esterase and ATPase (within 1 hour)
- Aminopeptidase (2 hours)
- Acidphosphatase (4 hours)
- Alkaline phosphatase (8 hours)

Abrasions





- An abrasion is destruction of the skin, which involves only superficial layers of skin, i.e., only epidermis.
- It is a two-dimensional injury - only length and breadth.
- It bleeds less and does not form scar after healing.
- The exposed raw surface is covered by exudation of lymph and blood, which produces a protective covering known as scab or crust.

Types

1. Scratches/Linear abrasions:

- These are caused by a sharp object passing across the skin, such as fingernails, pin or thorn etc.
- A scratch (linear abrasion) is an abrasion with length but no significant width, or very superficial incision.
- Even pointed objects can cause scratches.

2. Grazes (Sliding/Tangential/Scraping Abrasions):

- This occurs when a broad area of the skin is scraped against a broad, rough surface.
- An abrasion caused by violent lateral rubbing against a surface is called brush burn or gravel rash.

3. Imprint Abrasion:

- They are caused by impact of a rough object such as a person is knocked down by a motor car, the pattern of the radiator grill, head lamp or tyre tread may be seen on the skin.

4. Pressure Abrasion (Crushing/Friction Abrasion):

- They are caused by crushing of the superficial layers of the epidermis and are associated with a bruise of the surrounding area. e.g., ligature mark in hanging.

Age of Abrasions

Fresh	: Bright red
1 day	: Lymph and blood dries up leaving a bright red scab
2 to 3 days	: Reddish-brown scab
4 to 7 days	: Dark brown to Brownish-black scab. Epithelium grows and covers defect under the scab After 7 days: Scab dries, shrinks and falls out

Differential Diagnosis of Abrasions

1. Erosion of the skin produced by ants
2. Excoriation of skin by excreta
3. Pressure sores
4. Drying of the skin

Bruises/Contusions



- A contusion is extravasation of blood into the tissues, due to the rupture of the blood vessels (veins, venules and arterioles), caused due to blunt force.
- A contusion may be intradermal, subcutaneous or deep.
- Contusions may be present not only in the skin, but also in internal organs.
- Bruises may be seen in association with abrasions or lacerations.
- Prominent bruising following minor trauma is seen in people suffering from blood dyscrasias and phosphorus poisoning.
- Contusions over the scalp are better felt than seen.
- **Stomping:** Kicking and jumping on a person is known as stomping.
- **Battle's sign:** Here hemorrhage gravitates along the facial planes from basilar fracture of skull (Middle cranial fossa) and percolates behind and below the ear.
- **Patterned bruise/contusion:** The shape and pattern of the causative weapon is imprinted on the skin.
- **Delayed Bruising:** A deep bruise may take several hours or even 1-2 days to appear on the surface and also may not appear below the actual point of impact.
- **Artificial Bruises:** Some irritant substances when applied to skin produce injuries, which simulates bruises e.g. Semicarpus Anacardium (Marking Nut), Calotropis, Plumbago.

Differences between True Bruise and Artificial Bruise

Trait	Artificial Bruise	True Bruise
Cause	Juice of marking nut, calotropis or plumbago rosea.	Trauma.
Site	Exposed accessible parts.	Anywhere.
Color	Dark brown.	Typical color changes.
Shape	Irregular.	Usually round.
Margins	Well defined and regular, covered with small vesicles.	Not well defined, diffused and irregular; no vesicles.
Redness & inflammation	Seen in the surrounding skin.	Seen in the site.
Contents	Acrid serum.	Extravasated blood.
Itching	Present.	Absent.

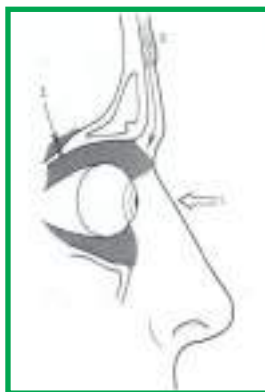


Vesicles	May be found on fingertips and other parts of the body due to scratching.	Absent.
Chemical tests	Positive for chemicals.	Negative.

Ectopic Bruise or Percolated Bruise or Migratory Contusion

Blood will track along the fascial planes or between muscle layers which form the least resistance and may appear where the tissue layers become superficial. E.g.:

1. Blunt trauma to the forehead may lead to gravitating of blood around the eye and cause black eye.



2. Black eye caused by the fracture of anterior cranial fossa.
3. Bruise in the neck in case of fracture of jawbone.
4. Bruise in the thigh due to fracture of pelvis.
5. Fracture of femur may cause bruise over outer aspect of lower thigh.
6. A blow on the upper thigh may cause a bruise above the knee.
7. Impact over the calf may give rise to bruise over the ankle.

Age of Bruise

- At first : Red
- Few hours to 3 days : Blue (deoxyHb)
- 4th Day : Bluish-black to brown (haemosiderin)
- 5 to 6 days : Greenish (haematoidin)
- 7 to 12 days : Yellow (bilirubin)
- 2 weeks : Normal

Color change begins from periphery towards centre of Bruise.

- Sub-conjunctival hemorrhage do not undergo usual color changes due to diffusion of atmospheric oxygen through the conjunctival tissue. They are at first red, then yellow before disappearing.

Antemortem v/s post-mortem bruising

- A certain amount of swelling and colour changes are usually found in a bruise caused during life.

- Coagulation of the effused blood into the subcutaneous tissues along with infiltration of blood in the tissues is no longer to be seen in postmortem bruises.
- However, a bruise is likely to be disfigured by decomposition and then it may pose a problem in its differentiation.
- The margins of post-mortem bruises are usually quite sharply defined.

Incision test

This test is used to differentiate Bruise from Hypostasis.

- On incision, blood is seen in blood vessel which is easily washed away in hypostasis.
- In Bruise there is extravasations of blood in surrounding tissue and cannot be washed away.

Difference between Hypostasis and Bruise

Trait	Hypostasis	Bruise
Cause	Due to distension of vessels with blood in the dermis.	Due to ruptured vessels Which may be superficial or deep.
Site	Occurs even extensive area of the most dependent parts.	Occurs in the site of and surrounding the injury; may appear anywhere on the body.
Appearance	No elevation of the involved area.	Often swollen because of extravasated blood and edema.
Epidermis	Not abraded.	May be abraded.
Margins	Clearly defined.	Merge with surrounding area.
Color	Uniform bluish-purple in color.	Old bruises are of different color. Fresh bruises may appear more intense than the adjacent hypostatic area.
Incision	On incision blood is seen in blood vessels, which can be easily washed away. Subcutaneous tissues are pale.	Shows extravasation of blood into the surrounding tissues, which is firmly clotted and cannot be washed by gentle stream of water.
Effect of pressure	Absent in areas of the body which are even under slight pressure.	Little lighter over the area of pressure or support.

Lacerations





- Laceration is a rupture or tear or a split in the skin, mucous membrane, muscle or any internal organ, involving depth more than the covering epithelium of the skin or that of an organ that is produced by application of blunt force.
- Lacerations do not reproduce the shape of the agent as distinct as are produced in case of abrasions and intradermal bruises.
- Margins are irregular and edges are contused with tissue bridges.
- Depending on the direction of force of impact a laceration may be split laceration (Perpendicular force), stretch laceration (Tangential force), avulsion laceration (almost horizontal force) or tear (Irregular force)

Chop Wounds (Slash Wounds)



- These are the wounds caused by sharp cutting heavy weapons such as butcher's knife, axe, hatchet, heavy sickle, etc.
- The margins are regular, and the edges are contused.

Incised Wounds



- An incised wound is a clean cut through the tissues caused by sharp cutting light weapons, such as razor blade, scalpel, knife etc.
- Length is the greatest dimension.
- Margins are regular and edges are not contused

Lacerated looking incised wounds:

- The incised wounds may look like a lacerated wound, when it is situated over loose and wrinkled areas of the body such as, Neck, axilla, scrotum & back of the elbow.
- The margins are inverted and look irregular.

Age of incised wound

Fresh	: Hematoma formation.
12 hours	: Edges are red, swollen, and adherent with blood and lymph. Leucocytic infiltration.
24 hours	: A continuous layer of endothelial cells cover the surface and edges are formed with an overlying crust or scab of dried clot.
36 hours	: The capillary network is complete.
48 to 72 hours	: The wound is filled with fibroblasts.
4 to 5 days	: Definite fibrils running parallel to the vessels are seen;1 Vessels show thickening and obliteration.
1 to 2 weeks	: Scar tissue is formed.

Stab Wounds



- These are the wounds caused by pointed weapons, when these weapons are driven into the skin and the underlying tissues such as knife, dagger, arrow, screwdriver, iron rod, etc.
- Depth is the greatest dimension. The length, width and depth of the stab wounds generally corresponds with the breadth, thickness and length of the penetrating blade.
- The margins are inverted. The regularity and irregularity of the margins depends on the type of the causative weapon.
- If the weapon is a knife or a dagger, the margins are clean cut, and edges are not abraded or contused, unless the blade has penetrated completely wherein the guard of the knife may cause contusion on the wound edges. The edges in case of stab wounds caused by blunt, relatively pointed weapons such as iron rod, the edges may be contused.

Defence Wounds



- These are the wounds resulting from an immediate and instinctive reaction of the victim to save himself when attacked.
- Active defense wounds are caused when the victim tries to grasp the weapon and passive defence wounds are caused when the victim raises his hands, arms or legs.
- These wounds are seen on the body of a victim.

Concept 6.2 : Fractures of the Skull

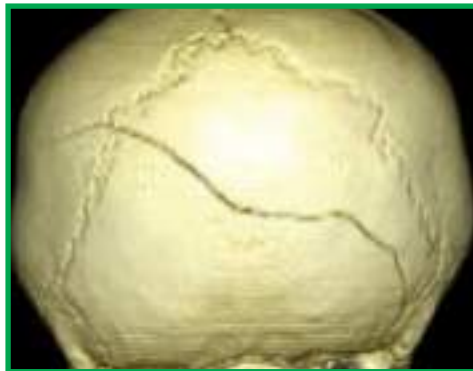
Learning objective: To know the different types of fracture of the skull

Time needed

1 st reading	30 minutes
2 nd look	15 minutes

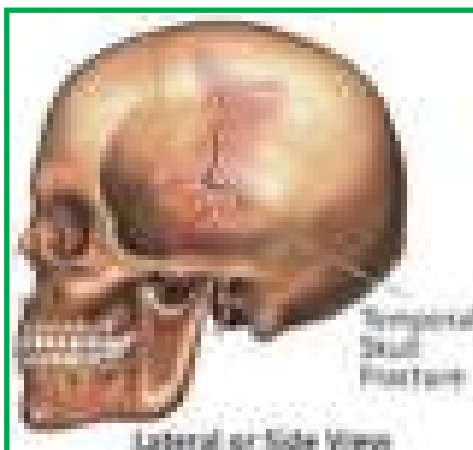
Fractures of the Vault of the Skull

1. Fissured/Linear Fractures



- These are linear fractures involving the whole thickness of the skull or inner or outer table only.
- About 70% of skull fractures are linear.
- About 20% of linear fractures are not found on X-ray.
- Crack fracture means fracture of only one table, either outer or inner

2. Radiating Fracture



- Many fracture lines are radiating from a single point

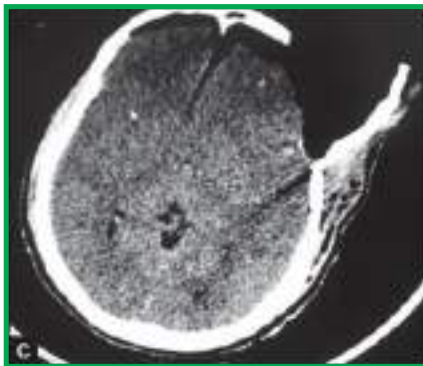


3. Depressed fracture (Signature fracture/ Fracture a la signature)



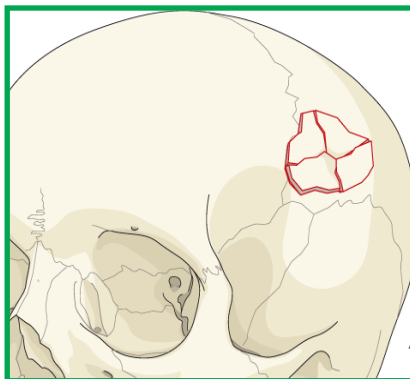
- Caused by blows from heavy weapon with a small striking surface, e.g., stone, stick, hammer, etc.

4. Elevated fracture:



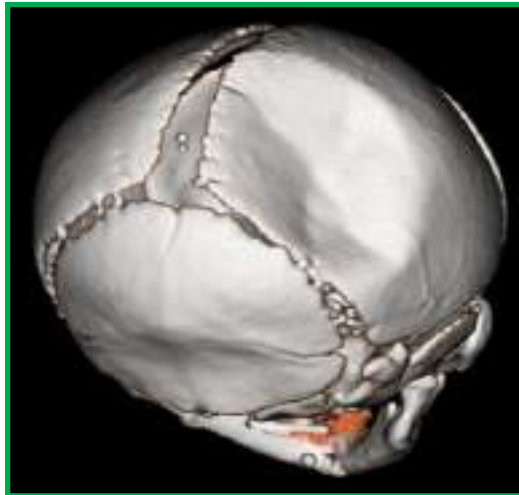
- One end of fractured fragment is elevated over the surface of skull and the other end may be depressed into cranial cavity.

5. Comminuted Fractures (Spider web/Mosaic fracture)



- Here, the bone gets broken into multiple pieces and they usually occur as a complication of fissured or depressed fractures.

6. Pond or Indented Fractures:

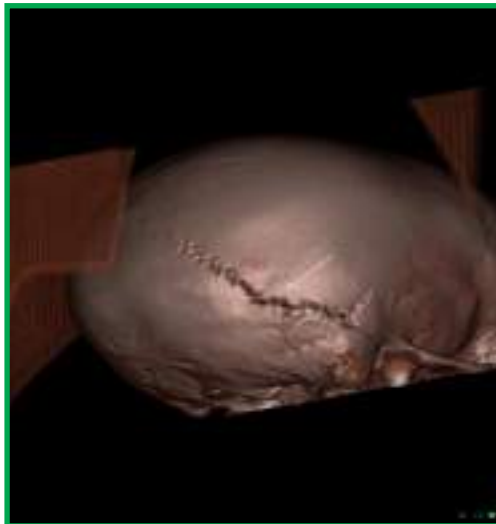


- These may be seen in infants where the skull is elastic and usually is produced by forcible compression of the skull by obstetric forceps or impact against some protruding flat object.

7. Gutter Fracture:

- It is the name used to indicate a furrow in the outer table of the skull, ordinarily the result of a glancing blow by a missile from a rifled firearm.
- These are frequently accompanied with comminuted depressed fractures of the inner table of the skull.

8. Separation of Suture (Diastatic Fractures)

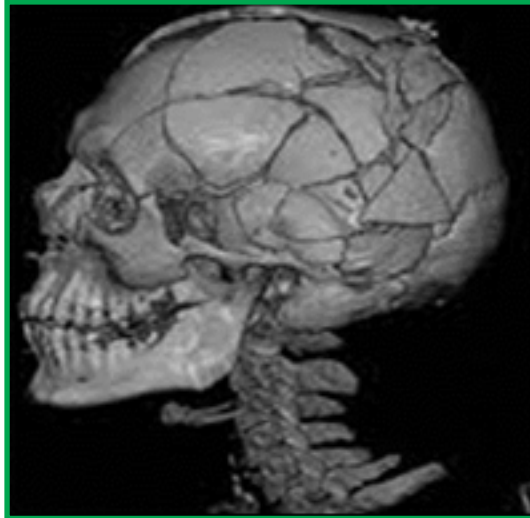


- Diastatic fractures are those in which the fracture line involves separation of one or more cranial sutures.
- Sagittal suture is commonly involved



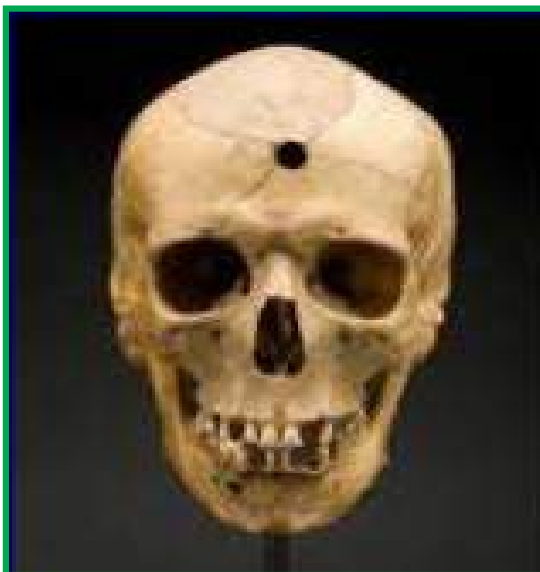
- These are most often seen in children and in young persons before the closure of the sutures and are commonly associated with epidural haemorrhage.

9. Expressed Fractures:



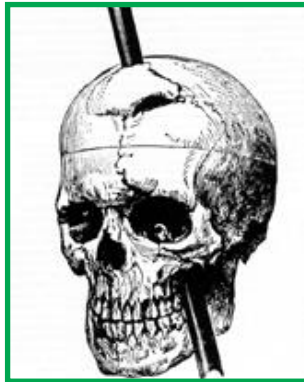
- These are rather uncommon but may occur as massive fragmentation/shattering of skull where the pieces may come to lie outside the normal curvature of the cranium in the pericranial tissues, in the orbits, or physically outside the head.
- Such fractures can occur due to massive trauma often involving contact/close-range firearm injuries or injuries due to blasts.

10. Penetrating fracture



- Penetrating the cranial cavity

11. Perforating fracture



- Entry and exit

12. Contrecoup Fractures:

- These are mostly seen in orbital portions of the frontal bones as simple linear fractures or sometimes in more complex form as stellate fractures.
- The involvement of frontal region may be explained because of development of 'negative pressure' within this region resulting from differential movements of brain versus skull following occipital impact that leads to implosion of the relatively thin and weak orbital roof.

Fractures of the Base of the Skull

1. Fracture of the anterior cranial fossa:

- Clinical manifestation: Bleeding from nose/mouth or CSF rhinorrhea, Raccoon Eye.
- 2. Fracture of the middle cranial fossa:
- Clinical manifestation: Bleeding from the ear, Battle's sign.

3. Fracture of the posterior cranial fossa:

- Clinical manifestation: Boggy swelling over upper nape.

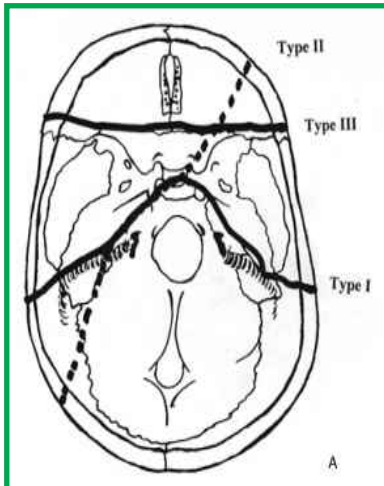
4. Ring fracture:

- Fracture of the base of the skull, typically involving the temporal bone, occipital bone, sphenoid bone, and/or ethmoid bone or sometimes only occipital bone.
- Usually fracture is seen 3 to 5 cm. away from the foramen magnum.



**Causes:**

1. Fall from height on feet/buttocks
2. Fall of heavy object/heavy blow on the vertex
3. Heavy blow on the chin.

5. Hinge fracture/Motor cyclist's fracture

- 'Hinge' fractures occur when the linear fracture passes across the middle cranial fossa, separating the skull base into 2 halves, and may be caused by a heavy blow to the side of the head (e.g. in motorcycle accidents).
- Type I: Coronal, passing through sella - most common: associated with impact on side of head or on tip of chin.

Type II: Front to back, passing through sella (Oblique).

Type III: Coronal but not through sella.



Concept 6.3 : Intracranial Lesions

Learning objective: To know coup & contrecoup injuries and intracranial hemorrhages – EDH, SDH, SAH and intracerebral

Time needed

1 st reading	30 minutes
2 nd look	15 minutes

Coup and Contrecoup Injuries

- When an impact is imparted to an immobile (stationary) head, the site of maximum cortical damage is most likely to be underneath or at least on the same side as the impact. This is so called, 'coup lesion'.
- When a moving head is suddenly decelerated as in case of a fall, though there might be a coup lesion at the site of the impact, there is usually cortical damage on the opposite side of the brain— 'contrecoup lesion'.
- Coup and contrecoup injuries are associated with cerebral contusions.
- Coup and contrecoup injuries can occur individually or together.
- Contrecoup injuries are rare before the age of 3 years.
- Intermediary coup injuries may be seen in between coup and contrecoup injuries.

Intracranial Hemorrhages

1. Extradural hemorrhage

- It is the least common type of meningeal bleeding (1-3% of head injury).
- EDH is primarily arterial blood (middle meningeal) but may be venous (diploic veins, middle meningeal and dural sinuses).
- Most common artery causing EDH is posterior branch of middle meningeal artery.
- Minimum amount of blood required for fatality in case of EDH is 100ml
- Lucid interval is seen in about 30-40% of cases.
- 90-95% of cases are associated with fracture.
- EDHs are generally unilateral in more than 95% of cases, however, bilateral or multiple EDHs are reported.

2. Subdural hemorrhage

- May occur from relatively small amount of trauma.
- It occurs due to rupture of bridging veins.
- Death may occur in cases of SDH, if hemorrhage is about 100-150ml.
- Other than trauma, it can be caused by
 - Rupture of an aneurysm or a superficial blood vessel transformation in the brain through the arachnoid into the subdural space.
 - Secondary to disease, e.g., cerebral tumour, cerebral aneurysms or blood disorders.
- Subdural hemorrhage is commonly seen in:
 1. Chronic alcoholics (Due to cortical thinning the veins become taut)



2. Old age (Due to cerebral atrophy the veins become taut)

3. Children (Infantile whiplash syndrome).

- Pachy Meningitis Hemorrhagica: It is a chronic subdural hemorrhage.
- Subdural hygroma - Accumulation of CSF in subdural space due to rupture of arachnoid layer.

3. Subarachnoid hemorrhage

- Traumatic SAH over the base of the brain can be caused by the lacerations of the internal carotid, vertebral or basal arteries. These injuries can be immediately fatal, if the hemorrhage is more than 30 ml.
- Most common site of rupture of Berry Aneurysm is Anterior Communicated artery.

4. Intra-cerebral hemorrhage

- It is most common non-traumatic intracranial hemorrhage.
- Small intraventricular hemorrhages occur in all kinds of cranio-cerebral injuries.



Concept 6.4 : Other Regional Injuries

Learning objective: To know the features of whiplash injury, railway spine, commotio cordis, Glasgow smile and common organs to be injured

Time needed

1 st reading	20 minutes
2 nd look	10 minutes

Whiplash Injury:

- Whiplash is a neck injury due to forceful, rapid back-and-forth movement of the neck, like the cracking of a whip.
- Whiplash most often occurs during a rear-end auto accident, is due to the violent acceleration or deceleration force.
- These injuries are commonly seen in vehicular accidents but may also be seen in cases of blows on the head/neck, shallow water diving, etc.
- Whiplash injury is caused by acute hyperextension followed by acute hyper flexion (as in rear end auto accident) or acute hyper flexion followed by acute hyperextension.
- There may be laceration of spinal cord without any external evidence.
- Most cervical spine fractures occur predominantly at two levels - at the level of C₂ or at C₆ or C₇.
- Most fatal cervical spine injuries occur in upper cervical levels, either at the cranio-cervical junction C₁, or at C₂.

Railway Spine:

- Railway spine means concussion of the spinal cord.
- Causes: Railway accidents, motor vehicle collisions, blow on the back, fall from a height, glancing bullet injury over the spine.
- There will be transient paralysis with usual recovery within over 48 hours.

Commotio cordis:

- Commotio cordis typically involves young (8-18 years; average age is 15), predominantly male, athletes in whom a sudden, blunt, non-penetrating and innocuous-appearing trauma to the anterior chest results in cardiac arrest and sudden death from ventricular fibrillation.

Glasgow Smile

(Glasgow grin, Anna grin, Chelsea grin or Chelsea smile)





- It refers to the wound that result from slashing a person's face from the edges of the mouth to the ears.
- The cut, which is usually made with a utility knife or a piece of broken glass, leaves a scar that makes the victim appear to be smiling broadly.
- Sometimes the attacker will stab or kick the victim after cutting them to make them scream, so that the wound is opened further.
- If cut deeply enough, the victim may bleed to death.
- The practice is said to have originated in Glasgow, Scotland, hence its name, Glasgow Smile, but also became popular with English street gangs as an intimidation tactic (especially in Chelsea, London, where it is known as a "Chelsea grin").
- Also known as a "buck 50" in New York City.
- It requires approximately 150 stitches to close.
- Commonest site of traumatic cardiac rupture: Right atrium
- Commonest site of traumatic aortic rupture: Descending thoracic aorta
- Liver is the most likely organ to be damaged in blunt abdominal trauma and is second only to the brain in overall visceral susceptibility.
- Commonest site of traumatic tear of intestine: Jejunum
- Minimum blood to give rise to Acute Cardiac Tamponade: 200 ml
- Amount of air needed to produce fatal air embolism: 100ml
- Minimum number of casualties to consider mass disaster: 12
- The non-gravid uterus is not usually injured in case of blunt abdominal injury
- Boxer's fracture: Fracture of metacarpal bones.



Concept 6.5 : Road Traffic Accidents

Learning objective: To know the pattern of injuries sustained by a pedestrian, injuries to the driver and tailgating

Time needed

1 st reading	30 minutes
2 nd look	15 minutes

Injuries to Pedestrian:

1. Primary impact injury:

- These include the injuries that are sustained when any part or parts of the victim first strike the vehicle.
- The part of the body involved will depend upon the position of the person in relation to the vehicle when struck, i.e. whether crossing the road or walking with or against the traffic, etc. The position of the injuries will be further modified by the fact whether both feet were on ground and one was raised, the nature of surface of the road and the footwear of the victim.
- In a typical case, the first impact tends to knock the legs and rotate them to the oncoming vehicle resulting in 'bumper injuries' on the legs (fractures of tibia and fibula, often compound and comminuted).
- Sometimes, the level of injuries may be low as compared to the height of the bumper, suggesting application of the brakes at the moment of the impact thereby causing dipping down of the bonnet.

2. Secondary impact injury:

- These injuries are the result of impact between the body part(s) and the vehicle for the second time as when the victim after striking against the vehicle is further scooped up/or otherwise hurled up on the vehicle resulting in injuries to the other parts of the body by the same vehicle

3. Secondary injuries or Tertiary Impact injury:

- These are sustained by the victim after being knocked down by the vehicle and striking the ground with the subsequent risk of being harmed by some different vehicle, thus receiving the injuries by striking against the ground or some object on the ground as well as those sustained through some other vehicle.

4. Run-over injury:

- Injuries sustained by the vehicle passing over the victim.

Injuries to Driver:

- When the most common frontal impact occurs, the unrestrained driver first slides forwards so that his legs strike the facia/parcel shelf area and his abdomen or lower chest contacts the lower edge of steering wheel.
- The body then flexes across the steering wheel and begins to rise, the heavy head goes forwards and there is flexion of the cervical and thoracic spines.
- Impact against the facia may produce abrasions, lacerations and fractures of the legs around knee or around the upper shin level.



- Pressure of feet upon the floor, especially when it is intruded by any structural component, can cause fracture anywhere from foot to femur. Hip joint may be dislocated posteriorly and even the fractures of pelvis are not uncommon.
- Impact of the abdomen and chest against the steering wheel may cause severe internal injuries.
- Other steering wheel lesions may be bruising of the lungs, fractures of ribs and/or sternum, cardiac contusions and haemothorax or pneumothorax or both.
- In the abdomen, liver rupture is frequent involving any part. Subcapsular tears can occur with the formation of subcapsular haematoma, which can rupture later.
- Spleen may show tears in some cases, often around the hilum and rarely, it may be avulsed from the pedicle.
- The mesentery and omentum may show bruising in some cases and rarely there may be laceration and fenestration enough to cause a lethal haemorrhage.
- Injuries to the neck: 'whiplash injuries' - There is often a double component in that the hyperflexion of deceleration is followed by a rebound hyperextension when the head meets an obstruction in the front.

Seat belt injuries:

- In India, seatbelt abrasion/contusion is seen on the right shoulder of the driver and over the left shoulder of the front seat occupant.
- In case of sudden deceleration, there may be acute flexion over the strap so that the shoulder strap of driver may give rise to rupture of the spleen and shoulder strap of the front seat passenger may give rise to rupture of the liver.
- The lap strap may give rise to avulsion and laceration of the mesentery and intestine.
- When there is impact, the body stops along with the car, as the body is restrained by the seat belt. But the internal organs continue to move, which may give rise to mesenteric/ hepatic/ splenic detachment.
 - Lap-shoulder belts alone reduce the mortalities by about 45% and Air bags alone by about 14%.
 - If both seat belts and air bags are used, fatalities are reduced by 50%.

Tailgating/Under Running:

- It may be seen in motor cyclists as well as car drivers, where a rider/driver rides/drives into the back of a truck or some other heavy vehicle sustaining injuries.



Concept 6.6 : Basic Principles of Ballistics

Learning objective: To know the basics of firearms such as definition of firearm & forensic ballistics, different types of firearms, rifling, caliber, bore, choking etc.

Time needed

1 st reading	40 minutes
2 nd look	20 minutes

Firearm: A firearm is any instrument or device designed to propel a projectile by means of expansive force of gases generated by combustion of an explosive substance in a closed space.

Forensic ballistics: It is the science dealing with the investigation of firearms, ammunition and the problems arising from their use.

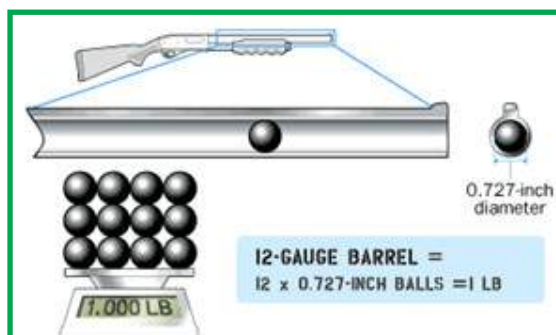
1. **Proximal/Interior/Internal Ballistics:** Physiochemical phenomenon from the time of detonation till the projectile leaves the barrel.
2. **Exterior/External Ballistics:** Study of the projective from the time it leaves the barrel till it reaches the target.
3. **Terminal/Wound Ballistics:** Study of effect of the projectile on the target (Study of wound)

Smooth Bored Firearms (Shotguns)

- Interior of the barrel is smooth.
- The projectiles are pellets; usually multiple in number which disperse on firing. [0.410 (Musket) used by police constable (India) where a single shot is fired]
- Disadvantages of Dispersion of pellets: It reduces usefulness of the weapon (Reduces effectiveness & Compactness)

Bore of a Shot gun:

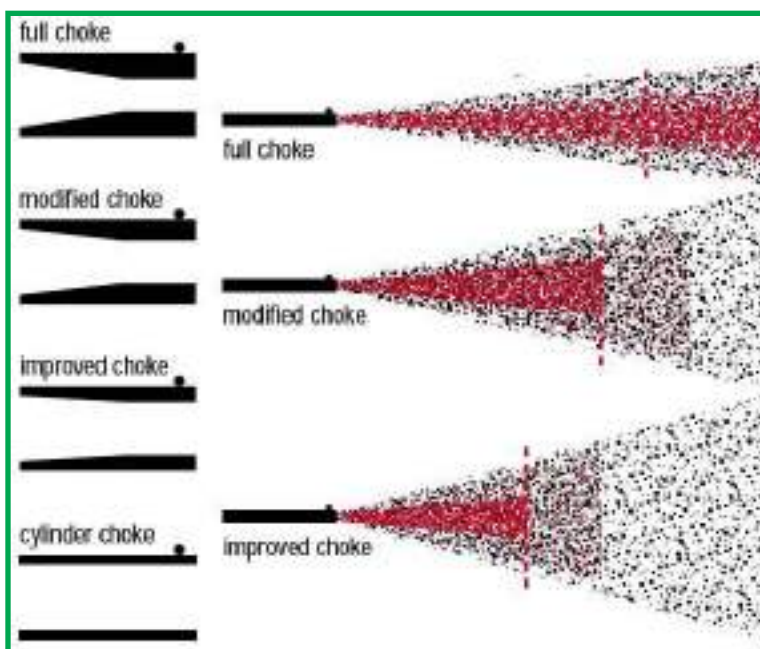
- It is the number of lead balls of equal size and shape which is made from one pound of lead, each ball precisely fitting the barrel.
- For example, 12 bore shotgun means, 12 balls of equal size and shape have been prepared from one pound of lead, each ball is precisely fitting the the interior of the barrel. Greater the bore lesser the lumen of the barrel.





Choking:

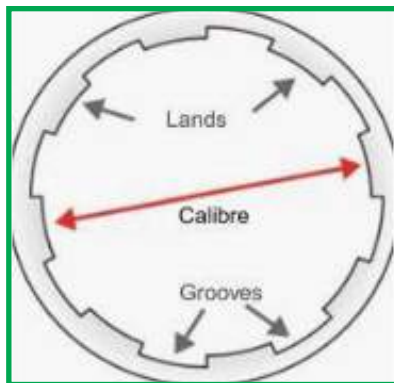
- The Degree of dispersion can be controlled to some extent by using a constricting device near the muzzle end, called choke.



Types of Choke	Constriction	% of shots found in 30" circle at 40yards
Full Choke	40/1000 of inch	65 – 70%
$\frac{3}{4}$ Choke	30/1000 of an inch	65%
$\frac{1}{2}$ Choke	20/1000 of an inch	60%
$\frac{1}{4}$ Choke	10/1000 of an inch	55%
Improved Cylinder	3-5/ 1000 of an inch	50%
True Cylinder (No Choke)	0/ 1000	30-40%

Rifled Firearms

- Interior of barrel is rifled, i.e., cut into spiral grooves. Rifling varies in number, direction, depth and width.
- The turning of spiral groove is called the twist and the angle of turning is called the pitch.
- The projectile is single, called – Bullet.
- Calibre or Gauge: Distance from one land to opposite land.



- Expressed in inches or mm, e.g., 0.22 pistol, 9 mm revolver etc.

Advantages of rifling

- Causes spinning of the bullet.
 - Gives gyroscopic stability to the bullet which increases the accuracy with which the target can be hit.
 - Increases the penetrating power of the bullet.
 - Prevents bullet from wobbling.
- Rifled firearms are divided into
 - Low velocity – Up to 360 meters/second
 - Medium velocity – 360-750 m/second
 - High velocity – 750-1260/second
 - Very high velocity – more than 1260 m/second



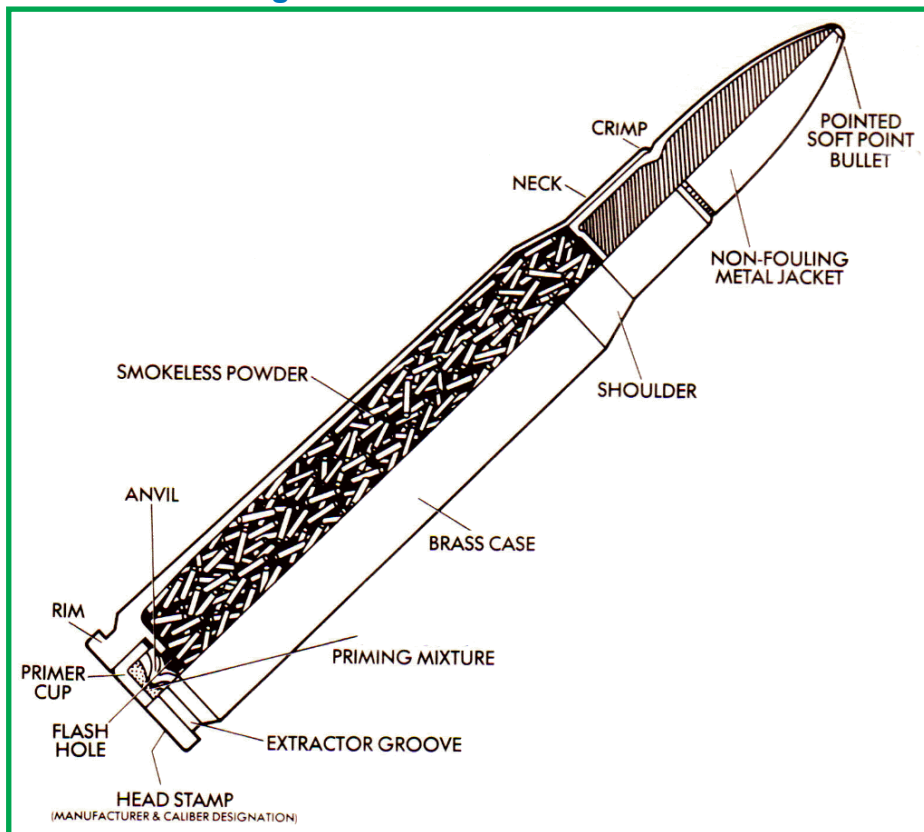
Concept 6.7 : Cartridges

Learning objective: To know the anatomy of rifled and smooth bored firearm cartridges, its composition, tests to detect the gunshot residue and the approximate distance travelled by various products of firing.

Time needed

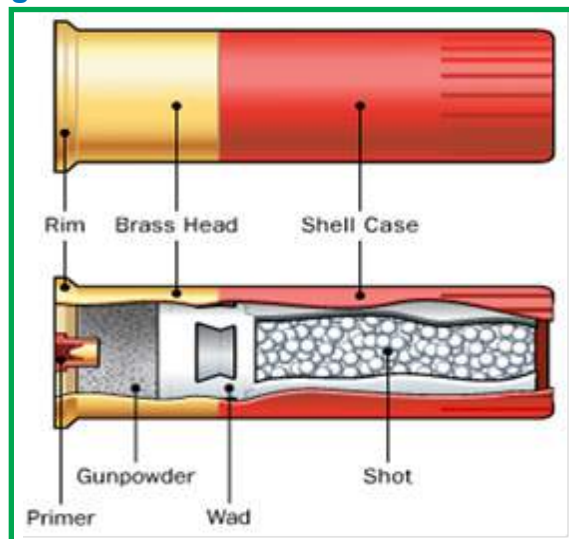
1 st reading	40 minutes
2 nd look	20 minutes

Rifled Firearm Cartridge:



- The case is made up of metal and is usually conical.
- The projectile is known as bullet.
- The extent of tissue damage by a bullet depends primarily on the velocity.
- Large round bullet causes greater damage to the body.
- A bullet should not be picked up with metal objects to prevent any scratches over the surface.

Shotgun Cartridge:



- The case is made up of cardboard or plastic and is cylindrical.
- The projectiles are almost always multiple, except in cases of Musket or where a single slug is used.
- The projectiles are usually known as pellets or shots.
- The pellets are usually made up of lead (soft or drop shots) or it may be hardened by adding antimony (Chilled shot). Nowadays copper, iron, tungsten and bismuth are also used. Depending on the size they are named as Buck shot (> 6mm), Bird shot (1.75-6mm) and Dust shot (<1.75mm).
- Wads are present only in shotgun cartridges. The wads
 - Separate the projectiles from the propellant.
 - Help to obturate the bore effectively.
 - The air cushion wad which is impregnated with grease helps to lubricate the barrel
 - Prevents heat from the gun powder from fusing or distorting the pellets.
 - Acts as piston
 - Prevents expanding gases from escaping.
 - Allows optimum pressure to develop.

The top wad/ overshoot wad is meant to keep the shots in place.

Primer

- It is a highly detonating sensitive material.
- Barium Nitrate, Antimony Sulphide and Lead Styphnate (BAL) are used commonly now a days as primer.
- Other chemicals used are Tetrazene, Potassium chlorate, Lead phthalate, Lead azide etc.
- They detonate on pressure and ignite gun powder.



Gun Powder (Propellant)

1. Black powder: Consists of

1. K Nitrate (75%) : Supplies Oxygen
2. Sulphur (10%) : Increases density and makes it more readily ignitable
3. Charcoal (15%) : Acts as Fuel
 - 1 gram of black powder produces 3000-4500 cc of gas.
 - Black powder is designated as FG, FFG, FFFG, etc. depending upon the size of the grains. The more number of 'F's means the finer are the grains and faster in burning.

2. Smokeless powder: It may be

1. Single based : Nitrocellulose.
2. Double based : Nitrocellulose + Nitroglycerine
3. Triple based : Nitrocellulose + Nitroglycerine + Nitroguanidine
 - These produce much less flame and smoke and more completely burnt than black powder
 - 1 gram produces 12000-13000 cc of gas.

3. Semi-smokeless powder: It is a mixture of 80% of black and 20% of smokeless powder.

Gun Shot Residues (GSR)

These are the residues derived from the primer and propellant (gun powder) on the hands of the person who has fired a firearm.

Tests for Gunshot residues:

For Propellant (Nitrous compound detection):

- Dermal Nitrate or Paraffin test or Diphenylamine test

For Primer (Heavy metals detection):

- Harrison and Gilroy Test
- NAA (Neutron Activation Analysis)
- FAAS (Flameless Atomic Absorption Spectrometry)
- TMDT (Trace Metal Detection Test)
- SEM-EDX (Scanning Electron Microscope-Energy Dispersion X-Ray) – Best Method

5% HNO₃ or 10% HCl is used to swab GSR

GSR on blood stained cloth can be visualized by Infra-red rays

Approximate distance Travelled by Various Products of Firing

Product	Rifled Firearm	Shotgun
Flame	8 cm	15cm
Smoke	15 cm	30cm
Un-burnt and Partially burnt particles	40-50cm (Handguns) 60-100 cm (Rifles)	60-90 cm
Wads	-----	2-5 metres (within the wound up to 2metres)



Concept 6.8 : Rifled Firearm Injuries

Learning objective: To know the wounds caused by a rifled firearm at various ranges.

Time needed

1 st reading	20 minutes
2 nd look	10 minutes

Contact shot:

- The muzzle end is in contact with the skin.
- Contact shot may be hard or firm contact or oblique contact. In case of firm/hard contact, there will be presence of muzzle impression.
- Where a thin layer of skin overlies bone, as in the head, these gases expand between the skin and the outer table of the skull, lifting and ballooning out the skin. If the stretching exceeds the elasticity of the skin, it will tear. These tears radiate from the entrance, producing a stellate or cruciform appearing wound of entrance.



Close shot

- The range is within the reach of the flame.
- The findings are:
 1. Wound of entry with abrasion and grease collar.
 2. Singeing of hair, scorching of skin.
 3. Blackening or smudging.
 4. Tattooing or peppering (begins when >1cm).

Near shot:

- The range is beyond the reach of the flame, but within the reach of powder particles.
- The findings are:
 1. Wound of entry with abrasion and grease collar.
 2. Blackening or smudging.
 3. Tattooing or peppering



Distant shot:

- The range is beyond the reach of powder particles.
- The findings are:
 1. Wound of entry with abrasion and grease collar

Exit Wounds

- The bullets that pass through the body cause exit wounds, sometimes known as 'outshoot wounds.
- The exit wound commonly presents a larger and more ragged appearance than the corresponding entrance wound, though exceptions are numerous, particularly depending upon the range of fire and other factors.
- Outshoot wounds may be of varying shapes and can be described as slit-like, stellate, cruciate, irregular or gaping.

Concept 6.9 : Smooth Bored Firearm Injuries

Learning objective: To know the appearance of wound caused by smooth bored firearm.

Time needed

1 st reading	20 minutes
2 nd look	10 minutes

- The appearance caused by the products of firing is like that of rifled firearm wound, except the effect of the projectile and wad.
- The pellets come out as a compact single mass so that the wound of entry will be usual round (circular) or oval up to 30 cm
- Between 30 cm to 1 meter, the rim of the wound is irregular and shows some scalloping, known as rat hole or cookie cutter appearance or nibbling or crenation.
- Over 2 meters and up to 4 meters, a few pellets deviate from the main mass and gives rise to satellite wounds of entry along with the main wound of entry.



- Beyond 4 meters, all the pellets disperse completely giving rise to multiple wounds of entry.



- As the range increases, the central defect becomes smaller and the number of surrounding pellet holes increases.
- The wad may be found deep into the wound up to 2meters.
- Exit wounds are generally not seen and if at all it is seen, it is seen only in contact shots



Concept 6.10 : Range of Firearms

Learning objective: To know the effective range of different firearms and estimation of the range of shotgun in yards by the spread of pellets in inches.

Time needed

1 st reading	20 minutes
2 nd look	10 minutes

Effective Range of Firearms

Weapon	Effective Range
Shotgun	30 - 40 meters
Musket	90 meters
Revolver	150 meters
Pistol	200 meters
Carbines	300 meters
Rifle	1000 - 3000 meters

Estimation of the range of shotgun in yards by the spread of pellets in inches

1. Half choke shotgun:

- Spread of pellets in inches = Range in yards
- For example, if the spread of pellets is 6 inches, the range is 6 yards

2. Full choke shotgun:

- Spread of pellets in inches = $\frac{3}{4}$ of range in yards
- For example, if the spread of pellets is 6 inches, the range is 8 yards

3. No choke shotgun:

- Spread of pellets in inches = $1.5 \times$ range in yards
- For example, if the spread of pellets is 6 inches, the range is 4 yards

Approximate spread of shot in centimeters at various distances

(Ref: Dr. Narayan Reddy)

	5 meters	10 meters	15 meters	20 meters	30 meters
Cylinder	20	50	65	75	
Half choke	13	30	40	50	
Full choke	8	25	35	45	75

Concept 6.11 : Terminologies In Ballistics

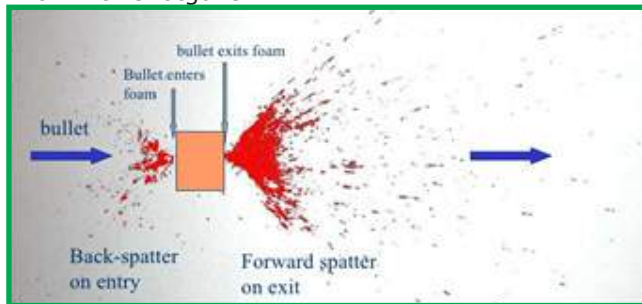
Learning objective: To know the different terminologies used in ballistics.

Time needed

1 st reading	20 minutes
2 nd look	10 minutes

Back spatter:

- In contact shot, the muzzle blast and the negative pressure in the barrel following discharge may suck blood, hair, fragments of tissue and cloth fibers, several cm. back into the barrel called "back spatter".
- It is more common with shotguns.



Forward spatter:

- Splashing of blood and tissue fragments through the wound of exit

Incendiary bullet:

- The tip of the bullet contains white Phosphorous, used to cause fire in the target (e.g., to ignite fuel tank)



Tracer bullet:

- The rear portion of the bullet core is removed, and the space is filled with a mixture of barium nitrate and powdered magnesium with strontium nitrate which burns during the flight of a bullet shedding red sparks. It leaves a visible mark or 'trace' while in flight.

**Souvenir bullet:**

- A bullet which is left in the body for long time. It may get surrounded by fibrous tissue. It may cause chronic lead poisoning.

Kennedy's phenomenon:

- Surgical intervention of gunshot wounds, so that proper evaluation of wounds becomes difficult.

Rayalaseema phenomenon:

- A bullet stuffed into the stab wound of the victim to mislead the police.

Fouling

- When the bullet comes out through the barrel, the metal fragments are scraped off, and these small fragments of metal from the bullet or the barrel impact the skin surface, around the wound of entry, the term 'fouling' is used.

Balling or welding of the shot:

- Conversion of shots into a compact mass usually by adding paraffin wax or glue.

Billiard ball phenomenon:

- When a shot gun is fired through an intervening object such as glass, at the time of impact with the glass, the pellets in the front get hit by those pellets in the behind, so that there will be an erroneous dispersion of the pellets.
- The range of firing cannot be estimated properly.

Gyrojet:

- These are cartridges or miniature rockets driven by solid fuel, which produces considerable heat and smokeless gas on burning.

**Concept 6.12 : Bomb Explosion**

Learning objective: To know the different types of bomb blast and its effects on the body

Time needed

1 st reading	15 minutes
2 nd look	8 minutes

Air blast:

Blast injuries are divided into the following 5 categories:

Primary:

- Caused by the direct pressure effects of the blast wave on the victim

Secondary:

- Caused by flying missiles that strike people

Tertiary:

- Caused by blast wind that can throw victims against solid objects

Quaternary:

- All other injuries not included in the first three classes. These include flash burns, crush injuries, and respiratory injuries

Quinary:

- Illnesses, injuries or diseases caused by chemical, biological or radiological substances
 - Most common injury is Tympanic membrane rupture
 - Lung is the 2nd common organ to be affected (Blast Lung)
 - Liver is least common to injure

Underwater blast:

- The injuries are more serious in Immersion blast than air blast
- Tympanic membrane is ruptured in case of complete submersion. Otherwise most common organ to be injured is the gastrointestinal tract. Injury to lung is less common.

Solid blast:

- This refers to wave energy that spreads through a rigid structure
- Most common injuries are skeletal fractures. Fracture of legs and vertebrae is more common. GIT damage is more common than Lungs

'Tiger skin abrasions' are associated with Aircraft explosions*.



Concept 6.13 : Temperature Related Events

Learning objective: To know the effects of heat or cold (general and local effects) on body at various temperature.

Time needed

1 st reading	40 minutes
2 nd look	20 minutes

- < 35°C : Hypothermia
- 32°C : Shivering stops
- < 30°C : Hypothalamus loses thermoregulatory ability
- < 27°C : Fatal hypothermia
- 5 - 8°C : Trench/Immersion foot
- < - 2.5°C : Frost bite (Skin becomes hard and black in 2 weeks)
- 44°C : Minimum temperature required for producing burn (44°C for 4-5 hours)
- 60°C : Minimum temperature required to produce Scald
- 65°C : Minimum temperature to produce pugilistic attitude

1. HEAT CRAMPS (MINER'S / STOKER'S/FIREMAN'S CRAMPS)

- They are caused by rapid dehydration of body through the loss of water and salt in the sweat.
- Muscle cramp is due to loss of Na⁺ ion.
- There is no increase in body temperature.

2. HEAT PROSTRATION (HEAT EXHAUSTION/HEAT SYNCOPE/HEAT COLLAPSE)

- Heat prostration follows exposure to excessive heat.
- There is no increase in body temperature.
- It is due to peripheral vascular collapse.

3. HEAT HYPERPYREXIA/HEAT STROKE

- Body temperature increases above the level of 40.5°C.
- There is absence of sweating.
- The term 'Thermic fever' or 'Sunstroke' is used when there has been direct exposure to the sun.
- There is failure of cutaneous blood circulation.
- High temperature, increased humidity, minor infections, muscular activity and lack of acclimatization are the principal factors in initiation.
- In case of 100% humidity, environmental temperature of 32°C may lead to heat stroke.
- Failure of cutaneous blood flow and sweating leads to breakdown of heat regulating center of hypothalamus.
- Breathing is rapid, deep and Kussmaul type.
- Edema and reduction of Purkinje's cells in cerebellum are the most important finding in autopsy.

General Effects of Hypothermia

Wischnewski ulcers:

- Hemorrhagic gastric lesions may be seen in hypothermia deaths (see below)
- They are not specific to hypothermia as they are identically seen in sepsis and shock, as well as in cases of alcohol misuse.



Hemorrhagic pancreatitis with fat necrosis:

- Most characteristic feature on autopsy

Paradoxical Undressing:

- It is a term for a phenomenon frequently seen in cases of lethal hypothermia. Shortly before death, the person will remove all their clothes, as if they were burning up, when in fact they are freezing. Because of this, people who have frozen to death are often found naked and are misidentified as victims of a violent crime.

Why does this happen?

- The reason for this paradoxical behavior seems to be the effect of a cold-induced paralysis of the nerves in the vessel walls, which leads to a vasodilatation, giving a feeling of warmth.

Hide and Die Syndrome (Terminal Burrowing Behavior):

- Once they have undressed, the dying person will frequently try to crawl into a small, enclosed space. For which reason, victims of hypothermia are often found naked, squeezed into cupboards or beneath beds. This is called Terminal Burrowing Behavior.
- Terminal burrowing behavior isn't widely studied or well-understood, but the German researchers described it as "obviously an autonomous process of the brain stem, which is triggered in the final state of hypothermia and produces a primitive and burrowing-like behavior of protection, as seen in hibernating animals."
- It is more commonly observed where there is a slow decrease in core body temperature.



Local Effects of Hypothermia

1. Trench foot (Immersion Foot):



- It is the result of prolonged exposure to severe cold (5 to 8 °C) and dampness.
- Wetness is an important contributory factor because when limbs are wet, cold is more penetrating.
- Necrosis of fingers, toes or hand and feet may occur.
- Obliterating angitis causes severe gangrene and loss of tissue.

2. Frost bite



- It occurs after exposure to extreme cold (less than -2.5°C) temperature or dry cold or from direct contact with cold object (below 0°C).
- In frostbite, skin becomes hard and black in 2 weeks.
- It is commonly seen in mountaineering and polar expeditions.
- Tissue injury results from freezing and vasoconstriction.
- It usually affects the distal aspects of extremities or exposed parts of face such as nose, ears, chin and cheeks.

3. Chilblains (Pernio)



- Painful inflammation of small blood vessels in the skin that occur in response to repeated exposure to cold but not freezing air.
- Can cause itching, red patches, swelling and blistering on hands and feet.



Concept 6.14 : Burns

Learning objective: To know the definition, classification, calculation of body surface area burns, pugilistic attitude and cause of death from burns.

Time needed

1 st reading	40 minutes
2 nd look	20 minutes



- A burn is an injury, which is caused by application of heat or chemical substances to the external or internal surfaces of the body.
- Burns is due to application of dry heat and Scalds is due to application of moist heat.
- Burn Injuries produced by application of dry heat by flame, radiant heat or some heated solid substance like metal or glass, Lightning, Electricity, UV and Infrared rays, X rays and Corrosives.

Classification of Burns

Dupuytren's Classification:

First degree	Erythema
Second degree	Vesication with blister formation
Third degree	Destruction of superficial layer of dermis
Fourth degree	Destruction of whole skin (dermis)
Fifth degree	Destruction of fascia and muscles
Sixth degree	Charring involving vessels, nerve, Bones



Wilson's Classification

Epidermal	Dupuytren's 1 st and 2 nd degree (These burns are very painful and heals without scar formation)
Dermo-epidermal	Dupuytren's 3 rd and 4 th degree Pain and shock are greater than in first degrees burns (Most painful).
Deep	Dupuytren's 5 th and 6 th degree (Relatively painless)

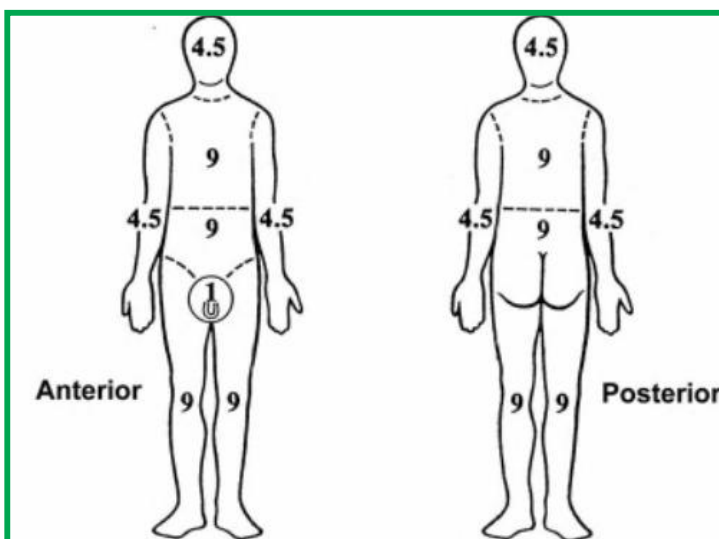
Hebra's Classification:

First degree	Dupuytren's 1 st and 2 nd degree
Second degree	Dupuytren's 3 rd and 4 th degree
Third degree	Dupuytren's 5 th and 6 th degree

Modern Classification

Superficial burns	It includes redness, erythema and may be involvement of papillary dermis
Deep burns	Burn lesion involves reticular dermis and deeper structures beneath the skin. Any burns involving more than true skin are grouped in this category

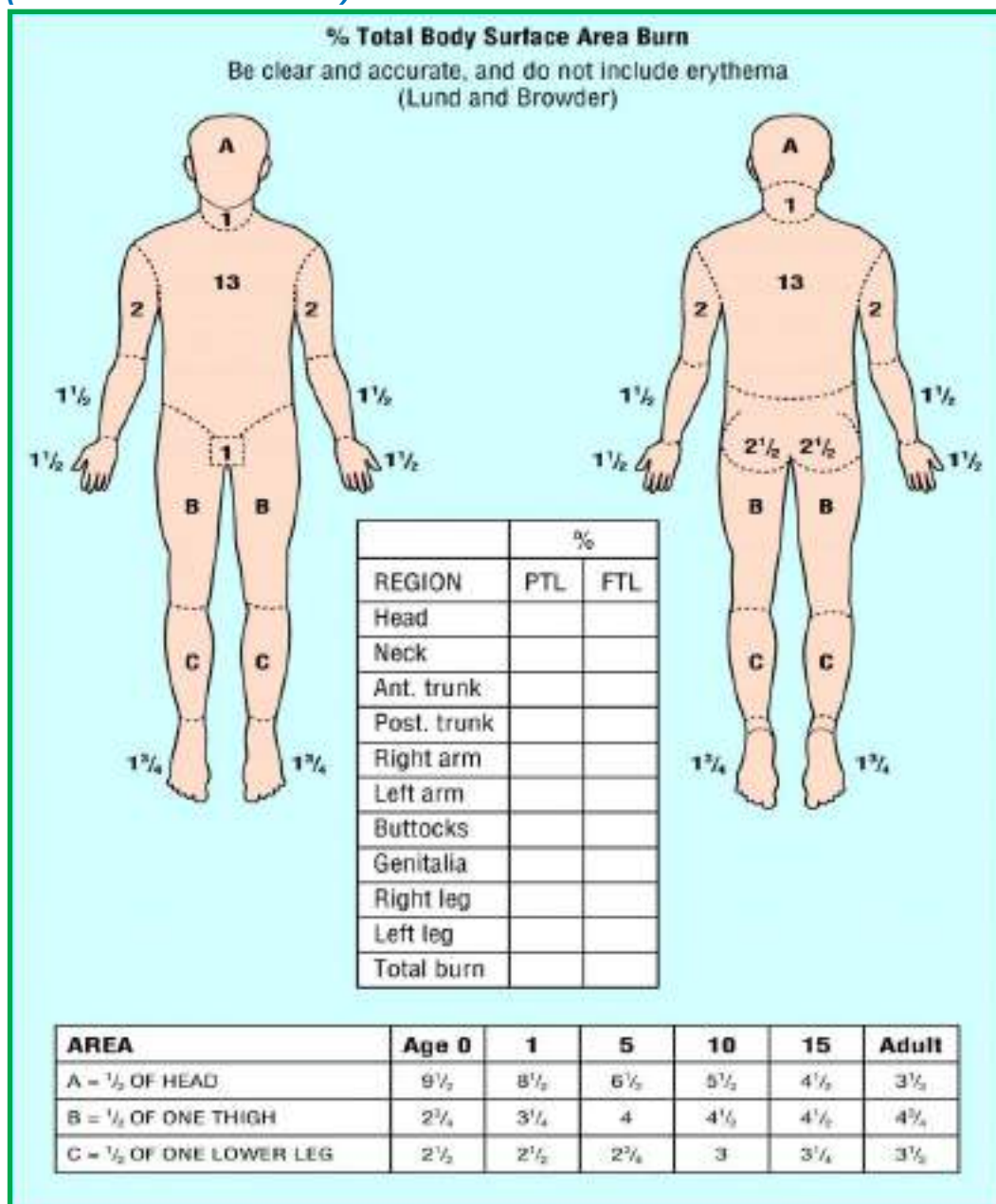
Calculation of Percentage of Body Surface Area Burn (WALLACE'S RULE/RULE OF NINE)



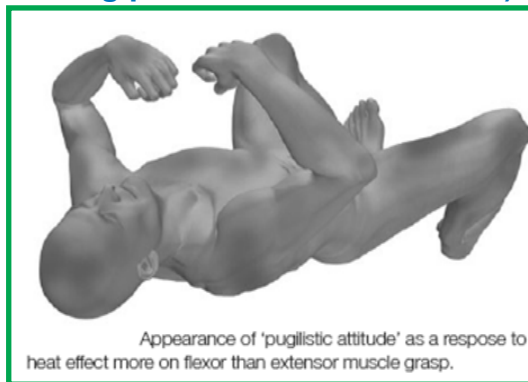


Estimation of Body Surface Area of Burns in Children

(Lund and Browder Chart)



Pugilistic Attitude: (Boxing attitude/Fencing posture/Defence attitude)



- Pugilistic attitude is due to heat stiffening, i.e., coagulation of muscle proteins, which causes contraction.
- Seen in both in Antemortem and Postmortem burns. It occurs whether the person was alive or not at the time of burns.
- Heat stiffening is due to exposure of the body to temperature above 65°C.
- It is seen in those dying due to burns and sudden immersion in boiling liquid.
- The postmortem staining may be bright if carbon monoxide has been inhaled and presence of such feature suggests antemortem nature of burn.
- In heat stiffening, body assumes a posture of generalized flexion. The body is flexed at all the joints EXCEPT over the back.
- The splits most commonly occur over extensor surface or elbows or Knee-joint or other joints or head.

Cause of Death in Burns

Immediate to within few hours	Primary shock- Neurogenic shock - due to pain Asphyxia - inhalation of smoke, suffocation
Within first 48 hours	Secondary shock – loss of fluid from burnt region
3-4 days	Toxaemia – absorption of various metabolite from burnt region
4-5 days and later	Sepsis, Gastric ulceration, Oedema of glottis, acute renal failure Gangrene, ARDS, tetanus, Pulmonary embolism,
Years after	Malignant transformation of burn scar (Marjolin's ulcer)

- Haemoglobinuria occurs when body surface burn percentage exceeds 30
- Minimum percentage of COHb required for cherry red discoloration is 30
- Teeth become loose in their socket in antemortem burns, whereas in case of postmortem burns the teeth are firmly attached.
- Cyanide levels and other toxic gases are elevated.
- Puppet organs: Due to heat, there will be shrinkage of internal organs which become firm.



Concept 6.15 : Scalds

Learning objective: To know the definition and characteristics of scalds.

Time needed

1 st reading	20 minutes
2 nd look	10 minutes

Definition: Scald is a thermal injury caused by moist heat.

- The general features of scalds are like those of burns, with erythema and blistering, but charring of the skin is only found when the liquid is extremely hot, such as with molten metal.
- The pattern of scalding will depend upon the way in which the body has been exposed to the fluid:



- A scald is an injury, which is caused by application of liquid above 60°C or from stream.
- Skin becomes sodden and bleached and when hot water is splashed, the water or fluid runs under due to gravity causing trickle pattern.
- There is no singeing of hair
- Clothes are wet but not burnt.

Classification:

- First degree – characterized by erythema formation of affected part.
- Second degree – characterized by blister formation with increased vascular permeability.
- Third degree – characterized by drying and desiccation of underlying tissue with necrosis.

Trickle Pattern in Accidental Scalding and “Glove & Stocking” Pattern of Scalding in Child Abuse:



Differences between Burns from Dry Heat, Moist Heat and Chemicals

Trait	Dry heat	Moist heat	Chemicals
Cause	Flame, heated solid substance or radiant heat	Steam or any liquid at or near boiling point	Corrosive acids and alkalies
Clothing	Burnt and may be adherent to the body	Usually wet but not burnt	Characteristic stains
Discolouration	Skin roasted, charred etc	Skin bleached	Distinctive depending upon the action of chemical on the skin
Site	At and above the site of flame	At and below the site of contact	At and below the site of contact
Skin	Dry, shrivelled, charred	Sodden and bleached	Stained, corroded
Vesication	At the circumference of burnt area	Most marked over burnt area	Rarely found
Red line	Present	Present	Absent
Singeing	Present	Absent	Absent
Charring	Present	Absent	May be present in case of mineral acids
Trickled marks (splashing)	Absent	Present	Present
Ulceration	Absent (unless infected)	Absent (unless infected)	Present due to penetrating and devitalising effects of the agent
Scarring	Thick and causes disfigurement	Thin and causes less disfigurement	Keloid scar and much disfigurement



Concept 6.16 : Electrical Injuries

Learning objective: To know the characteristic features of electrical injury on the body.

Time needed

1 st reading	20 minutes
2 nd look	10 minutes

There are two types of current namely:

1. Alternating current (AC)
2. Direct current (DC)
 - The direct current (DC) is less dangerous than alternate current (AC). A current of 50 to 80 mA of AC can be fatal in seconds whereas 250 mA DC for the same time is often appears non-fatal.

The electric current takes the path of least resistance.

- The average skin resistance is of the order of 500–10,000 ohms. Bone has a resistance of about 900,000 ohms.
- Skin is the primary resistor to the flow of current into the body.
- Duration of Contact: The longer the contact, the greater will be the damage. Low tension currents may prove lethal if the contact is maintained for sufficiently long periods.
- Awareness of the victim towards the possibility of shock being sustained may make the victim withstand one which might otherwise be dangerous.

Local Effects

1. Joule Burn:

- It is specific and diagnostic of contact electrical burn.
- Joule burn is endogenous burn.



- Appearance of an areola or pale halo around the electric mark is considered as more useful indicator for electrocution. It occurs at the periphery of electric lesion in form of blanched area. This halo occurs due to arteriolar spasm from direct effect of current on vessel wall musculature. The pallor survives death and can be noted at autopsy. It is considered as pathognomonic of electrical damage.



2. Flash or Spark Burn

- It is due to poor or intermittent contact with live electrical object/appliance/wire.
- The lesion caused by such intermittent contact may be a dry pitted area (often very tiny) or nodule due to arcing of current from the conductor (wire/ appliance/ object) to the skin.
- A yellowish parchment like scab (keratin nodule) may be noted with a pale halo round the lesion. It is due to melted keratin that fuses on cooling.

Arc eye: Photo keratitis due to Flash-over of the high voltage electrical current.

3. Electric Burns or Splits

When the electrical conductor is a wire, a linear burn may occur.

- The splits are dry, hard, firm, charred, insensitive, with ragged edges.
- Aseptic necrosis develops.

Current Pearls:

- Small balls of molten metal, derived from the electrode, may be carried deep into the tissues known as current pearls

Acro-reaction test:

- A microchemical test to detect the metal on the shin derived from the causative electrode.
- Helps to identify the wound of entry.

Bone Pearls or Wax Drippings:

- Heat generated by the current may melt the calcium phosphate, which is seen radiologically as typical round density foci, known as, Bone Pearls.

Zenker's Degeneration:

- Skeletal muscle changes in the path of the current.



Concept 6.17 Lightning Stroke

Learning objective: To know the effect of lightening on the body.

Time needed

1 st reading	20 minutes
2 nd look	10 minutes

It is a flash of lightning is due to an electrical discharge from a cloud to the earth.

Types of Burns

1. Arborescent burns (Filigree/Lichtenberg's flower/Keranographic burns or Feathering):

- These are superficial, irregular, thin, and tortuous markings resembling the branches of a tree.
- Most common site is shoulder and flanks.



- Appears within a few minutes to one hour.
- Cause of filigree burns: Staining of tissues with hemoglobin by rupture of RBCs, along the path of current.

2. Linear Burns:

- Irregular, linear, first degree burns may follow skin creases, especially if damp from sweating.
- Often found in the moist creases and folds of skin.
- Vary from 3 to 30cm. or more in length and 0.3 to 2.5 cm. in width.

3. Surface Burns:

- These are true burns and occur beneath metallic objects worn or carried by the person which are fused by the flash.



Factors resulting in Lightning Injury:

According to Spencer there are 4 factors that result in injury in a lightning flash.

1. Direct effect of high voltage current.
2. Burning by super-heated Air.
3. Effect of expanded and repelled air around the flash.
4. Compressed air pushed before the current produced by Lightning
(Sledgehammer effect) - Bruising is usually at the back of Head.

Even individuals quite remote from the flash may sustain injuries due to the effect of compressed air.



Concept 6.18 : Starvation

Learning objective: To know the characteristic feature, fatal period, and medicolegal implications of starvation.

Time needed

1 st reading	20 minutes
2 nd look	10 minutes

- In acute starvation Hunger pain (Hunger pangs) starts in about 12 to 24 hours and lasts in about 30 to 48 hours
- Fatal period in number of days:
 - Total deprivation of water and food -> 10 days (Both adult and newborns)
 - Only deprivation of food -> 60 days
 - Only withdrawal of water -> 10 days
- Fatal period by percentage of loss of body reserves:
 - Loss of -> 40% Body weight or
 - Loss of 20% Protein or
 - Loss of 80% Fat.
- In case of starvation, gall bladder is distended with bile as the bile is not used.
- The walls of the intestine may appear like tissue paper (sure sign).
- All the organs shrink except Brain.
- During starvation the substance which heart uses as energy source is acetoacetate.
- Brown atrophy of heart is seen in starvation deaths.
- The changes in starvation seen are Hypoglycemia, Hypothermia, Hyper triglyceremia and Keto-acidosis.
- The abdomen is of typical 'scaphoid shape',
- Bichat's buccal pad of fat is among the last sub-cutaneous adipose tissue to disappear.
- 'Baby-farmer' refers to children starved by their parents
- Forcible feeding of person on hunger strike – In India, if the hunger striker causes the imminent danger to life as a result of deliberate starvation, such person can be taken into custody by State for forcible feeding and to save the life.
- Right to life as guaranteed under article 21 of Constitution of India, does not include the right to die, and as such arrest and forcible feeding of persons going on hunger strike is lawful.
- Sometimes a hunger striker has issued a clear instruction not to treat him against his wishes. Under such circumstances, the moral obligation urges doctor to save the life but the duty urges to respect the patient's autonomy. The World Medical Association (WMA) declaration on hunger strikers (1991) states that the ultimate decision on intervention or non-intervention should be left with the individual doctor.
- In view of law, forcible feeding of prisoner, against their wishes, is not an assault but quite lawful because the prisoners are under the care of State and State must take adequate measures to prevent the prisoner from injuring himself or taking his own life.

**Concept 6.19 : Torture****Learning objective:** To know the different methods of torture**Time needed**

1 st reading	20 minutes
2 nd look	10 minutes

Falanga (Falaka, Bestinado)	Beating on the sole of the feet.
Telefono	Slapping on both ears
Wet submarine (Latina)	Head is submerged in polluted water
Dry submarino	Head and face are covered with plastic bag
La parrilla	Victim is strapped to a metal frame and subjected to electric shock
Cattle prod	High voltage electric shock
Black slave	Inserting heated metal skewer into anus
Planton	Forced standing.
Picana	Electric torture.
Sham Execution	Person is Blindfolded and threatened with an accident by an incoming vehicle with a sound.
Water boarding	Head is immobilized and water is poured into the face leading to experience of drowning
Chepuwa	Legs & thighs are tied tightly with bamboo sticks
Ghotna	Rolling a wooden/iron rod up & down the thighs
Parrot's perch/Jack	Head down from a horizontal pole placed under the knees with the wrists bound to the ankle

Istanbul protocol: First set of International guidelines for documentation of torture and its consequences.

CONCEPTS

- ⇒ **Concept 7.1 Asphyxial Stigmata**
- ⇒ **Concept 7.2 Hanging**
- ⇒ **Concept 7.3 Strangulation**
- ⇒ **Concept 7.4 Suffocation**
- ⇒ **Concept 7.5 Drowning**



Concept 7.1 : Asphyxial Stigmata

Learning objective: To know the definition of asphyxia, the changes takes place in case of asphyxia and the different types of mechanical asphyxial death.

Time needed

1 st reading	40 minutes
2 nd look	20 minutes

Asphyxia is a misnomer; it means 'Pulselessness'.

But the term "**ASPHYXIA**" is used for "**any conditions where there is interference with respiration due to any cause**".

The 'classical' features of asphyxia are found where the air passages are obstructed by pressure applied to the neck or to the chest and where there has been a struggle to breathe.

The classical features of 'asphyxia' are:

1. Congestion of the face and viscera;
2. Oedema of the face;
3. Cyanosis (blueness) of the skin of the face;
4. Petechial hemorrhages in the skin of the face and the eyes;
5. Increased fluidity of the blood – is now not accepted.
6. Dilatation of right chamber of heart.

Classical signs of asphyxia

1. **Cyanosis** due to diminished oxygen tension.
2. **Petechial hemorrhages** due to increased venous pressure.
3. **Visceral congestion & edema** due to increased capillary permeability.

Types and causes of asphyxia

1. **Mechanical asphyxia:** hanging, strangulation, choking, Traumatic asphyxia etc.
2. **Environmental asphyxia:** high altitude etc.
3. **Toxic asphyxia:** opium/CO/cyanide poisoning etc.
4. **Pathological asphyxia:** consolidation of lung etc.

Cyanosis

- It indicates bluish discoloration of skin or mucous membrane.
- It is due to formation of reduced-Hb. Inadequate tissue supply or utilisation of oxygen from any cause including asphyxia leads to formation of reduced-Hb, producing darkening of the blood.
- It is more pronounced in parts having abundant capillary and venous circulation like lips, tip of the nose, nail beds, ear lobes, tip of tongue etc.
- Normally well-oxygenated blood is bright red but with increase in quantity of reduced hemoglobin, it assumes dark colour.
- There must be at least **5 gm of reduced hemoglobin per 100 ml** blood before cyanosis becomes evident



- Cyanosis may not be evident in:
 - Marked anemia
 - When dermis is thick
- Cyanosis may be confused with postmortem lividity.

Petechial Hemorrhages

- These vary in size from a $\frac{1}{10}^{\text{th}}$ of a mm. to about 2 mm. **If larger than 2mm. they are called as ecchymosis.**
- Petechial hemorrhages are also called as “Tardieu’s spots”. **But Tardieu spots specifically refer to Petechial hemorrhages occurring in the visceral pleura.**
- These hemorrhages are caused by an acute rise in venous pressure. The rise in venous pressure causes over-distention and rupture of thin-walled venules, especially in lax tissue such as eyelid, pleura, epicardium etc.
- **Stasis hemorrhages** are fine pin-head sized hemorrhages seen beneath the mucosa of larynx, especially in subglottic space.
- They are seen in case of strangulation above the level of ligature mark. These hemorrhages are due to venous stasis and subsequent venous rupture.
- A few petechial hemorrhages can be seen on the surface of the lungs, heart etc. in many other conditions, but of particular importance is the finding that approximately 70 per cent of ‘cot deaths’ (SIDS) have them and they are often large and numerous in this situation.
- It is important that, these petechiae are not interpreted as evidence of external respiratory obstruction.

Mechanism:

- **Pressure around the neck** causing obstructed venous return from the head and neck leading to increased intravenous pressure and congestion of the area. And, consequent rupture of thin-walled venules, especially those in the lax tissues like conjunctiva and unsupported serous membranes like visceral pleura and epicardium.
- **Pressure upon the chest** leading to mismatch between right and left ventricular working (i.e., thinner and less potent right side of the heart being compressed more as compared to the left side). And thus, leading to considerable over-filling in the region of head, neck, upper part of chest, etc. with consequent production of petechiae.
- **Obstruction in the respiratory passage** (due to any cause like smothering, gagging, choking, etc.) causes indirect rise in intrathoracic pressure. And thus, opposing the hydrostatic pressure of the right ventricular filling with consequent congestion and production of petechiae.
- **Tardieu spots may be found in deaths due to acute hemorrhage, scurvy, purpura, hemophilia, coronary thrombosis, electric shock or poisoning.**

Fluidity of Blood

- In past fluidity was considered as a marker of asphyxia.
- It was thought that anoxia/hypoxia causes release of fibrinolysin enzymes from vessel wall.
- These enzyme causes fluidity of blood but fluidity of blood in postmortem state is a non-specific and erratic procedure.



Different types of Mechanical Asphyxial Death

Underlying cause of death	Name
Lack of oxygen in the inspired air	Suffocation
Blockage of the external respiratory orifices	Suffocation/smothering
Blockage of the internal airways by obstruction	Gagging/choking
Restriction of chest movement	Traumatic asphyxia
Blockage of the internal airways by external pressure	Strangulation/hanging
Blockage of the internal airways by liquid	Drowning



Concept 7.2 : Hanging

Learning objective: To know the definition, classification, cause of death of hanging, the force required for constriction of the neck, postmortem appearances in case of hanging and judicial hanging

Time needed

1 st reading	40 minutes
2 nd look	20 minutes

Hanging is that form of asphyxia which is caused by suspension of the body by a constriction around the neck, the constricting force being the weight of the body.

Complete Hanging: Entire body is suspended.



Partial Hanging: The bodies are partially suspended; the weight of the head acts as the constricting force.





Typical Hanging: The ligature runs from the midline above the thyroid cartilage symmetrically upward on both sides of the neck to the occipital region. Knot is placed at occiput.



Atypical Hanging: The point of suspension is not at occiput i.e. the knot is not at nape of neck. Thus, when knot in hanging is at other than nape of neck, it is called as atypical hanging.



Causes of Death

1. Asphyxia
2. Venous congestion
- 3. Combined asphyxia and Venous congestion are the commonest cause of death**
4. Cerebral ischemia
5. Reflex vagal inhibition
6. Fracture or dislocation of cervical vertebrae.

Structure	Constricting force required	Causative effect
Jugular vein	2 Kg	Cerebral apoplexy
Carotid artery	4-5 Kg	Cerebral Anoxia
Trachea	15 Kg	Asphyxia
Vertebral artery	20 Kg	Cerebral anemia



Postmortem Appearance

External features

- The ligature mark is **usually oblique** and does not encircle completely if fixed knot is used; but if slip knot/running noose is used, the ligature mark may be horizontal and completely encircles the neck with knot mark.
- The ligature mark is situated
Above the level of thyroid cartilage in 80% of cases
At the level of thyroid cartilage in 15% of cases
Below the level thyroid cartilage in 5% cases
- Broad ligature material may leave broad mark with less grooving whereas thin ligature material may have deep, narrow grooved impression (**Cheese –cutter method**-Narrow wire).
- Initially ligature mark may be pale in colour but it later becomes yellow-brown or dark-brown and hard **like parchment (rope burns) due to drying of the slightly abraded skin**.
- **Pseudo Ligature Mark:** A pseudo mark may be mistaken for ligature mark.
 1. In obese individuals or infants, the skin folds of neck may appear as ligature mark.
 2. In decomposed bodies, the pattern of necklace or neck jewelry or neck clothing such as scarf, dupatta, chunni, oodhni etc. may be mistaken for ligature mark.
- **Petechial haemorrhages are seen in about 25% of cases in the skin and conjunctiva.**
- Face may be pale or may be congested, puffed up and bluish (depending on the occlusion of the vessels).
- In partial hanging, carotid arteries and jugular veins are completely occluded, but vertebral arteries continue to supply blood to the head, producing congestion of the face and petechiae.
- When suspension is complete, asphyxia signs are slight, face is pale and petechial hemorrhages are relatively uncommon due to complete obstruction of the arterial system.
- The eyes are frequently protruded and the conjunctiva congested. The pupils are usually dilated.
- The neck stretched and elongated, and the **head is always inclined to the side opposite to the knot**.
- Tongue is protruded and may be caught between the teeth; the protruding part is usually dark brown or even black.
- **Dribbling of saliva** from the mouth is the most important external sign of antemortem hanging (Definite sign). It is due to stimulation of salivary glands by the ligature or congestive hypoxia. Salivation is increased by stimulation of **pterygopalatine ganglion**.
- **Le Facies Sympathique:** The maximum pressure is exerted over opposite side of the knot (**Bight area**), where it presses the Cervical Sympathetic trunk, the eye on the same side remains opened and the pupil is dilated. It indicates antemortem hanging.



- Seminal/urinal or stool emission is common, in case of antemortem hanging.
- **Glove and stock pattern of postmortem lividity** may be seen if body remains suspended for long time.

Internal features

- Dissection under the ligature mark show **white band of dry and glistening areolar tissue with few petechial hemorrhages in or around the tissue.**
- Hemorrhages in strap muscles are seen in about 25% of cases.
- Platysma and sternomastoid are ruptured in about 5-10% of cases.
- The **intima of the carotid arteries shows transverse splits in about 5-10% of cases** which is seen on the **ipsilateral** side of the knot and is **due to traction** rather than direct pressure. Extravasation of blood under the tear is a definite sign of antemortem hanging.
- Several horizontal intimal tears scattered along the carotid arteries at different levels are sometimes found in hanging associated with a long drop.
- **Hyoid bone is fractured in 15-20% cases** and is seen in persons above 40 years (Because of Calcification).
- Microscopic examination of thyroid gland and salivary gland shows focal interstitial hemorrhages whereas lymph gland shows congestion. These findings support the antemortem nature of hanging.
- Complete hanging is related to fracture of neck structures and to lesser extent to congestion of face while partial hangings show a high frequency of congestion of face and a low frequency of fracture of neck structure.
- Brain
 - May be congested if there is compression of jugular venous system
 - May be pale if there is compression of carotid and vertebral arteries.
- **Simon's hemorrhages:** Red stripes of bleeding into the outer layers of intervertebral discs of lumbar vertebrae; may be seen in bodies suspended for a long time.

Removal of ligature: The knot should not be released; instead the ligature should be cut away from the knot and the cut ends should be tied with a thread to prevent fraying.

Complex suicide: The person plans more than one method of suicide to make sure that death will occur.

Complicated suicide: When during the original method of suicide, unintentional trauma occurs which leads to death, e.g. a person hanging himself from a branch of tree, the branch breaks and the person dies due to complications of fall.

Judicial Hanging

- In India, hanging is the method of legal execution of death sentence.
- The length of rope from the point of suspension is equal to the height of individual.
- The face of the condemned person is covered with black mask, then to stand on a platform.
- The knot is kept under the angle of right jaw (As per Dr. KSN Reddy's book);

But as per consultation paper on mode of execution of death sentence and incidental matters by LAW COMMISSION OF INDIA, the noose should be placed one and half inches to the right or left of the middle line.



- With the help of lever, the platform is pulled back and the person drops down to 5 to 7 meters, depending on weight of the person.
- The sudden stoppage of moving body associated with position of knot causes the head to be jerked violently.
- This causes fracture-dislocation of cervical vertebrae at the level of C2-C3 or C3-C4. Bilateral fractures of either the pedicles or laminae of the arch of the second, third or fourth cervical vertebrae occur (**Hangman's fracture**). Rarely dislocation of atlanto-occipital joint or odontoid process of axis may occur.
- With proper Judicial hanging, there is a rupture of the brainstem between the pons and medulla resulting in instantaneous and irreversible loss of consciousness (Due to destruction of reticular formation) and in irreversible apnoea (Due to destruction of the region of respiratory center).
- **Asphyxial signs are not seen in properly performed judicial hanging.**



Concept 7.3 : Strangulation

Learning objective: To know the definition, types, cause of death of strangulation. To know about the meaning and features of ligature strangulation, throttling, mugging, bansdola, garroting and palmar strangulation. To know the differences between hanging and ligature strangulation.

Time needed

1 st reading	60 minutes
2 nd look	30 minutes

Definition: Strangulation is that form of asphyxia, which is caused from constriction of the neck, the constricting force is being other than the weight of the body.

- Strangulation is always homicidal unless proved otherwise.
- Suicidal strangulation is a rare phenomenon and occurs only if suicide employs special method and instrumentation.
- Accidental strangulation may occur if some material like scarf, dupatta, machine belt etc. is suddenly wrapped around the neck and constricting the neck causing death.

Causes of death

1. Asphyxia
2. Venous congestion
3. Combined asphyxia and Venous congestion
4. Cerebral ischemia
5. Reflex vagal inhibition
6. Fracture-dislocation of cervical vertebrae (Rare)

Types of strangulation:

1. Ligature strangulation
2. Manual strangulation or Throttling
3. Bansdola
4. Garroting
5. Mugging

1. Ligature Strangulation:

This is a strangulation effected by a ligature.





P.M. Appearances:

External

- The ligature mark may be at any level of the neck, but usually **below the level of thyroid cartilage**.
- **The mark completely encircles the neck transversely.**
- The position of the ligature mark depends on their relative position of the assailant and the victim and the mode of using the ligature.
- Petechial hemorrhages are usually found immediately adjacent to the ligature mark.
- Scratches and fingernail marks may be seen around the ligature mark.
- Intense congestion and deep cyanosis of the head and neck is seen in strangulation.
- The eyes wide open and pupils dilated.
- The tongue swollen and protruded.
- Petechial hemorrhages are common into the skin of the eyelids, face, forehead, behind the ears and scalp.
- Blood stained froth may escape from the mouth and nostrils and there may be **bleeding from nose and ear (relatively common in strangulation)**

Internal:

- **Severe engorgement and hemorrhage into the tissues in and around the area compressed. The adjacent muscles of the neck are usually lacerated.**
- Subcapsular and interstitial thyroid hemorrhages are common.
- **The intima of the carotid arteries is not usually damaged** unless a narrow ligature is applied.
- **Silvery looking spots** under pleural surface due to rupture of the air cells which disappear on pricking are seen in more than 50% of the cases.
- **Fracture of the hyoid bone is uncommon, but fracture of the thyroid cartilage is more common. Fracture of thyroid laminae and cricoid cartilage is less common.**

2. Throttling:

It is compression of neck manually i.e. by using human hands.

It is always homicidal.





- The situation and extent of bruised areas on the neck will depend upon the relative positions of the assailant and the victim, the manner of grasping neck, and the degree of pressure used.
- The bruises are produced by the tips or the pads of the fingers (6 penny bruises).
- The fingernail marks are especially caused by the thumb rather than the fingers.
- External signs of asphyxia are well marked.
- Hemorrhage in the subcutaneous tissues and the muscles underlying nail marks is usually scanty.
- **Carotid arteries show intimal tears in 10-15% of cases (5-10% of cases in Hanging) at or near the carotid sinus.**
- **Fracture of hyoid bone is seen in 30-50% of cases.**
- **The superior horn of thyroid is much more fragile and fractures much more than greater horn of hyoid bone.**
- **Fracture of the cricoid cartilage** due to antero-posterior compression of it against the spine, e.g., by the thumbs or the forearm of the assailant.
- **The muscles surrounding the larynx frequently show well marked bruising. Muscles, especially the sternocleidomastoid may be torn. The platysma muscle may be bruised.**

3. Garroting

- Garroting is a type of strangulation. The victims were attacked from behind without warning.
- Thugs used this method around 1867 in India. The robbers used this method in lonely places to kill travelers and rob them.
- There are various methods such as Indian method, Spanish method etc.
- **In Indian method**, the victim is attacked from behind without warning. The neck is grasped by a ligature thrown from behind and is quickly fastened or tightened by twisting it with lever or two sticks tied at the end of ligature. Asphyxiation of the unaware victim causes rapid loss of consciousness and death.
- **Spanish method**: In Spain it was the method of judicial execution. Here, a twisting device known as **Spanish windlass** is used. It consists of iron collar that is placed around the neck and tightened by screw for strangulating the victim.





4. Bansdola

- It is a form of strangulation. Two wooden poles or sticks or rods or bamboos are used.
- One bamboo or stick is placed over front of neck and another is placed behind the neck.
- One end of these sticks or bamboos are tied together by a rope and other ends are brought forcefully together so as to squeeze or compress the neck in between two sticks to cause death.

5. Mugging



- Also known as **arm lock**
- Strangulation is caused by holding the neck of person in the bend of the elbow or knee.
- Here pressure is exerted over larynx or side of neck by the forearm and arm.

Palmar Strangulation

- In this type, the palm of one hand is placed horizontally across the mouth and nostrils and then reinforced the pressure by placing the other hand on the top of first hand at right angle to the other.
- Here the heel of palm of upper hand presses the front of neck.

Differences between Hanging and Ligature Strangulation

Trait	Hanging	Ligature Strangulation
Age	More common in adolescents and young or elderly adults	No age limit as it can be affected on any age for enmity, rivalry, etc.
Nature of death	Mostly suicidal	Mostly homicidal
Face	Usually pale and petechiae rare	Congested, livid and marked with petechiae
Tongue	Swelling and protrusion is less marked	Swelling and protrusion is more marked
Bleeding	Bleeding from nose, mouth and ears not common	Bleeding from nose, mouth and ears may be found



Saliva	Often dribbles out of the mouth	Such dribbling is very rare
Neck	Stretched and elongated in fresh bodies	Not so
External signs of asphyxia	Usually not well-marked	Well-marked (minimal, if death is due to vasovagal and carotid sinus effect)
Ligature mark	Oblique, non-continuous, placed high up in the neck between the chin and the larynx. Base of the groove or furrow being hard, yellow and parchment-like. Subcutaneous tissue underneath the mark is usually hard, white and glistening	Horizontal or transverse, continuous round the neck, low down in the neck below or across the thyroid. Base of the groove or furrow being soft and reddish. Subcutaneous tissue underneath may be ecchymosed
Abrasions and ecchymoses	(a) Abrasions and ecchymoses round about the edges of the ligature mark are rare (b) Scratches, abrasions and bruises on the face, neck and other parts of the body are usually not present	(a) Abrasions and ecchymoses round about the edges of the ligature mark are common (b) Scratches, abrasions, fingernail marks and bruises on the face, neck and other parts of the body are usually present
Injury to muscles of neck	Rare	Common
Carotid arteries	Internal coats usually ruptured in violent cases of a long drop	Damage to internal coat is rare
Larynx and trachea	Fracture of larynx and trachea—rare and that too in judicial hanging	Fracture of larynx and trachea comparatively more common
Hyoid bone	Fracture of the hyoid bone less common	Fracture of the hyoid bone is uncommon (may be common in manual strangulation, i.e. throttling)
Thyroid cartilage	Fracture is less common	Fracture is more common
Cervical vertebrae	Fracture and/or dislocation common in judicial hanging	Fracture and/or dislocation—rare
Sexual assault	Evidence of sexual assault may rarely be seen in homicidal hanging	Sometimes evidence of sexual assault



Concept 7.4 : Suffocation

Learning objective: To know the definition and types of suffocation, features of different types of suffocation and café coronary.

Time needed

1 st reading	30 minutes
2 nd look	15 minutes

Definition: Suffocation is a type of mechanical asphyxia caused-

1. Either due to lack of oxygen in the environment (**Environmental suffocation**) or
2. By mechanical obstruction to the air passage by means other than constriction of the neck and drowning.
 - The concentration of oxygen in air is about 21%, nitrogen 79%, and CO₂ is 0.033%. An oxygen concentration of 16% or less is dangerous, and with 5% concentration, consciousness is lost rapidly, and death occurs within a few minutes.
 - Inhalation of irrespirable gases, such as CO₂, CO, H₂S or smoke from a burning house, or entering into disused wells produce suffocation.
 - **CO₂ and methane are the most commonly encountered suffocating gases.**

Types of Mechanical Suffocation:

Smothering:

- Death is due to mechanical occlusion of the mouth and nose that prevents breathing.



- Bruising or lacerations over inner aspect of lips are pathognomic sign.

Overlaying:

- Overlaying or compression suffocation results due to compression of the chest, so as to prevent breathing.
- It results when mother or other person sharing a bed with infant. During sleep, the mother or person may compress the infant by overlying over it or the body may cover the external respiratory orifices. These deaths are accidental in nature.

Gagging:

- Air entry into the respiratory tract is prevented by stuffing a gag material such as cloth or plastic in paper deep into the mouth to block the pharynx.

Choking:

- The Internal respiratory passage is blocked by a solid object, such as fish bone, pea, coin etc.



Traumatic asphyxia (Crush asphyxia, compression asphyxia)

- Traumatic asphyxia results from respiratory arrest due to mechanical fixation of the chest, so that the normal movement of the chest wall is prevented.
- Seen in cases like building collapse, earthquake, fall of a tree, overturning of a vehicle, stampede (**riot crush or human pile deaths**) etc.
- Cyanosis, Multiple petechial hemorrhages above the level of compression and a clear-cut line of demarcation at the level of compression.



- Death may be homicidal as in burking.
- Internally there are hemorrhages over pleura.
- Injuries to chest may be present with fracture of ribs.
- Lungs and heart may show contusions and/or laceration.

Burking

- **It is a method of homicidal smothering and traumatic asphyxia.**
- William Burk and William Hare Killed 16 persons in Edinburgh using this method and sold their body to Medical School. Burke used to kneel or sit on the chest of the victim and close his mouth and nose with his hands, and Hare used to pull the victim around the room.

Cafe Coronary

- The term is coined by Dr. Roger Haugen.
- This is a condition in which a healthy but grossly intoxicated person who begins a meal, suddenly turns blue, coughs, violently then collapses.
- The airways are normally protected from the entry of food or vomit by powerful reflexes (gag reflex), and anything that can reduce or eliminate those reflexes will render the individual at greater risk, for example acute alcohol intoxication, depressant drugs, anesthetics or many kinds of neurological disease.
- **Cause of Death:** In such people a bolus of food may enter the larynx or trachea resulting in parasympathetic over activity due to stimulation of branches of vagus nerve supplying the laryngeal or pharyngeal mucosa, leading to Cardiac Arrest.
- First aid in café coronary is **Heimlich's Manoeuvre**.



Concept 7.5 : Drowning

Learning objective: To know the definition, types pathophysiology of drowning, cause of death in drowning and postmortem appearances in death due to drowning.

Time needed

1 st reading	40 minutes
2 nd look	20 minutes

Definition: Drowning is a form of asphyxia due to aspiration of fluid into air passage caused by submersion of the body in water or other fluid.

Types of Drowning

1. **Typical Drowning (Wet Drowning or Primary Drowning)**
 - The water is inhaled into lungs.
 - The cause of death is cardiac arrest or ventricular fibrillation.
2. **Atypical Drowning**
 - A. Dry Drowning:**
 - Death results from laryngeal spasm due to trickling of Larynx by intruding water.
 - Seen in 10-20% of cases.
 - B. Immersion syndrome (Hydrocution or Submersion inhibition):**
 - Death is due to vagal inhibition due to cold water or water striking epigastrium.
 - C. Secondary Drowning (Post-immersion syndrome or Near Drowning or Delayed Drowning)**
 - This is not drowning in truest sense but a complication or Sequelae of submersion.
 - The submersion victim is resuscitated and survives for 24 hours, but develop complications like Electrolyte imbalance. Metabolic acidosis etc.
 - D. Submersion of an Unconscious**

Causes of Death

- Asphyxia
- Ventricular fibrillation
- Laryngeal spasm
- Vagal inhibition
- Myocardial anoxia
- Exhaustion
- Injuries

Pathophysiology of Drowning

Fresh water drowning → Inhalation of water into the respiratory tract while crying/ screaming for help in the process of drowning → Water is absorbed into the circulation resulting in gross haemodilution → This massive increase in blood volume leads to bursting of red blood cells with coincident liberation of potassium → Electrolyte imbalance → Heart suffers a serious biochemical insult triggering ventricular fibrillation → Cerebral anoxia → Death (in 3–5 minutes)



Salt water drowning → Inhalation of water into the respiratory tract while crying/ screaming for help in the process of drowning → Due to higher saline content of water, fluid (plasma) is drawn from the circulation and enters the alveolar spaces, thus producing haemoconcentration in the pulmonary circulation and massive pulmonary oedema → Due to haemoconcentration, red blood cells get crenated → Haemoconcentration and crenation of red blood cells lead to myocardial anoxia → Death (in 6–8 minutes)

***Hyperventilation before drowning can cause rapid death, as CO₂ will be flushed out and there will be no hypercapnia, which is necessary to stimulate respiratory centre.**

Postmortem Appearance

- Regurgitation of gastric contents into the larynx and trachea in cases of drowning is due to vomit reflex due to medullary hypoxia.

Postmortem Staining

- P.M. Hypostasis is **Light-Pink** due to the presence of unreduced Hb in the superficial blood vessels due to cold, whether antemortem or postmortem (but in some cases it may be dusky and cyanotic).
- In stagnant water Postmortem Staining is present and is usually found on the face, the upper part of chest, hands, lower arms, feet and calves.
- If the body is in running water, postmortem staining does not appear.

Froth in Drowning



- A fine, white, leathery, tenacious and persistent froth is seen at mouth and nostrils (occasionally, it may be blood-tinged due to some admixture with the blood expelled from the tears of lung tissue during drowning or mixed with debris/stomach contents, etc.). It is the most characteristic external sign of drowning.
- **Froth appears within two minutes of submersion**, and the quantity varies depending on the duration of submersion, and the violent respiratory efforts.
- Absence of foam in drowning can be found in death due to laryngeal spasm and immersion syndrome.



Froth without mucous is seen in death due to

- Strangulation,
- Acute pulmonary edema,
- Electrical shock,
- During an epileptic fit,
- Opium poisoning
- Putrefaction

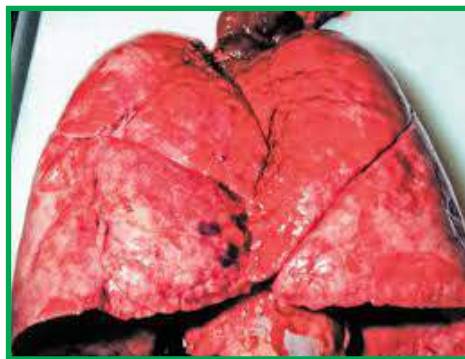
Cadaveric spasm:



- Grass, gravel, mud, sand, silt, weeds or aquatic vegetation, etc. may be found held in firmly clenched hands or feet due to **cadaveric spasm**. When present, it is an important sign suggesting that the victim struggled for existence while in water.

Appearance of lung in submersion

- Lungs usually are voluminous, bulky, water-logged and over-inflated.
- Surface may show pale-grey appearance and indentations of ribs.
- Overall picture of lungs and respiratory passage has been described as emphysema aquosum.



- Presence of foam, fluid, debris, weeds, vegetation, etc. in the bronchi and bronchioles is a significant finding in respect of antemortem drowning.
- Edema aquosum: Seen in Drowning of an unconscious whereas there will be edema with minimal froth.

Paltauf's haemorrhages:

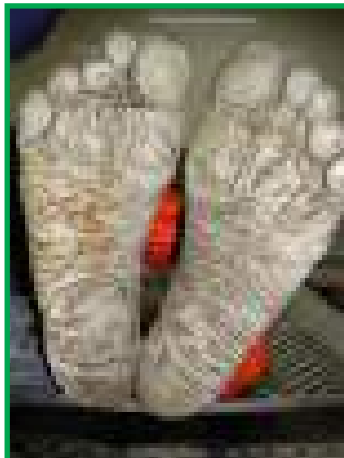
- The alveolar walls may rupture due to increased pressure during forced expirations and produce subpleural hemorrhages known as 'Paltauf's hemorrhages'.

Diatoms



- Diatoms are microscopic, unicellular algae.
- The outer siliceous (silica) coat is resistant to heat, acids and putrefaction.
- Size vary from 2 microns to 1 mm., but majority are 10-80 microns.
- Their shape may be circular, triangular, linear, crescentic, boat shaped, etc.
- The drowning fluid and the particles in it (diatoms, planktons etc.), pass from the ruptured alveolar wall into lymph channels and pulmonary veins and thus enter the left heart. Only a live body with circulation can transport the diatoms from the lungs to the other viscera. **They are also found in bile and urine.**
- The bone marrow of femur has maximum concentration of diatoms and is best.
- Technique: Acid digestion method
- If the same species of diatoms present in the drowning media is present in bone marrow and if the victim had not drunk the same water before submersion is the most important internal sign of antemortem drowning.

Washer Woman's Hands and Feet:



First seen over the fingers in 2-4 hours.

Wrinkling of limbs indicate that body was in water.



Changes in the palm and sole

- Wrinkling : Couple of Hours
- Bleaching : 4-8 Hours
- Soddening : 24 Hours (Washer woman's Hands/Feet)
- Separation : 48 Hours
- Peeling-off : 3-4 Days

Cutis anserina (goose skin or goose flesh):



- Granular and puckered appearance may be seen, due to spasm of erector pilae muscle due to cold, especially seen over the thighs.
- It is also seen in case of rigor mortis of erector pilae muscles.

Water in GIT

- Water may be present in stomach in case of drowning in 70% cases and in small intestine in 20% of cases.
- Water can be absent in stomach in cases of drowning due to sudden death due to vagal inhibition.
- It is a valuable confirmatory evidence if the chemical and microscopic nature of the water is same as that of the medium of submersion.
- Water in small intestine is regarded as positive evidence of death by drowning as it depends on peristaltic movement which is a vital act.
- Stomach may contain water and foreign material like sand, weeds, dirt, etc. because some may be swallowed during drowning while struggling for life.

Gettler's chloride test

- To differentiate fresh water drowning from sea water drowning
- Normal value of chloride is 600mg% in both chambers.
- In Fresh water drowning, chlorides get reduced by 50% in left ventricle, where as in sea water drowning it get increased by 30-40%.
- Chloride estimation is not of any help after 12 hours.
- It is not helpful in Putrefaction, Patent with Foramen ovale, drowning in Brackish Water.



Magnesium:

- The Mg content of the blood on the left side of the heart is more than 1.25mg/1000ml than on the right side **in saltwater drowning.**

Serum Strontium:

- The difference in the strontium concentration of blood from left and right heart are always > 75 microgram/L **in sea water drowning.**
- This helps to differentiate death due to drowning from postmortem submersion.

Floatation of body:

- In India occurs in about 12-18 hours in summer and 18-36 hours in winter.

CONCEPTS

- ⇒ **Concept 8.1 Impotence**
- ⇒ **Concept 8.2 Artificial Insemination**
- ⇒ **Concept 8.3 Legitimacy**
- ⇒ **Concept 8.4 Virginity**
- ⇒ **Concept 8.5 Sexual Offences**
- ⇒ **Concept 8.6 Pregnancy and Delivery**
- ⇒ **Concept 8.7 Abortion**
- ⇒ **Concept 8.8 Infant Deaths**
- ⇒ **Concept 8.9 Battered Baby Syndrome**
- ⇒ **Concept 8.10 Sudden Infant Death Syndrome**



Concept 8.1 : Impotence

Learning objective: To know the definition of impotency and its medicolegal importance.

Time needed

1 st reading	20 minutes
2 nd look	10 minutes

- Impotence is the inability of a person to perform sexual intercourse.
- Sterility is the inability of the male to beget children, and in the female the inability to conceive children
- Frigidity is the inability to initiate or maintain the sexual arousal pattern in the female.
- Impotence, in male, is defined as "persistent inability to develop or maintain a penile erection sufficient to conclude coitus to orgasm and ejaculation".
- The question of impotence and sterility may arise in

Civil cases:

- Nullity of marriage
- Divorce
- Adultery
- Disputed paternity and legitimacy
- Suite of adoption
- Claim for Damages

Criminal cases:

- Adultery
- Rape
- Unnatural sexual offences
 - Impotence cannot be placed as a defence for rape.
 - **Vaginismus** is involuntary spasm of perineal muscle so that sexual intercourse is not possible. Whenever, sexual intercourse is attempted, there is painful spasm of sphincter vaginae and levator ani with simultaneous spasmodic contraction of the adductor muscles of thighs and erector spinae, thus making penetration impossible (**Psychological**). Treatment is psychotherapy.
 - In males most frequent cause of erectile failure in Vasculogenic (about 40%), followed by Diabetes mellitus (20%), Psychogenic (12%) and Neurogenic (7%).
 - After vasectomy, the person should be advised to abstain from sexual intercourse for about 3 months.
 - **Sexual aversion disorder:** It is defined as "persistent or recurrent aversion to, and avoidance of, all or almost all, genital sexual contact with a sexual partner.
 - Legally, marriage is a contract between male and female and it is presupposed that it will be consummated by act of sexual intercourse. Thus, marriage gives implied consent for natural and complete sexual intercourse.

Under Section 12 of Hindu Marriage Act 1955, or Section 24 of Special Marriage Act 1954, a marriage can be null and void on the ground that her husband was impotent at the time of marriage and continues to be impotent; therefore he is incapable of fulfilling the rights of consummation of marriage by an act of sexual intercourse



Concept 8.2 : Artificial Insemination

Learning objective: To know the definition, types, medicolegal implication and law related to artificial insemination.

Time needed

1 st reading	40 minutes
2 nd look	20 minutes

- It is artificial introduction of semen into the vagina, cervix or uterus to produce pregnancy.
- **About 5% of males are infertile.**
- One ml of semen is deposited by means of syringe in or near cervix.
 - a) Artificial insemination Homologous (AIH)** – Semen of husband is normal but he is unable to pour it through intercourse.
 - b) Artificial insemination Donor (AID)** - Semen of husband is defective and hence it is taken from another healthy, suitable individual.

Indications:

When the husband is impotent.

- When the husband is unable to deposit the semen in vagina due to hypospadias, epispadias etc.
- When the husband is sterile.
- When there is Rh incompatibility between husband and wife.
- When husband is suffering from hereditary disease.

Legal Problems of Artificial Insemination

In India, there is no Law on issues relating to ART. But in Delhi, THE DELHI ARTIFICIAL INSEMINATION (HUMAN) ACT 1995 is in force. Code of conduct for ART is formulated by Indian Council of Medical Research (ICMR).

- Even though The ICMR guidelines are suggestive of the child born by AID is legitimate, the Law does not consider the child to be legitimate. The child born of AID must be legally adopted by its parents, so that the husband is legally considered as father of the child and the child can inherit the property and false declaration or furnishing false information is prevented.
- Donor and recipient cannot be held guilty of adultery in India.

The Delhi Artificial Insemination (Human) Act 1995

An Act to provide for the regulation of donation, sale, and supply of human semen and ovum for the purpose of artificial insemination and for matters connected therewith or incidental thereto.

Duties of qualified medical practitioner/Government hospitals, etc, performing artificial insemination:

1. Keep complete records of the bio-data including mark of identification of the donor and the recipient of the semen or ovum.
2. Test the recipient for "HIV 1 and 2" and sexually transmitted diseases before performing artificial insemination.



3. Seek the written consent of the husband and the wife, seeking artificial insemination.
4. Seek the written consent of the donor and the recipient and their spouse, in case of requests of semen or ovum from specified donor/recipient.
5. Not segregate the XX and XY chromosomes for artificial insemination.
6. Maintain secrecy about the identity of the donor and the recipient of the semen/ovum.
7. Storage of donated semen before use.-
 - The donated **semen shall be stored** either by cryo preservation of liquid nitrogen freezing or any other safe method for a period of **minimum 3 months** in order to exclude window period of HIV 1 and 2 infections in the donor.
 - Second test on donor before use of donated semen.-
 - At the end of three months, a second ELISA Test shall, by the name method, be performed on the donor.
 - If, after conducting of necessary test, the donor is found fit, only then, the semen shall be used.
8. Seek the written consent of the recipient for using the semen on the basis of only one ELISA Test being negative where facilities for cryo-preservation and liquid nitrogen for semen are not available.

In case of Contravening the provisions of this Act, the doctor may be Punishable with imprisonment for a term which may extend to three months and with fine of five thousand rupees.

ICMR Guidelines for ART Clinics in India

1. The individual must be free of HIV and hepatitis B and C infections, hypertension, diabetes, sexually transmitted diseases, and identifiable and common genetic disorders such as thalassemia.
2. The age of the donor must not be below 21 or above 45 years and for the donor woman between 18 and 35 years
3. Requirements for an Oocyte or Gametes produced by a person under the age of 21 shall not be used.
4. An analysis must be carried out on the semen of the individual, preferably using a semen analyzer, and the semen must be found to be normal according to WHO method manual for semen analysis, if intended to be used for ART.
5. The blood group and the Rh status of the individual must be determined and placed on record.
6. Other relevant information in respect of the donor, such as height, weight, age, educational qualifications, profession, colour of the skin and the eyes, record of major diseases including any psychiatric disorder, and the family background in respect of history of any familial disorder, must be recorded in an appropriate proforma.
7. Donors whose semen is frozen for future use are required to report to the ART bank **six months after donation** to be checked for HIV infection / disease status.
8. A child born through ART has **a right to seek information** (including a copy of the DNA fingerprint, if available) about his genetic parent/surrogate mother **on reaching 18 years**, excepting information on the name and address – that is, the individual's personal identity – of the gamete donor or the surrogate mother.



9. There would **be no bar to the use of ART by single women** who wishes to have a child, and no ART clinic may refuse to offer its services to the above.
10. Collection of gametes from a dying person will only be permitted if the widow wishes to have a child.
11. A third-party donor and a surrogate mother must relinquish in writing all parental rights concerning the offspring and vice versa.
- 12. No ART procedure shall be done without the spouse's consent.**
- 13. No more than three eggs or embryos should be placed in a woman** during any one treatment cycle, regardless of the procedure used, excepting under exceptional circumstances {such as elderly women(above 37 years), poor implantation (more than three previous failures), advanced endometriosis, or poor embryo quality} which should be recorded.
14. Use of sperm donated by a relative or a known friend of either the wife or the husband shall not be permitted.
15. It will be the responsibility of the ART clinic to obtain sperm from appropriate banks; neither the clinic nor the couple shall have the right to know the donor identity and address, but both the clinic and the couple, however, shall have the right to have the fullest possible information from the semen bank on the donor such as height, weight, skin colour, educational qualification, profession, family background, freedom from any known diseases or carrier status.
16. When DNA fingerprinting technology becomes commercially available, the ART clinic may offer to the couple, a DNA fingerprint of the donor without revealing his/her identity,
17. Semen from two individuals must never be mixed before use, under any circumstances.
18. A child born through ART shall be presumed to be the legitimate child of the couple, born within wedlock, with consent of both the spouses, and with all the attendant rights of parentage, support and inheritance.
- 19. Record** of semen received, stored and supplied should be maintained and must be kept for **10 years**
20. Semen samples must be **cryopreserved for at least six months before first use**, at which time the semen donor must be tested for HIV and hepatitis B and C.

Surrogate Birth

A surrogate mother is a woman who agrees to carry someone else's baby. She becomes pregnant using some form of assisted reproductive technology, frequently IVF or Artificial insemination with the semen of the barren woman's husband is carried out in a hired woman. The surrogate mother carries the baby to term and gives birth, and the baby is released from the hospital to its intended parents.

Surrogacy (Regulation) Bill 2016

Salient features:

- Ban on commercial surrogacy
- Only for Indians. NRI's (Non-Resident Indians) and OCI (Overseas Citizens of India) card holders are barred



- Only for heterosexual couples with proven infertility
- But couple with a mentally or physically challenged child can go for surrogacy
- Can have only one child
- Can go for surrogacy only after 5 years of their marriage
- Wife should be between 23 and 50 years and husband between 26 and 55 years of age
- The surrogate child will be deemed to be the biological child of the intending couple
- The hospital should maintain the records for 25 years

Who can be the surrogate mother?

- Close relative (Bill has not defined that who is close relative)
- Married
- Has a child of her own
- 25 – 35 years of age
- Can be surrogate only once

For an abortion,

- As per under the provisions of MTP Act, 1971
- Approval of the appropriate authority is required
- Consent of the surrogate mother is required



Concept 8.3 : Legitimacy

Learning objective: To know the definition and medicolegal implication of legitimacy.

Time needed

1 st reading	20 minutes
2 nd look	10 minutes

Sec.112 of IEA:

Birth during marriage, conclusive proof of legitimacy.—The fact that any person was born during the continuance of a valid marriage between his mother and any man, or within 280 days after its dissolution, the mother remaining unmarried, shall be conclusive proof that he is the legitimate son of that man, unless it can be shown that the parties to the marriage had no access to each other at any time when he could have been begotten.

Illegitimacy: A child becomes Illegitimate or Bastard, if proved that

- The husband was under the age of puberty.
- The husband is physically incapable to beget children due to any cause.
- Did have access to his wife during the time the child was begotten.
- The blood group or DNA fingerprinting is not compatible.

Affiliation cases (suits for adoption):

- A woman may allege a particular man to be the father of her illegitimate child and file a case in the court for fixing the paternity.
- **As per Sec 125 Cr.P.C.**, a first class Magistrate can sanction a monthly allowance of any sum depending upon the circumstances of the case for the maintenance of such child.

Atavism (Atavis=grandfather):

- Normally a child resembles its parents, but in case of atavism, a child doesn't resemble its parents, but resembles its grandparents.
- It is due to inheritance of characteristics from remote rather than from immediate ancestors, due to a chance recombination of genes.

Suppositious child:

- It is a **fictitious child**, never born to the woman claiming that it is belonging to her (For blackmailing, claiming property, breach of promise etc.).

Posthumous child:

- Child born after death of a father in a legally married couple.



Concept 8.4 : Virginity

Learning objective: To know the definition of virginity and defloration, medicolegal importance, types of hymen and differentiation between a virgin and a deflorate.

Time needed

1 st reading	30 minutes
2 nd look	15 minutes

- **A True Virgin** is a female who has not experienced sexual intercourse, vagina is tight and narrow, hymen may or may not show rupture.
- **A False Virgin** - Hymen intact but experienced sexual intercourse.
- **Defloration** means loss of virginity.
- Hymen is torn by sexual intercourse or by foreign body, is situated posteriorly
- at 6 o' clock position or may be at the sides (postero-laterally), i.e. between 5 and 7 o' dock position. The tears are usually complete, touches the vaginal wall. By digital penetration hymen usually ruptures anteriorly at 12 o'clock position or antero-laterally.

Types of hymen

- Annular—a circumferential ring of thin or thick tissue, perforated near the centre.
- Semilunar—this common variant has a crescentic shape with concavity upward.
- Septate - representing as a band of tissue running down the middle.
- Cribriform—multiple naturally occurring perforations through to the vaginal canal.
- Microperforate—showing large posterior component, with a tiny opening into the vaginal canal.
- Fimbriated—showing fringed edge.
- Vertical—with a vertical slit-like opening.
- Imperforate—absence of opening.

Medicolegal importance

1. **Nullity of marriage:** Presence of virginity after marriage indicates non-consummation of marriage (no sexual intercourse) and it is a ground for **divorce**.
2. **Defamation:** A woman may sue a person for damage of her reputation that she is not virgin.
3. **In rape** cases, loss of virginity may indicate commission of crime.
 - Fimbriated Hymen looks like torn hymen, but the invaginated portion does not touch the vaginal wall.
 - **Causes of rupture of hymen:**
 - An accident (Hymen does not rupture by riding, jumping, dancing etc.).
 - Masturbation.
 - Sola pith or sanitary tampons introduced into vagina
 - Diptherial ulcers
 - Operations for imperforate hymen/per vaginal examination.



- A female who had given birth to child exhibits only remnants of hymen known as **carunculae myrtiformes***.

Difference between virgin and deflorate female

Features	Virgin	Deflorate
Hymen	A membranous structure, varying in position, consistency, structure and shape. In children, it appears to be situated deeply because of the rotundity of the labia majora due to their excessive fat content. It barely admits tip of little finger in them. Shortly after puberty, it reaches the adult form and is situated at the orifice of vagina, partially closing it. In adults, when the edges of the hymenal orifice/opening are stretched and it barely admits one finger, the presumption is in favour of virginity.	Usually ruptured. Exception being false virgin wherein hymen being thick, fleshy, or fibro-elastic, loose and edges undulated, it may remain intact despite repeated sexual intercourse. And, the hymenal orifice/opening may allow two fingers to pass through easily. In such cases, accessory signs of virginity (as outlined below in this table) need be considered to arrive at some satisfactory opinion as to whether one is dealing with the true virgin or false virgin.
Fossa navicularis	Present	Disappears
Labia majora	Firm, lie in apposition	Separated and flabby
Labia minora	Pink, soft and sensitive to touch	Enlarged, pigmented, separated, peeps out
Vagina	A tubular organ about 9 cm long. In a virgin, vagina is pinkish in colour, sensitive to touch, and its walls are approximated. Vaginal rugae are well-pronounced.	After repeated sexual intercourse, vagina lengthens into posterior fornix and the rugae/rugosities become less obvious (such changes are not usually produced with the regular use of tampons or digital stimulation).



Concept 8.5 : SEXUAL OFFENCES

Learning objective: To know the classification of sexual offences and the punishment.

Time needed

1 st reading	120 minutes
2 nd look	60 minutes

Classification of Sexual Offences

• Unnatural Offences (377 IPC)

1. Bestiality-Sexual intercourse with lower animal.
2. Sin of Gomorrah - Buccal coitus, coitus per os.
3. Sodomy or Buggery - Anal intercourse with a male or female.
4. Tribadism or Lesbianism-Female homosexuality
(2, 3 and 4 are not punishable if done with consent)

• Natural Sexual Offences

1. Rape.
2. Incest – (With consent It's not an offence in India)
3. Adultery (Not an offence now in India)

• Sexual Paraphilias (older terms: Sexual Perversions/Deviations)

Sadism, Masochism, Necrophilia, Fetichism, Transvestism, Exhibitionism, Masturbation, Frotteurism, Undinism etc.

• Sex linked offences

Stalking, Voyeurism, Sexual harassment, Disrobe, Trafficking, Indescent assault.

Rape

• Sec. 375 IPC defines Rape, Sec. 376 IPC defines Punishment for Rape

• Sec 375 IPC

A man is said to commit "rape" if he

- (a) penetrates his penis, to any extent, into the **vagina, mouth, urethra or anus** of a woman or makes her to do so with him or any other person; or
- (b) inserts, to any extent, **any object** or a part of the body, not being the penis, into the **vagina, the urethra or anus** of a woman or makes her to do so with him or any other person; or
- (c) manipulates **any part of the body** of a woman so as to cause penetration into the **vagina, urethra, anus** or any part of body of such woman or makes her to do so with him or any other person; or
- (d) applies **his mouth to the vagina, anus, urethra** of a woman or makes her to do so with him or any other person, under the circumstances falling under any of the following seven descriptions:
 1. Against her will.
 2. Without her consent.



3. With her consent, when her consent has been obtained by putting her or any person in whom she is interested in fear of death or hurt.
4. With her consent, when woman believes he is another man to whom she is lawfully married.
5. With her consent, when she is unable to understand the nature and consequences of that to which she gives consent.
6. With or without her consent when she is **under 18 years** of age; or
- 7. When she is unable to communicate consent.**

Provided that a woman who does not physically resist to the act of penetration shall not by the reason only of that fact, be regarded as consenting to the sexual activity.

Exception 1 – A medical procedure or intervention shall not constitute rape

Exception 2 – Sexual intercourse or sexual acts by a man with his own **wife**, the wife not being under **15 years of age**, is not rape

The Supreme Court on October 11, 2017 **criminalised sex between a man and his underaged wife**, provided a complaint is filed within a year.

The court said the exception in the rape law that allowed a man to have sex with his minor wife aged between 15 and 18 was arbitrary and violated the Constitution. It also said the Exception 2 in Section 375 of the Indian Penal Code was contrary to the philosophy of other statutes and violated the bodily integrity of a girl child.

For the purposes of this section, **“vagina” shall also include labia majora.**

- A woman of 18 years and above can give valid consent for sexual intercourse.
- The slightest penetration of the penis within the vulva, with or without emission of semen or rupture of hymen constitutes rape.
 - Rape can be committed even when there is inability to produce erection of penis.
 - Rape on virgin cause tear at posterior or posterolateral position of hymen. Fingernail scratches are present particularly at labia minor.
 - Under the law, rape can only be committed by a man, and a woman cannot rape a man, except in France* where even a female can be charged of rape.
 - In India, there is no age limit under which a boy is considered physically incapable of committing rape.
 - Medical proof of sexual intercourse is not legal proof of rape.

Rape is a cognizable offence. **All the offences under this section are cognizable and non-bailable EXCEPT 376B which is cognizable but bailable.**



Punishment for Rape Under Section 376 I.P.C.

376(1)	Rape.	Rigorous imprisonment of not less than 10 years but which may extend to imprisonment for life and with fine.	Cognizable	Non-bailable	Court of Session
376(2)	Rape by a Police officer Public servant Member of armed forces Person on the management or on the staff of a Jail/Remand home / Children's institution Person on the management or on the staff of a hospital/ Relative /Guardian / Teacher/a person in a position of trust Person who is in a position of control or dominance Person while committing rape causes grievous bodily harm Person who commits rape repeatedly on the same woman. Rape during Communal violence. Rape on a woman knowing her to be Pregnant. Rape on a woman Incapable of giving consent. Rape on a woman suffering from mental or physical disability.	Rigorous imprisonment of not less than 10 years but which may extend to imprisonment for life which shall mean the remainder of that person's natural life and with fine	Cognizable	Non-bailable	Court of Session



376(3)	Persons committing offence of women under 16 years of age.	Rigorous imprisonment for a term which shall not be less than 20 years , but which may extend to imprisonment for life , which shall mean imprisonment for the remainder of that person's natural life, and shall also be liable to fine	Cognizable	Non-bailable	Court of Session
376 A	Person committing an offence of rape and inflicting injury which causes death or causes the woman to be in a persistent vegetative State	Rigorous imprisonment of not less than 20 years but which may extend to imprisonment for life which shall mean imprisonment for the remainder of that person's natural life or with death	Cognizable	Non-bailable	Court of Session
376AB	"Persons committing offence of women under 12 years of age	Rigorous imprisonment of not less than 20 years but which may extend to imprisonment for life , which shall mean imprisonment for the remainder of that person's natural life and with fine or with death	Cognizable	Non-bailable	Court of Session
376 B	Sexual intercourse by husband upon his wife during separation	Imprisonment for not less than 2 years but which may extend to 7 years and with fine	Cognizable (but only on - complaint of the victim)	Bailable	Court of Session
376 C	Sexual intercourse by a person in authority	Rigorous imprisonment for not less than 5 years but which may extend to 10 years and with fine	Cognizable	Non-bailable	Court of Session
376 D	Gang rape	Rigorous imprisonment for not less than 20 years but which may extend to imprisonment for life which shall mean imprisonment for the remainder of that person's natural life and with fine to be paid to the victim	Cognizable	Non-bailable	Court of Session



376DA	Gang rape on a woman under 16 years of age	Rigorous imprisonment of life which shall mean imprisonment for the remainder of that person's natural life and with fine	Cognizable	Non-bailable	Court of Session
376DB	Gang rape on a woman under 12 years of age	Imprisonment for life which shall mean imprisonment for the remainder of that person's natural life and with fine or with death	Cognizable	Non-bailable	Court of Session
376 E	Repeat offenders	Imprisonment for life which shall mean imprisonment for the remainder of that person's natural life or with death	Cognizable	Non-bailable	Court of Session

S.228A, I.P.C. Disclosure of identity of the victim of certain offences etc.

Whoever prints or publishes the name or any matter which may make known the identity of any person against whom an offence under section 376, section 376A, section 376B, section 376C or section 376D is alleged or found to have been committed (hereafter in this section referred to as the victim) shall be punished with imprisonment of either description for a term which may extend to two years and shall also be liable to fine.

Offences Against Women (I.P.C.)

354.	Assault or use of criminal force to woman with intent to outrage her modesty. (INDECENT ASSAULT)	Imprisonment of 1 year which may extend to 5 years, and with fine.	Cognizable	Non-bailable	Any Magistrate.
354A.	Sexual harassment of the nature of unwelcome physical contact and advances or a demand or request for sexual favours, showing pornography.	Imprisonment which may extend to 3 years or with fine or with both.	Cognizable	Bailable	Any Magistrate.
	Sexual harassment of the nature of making sexually coloured remark.	Imprisonment which may extend to 1 year or with fine or with both.	Cognizable	Bailable	Any Magistrate.



354B.	Criminal force to woman with intent to disrobe .	Imprisonment of not less than 3 years but which may extend to 7 years and with fine.	Cognizable	Non-bailable	Any Magistrate
354C.	Voyeurism.	Imprisonment of not less than 1 year but which may extend to 3 years and with fine for first conviction.	Cognizable	Bailable	Any Magistrate
		Imprisonment of not less than 3 years but which may extend to 7 years and with fine for second or subsequent conviction.	Cognizable	Non-bailable	Any Magistrate
354D.	Stalking.	Imprisonment up to 3 years and with fine for first conviction.	Cognizable	Bailable	Any Magistrate
		Imprisonment up to 5 years and with fine for second or subsequent conviction.	Cognizable	Non-bailable	Any Magistrate

Sec. 509 I.P.C.: Word, gesture or act intended to insult the modesty of a woman. —

Whoever, intending to insult the modesty of any woman, utters any word, makes any sound or gesture, or exhibits any object, intending that such word or sound shall be heard, or that such gesture or object shall be seen, by such woman, or intrudes upon the privacy of such woman, shall be punished with simple imprisonment for a term which may extend to one year, or with fine, or with both.

Sec.509 I.P.C.: Word, gesture or act intended to insult the modesty of a woman

Whoever, intending to insult the modesty of any woman, utters any word, makes any sound or gesture, or exhibits any object, intending that such word or sound shall be heard, or that such gesture or object shall be seen, by such woman, or intrudes upon the privacy of such woman, shall be punished with simple imprisonment for a term which may extend to one year, or with fine, or with both.

Sec.53-A Cr.P.C.: Examination of person accused of rape by medical practitioner

- (1) **When a person is arrested on a charge of committing an offence of rape** or an attempt to commit rape and there are reasonable grounds for believing that an



examination of his person will afford evidence as to the commission of such offence, it shall be lawful for a registered medical practitioner employed in a hospital run by the Government or by a local authority and in the absence of such a practitioner within the radius of 16 kilometres from the place where the offence has been committed by any other registered medical practitioner, acting at the request of a **police officer not below the rank of a sub-inspector** and for any person acting in good faith in his aid and under his direction, to make such an examination of the arrested person and to use such force as is reasonably necessary for that purpose.

- (2) The registered medical practitioner conducting such examination shall, without delay, examine such person and prepare a report of his examination giving the following particulars, namely:
 - (i) The name and address of the accused and of the person by whom he was brought;
 - (ii) The age of the accused;
 - (iii) Marks of injury, if any, on the person of the accused;
 - (iv) The description of material taken from the person of the accused for DNA profiling; and
 - (v) Other material particulars in reasonable detail.
- (3) The report shall state precisely the reasons for each conclusion arrived at.
- (4) The exact time of commencement and completion of the examination shall also be noted in the report.
- (5) The registered medical practitioner shall, without delay, forward the report to the investigating officer, who shall forward it to the Magistrate.

Sec. 327(2) Cr.P.C.: The inquiry into and trial of sexual assault or an offence under section 376 and subsections of section 376 of the Indian Penal Code shall be conducted in camera (Means the judge and staff along with both parties and their lawyers will be allowed inside at the time of trial)

Unnatural Sexual Offences

Sec. 377 I.P.C.: Unnatural offences.— Whoever voluntarily has **carnal intercourse** against the order of nature with any man, woman or animal, shall be punished with imprisonment for life, or with imprisonment of either description for a term which may extend to ten years, and shall also be liable to fine.

Explanation.—Penetration is sufficient to constitute the carnal intercourse necessary to the offence described in this section.

On 06/09/18, The Supreme Court of India had passed a verdict that, "Consensual sex between adults in a private space, which is not harmful to women or children, cannot be denied as it is a matter of individual choice". It also stated that **"Section 377 results in discrimination and is violative of constitutional principles"**.



Sodomy

Anal findings in recent case of non-habituated agent	Anal findings in habitual passive agent
Pain and tenderness during examination Foreign hair or loose hair may be noted Evidence of used lubricant traces can be found Bleeding Bruising or perianal abrasions may be evident Semen Tear or anal laceration may be noted. The anal lacerations are usually triangular in shape with base at external sphincter and apex inward. The only proof of sodomy is presence of spermatozoa in the anal canal.	Blood stains or fresh injury is rarely observed Perianal hairs are usually shaved, and local hygiene is maintained Generalized reddening and thickening of perianal tissue External venous congestion Funneled anus Scars or tags and fissures Lateral buttock Traction test ‘+’ve Reflex anal dilatation and loss of sphincter tone may be noted, and the person do not experience pain or tenderness Shortening and eversion of anal canal There may be evidence of prolapsed rectum.

Lateral Buttock Traction Test:

- The thumb is placed on the cheeks of the buttocks on either side of the anus and gentle lateral traction is applied.
- In patients who are not accustomed to anal penetration (penile or instrumental or any other), the traction results in reflex constriction of the anal sphincter.
- The patients who are used to anal penetration react to the lateral traction by relaxation of the sphincter.

Sexual Paraphilia (Disorder of sexual preference)

Paraphilia (also known as sexual perversion and sexual deviation) is the experience of intense sexual arousal to atypical objects, situations, or individuals and sexual pleasure obtained without sexual intercourse.

1. **Sadism:** Sexual gratification by torturing or inflicting pain on someone.
2. **Masochism:** Opposite to sadism. sexual gratification is obtained or increased by suffering pain and cruelty from one's partner.
3. **Lust murder:** Murder serves as stimulus for the sexual act and becomes the equivalent of coitus.
4. **Satyrism:** Uncontrollable or excessive sexual desire in a man.
5. **Nymphomania:** Excessive sexual desire and drive in females.
6. **Erotographomania:** The obsessive desire to write love letters/poems/literature, usually in connection with sexual arousal.
7. **Agalmatophilia:** Sexual attraction to a statue, doll, mannequin or other similar figurative object.
8. **Myxoscopia:** It is a type of voyeurism in which Sexual pleasure is obtained by watching others engaged in sexual intercourse.



9. **Troilism:** Obtaining sexual arousal and gratification by sharing a sexual partner (or close relative) while watching or looking on. A troilist becomes aroused and gratified by the "sharing"(Sexual activity involving three participants).
10. **Coprolagnia:** Sexual pleasure is obtained from the thought, sight, or touching of excrement.
11. **Coprolalia:** Sexual excitement is obtained by using obscene language.
12. **Hybristophilia:** Sexual arousal is obtained by being with a partner known to have committed an outrage, cheating, lying, known infidelities or crime, such as rape, murder, or armed robbery.
13. **Mysoiphilia:** Sexual pleasure associated with something soiled or filthy, usually a kind of undergarment after use.
14. **Sexual oralism:** Obtaining sexual pleasure from the application of mouth to the sexual organs.
15. **Irrumination:** Act of thrusting of the penis into the mouth or throat, between the legs, breasts, feet or upper thighs (also known as interfemoral sex), or between the abdomens of two partners.
16. **Klismaphilia:** is a paraphilia involving enjoyment of, and sexual arousal from, enemas.



Concept 8.6 : Pregnancy and Delivery

Learning objective: To know the definition of pregnancy and delivery, DEFINITE signs of pregnancy, pseudocyesis, superfecundation, superfetation, fetus papyraceous, precipitate labour and lochia.

Time needed

1 st reading	30 minutes
2 nd look	15 minutes

A woman is said to be pregnant from the time of fertilization of the ovum by a spermatozoon till the birth of the child.

Definite/Positive Signs of Pregnancy:

1. Fetal parts and movements:

- Active fetal movements are felt by placing the hands on the abdomen from **16-18 weeks** and may be seen by 5th month. Fetal parts such as head and limbs can be distinctly felt after 24 weeks of gestation.

2. Fetal heart sounds:

- FHS are heard between **18 and 20 weeks** by stethoscope/fetoscope.
- The fetal heart rate is 160/minute at 5th month and 120/minute at 9th month.
- Fetal heart sounds are not felt:
 - When the fetus is dead
 - When there is excessive quantity of liquor amnii
 - When abdominal wall is very fat
 - When examination is made before 18 weeks of pregnancy

3. X-Ray:

- At **15-16 weeks**, fetal parts can be detected with certainty, but occasionally parts are detected as early as 10 weeks. The shadows on X-ray are:
 - Crescentic or annular shadow of the skull
 - Beaded appearance of vertebrae
 - Step ladder pattern of ribs and
 - Irregular linear shadows of limbs

4. Ultrasonography:

- Gestational sac** is seen as white ring by **6th week**.
- Distinct echos from the embryo within the gestational ring by 7th week.
- Fetal heartbeat** can be made out by **10th week**.

Sec. 416 of Cr.P.C.: "If a woman sentenced to death is found to be pregnant, the High Court shall commute the sentence to imprisonment for life".

Pseudocyesis

(False/Spurious/Phantom/Hysterical/Imaginary pregnancy)

- In this condition, the woman believes or imagines that she is pregnant when she is not pregnant.



- It is **purely psychological**.
- It is generally believed that false pregnancy is caused by changes in the endocrine system of the body, leading to the secretion of hormones that cause physical changes similar to those during pregnancy.
- It may be seen in **a childless married lady nearing menopause**.
- The woman has subjective symptoms of pregnancy in form of enlarged abdomen, breast changes with amenorrhea.
- The woman has imaginary thoughts that fetus is growing inside her womb.
- X-ray or sonography can confirm the diagnosis.

Superfecundation:

- Superfecundation is the **fertilization of two or more ova from the same cycle** by sperm from separate acts of sexual intercourse.
- Heteropaternal superfecundation occurs when two different males father fraternal twins.
- In common usage, the term superfecundation is often used instead of heteropaternal superfecundation.

Superfoetation:

- Superfetation means **the fertilization of an ovum from a subsequent ovulation** in a woman who is already pregnant.
- Two fetuses are born either at the same time showing different stages of development, or two fully developed fetuses are born varying from 1-3 months.

Fetus papyraceous (Fetus compresses).

- In twin pregnancy, one fetus may grow and develop more than other fetus. The second under-developed fetus may get compressed and flattened. Such fetus is termed as fetus papyraceous

Precipitate Labour

- Here, all 3 stages of labour are merged together and the mother may deliver the baby without her knowledge suddenly.
- The baby may fall into the lavatory pan and die of drowning or suffocation or it may fall on the ground and may die of head injury.
- In case of skull fracture usually it is **fissured** and limited to **parietal bones**.
- If occurs it is usually seen in multiparae with roomy pelvis and small foetus.
- Caput succedaneum and cephalohematoma **are not seen**.

The umbilical cord if torn is torn near the fetal end.

LOCHIA: It is a vaginal discharge seen after delivery, which is as a result of healing process of placental site.

- **Lochia Rubra:** First 4-5 days bright red in colour.
- **Lochia Serosa:** Next 4 days, serous and paler in colour.
- **Lochia Alba:** After 9-10 days, thicker, scantier and white or yellowish white.

It disappears in 2-3 weeks.

Section 318 I.P.C.: Concealment of birth by secret disposal of dead body.—

Whoever, by secretly burying or otherwise disposing of the dead body of a child whether



such child die before or after or during its birth, intentionally conceals or endeavors to conceal the birth of such child, shall be punished with imprisonment of either description for a term which may extend to two years, or with fine, or with both.

Section 317 I.P.C.: Exposure and abandonment of child under twelve years, by parent or person having care of it.—Whoever being the father or mother of a child under the age of twelve years, or having the care of such child, shall expose or leave such child in any place with the intention of wholly abandoning such child, shall be punished with imprisonment of either description for a term which may extend to seven years, or with fine, or with both. Explanation:- This section is not intended to prevent the trial of the offender for murder or culpable homicide, as the case may be, if the child dies in consequence of the exposure.



Concept 8.7 : Abortion

Learning objective: To know the definition of abortion, rules and regulations of MTP Act 1971 and criminal abortion.

Time needed

1 st reading	40 minutes
2 nd look	20 minutes

- **Legally, Abortion (miscarriage) means the premature expulsion of products of conception from mother's womb, either spontaneous or induced at any time before full term.**
- **Natural abortion takes place in 10-15%** of all pregnancies and is most common in 2nd or third month.

MTP ACT 1971

The Medical Termination of Pregnancy Act was **passed in 1971**. (Amended in 2002- The Medical Termination of Pregnancy (Amendment) Act, 2002, and **Rules & Regulations, 2003**.)

- Indications of MTP are: "SETH".
 1. **Social:** Failure of contraceptive methods in case of a **married woman**.
 2. **Eugenic:** Child born with serious physical or mental abnormalities.
 3. **Therapeutic:** Continuation of pregnancy endangers life of the mother.
 4. **Humanitarian:** Rape resulting in pregnancy.
- **Consent of husband is not necessary.**
- MTP Act, 1971 allows termination of pregnancy **up to 20 weeks** (However Termination of pregnancy can be carried out even after 20 weeks, if the continuation of pregnancy endangers the life of the mother- But not under the preview of MTP Act 1971).

Rules for Doing MTP

1. Qualification Required

- Only qualified Registered Medical Practitioner, having following required experience can terminate the pregnancy.
- A RMP who has **assisted in at least 25 cases of MTP** in a recognized hospital.
- A Doctor with **MD in Gynecology and Obstetrics or DGO** qualification or has **6 months of experience in house surgeon ship** in obstetrics in a recognized hospital.

2. Place – MTP can be Carried Out at

- A hospital maintained or established by government.
- Non-government hospital approved by government.

3. Consent

- A female above 18 years of age with sound mind can give consent for MTP
- In minor females (i.e. < 18 years) or mentally ill, consent of parents or guardian is necessary.



4. Duration of Pregnancy

- When duration of pregnancy is **below 12 weeks of gestation, it can be terminated by the opinion of one Registered Medical Practitioner (RMP).**
- When duration of pregnancy is **above 12 weeks but less than 20 weeks (i.e. 12–20 weeks), two RMPs should agree that there is an indication.**

5. Documentation and Record

- According to regulation 5 of MTP Regulations, all approved centers are required to maintain an admission register in the format prescribed in form III. It should be **maintained for at least 5 years** from the last entry.

Criminal Abortion

Any abortion, which does not come under the provisions of the Medical Termination of Pregnancy (MTP) Act 1971, and when there is no therapeutic indication for termination is considered as criminal abortion.

Methods of Criminal Abortion:

Abortifacient Drugs

1. ECBOLICS

- **They increase uterine contractions.**
- **Ergot is the most commonly used ecbolic.**
- Others include Pituitary extract, Quinine, Cotton root bark, Diachylon (lead oleate), Gossypium etc.

2. EMMENAGOGUES

- **They act by increasing the menstrual blood,** flow and causing expulsion.
- Sanguinarin, estrogens, senecio, Oil of savin, Borax, Apiol, are chief emmenagogues.

3. IRRITANTS:

- **Genitourinary tract irritants** – these agents produce inflammation of genito - urinary tract and reflexly irritate the uterus and induce uterine contraction - example Cantharides, turpentine oil.
- **Gastrointestinal tract irritants** – these agents cause reflex contraction of uterine muscles – example: croton oil, colocynth etc.
- **Systemic poisons** – For example: arsenic, mercury, calotropis, copper, unripe fruit of papaya, Plumbago etc.
- **Abortion pills** – these pills are made up of lead, diphenylephylene etc.

Other Methods

- Syringing
- Rupture of membranes
- Dilatation of cervix
- **Cupping:** A diya is placed on the abdomen and is covered by a metal mug, and the mug is pulled which results in placental separation.

***Practiced in advanced pregnancy.**



- **Abortion sticks:**

- This is a thin wooden or bamboo stick about 15 to 20 cm in length and 0.5 to 1 cm in diameter.
- One end of stick is wrapped with cloth or cotton wool and is soaked in or smeared with irritant abortifacient substances.
- The substances consist of juice of marking nut, calotropis, oleander, abrus, plumbago or paste made up of arsenic oxide, arsenic sulphide, lead etc.
- The stick is when passed into the uterus resulting in rupture of membrane and expulsion of product of conception.

Causes of Death in Criminal Abortion

Immediate cause:

1. Vagal inhibition
2. Air embolism
3. Haemorrhage
4. Fat embolism
5. Amniotic fluid embolism
6. Poisoning (rarely)

Delayed cause (onset within 48-72 hours):

1. Septicemia
2. Pyaemia
3. Confined local infection and toxemia
4. General peritonitis
5. Tetanus

Remote causes:

1. Jaundice
2. Renal failure
3. Bacterial endocarditis
4. Pulmonary embolism



Concept 8.8 : Infant Deaths

Learning objective: To know the definition of various terms, maceration, mummification, differentiation between live birth and dead birth.

Time needed

1 st reading	40 minutes
2 nd look	20 minutes

Infanticide: Deliberate killing of a child below the age of 1 year.

- **In India, there is no distinction in law between infanticide and murder**, such as exists in many Western countries like England, Germany, France, etc.
- In English law, there are special provisions dealing with certain offences against children.
- The English Infanticide Act, 1938, Section 1, provides: Where a woman by any willful act or omission causes the death of her child, the child being under the age of 12 months, but at the time of act or omission the balance of her mind was disturbed by reason of her not having fully recovered from the effect of giving birth to the child or by reason of effect of lactation consequent upon the birth of the child, then, notwithstanding that the circumstances were such that but for this act, the offence would have amounted to murder, she shall be guilty of felony of infanticide and may for such offence be dealt with and punished as if she had been guilty of the offence of manslaughter of the child.

Foeticide: Killing of a fetus at any time prior to birth.

Filicide: Killing of a child by its own parents.

Neonaticide: Killing of a child within 24 hours of its birth (As per medical journals).

Still Born Child: A child which is **born after 28 weeks of pregnancy**, and did not breathe or show any other signs of life, at any time after being completely expelled from its mother. **In other words, the child was alive in utero, but dies during the process of birth.**

Dead Born Child: A dead born child is one which has died in utero and may show any one of the signs such as, Rigor mortis, Maceration, Mummification or Putrefaction after it is completely born.

Maceration:

- This is a process of aseptic autolysis.
- The changes of maceration were well studied and classified by **Langley**.
- This occurs when the dead child remains in the uterus for about 3 or 4 days surrounded with liquor amnii but the exclusion of air.
- The earliest sign is reddish or brownish pink (coppery brown) color of the skin with peeling and slippage, which can be seen in 12 hours after death.
- It has a sweetish disagreeable odour.
- The body is soft, flaccid and flattens out when placed on a level surface.
- The blisters (appear in 24 hours) contain serous or serosanguinous fluid.
- There is abnormal mobility at the joints.
- The skull bones are separated with collapsed vertebral column.

The typical features are seen in 3-4 days.



Mummification:

- When a fetus with deficient supply of blood dies in utero with intact amniotic membrane and scanty liquor amnii, the fetus becomes dry and shriveled.

Putrefaction:

- If air enters through torn amniotic membrane, the process of putrefaction starts.

Differences between Respired and Unrespired Baby

Features	Respired lung	Unrespired lung
Chest	Arched or drum shaped. Circumference greater than that of abdomen. Intercostal spaces wider	Flat. Circumference less than that of abdomen. Intercostal spaces narrow
Diaphragm	Level of sixth or seventh rib	Level of fourth or fifth rib
LUNGS		
Position	Fill the thoracic cavity, overlap heart, with taut covering pleura	Lying at the back of thoracic cavity behind the heart. Covering pleura is wrinkled and loose
Volume	Voluminous	Small
Edges/margins	Rounded to varying extent (weak/ feeble or brief respiration ordinarily affects the margins, whilst more robust or prolonged breathing leads to total expansion)	Clearly defined
Colour	Mottled pink	Uniformly reddish brown or bluish red
Appearance	Marbled due to expanded air vesicles and development of circulation	Smooth and not marbled
Consistency	Spongy, elastic and crepitant	Dense, firm, liver-like and noncrepitant
Alveoli	Expanded, rising above the surface	Not so
Cut section	Exude frothy blood	Exude little blood but no froth unless decomposed
Weight	1/35 of body weight	1/70 of body weight
Medicolegal importance	Significant of 'live birth'	Indicates still birth or dead birth



Hydrostatic test (Raygat's test or Breslau's First Life test):

- This test is conducted to know whether the child has breathed or not.
- First, the ligature is tied on the bronchi and lungs are separated.
- Each lung is individually placed in water, then is cut into 12-20 pieces and placed in water to see whether they float or sink.
- A small piece of liver may serve as control.
- If they float, they are each squeezed between thumb and index finger to remove the tidal air.
- If all the pieces float, it indicates that the respiration has taken place.
- If all the pieces sink, it means the child has not breathed.
- If some pieces sink and some pieces float, it indicates partial or feeble respiration.

Fallacies of hydrostatic test:

- The **expanded lungs may sink** in cases of: diseases such as acute edema, pneumonia, congenital syphilis, etc. or atelectasis.
- The **unexpanded lungs may float**: due to putrefaction or artificial respiration.

Hydrostatic test is not necessary in cases of:

- When the fetus is a monster,
- When the fetus is macerated or mummified
- When the fetus is born before 180 days of gestation,
- When Stomach contains milk and
- When umbilical cord has separated, and a scar has formed.

Stomach-Bowel test (Breslau's Second Life test):

- This is a good corroborative test.
- It is based on the principle that when respiration is established, there is a probability that air is swallowed and may pass into the stomach and small intestine.
- It is performed by placing double ligatures at each end of the stomach and at different parts of the small intestine.
- The various parts are tested for floatation, and if positive results are shown, they are punctured under water, then the contained may be seen to escape to the surface.
- If no escape, the test is negative.

Fodere's/Static Test:

- **Before respiration** the weight of the lungs is **35g**,
- **After respiration** it will be **70-g**.

Plocquet's Test:

- The ratio between the weight of the lung and body is: **1:70** before respiration and **1:35** after respiration.

Wredin's Test:

- Replacement of gelatinous tissue in the middle ear by air after respiration.



Osborn's no Touch Technique:

- The lungs are removed intact by scalpel to eliminate artifacts. The whole lung is fixed, and sections are taken. Un respired lungs are lined by columnar and Respired lungs are lined by Squamous epithelium.

Changes In Umbilical Cord:

- 12-24 Hours: Cord shrinks and dries (Vessels begin to be closed in 24 hours).
- 36-48 hours: Inflammatory ring at the base.
- **5-6 days: Mummifies and falls.**
- 10-12 days: Cicatrizes

Level of Fetal hemoglobin:

- At 5th month of IUL: 94%
- **At birth : 80%**
- At 3 months : 7-8%
- At 6 months : 0

***After birth, Nucleated RBCs clear off from the circulation in 24 hours**



Concept 8.9 : Battered Baby Syndrome

Learning objective: To know the meaning of battered baby syndrome and the findings in the victim, to know Cinderella syndrome, shaken baby syndrome, Munchausen's Syndrome and Munchausen's Syndrome by proxy.

Time needed

1 st reading	15 minutes
2 nd look	8 minutes

Also known as:

- Caffey's syndrome
- Non accidental injuries of childhood (**NAI**)
- Inflicted Traumatic Brain Injury (**ITBI**)
- Inflicted Childhood Neurotrauma (**ICN**)

Definition: A battered child is a child who has received repetitive physical injuries as a result of non-accidental violence, produced by a parent or guardian.

In addition, there may be deprivation of love, care, affection and nutrition.

- Usually seen in a child less than 3 years, but may be seen up to 5 years of age.
- Incidence is slightly more in males.
- Unwanted child
- Young parents (20-30years) with low socio-economic status
- Inconsistent history and findings of physical examination (Mismatch).
- Multiple bruises of different colors in same individual (Different age).
- Egg shell Fracture: Radiating skull fracture.

Cinderella Syndrome: False accusation by adopted children of being mistreated or neglected by their adoptive mothers is known as Cinderella syndrome.

Shaken Baby Syndrome (Infantile Whiplash Syndrome).

- This is a form of Child abuse.
- Usually occur in children <2 years, but may be seen up to the age of 5 years.
- Acceleration and Deceleration Injuries (Ac-Dc) induced by violent shaking.
- "Triad" of SBS includes Cerebral Edema, SDH and Retinal hemorrhage

Munchausen's Syndrome:

It is nothing but feigning the illness or injury and visiting various hospitals for unnecessary investigations and treatment.

Munchausen's Syndrome of Proxy:

Child is brought to hospital with repeated frivolous complains by the parents. Sometimes parents themselves may inflict harm on their child.

**Concept 8.10 : Sudden Infant Death Syndrome (SIDS):**

Learning objective: To know the definition, incidence and risk factors of sudden infant death syndrome.

Time needed

1 st reading	10 minutes
2 nd look	5 minutes

- It is known as Cot Death in Britain and Crib Death in North America.

Definition: "The sudden death of any infant or young child that is unexpected by history and in whom a thorough necropsy fails to demonstrate an adequate cause of death".

Incidence: Incidence is 0.6/1000 live births.

Identified risk factors include the following:

1. Winter season: Higher rate of incidence in the winter season.
2. Respiratory disease: Deaths occurring particularly in the regional occurrence of respiratory disease.
3. Male child: SIDS has a male predominance.
4. Higher incidence in cities than in rural areas.
5. A characteristic age distribution from 2 weeks to 2 years, with a **peak at 2-4 months**.
6. An increased incidence in twins, in babies of low birthweight, among off springs of young mothers.
7. Poor living conditions.
8. Bottle-fed babies.
9. Most fatalities seem to occur during the night, the babies being found dead in the morning, the child being previously healthy or only mildly unwell.

Cause of death: Not known, but most accepted hypothesis is "**Sleep apnoea**".

CONCEPTS

- ⇒ **Concept 9.1 Definition and History**
- ⇒ **Concept 9.2 Diagnosis of Mental Illness**
- ⇒ **Concept 9.3 Mental Disorder and civil Responsibility**
- ⇒ **Concept 9.4 Mental Disorder and Criminal responsibility**



Concept 9.1 : Definition and History

Learning objective: To know the definition of forensic psychiatry and the history.

Time needed

1 st reading	10 minutes
2 nd look	5 minutes

- **Forensic Psychiatry** deals with the application of knowledge of psychiatry in the administration of law and justice.
- Insanity (lunacy or mental unsoundness or mental derangement or mental disorder) is defined as *a disease of mind or the personality in which there is derangement or impairment of mental or emotional processes*.
- The Indian Lunacy Act 1912 defined lunatic as *an idiot or a person of unsound mind*. However, **The Mental Health Act 1987** has replaced the Indian Lunacy Act 1912. The Mental Health Act 1987 uses the term "**mentally ill person**" instead of lunatic.
- The Mental Health Act defines mentally ill person as *"a person who is in need of treatment by reason of any mental disorder other than mental retardation"*
- **Insanity is an old term** used loosely to denote any mental disorder or mental illness. The Indian Penal Code employs the term **unsoundness of mind** while referring to insanity.
- It is better to use term mentally ill person (as defined under Mental Health Act 1987) rather than using term such as insane or lunatic.



Concept 9.2 : Diagnosis of Mental Illness

Learning objective: To know how to diagnose insanity the definition of forensic psychiatry and the history.

Time needed

1 st reading	15 minutes
2 nd look	8 minutes

Diagnosis

- The individual should be kept for observation till 10 days.
- Only with the permission of Magistrate a person can be detained **up to 30 days**.
- Certificate can be issued after minimum 3 examinations.

Feigned Mental Illness

- Also called as false insanity, fabricated insanity, artificial insanity
- In this condition, a person fabricates the sign and symptoms of insanity
- A person may feign insanity to escape from punishment or with some motive
- In most of the cases, it is easy to detect feigned insanity from true insanity but small number of cases may pose difficulty.

Difference between Real and Feigned Mental Illness

Trait	Real mental illness	Feigned mental illness
Onset	Gradual	Sudden
Motive	Absent	Present
Predisposing factors	Usually present e.g. H/o of insanity in parents or sudden monetary loss, grief etc.	Absent
Signs and symptoms	Uniform and present whether the patient is being observed or not	Present only when conscious of being observed
Facial expressions	Peculiar e.g. vacant look or fixed look of excitement	No peculiarity
Insomnia	Present	Cannot persist
Exertion	Patient can stand exertion of fatigue hunger sleep	Breaks down with exertion
Habits	Dirty and Filthy	No dirty & Filthy
Skin & lips	Dry, harsh	Normal
Frequent examination	Does not mind examination	Resents from fear of detection



Concept 9.3 : Mental Disorder and Civil Responsibility

Learning objective: To know the civil responsibilities of a mentally ill person.

Time needed

1 st reading	20 minutes
2 nd look	10 minutes

- Chapter 6 of MHA 1987 deals with management of property of mentally ill person.
- If a mentally ill person is incapable of taking care of himself, the District Court or the Collector of the district may appoint any suitable person to be his guardian (**Section 53 of MHA 1987**).
- The district Court may appoint any suitable person to be manager for the property belonging to mentally ill person and to supervise the same.
- The Court may grant the manager the necessary power and may order the sale of property for the payment of his debts and expenses.
- According to **Sec. 90 I.P.C.**, consent given by a person suffering from mental illness or of unsound mind, becomes invalid.
- Similarly consent given by mentally ill female to the act of sexual intercourse becomes invalid and the act amounts to rape (**Sec. 375 of I.P.C.**).
- A contract becomes invalid, if at the time of doing such contract or making such contract, one of the parties was mentally ill.
- Mental illness developing after contract does not make it invalid.
- Mentally ill person when in lucid interval may make a contract.
- According to **Sec. 118 I.E.A.**, a mentally ill person is not considered as incompetent to give evidence, unless he is prevented by his mental illness from understanding the questions put to him and giving rational answers to them. Can give evidence during Lucid Interval.
- A mentally ill person is liable for tort or civil wrong unless the disease of his mind is so great that he cannot understand the nature and consequences of his act.
- **According to the Hindu Marriage Act 1955**, the marriage solemnized becomes null and void if at the time of marriage:
 1. Due to unsoundness of mind, if either party is incapable of giving a valid consent to a marriage; or
 2. Though capable of giving valid consent, has been suffering from mental disorder of such a kind or to such an extent as to be unfit for marriage and the procreation of children; or
 3. Has been subject to recurrent attacks of insanity.

Insanity and Testamentary Capacity:

- Testamentary capacity (Testament = will) is the mental ability of a person to make a valid will.
- To make a valid Will, it should have following components:
 1. He should be major.
 2. The person should be of sound mind.



3. The person making Will should understand the nature of Will.
 4. The person should have knowledge of his property that has to be disposed off.
 5. The person should recognize the individuals who have moral claims to heir his property.
- A civil court may invalidate the Will if the person making such Will is of unsound mind at the time of making Will
 - A Will made under the influence of somebody else is also invalid.
 - A person suffering from mental illness can make valid Will during the period of lucid interval.
 - **Holograph will** be a Will written by testator in his own handwriting.



Concept 9.4 : Mental Disorder And Criminal Responsibility

Learning objective: To know the criminal responsibilities of a mentally ill person.

Time needed

1 st reading	40 minutes
2 nd look	20 minutes

- The law presumes that for every criminal act, there must be criminal intent or mind, **mens rea** (mens = mind; rea = guilty) motivating it.
- The following are the tests for judging criminal responsibility.

MC NAUGHTEN RULE (*The Right or Wrong Test/The Legal Test*):

- English courts, in dealing with the responsibility of the insane in criminal cases are guided by the rules laid down after the **McNaughton trial in 1843** - To establish defence on the ground of insanity, it must be clearly shown that, at the time of committing the act, the accused was labouring under such a defect of reason, from disease of the mind, as not to know the nature and quality of the act he was doing; or, if he did know this, that he did not know that what he was doing was wrong.
- The most important aspect of this rule is as follows:

An accused person is not criminally responsible, if it is proved that, at the time of committing the crime that he was suffering from such a defect of reason from disease of mind that he **did not know the nature and quality of act** he was doing or if he did know this that he **did not know that what he was doing was wrong**.

SEC. 84 OF IPC.: This legal test has also been accepted in India as the law of criminal responsibilities under **Sec. 84 of IPC., - Nothing is an offence which is done by a person who, at the time of doing it, by reason of unsoundness of mind, is incapable of knowing the nature of the act, or that he is doing what is either wrong or contrary to law.**

Sec. 115 of 'THE MENTAL HEALTHCARE ACT, 2017 states that:

- a) Notwithstanding anything contained in section 309 of the Indian Penal Code **any person who attempts to commit suicide shall be presumed, unless proved otherwise, to have severe stress and shall not be tried and punished under the said Code.**
- b) The appropriate Government shall have a duty to provide care, treatment and rehabilitation to a person, having severe stress and who attempted to commit suicide, to reduce the risk of recurrence of attempt to commit suicide.

Criminal responsibilities of an insane in some special circumstances are considered below.

1. **Somnambulism:** It is a condition in which a person walks about in his sleep and therefore also called as sleepwalking. The person is not held responsible for any unlawful act committed during sleepwalking state. But once he comes to know about his condition, he must make necessary arrangements not to repeat the crime, such as asking his friends or relatives to lock the room etc.
2. **Somnolentia** (semi-somnolence or Sleep drunkenness): It is a condition midway between sleep and wakefulness. When a person is aroused from his deep sleep, suddenly he may get confused, becomes violent and may commit some crime. The person is not usually held responsible for any unlawful act committed during Somnolentia state.



3. **Hypnotism** (mesmerism): It is a condition where a trance or sleep like state is induced by a process of suggestion. A hypnotized person may do acts as per orders given by hypnotizer. After wearing of hypnotism, the person does not remember the acts done by him. *Hypnotism cannot be pleaded as defense in criminal acts. Both parties i.e. the hypnotizer and hypnotic person are held guilty.*
4. **Automatism**: The performance of an act of which he is unaware and over which he does not have conscious control (After an episode of epileptic fit, cerebral concussion, hypoglycemia, Barbiturate or CO poisoning etc.)
The person is NOT HELD liable for his actions.
5. **Drunkenness**: If a person voluntarily consumes alcohol or an intoxicating drink with knowledge or intent and commits crime under the influence of drink then the person is held responsible for his act (Section 86 of IPC).

However, if any intoxicant was administered to a person without his knowledge or against his will then the person is not held responsible for his act (Section 85 of IPC).

Rules in some other Countries

Durham Rule

The Durham's rule states, "*An accused is not criminally responsible if his unlawful act was the product of mental Disease or mental Defect*".

- It was held that the rule was broader than M'Naughton rule. However, the rule had created problems.
- The rule states that the unlawful act of a person was product of **mental disease** or **mental defect**. The ambiguity was with reference to these words because what constitute mental disease or mental defect was not made clear or defined.

Curren's Rule

The Curren's rule states that "*An accused is not criminally responsible, if at the time of committing the act, the defendant, as a result of mental disease or defect, lacks substantial Capacity to Conform his Conduct to the requirements of law*".

As per Curren's rule, it was contested that, at the time of committing the criminal act, a person may have knowledge that what he was doing was wrong but he neither had the capacity nor the will to control (adjust) his act. Therefore such person should not be held responsible.

American Law Institute (ALI TEST, 1970)

The ALI test held that "*A person is not criminally responsible, if at the time of committing the act, as a result of mental disease or defect lacked substantial capacity either to Appreciate the wrongfulness of his conduct or to conform his conduct to the requirements of the law*".

Irresistible Impulse Test (New Hampshire Doctrine):

According to this, "*An accused is not criminally responsible, even if knows the nature and quality of his act and knows that it is wrong, if he is incapable of restraining himself from committing the act, because the free agency of his will has been destroyed by mental disease*".

CONCEPTS

- ⇒ **Concept 10.1** Presumptive/Screening tests for Blood
- ⇒ **Concept 10.2** Confirmatory tests for Blood
- ⇒ **Concept 10.3** Other tests for Blood
- ⇒ **Concept 10.4** Semen
- ⇒ **Concept 10.5** Other Body Fluids
- ⇒ **Concept 10.6** Hair
- ⇒ **Concept 10.7** Revealing Concoeled Information
- ⇒ **Concept 10.8** DNA Profiling (DNA Fingerprinting/DNA Typing)



Concept 10.1 : Presumptive/Screening tests for Blood

Learning objective: To know the various screening tests and its importance.

Time needed

1 st reading	30 minutes
2 nd look	15 minutes

Screening tests/Presumptive tests for Blood

Advantages of Screening Test:

1. Screening tests are sensitive tests.
2. Less time is required and are economical.
3. If screening tests are negative, then no need to proceed for confirmatory tests.

Disadvantages:

1. **These are only screening tests and are not confirmatory.**
2. One drawback of presumptive test is the number of substances that can produce false-positive results. Rust, copper and metal salts, salt-treated lumber, potatoes, and horseradish may all cause a positive result with PH. Usually, if one of these substances is present, the reaction time is slower, and the color change takes longer to appear.

Benzidine test (No longer used as Benzidine is Carcinogenic)

- Most reliable chemical test for blood.
- Add a drop of saturated solution of benzidine in glacial acetic acid and then a drop of 10 volumes **hydrogen peroxide**.
- If blood is present, dark blue colour is produced immediately.
- A positive reaction is given by blood of almost any age, blood that has been exposed to heat or cold. **It detects blood when present in a dilution of 1:3,00,000.**

Kastle-meyer test (Phenolphthalein test):

- To a solution extracted from the stain with distilled water, add 10 to 20 drops of phenolphthalein reagent and then a drop or two of ten volumes hydrogen peroxide
- If blood is present, a pink or purple color develops immediately.
- **This test is more specific for blood than Benzidine test, but comparatively less sensitive.**

Note: The tests employing guaiacum and leucomalachite green tests are rarely used in medico-legal work.

Luminol test:

- Luminol is a chemical presumptive test that, instead of producing a color change reaction, causes stained areas to emit light which must be observed under 'black' light. (UV Lamp)
- **If the crime scene is washed, the suspected area is sprayed with Luminol (3-amino phthalylhydrazide), which would make entire area glow bluish in the dark.**



- **Luminol test is considered the best overall presumptive blood test because it has the greatest sensitivity and specificity of all. Sensitivity is 20 times more than other tests. Hb has been detected in 1:10 million dilutions.**
 - **Phenolphthalein (PH) is the most commonly used presumptive test** for blood and may be used by itself or in concert with other presumptive tests.
 - Although TMB is more specific than PH, meaning fewer false-positive results, it is less sensitive than PH and does not work as well on highly diluted blood stains.
 - Vegetable stains can be differentiated from blood stains by the presence of Tannin.

Presumptive tests for blood and their reactions

Test	Result when positive
Benzidine	Blue color
Phenolphthalein	Pink / Purple color
Leucomalachite green	Blue-green color
Orthotolidine	Green to Blue color
Luminol	Emits light in dark
Guaicum test	Deep blue color



Concept 10.2 : Confirmatory tests for Blood

Learning objective: To know the various confirmatory tests and its importance

Time needed

1 st reading	30 minutes
2 nd look	15 minutes

Crystal Tests:

Haemin crystal test (*Teichmann's Test*)

- A small crystal of sodium chloride and 3 drops glacial acetic acid are placed on a glass slide.
- **Brownish-black rhombic crystals** of haemin or haematin chloride arranged singly or in clusters are seen if blood is present.
- **Teichman's Test is negative if stain is old, while Takayama's test is positive.**

Haemochromogen crystal test (*Takayama's test*)

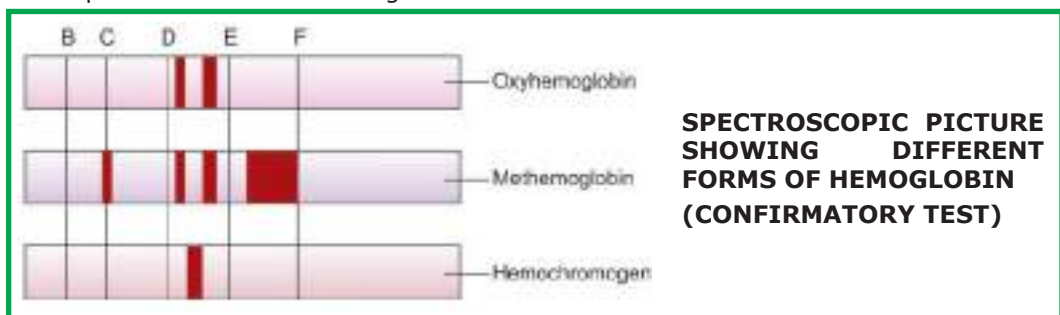
- It has MORE Value.
- 2-3 drops of **Takayama reagent (Sodium hydroxide + Pyridine + Glucose)** is added to the sample.
- **Pink feathery crystals** of Haemochromogen are seen as confirmatory.

Microscopic Examination

- Microscopic examination can be done by wet film or stained smears with Leishman's stain. Presence of intact red blood cells confirmed presence of blood
- Human — RBCs are circular, biconcave, non-nucleated cells with a diameter of 7.2 μ .
- All mammals RBCs are circular, biconcave and non-nucleated cells except that of camels. In camel, the RBCs are oval, biconvex and non-nucleated.
- In birds, fish, amphibians and reptiles, RBCs are oval, biconvex and nucleated.

Spectroscopic Examination

- **It is the most delicate and reliable test for detecting the presence of blood in both old and recent stains.**
- Hemoglobin and its derivatives show characteristic bands of absorption at specific wavelength. Presence of two or more bands in the Spectroscopic examination confirms the presence of blood in the given stain





Concept 10.3 : Other tests for Blood

Learning objective: To know the other tests such as whether the blood is human or not, age of blood stain, to identify the blood group and sex of a person from blood stain.

Time needed

1 st reading	30 minutes
2 nd look	15 minutes

Human Blood or Not:

1. Microscopic examination
2. Iso-enzyme method
3. Immunological Methods:
 - Precipitin test
 - Antiglobulin Inhibition/Consumption Test
 - Gel diffusion
 - Double diffusion in agar gel
 - Precipitation – electrophoresis
 - Latex Test
- **Precipitin test is positive in dead body up to 10 years.**
- Precipitin test determines whether the blood is derived from human beings or from a lower animal (**species specific test**).
- Species testing of blood is typically accomplished through an antigen–antibody reaction.

Age of a Bloodstain

It can be known by:

1. Change in color:

- Gross examination: Fresh stains appear red and sticky. As age advances, it turns brown due to oxidation of hemoglobin to methemoglobin.
- Color changes measured on colorimeter or **spectrophotometer**.

3. Immunoelctrophoressis:

- Can be **used to determine the age of bloodstains**. There is gradual disappearance of beta-globulins and gamma-globulins with increase in the age of blood stains.

Identification of Blood Group

Blood group from blood/stains can be determined by following methods:

1. Absorption-elution/Acid elusion technique
2. Absorption-inhibition method
3. Mixed agglutination test
4. Latte's crust test



Identification of Sex

Sex from bloodstains can be identified by

1. Leishman stained blood films — for presence of **Davidson body**
2. Demonstration of **Y chromosome on fluorescence** microscopy
3. **DNA analysis**

Best tests for Blood

Screening	Luminol test
Confirmatory	Spectroscopic test
Grouping in old stains	Acid dilution test/ Latte's crust method
Age of the stain	Immunoelectrophoresis
Washed blood	Luminol test (Reagent used is Aminophthalhydrazide)



Concept 10.4 : Semen

Learning objective: To know the various tests for semen, the medicolegal importance of semen and motility of sperm.

Time needed

1 st reading	50 minutes
2 nd look	25 minutes

- For forensic purposes, the composition of semen can be simplified into two components: seminal fluid and spermatozoa.
- Seminal fluid is a protein-rich body fluid originating primarily from the prostate and seminal vesicles.
- In men who have had a vasectomy, certain birth defects, or as the result of some diseases, seminal fluid will either not contain spermatozoa or contain very few.
- Therefore, it is useful to be able to forensically test for the presence of both seminal fluid and spermatozoa.
- Seminal stains have to be detected in cases of rape or attempted rape, sexual murder of the female, sodomy and bestiality.
 - Fertility of fluid has to be proved in disputed paternity.
 - Seminal fluid choline is originated from Leyding cells.
 - Smegma:** If the smegma is present around glans of penis, it is suggestive of the fact that an individual did not have sexual intercourse in last 24 hours.
 - Seminal stain produces fluorescence (Blue-white color) on exposure to UV light.**
 - pH of seminal fluid is 7.35 – 7.5**
 - Derivatives of seminal fluid
 - Testis : Spermatozoa + Epithelial cells
 - Seminal vesicles: Choline + Lecithin
 - Prostate : Acid phosphatase + Spermine.

NOTE: The only absolute proof of semen in the finding of at least one unbroken spermatozoon or electrophoretic LHD isoenzyme detection of sperms.

Test	Features
Barberio's test	Spermine present in semen reacts with picric acid to form yellowish needle shaped crystals of spermine picrate
Florence's test	Choline from semen reacts with Florence solution (potassium iodide + iodine + distilled water) to form brownish rhomboid shaped crystals of choline iodide
Acid phosphatase Test	Demonstration of High acid phosphatase activity suggests stain/ secretions as semen. It can show even in absence of sperms as in azoospermia. Acid phosphatase activity of human semen per ml is 340 - 360 Bodansky units or 2500 - 3500 Angstrom units
Zinc test	Presence high concentration of zinc (140 mg/ml) is used as marker for semen
Fluorescence	Seminal stains fluorescence bluish-white in color. UV light can detect even old/ invisible stains



Microscopy and Precipitation reaction	For confirmation of it being human sperm. Picroindigocarmine stain (Christmas tree stain)
ELISA	ELISA for human semen identification and is based on biotinylated monoclonal antibody to seminal vesicle
Prostate specific antigen (P 30)	Prostate specific antigen (P 30) has been utilized to identify semen as a marker. This test has replaced the quantitative analysis for acid phosphatase.
TLC	Only test to detect both choline and spermine in seminal stain
Ammonium molybdate test	For semen stains, detects presence of phosphorous.
Creatine phosphokinase	Normal seminal fluid contains 385 to 1400 units of CPK/ml. Levels over 400 units are almost diagnostic. The enzyme is stable and can be demonstrated as late as 6 months after soiling.

Motility of sperm

- In living persons
 - **Motile sperms may be found in vaginal washings up to 6 hours and rarely up to 12 hours after coitus.**
 - Non-motile forms are detectable up to 24 hours.
 - The sperms may remain alive in the uterine cavity for 3-5 days.
- In dead persons
 1. Vagina – sperm head found up to 9 days in vagina
 2. Cervix – sperm head found up to 12 days in cervix
 3. Uterus – sperm head found up to 15 days
 4. Anus – sperms found up to 2 days
 5. Mouth/oral cavity – up to 9 hours



Concept 10.5 : Other Body Fluids

Learning objective: To know the tests to detect saliva, milk, urine and feces.

Time needed

1 st reading	15 minutes
2 nd look	8 minutes

Saliva

- Blood groups can be determined in secretors
- Sex of a person can be demonstrated from the buccal cells present in saliva
- Invisible dried stains of saliva over skin can be detected by fluorescence spectroscopy. It is rapid, sensitive and non-destructive technique.
- **Phadebas test** and/or **Starch-Iodine Test/Alpha-Amylase (or α -Amylase) test** are used to detect Saliva and can be confirmed by the Presence of buccal squamous cell.

Milk

- Presence of Colostrum: By the detection of **Trypsin inhibitor**.
- Presence of Milk: By the detection of **Casein and Lactose**.

Urine

- Chemical tests to detect urine from the stains depend on the **presence of Urea and creatinine**.

Feces

- Chemical Test: Detection of urobilinogen, a bile pigment excreted in feces, which may be detected using its fluorescent reaction to **Edelman's reagent**



Concept 10.6 : Hair

Learning objective: To know the medicolegal importance of hair, growth of hair and how to differentiate between human & animal hair.

Time needed

1 st reading	20 minutes
2 nd look	10 minutes

Trichology is the study of hair.

Presence of Barr bodies in root sheath can help in sex-determination

- Blood group from hair can be determined
- Chemical analysis of hair may reveal presence of poison
- Can also be used for identification of race
- It needs to be determined if hair is human or animal
- Blood groups can be determined in a hair from any part of the body by a modified absorption elution technique.
- Chronological order of appearance of hairs:
 - **Pubic Hair** → **Moustache** → **Beard** → **Axillary Hairs**
- **Scalp hairs grow at 3 mm a week, Beard 0.4mm/day. (Nail grows 0.1mm/day)**
- **Hair becomes loose after 72 hours of death**

Features	Human hair	Animal hair
Appearance	Fine and thin	Coarse and thick
Cuticle	Scales are small, flattened (Mortize type VII), serrated Margin and surrounds the shaft	Scales are large, projecting, wavy or step like and in various patterns
Cortex	Thick, 4-10 times as broad as medulla	Thin cortex
Medulla	Varies considerably, may be narrow, absent or Fragmented or discontinuous	Broad, always present, Continuous and wider
Pigment location	Towards periphery	Near medulla
Precipitin test	Specific for humans	Used to differentiate between diff species and humans
Medullary index	< 0.3	> 0.5
Shaft	Diameter between 50-150μ	Either less than 25μ or more than 300μ

Concept 10.7 : Revealing the Concoeled Information

Learning objective: To know the methods to reveal the concealed information – Narcoanalysis, Polygraph, Brain fingerprinting and Brain mapping.

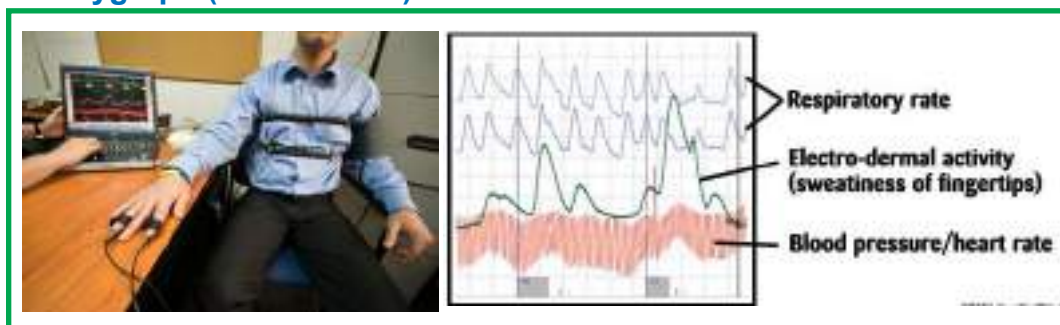
Time needed

1 st reading	30 minutes
2 nd look	15 minutes

1. Narcoanalysis

- Narcoanalysis is a procedure of investigation of mental content of a person done after application of a light general anesthetic drugs.
- This investigative technique is based on the principle that at a point very close to unconsciousness, the subject would be mentally incapable of resistance to questioning and incapable of inventing falsehood that he has used to conceal his guilt.
- Drugs commonly used are
 - Thiopentone sodium (Na Pentothal)**
 - Scopolamine hydrobromide
 - Sodium seconol
 - Sodium amytal
 - Benzodiazepines

2. Polygraph (Lie Detector)



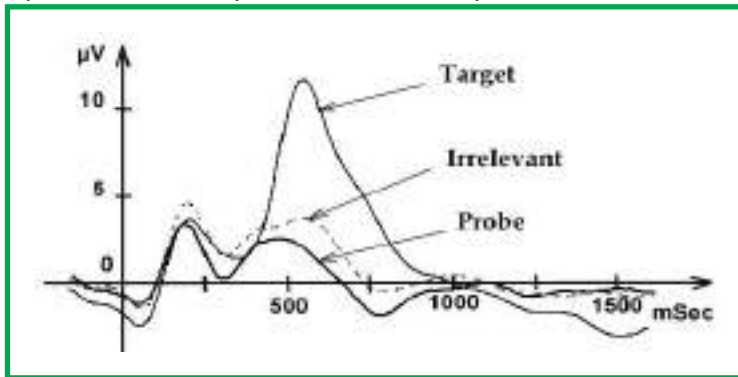
- This measure and records several physiological indices such as, **blood pressure, pulse, respiration, and skin conductivity** while the subject is asked and answers a series of questions.
- It is based on the principle that deceptive answers will produce physiological responses that can be differentiated from those associated with non-deceptive answers.

3. Brain Fingerprinting

- Invented by Lawrence Farwell**
- It is a technique that uses electroencephalography (EEG) to determine whether specific information is stored in a subject's brain by measuring electrical brainwaves and recording a brain response known as a **P300-MERMER** (memory and encoding



related multifaceted electroencephalographic response) in response to words, phrases, or pictures that are presented on a computer screen.



4. Brain Mapping (fMRI)

- **Discovered by Seiji Ogawa.**
- The primary form of fMRI (Functional magnetic resonance imaging) uses the blood-oxygen-level dependent (**BOLD**) contrast.
- It is based on uptake of oxygen in the brain cells in response to questionnaire.

NOTE: According to Article 20(3) of Constitution of India, no person accused of any offense shall be compelled to be witness against himself.

The Supreme Court in the year 2010 held that no individual should be forcibly subjected to narcoanalysis, polygraph and brain mapping tests on accused, suspects and witnesses without their consent as they violate the right against incrimination.



Concept 10.8 : DNA Profiling (DNA Fingerprinting/DNA Typing)

Learning objective: To know the application, advantages and disadvantages of DNA fingerprinting, different methods of DNA fingerprinting and selection of DNA samples and preservatives used.

Time needed

1 st reading	40 minutes
2 nd look	20 minutes

Dr. Alec Jeffrey in 1985 developed DNA fingerprinting

Dr. Kary Banks Mullis invented Polymerase Chain Reaction (PCR)

Application of DNA Profiling

1. To establish identity of a person in
 - Sexual crimes – rape/sodomy/buccal coitus
 - Violent crimes – murder
 - Accidents/ mass disaster
 - Missing person
 - Mistaken identity etc.
2. To acquit a falsely implicated person from such similar crime.
3. Identification in postmortem practice
 - Accidents/Disasters/Mutilated remains/Skeleton/Exhumation etc.
 - In embalmed tissues.
4. Disputed paternity and/or maternity.
5. To resolve disputes of:
 - Adultery
 - Incest
 - Child born out of rape cases
 - Custody of a child born out of wedlock
 - False implication on a person being father
6. Extortion cases.
7. Immigration cases.
8. Determination of twin zygosity.
9. To identify sex.

Advantages of DNA fingerprinting:

1. Conclusive method of identification of an individual
2. Method can be applied to old stains or biological material
3. Small quantity of sample is required

Disadvantages of DNA fingerprinting:

1. DNA profiling cannot differentiate between monozygotic twins
2. Expensive



3. Interpretation requires trained manpower
4. Susceptible for contamination.

Basics:

Tandem repeated DNA sequences are present in human genome and they show variability in different individuals.

These tandemly repeated regions of DNA are classified into several groups depending on the size of the repeat region such as:

1. **Minisatellites** – Variable number of tandem repeats – **VNTRs**
2. **Microsatellites** – Short tandem repeats – **STR**

Methods of analysis of DNA collected above are:

1. Restriction fragment length polymorphism (RFLP) technique
2. **Polymerase Chain Reaction (PCR)** technique
3. **Short Tandem Repeats (STR)** method
4. **Mitochondrial DNA (MtDNA)** analysis
5. Other new methods
 - Y-Chromosome STR Analysis
 - Single-nucleotide polymorphism (SNP) analysis
 - Mini-STR
 - Low copy number (LCN) DNA testing

The most preferred method of DNA analysis currently used in crime laboratories is Short Tandem Repeat (STR) analysis.

The venom of female banded krait is used as one of the chemical scissors (Restriction Endonuclease-RE – to cut the minisatellite) in DNA fingerprinting.

DNA Samples and Preservatives Used

Sample	Method for collection/packing	Preservative
Blood	Use clean sterile container Add recommended preservative Bring the sample on ice	4% EDTA
Tissue, muscle, skin, organs	Place sample in clean sterile container	Normal saline or Keep tissue as it is in –20°C
Teeth	Air dry, place them in clean and sterile container	No preservative
Scalp hairs with root	Air dry sample, place in clean and sterile container	No preservative
Bone	Air dry, wrap in clean paper	No preservative
Blood stained clothes/ scrapings	Air dry sample, pack in clean paper	No preservative
Semen stains	Air dry clothes and pack in clean paper	No preservative
Vaginal swabs	Air dry, place the swabs in dry, clean and sterile container	No preservative



Vaginal smear	On glass slide, place slides in clean paper packet	No preservative
Vaginal/seminal fluid	Collect in clean and sterile container	Frozen solid
Saliva	Collect in clean and sterile container	Frozen solid
Saliva stain on fabric	Air dry and pack in clean paper	No preservative

***For Visceral samples, Dimethyl sulphoxide (DMSO) is a better preservative.**

CONCEPTS

- ⇒ **Concept 11.1 General Toxicology**
- ⇒ **Concept 11.2 Classification Of Poisons**
- ⇒ **Concept 11.3 Corrosives**
- ⇒ **Concept 11.4 Non-Metallic Poisons**
- ⇒ **Concept 11.5 Agricultural Poisoning**
- ⇒ **Concept 11.6 Metallic Poisons**
- ⇒ **Concept 11.7 Irritant Plant Poisons**
- ⇒ **Concept 11.8 Irritant Animal Poisons**
- ⇒ **Concept 11.9 Alcohol**
- ⇒ **Concept 11.10 Opium**
- ⇒ **Concept 11.11 Sedatives And Hypnotics**
- ⇒ **Concept 11.12 Delirients**
- ⇒ **Concept 11.13 Spinal Poisons**
- ⇒ **Concept 11.14 Peripheral Nerve Poisons**
- ⇒ **Concept 11.15 Cardiac Poisons**
- ⇒ **Concept 11.16 Asphyxiants**
- ⇒ **Concept 11.17 Food Poisoning**
- ⇒ **Concept 11.18 Psychotropic Substances**
- ⇒ **Appendix**



Concept 11.1 : General Toxicology

Learning objective: To know about some poisons of interest, gastric lavage, antidotes, diaphoretics and Drugs and cosmetics rules, 1945

Time needed

1 st reading	90 minutes
2 nd look	45 minutes

Poisons of Interest

Ideal homicidal poison

- Ideal homicidal poisons - Thallium, fluoride compounds
- Commonly used homicidal poisons - Arsenic, aconite

Ideal suicidal poison

- Ideal suicide poison - Cyanide
- Commonly used suicidal poisons: Insecticides (OP compounds, Endrin), Opium, Barbiturates.
- Organophosphorus compounds are most commonly used as suicidal poison.

Stupefying Agents:

- Dhatura, Cannabis indica, Chloral hydrate (Strong in taste, pungent odor)

Abortifacient Drugs:

- Calotropis, oleanders, aconite, croton, semecarpus, cantharides, ergot, lead, arsenic etc.

Cattle Poisoning:

- The usual poisons are abrus precatorious, oleanders, calotropis, aconite, arsenic, organophosphorus, strychnine, zinc phosphide, nitrate etc.

Arrow Poisons:

- Abrus precatorius, croton oil, calotropis, aconite, strychnine, curare and snake venom.

Aphrodisiacs

- Cantharides, cocaine, cannabis, opium, strychnine, arsenic



Gastric Lavage

Indications	Contraindications	Complications
It is useful anytime within 2 hours after ingestion of a poison. (Some authorities recommend lavage up to 6-12 hours after ingestion in poisoning by tricyclic antidepressants, salicylates, carbamazepine and barbiturates)	- All corrosives except Carbolic acid - Mechanical poisons - Esophageal varices - Haemorrhagic diathesis - Comatose patients - Impaired gag reflex - Volatile poisons - Marked hypothermia - Significant electrolyte imbalance - Severe heart disease - Advanced pregnancy	- Aspiration pneumonia - Mallory Weiss tears - Laryngospasm - Perforation of esophagus / stomach - Hypothermia - Electrolyte imbalance - Sinus bradycardia

Gastric Lavage Tube

Name	Ewald or Boa's tube
Diameter	1 cm
Length	1 and ½ meter
Mark at	50 cm
Openings	Lateral
Patient position	Left lateral (Best) or prone
Material used	Potassium permanganate 1:5000, Sodium Bicarbonate 5%, Tannic acid 4%, Sodium or potassium Iodide 1 % Calcium lactate 1-3%, Saturated lime water or starch





Fluids/Substances used for Gastric Lavage

- Water or normal saline is the most commonly used solution for gastric lavage.
- Potassium permanganate is used as lavage fluid for oxidizable poisons such as Opium and its derivatives, Strychnine, Phosphorous, Cyanide, Barbiturates, Atropine, and other alkaloids.
- It is used in the form of 1:5000 solution.
- In opium poisoning KMnO_4 is used in higher concentrations (1:500) and lavage is done even when opium has been administered through parenteral route.
- KMnO_4 is not useful in Heavy metal Poisoning.
- In case of Poisoning by KMnO_4 lesions resemble tertiary syphilis

Substance used for gastric lavage in specific poisoning:

Arsenic → Freshly prepared Ferric oxide (hydrated)

Mercury → Sodium Formaldehyde Sulphoxylate

Copper → Potassium Ferrocyanide (Non-toxic salt of cyanide)

Activated Charcoal

- Activated charcoal is tasteless, black, fine powder.
- It adsorbs the poisons in stomach and hence decreases the systemic absorption of poison.
- Dose is given as 1 gm/kg body weight.
- Required quantity of activated charcoal is mixed with water and this mixture is administered to patient.
- Charcoal is activated by using steam, carbon monoxide etc.
- Charcoal acts by Adsorption (not by Absorption)
- Indications: Acetaminophen, aspirin, barbiturates, tricyclic antidepressants, theophylline, phenytoin, and a majority of inorganic and organic materials.
- Activated charcoal does not effectively adsorb alcohols, metals such as iron and lithium, electrolytes such as magnesium, potassium, or sodium, and acids or alkalis due to the polarity of these substances.

Universal Antidote:

It is combination of physical and chemical antidotes.

It is an obsolete antidote and had only historical importance.

Composition

1. Magnesium oxide (1 part) : Neutralizes acid without gas formation
2. Charcoal (2 parts) : Adsorbs alkaloids
3. Tannic acid (1 part) : Precipitates alkaloids.

Coma Cocktail:

Combination of 3 medicines can be given in unknown poisoning with coma.

1. Dextrose (50%) : 100 ml
2. Naloxone : 2 mg
3. B_1 (Thiamine) : 100 mg



Chelating Agents

1. BAL

- British anti-lewisite or Dimercaprol
- It is given by **deep I.M.** (5 mg/kg stat followed by 2 to 3 mg/kg every 4 to 8 hours for two days and then once a day for 10 days)
- BAL is useful against metals that interfere with sulfhydryl enzymes in the body such as **arsenic, mercury, bismuth, copper, antimony, and nickel.**
- **Contraindicated in** Liver damage, G6PD deficiency, Iron and cadmium toxicity.

2. DMSA (SUCCIMER) (Dimercapto-succinic acid)

- It is superior to EDTA in the treatment of Lead poisoning.
- It can be given in Glucose-6-PD deficiencies.
- It is less nephrotoxic.
- It is given only orally.
- It is used against **Lead, Mercury and Arsenic** poisoning.
- **A combination of DMSA and EDTA is said to be more effective.**

3. DMPS (Dimercaptopropane-sulfonate)

- It is effective in the treatment of **Lead, Mercury and Arsenic** poisoning.

4. E.D.T.A. (Ethylenediaminetetraacetic acid) (Calcium Disodium Edetate/ Versanate)

- EDTA is effective against Lead, Copper, Cobalt, Cadmium, Iron and Nickel poisoning, **but now a days it is exclusively used for Lead poisoning.**

5. PENICILLAMINE (D-penicillamine/Cuprimine)

Indications

1. Copper poisoning – Drug of choice
2. Mercury poisoning – alternative to BAL
3. Chronic lead poisoning
4. Wilson's disease
5. Cystinuria and cystine stones

6. DESFERRIOXAMINE

- Ferrioxamine is a long chain iron-containing complex obtained from an actinomycete. Chemical removal of iron from it yields desferrioxamine that has great affinity for iron.
- **Indications:** Acute iron poisoning, Transfusion siderosis.
- Desferrioxamine is also useful in treatment of toxicity with **radioactive heavy metals.**

Summary

Only Oral : DMSA (Succimer)

Only Parenteral : BAL (I.M.), EDTA (I.V.)

Both Oral + Parenteral : DMPS (I.V.), Penicillamine (I.V.), Desferrioxamine (I.M.)

1. BAL is useful against arsenic, mercury, bismuth, copper, antimony, and nickel.

2. DMSA and DMPS are effective in the treatment of Lead, Mercury and Arsenic.



3. Pencillamine is drug of choice for Copper.

4. Desferrioxamine is drug of choice in iron poisoning and used in toxicity with Radioactive heavy metals.

Diaphoretics:

- **These increases sweating.**
- The excessive sweating can be produced by application of heat
- (e.g.: Blankets, Hot water bottles and administration of hot beverages will cause increased perspiration).
- **The best diaphoretic is Pilocarpine Nitrate, 5 mg subcutaneously**
- The other diaphoretics are alcohols, salicylates and Antipyretics

Drugs and Cosmetics Rules, 1945

Classification of drugs in schedules:

- C - Biological and special products
- E - List of Poisons
- F - Vaccines and Sera
- G - Hormonal preparations
- H - drugs/poisons to be sold only on prescription of RMP
- J - Diseases for cure of which no drug should be advertised
- L - Antibodies, Antihistaminic, chemo therapeutic agents
- X - Potential drug of Abuse (Barbiturates, Sedatives, Amphetamines, etc.)



Concept 11.2 : Classification of Poisons

Learning objective: To know the basic classification of poisons depending on their action and site of action

Time needed

1 st reading	20 minutes
2 nd look	10 minutes

I. Corrosives:

A. Strong acids:

- 1. Mineral or inorganic acids:** Sulphuric, nitric, hydrochloric acids, etc.
- 2. Organic acids:** Carbolic, oxalic, acetic, salicylic acids, etc.

B. Strong alkalies:

Hydrates and carbonates of sodium, potassium and ammonia, etc.

II. Irritants:

A. Inorganic

- 1. Non-metallic:** Phosphorus, halogens
- 2. Metallic:** Arsenic, lead, mercury, copper, thallium, zinc, manganese, etc.

B. Organic

- 1. Vegetable poisons:** Castor oil, croton oil, Abrus precatorius (rati/gunja), Calotropis (akdo/madar), capsicum (mirch), Plumbago zeylinica (chitra), Plumbago rosea (lal chitra) and aloes, etc.
- 2. Animal poisons:** Snakes, insects, spiders, scorpions, cantharides, etc.

C. Mechanical: Powdered glass, chopped hair, diamond dust, etc.

III. Neurotoxic

A. Cerebral

- 1. Somniferous:** Opium and its alkaloids
- 2. Inebriants:** Alcohol, ether, chloroform, etc.
- 3. Deliriants:** Dhatura, Atropa belladonna, hyscyamus, cannabis, cocaine, etc.

B. Spinal

- 1. Excitatory:** Strychnine nux vomica
- 2. Inhibitory:** Gelsemium, etc.

C. Peripheral: Curare, conium, etc.

IV. Cardiac:

Nicotine, oleander (kaner), aconite, digitalis etc.

V. Asphyxiants:

A. Irrespirable gases: Carbon monoxide, carbon dioxide, hydrogen sulphide, cyanogen gas

B. Cyanides

VI. Miscellaneous:

Paracetamol, Tricyclic antidepressants etc.



Concept 11.3 : Corrosive Poisons

Learning objective: To know the properties, MOA, clinical features, PM findings and treatment of sulphuric acid, hydrochloric acid, nitric acid, oxalic acid, carbolic acid and alkalis.

Time needed

1 st reading	90 minutes
2 nd look	45 minutes

Sulphuric Acid (Oil of Vitriol)

- Sulphuric acid is the **strongest corrosive poison**.
- The lips are usually swollen, and excoriated and brown or black streaks may be found from the angle of the mouth to the sides of the chin, and sometimes to the front of the neck due to the flow of the acid.
- There is corrosion of mucous membranes of mouth, throat and oesophagus, burning pain, stridor and dysphagia.
- Epigastric pain soon spreads all over the abdomen and thorax.
- **Pharyngeal pain is the most common presenting symptom.**
- Eructation, nausea and vomiting occur.
- The vomit is brown or black, mucoid, strongly acid and may contain shreds of charred wall of the stomach.
- Thirst is intense, but there is vomiting on drinking water.
- Constipation is severe and there is tenesmus.
- **Circulatory collapse may cause immediate death or death may result from Asphyxia due to oedema of glottis.**
- The eyes are sunken, and pupils are usually dilated. The mind remains clear till death.
- Oedema, erythema and ulceration of the oesophagus may be followed by fibrosis with stricture formation and obstruction of the gastric outlet.

Fatal dose : 5 to 10 ml

Fatal period : 12 to 24 hours

Causes of death

1. **Circulatory collapse**
2. Spasm or oedema of glottis
3. Collapse due to perforation of stomach
4. Toxaemia
5. Delayed death may occur due to hypostatic, pneumonia, secondary infection, renal failure or starvation due to stricture of oesophagus.

Treatment:

1. **Gastric lavage or emetics are contraindicated.**
2. The acid should be immediately diluted and neutralised by giving 250 ml of water or



milk mixed with 4 t.s.f. of **calcium or magnesium oxide (antidote)**, aluminium hydroxide gel or calcined magnesia or soap water may be used.

3. **Alkaline carbonates and bicarbonates are contraindicated**, because it liberates carbon dioxide, which may cause gastric dilatation and sometimes rupture.
4. Give demulcents - olive oil, milk, egg whites, starch water, mineral oil, melted butter.
5. Prednisolone 60 mg/day may be given to prevent oesophageal stricture and for shock. Later, half an inch diameter of mercury-filled boogie should be passed daily if stricture develops.
6. Correct shock.
7. Tracheostomy - If there is oedema of the glottis.
8. Give nothing by mouth.
9. Skin burns are washed with large amount of water and a paste of magnesium oxide or sodium bicarbonate is applied.
10. Eye burns are irrigated with water or sodium bicarbonate solution for 10 to 15 minutes.
11. Symptomatic.

Post-mortem appearance

- Gross corrosion of skin with blackish or **chemical charring** of the affected area.
- Lips, angles of mouth or fingers of the hand and sometimes the chin, front of abdomen and chest show such corrosion due to **trickling** of acidulated saliva.
- Corrosion with mild to moderate degree of charring is present in the mucous membrane of the oesophagus.
- Depending upon the amount and concentration of the acid, the wall of the stomach is soft, swollen with blackish corrosion, desquamation, haemorrhage, ulceration and perforation with occasionally the whole stomach changing to blackish disintegrated mass.
- **If the victim has survived for two days or more, in many cases little or no free acid can be found in the viscera**, because the acid is converted to substances normally present in the body.

Vitriolage (Vitriol Throwing)

- Throwing of sulphuric acid or any other corrosives on another individual is known as vitriolage.
- **Most common agent used for vitriolage is sulphuric acid.**
- Sometimes, **nitric acid, carbolic acid, corrosive alkali or juice of marking nut or calotropis** is used to disfigure the face.
- Death may result from shock or toxæmia.

Nitric Acid (HNO_3): Aqua Fortis, Red spirit of Nitre

- In concentrated form, it combines with organic matter and produces a yellow discoloration of tissue due to the production of picric acid (**xanthoproteic reaction**).
- Signs and symptoms are those of poisoning by sulphuric acid.



- It causes **yellow discoloration** of the tissues.
- **It is a fuming liquid** and Inhalation of fumes causes lacrimation, photophobia, irritation of air passages and lungs producing sneezing, coughing, dyspnoea and asphyxia.

Fatal dose : 10 to 15 ml

Fatal period : 12 to 24 hours

Post-mortem appearance

- There is usually corrosion with yellowish discolouration of the skin of affected areas due to xanthoproteic reaction.
- Similar changes are noticed on the mucous membrane of mouth, tongue and oesophagus
- The stomach wall is swollen, soft with desquamation, haemorrhage and ulceration.
- Perforation is not as common as in case of sulphuric acid.
- **Xanthoproteic** reaction is not much prominent due to altered blood, which causes dark brown discolouration of the mucous membrane of the stomach.
- When there is perforation of the stomach with leakage of the acid, corrosion of the nearing organs/tissues with development of chemical peritonitis occurs.
- Upper part of the small intestine shows signs of irritation.
- In case the vapours are inhaled, there occurs congestion of the respiratory tract with congestion and oedema of the lungs. Similarly, if vomitus is inhaled same findings usually occur.

Treatment: Same as for sulphuric acid.

Hydrochloric Acid (Muriatic Acid)

- It is a **fuming liquid** and Inhalation of fumes causes lacrimation, photophobia, irritation of air passages and lungs producing sneezing, coughing, dyspnoea and asphyxia
- It causes greyish discoloration of mucous membrane, and later becomes brown or black.

Fatal dose : 15 to 20 ml

Fatal period : 18 to 36 hours

Post-mortem appearance

- Here, there may not be much corrosion of the skin. There may be damage of the skin over these areas with brownish parchmentation.
- The mucous membranes of the mouth and tongue show reddish brown corrosion. Similar changes may be seen on the inner surface of oesophagus.
- The stomach is soft, swollen with congestion, desquamation, haemorrhagic points and ulceration of the inner surface. It contains altered blood with mucous shreds.
- Perforation is uncommon.
- The upper part of the small intestine shows signs of irritation
- In case the vapours are inhaled, there occurs congestion of the respiratory tract with congestion and oedema of the lungs. Similarly, if vomitus is inhaled, same findings usually occur.



Oxalic Acid (Salt of Sorrel, Acid of Sugar)

- It has got both local as well as systemic action.
- In the form of oxalates, it exists as a natural constituent of many plants, e.g. spinach, rhubarb, cabbage etc.
- Oxalic acid resembles - Magnesium sulphate.

Signs and symptoms

- Oxalic acid does not cause much corrosion of the skin locally.
- There may be some degree of irritation and if the person survives, cuticle may fall off after a few days.
- There is a sour taste in the mouth, burning in the throat and stomach within a short time.
- Vomiting is severe and black in colour due to altered blood.
- Large doses may cause rapid death from shock.
- Where the death occurs shortly, intestinal tract may not be affected, but when life is prolonged, there is pain and tenderness over the abdomen, and purging and tenesmus may appear.
- After absorption, signs of collapse and prostration soon appear.
- Hypocalcaemia causes tingling and numbness of fingers and limbs.
- There is muscular tenderness, irritation and tetanic convulsions.
- Respiration is slow. There is bradycardia with weak, irregular pulse.
- **Ventricular fibrillation may lead to death.**
- If the patient survives hypocalcaemia, there may be toxic nephritis. In such cases, there is uraemia with scanty urination, haematuria, albuminuria, **oxaluria** (presence of calcium oxalate crystals in the urine is termed as oxaluria. These crystals have the shape of an envelope when seen under a microscope).
- Delayed poisoning by oxalic acid is characterised by —**Uraemia**.
- In fatal cases, **death usually occurs within 2 days to 2 weeks**.

Fatal dose : 15 to 20 gm.

Fatal period : 1 to 2 hours.

Treatment

1. The stomach is washed out carefully using calcium lactate or gluconate.
2. For oxalate poisoning, any preparation of calcium which converts the poison into insoluble calcium oxalate are used e.g. lime water, calcium lactate, calcium gluconate, calcium chloride, a suspension of chalk in water or milk. (Calcium gluconate 10%, 10 ml I.V. at frequent intervals).
3. 1.5 gm. of chalk will neutralise about one gram of oxalic acid.
4. **Parathyroid extract in severe cases.**
5. Demulcent drinks.
6. Dialysis or exchange transfusion for renal failure.

Post-mortem appearance

1. Stomach is reddened or eroded or almost black.
2. The stomach contents are gelatinous and brownish due to acid haematin formation.



Carbolic Acid (Phenol)

- Pure carbolic acid consists of long, colourless, prismatic, needle-like crystals, which turn pink on exposure to light.
- It has a characteristic odour, the so-called **phenolic odour**.
- It is freely soluble in boiling water, alcohol and oils.
- Crude commercial carbolic acid is a dark brown liquid containing several impurities like cresol. Household phenol contains 5% phenol in water
- It has got both local (mild) as well as systemic (profound) action.

Signs and Symptoms:

- Poisoning by carbolic acid is known as **carbolicism**.
- **On contact with skin, it** causes burning and numbness due to damage to nerve endings. Necrosis and gangrene of the tissue, which becomes green white or brown white.
- Hot burning pain extends from the mouth to the stomach followed by tingling and later anaesthesia. Nausea and vomiting in 20% of cases.
- Pulmonary and laryngeal edema develops due to irritation.
- **It is Depressant of nervous system, especially the respiratory centre.**
- Urine is scanty and green in color

Fatal dose : 1 to 2 gm.

Fatal period : 3 to 4 hrs

Causes of death

1. Syncope

2. Asphyxia due to Failure of respiration, Oedema of glottis, Complication e.g., bronchopneumonia.

Diagnosis

Ferric Chloride Test: Add a few drops of 10% ferric chloride in urine. A violet or blue colour indicates the presence of phenolic compounds.

Treatment

1. The stomach should be washed with plenty of lukewarm water containing animal charcoal, olive oil, castor oil, **magnesium or sodium sulphate** or saccharated lime with which phenol combines and forms harmless products.
2. Magnesium sulphate or medicinal liquid paraffin should be left in the stomach.

Post-mortem appearance

1. The stomach mucosal folds are swollen and covered by opaque, coagulated, grey or brown mucous membrane. The mucous membrane is thickening and looks leathery (**white Leathery appearance**).
2. Liver and spleen-show whitish, hardened patch.
3. Kidneys-show haemorrhagic nephritis (**PCT necrosis**)
4. **Phenol delays putrefaction**

The acid that is wildly used in leather & rubber industry is FORMIC ACID



Alkalis:

- Fatal dose: 10-15 g for most alkalis; 15-20 ml for Ammonia.
- **Caustic = Corrosive (not alkali)**
- Caustic Soda- Sodium Hydroxide
- Caustic Potash -Potassium Hydroxide
- Washing Soda -Sodium Carbonate
- Household Bleach-Sodium Hypochlorite
- Household Cleaning Agent- Potassium Carbonate
- Oesophagus is more severely affected than the stomach (In contrast to acids)
- Emesis, Gastric lavage, Catharsis and Activated Charcoal are absolutely contraindicated.
- Skin involvement results in greyish soapy necrotic areas without charring.
- Neutralization with acidic solutions is contraindicated because exothermic reactions can enhance the risk of perforation.



Concept 11.4 : Non-Metallic Poisons

Learning objective: To know the properties, MOA, clinical features, PM findings and treatment of phosphorus, and iodine.

Time needed

1 st reading	40 minutes
2 nd look	20 minutes

1. Phosphorus

These are of two varieties.

1. White or crystalline (On exposure to air, it becomes yellow, called Yellow Phosphorus)
2. Red or amorphous
 - Difference between white and Red Phosphorus is that red phosphorus is non-toxic where as white/yellow Phosphorus is highly toxic.
 - **Phosphorus is a protoplasmic poison.** It affects cellular metabolism comparable to ischaemia produced by embolism during life.
 - Till 1931, yellow phosphorus was being used in the manufacture of Lucifer matches.
 - **The tip of the present-day safety matches, the matchstick contains Potassium Chlorate and Antimony Sulphide whereas the side of the matchbox contains Red Phosphorous and powdered glass.**
 - **It is a powerful hepatotoxic poison as well as Nephrotoxic poison.**
 - **Breath will be garlicky in odour.** Phosphorous is luminous in nature because of phosphorescence action.
 - It ignites at room temperature giving off dense white fumes of phosphorus pentoxide.
 - Phosphorus is known as **Diwali poison**. Accidental poisoning in children may occur due to chewing of fireworks.
 - **Diwali Poisons** are:
 - Phosphorus
 - Mercury thiocyanate (small tablets when lit produce snake like appearance)
 - Antimony
 - Arsenic
 - Strontium

Signs and Symptoms

- Massive intake of phosphorus (over 1 gm) results in **fulminant poisoning**.
- The dominant clinical feature is peripheral vascular collapse.
- Death may occur in 12 to 48 hours.

Acute poisoning results from a moderate dose of phosphorus (0.1–1 gm).

- Usually, there are two phases—primary, due to local irritant action on the gastrointestinal tract and secondary, due to action of the absorbed poison.



- The primary symptoms occur usually within 2–6 hours.
- The initial features include a garlic-like taste, and burning in the mouth, throat, retrosternal area and epigastrium.
- These are followed by nausea, vomiting and sometimes diarrhoea.
- The vomitus has a garlic odour and is luminous in the dark.
- In most cases, the above symptoms abate temporarily and after a gap of 2–6 days secondary symptoms appear due to action of the absorbed poison.
- The original symptoms return, and in addition, jaundice appears.
- Abdominal pain increases and distention becomes evident.
- Vomiting becomes distressing and bleeding tendencies become prominent. Hepatic and splenic enlargement occurs.
- In early stages, liver is enlarged due to fatty degeneration (necrobiosis); in the late stages, it is shrunk due to necrosis (acute yellow atrophy).
- The patient may develop acute renal failure, oliguria and albuminuria.
- Nervous symptoms develop in the later stages, and these may include headache, restlessness, tinnitus, deafness, impaired vision, convulsion and coma.
- Priapism is frequent.
- Death usually follows hepatic and renal insufficiency.

Fatal dose : 60-120 mg.

Fatal period : 2 to 8 days.

Treatment

1. Gastric lavage using **1:5000 solution of potassium permanganate** oxidises phosphorus into phosphoric acid and phosphates, which are harmless.
2. **Antidote-copper sulphate**: it coats the particles of phosphorus with a film of copper phosphide which is relatively harmless, **this antidote is obsolete now.**
3. **Vitamin K** is useful in treatment (c.f. cyanide treatment vitamin B12 is useful).
4. **Oil and fats should be avoided**, as it increases the absorption of Phosphorous.
5. Peritoneal or haemodialysis.
6. Burns should be thoroughly washed with 1% **copper sulphate** solution in water.

Post-mortem appearances:

- In acute poisoning jaundice is produced.
- The gastric and intestinal contents may smell of garlic.
- The mucous membranes of the stomach and intestine are yellowish or greyish white in colour.
- Multiple small or large haemorrhages are seen in the skin, subcutaneous tissues, muscles serosal and mucosal surface.
- **The viscera for chemical analysis should be preserved in Sodium Chloride and not in Rectified spirit**, as the luminosity is lost.
- Phosphorous can be detected even in putrefied bodies, because **it resists putrefaction.**



2. Iodine

- It is a protoplasmic poison fixing protein and causing necrosis.

Signs and Symptoms:

- Swallowed in the solid form, it acts as acid corrosive poison.
- There is intense thirst, salivation, vomiting and lips are stained **brown**.
- Vomiting matter-dark yellow or blue in colour with peculiar odour of iodine.
- Urine-scantly, brown in colour.

Fatal dose : 2-4 gm. (30-60 ml of tincture).

Fatal period : 1 to several days.

Treatment

- Stomach wash with warm water containing soluble **starch and albumin** or 5% solution of **sodium thiosulphate** (It reduces free iodine to non- toxic Iodides).

Chronic poisoning (Iodism):

- The symptoms are pain over the frontal sinus, running nose, conjunctivitis, bronchial catarrh, salivating nausea, vomiting, purging, emaciation, wasting of breasts, testis etc. and erythematous patches of the skin, urticaria, etc. (**Ioderma**)



Concept 11.5 : Agricultural Poisoning

Learning objective: To know the properties, MOA, clinical features, PM findings and treatment of organophosphorus compounds, carbamates, organochlorine compounds Plant products, flourides, aluminium phosphide, zinc phosphide

Time needed

1 st reading	60 minutes
2 nd look	30 minutes

Classification

1.	Organophosphorous compounds:	These areir reversible cholinesterase inhibitors. Atropine and oximes are given as antidotes.
2.	Organochlorine compounds	These interfere with the nerve impulse transmission. There is no specific antidote.
3.	Carbamates	These are reversible cholinesterase inhibitors. Only Atropine is given as Antidote. (Oximes are contraindicated)
4.	Plant products	Nicotine, Rotenone, and Pyrethrine

1. Organophosphorus Compounds (OPC)

- They are derived from phosphoric acid and form two series of compounds:
 - Alkyl phosphates:** HETP, TEPP, OMPA, **Malathion** etc.
 - Aryl phosphates:** Parathion (Follidol), Methyl Parathion (Metacide), Diazinon (Tik-20), Paraoxon etc

Mechanism of Action of OPC

- Organophosphorus insecticides irreversibly inhibit acetyl cholinesterase and cause accumulation of acetyl choline at muscarinic and nicotinic synapses.

Clinical Features

- The onset of features of organophosphate poisoning **occurs most rapidly after inhalation** and least rapidly if absorbed percutaneously.
- Massive exposure can produce problem within minutes.
- An acute **garlic** odour is a characteristic feature of poisoning.

Muscarinic features (parasympathetic):

- These can be remembered using the acronym **SLUDGE**, denoting salivation, lacrimation, urination, defecation, gastrointestinal cramping and emesis.
- Bronchorrhoea and bronchoconstriction may be intense and may lead to disturbed respiratory functions.
- Miosis** is a characteristic feature but is not present in all cases.
- The cardiovascular features include hypotension and bradycardia.



Nicotinic features (somatic motor and sympathetic nerve endings):

- These features include muscle fasciculations, muscle cramps, fatigue, loss of deep tendon reflexes, paralysis.
- Tachycardia and hypertension may be there.

CNS features:

- Various neurological features include severe headache, restlessness, tremors, ataxia, generalised weakness, emotional lability, confusion, coma, seizures and depression of the cardio-respiratory centre.

Intermediary Syndrome:

- Sometimes occur 1 to 4 days after poisoning.
- There is muscle weakness and paralysis characterised by motor cranial nerve palsies, weakness of neck flexor and proximal limb muscles, and acute respiratory paresis.

Delayed Syndrome:

- Sometimes occur 1 to 4 weeks after poisoning.
- It is due to nerve demyelination and is characterised by flaccid weakness and atrophy of distal limb muscles, or spasticity or ataxia.

These syndromes do not respond to atropine or oximes.

Fatal dose : TEPP 140 mg; OMPA 175 mg; Parathion 175 mg; Malathion and diazinon 1 gm orally.

Fatal period : Within 24 hours.

Severity of Poisoning:

- Normal level of cholinesterase is 4,000 to 11,000 I.U.
- **Signs and symptoms start only when the ChE level falls below 50% of normal.**
 - **Mild Poisoning** : **20-50% of normal**
 - **Moderate Poisoning** : **10-20% of normal**
 - **Severe Poisoning** : **<10% of normal**

Diagnosis

- 1. RBC cholinesterase or True ChE:** It occurs abundantly in the nervous tissue, muscles, glands and erythrocytes.
 - If the RBC cholinesterase level is < 50% of normal, it indicates organophosphate toxicity.
 - However, false depression of RBC cholinesterase level is seen in pernicious anaemia, antimalarial treatment, haemoglobinopathies and in the blood collected in oxalate tubes.
- 2. Plasma or Pseudocholinesterase:** It is a liver acute-phase protein that circulates in the blood plasma.
 - It is found in CNS white matter, the pancreas, and the heart.
 - It can be affected by many factors, including pregnancy, infection, and medical illness.
 - Additionally, a patient's levels can vary up to 50% with repeated testing.



- Depression of plasma cholinesterase level (to < 50%) is a less reliable indicator of toxicity but is easier to assay and more commonly done.
 - Being a liver protein, plasma cholinesterase activity is depressed in cirrhosis, malnutrition, infections and neoplasia.
- 3. Motor end-plate Cholinesterase** can be demonstrated histo-chemically in the muscles kept at room temperature for 1–2 days, and up to several months in the tissues stored at 4–6° C.
- 4. Serum Levels of OP:** It is not a preferred method.

Treatment:

- Ensure the adequacy of the airways and circulation.
- **Decontamination:** After one dose of atropine, the patient may be decontaminated depending upon the route of administration/absorption.
- If **skin spillage** has occurred, it is imperative that the patient be stripped and washed thoroughly with soap and water.
- If **ocular exposure** has occurred, copious eye irrigation should be done with normal saline. If it is not available, tap water can be used.
- In case of **ingestion**, stomach wash can be done. Activated charcoal is beneficial
 1. **Atropine**, a muscarinic receptor antagonist, should be administered for muscarinic effect.
 2. Pralidoxime (2-P AM), an oxime that **reactivates cholinesterase***, is indicated for nicotinic symptoms in organophosphorus poisoning.
 3. **Diazepam** is also thought to be helpful through its central anticonvulsive properties and is effective against muscle fasciculations. It is recommended in doses of 5 mg intravenously every 10 minutes to a maximum dose of 15 mg.
 4. For the treatment of ventricular arrhythmias, **isoproterenol**, **lidocaine** may be used.

Postmortem appearances:

- Blood stained froth is seen at the mouth and nose.
- Stomach content may smell of kerosene (Due to Aromax a solvent present in pesticides).

Jamaica ginger (Jake) paralysis: Due to contamination of Ethanol with OP (Triorthocresyl Phosphate -TOCP)

2. Carbamates

- Carbamate insecticides include carbaryl, aidicard, baygon, ficam and propoxur.
- **Carbamates reversibly inhibits acetyl cholinesterase enzyme.**
- In the carbamate poisoning, the measurement of cholinesterase activity in the RBC and plasma is unreliable as the enzyme activity returns to normal within a few hours.
- Atropine is the antidote.
- Artificial respiration and gastric lavage is given.

***Pralidoxime should not be given because:** - Carbamate Oxime complex is more potent inhibitor of Cholinesterase than carbamate alone. However, oximes are considered



to offer some antidotal properties in patients exposed to aliphatic oxime carbamates (aldicarb, methomyl).

3. Organochlorine (OC) Compounds:

E.g., Endrin, Dieldrin, Aldrin, DDT, Gamaxane, BHC, Lindane, Endosulfan, Toxaphene

These interfere with the nerve impulse transmission.

There is **no specific antidote**.

Endrin

- It is a polycyclic, polychlorinated hydrocarbon.
- It is also called **plant penicillin**.
- It causes **Dilatation of pupils**.

4. Pyrethrins & Pyrethroids

- Pyrethrins are active extracts of the **Chrysanthemum** plant.
- Pyrethroids are synthetic analogues.

These are used as insect repellents and insecticides in **household sprays, mats, coils etc**

5. Flouride

- Used as rodenticide.
- Organic compounds are considered to be **Ideal homicidal poison**.
- Flouride compounds react with HCl in stomach and **form Hydrofluoric acid**, which is a corrosive.
- After absorption it binds with Ca, K & Mg and **causes hypocalcaemia**, hypokalaemia and hypomagnesaemia.
- Treatment of choice is **calcium**.

6. Aluminium Phosphide (Celphos)

- It is available as greyish green tablets of 3 gm.
- AIP when exposed to air or moisture liberates Phosphine which causes multi organ damage.
- This is known to cause oesophageal stricture.
- Each tablet of AIP liberates 1 gm. of phosphine, a systemic poison.
- It inhibits cytochrome C oxidase.
- It causes oesophageal stricture.
- Garlicky/fishy odour.
- **Liver shows centrizonal haemorrhagic necrosis.**
- **Treatment of choice is MgSO₄**. There is no specific antidote.
- Stomach wash and water is contraindicated.
- Activate charcoal and paraffin for adsorption and excretion of PH₃ respectively.

Fatal dose : 1-3 tablets

Fatal period : 1-4 hours (Majority die within 24 hours)



7. Zinc Phosphide (Rat Poison or Rodenticide)

- It reacts with acid in the stomach and liberates phosphine.
- The symptoms are vomiting, diarrhoea, cyanosis, respiratory distress, fever and death.

Fatal dose : 5 gm.

Fatal period : 24 hours.

It has a garlicky/fishy odour.

Treatment:

- Stomach wash with potassium permanganate.
- Purgatives.



Concept 11.6 : Metallic Poisons

Learning objective: To know the properties, MOA, clinical features, PM findings and treatment of arsenic, mercury, lead and copper.

Time needed

1 st reading	90 minutes
2 nd look	45 minutes

- Metals combine with –SH groups interfere with cellular respiration
- Antidotes: Chelating agents
- Additional viscera to be preserved, such as Bone, Hair, Skin, Muscle and Nails.
- Retards Putrefaction
- Resist Putrefaction

1. Arsenic

- **Commonest source of acute heavy metal poisoning and second only to Lead in Chronic Poisoning.**
- The most toxic form is **arsine gas** (Inhalation causes hemolysis).
- Metallic arsenic is not poisonous, as it is not absorbed from the alimentary canal. Poisonous compounds:
 1. Arsenious oxide or Arsenic trioxide (Sankhya or Somalkar): it is known as white arsenic.
 2. **Copper acetoarsenite (paris/emerald green):** It combines with sulphhydryl enzymes and interferes with cell metabolism.
 3. **Copper Arsenite (Schcele's green).**

Signs and Symptoms:

1. **The Fulminant type:** Large doses of arsenic can cause death in one to 3 hours from shock.
2. **The Gastro enteric type:** This is acute poisoning, resembling bacterial food poisoning or cholera. **This is the most common form.**
 - The stools are expelled frequently and involuntarily, are dark coloured, stinking and bloody, but later becomes colorless, odourless and water resembling rice water stools of cholera.

Sequence of symptoms:

1. Throat pain
2. Vomiting (Bile, Blood and Mucous)
3. Purging (Tenesmus present)
3. **Narcotic form:** G.I. symptoms are very slight. Giddiness, **Formication**, Tenderness of the muscles, delirium, coma and death.

Fatal dose : 200 to 300 mg of Arsenious Trioxide

Fatal period : 1-2 days



- The classic finding is a peripheral neuropathy
- In high-level arsenic exposures, onset of neuropathy may occur after 7 to 14 days,

Treatment

1. Freshly prepared precipitated hydrated ferric oxide is given. Dialysed Iron is substitute.
2. In arsenic poisoning BAL is an antidote.
3. DMSA or DMPS is better than BAL, if available.
4. Alkali is contraindicated.

Trait	Arsenic poisoning	Cholera
Throat pain	Before vomiting	After vomiting
Purging	After vomiting	Before vomiting
Stools	Initial dark & bloody, later rice watery	Rice watery
Tenesmus & anal irritation	Present	Absent
Voice	Normal	Rough and whistling
Conjunctivae	Inflamed	Not inflamed

Chronic poisoning:

- This is much more insidious in nature.
- The onset of symptoms usually occurs at 2–8 weeks.
- Chronic poisoning may follow acute poisoning, especially when recovery has occurred from a large dose of arsenic.

GIT symptoms:

- Usually associated with loss of weight, malaise, loss of appetite, salivation, colicky pain, constipation or sometimes diarrhoea and vomiting of glairy mucous tinged with bile.
- Tongue is usually coated with a thin, white, silvery fur.
- Circumscribed oedema of lower eyelids and ankles may be seen.

Skin symptoms

- Usually begin with a persistent erythematous flush leading to hyperkeratotic skin and desquamation.
- Pigmentation is patchy ('raindrops on a dusty road').
- Hyperkeratosis is most prominent in the distal parts of the body.
- A diffuse desquamation of the palms and soles is characteristic.
- **Mee's lines** (transverse white striae of the fingernails, technically called striate leukonychia) may also be seen.



Blood:

- Anaemia and leukopaenia are commonly seen.
- Thrombocytopaenia is also frequently seen.
- Anaemia is normocytic and normochromic and is partly caused by haemolysis.

Peripheral neuropathy:

- Sensory and motor polyneuritis (sensory symptoms usually predominate) manifesting as numbness and tingling in a 'stocking glove' distribution and distal weakness are the important features.
- Respiratory muscle involvement may also occur.

Medico-legal Importance

- Arsenic is the most popular homicidal poison.
- **Napolean Bonaparte** was killed using Arsenic poison (c.f. Socrates was killed using Hemlock poisoning).
- **Arsenic is excreted into the stomach and intestines after absorption, even when administered by channels other than mouth.** Hence, detection of arsenic in these organs does not prove that it had necessarily been given through the mouth.
- It can be detected in completely decomposed body. It can be found in bones, hair and nails for a long time.
- It can be detected in charred bone and ashes.
- It is sometimes used in abortion sticks.

Arsenophagists: People who take arsenic daily as tonic or as an aphrodisiac and they acquire a tolerance of up to 0.3 gm. or more in one dose.

Distribution of Arsenic:

- **Arsenic is rapidly cleared from blood.**
- **> 100 µg of arsenic in 24 hours urine indicates toxicity.**
- In the early stages, arsenic is found in greatest quantity in liver, followed by Kidneys and Spleen.
- **When acute arsenic poisoning is suspected, an X-ray of the abdomen may reveal ingested arsenic, which is radiopaque.**
- Urinary arsenic should be measured in 24-hour specimens collected after 48 hours of abstinence from seafood ingestion. Normal levels of total urinary arsenic excretion are less than 50 µg/dl, excretion of 100 µg or more per day is indicative of poisoning. Urine becomes positive within 6 hours of poisoning and may continue to be positive for about a couple of weeks.
- **The greatest concentration of arsenic is found in hair and nails.** Its deposition in hair may begin in 15 days after administration.

Note: It was previously thought that it took a week or two for ingested arsenic to appear in the keratinised tissues such as hair and nails, but more sensitive analytic techniques have shown that metal can appear there within hours. The appearance of the metal in these tissues, possibly, is due to its rapid excretion into sweat and sebaceous secretions and spreading into the hair and nails via surface diffusion.

- **It is found in the Muscles for days; in the bones, and in the keratin tissues – Hair, Nails and Skin for years.**



Tests for Arsenic: -

1. Reinsch Test
2. Marsh Test
3. Gutzeit Test.

2. Mercury

- Metallic or elemental mercury per se is non-toxic.
- **Mercuric chloride** or corrosive sublimate **is by far the most common cause of acute poisoning (Amongst different forms of mercury).**
- **Mercurous chloride or calomel is used as purgative as it is nontoxic for human consumption in therapeutic dose.**
- **Mercuric sulphide is used as vermilion or sindhoor.**

Acute Poisoning

- Poisoning **may occur through inhalation** while heating metal in a closed room, or following gold refining in an enclosed area.
- Symptoms include cough, dyspnoea, fever, headache, chills (metal fume fever), gastrointestinal disturbances including metallic taste and blurring of vision.
- The mouth, tongue and fauces usually become corroded and the mucous membrane appears greyish white.
- Nausea with frequent vomiting is seen.
- With development of renal damage, there occurs oliguria, albuminuria and haematuria.
- **The term 'quicksilver' has its origin in the false belief that mercury can quicken a boxer's punches.**

I.V. injection results in **Mercurialism**, characterised by

- **Thrombophlebitis**
- **Granuloma**
- **Pulmonary embolism**

Chronic poisoning (hydrargyris):

Chronic exposure to elemental Mercury give rise to a

Classical Triad:

1. **Gingivitis, Stomatitis, Salivation**
2. **Tremors and**
3. **Neuropsychiatric manifestation**

Mercuria lentis → It is due to brownish deposit of mercury on the anterior lens capsule.

Tremor → Danbury Tremor (a mild tremor which begins in the hands), Hatter's Shakes/ Glassblower's Shakes (moderate) and Concussio Mercurialis (severe form)

Erethism → **Psychiatric manifestations** - abnormal shyness, anxiety, depression, timidity, loss of confidence, irritability, emotional instability, loss of memory, insomnia and in later stages, delirium with hallucinations and manic-depressive psychosis (**mad-hatter**).

Acrodynia or Pink Disease or Swift's disease (Acro-Limbs, dynia-Pain) → pink skin rash, photophobia, swelling and paraesthesia of limbs, fever and irritability.



Minamata Bay disease → The people who had eaten fish contaminated with methyl mercury, at a place called Minamata Bay in Japan, suffered from poisoning, hence the name.

Fatal dose : 1-2 gm of mercuric chloride

Fatal period : 3 to 5 days

Treatment

1. Gastric lavage with sodium formaldehyde sulfoxylate.
2. Egg albumin, which forms an insoluble albuminate BAL.
3. Penicillamine

EDTA is contraindicated.

3. Lead (Pb)

- **Lead sulphide is least poisonous.**
- Lead tetroxide is used as vermilion or sindhoor,
- **Tetra ethyl lead was used as anti-knocking agent in petrol** (Now banned).
- Lead acetate – sugar of lead.
- Elemental lead and inorganic lead compounds are absorbed through ingestion or inhalation.
- Organic lead (tetra-ethyl lead) is absorbed to a significant degree through the skin as well.
- **The largest proportion of absorbed lead is incorporated into the skeleton, which contains >90% of the body's total lead burden.**

Mechanism of Action:

- The toxicity of lead is probably related to its affinity for cell membranes and mitochondria, as a result of which it interferes with mitochondrial oxidative phosphorylation and sodium, potassium and calcium ATPases.
- Lead depresses the enzymes responsible for haem synthesis and shortens erythrocyte lifespan leading to microcytic or normocytic hypochromic anaemia.
- Lead blocks the conversion of δ -aminolaevulinic acid to porphobilinogen by **blocking the enzyme aminolaevulinic acid dehydrase.**
- This leads to an increase in δ -aminolaevulinic acid in blood and urine.
- Lead also inhibits ferro chelatase, which results in elevated free erythrocyte protoporphyrin (FEP) levels.

Acute Poisoning:

The symptoms are metallic taste, dry throat, peripheral circulatory collapse, paraesthesia, depression, coma and death.

- **In acute poisoning, lead accumulated in liver.***

Fatal dose : Lead acetate 20 gm.; lead carbonate 40 gm.

Fatal period : 1-2 days

Treatment

- The combination of BAL and calcium disodium versenate or DMSA is effective.



Chronic poisoning (Plumbism or Saturanism)

- Chronic lead poisoning may occur in the industrial environment due to **inhalation** of lead dust or lead vapour arising from burning of paints, battery, smouldering, glass blowing and polishing, enamel factories, dye, cosmetic, etc.
- It may also occur due to low dose consumption from drinking water supplied through lead pipes, food preserved in tin containers having lead lining, food contaminated with lead in the course of preservation, etc.
- Poisoning may occur due to prolonged use of vermilion and cosmetics containing lead.
- Absorption of tetraethyl lead through skin is common in people who handle petrol or gasoline.
- Chronic poisoning results from a daily intake of one to two mg of lead.
- Chronic poisoning may also result from the mobilisation of lead already stored in the body. As long as the reaction of blood is normal, the stored lead is slowly eliminated from the bones. However, when the reaction changes (for example, in acidosis) there may be sudden mobilisation of stored lead, and symptoms of acute or chronic poisoning may develop.

Signs and Symptoms:

- In the early phase, chronic lead poisoning is manifested by facial pallor, anaemia, basophilic stippling of red cells, blue line in the gum (in about 50-70% of cases), retinal stippling and in the later phase by colic, constipation, palsy, encephalopathy, disturbance of genito-urinary and cardiovascular system.
- **The basophilic stippling of the red cells is due to condensation of iron containing ribonucleic acid near the mitochondria.** These are stained with basic dyes and hence the name.
- Lead palsy is said to be due to interference with phosphocreatinine metabolism at the muscular level.
- Lead encephalopathy may be due to inactivation of monoamine oxidase due to combination of lead with the SH radical of the enzyme. Lead osteopathy is most commonly seen between 2-5 years of age.
- Effects on Reproductive System: Chronic exposure may cause sterility in both male and female patients. In males, there may be loss of libido. In females, there may be menstrual irregularities, may be abortion due to chronic atrophy or spasmodic contraction of the uterus. **Even a healthy woman, if impregnated by a man suffering from chronic lead poisoning, is likely to abort, due to blastophoric influence of the disease upon the spermatozoa.**

Distribution:

- Lead is normally present in almost all the tissues.
- Liver, kidney and spleen among the soft tissues show the highest concentration.
- **The bones contain large amounts and also hair and nails.**

Treatment:

1. Most effective treatment of plumbism is DMSA
2. Calcium-disodium versenate



3. BAL
4. Penicillamine.

Diagnosis of chronic lead poisoning:

1. Complete blood count and peripheral smear
2. FEP (Free Erythrocyte Protoporphyrin) and ZnP (Zinc Protoporphyrin) levels ($> 50 \mu\text{g}/100 \text{ ml}$)
3. Blood lead level:
 - Permissible blood level is $35 \mu\text{g}/100\text{ml}$
 - **(Chelation therapy be considered when a child has a blood lead test result greater than or equal to $45 \mu\text{g}/100\text{ml}$).**
4. Urinary lead ($>150 \mu\text{g}/\text{litre}$) and Urinary ALA and Coproporphyrins.
5. **Punctate basophilic RBC : $> 200 \text{ cells}/\text{Cu mm}$.**

4. Copper

Acute poisoning

- Ingestion of large amounts of copper salts may cause acute poisoning.
- Symptoms usually commence within a short period.
- There is metallic taste in the mouth with salivation and thirst.
- Sensation of burning with abdominal pain; vomiting and diarrhoea usually follow.
- The stools are liquid and brown but not bloody.
- The urine is scanty and inky in appearance. It may contain albumin and casts.
- In severe cases, jaundice occurs due to both haemolysis as well as direct liver damage produced by copper sulphate.
- Renal failure may occur due to direct toxicity as well as intravascular haemolysis. Convulsions and coma usually precede death.

Treatment

- Stomach wash with solution potassium ferrocyanide which acts as an antidote by forming an insoluble cupric ferrocyanide.

Chronic poisoning

- It can result from occupational exposure to copper fumes (during refining or welding) or to copper-containing dust, which causes 'metal-fume fever' with upper respiratory tract symptoms, headache, fever and myalgia.
- **Vineyard sprayer's lung disease:** Chronic inhalation of copper sulphate spray used as an insecticide in vineyards can cause this condition, characterised by a histocytic granulomatous lung.
- Chronic copper poisoning resembles Wilson's disease (Hepatolenticular Degeneration).

Fatal dose : Copper Subacetate 15 gm. Copper Sulphate- 30 gm.

Fatal period : 1-3 days

Treatment : N-penicillamine, EDTA, BAL.



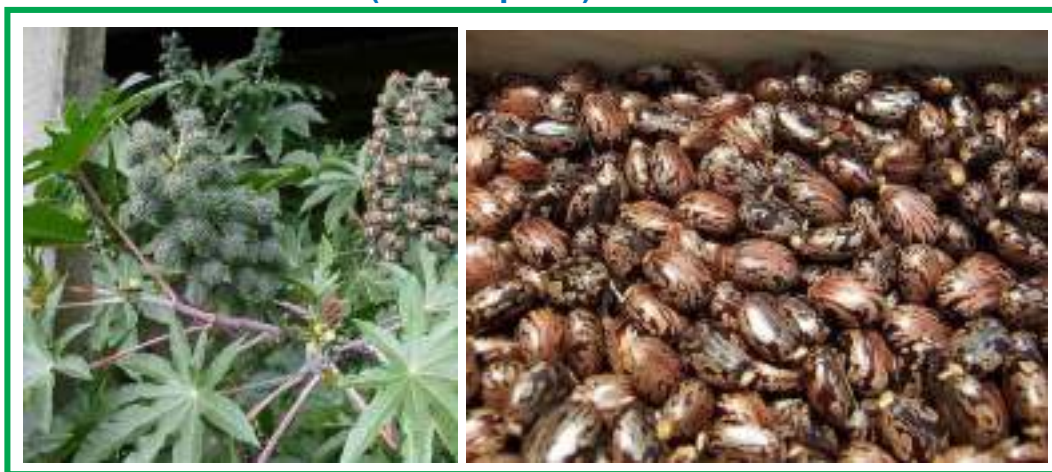
Concept 11.7 : Irritant Plant Poisons

Learning objective: To identify and to know the plant irritants such as castor, croton, abrus, calotropis, capsicum, semecarpus and plumbago.

Time needed

1 st reading	60 minutes
2 nd look	30 minutes

1. Ricinus Communis (Castor plant)



- The castor plant (arandi*) grows all over India.
- Entire plant is poisonous (seeds are most poisonous), containing a toxalbumen **RICIN**, a water-soluble glycoprotein and a powerful allergen (CBA).
- **Ricin is a biological warfare agent. ***
- A **toxalbumen or phytotoxin** is a toxic protein, which resembles a bacterial toxin in action and causes agglutination of red cells with some **haemolysis** and is antigenic in nature.
- The castor **oil does not contain ricin**; it is a drastic purgative.
- **Ricin is excreted by the intestinal epithelium.**

Signs and Symptoms:

Poisoning doesn't take place when the seeds are swallowed but only when it is crushed. Symptoms include salivation, bloody diarrhoea, impaired sight, delirium, convulsions, uraemia and jaundice

- Fatal dose : 10 seeds; Ricin: 1 mg/Kg body weight (Oral), 50-100mcg (Injection).
- Fatal period : Two to five days.
- Treatment : Gastric lavage, demulcents.

2. Croton Tiglium (Jamalghota or Naepala)



- Croton tiglium (Jamalghota or naepala) seeds contain **crotin**, a toxalbumen.
- Both press cake and **oil (extremely toxic) contain crotin**.
- **Signs and Symptoms:** There is hot burning pain from mouth to stomach, salivation, vomiting, purging, vertigo, prostration, collapse and death.
- Fatal dose: 4-5 seeds; 1-2 ml of oil.
- Fatal period: 6 hours to 3 days.
- Treatment: Stomach wash and demulcents.

3. Abrus Precatorius

(Ratti, Gunja, Rosary bead, Jequirity, Indian Liquorice)



- It is also known as Jequirity or Indian liquorice (gunchi or **rati**).
- The seeds are egg-shaped, bright scarlet colour with a large black spot at one end. *
- The seeds contain an active principle **abrin**, a toxalbumen, which is **similar to viperine snake venom**; also contain Abrine, Abralin, Abric acid.
- All parts of the plant are poisonous.
- Used as a **cattle poison** by making Needles (**Suis**)*.

Signs and Symptoms

- After ingestion, symptoms include abdominal pain, diarrhoea, weakness, cold perspiration, trembling of the hands, weak rapid pulse and rectal bleeding.



- When an extract of seeds is injected under the skin of the animal, inflammation, oedema, oozing of haemorrhagic fluid from the site of puncture with necrosis. The animal drops down after 3 to 4 days. **Symptoms resemble viperine snake bite.**
- Fatal Dose: 90 to 120 mg. by injection, 10 gm. orally.
- Fatal Period: 3 to 5 days.
 - **Treatment:** Injection of anti-abrin. The needle should be dissected out.
 - **Poisoning:** The seeds are used for killing cattle. Small sharp-pointed spikes or 'suis' are prepared which are then dried in the sun.

4. ERGOT



- Ergot is the dried sclerotinum of the fungus *Claviceps purpurea*, which grows on cereals like rye, barley, wheat, oats, etc.
- It contains alkaloids, ergotoxin, ergotamine, and ergometrine.
- **St. Anthony's fire:** Consumption of Rye bread contaminated with Ergot causing Burning sensation in extremities, Convulsions and Delirium.

Signs and Symptoms

- In acute cases, there is nausea, vomiting, diarrhoea, giddiness, tightness in the chest, difficulty in breathing.
- There may be tingling and numbness in the hands and feet, paraesthesia, followed by twitching or cramps in the muscles.
- **Bleeding from nose and other mucous surface is common.**

Chronic Poisoning (Ergotism)

- There is tingling and numbness of the skin, vasomotor disturbances leading to dry gangrene of the fingers, toes, ears, nose etc.
- There is a sensation of insects creeping under the skin (tactile hallucination). This is also known as Formication.
- Neurologic disorder characterised by hallucinations, ataxia, and sometimes convulsions.

Fatal dose : 1-2 gm.

Fatal period : One to several days.

Treatment : Wash the stomach and give purgatives. Vasodilators, e.g., nitrites are useful.

5. Calotropis (Madar plant)



- The juice produces an acrid bitter taste, salivation, dilated pupils, titanic convulsions, collapse and death.
- Active principles: Calotropin, Calotoxin, Uscharin, Gigantin

Medico-legal Importance:

1. Used as an abortifacient (The juice is taken by mouth or introduced into uterus on an abortion stick).
2. Occasionally used to produce **artificial bruises**.
3. Used to produce artificial conjunctivitis.
4. Used for Vitriolage.
5. Cattle poison
6. Sometimes as an arrow poison
7. The roots of calotropis procera plant are even poisonous to cobra.

6. Capsicum Annum



- Capsicum or chillies (mirchi) have a pungent odour and taste and are used as a condiment.
- The active principles are capsaicin and capsin.
- It acts as an irritant poison.



- “Hunan hand” is a contact dermatitis resulting from the direct handling of chili peppers containing capsaicin.
- On cut-section of the seeds of capsicum, the embryo appears like the Capsicum seeds resembles Datura seeds.

Differentiating Features of Chilli Seeds and Dhatara Seeds

Features	Chilli seeds	Dhatara seeds
Size	Smaller	Bigger
Colour	Yellow	Rather brown
Appearance	Rather round in shape and smooth	Kidney shaped, finely pitted and reticulated
Smell	Pungent	Odourless
Taste	Pungent	Bitter
Border	Convex border with single edge	Convex border with double edge
On section	Embryo embedded in fleshy albumin and curved inwards (Figure of ‘6’)	Embryo embedded in white oily albumin and curved outwards

7. Semecarpus Anacardium (Marking Nut)



- Markings nuts (bhilawa) are black, heart-shaped with rough projections at the base.
- Their pericarp contains an irritant juice which is brownish, oily and acrid but turns black on exposure to air.
- The active principles are semecarpol and bhilawanol.

Signs and Symptoms

- **The lesion resembles a bruise.**
- The juice, when applied externally causes irritation and a painful blister, which contains acrid serum.
- Colour of Artificial Bruise is Dark Brown.

Fatal dose : 5 to 10 gm.

Fatal period : 12 to 24 hours.

**Medico-legal Importances:**

1. Used to produce artificial bruises.
2. Used to produce artificial conjunctivitis.
3. Used as an abortifacient.
4. Used for vitriolage.

Differentiating Features of Artificial and True Bruise

Features	Artificial bruise	True bruise
Cause	Chemical	Trauma
Situation	Accessible parts	Anywhere
Appearance	Blister formation	No blister formation
Fingers	May show marks due to scratching	Not so
Itching	Present	Not so
Colour changes	Nil	Characteristic
Contents	Acrid serum	Extravasated blood
Analysis	Chemical detectable in the blister fluid	Not so

8. Plumbago Rosea and Plumbago Zyelanica

- Active principle is Plumbagin
 - Used as an abortifacient
 - **Used to produce artificial bruises**
- *Jatropha oil is used as Biodiesel**



Concept 11.8 : Irritant Animal Poisons

Learning objective: To know the Classification, features, clinical features and treatment of snake bite poisoning, poisoning by scorpion sting and cantharides.

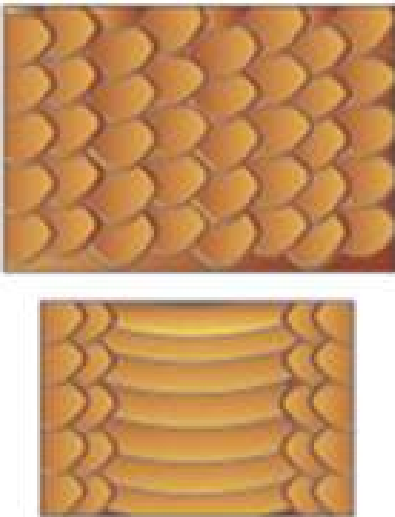
Time needed

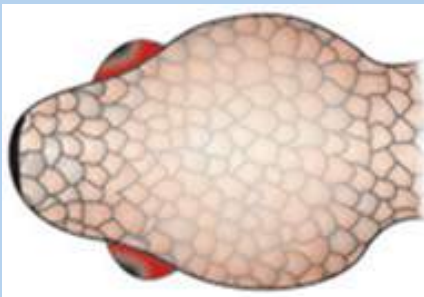
1 st reading	90 minutes
2 nd look	45 minutes

1. Snakes

Sl. No.	Family	Toxicity	Examples
1	Elapidae	Neurotoxic	Common Cobra, Common Krait
2	Viperidae	Haemotoxic	Russell's viper & Saw-scaled viper
3	Crotalidae	Haemotoxic	Rattle snake, Pit viper
4	Hydrophidae	Myotoxic	Sea Snakes
5	Colubridae	Nontoxic	Bird Snake, Boom slang, Checkered keelback

Differentiating Features of Poisonous and Non-Poisonous Snakes

Trait	Poisonous	Non-poisonous
Belly scales	Cover the entire breadth 	Does not cover the entire breadth 

Head scales	Small 	Large 
Teeth	2 long fangs 	Multiple small teeth 
Tail	Compressed 	Not much compressed 
Habits	Nocturnal	Not so



Five Snakes which are Dangerously Poisonous to Man in India:

1. King cobra (*Ophiophagus hanna*)



2. Common Cobra (*Naja Naja*)



3. Common krait (*Bangarus caeruleus*)



Image credit: Wikimedia Commons/Jayendra Chiplunkar

4. Russell's viper (*Russelia Viperi*)



5. Saw-scaled viper (*Echis carinatus*)



- **The most common poisonous snake is common krait in India*.**
 - *Bangarus fasciatus* is scientific name of Banded Krait.





Clinical Manifestations

- **The most common manifestation (symptom)** following snake bite (poisonous or non-poisonous) is **fright**.

Elapids

- Local symptoms start within 6 to 8 minutes.
- They produce minimum local effects, which may be in the form of swelling, blistering and superficial necrosis.
- However, elapid venoms are best known for their neurotoxic effects.
- Early symptoms usually include vomiting, hypersalivation, headache, heaviness of the eyelids, blurred vision, paraesthesiae around the mouth, hyperacusis, dizziness, vertigo and 'gooseflesh'.
- Paralysis is first detectable as **ptosis and external ophthalmoplegia** appearing as early as a few minutes after the bite, but sometimes may be delayed for some hours.
- Later, the face, palate, jaws, tongue, neck muscles and muscles of deglutition may become paralysed.
- Respiratory failure may be precipitated by airway obstruction at this stage or later after paralysis of intercostal muscles and diaphragm.
- Coma sets in and finally the respiration stops with or without convulsions and the heart stops.
- Neurotoxic effects are completely reversible either in response to antivenom or anticholinesterases, or they may wear-off spontaneously in about a week.
- 'Spitting' by Elapids may produce venom ophthalmia. There occurs intense pain in the eye, blepharospasm, palpebral oedema and leucorrhoea. Rarely, venom is absorbed into anterior chamber causing hypopyon and anterior uveitis.

Vipers

- When venom is injected, the spot develops severe pain within 8 minutes and the onset of swelling starts within 15 minutes.
- Persistent bleeding from the bite site is a constant feature.
- Blisters appear in about 12 hours and involve the entire limb.
- Tingling and numbness over the tongue and mouth or scalp and paraesthesia around the wound occur.
- In severe cases, the main feature is persisting shock.
- Bleeding time and clotting time are increased.
- A haemorrhagic syndrome with blood stained sputum, haemorrhages from gums, rectum, the site of the bite etc. occur due to increased coagulation time.
- Intravascular haemolysis may lead to haemoglobinuria and renal failure.
- Convulsions are not seen.
- Death is usually due to shock and haemorrhage.

Sea-snakes

- Persons bitten by sea snakes usually complain of headache, a thick feeling of the tongue, thirst, sweating and vomiting.
- Generalised aching, stiffness and tenderness of the muscles may follow.
- **Trismus is common.**



- Later, there is generalised flaccid paralysis as in elapid neurotoxicity.
- Myoglobinuria appears usually after some hours of the bite.
- Myoglobin and potassium released from damaged skeletal muscles can cause renal failure, while hyperkalaemia may precipitate cardiac arrest.

Fatal dose:

- Cobra 12 mg., Russell's viper 15 mg., Echis 8 mg., and Krait 6 mg. of dried venom.

Fatal period:

- Cobra half to six hours; viper one to two days.

Treatment

- Reassurance
- Immobilize the affected area (Use a splint)
- Wash the area with soap and water.
- Non-sedating, non-salicylate analgesic –paracetamol is best
- Do NOT allow the person to become over-exerted.
- Do NOT apply a tourniquet.
- Do NOT apply cold compresses to a snake bite.
- Do NOT cut into a snake bite with a knife or razor.
- Do NOT try to suck out the venom by mouth.
- Poly valent Anti snake venom: It is effective against 4 snakes namely
 1. Common cobra
 2. Russel's viper
 3. Saw scaled viper
 4. Common Krait
- **Useful only when given within 4 hours of bite, less value if delayed for 8 hours and is of doubtful value after 24 hours. ***
- **Dose:** Begin with 10 vials. If a total of 25-20 vials have been administered without much improvement, further antivenom therapy is unlikely to be helpful and must be stopped. Dose of antivenom is the same for children and is not contraindicated in pregnancy.

2. Scorpion Sting:



- The venom usually carries hemotoxic and neurotoxic actions.
- It is a potent autonomic stimulator resulting in the release of massive amounts of catecholamines from the adrenal glands and nerve endings into the circulation.
- It also has some direct effect on the myocardium. Both these actions result in cardiac arrhythmias, hypertension and systolic dysfunction.
- Later, due to depletion of catecholamines, hypotension, bradycardia, etc. occur.
- The red scorpion is more venomous than black scorpion.
- The toxicity is more than that of snakes; but only small dose is injected.

Symptoms and Signs

- Local irritation is characterised by redness and burning pain radiating from the site. In most cases, the pain grows within a few hours of being stung.
- The victim may not be able to localise the pain due to its radiation along the dermatomes involved.
- However, the presence of local swelling and a punctated haemorrhagic spot may help in localising the site of the sting.
- There may be headache, giddiness, nausea, profuse perspiration, chest discomfort, paraesthesia, hypersalivation, cold extremities and sometimes, priapism.
- Hypertension may occur within 6 hours of sting, while pulmonary oedema takes longer time.
- Later, features suggestive of myocarditis may develop.
- Neurologic manifestations may persist for up to a week or so.
- While the mortality in adults is negligible, children may succumb from pulmonary oedema

Treatment

- Stings of nonlethal species require at most ice packs, analgesics or antihistamines.
- **Antivenin therapy** can reduce or eliminate mortality from more severe envenomation.
- Keeping the patient calm and applying pressure dressings and cold packs to the sting site decreases the absorption of venom.

3. Cantharides





- Spanish fly (blister beetle) is used externally as an irritant and is commonly popular as an Aphrodisiac.
- **The active principle is cantharidin.**
- The Indian fly (beetle) contains about 3% cantharidin.
- It gives rise to Priapism and Strangury.
- Cantharidin is readily absorbed from all surfaces including the skin.
- Fatal Dose: 15 to 50 mg of cantharidin, or 1.5 gm of powdered cantharides.
- Fatal Period: 24 to 36 hours.



Concept 11.9 : Alcohol

Learning objective: To know the properties, symptomatology, diagnostic tests of alcohol poisoning, Widmark's formula and law in relation to drunken driving.

Time needed

1 st reading	30 minutes
2 nd look	15 minutes

- 20% of alcohol is absorbed from the stomach and 80% from the intestine.
- The maximum concentration in blood is reached in within 45-90 minutes.
- Absorption is most rapid at concentrations of 10-20%
- 90% of alcohol is metabolised in Liver; and remaining is excreted through breath (5%) and urine (5%).
- Rate of fall in BAC is 15 mg% /hour, Ethyl Alcohol follows Zero order Kinetics.
- Tryptophan metabolism is disrupted in Chronic Alcoholism.
- Absolute Alcohol -> 99.5% Alcohol
- Rectified Spirit -> 90% Alcohol
- Denatured Alcohol -> 95% Alcohol+5% wood naphtha
- 100 Proof ethanol -> 50% Ethanol
- Relative concentration of Alcohol at equilibrium:
 - Blood : Urine -> 1 : 1.33 Blood : Alveolar air -> 1: 0.0021 of alveolar air

Symptomatology

1. Stage of excitement (50-150 mg %)
 - Alcohol gaze nystagmus
 - Jerking movement in the direction of gaze. Independent of position of head.
 - **Average level of 80 mg%** (40 - 100mg %) cause Alcohol gaze Nystagmus.
 - Term 'under the influence' of alcohol is used when blood concentration is 80-100mg%.
2. Stage of Incoordination (150-300 mg %) - Drunk or Intoxicated
 - **Critical level of alcohol is above 150 mg% or 0.15g%.**
3. Stage of Coma (>300 mg %)
 - Above 400 mg% it may be Fatal.

Widmark's Formula

To know the amount of alcohol consumed by the blood level concentration of alcohol or vice versa

- It considers size, sex and type of alcoholic liquor consumed.
- It was given by Swedish Toxicologist Eric Matteo Prochet Widmark **a = cpr**
a – Weight of alcohol in g.



c – Blood alcohol concentration in mg/kg

p – Body weight in Kg

r – constant and its value is

0.68 - male

0.55 - female

For Urine analysis the formula is $a = \frac{3}{4} prq$, q is alcohol concentration in urine in mg/kg.

Legal Limit prescribed by Indian Motor Vehicle act is 30 mg% of Blood Alcohol Level (BAL)

Tests for Estimation Of Alcohol

- Macro Method: - **Hine and Kozelka method** (Color/Spot Test)
- Micro Method: **Cavett's Test**
- Chemical methods: Based on principle of Reduction of **Potassium-dichromate**
- Breath analyser test is based on Henry's Gas law; The residual alcohol in mouth takes about 20 min to disappear and within this period breath analyser test may be false positive
- **Gas Chromatography**: - Most desirable method for medico legal purpose.

Punishment for driving under the influence of Alcohol or drugs as per Sec.185 of Indian Motor Vehicle Act:

First offence: Up to 6 months of imprisonment or fine up to Rs.2000 or both

Subsequent offence within 3 years of previous commission: Up to 2 years of imprisonment or Fine up to Rs.3000 or both



Concept 11.10 : Opium

Learning objective: To identify the opium plant and to know the properties, MOA, clinical features, PM findings and treatment of opium poisoning and heroin.

Time needed

1 st reading	30 minutes
2 nd look	15 minutes



- Opium (**Afim**) is also known as Kasoomba or Madak or Chandu.
- Opium is the dried juice obtained from the poppy (papaver somniferous).
- It is a somniferous poison (Reduces pain and induce sleep)
- Opium contains two chemically different groups of alkaloids, namely:
 1. **Phenanthrenes** (Narcotic)
 - **Morphine 10%**
 - **Codeine 0.5%**
 - **Thebaine 0.3% (can cause convulsions)**
 2. **Isoquinolines** (Non-narcotic)
 - **Papaverine 10%**
 - **Narcotine 6%**
- The artificial derivatives are heroin (Di-acetyl morphine) and dihydromorphine.
- Opiates exert their effects because of their chemical similarity to natural substances called **endorphins**.
- Opioid drugs can produce euphoria and both psychological and physical addiction.
- The pupils are contracted to pinpoint size and do not react to light, but in late stage they may be found to be **dilated**.

Fatal dose : opium 2 gm.; morphine 0.2 g

Fatal period : 6-12 hours



Treatment:

1. The preferred, more definitive treatment for the typical overdose is the narcotic antagonist **naloxone** I.V.
2. Stomach wash with a solution **of 1:500 potassium permanganate** (High concentration). Stomach wash should be given, even if the drug is taken parenterally, because the alkaloid is re excreted in the stomach after absorption.
3. Atropine is not recommended as it can cause death by paralyzing the motor and sensory nerves like morphine.
4. N-allyl normorphine (lethidrone or nalorphine), levorphanol and amiphenazole is no more recommended.
5. **Nalmefene** is one of the latest treatments for opium Poisoning; it has got longer duration of effect.
6. When coma is deep-artificial respiration and oxygen is given.

Postmortem appearance:

- Signs of asphyxia are prominent. Froth is seen at the mouth and nostrils.
- The brain, meninges and abdominal organs are congested.
- Postmortem hypostasis: Black coloured.

Chronic poisoning (Morphinism; morphinomania):

- Opium addicts can tolerate 3 to 6 gm. per day.
- The habitual use first causes a pleasurable feeling of relief and well-being, but as larger doses are taken there is disinterest and recurring periods of depression follow.
- Loss of memory, mental fatigue, and gradual intellectual, and moral deterioration occur.

Withdrawal symptoms of opioids tend to be opposite to the acute effects of the drug.

Treatment: Gradual withdrawal of the drug.

Methadone 30-40 mg. daily, to be tapered off gradually.

Propranolol to relieve craving and anxiety.

HEROIN (Diacetyl Morphine):

- Also known as: **Smack, Brown sugar, Junk, Dope.**
- It's a synthetic form of opium.
- It is white in colour.
- **"Cold turkey"**: Abrupt cessation of a substance dependence and the resulting unpleasant experience,
- **"Cutting In"**: Term used for adulteration of heroin.
- **Substances used for adulterations:** Quinidine Mannitol, Fructose, Talc, Chalk powder.
- **Speed ball: Heroin + Cocaine**
- **Hot shot: Heroin + Strychnine**



Concept 11.11 : Sedatives and Hypnotics

Learning objective: To know the properties, clinical features, PM findings and treatment of barbiturates and criminal uses of chloral hydrate.

Time needed

1 st reading	10 minutes
2 nd look	5 minutes

1. Barbiturates:

- It gives rise to golden urine (because of oliguria and concentrated urine)
- Barbiturate blisters may be seen on the dependent parts of skin (another poison is CO) in about 6% of cases.
- **Barbiturate Automatism**-May gives rise to accidental overdose
- Intravenous Thiopentone is used as **Truth Serum** in narcoanalysis.
- **Treatment:** Gastric lavage (can be given up to 8-24 hours post-ingestion).
Forced alkaline diuresis.
Haemodialysis, Exchange transfusion, Charcoal hemoperfusion.
- **Post-mortem appearances:** Symmetrical necrosis of globus pallidus and corpus callosum in delayed deaths.

2. Chloral Hydrate (Dry Wine)

- It may be given in food or drink to render a person suddenly helpless for the purpose of robbery.
- Because its action is so rapid, it is named as "**knockout drops**".
- **Micky Finn: Alcohol + Chloral hydrate.**

Concept 11.12 : Deliriant Poisons

Learning objective: To identify and to know the properties, MOA, clinical features, PM findings and treatment of datura, cannabis and cocaine.

Time needed

1 st reading	40 minutes
2 nd look	20 minutes

1. Datura Fastuosa



- There are two varieties:
 1. Datura alba-white flowered plant.
 2. Datura Niger - a deep purple flowered plant.
- The fruits are spherical and have sharp spines (thorn- apple).
- They contain 0.2 to 1.4% of **hyoscine (scopolamine), hyoscyamine and traces of atropine**.
- Scopolamine is used as Truth Serum for Narco-analysis.

Signs and symptoms:

All the important signs and symptoms and datura starts with Letter 'D'

1. Dryness of mouth and throat
2. Dysphagia.
3. Dysarthria
4. Dry and hot skin (hyperpyrexia 103°F body temperature).
5. Diplopia.
6. Dilated pupils.
7. Dilated blood vessels resulting in flushing of face.
8. Delirium:
 - **Muttering delirium** is present. Irrelevant talking.
 - Pill rolling movement (also seen in Parkinsonism).



9. Drunken gait.
10. Drowsiness.
11. Death due to respiratory failure.

Cornpicker's pupil: Unilateral dilatation of pupil due to pollen*.

Fatal dose : 1 gm. (100-125 seeds)

Fatal period : 24 hours

Treatment

- i. Stomach wash with potassium permanganate and weak solution of tannic acid.
- ii. Physostigmine is specific antidote in Datura poisoning.
- iii. Pilocarpine nitrate, Neostigmine can also be given as antidote

Mydriatic test: The pupil dilates within half an hour, if Datura is present.

2. Cannabis Sativa or Indica



- It is also known as Indian hemp.
- The principal constituent of resin of marijuana is Tetra Hydro cannabinol (THC). It is a CNS stimulant.
- It is used in the following forms:
 1. Ganja (Marijuana, Marihuana, Mary Jane, Pot, Weed, Grass, Reefer, **PURPLE HAZE**): Prepared from the flower tops* of female plant (15-25% of THC)
 2. Bhang: it is prepared from the dried leaves and fruit shoots (leaves*). It is mildest and contains 15% of THC.
 3. Majun: it is a sweet prepared with bhang.
 4. Charas or hashish (Most potent): it is the resin exuding from the leaves and stems of the plant. It contains 25-40% of active principle.

Hashish oil is most potent of all cannabis preparations and contains up to 60% of THC

Signs and Symptoms-Large doses cause:

1. **Inebriation:** the person becomes dreamy or semi-conscious and he has realistic vision, usually of sexual nature e.g. he sees nude beautiful women dancing before him, playing music. It causes psychological high, raises heart rate, and delays psychomotor skills.



2. **Narcosis:** there is giddiness and ataxia, tingling and numbness of the skin, general anaesthesia.

Fatal dose : Charas 2 gm.; Ganja 8 gm.; THC 30mg./Kg.

Fatal period : Several days.

No specific antidote.

3. Cocaine

Also known as Coke, Snow, Cadillac, WHITE LADY etc.

- Obtained from leaves of *Erythroxylum coca*.



- Used as a local anaesthetic, as a vaso constrictor.
- The usual route of intake is snorting and skin popping.
- It is an **Aphrodisiac**.
- **Crack is smokable form of cocaine; Baking soda is added to cocaine.**

Signs and Symptoms:

1. **Stage of excitement:** there is bitter taste, dryness of mouth, loss of depression and fatigue, **RAISED temperature and hypertension (like amphetamine)**. The hypertension may give rise to **cerebral bleeding**.
2. **Stage of depression:** within an hour, respirations become feeble, **profuse perspiration**, collapse, convulsions and death.

Fatal dose: 1 gm. orally.

- Procaine is half, butacaine is twice and dibucaine 5-10 times as toxic as cocaine

Fatal period: Few minutes to few hours.

Antidote: Amyl Nitrite.



Concept 11.13 : Spinal Poisons

Learning objective: To know the identification, properties, MOA, clinical features, PM findings and treatment of strychnos nux vomica

Time needed

1 st reading	20 minutes
2 nd look	10 minutes

Strychnos Nux Vomica (Kuchila)



- It is a spinal excitatory poison.
- Strychnine is a powerful alkaloid obtained from the seeds of the strychnos nux vomica.
- The seeds contain the alkaloids- strychnine, brucine and loganine.
- Strychnine poisoning resembles Tetanus.
- The action is particularly noted in Anterior horn cells (Renshaw cells), at post-synaptic receptor sites by inhibiting the inhibitory transmitter Glycine, resulting in reflex excitation.
- In strychnine poisoning convulsions affect all muscles at a time.
- The mouth is covered with froth, frequently blood stained.

Test done for Strychnine Poisoning

1. Wenzell's Test (Confuser~Wetzel's Test is done for CO poisoning)
2. Sonnenschein's Test.

Fatal dose : 30-100 mg; one crushed seed.

Fatal period : 1-2 hrs.

Treatment

- i. Short acting barbiturates
- ii. Diazepam
- iii. Stomach wash with potassium permanganate.
- iv. Acidification of urine enhances excretion of strychnine.

**Postmortem appearance:**

- Rigor mortis appears early and passes off quickly.
- Postmortem caloricity is seen.

Difference Between Strychnine Poisoning and Tetanus

Trait	Strychnine poisoning	Tetanus
History	Of poisoning	Of injury
Fever	Not usual	Usual
Onset	Rapid	Comparatively delayed
Convulsions	Generalised and affect all muscles; chest fixed during convulsions	Starts usually with face, lockjaw being an early manifestation; chest not fixed during convulsion
State in between convulsion	Complete relaxation in between the seizures	Relaxation between the spasms is never complete
Fatality	Usually in a few hours	Death rare in a few hours and may be delayed for several days
Laboratory investigation	Chemical analysis reveals the poison	Microbiological test positive



Concept 11.14 : Peripheral Nerve Poisons

Learning objective: To identify the plant and to know the clinical features of curare and conium.

Time needed

1 st reading	15 minutes
2 nd look	8 minutes

1. Curare



- It is found in various species of Strychnos.
- Active principle is **Curarine and curine**.
- Action is at myoneural junction by blocking the post synaptic nicotinic acetylcholine receptors in muscle causing flaccid paralysis of skeletal muscles.
- **Used as an arrow poison.**
- Antidote: Atropine, followed by Neostigmine.
- It is not poisonous when swallowed.
- Cause of Death due to Asphyxia because of paralysis of Muscles.

2. Conium Musculatum (Hemlock)





- Active principle is Coniline.
- Conium maculatum is also known as Hemlock, contains mainly coniline and other 7 alkaloids.
- It causes burning in mouth and throat, vomiting, diarrhoea, slow respiration, increased and later slow pulse, mental confusion, tremors, ataxia, sometimes blindness, progressive motor paralysis extending upwards from the extremities, coma and **death from respiratory paralysis.**
- **Socrates** was executed by the administration of Hemlock. **It has got mousy odour.**



Concept 11.15 : Cardiac Poisons

Learning objective: To identify the plants of tobacco, digitalis, pink & yellow oleander, cerbera thevetia and aconite.

Time needed

1 st reading	30 minutes
2 nd look	15 minutes

1. Nicotiana tabacum



Active principles: Nicotine, Anabasine (equally toxic), and nornicotine (less toxic)

May give rise to **toxic amblyopia**.

Mecamylamine (Inversine) is a specific antidote given orally.

2. Digitalis purpurea



May give rise to **Xanthopsia (Yellow vision)**

3. Nerium odorum (white/pink oleander)



4. Cerbera Thevetia (Yellow oleander)



5. Cerbera odallam (Suicide tree)



The **fruit** resembles unripe mango.



6. Quinine.

7. Aconite (Sweet Poison/Meetha Zehar)



Signs and symptoms:

- **Tingling and numbness in the mouth** and later all over the body
- **Salivation**, dysphagia,
- Profuse sweating, subnormal temperature,
- **Hypotension**,
- Initial tachycardia followed by bradycardia.
- Alternate dilatation and contraction of pupil, called **HIPPUS***.
- It is one of the commonly used homicidal poison (Like Arsenic)



Concept 11.16 : Asphyxiants Sedatives and Hypnotics

Learning objective: To know the properties, MOA, clinical features, PM findings and treatment of cyanide, CO, hydrogen sulphide and war gases

Time needed

1 st reading	40 minutes
2 nd look	20 minutes

1. Hydrocyanic Acid

- It occurs as gas (Hydrogen cyanide), liquid (Hydrocyanic acid or prussic acid) and salts (sodium/potassium/silver cyanide)
- It gives bitter almond smell but **20-40% of human population cannot perceive the smell**, which is inherited as sex linked recessive trait.
- **Cyanosis is a late feature.**
- It is also called prussic acid or cyanogen.
- Amygdaline is the glucoside of vegetable origin found in cyanides. Amygdalin is acted upon by Emulsin to produce Hydrocyanic acid.
- More than 5% carboxyhaemoglobin is seen in cyanide poisoning. Cyanide inhibits the action of: **Cytochrome oxidase** and **Carbonic anhydrase**.
- It kills by creating histotoxic or cytotoxic anoxia.
- Massive doses may produce sudden loss of consciousness and prompt death from respiratory arrest.
- **People suffering from Achlorhydria may not suffer** from toxic effect of oral ingestion of potassium cyanide.
- The mouth is covered with foam which is sometimes blood stained.
- **Death occurs from respiratory failure.**

Fatal dose : 50-100mg of prussic acid, **100-200mg of salt**

Fatal period : 2- 10 minutes.

Treatment

- Amyl nitrite is used by inhalation.
- Sodium nitrite is given I.V.
- Sodium thiosulphate in 50% solution I.V. converts cyanide to non-toxic thiocyanates.
- 4-dimethylaminophenol
- Alpha-ketoglutaric acid
- Methylene blue is NOT an antidote
- Dicobalt edetate.
- Para-Amino Propiophenone (PAPP)
- Hydroxocobalamin (Vitamin B₁₂ precursor)

P.M appearance: The blood is **brick -red** due to formation of cyanmethaemoglobin



2. Carbon Monoxide

- Upper limit of safety of carbon monoxide in air is 0.01%.
- Car exhaust: 4-7% CO
- Domestic gas: 7-15% CO
- Non-smokers may have up to 5% of carboxyHb and smokers up to 10%
- **It Block : Cytochrome - A3 Oxidase and P450**
- **Hb has got 200-300times more affinity for CO than O2.**
- Minimum carboxyHb required to produce cherry red discoloration is 30%.
- At 40% concentration, commonest symptom is muscular weakness.
- 40-50% COHb produces symptoms like alcoholic intoxication.
- 50%-60% produces syncope or coma with intermittent convulsions, and is potentially **Lethal.**
- **Death: Due to Anaemic anoxia/chemical asphyxia.**

Tests done for CO poisoning:

- Kunkel's Test (Tannic Acid Test)
- Wetzel's Test
- Hoppe-Seyler's Test.
- Spectroscopic examination.

P.M appearance

- A **cherry- red** coloration of the skin, mucous membranes and areas of hypostasis,
- Fine froth may be seen at mouth and nose.
- Blood remains fluid without clotting.
- **Bilateral symmetrical necrosis of the lenticular nuclei and punctiform haemorrhages in the white matter of brain**

3. Hydrogen Sulphide

- Sewer gas contain **H₂S, CO₂ and Methane.**
- **Amyl nitrite (Also for cyanide & cocaine)** and Sodium nitrites are given as antidotes.

4. War Gases

- Vesicants:** Mustard gas, lewisite,
- Asphyxiants:** chlorine, phosgene,
- Tear gases:** chloracetophenone (CAP), ethylchloroacetate (K,S,K.) bromobenzyl cyanide (B.B.C),
- Nerve gases:** They are compounds related to phosphate esters in action and toxicity.
- Sternutators:** Gases which causes nasal irritation, e.g., Diphenylamine chlorarsine (**sickening gas**)
- Paralysants:** Hydrocyanic acid, CO, Sulphuretted hydrogen.
- Nerve gases:** Sarin, soman, tabun

Concept 11.17 : Food Poisoning

Learning objective: To know about the MOA, clinical features & treatment of botulism, to identify Lathyrus sativus & argemone Mexicana and its clinical features, MOA of sweet clover disease and fish poisoning.

Time needed

1 st reading	40 minutes
2 nd look	20 minutes

Food Borne Botulism:

- This is usually caused in humans by types A, B, E and rarely F.
- Botulism is intoxication, not an infection.
- The causative organism **Cl. Botulinum multiplies in the food** before it is consumed and produces a powerful exotoxin under suitable anaerobic conditions.
- **The fatal dose for an adult is 0.01 mg or even less.**
- Only the food contaminated with Type A or B toxin, give rise to putrefied smell or taste but it may taste and appear normal if contaminated by E toxin.
- The toxin paralyses the nerve ending, by blocking the nerve impulses at the myoneural junctions. It blocks the action of Acetyl Choline. Its action is selective being confined to the cholinergic fibres of the autonomic nervous system.
- Botulinum toxin is used for treatment of Blepharospasm, Risus Sardonius and Strabismus.

Signs and Symptoms

- The incubation period is 12 to 30 hrs.
- There is nausea, vomiting, constipation, ocular paresis, **ptosis**, thirst, pharyngeal paralysis, salivation, sometimes aphonia.
- Excessive fatigue, diplopia, marked muscular weakness.
- The patient is conscious till death, which is preceded by coma or delirium.
- Bulbar palsy and descending paralysis are seen.

Differential diagnosis: Tetanus, Epilepsy, Acute gastroenteritis, Encephalitis, Multiple sclerosis, GB syndrome, Diphtheria, CO poisoning, OP poisoning and elapid snake bite.

Treatment: Botulinum Antitoxin (Types A, B and E).

Lathyrus Sativus (Kesari Dhal)





- Consumption exceeding 30% of the total diet for more than 6 months; produces lathyrism.
- The active neurotoxic principle is Beta (N)-oxalyl amino alanine-**BOAA**.
- The continuous use of sativus produces Neurolathyrism, characterised by progressive **spastic paraplegia/quadriplegia**; sphincters sensation and mental faculties are preserved.

Argemone Mexicana (Yellow Poppy)



- The oil contains two alkaloids:
 - **Sanguinarine**, and
 - **Dihydro sanguinarine**.
- This is adulterated with mustard oil and on consumption causes **epidemic dropsy**.
- **Hyper secretory glaucoma*** is seen in epidemic dropsy.
- Convulsions are not seen in Epidemic Dropsy.

Sweet Clover Disease:



The coumarin present in the sweet clover is converted into Vit. K antagonist dicoumarol, giving rise to haemorrhagic disease.



Fish Poisoning (Ichthyotoxicosis)

Ciguatera fish poisoning:

- Caused by eating reef fish, which produces ciguatoxin which alters the Na⁺ permeability giving rise **to reversal of hot/cold temperature perception**.

Gymnothorax poisoning:

- By eating Moray eels, giving rise to **prominent abdominal breathing & absent thoracic breathing**.

Scombroid food poisoning:

- Caused by eating spoiled fish.
- The histidine is converted into histamine **giving rise to Allergic Reaction**



Concept 11.18 : Psychotropin Substances

Learning objective: To know some of psychedelics and rave party drugs.

Time needed

1 st reading	10 minutes
2 nd look	5 minutes

Psychedelics (Hallucinogens):

The important hallucinogenic drugs are **LSD**, **Cannabis**, **Mescaline (from the peyote cactus)**, **MAGIC MUSHROOMS** (contain psilocybin and psilocin), **Phencyclidine**.

LSD give rise to 'Flashback phenomenon' and 'Bad Trip'.

Rave Party/Designer Drugs:

- **ECSTACY:** MDMA (Methylenedioxymethamphetamine)
- **LOVE DRUG:** MDA (Methylenedioxyamphetamine)
- **EVE:** MDEA (Methylenedioxyethamphetamine)
- **DATE RAPE DRUGS:** Gama Hydroxy Butyric Acid (GHBA),
Flunitrazepam (Rohypnol)
Alcohol, ketamine



APPENDIX

1. Specific Antidotes For Poisons

Poison	Specific antidotes
Arsenic	Hydrated Ferric Oxide, DMSA, DMPS, BAL
Amanita phalloids	Benzyl Penicillin
Amanita muscaria (Fly agaric)	Atropine (Controversial)
Benzodiazepines	Flumazenil
Botulism	Guanidine
Cadmium	N-Acetyl Penicillamine
Carbon Monoxide	Hyperbaric Oxygen, Tocopherol (Vit. E)
Copper	Potassium ferrocyanide, Penicillamine
Cyanide	Amyl Nitrite Na Nitrite Na Thiosulphate Para-Amino-Propiophenone (4-PAPP) Dicobalt edetate (Kelocyanor) Vitamin B12 (Hydroxy cobalamine) 4-Dimethyl Amino Phenol (4-DAMP) Alpha-ketoglutaric acid
Coumarin Derivatives	Phytomenadione (Vitamin K1)
Datura	Physostigmine
Ethylene Glycol	4-Methyl Pyrazole (fomipazole), Ethyl Alcohol, Pyridoxine
Ergot	Sodium Nitroprusside
Heparin	Protamine Sulphate
H ₂ S	Ethyl Alcohol
Isoniazid	Pyridoxine
Iodine	Sodium Thiosulphate, Starch
Iron	Desferrioxamine
Lead	DMSA, DMPS, EDTA, BAL
Mercury	Sodium formaldehyde sulfoxylate, Penicillamine, BAL
Methemoglobinaemia (Nitrites)	Toluidine Blue
Methanol	4-Methyl Pyrozole (fomipazole), Ethyl Alcohol



OP	Atropine, Oximes
Opiates	Naloxone
Oxalic Acid, Fluorides	Calcium salts
Paracetamol	N-Acetyl cysteine (Mucomyst), Methionine
Phosphorus	Copper sulfate / KMNO ₄
Thallium	Prussian Blue (Potassium Hexa Cyanoferrate)

2. Chemical Antidotes

Antidote	Poison	Action
Common salt	Silver nitrate	Forms silver chloride
Albumin	Mercury chloride	Precipitates
Dialyzed iron	Arsenic	Neutralizes
Copper sulphate	Phosphorous	Precipitates
Tannic acid	Alkaloids	Precipitates
Alkalis	Acids	Neutralizes
Acids	Alkalis	Neutralizes

3. Hemodialysis

Haemodialysis is useful in **Chloral hydrate, Paraldehyde, Quinine, Strychnine** and the poisons listed below (**BLAST-EID**):

B	Barbiturates, Bromides, Boric Acid
L	Lithium
A	Alcohol (Ethanol, Methanol), Amphetamine
S	Salicylates
T	Theophylline, Thiocyanates
E	Ethylene glycol
I	Isoniazid
D	Depakote, Digitalis



Hemodialysis is Not useful in	Hemoperfusion is Useful in	Peritoneal dialysis effectively removes
• Kerosene • Benzodiazepines • OP • Digitalis • Heroin • Chloroquine • Copper sulphate	• Chloramphenicol • Disopyramide • Hypnotic sedatives [Barbiturates] • Ethchlorvynol • Glutethimide • Meprobamate, Methaqualone • Phenytoin • Procainamide • Theophylline	• Alcohol • Long acting barbiturates • Chloral hydrate • Lithium • Salicylates • Sodium Chlorate

5. Taste of Poisons:

Taste	Poison
Bitter	Datura, strychnine
Burning	Acids
Acrid	Calotropis
Sweet	Aconite
Sour	Oxalic acid
Metallic	Copper, iodine
Sweet burning	Carbolic acid
Caustic	Alkali

6. Diagnostic Odour

Odour	Drug/ poison
Garlicky	Arsenic, P, OP, Thallium, Selenium, Tellurium
Bitter almond	Cyanide, Prussic Acid
Burnt rope	Cannabis
Fishy/musty	ZnP, AlP (Garlicky also)
Rotten egg	H ₂ S, Disulfiram, Carbon disulphide, NAC
Shoe polish	Nitrobenzene
Acetone (Apple like)	Chloroform, Ethanol, Isopropanol
Acrid (Pear like)	Chloral hydrate, Paraldehyde (C > P)
Wintergreen	Methyl salicylates
Moth balls	Camphor, Naphthalene



Hospital odour	Carbolic acid
Carrot/Mousy	Hemlock (Conium)
Sewer Gas smell	H ₂ S
Kerosene	Organophosphates

7. Coloration of Mucous Membrane of Stomach

Green	Ferrous sulphate
Blue	Amytal
Pink	Soneryl
Slate	Mercury
Black	Sulphuric acid, Acetic acid,
Grey	Hydrochloric acid, Oxalic acid (blackened by blood)
Yellow/Dark brown	Nitric acid
Buffed white/Greyish white	Carbolic acid
Grey white	Caustic alkalis
Blue/Green	Copper
Brown	Iodine, Cresols (Leathery)
Yellow	Phosphorus

8. Effects of Poisons on Kidney

Poisons causing PCT necrosis	Poisons imparting color to urine	Poisons producing albuminuria
Lysol, Phenol, Mercury, Cadmium (Important poisons) Others: CCl ₄ , Oxalic acid, Ethylene glycol, Lead, Arsenic, Gold, Mushrooms, Antibiotics (gentamycin, sulphonamides, cephalosporin), Anesthetic agents (halothane, methoxyflurane), Barbiturates, Salicylates, X-Ray contrast material.	Green: Phenol, Cresol Orange: Rifampicin Phenothiazines, Santonin Yellow: Dinitrophenol, Arsine Pink: Aniline, Eosin, Mercury Purple: Porphyrins Brown: Nitric Acid Brown to black: Thymol, Naphthalene Red: Phenolphthalein, Mephensin Blue: Methylene blue	Arsenic Mercury Chromate Phenol Thallium



9. Poison and Eye

Eye changes	Poison
Corneal deposit	Amodiaquine
Xanthopsia	Aconite
Ptosis	Thallium, Gelsemium, Botulinum toxin, Elapids
Hippus	Aconite
Deposition in lens	Mercury
Complete/partial blindness	Methyl alcohol, Arsenic, Chloroquine, Ergot, Lead, Mercury, Tobacco
Corneal stippling	Chloroquine
Retinal stippling	Lead, Chloroquine, Phenothiazines
Papilledema	Lead, Vitamin A toxicity
Altered colour perception	Carbon monoxide, Cannabis, LSD, Digitalis

10. Effect of Poison on Pupil

Miosis	Mydriasis	Fixation of pupils	Nystagmus:
Barbiturates, Benzodiazepines Carbamates Caffeine, Carbolic acid Nicotine Opiates Organophosphate	Alcohol Amphetamines, Antihistamines Cocaine, CO, Cyanide Datura Ephedrine	Anesthetic agents Reserpine Rauwolfia alkaloids	Alcohol Barbiturates Carbamazepine Phencyclidine Phenytoin

11. Poisons Producing Temperature Changes

Hypothermia	Hyperthermia
Opiates Alcohol Carbon monoxide Barbiturate	Strychnine Cocaine Datura Curare

12. Common Radio-Opaque Poisons:

CCl₄, Chloral hydrate, Enteric coated tablets, Heavy metals, Iodides, Iron, Phenothiazines, Salicylates



14. Diagnostic Tests in Toxicology

Ferric chloride Test	Phenol, salicylates, phenothiazines, oxyphenbutazone, phenyl butazone
Dichromate Test, Hine and Kozelka Test and Cavette's Tet	Ethanol
Silver Nitrate Test	ZnP, ALP
Marquis Test, Denige's Test, Husemann's Test	Opium
Lee Jones Test	Cyanide, Salicylates
Reinsch Test	Arsenic, Bismuth, Mercury, Antimony
Reinsch, Marsh's & Gutzeit Test	Arsenic
Kunkel's Test (Tannic Acid Test), Wetzel's Test, Hoppe-Seyler's Test.	CO
Tensilon/Edrophonium challenge Test	Inject Edrophonium through I.V., If paralysis due to Myasthenia : Recovery, Botulism : No recovery
Wenzell's Test, Sonnenschein's Test.	Strychnine

15. Active Principles in the Poisonous Plants

Plant	Active Principles
Abrus Precatorius	Abrin (Toxalbumen), Abrine (Amino acid), Abralin (glucoside), Abric Acid
Croton Tiglium:	Crotin (Toxalbumen), Crotonoside (glycoside)
Ricinus Communis	Ricin
Calotropis	Calotropin Calotoxin Calactin Uscharin, Gigantin , trypsin in milky juice
Semicarpus Anacardium	Semicarpol, Bhilawanol
Capsicum	Capsaicin, Capsicin
Ergot	Ergotamine, Ergotoxine, Ergometrine
Datura	Hyoscine, Hyoscyamine, Traces of Atropine
Cannabis	δ Tetra Hydro Cannabinol (THC)
Cocaine	Ecgonine, Hygrine, Cinnamyl cocaine
Strychnos nux vomica	Strychnine (More potent), Brucine, Loganin
Curare	Curarine, Curine
Conium (Hemlock)	Coniline, Methylconiline
Digitalis	Digitoxin, Digoxin, Digitalin, Digitonin
Nicotine	Nicotine, Anabasine (equally toxic), nornicotine
Cerbera Thevetia	Thevetin, Thevetoxin, Nerifolin
Nerium Odorum	Oleandrin, Nerin , Folinerin, Rosagenin



Aconite	Aconitine, Aconine, Bikhacanitine, Picraconitine, Pseudoaconitine, Mesaconitine, Jesaconitine etc.
Cerbera Odallam:	Cerberin, Cerberoside, Odollin, Odolotoxin, Thevetin, Cerapain

16. Poisons and Disease

Poison	Condition
Zinc (By melting metals)	Metal Fume Fever (Aka, Monday fever, Foundry fever, Brass chills, Brazier disease, Smelter shakes. Symptoms: Fever + chills + malaise
Flouropolymers (By melting Flouropolymers)	Polymer Fume Fever (Meat Wrapper's Asthma) Symptoms: Fever + chills + malaise + wheezing
Manganese	Parkinsonism like symptoms Angurugu syndrome (Neurological disease characterised by upper motor neuron, cerebellar signs, and oculomotor symptoms) Manganese Madness (Speech disorders, hallucinations and compulsive behaviour).
Nickel	Lung Cancer
Cobalt	Cardiomyopathy (Beer drinker's heart)
Cadmium	Ouch Ouch Disease (Proteinuria and painful bony lesions)
Alcohol	Holiday heart syndrome
Copper sulphate	Vineyard sprayer's lung disease

17. Poisons that Mimick Natural Disease

Poisons	Disease
1. Arsenic	Cholera, Fading Measles, Addison's Disease
2. Strychnine	Tetanus
3. Zinc	Malarial Chills
4. Thallium	Natural death, GB syndrome, Porphyria
5. Di-nitro compounds	Thyrotoxicosis
6. Organophosphates	Bronchial Asthma
7. Bromides, Iodides	Acne
8. Iodine	Mumps
9. Mercury	Diphtheritic colitis
10. Manganese	Parkinsonism
11. Oxalic acid, Ethylene glycol	Tetany
12. Phosphorous	Hepatic failure
13. Aconite	Myocardial infarction

1. Sections of Indian Penal Code

- 34 → Acts done by several persons in furtherance of common intention
- 44 → Injury
- 45 → Life (The word "life" denotes the life of a human being, unless the contrary appears from the context)
- 46 → Death (The word "death" denotes the death of a human being, unless the contrary appears from the context)
- 51 → Oath and solemn affirmation
- 54 → Commutation of sentence of death
- 55 → Commutation of sentence of imprisonment for life
- 82 → < 7 years: Not liable for criminal act
- 83 → 7-12 years: May/may not be liable for criminal act (Depending on mental maturity)
- 84 → Criminal responsibility of a mentally ill person
- 85 → Involuntary intoxication: Not liable for criminal act
- 86 → Voluntary intoxication: Liable for criminal act
- 87 → > 18 years, can give consent for surgical procedure
- 88 → Act done by consent in good faith for person's benefit
- 89 → < 12 years – Parent/guardian can give consent
- 90 → Defines invalid consent (Consent is invalid when given - under fear or misconception or under intoxication or by a mentally ill person or a child < 12 years)
- 92 → Consent in emergency
- 166B → Punishment for non-treatment of victim of rape/acid attack
- 172 → Absconding to avoid service of summons
- 174 → Non- attendance for summons
- 176 → Omission to give information to public servant
- 177 → Furnishing false information
- 178 → Refusing oath or affirmation
- 191 → Giving false evidence (Perjury) - Definition
- 192 → Fabricating false evidence – Definition
- 193 → Punishment for Sec. 191, 192 and 197 IPC
- 197 → Issuing or signing false certificate – Definition
- 198 → Using as true a certificate knowing to be false
- 201 → Causing disappearance of evidence
- 204 → Destruction of document or electronic record to prevent its production as evidence



- 228A → Punishment for disclosure of identity of rape victim
- 269 → Negligent act likely to spread infection of disease dangerous to life
- 270 → Malignant act likely to spread infection of disease dangerous to life
- 271 → disobedience to quarantine rule
- 272 → Adulteration of food or drink intended for sale
- 273 → Sale of noxious food or drink
- 274 → Adulteration of drugs
- 275 → Sale of adulterated drugs
- 276 → Sale of drug as a different drug or preparation
- 277 → Fouling water of public spring or reservoir
- 284 → Negligent conduct with respect to poisonous substance
- 290 → Punishment for public nuisance (Frotteurism, Exhibitionism)
- 294 → Obscene acts and songs (Exhibitionism)
- 297 → Trespassing on burial places/ wounding the feelings or religion of any person/ indignity to any human corpse (Necrophilia & Necrophagia)
- 299 → Culpable homicide - Definition
- 300 → Murder – Definition
- 301 → Culpable homicide by causing death of person other than person whose death was intended
- 302 → Punishment for murder
- 304 → Punishment for culpable homicide not amounting to murder
- 304A → Causing death by negligence
- 304B → Dowry Death
- 306 → Abetment of suicide
- 307 → Attempt to murder
- 308 → Attempt to commit culpable homicide
- 309 → Attempt to commit suicide
- 312 → Causing miscarriage (with consent)
- 313 → Causing miscarriage without woman's consent
- 314 → Death of mother caused due to miscarriage
- 315 → Preventing child being born alive or to cause it to die after birth
- 316 → Causing death of quick unborn child by act amounting to culpable homicide
- 317 → Exposure & abandonment of child under 12 years, by parent or person having care of it
- 318 → Concealment of birth by secret disposal of dead body
- 319 → Hurt
- 320 → Grievous Hurt
- 324 → Voluntarily causing hurt by dangerous weapons or means
- 326 → Voluntarily causing grievous hurt by dangerous weapons or means
- 326A → Voluntarily causing grievous hurt by use of acid, etc.
- 326B → Voluntarily throwing or attempting to throw acid, etc.
- 334 → Voluntarily causing hurt on provocation



- 335 → Voluntarily causing grievous hurt on provocation
- 336 → Act endangering life or personal safety of others
- 337 → Causing hurt by an act endangering life or personal safety of others
- 338 → Causing grievous hurt by an act endangering life or personal safety of others
- 342 → Punishment for wrongful confinement
- 351 → Assault – Definition
- 352 → Punishment for assault
- 354 → Indecent assault (Outraging the modesty of a female)
- 354A → Sexual harassment
- 354B → Disrobe
- 354C → Voyeurism
- 354D → Stalking
- 361 → Kidnapping from lawful guardianship (Any minor under 16 years male, or under 18 years female or any person of unsound mind)
- 362 → Abduction—Whoever by force compels, or by any deceitful means induces, any Person to go from any place, is said to abduct that person
- 363 → Punishment for kidnapping
- 366 → Kidnapping, abducting or inducing woman to compel her marriage, etc.
- 366A → Procurement of minor girl (< 18 years) for illicit intercourse
- 366B → Importation of girl (< 21 years) from foreign country for illicit intercourse
- 369 → Kidnapping or abducting child under ten years with intent to steal from its person
- 375 → Rape: Definition
- 376 → Punishment for rape
- 377 → Unnatural sexual offences
- 379 → Punishment for theft
- 380 → Punishment in dwelling house, etc.
- 392 → Punishment for robbery
- 395 → Punishment for dacoity (5 or more persons)
- 497 → Adultery (Not a criminal offence)
- 498A → Dowry harassment
- 509 → Word, gesture or act intended to insult the modesty of a woman (Frotteurism, exhibitionism)

2. Sections of Criminal Procedure Code (CRPC)

- 39 → Duty to give information
- 53(1) → Examination of an accused (on arrest) by M.O.
- 53(2) → Examination of female accused by lady M.O.
- 53 A → Examination of accused of rape by M.O. (Protocol)
- 54 → Examination of an accused on his request
- 61–69 → Summons
- 164A → Examination of the victim of Rape (Protocol)
- 174 → Police inquest



- 176 → Magistrate inquest
327(2) → In camera trial
357C → All hospitals should provide first-aid or medical treatment free of cost to the victims of Rape & Acid attack and shall immediately inform the police
416 → If a woman sentenced to death is found to be pregnant, the High Court shall commute the sentence to imprisonment for life

3. Indian Evidence Act (IEA)

Sec.3 : Evidence

Sec.32 (1): Dying declaration

Sec.45 : Expert Witness

Sec.154 : Hostile Witness

4. Indian Contract Act

Sec. 13 → Consent

5. PNDT and PCPNDT Act

A national law, **the Pre-natal Diagnostic Techniques (Regulation and Prevention of Misuse) Act (PNDT Act), 1994** was enacted to prevent sex determination and came into force on January 1st, 1996. However, this law was never implemented. In the meantime new techniques had been developed that used pre-conception or during-conception sex selection. To bring these new technologies under the purview of the Act and to ensure rigorous implementation, the law was amended in 2003 and is renamed the **Pre-conception and Pre-natal Diagnostic Techniques (Prohibition of Sex Selection) Act (PCPNDT Act)**, (effective from February 14, 2003).

- 1. Pre-natal diagnostic techniques can be conducted only for the purposes of detection of any of the following abnormalities, namely:**
 - i. Chromosomal abnormalities;
 - ii. Genetic metabolic diseases;
 - iii. Haemoglobinopathies;
 - iv. Sex-linked genetic diseases;
 - v. Congenital anomalies;
 - vi. Any other abnormalities or diseases as may be specified by the Central Supervisory Board;
- 2. Pre-natal diagnostic techniques can be used or conducted when the person qualified to do so is satisfied that any of the following conditions are fulfilled, namely:**
 - i. Age of the pregnant woman is **above thirty-five years**;
 - ii. The pregnant woman has undergone of **two or more spontaneous abortions or foetal loss**;
 - iii. The pregnant woman had been **exposed to potentially teratogenic agents** such as drugs, radiation, infection or chemicals;
 - iv. The pregnant woman has a **family history of mental retardation or physical deformities** such as spasticity or any other genetic disease;
 - v. Any other condition as may be specified by the Central Supervisory Board;



3. Punishment for violation of the act:

For a doctor or medical person who misuses these techniques for sex selection:

First offence: 3 years imprisonment and fine up to Rs.10,000 and Suspension of Registration by the Medical Council for 5 years.

Subsequent offence: 5 years imprisonment and fine up to Rs.50,000 and Permanent removal of Registration by the Medical Council.

Persons seeking to know the sex of the fetus:

First offence: 3 years imprisonment and/or fine Rs.50,000

Subsequent offence: 5 years imprisonment and/or fine Rs.1,00,000.

(The pregnant woman herself is considered innocent under the Act, unless and until proved otherwise. It is presumed that she will have been compelled to undergo sex determination tests by her husband and relatives)

Persons connected with advertising of sex selection/ sex determination services:

3 years imprisonment and/or a fine of Rs 10,000 with additional fine for continuing contravention at the rate of Rs.500 per day.

- **Offence to be cognizable, non-bailable and non-compoundable.**
- **No court other than that of a Metropolitan Magistrate or a Judicial Magistrate of the first class shall try any offence punishable under this Act.**
- **Only doctors qualified under the Act (MD in Medicine, Gynaecologists, Paediatricians and Medical Geneticist) can conduct these diagnostic techniques including ultrasonography.**

6. The Transplantation of Human Organs Act, 1994, Transplantation of Human Organs (Amendment) Act 2011

An Act to provide for the regulation of removal, storage and transplantation of **human organs and tissues** for therapeutic purposes and for the prevention of commercial dealings in human organs and for matters connected therewith or incidental thereto.

1. Brain-stem death should be certified by a Board of medical experts consisting of the following namely:
 - (i) The registered medical practitioner (**RMP**) in charge of the hospital in which brain-stem death has occurred;
 - (ii) An **independent RMP**, being a specialist, to be nominated by RMP specified in clause (i)
 - (iii) A **neurologist or a neurosurgeon** to be nominated by the RMP specified in clause (i)
 - (iv) The **RMP treating** the person whose brain-stem death has occurred.

Note: Where a neurologist or a neurosurgeon is not available, the RMP may nominate an independent RMP, being a surgeon or a physician and an anaesthetist or intensivist subject to the condition that they are not members of the transplantation team for the recipient concerned.

2. In the case of a dead body lying in a hospital or prison and not claimed by any of the near relatives of the deceased person **within 48 hours** from the time of the death of the person concerned, the authority for the removal of any human organ from the



dead body which so remains unclaimed may be given.

3. Organs and tissues can be donated by **Near relative**, means spouse, son, daughter, father, mother, brother, sister, grandfather, grandmother, grandson or granddaughter
4. Tissue means a group of cells, **except blood**, performing a particular function in the human body.
5. No human organs or tissues or both shall be removed from the body of **a minor and mentally challenged** person before his death for the purpose of transplantation.
6. No court other than that of a Metropolitan Magistrate or a Judicial Magistrate of the first class shall try any offence punishable under this Act.
7. **Punishment for removal of human organ without authority:**
 - Imprisonment for a term which may extend to **10 years** and with fine which may extend to **Rs.20,00,000**.
 - **Removal of the name** of the medical practitioner from the register of the Council for a period of **3 years for the first offence and permanently for the subsequent offence**.
8. **Punishment for commercial dealings in human organs:**
 - Imprisonment for a term which shall not be less than 5 years but which may extend to 10 years and shall be liable to fine which shall not be less than Rs.20,00,000 but may extend to Rs.1,00,00,000.

7. The Dowry Prohibition Act, 1961 (Last amendment in 1986)

Penalty for giving or taking dowry:

- Imprisonment for a term which **shall not be less than 5 years**, and with fine which shall not be less than **Rs.15,000** or the amount of the value of such dowry, whichever is more.

Penalty for demanding dowry:

- Imprisonment for a term which shall not be less than 6 months*, but which may extend to 2 years and with fine which may extend to Rs.10000.

*Court may, for a adequate and special reasons to be mentioned in the judgment, impose a sentence of imprisonment for a term of less than six months.

8. The Protection of Children from Sexual Offences (POCSO) Act, 2012

A. Penetrative Sexual Assault:

A person is said to commit "penetrative sexual assault" if-

- (a) he penetrates his penis to any extent into the vagina, mouth, urethra or anus of a child or makes the child to do so with him or any other person; or
- (b) he inserts, to any extent, any object or a part of the body, not being the penis, into the vagina, the urethra or anus of the child or makes the child to do so with him or any other person; or
- (c) he manipulates any part of the body of the child so as to cause penetration into the vagina, the urethra or the anus or any part of body of the child or makes the child to do so with him or any other person; or
- (d) he applies his mouth to the penis, vagina, anus, urethra of the child or makes the child to do so to such person or any other person.



Punishment: Minimum 10 years to life imprisonment + fine.

If the age of the child is < 16 years: Minimum 20 years to life imprisonment (which shall mean imprisonment for the remainder of natural life of that person)

B. Aggravated Penetrative Sexual Assault:

It means Penetrative sexual assault (PSA) on a child

- a) By a police officer; or
- b) By a member of the armed forces or security forces; or
- c) By a public servant; or
- d) By the management or on the staff of a jail, remand home, protection home, observation home, or other place of custody or care and protection established by or under any law for the time being in force on the inmate of such place; or
- e) By management or staff of a hospital, whether government or private in that hospital; or
- f) By management or staff of an educational institution or religious institution in that institution; or
- g) By more than one person (gang penetrative sexual assault); or
- h) By using deadly weapons, fire, heated substance or corrosive substance; or
- i) Causing grievous hurt or causing bodily harm and injury or injury to the sexual organs of the child; or
- j) Which - (i) physically incapacitates the child or causes the child to become mentally ill or causes impairment of any kind so as to render the child unable to perform regular tasks, temporarily or permanently; (ii) in the case of female child, makes the child pregnant as a consequence of sexual assault; (iii) inflicts the child with HIV or any other life threatening disease or infection which may either temporarily or permanently impair the child by rendering him physically incapacitated, or mentally ill to perform regular tasks; (iv) causes death of the child; or
- k) Whoever, taking advantage of a child's mental or physical disability, commits penetrative sexual assault on the child; or
- l) Whoever commits penetrative sexual assault on the child more than once or repeatedly; or
- m) Whoever commits penetrative sexual assault on a child below 12 years; or
- n) Whoever being a relative of the child through blood or adoption or marriage or guardianship or in foster care or having a domestic relationship with the parent of the child or who is living in the same or shared household with the child, commits penetrative sexual assault on such child; or
- o) Whoever being, in the ownership, or management, or staff, of any institution providing services to the child, commits PSA on the child; or
- p) Whoever being in a position of trust or authority of a child commits PSA on the child in an institution or home of the child or anywhere else; or
- q) Whoever commits PSA on a child knowing the child is pregnant; or
- r) Whoever commits PSA on a child and attempts to murder the child; or
- s) Whoever commits PSA on a child in the course of communal or sectarian violence or during any natural calamity or in similar situations; or
- t) Whoever commits PSA on a child and who has been previously convicted of having committed any offence under this Act or any sexual offence punishable under any



other law for the time being in force; or

- u) Whoever commits PSA on a child and makes the child to strip or parade naked in public, is said to commit aggravated penetrative sexual assault.

Punishment: Minimum 20 years to life imprisonment (which shall mean imprisonment for the remainder of natural life of that person) + Fine or with death

C. Sexual Assault

- Whoever, with sexual intent touches the vagina, penis, anus or breast of the child or makes the child touch the vagina, penis, anus or breast of such person or any other person, or does any other act with sexual intent which involves physical contact without penetration is said to commit sexual assault.

Punishment: Minimum 3 years of imprisonment which may extend to 5 years + Fine

D. Aggravated Sexual Assault:

It means sexual assault (SA) on a child

- a) By a police officer; or
- b) By a member of the armed forces or security forces; or
- c) By a public servant; or
- d) By the management or on the staff of a jail, remand home, protection home, observation home, or other place of custody or care and protection established by or under any law for the time being in force on the inmate of such place; or
- e) By management or staff of a hospital, whether govt. or private in that hospital; or
- f) By management or staff of an educational institution or religious institution in that institution; or
- g) By more than one person (gang penetrative sexual assault); or
- h) By using deadly weapons, fire, heated substance or corrosive substance; or
- i) Causing grievous hurt or causing bodily harm and injury or injury to the sexual organs of the child; or
- j) Which - (i) physically incapacitates the child or causes the child to become mentally ill or causes impairment of any kind so as to render the child unable to perform regular tasks, temporarily or permanently; (ii) inflicts the child with HIV or any other life threatening disease or infection which may either temporarily or permanently impair the child by rendering him physically incapacitated, or mentally ill to perform regular tasks; or
- k) Whoever, taking advantage of a child's mental or physical disability, commits sexual assault on the child; or
- l) Whoever commits sexual assault on the child more than once or repeatedly; or
- m) Whoever commits sexual assault on a child below 12 years; or
- n) Whoever being a relative of the child through blood or adoption or marriage or guardianship or in foster care or having a domestic relationship with the parent of the child or who is living in the same or shared household with the child, commits sexual assault on such child; or
- o) Whoever being, in the ownership, or management, or staff, of any institution providing services to the child, commits sexual assault on the child; or
- p) Whoever being in a position of trust or authority of a child commits sexual assault on the child in an institution or home of the child or anywhere else or



- q) Whoever commits sexual assault on a child knowing the child is pregnant or
- r) Whoever commits sexual assault on a child and attempts to murder the child or
- s) Whoever commits sexual assault on a child in the course of communal or sectarian violence or during any natural calamity or in similar situations or
- t) Whoever commits sexual assault on a child and who has been previously convicted of having committed any offence under this Act or any sexual offence punishable under any other law for the time being in force or
- u) Whoever commits sexual assault on a child and makes the child to strip or parade naked in public, is said to commit aggravated penetrative sexual assault.
- v) Whoever persuades, induces, entices or coerces a child to get administered or administers or direct anyone to administer, help in getting administered any drug or hormone or any chemical substance, to a child with the intent that such child attains early sexual maturity.

Punishment: Minimum 5 years of imprisonment which may extend to 7 years + Fine

E. Sexual Harassment

A person is said to commit sexual harassment upon a child when such person with sexual intent, -

- a) utters any word or makes any sound, or makes any gesture or exhibits any object or part of body with the intention that such word or sound shall be heard, or such gesture or object or part of body shall be seen by the child; or
- b) makes a child exhibit his body or any part of his body so as it is seen by such person or any other person; or
- c) shows any object to a child in any form or media for pornographic purposes; or
- d) repeatedly or constantly follows or watches or contacts a child either directly or through electronic, digital or any other means; or
- e) threatens to use, in any form of media, a real or fabricated depiction through electronic, film or digital or any other mode, of any part of the body of the child or the involvement of the child in a sexual act; or
- f) entices a child for pornographic purposes or gives gratification, therefore.

Punishment: Up to 3 years of imprisonment + Fine

F. Using Child for Pornographic Purposes:

Procedure for Reporting of Cases:

1. Any person (including the child), who has apprehension that an offence under POCSO Act is likely to be committed or has knowledge that such an offence has been committed, he shall provide such information to –
 - a) the Special Juvenile Police Unit (SJPU); or
 - b) the local police.
2. Every report shall be ascribed an entry number, recorded in writing, be read over to the informant and shall be entered in a book to be kept by the Police Unit
3. Where the SJPU or local police is satisfied that the child against whom an offence has been committed is in need of care and protection, then, it shall, after recording the reasons in writing, make immediate arrangement to give him such care and protection (including admitting the child into shelter home or to the nearest hospital) within 24 hours of the report.



4. The SJPU or local police shall, without unnecessary delay but within a period of 24 hours, report the matter to the Child Welfare Committee and the Special Court or where no Special Court has been designated, to the Court of Session, including need of the child for care and protection and steps taken in this regard.

Punishment for Failure to Report or Record a Case

1. Any person, who fails to report the commission of an offence under POCSO Act or who fails to record such offence shall be punished with imprisonment of either description which may extend to 6 months or with fine or with both.
2. Any person, being in-charge of any company or an institution (by whatever name called) who fails to report the commission of an offence under in respect of a subordinate under his control, shall be punished with imprisonment for a term which may extend to 1 year and with fine.
 - No reports in any media shall disclose, the identity of a child including his name, address, photograph, family details, school, neighborhood or any other particulars which may lead to disclosure of identity of the child (Minimum 6 months imprisonment which may extend to 1 year or fine or both)

Procedures for Recording Statement of the Child (By Police or Magistrate)

1. The statement of the child shall be recorded at the residence of the child or at a place where he usually resides or at the place of his choice and as far as practicable by a woman police officer not below the rank of sub-inspector.
2. Police officer to not be in uniform while recording the statement of the child.
3. The police officer making the investigation, shall, while examining the child, ensure that at no point of time the child come in the contact in any way with the accused.
4. No child shall be detained in the police station in the night for any reason.
5. The police officer shall ensure that the identity of the child is protected from the public media, unless otherwise directed by the Special Court in the interest of the child
6. The Magistrate or the police officer, as the case may be, shall record the statement in the presence of the parents of the child or any other person in whom the child has trust or confidence.
7. The statement of the child to be recorded as spoken by the child.
8. Wherever possible, the Magistrate or the police officer, as the case may be, shall ensure that the statement of the child is also recorded by audio-video electronic means.

The Medical Examination of a Child

1. In case the victim is a girl child, the medical examination shall be conducted by a woman doctor.
2. The medical examination shall be conducted in the presence of the parent of the child or any other person in whom the child has trust or confidence.
3. Where, in case the parent of the child or other person cannot be present, for any reason, during the medical examination of the child, the medical examination shall be conducted in the presence of a woman nominated by the head of the medical institution.



9. The Narcotic Drugs and Psychotropic Substances Act, 1985

- Amended in 1988, 2001 and 2014
- Narcotic drugs include Opium, Concentrate of Poppy Straw, Morphine and its salts, Coca Leaf, Cannabis, Acetorphine, Diacetylmorphine (Heroin), Dihydrodesoxymorphine (Desomorphine), Etorphine and Ketobemidone.
- "Addict" is defined as a person who has dependence on any narcotic drug or psychotropic substance.
- If addicts are convicted for consumption or offences involving small quantity then they can be diverted **to treatment by the Court, instead of prison, for undergoing treatment for detoxification.**
- Immunity from prosecution to addicts volunteering for treatment.
- A person arrested under the Act for minor offences like consumption and those involving small quantity of narcotic drugs and psychotropic substances is entitled to bail

Offences and Penalties

Offences	Penalty
Cultivation of opium, cannabis or coca plants without license	Rigorous imprisonment-up to 10 years + fine up to Rs.1 lakh
Embezzlement of opium by licensed farmer	Rigorous imprisonment -10 to 20 years + fine Rs. 1 to 2 lakhs (regardless of the quantity)
Production, manufacture, possession, sale, purchase, transport, import inter- state, export inter-state or use of narcotic drugs and psychotropic substances	Small quantity - Rigorous imprisonment up to 6 months or fine up to Rs. 10,000 or both. More than small quantity but less than commercial quantity - Rigorous imprisonment. up to 10 years + fine up to Rs. 1 Lakhs. Commercial quantity - Rigorous imprisonment 10 to 20 years + fine Rs. 1 to 2 Lakhs
Violations pertaining to controlled substances (precursors)	Rigorous imprisonment up to 10 years + fine Rs. 1 to 2 lakhs
Preparation to commit an offence	Half the punishment for the offence
Repeat offence	One and half times the punishment for the offence. Death penalty in some cases.
Consumption of drugs	Cocaine, morphine, heroin - Rigorous imprisonment up to 1 year or fine up to Rs. 20,000 or both. Other drugs - Imprisonment up to 6 months or fine up to Rs. 10,000 or both. Addicts volunteering for treatment enjoy immunity from prosecution
Punishment for violations not elsewhere specified	Imprisonment up to six months or fine or both



Small and Commercial Quantities

The quantities for some common drugs are as follows:

Drug	Small Quantity	Commercial Quantity
Amphetamine	2 grams	50 grams
Buprenorphine	1gram	20 grams
Charas/Hashish	100 grams	1 kg
Cocaine	2 grams	100 grams
Codeine	10 grams	1 kg
Diazepam	20 grams	500 grams
Ganja	1 kg	20 kg
Heroin	5 grams	250 grams
MDMA	0.5 gram	10 grams
Methamphetamine	2 grams	50 grams
Methaqualone	20 grams	500grams
Morphine	5 grams	250 grams
Poppy straw	1 kg	50 kg