



RRB

Nursing Superintendent

Railway Recruitment Board (RRB)

Volume - 1

(Non Nursing)

General Awareness & Science





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CHAPTER

General Awareness

First in India (male & female)

First in India – Males

Achievement	Name	Year	Description
First President	Dr. Rajendra Prasad	1950	Only President to serve two terms.
First Prime Minister	Pt. Jawaharlal Nehru	1947	Played major role in shaping India's democracy.
First Vice President	Dr. S. Radhakrishnan	1952	Great philosopher and teacher; Teacher's Day celebrated on his birthday.
First Indian to win Nobel Prize	Rabindranath Tagore	1913	For "Gitanjali" in Literature.
First Indian in Space	Rakesh Sharma	1984	His words: "Saare Jahan Se Achha."
First Commander-in-Chief of Indian Army	General K.M. Cariappa	1949	Took over from British officers.

First in India – Females

Achievement	Name	Year	Description
First Woman President	Pratibha Devisingh Patil	2007	Served as the 12th President of India.
First Woman Prime Minister	Indira Gandhi	1966	Only woman PM of India so far.
First Woman IPS Officer	Kiran Bedi	1972	Known for prison reforms.
First Woman Governor	Sarojini Naidu	1947	Governor of Uttar Pradesh.
First Woman to climb Mount Everest	Bachendri Pal	1984	First Indian woman mountaineer to reach summit.
First Woman Chief Minister	Sucheta Kriplani	1963	CM of Uttar Pradesh.

Revolutions in india

Revolutions in India are named based on the color associated with the field they transformed.

Revolution	Color	Area/Focus	Key Person
Green Revolution	Green	Agriculture (Wheat, Rice)	Dr. M.S. Swaminathan
White Revolution	White	Milk Production	Dr. Verghese Kurien (Amul)
Blue Revolution	Blue	Fisheries	Dr. Hiralal Chaudhary
Yellow Revolution	Yellow	Oilseeds	Sam Pitroda
Silver Revolution	Silver	Egg Production	Dr. B. V. Rao
Pink Revolution	Pink	Meat & Onion	Durgesh Patel
Golden Revolution	Golden	Fruits & Honey	Nirpakh Tuteja
Brown Revolution	Brown	Leather & Cocoa	—

International organizations & headquarters

Organization	Headquarters	Established	Function
United Nations (UN)	New York, USA	1945	Maintains international peace & security.
World Health Organization (WHO)	Geneva, Switzerland	1948	Global public health.
World Bank	Washington D.C., USA	1944	Provides loans for development.
IMF (International Monetary Fund)	Washington D.C., USA	1944	Monetary cooperation & financial stability.
UNESCO	Paris, France	1945	Education, Science, Culture.
ILO (International Labour Organization)	Geneva, Switzerland	1919	Workers' rights.
FAO (Food and Agriculture Organization)	Rome, Italy	1945	Fights hunger globally.
WTO (World Trade Organization)	Geneva, Switzerland	1995	Regulates international trade.

Public sector companies & headquarters

Company	Headquarters	Sector	Established
ONGC	Dehradun	Oil & Gas	1956
BHEL	New Delhi	Heavy Electricals	1953
SAIL	New Delhi	Steel	1954
NTPC	New Delhi	Power Generation	1975
GAIL	New Delhi	Natural Gas	1984
IOCL	New Delhi	Petroleum	1959
HPCL	Mumbai	Petroleum	1974
BPCL	Mumbai	Petroleum	1976

Research & educational institutes in india

Institute	Location	Area of Work
ISRO	Bengaluru	Space research & satellite development
DRDO	New Delhi	Defence research and innovations
CSIR	New Delhi	Scientific and Industrial Research
IARI (Pusa Institute)	New Delhi	Agricultural research
ICMR	New Delhi	Medical research
AIIMS	New Delhi	Medical education & health care
BARC	Mumbai	Atomic research
IITs	Various	Engineering & Technology
IISC	Bengaluru	Advanced scientific research

Indian states – capitals, festivals & dances

State	Capital	Major Festival	Dance Form
Andhra Pradesh	Amaravati	Pongal	Kuchipudi
Arunachal Pradesh	Itanagar	Losar	Aji Lhamu
Assam	Dispur	Bihu	Bihu Dance

Gujarat	Gandhinagar	Navratri	Garba
Punjab	Chandigarh	Baisakhi	Bhangra
Odisha	Bhubaneswar	Rath Yatra	Odissi
Tamil Nadu	Chennai	Pongal	Bharatanatyam
Kerala	Thiruvananthapuram	Onam	Kathakali
West Bengal	Kolkata	Durga Puja	Chau

Hills and Their Locations

Hill Range	State/Region	Key Facts
Aravalli Hills	Rajasthan	Oldest mountain range in India; extends to Delhi.
Nilgiri Hills	Tamil Nadu, Kerala, Karnataka	Meeting point of Eastern & Western Ghats.
Shivalik Hills	Himachal, Uttarakhand	Outer Himalayas; youngest range.
Satpura Hills	Madhya Pradesh	Between Narmada & Tapti rivers.
Vindhya Range	MP–UP border	Divides North and South India.
Annamalai Hills	Tamil Nadu	Includes Doddabetta Peak.
Rajmahal Hills	Jharkhand	Volcanic origin.
Khasi Hills	Meghalaya	Known for “Living Root Bridges.”
Cardamom Hills	Kerala	Famous for spice plantations.

Important Passes in India

Pass	State	Connects	Importance
Nathula Pass	Sikkim	India–China (Tibet)	Border trade route.
Jelep La	Sikkim	India–Tibet	Alternative to Nathula.
Rohtang Pass	Himachal Pradesh	Kullu–Lahaul Spiti	Gateway to Leh–Ladakh.
Zoji La	J&K (Ladakh)	Srinagar–Leh	Vital for military supply.
Shipki La	Himachal Pradesh	India–Tibet	Satluj River crosses here.
Bomdi La	Arunachal Pradesh	Tawang–Assam	India–China border area.
Banihal Pass	J&K	Jammu–Srinagar	Jawahar Tunnel located here.

Superlatives in India

Title	Name	Location/Fact
Highest Peak	Kanchenjunga	Sikkim (8,586 m)
Largest State (Area)	Rajasthan	—
Smallest State	Goa	—
Most Populous State	Uttar Pradesh	—
Least Populous State	Sikkim	—
Longest River	Ganga	—
Largest Lake	Vembanad Lake	Kerala
Highest Dam	Tehri Dam	Uttarakhand
Oldest Mountain Range	Aravalli	Rajasthan
Largest Delta	Sundarban Delta	West Bengal

National Symbols of India

Symbol	Name	Description
National Flag	Tiranga	Saffron, White, Green with Ashoka Chakra.
National Emblem	Lion Capital of Ashoka	Sarnath Pillar; “Satyameva Jayate.”
National Anthem	Jana Gana Mana	Written by Rabindranath Tagore.

National Song	Vande Mataram	Written by Bankim Chandra Chatterjee.
National Animal	Bengal Tiger	Symbol of strength.
National Bird	Peacock	Beauty and grace.
National Flower	Lotus	Purity.
National Fruit	Mango	King of fruits.
National Tree	Banyan Tree	Immortality.
National Aquatic Animal	Ganges River Dolphin	Found in Ganga River.

Famous Books and Authors (Ancient India)

Book	Author	Description
Arthashastra	Kautilya (Chanakya)	Treatise on economics & politics.
Ramayana	Valmiki	Epic of Lord Rama.
Mahabharata	Ved Vyasa	Longest epic poem.
Meghaduta	Kalidasa	Poem about cloud messenger.
Shakuntala	Kalidasa	Sanskrit drama.
Manusmriti	Manu	Ancient law book.

Books and Authors (Modern India)

Book	Author	Category
Wings of Fire	Dr. A.P.J. Abdul Kalam	Autobiography
India Wins Freedom	Maulana Abul Kalam Azad	Freedom Movement
Discovery of India	Jawaharlal Nehru	Indian History
Train to Pakistan	Khushwant Singh	Partition Story
God of Small Things	Arundhati Roy	Booker Prize Winner
Midnight's Children	Salman Rushdie	Booker Prize Winner
Ignited Minds	Dr. A.P.J. Abdul Kalam	Motivation

National parks, tiger reserves & wildlife sanctuaries

Name	State	Known For
Jim Corbett NP	Uttarakhand	First National Park; Tigers
Kaziranga NP	Assam	One-horned Rhinoceros
Gir NP	Gujarat	Asiatic Lions
Sundarbans NP	West Bengal	Royal Bengal Tiger
Ranthambore NP	Rajasthan	Tigers
Kanha NP	Madhya Pradesh	Barasingha Deer
Bandhavgarh NP	Madhya Pradesh	Tiger population
Periyar NP	Kerala	Elephants
Silent Valley NP	Kerala	Rainforest ecosystem
Hemis NP	Ladakh	Snow Leopard habitat

Census of India (2011)

Category	Data	Notes
Total Population	1.21 Billion	17.5% of world population
Male	62.37 crore	—
Female	58.64 crore	—
Sex Ratio	943 females/1000 males	Improved from 933 in 2001

Literacy Rate	74.04%	Kerala highest, Bihar lowest
Male Literacy	82.14%	—
Female Literacy	65.46%	—
Most Populous State	Uttar Pradesh	—
Least Populous State	Sikkim	—
Highest Literacy	Kerala (94%)	—
Lowest Literacy	Bihar (63.8%)	—
Most Densely Populated	Bihar	1102/sq km
Least Densely Populated	Arunachal Pradesh	17/sq km

Important awards & their fields

Award	Field	Description
Bharat Ratna	Civilian	Highest civilian award.
Padma Vibhushan	Civilian	Exceptional service.
Padma Bhushan	Civilian	Distinguished service.
Padma Shri	Civilian	Distinguished contribution.
Dadasaheb Phalke Award	Cinema	Lifetime achievement in films.
Arjuna Award	Sports	Excellence in sports.
Khel Ratna (Dhyan Chand)	Sports	Highest sports honor.
Sahitya Akademi	Literature	Indian authors' contribution.
Jnanpith Award	Literature	Highest literary award.
Gallantry Awards	Bravery	Param Vir Chakra, Vir Chakra, etc.

Famous Indian Cities and Their Nicknames

City	Nickname	Reason
Mumbai	City of Dreams	Bollywood, financial hub
Delhi	City of Rallies	Political capital
Bengaluru	Silicon Valley	IT industry
Kolkata	City of Joy	Cultural hub
Jaipur	Pink City	Painted pink for hospitality
Ahmedabad	Manchester of India	Textile industry
Surat	Diamond City	Diamond cutting/polishing
Hyderabad	City of Pearls	Old pearl trade
Pune	Oxford of the East	Education hub
Indore	Cleanest City	Swachh Bharat Ranking

Sports in india

Major Sports & Their Associated Trophies

Sport	Trophy / Cup	Important Facts
Cricket	Ranji Trophy, Duleep Trophy, Irani Trophy, Vijay Hazare Trophy, Deodhar Trophy	ICC World Cup first won by India in 1983 (Kapil Dev), 2011 (M.S. Dhoni).
Hockey	Sultan Azlan Shah Cup, Beighton Cup, Rangaswami Cup	Dhyan Chand is known as "The Wizard of Hockey."
Football	Santosh Trophy, Durand Cup, Federation Cup	India hosted the FIFA U-17 World Cup (2017).
Badminton	Thomas Cup, Uber Cup, All England Championship	India won its first Thomas Cup in 2022.

Tennis	Davis Cup, Wimbledon, US Open	Sania Mirza, Rohan Bopanna, Leander Paes are famous players.
Kabaddi	Pro Kabaddi League Trophy, Asian Games	India is multiple-time world champion.
Athletics	Asian Games, Commonwealth Games, Olympics	Neeraj Chopra won Olympic Gold (Javelin Throw) in 2020 Tokyo Olympics.
Chess	Chess Olympiad	Viswanathan Anand – India’s first Grandmaster.
Shooting	ISSF World Cup	Abhinav Bindra won India’s first individual Olympic Gold (2008).

National Games of India

- **National Game:** Hockey
- **National Sports Day:** 29th August (Birth anniversary of Dhyan Chand)

Indian Ministers (as of 2025)

Ministry	Minister (2025)	Remarks
Prime Minister	Narendra Modi	Also holds charge of Personnel, Public Grievances & Pensions.
Home Affairs	Amit Shah	Also handles Cooperation Ministry.
Defence	Rajnath Singh	Former CM of Uttar Pradesh.
Finance & Corporate Affairs	Nirmala Sitharaman	First full-time woman Finance Minister.
External Affairs	Dr. S. Jaishankar	Former Foreign Secretary.
Health & Family Welfare	Mansukh Mandaviya	Key role in COVID-19 vaccination programme.
Education	Dharmendra Pradhan	Also handles Skill Development.
Women & Child Development	Smriti Irani	Former HRD Minister.
Agriculture & Farmers’ Welfare	Arjun Munda	Focus on farmer support schemes.
Railways, Communications, Electronics & IT	Ashwini Vaishnaw	Introduced Vande Bharat Express.
Environment, Forest & Climate Change	Bhupender Yadav	Advocate of “Mission LiFE” initiative.
Road Transport & Highways	Nitin Gadkari	Works on expressway and highway projects.

Heads of important national institutions (2025)

Institution	Head	Headquarters
ISRO (Indian Space Research Organisation)	S. Somanath	Bengaluru
DRDO (Defence Research and Development Organisation)	Dr. Samir V. Kamat	New Delhi
NITI Aayog	B.V.R. Subrahmanyam	New Delhi
RBI (Reserve Bank of India)	Shaktikanta Das	Mumbai
SEBI (Securities and Exchange Board of India)	Madhabi Puri Buch	Mumbai

Election Commission of India	Rajiv Kumar (Chief Election Commissioner)	New Delhi
UPSC (Union Public Service Commission)	Dr. Manoj Soni	New Delhi
AIIMS (All India Institute of Medical Sciences)	Dr. M. Srinivas (Director, AIIMS Delhi)	New Delhi
ICMR (Indian Council of Medical Research)	Dr. Rajiv Bahl	New Delhi
CBI (Central Bureau of Investigation)	Praveen Sood	New Delhi
Comptroller & Auditor General (CAG)	Girish Chandra Murmu	New Delhi

Major Indian Companies & ceos (as of 2025)

Company	CEO / Chairperson	Headquarters
Tata Sons	N. Chandrasekaran	Mumbai
Reliance Industries Ltd.	Mukesh Ambani	Mumbai
Adani Group	Gautam Adani	Ahmedabad
Infosys	Salil Parekh	Bengaluru
Wipro	Srini Pallia	Bengaluru
HCL Technologies	C. Vijayakumar	Noida
Bharti Airtel	Gopal Vittal	New Delhi
TCS (Tata Consultancy Services)	K. Krithivasan	Mumbai
HDFC Bank	Sashidhar Jagdishan	Mumbai
ICICI Bank	Sandeep Bakhshi	Mumbai
Axis Bank	Amitabh Chaudhry	Mumbai
State Bank of India (SBI)	Dinesh Kumar Khara	Mumbai
Google (Global)	Sundar Pichai	California, USA
Microsoft (Global)	Satya Nadella	Washington, USA
Amazon (Global)	Andy Jassy	Seattle, USA

National health programmes

Programme	Full Form / Objective	Launched
National Health Mission (NHM)	To strengthen health systems in rural & urban areas.	2013
Janani Suraksha Yojana (JSY)	To promote institutional deliveries and reduce maternal mortality.	2005
Janani Shishu Suraksha Karyakram (JSSK)	Free healthcare and transport for pregnant women and infants.	2011
Ayushman Bharat (PM-JAY)	Provides ₹5 lakh health insurance per family per year.	2018
National Tuberculosis Elimination Programme (NTEP)	Eliminate TB by 2025 (earlier RNTCP).	1997
National AIDS Control Programme (NACP)	Prevent & control HIV/AIDS.	1992
National Leprosy Eradication Programme (NLEP)	Early detection and treatment of leprosy.	1955
National Mental Health Programme (NMHP)	Provides mental health services and awareness.	1982

Universal Immunization Programme (UIP)	Immunization against 12 vaccine-preventable diseases.	1985
National Programme for Prevention & Control of Cancer, Diabetes, Cardiovascular Diseases and Stroke (NPCDCS)	Focus on non-communicable diseases.	2008
National Programme for Control of Blindness (NPCB)	To eliminate avoidable blindness.	1976
National Vector Borne Disease Control Programme (NVBDCP)	Combats malaria, dengue, chikungunya, kala-azar, etc.	2003
Rashtriya Bal Swasthya Karyakram (RBSK)	Child health screening and early intervention.	2013
Rashtriya Kishor Swasthya Karyakram (RKSK)	Adolescent health programme.	2014

National facts & quick reference (exam focus)

Category	Fact / Information
National Calendar	Saka Calendar (Starts on 22nd March)
National Flag Ratio	3:2
National Anthem Duration	52 seconds
National Song Duration	1 minute 5 seconds
National Currency	Indian Rupee (₹)
National Animal	Bengal Tiger
National Bird	Peacock
National Game	Hockey
National Heritage Animal	Elephant
National Reptile	King Cobra
National Aquatic Animal	Ganges River Dolphin
National Motto	“Satyameva Jayate” – Truth Alone Triumphs

Important days & themes

These are frequently asked in nursing, UPSC, and SSC exams, especially those related to health and environment.

Date	Day	Theme (2025/Latest)
January 12	National Youth Day	Based on birth anniversary of Swami Vivekananda.
January 26	Republic Day	Constitution came into force (1950).
March 8	International Women’s Day	Theme 2025: “Invest in Women: Accelerate Progress.”
March 24	World Tuberculosis Day	Theme 2025: “Yes! We can end TB.”
April 7	World Health Day	Theme 2025: “My Health, My Right.”
May 12	International Nurses Day	Theme 2025: “Our Nurses. Our Future.”
June 5	World Environment Day	Theme 2025: “Land Restoration for Our Future.”
June 21	International Yoga Day	Theme 2025: “Yoga for Women’s Wellness.”
July 1	National Doctor’s Day	In memory of Dr. B. C. Roy.
October 1	International Day for Older Persons	Promotes elder health awareness.
December 1	World AIDS Day	Theme 2025: “Equalize: End Inequalities.”

Dams and rivers

Dam	River	State	Importance
Bhakra Nangal Dam	Sutlej	Himachal Pradesh	Highest gravity dam in India.
Tehri Dam	Bhagirathi	Uttarakhand	Tallest dam in India.
Hirakud Dam	Mahanadi	Odisha	Longest earthen dam in India.
Sardar Sarovar Dam	Narmada	Gujarat	Major multi-purpose project.
Nagarjuna Sagar Dam	Krishna	Telangana	Largest masonry dam.
Idukki Dam	Periyar	Kerala	Arch dam for hydroelectric power.
Mettur Dam	Cauvery	Tamil Nadu	Important irrigation project.
Rihand Dam	Son River	Uttar Pradesh	Produces hydroelectric power.

Airports & seaports in india

Major International Airports

Airport	Location	Named After
Indira Gandhi International Airport	New Delhi	Former PM Indira Gandhi
Chhatrapati Shivaji Maharaj International Airport	Mumbai	Maratha ruler Shivaji
Kempegowda International Airport	Bengaluru	Founder of Bengaluru
Netaji Subhas Chandra Bose Airport	Kolkata	Freedom fighter
Rajiv Gandhi International Airport	Hyderabad	Former PM Rajiv Gandhi
Cochin International Airport	Kerala	First solar-powered airport
Chennai International Airport	Tamil Nadu	—

Major Ports

Port	State	Type
Kandla (Deendayal Port)	Gujarat	Major
Mumbai Port	Maharashtra	Major
Jawaharlal Nehru Port (Nhava Sheva)	Maharashtra	Largest container port
Chennai Port	Tamil Nadu	Oldest port in South India
Visakhapatnam Port	Andhra Pradesh	Natural deep-water port
Kolkata (Haldia)	West Bengal	Inland river port
Paradip Port	Odisha	Iron ore & coal export

Important committees & reports

Committee	Head	Purpose
Kothari Commission	D.S. Kothari	Education reforms (1964–66).
Bhore Committee	Sir Joseph Bhore	Health planning (1946). Basis for Primary Health Centres.
Mudaliar Committee	Dr. A.L. Mudaliar	Secondary health care improvement (1962).
Chadha Committee	Dr. M.S. Chadha	Integration of malaria control with PHC.
Jajati Keshari Panda Committee	J.K. Panda	Family welfare planning.
Balwant Rai Mehta Committee	Balwant Rai Mehta	Introduced Panchayati Raj (1957).
Ashok Mehta Committee	Ashok Mehta	Strengthened Panchayati Raj (1977).
Malimath Committee	Justice Malimath	Criminal justice system reforms.

Indian space missions (isro)

Mission	Year	Objective
Aryabhata	1975	First Indian satellite.
Chandrayaan-1	2008	First Moon mission; discovered water on Moon.
Mangalyaan (Mars Orbiter Mission)	2013	First interplanetary mission; Mars orbit.
Chandrayaan-2	2019	Attempted soft landing near Moon's South Pole.
Chandrayaan-3	2023	Successful landing near Moon's South Pole.
Aditya-L1	2023	India's first solar observation mission.
Gaganyaan (Upcoming)	2025	India's first human spaceflight mission.

Indian defence facts

Force	Motto	Founded	Head (2025)
Indian Army	"Service Before Self"	1895	Gen. Upendra Dwivedi
Indian Navy	"Sham No Varunah" (May the Lord of Water be Auspicious)	1950	Admiral Dinesh K. Tripathi
Indian Air Force	"Touch the Sky with Glory"	1932	Air Chief Marshal V. R. Chaudhari
BSF	"Duty Unto Death"	1965	Nitin Agrawal
CRPF	"Service and Loyalty"	1939	Anish Dayal Singh
ITBP	"Shaurya, Dridhata, Karm Nishtha"	1962	A.P. Maheshwari
Coast Guard	"Vayam Rakshamah"	1977	Rakesh Pal

Important Government Schemes (Non-Health)

Scheme	Ministry	Objective
PM-KISAN	Agriculture	₹6,000 annual income support to farmers.
PM Awas Yojana (Urban/Rural)	Housing & Urban Affairs	Affordable housing for all.
Beti Bachao Beti Padhao	Women & Child Development	Save and educate the girl child.
Swachh Bharat Mission	Jal Shakti / Urban Dev.	Clean India, sanitation.
Digital India Mission	Electronics & IT	Promote digital governance.
Skill India Mission	Skill Development	Vocational training and jobs.
Make in India	Commerce & Industry	Boost manufacturing in India.
Start-Up India	DPIIT	Promote entrepreneurship.
PM Ujjwala Yojana	Petroleum & Natural Gas	Free LPG to BPL households.
Atal Pension Yojana	Finance	Pension for unorganised sector.

Indian constitution – basic facts

Topic	Detail
Adopted	26 November 1949
Came into Force	26 January 1950
Drafted by	Dr. B.R. Ambedkar
Total Articles (Original)	395
Schedules (Original)	8 (Now 12)
Official Language	Hindi in Devanagari Script

National Language	None (No national language in Constitution)
Longest Written Constitution	In the world
Fundamental Rights	Articles 12–35
Directive Principles of State Policy (DPSP)	Articles 36–51
Fundamental Duties	Added by 42nd Amendment (1976)
Emergency Provisions	Article 352–360
Amendment Power	Article 368

Important temples, monuments & unesco heritage sites

Site	Location	Type
Taj Mahal	Agra, UP	UNESCO World Heritage Site (1983)
Qutub Minar	Delhi	Tallest brick minaret.
Konark Sun Temple	Odisha	13th-century chariot-shaped temple.
Khajuraho Temples	Madhya Pradesh	Famous for sculpture art.
Hampi	Karnataka	Capital of Vijayanagara Empire.
Ajanta & Ellora Caves	Maharashtra	Buddhist & Jain monuments.
Sanchi Stupa	MP	Oldest stone structure in India.
Rani ki Vav	Gujarat	Stepwell architecture.
Mahabalipuram Temples	Tamil Nadu	Pallava art & architecture.
Kaziranga & Manas NP	Assam	Natural UNESCO Sites.

National & international organisations (india's role)

Organisation	India's Role	Headquarters
SAARC	Founding Member (1985)	Kathmandu, Nepal
G20	Member; hosted G20 Summit in 2023	Rotating Presidency
BRICS	Member with Brazil, Russia, China, South Africa	Shanghai
ASEAN	Dialogue Partner	Jakarta
WHO	Member since 1948	Geneva
UNESCO	Member since 1945	Paris
Commonwealth	Member country	London
NAM (Non-Aligned Movement)	Founding member (1961)	Belgrade

World health organization (who) – important facts

Point	Detail
Full Form	World Health Organization
Founded	7 April 1948
Headquarters	Geneva, Switzerland
Parent Organization	United Nations
Current Director-General (2025)	Dr. Tedros Adhanom Ghebreyesus
Official Languages	6 (English, French, Arabic, Spanish, Chinese, Russian)
World Health Day	7 April (WHO Foundation Day)
WHO Regional Office for South-East Asia	New Delhi, India
India's Membership	Founding member (since 1948)

Main Functions

- International health cooperation & disease control.
- Setting global health standards.
- Epidemiological surveillance & immunization support.
- Publishes World Health Report and International Classification of Diseases (ICD).

Important national & international health days

Date	Day	Objective
January 12	National Youth Day	To inspire youth for nation-building.
March 24	World Tuberculosis Day	To end TB globally.
April 7	World Health Day	Marks the establishment of WHO.
May 12	International Nurses Day	Honors Florence Nightingale.
May 31	World No Tobacco Day	To promote tobacco-free living.
June 14	World Blood Donor Day	To encourage voluntary blood donation.
July 11	World Population Day	To focus on population issues.
October 10	World Mental Health Day	Mental health awareness.
November 14	World Diabetes Day / Children's Day	Health + Education awareness.
December 1	World AIDS Day	End HIV/AIDS stigma and spread.

History of nursing in india

Year/Period	Event/Development
1854	Florence Nightingale's work in Crimean War laid foundation for modern nursing.
1867	First Nursing School in India established at St. Stephens Hospital, Delhi.
1909	First nursing registration council established in Madras Presidency.
1947	Indian Nursing Council (INC) established under Central Government.
1948	INC Act passed; regulates nursing education and profession.
1949	Florence Nightingale School of Nursing started at Delhi.
1956	WHO collaboration with INC began.
1976	ANM and GNM syllabi standardized by INC.
2019	National Nursing and Midwifery Commission Bill proposed.

Current President of Indian Nursing Council (2025): Dr. Elizabeth I. George

Important nursing organisations

Organisation	Headquarters	Function
Indian Nursing Council (INC)	New Delhi	Regulates nursing education and registration in India.
Trained Nurses' Association of India (TNAI)	New Delhi	Professional body for nurses; promotes education & welfare.
International Council of Nurses (ICN)	Geneva, Switzerland	Global federation of nurses' associations.
State Nursing Councils	In each state	Register and license nurses locally.
WHO (SEARO)	New Delhi	Regional health cooperation in South-East Asia.

National health organizations (india)

Organization	Headquarters	Function
ICMR (Indian Council of Medical Research)	New Delhi	Biomedical research and public health studies.
NCDC (National Centre for Disease Control)	New Delhi	Disease surveillance and outbreak management.

AIIMS (All India Institute of Medical Sciences)	New Delhi	Premier medical education and research institute.
DGHS (Directorate General of Health Services)	New Delhi	Policy formulation for health programs.
NIHF (National Institute of Health & Family Welfare)	New Delhi	Training for health personnel.
NVBDCP	New Delhi	Vector-borne disease control (malaria, dengue).
NACO	New Delhi	National AIDS Control Organisation.
FSSAI	New Delhi	Regulates food safety and nutrition.

Vaccination & immunization programmes

Programme	Year	Objective
EPI (Expanded Programme on Immunization)	1978	Basic immunization for children.
UIP (Universal Immunization Programme)	1985	Immunization against 12 diseases.
Mission Indradhanush	2014	Full immunization for all children.
Intensified Mission Indradhanush (IMI)	2017	Reach unreached children.
Pulse Polio Programme	1995	Eradicate polio (India declared polio-free in 2014).

Vaccines under UIP

- BCG (Tuberculosis)
- OPV (Polio)
- DPT (Diphtheria, Pertussis, Tetanus)
- Hepatitis B
- Hib
- Measles, Rubella
- Rotavirus, Pneumococcal, JE in endemic areas

Important national health missions

Mission	Objective	Launched
National Rural Health Mission (NRHM)	Strengthen rural health infrastructure.	2005
National Urban Health Mission (NUHM)	Urban poor healthcare.	2013
National Health Mission (NHM)	Combined NRHM + NUHM.	2013
Ayushman Bharat (PM-JAY)	Health insurance for poor families.	2018
POSHAN Abhiyaan	To reduce malnutrition in children & women.	2018
PM National Dialysis Programme	Free dialysis service to poor patients.	2016

National disease control programmes

Programme	Target Disease	Nodal Agency
NTEP (National TB Elimination Programme)	Tuberculosis	Central TB Division
NVBDCP	Malaria, Dengue, Chikungunya, Filariasis, Kala-azar	Ministry of Health

NACP	HIV/AIDS	NACO
NLEP	Leprosy	Directorate of Health Services
NPCDCS	Cancer, Diabetes, CVD, Stroke	Non-Communicable Diseases Division
NPCBVI	Blindness & Visual Impairment	Health Ministry
NDDCP	Deafness	ENT division
IDSP	Integrated Disease Surveillance Programme	NCDC

Ayush & traditional medicine in india

System	Full Form	Governing Body
AYUSH	Ayurveda, Yoga, Unani, Siddha, Homeopathy	Ministry of AYUSH
CCIM	Central Council of Indian Medicine	Regulates Ayurvedic education
CCRH	Central Council for Research in Homeopathy	Research body
CCRYN	Central Council for Research in Yoga & Naturopathy	Yoga research & promotion
NMPB	National Medicinal Plants Board	Conservation of medicinal plants

Women & child welfare programmes

Programme	Objective	Year
ICDS (Integrated Child Development Services)	Supplementary nutrition, health, and preschool education.	1975
Beti Bachao Beti Padhao	Improve sex ratio & girl child education.	2015
Janani Suraksha Yojana (JSY)	Safe motherhood & institutional delivery.	2005
Janani Shishu Suraksha Karyakram (JSSK)	Free delivery and treatment for mothers & infants.	2011
POSHAN Abhiyaan	Nutrition for women and children.	2018
Kishori Shakti Yojana	Empower adolescent girls.	2000

Health and family welfare schemes

Scheme	Objective	Target Group
Rashtriya Swasthya Bima Yojana (RSBY)	Health insurance for BPL families.	Poor households
LaQshya Programme	Improve quality of maternity care.	Pregnant women
Pradhan Mantri Surakshit Matritva Abhiyan (PMSMA)	Free antenatal care on 9th of every month.	Pregnant women
Mission Parivar Vikas	Family planning in high fertility districts.	Women of reproductive age
PM Jan Aushadhi Yojana	Provide affordable generic medicines.	All citizens

Indian medical & nursing acts

Act	Year	Purpose
Indian Nursing Council Act	1947	Regulates nursing education and registration.
Indian Medical Council Act	1956	Regulates medical education (Replaced by NMC Act 2019).

Pharmacy Act	1948	Regulates pharmacy education and practice.
Dentists Act	1948	Regulates dental education and profession.
Clinical Establishments Act	2010	Standardizes healthcare facilities.
Drugs and Cosmetics Act	1940	Regulates drug quality and manufacturing.
Mental Healthcare Act	2017	Protects rights of persons with mental illness.

Indian medical research & education institutes

Institute	Location	Focus Area
AIIMS (All India Institute of Medical Sciences)	New Delhi + Multiple Cities	Medical education, research, patient care.
JIPMER	Puducherry	Medical teaching & research.
PGIMER	Chandigarh	Postgraduate medical training.
NIMHANS	Bengaluru	Mental health & neurosciences.
ICMR	New Delhi	Medical research and public health.
NIPER	Mohali	Pharmaceutical education & research.
AFMC	Pune	Armed Forces Medical training.

International health organisations

Organisation	Headquarters	Year	Objective
World Health Organization (WHO)	Geneva, Switzerland	1948	Promote global health and coordinate international health efforts.
UNICEF (United Nations International Children's Emergency Fund)	New York, USA	1946	Child health, education, and nutrition.
UNESCO (United Nations Educational, Scientific and Cultural Organization)	Paris, France	1945	Promotes education, science, and culture.
UNFPA (United Nations Population Fund)	New York, USA	1969	Population control and family planning.
World Bank	Washington D.C., USA	1944	Financial and health development aid.
FAO (Food and Agriculture Organization)	Rome, Italy	1945	Eradicate hunger and improve food security.
ILO (International Labour Organization)	Geneva, Switzerland	1919	Improve labour standards and social welfare.
ICN (International Council of Nurses)	Geneva, Switzerland	1899	Represents nurses worldwide and sets nursing standards.
Red Cross (IFRC)	Geneva, Switzerland	1863	Humanitarian aid during disaster and war.
World Food Programme (WFP)	Rome, Italy	1961	Provides food assistance in emergencies.

Medical discoveries & inventors

Discovery / Invention	Scientist	Year	Significance
X-rays	Wilhelm Conrad Roentgen	1895	First medical imaging technique.
Penicillin (Antibiotic)	Alexander Fleming	1928	First antibiotic drug; revolutionized medicine.
Smallpox Vaccine	Edward Jenner	1796	First vaccine in human history.
Stethoscope	René Laennec	1816	Used for auscultation of heart and lungs.
Thermometer	Gabriel Fahrenheit	1714	Measures body temperature.
Blood Circulation	William Harvey	1628	Explained heart and circulation.
Insulin (Diabetes Treatment)	Frederick Banting & Charles Best	1921	Controls blood sugar.
Polio Vaccine	Jonas Salk / Albert Sabin	1955 / 1961	Eradicated polio globally.
DNA Structure	James Watson & Francis Crick	1953	Discovered double-helix structure.
Anaesthesia	Crawford Long	1842	First used ether for surgery.
Antiseptic Surgery	Joseph Lister	1867	Introduced carbolic acid in surgery.

Diseases and discoverers

Disease / Pathogen	Discovered By	Year
Tuberculosis (Mycobacterium tuberculosis)	Robert Koch	1882
Cholera (Vibrio cholerae)	Robert Koch	1883
Malaria (Plasmodium)	Sir Ronald Ross	1897
Typhoid (Salmonella typhi)	Eberth	1880
Diphtheria (Corynebacterium diphtheriae)	Klebs & Loeffler	1884
Polio Virus	Karl Landsteiner	1909
AIDS (HIV Virus)	Luc Montagnier & Robert Gallo	1983
COVID-19 (Coronavirus SARS-CoV-2)	First identified in Wuhan, China	2019
Rabies Vaccine	Louis Pasteur	1885
Syphilis (Treponema pallidum)	Fritz Schaudinn	1905
Leprosy (Mycobacterium leprae)	G. Armauer Hansen	1873

Important health reports & committees in india

Committee / Report	Year	Recommendation / Significance
Bhore Committee	1946	Laid foundation of Primary Health Care in India.
Mudaliar Committee	1962	Strengthened secondary & tertiary healthcare.
Chadha Committee	1963	Integrated malaria control with PHCs.
Mukherjee Committee	1966	Revised basic health services.
Jungalwalla Committee	1967	Unified medical & health services.
Kartar Singh Committee	1973	Multipurpose health workers introduced.
Srivastava Committee	1975	Creation of Rural Health Practitioners & Medical Colleges.

Bajaj Committee	1986	Proposed National Health Policy (1983 revision).
Bora Committee	1995	Strengthening district hospitals.
National Health Policy Reports	1983, 2002, 2017	Health planning & universal coverage goals.

Miscellaneous nursing general knowledge

Topic	Fact
Founder of Modern Nursing	Florence Nightingale
Birth Date of Florence Nightingale	12 May 1820 (Celebrated as International Nurses Day)
Known As	“The Lady with the Lamp”
First Nursing School in India	St. Stephen’s Hospital, Delhi (1867)
Father of Modern Medicine	Hippocrates
Father of Microbiology	Louis Pasteur
Father of Immunology	Edward Jenner
Father of Bacteriology	Robert Koch
World Red Cross Day	8 May
National Safe Motherhood Day (India)	11 April
National Newborn Week	15–21 November
ICD (International Classification of Diseases)	Maintained by WHO for disease coding
First WHO Director-General from India	Dr. Marcolino Gomes Candau (served globally, Indian origin staff included in SEARO New Delhi)
India’s First Nurse to Get Florence Nightingale Award	K. C. Geetha (Kerala)

Current national affairs (2024–2025)

Event / Area	Key Facts (as of 2025)
President of India	Smt. Droupadi Murmu (First tribal woman President)
Vice President	Jagdeep Dhankhar
Prime Minister	Narendra Modi
Chief Justice of India (CJI)	Justice D.Y. Chandrachud
Lok Sabha Speaker	Om Birla
Election Commission Chief	Rajiv Kumar
RBI Governor	Shaktikanta Das
ISRO Achievement	Chandrayaan-3 successfully landed on Moon’s South Pole (2023)
Aditya-L1 Mission	India’s first solar observation satellite (2023)
G20 Summit 2023	Hosted in New Delhi – Theme: “One Earth, One Family, One Future.”
India’s GDP Growth (2024–25)	Approx. 7.2% (World’s fastest-growing major economy)
Union Budget 2025 Theme	Focus on infrastructure, digital health, and AI in healthcare.
National Education Policy	NEP 2020 – continues implementation for holistic education.

Environment & ecology

Topic	Details
National Environment Policy	Adopted in 2006; focuses on sustainable development.
Forest Cover (2023 Report)	21.71% of India’s area covered by forest.

Chipko Movement	Started in Uttarakhand (1973) by Gaura Devi; “Hug the trees” to prevent deforestation.
Project Tiger	Launched in 1973 to protect tigers.
Project Elephant	Launched in 1992 for elephant protection.
Ramsar Convention	Wetland conservation treaty (India joined in 1982).
Largest Biosphere Reserve	Gulf of Mannar (Tamil Nadu).
Clean India Mission	Launched in 2014 to promote sanitation.
Plastic Waste Management Rule	Implemented 2016, amended 2022 (single-use plastic ban).

Important Environmental Days

Date	Day
5 June	World Environment Day
21 March	World Forestry Day
22 April	Earth Day
16 September	World Ozone Day
2 February	World Wetlands Day

Basic science and discoveries

Field	Discovery / Inventor	Importance
Physics	Isaac Newton	Laws of Motion & Gravity
Chemistry	Dmitri Mendeleev	Periodic Table
Biology	Charles Darwin	Theory of Evolution
Electricity	Benjamin Franklin	Electrical charge
Vaccination	Edward Jenner	Smallpox prevention
Penicillin	Alexander Fleming	First antibiotic
DNA Structure	Watson & Crick	Genetic code
Radioactivity	Marie & Pierre Curie	Discovery of radium & polonium
Telephone	Alexander Graham Bell	Communication revolution
Light Bulb	Thomas Edison	Electricity application
Computer	Charles Babbage	Father of Computer
Internet (ARPANET)	U.S. Defense Department	1969 foundation of modern internet

Science & technology in india

Organization	Function	Headquarters
ISRO	Space research & satellite launch	Bengaluru
DRDO	Defence technology	New Delhi
CSIR	Scientific & Industrial Research	New Delhi
BARC	Atomic research	Mumbai
IITs / NITs	Higher education & innovation	Across India
ICMR	Medical research	New Delhi
CDAC	Advanced computing (developed PARAM supercomputer)	Pune
NIC (National Informatics Centre)	e-Governance & IT infrastructure	New Delhi

Recent Indian Scientific Achievements

- Chandrayaan-3 (2023) – Successful Moon landing.
- Aditya-L1 (2023) – India's first solar observation mission.
- Vikram-S Rocket (2022) – India's first private space rocket.
- Covid-19 Vaccine Development – Covaxin (Bharat Biotech) & Covishield (Serum Institute of India).

Indian economy – basic facts

Topic	Detail
India's GDP (2024–25)	Approx. \$4 trillion; 5th largest economy globally.
Currency	Indian Rupee (₹); Controlled by RBI.
Economic Planning	NITI Aayog replaced Planning Commission (2015).
Five-Year Plans	Discontinued after 12th Plan (2017).
Primary Sector	Agriculture, fishing, mining.
Secondary Sector	Industry & manufacturing.
Tertiary Sector	Services, IT, banking, tourism.
Inflation Control	Managed by RBI using Repo & Reverse Repo rates.
GST (Goods and Services Tax)	Introduced July 1, 2017; One nation, one tax.
Budget Presentation Date	1st February each year.
Largest Employer Sector in India	Agriculture.

Important economic institutions in india

Institution	Head / Chairperson (2025)	Function
RBI (Reserve Bank of India)	Shaktikanta Das	Controls monetary policy.
NABARD	Shaji K.V.	Rural & agricultural financing.
SIDBI	Sivasubramanian Ramann	Promotes small-scale industries.
EXIM Bank	Harsha Bangari	Export-import financing.
SEBI	Madhabi Puri Buch	Regulates capital markets.
IRDAI	Debasish Panda	Insurance regulation.
EPFO	Neelam Shami Rao	Provident fund management.

Indian tax & banking system

Concept	Explanation
Direct Tax	Paid directly (Income Tax, Corporate Tax).
Indirect Tax	Paid via goods/services (GST).
Repo Rate	Rate at which RBI lends to banks.
Reverse Repo Rate	Rate at which RBI borrows from banks.
Bank Rate	Long-term lending rate of RBI.
CRR (Cash Reserve Ratio)	% of deposits banks keep with RBI.
SLR (Statutory Liquidity Ratio)	% of deposits kept in liquid form (gold, cash, securities).
Financial Inclusion Scheme	Pradhan Mantri Jan Dhan Yojana (2014).
Digital Payment Systems	UPI, RuPay, BHIM, Paytm, etc.
RBI Established	1935 (Nationalized in 1949).

International economic organisations

Organisation	Headquarters	Function
IMF (International Monetary Fund)	Washington D.C.	Financial stability & global trade.
World Bank	Washington D.C.	Development loans to nations.

WTO (World Trade Organization)	Geneva	Regulates international trade.
ADB (Asian Development Bank)	Manila, Philippines	Promotes economic growth in Asia.
OECD	Paris, France	Economic cooperation.
AIIB (Asian Infrastructure Investment Bank)	Beijing, China	Funds Asian infrastructure projects.
BRICS Bank (NDB)	Shanghai, China	BRICS nations' financial cooperation.

Environmental organisations & reports

Organisation	Report / Function	Headquarters
IPCC (Intergovernmental Panel on Climate Change)	Publishes Climate Change Reports	Geneva
UNEP (United Nations Environment Programme)	Coordinates global environmental activities	Nairobi, Kenya
WWF (World Wide Fund for Nature)	Conservation of wildlife and forests	Gland, Switzerland
Greenpeace International	Environmental activism	Amsterdam, Netherlands
IUCN (International Union for Conservation of Nature)	Publishes Red Data Book (endangered species list)	Gland, Switzerland
CITES	Protects endangered flora and fauna	Geneva
Montreal Protocol	Protects ozone layer	1987 (Signed in Canada)
Paris Agreement (UNFCCC)	Climate action framework	2015

India in global rankings & reports (2025)

Report / Index	Published By	India's Rank (Approx.)	Notes
Human Development Index (HDI)	UNDP	134 / 193	Moderate category.
Global Hunger Index	Concern Worldwide	111 / 125	Moderate concern.
Global Innovation Index	WIPO	40 / 132	Top in lower-middle-income group.
Ease of Doing Business Index	World Bank (last issued 2020)	63 / 190	Business reforms recognized.
World Happiness Report	UN	126 / 137	Focus on mental health & well-being.
Corruption Perception Index	Transparency International	93 / 180	—
Global Gender Gap Index	World Economic Forum	127 / 146	Gender parity in education improving.
Climate Change Performance Index (CCPI)	Germanwatch	8 / 60	Among top-performing nations.

Constitutional Bodies of India

Body	Head	Function
Election Commission of India (ECI)	Rajiv Kumar	Conducts elections.
Union Public Service Commission (UPSC)	Dr. Manoj Soni	Recruits for civil services.
Comptroller and Auditor General (CAG)	Girish Chandra Murmu	Audits govt. accounts.
Finance Commission	N.K. Singh (15th Commission)	Revenue distribution between Centre and States.
National Human Rights Commission (NHRC)	Justice Arun Mishra	Safeguards human rights.
NITI Aayog	B.V.R. Subrahmanyam	Policy think tank replacing Planning Commission (2015).
Central Vigilance Commission (CVC)	Praveen Kumar Srivastava	Checks corruption in government.
Central Information Commission (CIC)	Heeralal Samariya	Implements RTI Act.

Indian geography – general facts

Feature	Description
Location	8°4'N – 37°6'N latitude, 68°7'E – 97°25'E longitude
Area	3.287 million sq. km (7th largest country)
Coastline Length	7,516 km
Highest Peak	Kanchenjunga (8,586 m) – Sikkim
Northernmost Point	Indira Col (Ladakh)
Southernmost Point	Indira Point (Nicobar Islands)
Longest River (India)	Ganga
Largest River (Origin in India)	Godavari – “Dakshin Ganga”
Largest Lake	Vembanad Lake (Kerala)
Longest Glacier	Siachen Glacier (Ladakh)
Largest Plateau	Deccan Plateau
Largest Desert	Thar Desert (Rajasthan)
Highest Waterfall	Kunchikal Falls (Karnataka)

Important rivers and their tributaries

River	Origin	Major Tributaries	Empties Into
Ganga	Gangotri Glacier	Yamuna, Ghaghara, Gandak, Kosi	Bay of Bengal
Yamuna	Yamunotri Glacier	Chambal, Betwa, Ken	Ganga
Brahmaputra	Mansarovar (Tibet – Tsangpo)	Subansiri, Dibang, Lohit	Bay of Bengal
Godavari	Nasik (Maharashtra)	Manjira, Indravati	Bay of Bengal
Krishna	Western Ghats (Maharashtra)	Bhima, Tungabhadra	Bay of Bengal
Narmada	Amarkantak (MP)	—	Arabian Sea
Tapti	Satpura Hills	—	Arabian Sea
Cauvery	Coorg (Karnataka)	Bhavani, Kabini	Bay of Bengal
Mahanadi	Chhattisgarh	Seonath, Ib	Bay of Bengal

Indian mountain ranges

Range	Location	Key Facts
Himalayas	Northern India	Three ranges – Himadri, Himachal, Shivalik.
Aravalli Range	Rajasthan	Oldest mountain range; Guru Shikhar is highest peak.
Vindhya Range	Central India	Natural divider of North & South India.
Satpura Range	MP–Maharashtra	Source of rivers Narmada & Tapti.
Western Ghats	Western coast	UNESCO World Heritage Site; biodiversity hotspot.
Eastern Ghats	East coast	Discontinuous range; intersected by rivers.
Nilgiri Hills	South India	Meeting point of Ghats.
Karakoram Range	Ladakh	Contains Siachen Glacier.

Major indian cities on rivers

City	River
Delhi	Yamuna
Varanasi	Ganga
Kolkata	Hooghly
Ahmedabad	Sabarmati
Hyderabad	Musi
Chennai	Cooum
Patna	Ganga
Allahabad (Prayagraj)	Confluence of Ganga, Yamuna, Saraswati
Guwahati	Brahmaputra
Cuttack	Mahanadi

Indian history – ancient to modern overview

Period	Key Features
Indus Valley Civilization (2500–1500 BCE)	Urban planning, drainage, cities: Harappa & Mohenjo-Daro.
Vedic Period (1500–600 BCE)	Society based on Vedas; rise of kingdoms.
Mauryan Empire (322–185 BCE)	Founded by Chandragupta Maurya; Ashoka embraced Buddhism.
Gupta Empire (320–550 CE)	Golden Age of India – art, literature, science flourished.
Delhi Sultanate (1206–1526 CE)	Muslim rule started in India; five dynasties.
Mughal Empire (1526–1857)	Established by Babur; reached height under Akbar, Shah Jahan, Aurangzeb.
British Rule (1858–1947)	East India Company followed by British Crown; independence achieved 1947.
Freedom Movement	Led by Mahatma Gandhi – Non-Cooperation, Civil Disobedience, Quit India Movement.

Major government projects & initiatives

Scheme / Mission	Year	Objective
Digital India	2015	Promote digital literacy and governance.
Smart Cities Mission	2015	Develop 100 modern cities.
AMRUT (Urban Renewal Mission)	2015	Improve urban water & sewerage services.
Pradhan Mantri Awas Yojana (PMAY)	2015	Affordable housing for all.

Atmanirbhar Bharat Abhiyan	2020	Self-reliant India mission.
Swachh Bharat Abhiyan	2014	Clean India and sanitation.
Make in India	2014	Promote manufacturing.
Skill India Mission	2015	Vocational training for youth.
BharatNet Project	2011	Broadband in rural India.
Jal Jeevan Mission	2019	Tap water for every household by 2024.

Digital & infrastructure initiatives

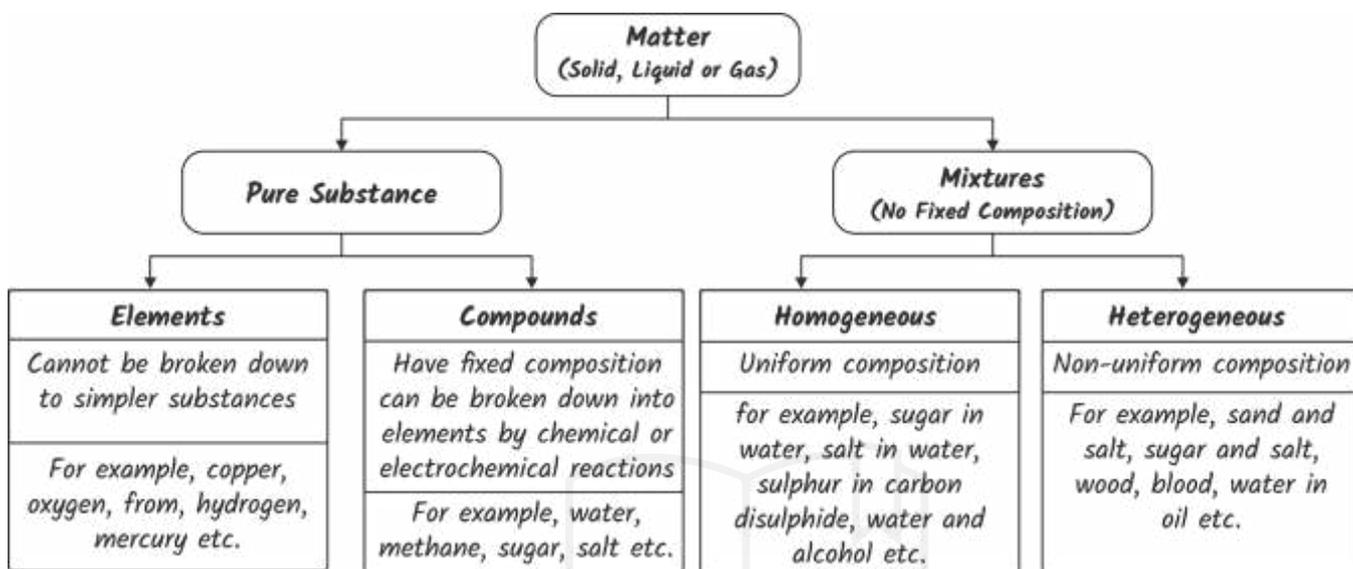
Initiative	Ministry	Purpose
Aadhaar	UIDAI (MeitY)	Biometric-based digital identity.
DigiLocker	MeitY	Digital document storage.
BHIM / UPI	NPCI	Unified Payments Interface – digital payments.
eSanjeevani	Health Ministry	Online telemedicine platform.
Ayushman Bharat Digital Mission	Health Ministry	Digital Health ID for citizens.
PM Gati Shakti	Ministry of Commerce	National infrastructure master plan.
PM Kisan Samman Nidhi	Agriculture	₹6,000 annual benefit to farmers.
eNAM	Agriculture	National digital agriculture market.
One Nation One Ration Card	Consumer Affairs	Nationwide portability of ration.
PM Surya Ghar Muft Bijli Yojana (2024)	MNRE	Rooftop solar power for households.

2

CHAPTER

Basics of Everyday Chemistry

Matter



- Anything that has mass & occupies space
- Made of very tiny particles k/a atoms.
 - ✓ Have space between them and are continuously moving.
 - ✓ Attract each other.

- States of matter
 - ✓ There are four natural states of matter: Solids, liquids, gases and plasma.
 - ✓ The fifth state is the man-made Bose-Einstein condensates.

Solid	<ul style="list-style-type: none"> ➤ Particles are packed tightly together. ➤ Very low kinetic energy. ➤ Definite shape, mass and volume, ➤ Do not conform to shape of container in which they are placed. ➤ Have a high density.
Liquid	<ul style="list-style-type: none"> ➤ Particles more loosely packed than in solid ➤ Have indefinite shape and conforms to the shape of its container. ➤ Difficult to compress. ➤ Fixed volume

Gas	<ul style="list-style-type: none"> ➤ Particles loosely spaced and have high kinetic energy. ➤ No definite shape or volume. ➤ Can be compressed
Plasma	<ul style="list-style-type: none"> ➤ Highly charged particles with extremely high kinetic energy. ➤ Noble gases (helium, neon, argon, krypton, xenon and radon) used to make glowing signs by using electricity to ionize them to the plasma state. ➤ Not a common state of matter on Earth - most common state of matter in the universe, ➤ Stars - superheated balls of plasma.
Bose-Einstein Condensate:	<ul style="list-style-type: none"> ➤ State of matter of a dilute gas of bosons cooled to temperatures very close to absolute zero. ➤ Refers to breakdown of atoms into a single quantum state. ➤ Found at low temperatures when particles are not incapable of moving. ➤ First proposed around 1924 by Satyendra Nath Bose and Albert Einstein. ➤ Plasmas - super hot and super excited atoms ➤ Bose-Einstein condensate (BEC) - super unexcited and super cold atoms.

➤ **Types of Matter:**

1. Pure Substances

➤ **Substances made of only one type of particles.**

➤ **Types:**

A. Elements

➤ **A substance which cannot be broken down further by chemical reactions, by cooling, heating, or by electrolysis.**

➤ **Example:** Sulphur, Iron, Carbon, etc

➤ **No. of elements known at present are > 100.**

➤ **92 - naturally occurring, and the rest are man made.**

➤ **Majority are solid.**

➤ **11 elements - gaseous state at room temperature.**

➤ **2 elements - liquid at room temperature-mercury and bromine.**

➤ **Divided into metals, metalloids, and nonmetals.**

Metals	<ul style="list-style-type: none"> ➤ Eg: gold, silver, copper, iron, sodium, potassium etc. ➤ Properties: <ul style="list-style-type: none"> ✓ Lustrous ✓ Good conductor of heat and electricity ✓ Ductile: can be drawn into wires ✓ Malleable: can be hammered into thin sheets ✓ Sonorous: make a ringing sound when hit ➤ Mercury is the only metal that is liquid at room temperature
Non- metals	<ul style="list-style-type: none"> ➤ Eg: hydrogen, oxygen, iodine, carbon (coal, coke), bromine, chlorine etc. ➤ Properties: <ul style="list-style-type: none"> ✓ display a variety of colours ✓ poor conductors of heat and electricity ✓ are not lustrous, sonorous or malleable
Metalloids	<ul style="list-style-type: none"> ➤ Have intermediate properties between metals and non-metals ➤ Eg: Boron, Silicon, Germanium, Arsenic, Antimony, Tellurium

B. Compound:

- **Formed when 2 or more chemical elements chemically bonded together.**
- **2 types of chemical bonds - covalent and ionic bonds.**
- **Properties different from its constituent elements.**
- **Properties:**
 - ✓ **Elements in any compound always present in fixed ratios.**
 - ✓ **Chemical compound separated into simpler substances by chemical reactions.**
 - ✓ **Composition, texture and colour of compound same throughout.**

2. Mixtures:

- **Elements or compounds mix together to form a mixture**
- **No new compound is formed.**
- **Eg:**
 - ✓ **Crude oil:** A mixture of organic compounds (mainly hydrocarbons)
 - ✓ **Seawater:** A mixture of various salt and water.
 - ✓ **Air:** a mixture of various gases like oxygen, carbon dioxide, nitrogen, argon, neon, etc.
 - ✓ **Ink:** A mixture of coloured dyes.
 - ✓ **Gunpowder:** A mixture of sulfur, potassium nitrate and carbon.

➤ **Characteristics:**

- ✓ **No chemical force acting between 2 or more mixed substances.**
- ✓ **Heterogeneous or homogeneous in nature.**
- ✓ **Proportions vary in an indefinite manner.**
- ✓ **Properties depend upon the individual components.**
- ✓ **Constituents can be separated by physical methods.**
- ✓ **Boiling point and melting point depends upon properties of constituents.**
- ✓ **No change in energy.**
- ✓ **All states of matter combine to form mixtures.**

➤ **Types:**

Homogeneous mixtures	Heterogeneous mixtures
➤ Have uniform composition.	➤ Have non uniform composition
➤ No visible boundaries of separation between its constituents.	➤ Visible boundaries of separation between its constituents.
➤ Eg: salt in water, sugar in water.	➤ Eg: water and sand, oil and water.

Comparison between Mixture and Compound:

Compound	Mixture
1. The composition of elements present in a compound is fixed	The composition of elements present in a mixture is not fixed
2. The properties of a compound are different from those of its elements	It shows the properties of all its constituent elements.
3. Its constituents can be separated by chemical method only.	Its constituents can be separated by physical method.
4. A compound is always homogeneous in nature	The mixtures can be homogeneous or heterogeneous

Superconductivity:

- **Complete disappearance of electrical resistance in various solids when cooled below a characteristic temperature.**
- This temperature, k/a **transition temperature**, varies for different materials but generally is **below 20 K** ($-253\text{ }^{\circ}\text{C}$).

Uses:

- **Medical magnetic-imaging devices, magnetic energy-storage systems, motors, generators, transformers, computer parts, and very sensitive devices for measuring magnetic fields, voltages, or currents.**

Advantage: low power dissipation, high-speed operation, and high sensitivity.

Meissner Effect: When a material makes the transition from the normal to the superconducting state, it actively excludes magnetic fields from its interior.

Applications:

1. **SQUIDS (Superconducting Quantum Interference Devices):**

- Detect even the weakest magnetic field.
- Used in mine detection equipment to help in the removal of landmines.

2. **The USA is developing "E-bombs":**

- Make use of strong, superconductor-derived magnetic fields to create a fast, high-intensity electromagnetic pulse that can disable an enemy's electronic equipment.

3. **Powerful superconducting electromagnets:**

- In magnetic resonance imaging (MRI) and nuclear magnetic resonance (NMR) machines, magnetic confinement fusion reactors (e.g. tokamaks), and the beam-steering and focusing magnets used in particle accelerators.

4. **RF and microwave filters:**

- For mobile phone base stations, as well as military ultra-sensitive/selective receivers

5. **To launch satellites:**

- Superconducting magnetic propulsion systems may be used to launch satellites into orbits directly from the earth without the use of rockets.

6. **Maglev (magnetic levitation) trains:**

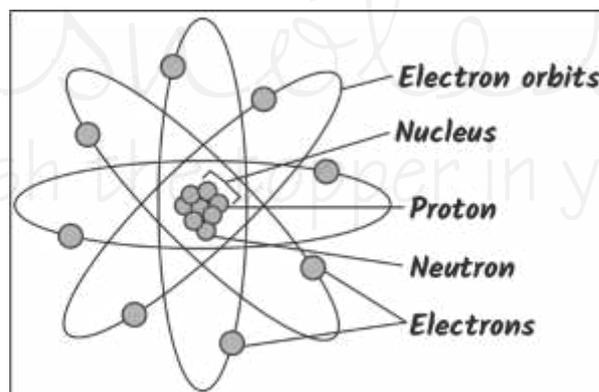
- Work because a superconductor repels a magnetic field so a magnet will float above a superconductor—this virtually eliminates the friction between the train and the track.

Atoms & molecules

Atoms

- **Smallest particles of an element which can take part in a chemical reaction.**
- **Size measured in nanometres.**

Structure of Atom



Protons:

- **Positively charged subatomic particles.**
- **Charge - $1e$ (1.602×10^{-19})**
- **Mass - 1.672×10^{-24}**
- **> 1800 times heavier than electrons.**
- **Number of protons in atoms = atomic number of the element.**

Neutrons:

- Mass = proton(1.674×10^{-24}).
- Electrically neutral particles and carry no charge.
- Different isotopes of an element - same number of protons but different neutrons.

Electrons:

- Charge- $-1e$ (-1.602×10^{-19}).
- Mass - 9.1×10^{-31} .
- Relatively negligible mass.

Basic properties

Atomic number:

- Number of units of protons in the nucleus.
- Usually denoted by the letter Z
- Eg: if an atom has a Z of 6, it is carbon, while a Z of 92 corresponds to uranium.
- Neutral atom - number of protons = electrons.

Mass Number:

- Number of (protons + neutrons) present in nucleus of an atom.
- Eg, mass of carbon is 12 u because it has 6 protons and 6 neutrons, $6 u + 6 u = 12 u$.

Isotopes:

- Nuclei with same number of protons but different numbers of neutrons
- All chemical elements have many isotopes.

Orbits and energy levels:

- Orbital- Most probable pathway that an electron most likely moves around a nucleus.
- Arranged according to amount of energy that electrons in these orbitals are composed of k/a energy levels.

Isobars:

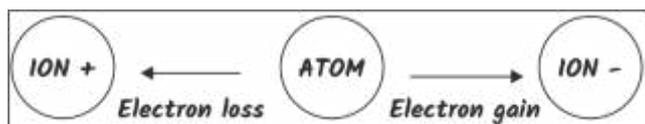
- Atoms of different elements with different atomic numbers having same mass number.
- Eg: calcium has atomic number 20, and argon has atomic number 18 but the mass number of both is 40.
 - ✓ Total number of nucleons is same in atoms of this pair of elements

Molecules

- Group of atoms chemically bonded together or held together by attractive forces
- Smallest particle of an element/ compound capable of an independent existence and shows properties of that substance.
- Atoms of same element or different elements join together to form molecules.

Different forms	<ul style="list-style-type: none">➤ Diatomic molecules: Contain 2 atoms chemically bonded.➤ Homonuclear diatomic molecule: When 2 atoms are identical<ul style="list-style-type: none">✓ Eg: oxygen molecule (O_2)➤ Heteronuclear diatomic molecule: When atoms are different,<ul style="list-style-type: none">✓ Eg: carbon monoxide molecule (CO)➤ Polyatomic molecules: molecules containing >2 atoms.<ul style="list-style-type: none">✓ Eg: carbon dioxide (CO_2) and water (H_2O).✓ May contain many thousands of component atoms
Molecular weight	<ul style="list-style-type: none">➤ Sum of atomic weights of component atoms of a molecule.

Ions:



- Metals and non-metals leads to formation of compounds that possess charged species k/a ions.
- A charged particle and can be negatively or positively charged.
- Types:

Positive Ions (Cations)		Negative Ions (anion)	
Name	Formula	Name	Formula
Hydrogen	H^+	Chloride	Cl^-
Sodium	Na^+	Bromide	Br^-
Silver	Ag^+	Fluoride	F^-
Potassium	K^+	Iodide	I^-
Ammonium	NH_4^+	Nitrate	NO_3^-
Barium	Ba^{2+}	Oxide	O^{2-}
Calcium	Ca^{2+}	Sulphide	S^{2-}
Copper (II)	Cu^{2+}	Sulphate	SO_4^{2-}
Magnesium	Mg^{2+}	Carbonate	CO_3^{2-}
Zinc	Zn^{2+}	Hydrogencarbonate	HCO_3^-
Lead	Pb^{2+}		
Iron(II)	Fe^{2+}		
Iron (III)	Fe^{3+}		
Aluminium	Al^{3+}		

1. Anion:

- Negatively charged ion
- Electrons > protons
- Eg, Cl^- symbol for chlorine anion, carries a single negative charge (-1).

2. Cation:

- Positively charged ion
- Protons > electrons.
- Eg, Ca^{2+} indicates a cation with a +2 charge.

Polyatomic ion:

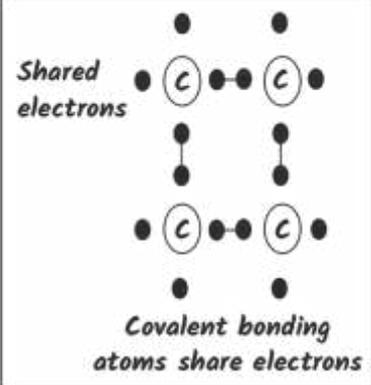
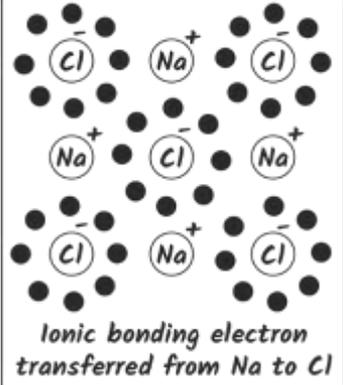
- Group of atoms carrying a charge.

Monoatomic ion:

- an ion which consists of a single atom
- Eg: hydrogen ion, H^+

Chemical bonds

- Connections between atoms in a molecule.
- Hold atoms together to make compounds or molecules.
- Include both strong intramolecular interactions, such as covalent and ionic bonds.

Covalent Bonds	Ionic Bonds
 <p>Shared electrons</p> <p>Covalent bonding atoms share electrons</p> <ul style="list-style-type: none"> ➤ Involve sharing of one or more electrons to help each atom satisfy octet rule. ➤ Forms between two nonmetals. 	 <p>Ionic bonding electron transferred from Na to Cl</p> <ul style="list-style-type: none"> ➤ Involve transfer of 1 or more electrons to help satisfy octet rule. ➤ Forms between a metal and a non-metal.

Chemical Reactions

- Reactions in which **one or more new substances with new physical and chemical properties are formed**.
- **Irreversible**
- **Eg:** Rusting of iron, the setting of milk into curd, digestion of food, respiration, etc.
- **Only a rearrangement of atoms takes place in a chemical reaction.**
- **Reactants:** substances which take part in a chemical reaction.
- **Products:** new substances produced as a result of a chemical reaction.
- **Eg.**

$$2\text{Mg}(s) + \text{O}_2(g) \xrightarrow{\Delta} 2\text{MgO}(s)$$

Reactant	Reactant	Product
----------	----------	---------

Why is magnesium ribbon cleaned by rubbing with sandpaper before burning in air?

To remove the protective layer of basic magnesium carbonate from surface of the magnesium ribbon.

Properties of Chemical reactions

- **Evolution of a gas**
 - ✓ $\text{Zn}(s) + \text{H}_2\text{SO}_4(aq) \rightarrow \text{ZnSO}_4(aq) + \text{H}_2(g) \uparrow$
- **Change in temperature**
 - ✓ $\text{CaO} + \text{H}_2\text{O} \rightarrow \text{Ca}(\text{OH})_2 + \text{Heat}$
- **Formation of a precipitate**
 - ✓ $\text{BaCl}_2(aq) + \text{H}_2\text{SO}_4(aq) \rightarrow \text{BaSO}_4(s) (\text{ppt} \downarrow) + 2\text{HCl}(aq)$
- **Change in colour**
 - ✓ Rusting of iron- color changes to brown
- **Change of state**
 - ✓ $\text{NH}_3(g) + \text{HCl}(g) \rightarrow \text{NH}_4\text{Cl}(s)$

Chemical Equation

- **Representation of chemical reaction using symbols and formulae of the substances.**
- **2 types:**
 1. **Balanced Chemical Equation**
 - Has the **number of atoms of each element equal on both sides**.
 - **Eg:** $\text{Zn} + \text{H}_2\text{SO}_4 \rightarrow \text{ZnSO}_4 + \text{H}_2$

2. Unbalanced Chemical Equation

- Number of atoms of each element in reactants is not equal to number of atoms of each element present in the product.



Types:

1. Combination Reaction:

- Reactions in which two or more reactants combine to form one product.
- General expression: $A + B \rightarrow AB$
- Eg:
 $\text{Mg}(s) + \text{O}_2(g) \rightarrow 2\text{MgO}(s)$
Magnesium + Oxygen \rightarrow Magnesium Oxide

2. Decomposition Reaction:

- Reactions in which one compound decomposes in two or more compounds or elements.
- Opposite of combination reaction.
- General expression: $AB \rightarrow A + B$
- Eg:
 $\text{CaCO}_3(s) + \text{heat} \rightarrow \text{CaO}(s) + \text{CO}_2(g)$
Calcium carbonate \rightarrow Calcium oxide + Carbon dioxide

➤ Types:

A. Thermal Decomposition:

- Decomposition of a substance on heating.
- Eg: $2\text{Pb}(\text{NO}_3)_2(s) + \text{heat} \rightarrow 2\text{PbO}(s) + 4\text{NO}_2(g) + \text{O}_2(g)$

B. Electrolytic Decomposition/ Electrolysis:

- Reactions in which compounds decompose into simpler compounds because of passing of electricity.
- Eg:
 $\text{H}_2\text{O} + \text{electricity} \rightarrow \text{H}_2 + \text{O}_2$

C. Photolysis/ Photo Decomposition Reaction:

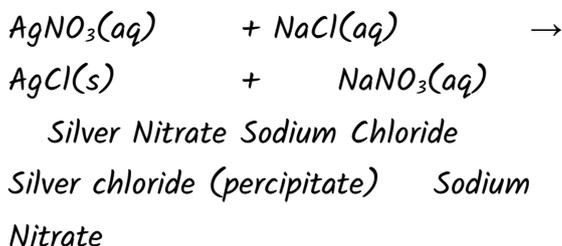
- Compound decomposes because of sunlight.
- Eg:
 $2\text{AgCl}(s) \text{ (white)} + \text{Sunlight} \rightarrow 2\text{Ag}(s) \text{ (grey)} + \text{Cl}_2(g)$

3. Displacement Reaction:

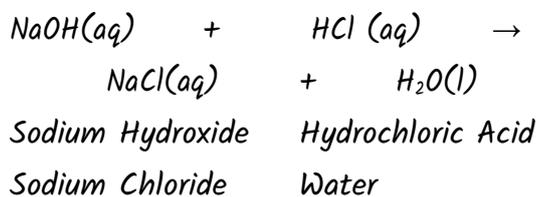
- A more reactive element displaces a less reactive element from a compound.
- aka Substitution Reaction or Single Displacement/ replacement reactions.
- General expression: $A + BC \rightarrow AC + B$
- Eg:
 $\text{Zn}(s) + \text{CuSO}_4(aq) \rightarrow \text{ZnSO}_4(aq) + \text{Cu}(s)$ (Zn more reactive than Cu)

4. Double Displacement Reaction:

- Ions are exchanged between 2 reactants forming new compounds.
- General expression: $AB + CD \rightarrow AC + BD$
- Eg:
 $\text{NaOH}(aq) + \text{HCl}(aq) \rightarrow \text{NaCl}(aq) + \text{H}_2\text{O}(l)$
- Double Displacement Reaction, in which precipitate is formed = precipitation reaction.



- Neutralisation reactions also the example.



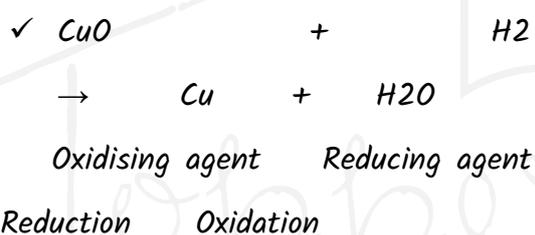
5. Oxidation and Reduction Reactions:

- **Oxidation:** Addition of oxygen or removal of hydrogen from a compound.
- **Reduction:** Addition of hydrogen or removal of oxygen from a compound.
- Oxidation and Reduction take place together.

Oxidizing Agent	➤ Substance that gets reduced in a chemical reaction
Reducing Agent	➤ Substance that gets oxidized.

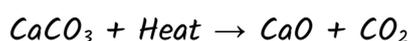
- **Redox Reactions:** Oxidation + Reduction

- Eg.



6. Exothermic and Endothermic Reactions:

- **Exothermic Reaction:** Reaction which produces energy.
- Most decomposition reactions are exothermic.
- ✓ Eg:
Respiration: $\text{C}_6\text{H}_{12}\text{O}_6 + \text{O}_2 \rightarrow \text{CO}_2 + \text{H}_2\text{O} + \text{Heat}$
- **Endothermic Reaction:** Heat energy is absorbed.
- ✓ Eg:



Effects of Oxidation Reactions in Our Daily Life:

1. Corrosion:

- An undesirable change that occurs in metals when attacked by moisture, air, acids and bases.
- Eg. Corrosion (rusting) of Iron: $\text{Fe}_2\text{O}_3 \cdot x\text{H}_2\text{O}$ (Hydrated iron oxide)

2. Rancidity:

- Undesirable change that takes place in oil containing food items due to the oxidation of fatty acids.

Physical Reactions:

- Reaction in which no new substances are formed.
- **Reversible**
- Eg. Forming of ice from water, breaking of a pot etc

Equilibrium

- **State at which there is no further change in concentration** of reactants and products.
- Eg.
 $\text{N}_2(\text{g}) + 3\text{H}_2(\text{g}) \rightarrow 2\text{NH}_3(\text{g})$
- Rate of forward reaction = rate of backward reaction.
- **Equilibrium mixture:**
 - ✓ Mixture of reactants and products in equilibrium state.
- **Types**

Homogeneous Equilibrium	Heterogeneous Equilibrium
<ul style="list-style-type: none"> ➤ Reactants and products of chemical equilibrium are all in same phase. ➤ Number of molecules of the products = number of molecules of the reactants. ➤ $N_2(g) + O_2(g) \rightleftharpoons 2NO(g)$ 	<ul style="list-style-type: none"> ➤ Reactants and products of chemical equilibrium are present in different phases. ➤ $CaCO_3(s) \rightleftharpoons CaO(s) + CO_2(g)$

➤ **Factors Affecting Chemical Equilibrium**

Concentration	➤ When concentration of reactant or product is changed, change in composition of mixture in chemical equilibrium.
Pressure	➤ If change in pressure it can affect gaseous reaction as total number of gaseous reactants and products are now different.
Temperature	<ul style="list-style-type: none"> ➤ As temperature ↑, equilibrium constant of exothermic reaction ↓. ➤ Endothermic reaction - equilibrium constant ↑ as temperature ↑.

Catalyst	<ul style="list-style-type: none"> ➤ Does not affect the chemical equilibrium. ➤ Only speeds up a forward & backward reaction. ➤ Reaction reaches equilibrium faster.
Inert Gas	➤ Does not take part in reaction so equilibrium remains undisturbed.

Acids and Bases

Indicators

➤ Substances which indicate acidic or basic nature of solution by the colour change.

➤ **Types:**

1. Natural Indicators:

➤ Indicators obtained from natural sources.

➤ Eg. Litmus, turmeric, red cabbage, China rose, etc..

A. Litmus:

➤ Obtained from lichens.

➤ Originally purple in colour.

➤ Acid turns blue litmus paper red.

➤ Base turns red litmus paper blue.

B. Turmeric:

➤ Originally yellow.

➤ Turns reddish brown with base.

➤ Does not change colour with acid.

C. Red Cabbage:

➤ Originally purple in colour.

➤ Turns reddish with acid

➤ Greenish with base.

2. Olfactory Indicator:

- Substances which change their smell when mixed with acid or base. Eg;

A. Onion:

- Loses its smell when added with base.
- Does not change its smell with acid.

B. Vanilla:

- Smell vanishes with base
- Does not vanish with an acid.

3. Synthetic Indicator:

- Synthesized in the laboratory.

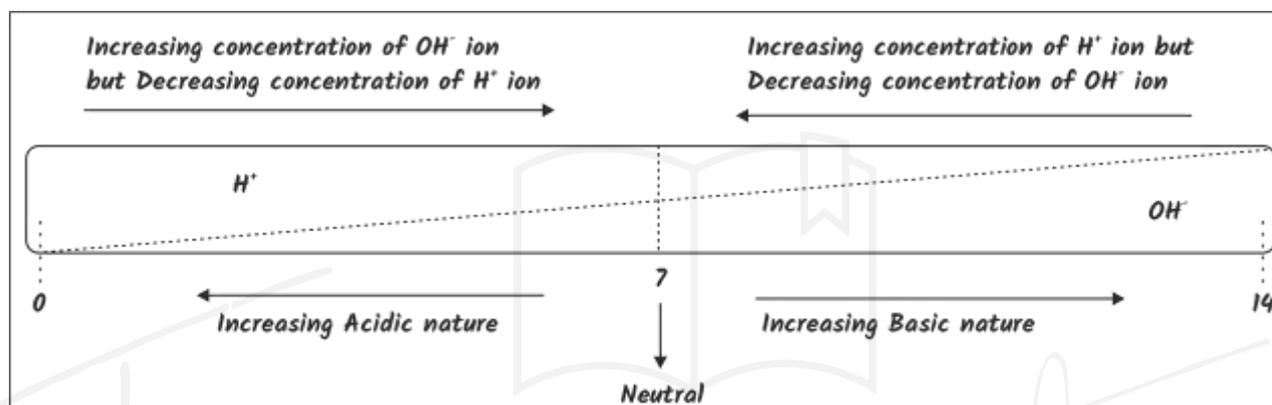
A. Phenolphthalein

- Originally colourless.
- Remains colourless with acid
- Turns into pink with a base.

B. Methyl orange

- Originally orange in colour.
- Turns red with acid
- Turns yellow with base.

pH scale



- A scale developed to measure the concentration of hydrogen ion in a solution
- p in pH implies 'potenz' in German.
- Ranges from 0 (highly acidic) - 14 (highly alkaline).
- pH of a neutral solution is 7.

Acids

- Sour in taste, turn blue litmus red, and dissolve in water to release H^+ ions.

➤ Types:

1. Natural/ Organic Acids:

- Obtained from natural sources.
- Eg.

Acids	Sources
Acetic acid	Vinegar
Ascorbic acid	Guava, amla
Citric acid	Lemon, orange and other citrus fruits
Lactic acid	Sour milk, curd

Methanoic acid	Ant sting, nettle sting
Oxalic acid	Tomato
Tartaric acid	Tamarind

2. Mineral Acids:

- Prepared from minerals.
- aka Inorganic acids, man-made acids or synthetic acid.
- Eg:
 - ✓ Hydrochloric acid (HCl)
 - ✓ Sulphuric acid (H_2SO_4)
 - ✓ Nitric acid (HNO_3)
 - ✓ Carbonic acid (H_2CO_3)
 - ✓ Phosphoric acid (H_3PO_4) etc.

Bases

- **Bitter** in taste, have **soapy touch**, turn **red litmus blue** and give **hydroxide ions** (OH^-) in aqueous solution.
- **Eg:**
 - ✓ **Sodium hydroxide** (caustic soda) - NaOH
 - ✓ **Calcium hydroxide** - $\text{Ca}(\text{OH})_2$
 - ✓ **Potassium hydroxide** (caustic potash) - (KOH)

Alkali

An **alkali** is a type of **base** that is soluble in water. When an alkali dissolves in water, it releases hydroxide ions (OH^-), making the solution alkaline (basic). Common examples of alkalis include: Sodium hydroxide (NaOH), Potassium hydroxide (KOH), Calcium hydroxide ($\text{Ca}(\text{OH})_2$), Magnesium hydroxide ($\text{Mg}(\text{OH})_2$), Lithium hydroxide (LiOH) etc. The dissolution of Alkali is an exothermic reaction as during the dissolution process ionic bonds break and heat is released in the solution.

Properties of Acids and Bases

Acids	Bases
<ul style="list-style-type: none"> ➤ Sour in taste ➤ Corrosive in nature. ➤ Good conductors of electricity. ➤ pH values are < 7. ➤ When reacted with metals, these substances produce hydrogen gas. 	<ul style="list-style-type: none"> ➤ Are bitter in taste, ➤ Feel soapy to touch ➤ Good conductors of electricity in aqueous solutions. ➤ pH values > 7.

<ul style="list-style-type: none"> ➤ Release Hydrogen ions (H^+) when dissolved in water ➤ Turn Blue litmus red ➤ Examples: Sulfuric acid [H_2SO_4], Hydrochloric acid [HCl], Acetic acid [CH_3COOH]. 	<ul style="list-style-type: none"> ➤ Release hydroxide ions (OH^- ions) when dissolved in water. ➤ turn red litmus paper blue. ➤ Examples: Sodium hydroxide [NaOH], milk of magnesia [$\text{Mg}(\text{OH})_2$], calcium hydroxide [$\text{Ca}(\text{OH})_2$].
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Salts:

- **Ionic compounds produced after neutralization** reaction between acid and base.
- **Electrically neutral.**
- **Most common-** sodium chloride.
- **Characteristics :**
 - ✓ **Crystalline** solid.
 - ✓ **Transparent** or **opaque**.
 - ✓ **Soluble** in water.
 - ✓ **Solution conducts electricity** .
 - ✓ **Neutral** salts are **odourless**.
 - ✓ **Can be colourless** or **coloured**.

Neutralization

- Neutralization is a chemical reaction in which an acid and a base react to form water and a salt, effectively canceling out each other's properties.

- This can be understood by the experiment in which, **NaOH** (a base) neutralizes the acidic components of onion juice and clove oil, reducing their characteristic smells, while **HCl** (an acid) doesn't have the same neutralizing effect. This demonstrates a neutralization reaction, where an acid reacts with a base to form water and neutralize certain properties, such as smell in this case.

Another example can be Calamine solution, containing zinc carbonate ($ZnCO_3$), neutralizes the formic acid ($HCOOH$) from an ant bite, soothing irritation and providing relief.

Physical vs. Chemical Changes

- There are several changes we come across daily e.g dissolving sugar in water, or flattening a metal rod by beating it.
- These involve changes in the form of the substance.

Physical change

- Any change to the physical properties of a substance is called a physical change.
- Physical changes are usually reversible as no new substance is formed. It is the same substance but with changed physical properties.
- Physical properties: Physical properties include size, shape, colour and state (solid/liquid/gas) of a substance.

Chemical change

- A change in which one or more new substances are formed is called as a chemical change.
- Usually a chemical change involves a chemical reaction, which forms new products.
- Example : Rusting of Iron, or burning wood.

Metallic Oxides

- Formation of metal oxides are examples of chemical changes. They are formed by the reaction of oxygen in air.
 - ✓ Burning of Magnesium ribbon:
 - ✓ $2Mg + O_2 \rightarrow 2MgO$
 - ✓ The product formed is the oxide of magnesium, which is in the form of ash. It does not look anything like the magnesium ribbon used for burning.

Reaction of metallic oxides with water

- Reaction of metal oxides with water form metal hydroxides.
- Example dissolving Magnesium oxide in water, by stirring the ash very well with water.
 - $MgO + H_2O \rightarrow Mg(OH)_2$
 - The product formed is basic in nature and turns red litmus paper → blue

Reaction between baking soda and vinegar

- When a pinch of baking soda is added to vinegar we hear a hissing sound and observe the formation of bubbles.
- Vinegar (Acetic Acid) + Baking Soda (Sodium bicarbonate) → CO_2 (Carbon dioxide) + Other products

➤ The carbon dioxide produced during the reaction of Vinegar and baking soda, when passed through lime water gives calcium carbonate, as follows:



✓ The calcium carbonate turns lime water milky.

Observations that indicate a chemical change

- Heat or light is absorbed or given out during a chemical reaction.
- Production of sound
- Production of gases or precipitates
- Production of smell
- A colour change may occur

Rusting

- When substances made of Iron are exposed to oxygen and moisture in the atmosphere, it forms a red layer, which is called **rust**.
- The formation of rust can be represented by the following reaction:

➤ $4\text{Fe} + 3\text{O}_2 \rightarrow 2\text{Fe}_2\text{O}_3$. The chemical formula for rust is $\text{Fe}_2\text{O}_3 \cdot n\text{H}_2\text{O}$. More the moisture in the air, quicker the formation of rust.

Galvanization

- The process of depositing zinc on the surface of Iron to prevent rusting is called as **galvanisation**.
- **Example:** Iron water pipes are galvanised. Ships are made out of iron which is galvanised. Due to the presence of salts in seawater, the process of rusting is hastened. Hence ships need to replace their iron body every year.

Crystallisation

The process of separation of salts from their solution is called as crystallisation. It is a purification technique that purifies seawater or separates crystals from impure samples. It is a physical change.

Chemistry in daily life

Common Compounds and their chemical formula

Common Name	Chemical Name	Chemical Formula	Usage
Table Salt	Sodium Chloride	NaCl	Cooking, food preservation, de-icing roads
Baking Soda	Sodium Bicarbonate	NaHCO_3	Baking, cleaning, neutralizing acids
Vinegar	Acetic Acid	CH_3COOH	Cooking, cleaning, food preservation
Bleaching Powder	Calcium Hypochlorite	Ca(OCl)_2	Disinfecting, bleaching fabrics, water treatment

Epsom Salt	Magnesium Sulfate	$MgSO_4 \cdot H_2O$	Epsom salt baths, gardening, laxative
Gypsum	Calcium Sulfate	$CaSO_4 \cdot H_2O$	Construction (drywall), cement, soil conditioner
Ammonia	Ammonium Hydroxide	NH_4OH	Cleaning products, fertilizer production
Plaster of Paris	Calcium Sulfate Hemihydrate	$CaSO_4 \cdot 1/2 H_2O$	Making casts, sculptures, toys
Laughing Gas	Nitrous Oxide	N_2O	Anesthetic in dentistry, recreational use
Caustic Soda	Sodium Hydroxide	$NaOH$	Soap making, drain cleaner, chemical manufacturing
Washing Soda	Sodium Carbonate	Na_2CO_3	Laundry detergent, water softening, glass making
Quick Lime	Calcium Oxide	CaO	Construction, cement manufacture, steel production
Slaked Lime	Calcium Hydroxide	$Ca(OH)_2$	Water treatment, construction, paper production

Chemicals of Food in Everyday Life

In food materials following chemicals are widely used,

1. Colouring agents
2. Artificial preservatives
3. Flow stabilizers
4. Binding substance
5. Artificial sweetness
6. Antioxidants
7. Minerals
8. Vitamins

Except vitamins remaining substances do not have nutritional value.

- **Artificial Preservatives:** These prevent spoilage of food by stopping the growth of microorganism. For example, Sodium benzoate, sodium meta bisulphate, Alitame etc.

- **Artificial Sweetness:** These do not impart any calories to the body. Since these substances are excreted through urine. For example,

1. **Aspartame:** It is used in cool drinks and ice-creams.
2. **Alitame:** It is 2000 times sweeter than sucrose.

Ortho-sulphobenzimide, commonly known as **saccharin**, was one of the first artificial sweeteners discovered in the late 19th century. This is 300-500 times sweeter than cane sugar.

Antioxidants: These prevent the spoilage of food by preventing the oxidation of food. For example,

1. Butylated hydroxyl tolerance (BHT)
2. Butylated hydroxyl anisole (BHA)

Purpose	Definition	Commonly Used Chemicals
Colouring Agents	Add color to food, cosmetics, or other products.	Tartrazine ($C_{16}H_9N_4Na_3O_4S_2$), Beta-Carotene ($C_{40}H_{56}$), Titanium Dioxide (TiO_2)
Artificial Preservatives	Extend the shelf life of food by preventing spoilage.	Sodium Benzoate ($C_7H_5NaO_2$), Potassium Sorbate ($C_6H_7KO_2$), Sodium Nitrite ($NaNO_2$)
Flow Stabilizers	Maintain the desired consistency and prevent clumping in products.	Silicon Dioxide (SiO_2), Magnesium Stearate ($C_{36}H_{70}MgO_4$)
Binding Substances	Hold ingredients together in food, pharmaceuticals, and other products.	Gelatin, Pectin ($C_6H_{10}O_7$), Cellulose ($C_6H_{10}O_5$) _n
Artificial Sweeteners	Provide a sweet taste with little or no calories.	Aspartame ($C_{14}H_{18}N_2O_5$), Sucralose ($C_{12}H_{19}Cl_3O_8$), Saccharin ($C_7H_5NO_{3S}$)
Antioxidants	Prevent oxidation and spoilage of food and other products.	Ascorbic Acid (Vitamin C, $C_6H_8O_6$), Butylated Hydroxytoluene (BHT, $C_{15}H_{24}O$)
Flavor Enhancers	Improve the taste and add umami flavor to food.	Monosodium Glutamate (MSG, $C_5H_8NO_4Na$)

Chemistry of Cleansing Agents in Everyday Life

What are Soaps and Detergents?

- Soaps are sodium or potassium salt of higher carboxylic acid such as stearic acid, Palmitic acid and oleic acid whereas detergents contain a long chain of alkyl groups. Detergents in comparison to soaps can also function in hard water.
- **Saponification:** Alkaline hydrolysis of triesters of glycerol to form soap is known as saponification. Soaps do not function in hard water since they precipitate in it.

How do soaps work?

- Soaps are generally sodium or potassium salts of long chain fatty acids. Soap molecules have a hydrophobic as well as hydrophilic part. While the hydrophilic part clings to the water when washing, the hydrophobic end clings to the dirt particles. Thus, when we pour away the water, the dirt particles wash away with the soap molecules.

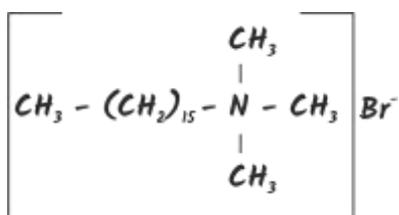
- **Emulsification:** **Emulsification** is the process of mixing two immiscible liquids (such as oil and water) to form a stable mixture called an **emulsion**. This is usually achieved with the help of an **emulsifying agent** (like soap or lecithin) that reduces the surface tension between the two liquids, allowing them to stay mixed.

Types of Soaps

1. **Toilet Soaps:** Potassium soaps are softer than sodium soaps.
2. **Floating Soaps:** These can be prepared by beating soap bubbles.
3. **Transparent Soaps:** This contains soap dissolved in excess of alcohol and it is evaporated.
4. **Medicated Soaps:** These contain soaps by adding little amounts of Dettol, Savlon etc.
5. **Laundry Soaps** mainly contains Sodium rosinate, borax.

Types of Detergents

- **Anionic Detergent:** In this, anion acts as detergents. For example, Sodium Lauryl Sulphate
- **Cationic Detergents:** In this type, cation acts as a detergent. For example, Cetyl trimethyl ammonium bromide.



- **Non-ionic Detergents:** These are neutral. The whole molecule acts as a detergent. For example, Polyethylene glycol stearate.

Chemistry of Cosmetics in Everyday life

Cosmetics contains the following categories of chemicals.

- **Emulsifier:** These increase the stability of the emulsion. For example, Potassium cetyl sulfate.
- **Preservatives:** These are added to cosmetics to increase their shelf life. For example, benzyl alcohol, salicylic acid.
- **Thickeners:** These give an appealing consistency. For example, Cetyl alcohol, Stearic acid.
- **Emollient:** These soften the skin by preventing water loss. For example, Glycerine, zinc oxide.
- **Glimmer and Shiners:** For example, mica, bismuth oxychloride.

Drugs

Drugs are generally chemicals of very low molecular mass, which produce clinically beneficial effects by interacting with target bio-molecules in various biological processes in the body.

Type of Drug	Description	Example
<i>Analgesics</i>	<i>Relieve pain</i>	<i>Aspirin, Paracetamol, ibuprofen, diclofenac. Morphine, Codeine, Heroin etc.</i>
<i>Narcotic Analgesics (Opioids)</i>	<i>Relieve severe pain</i>	<i>Oxycodone, Morphine, Codeine, Heroin etc.</i>
<i>TranquilisersTranquillizers</i>	<i>Reduce anxiety and tension Have a hypnotic effect, so used in sleeping pills.</i>	<i>Maprobamate, Equanil, Chlordiazepoxide, Phenelzine etc.</i>
<i>Antibiotics (In 1929, Alexander Fleming discovered antibiotics from fungus Penicillium notatum)</i>	<i>Drugs to fight bacteria</i>	<i>Penicillin, Ofloxacin, amino glycosides, Chloramphenicol, Erythromycin, Tetracycline, etc.</i>
<i>Antiseptics</i>	<i>Drugs to reduce the growth of harmful microorganisms without affecting living tissues. They are applied to living tissues such as cuts or wounds</i>	<i>BithionolBiothionol (mixed in soaps), Tincture of iodine (2-3% solution of iodine in a mixture of alcohol and water), Dettol (Mix of chloroxylenol and terpineol), Dilute aqueous solution of Boric Acid, Cetyltrimethylammonium Bromide etc.</i>
<i>Antacids</i>	<i>Drugs to neutralize stomach acid, relieves heartburn.</i>	<i>Milk of magnesia (Magnesium hydroxide), Magnesium carbonate, Magnesium trisilicate, Aluminium phosphate, etc.</i>
<i>Antihistamines</i>	<i>Drugs to reduce/check the release of histamines and control allergic reactions.</i>	<i>Cetirizine, levocetirizine, desloratadine, brompheniramine, Terfenadine.</i>
<i>Antifertility Drug</i>	<i>Drugs used for preventing fertilization. Mix of estrogen and progesterone derivatives.</i>	<i>Norethindrone (Novestrol), Ethinylestradiol (estrogen derivative).</i>

Important Fuel Gases

Gas	Main Components	Secondary Components
CNG (Compressed Natural Gas)	Methane	Ethane, Propane, Butane, Nitrogen
LPG (Liquefied Petroleum Gas)	Propane, Butane	Ethane, Pentane, Propylene, Butylene
Biogas	Methane, Carbon Dioxide	Hydrogen, Nitrogen, Hydrogen Sulfide, Oxygen
Town Gas (Coal Gas)	Hydrogen, Methane, Carbon Monoxide	Carbon Dioxide, Nitrogen
Natural Gas	Methane	Ethane, Propane, Butane, Carbon Dioxide, Nitrogen

Important Chemical tests

Test	Analysis of
Phosphatase Test	Enzyme activity in dairy products
Benedict's Test	Reducing sugars (glucose, fructose)
Tollen's Test	Aldehydes
Biuret Test	Proteins (peptide bonds)
Fehling's Test	Reducing sugars (aldehydes vs ketones)
Iodine Test	Starch
Flame Test	Metal ions (characteristic colors)
Litmus Test	Acidity or alkalinity (pH)
Ninhydrin Test	Amino acids
Sodium Nitroprusside Test	Ketones

Methyl Orange/Bromothymol Blue Test	pH levels
Lucas Test	Alcohols (primary, secondary, tertiary)
Silver Nitrate Test	Halide ions (chlorides, bromides, iodides)
Kjeldahl Method	Nitrogen content in organic compounds
Molisch's Test	Carbohydrates

Major Textiles and Their Lifecycle Processes

Cotton

1. **Ginning:** Separation of cotton fibers from seeds.
2. **Carding:** Aligning fibers to form a continuous web.
3. **Spinning:** Twisting fibers to make yarn.
4. **Weaving/Knitting:** Interlacing yarn to make fabric.
5. **Finishing:** Processes like bleaching, dyeing, and printing to enhance appearance and performance.

Silk

1. *Sericulture: Rearing of silkworms for the production of silk.*
2. *Moulting: Process where silkworms shed their outer layer.*
3. *Reeling: Extracting silk fibers from cocoons.*
4. *Throwing: Twisting silk fibers to create a strong thread.*
5. *Weaving: Interlacing silk threads to create fabric.*

Wool

1. *Shearing: Removing wool from the body of an animal.*
2. *Scouring: Washing the raw, sheared wool to remove grease, dirt, and impurities.*
3. *Carding: Aligning fibers to form a continuous web.*
4. *Spinning: Twisting fibers to make yarn.*
5. *Weaving/Knitting: Interlacing yarn to create fabric.*

Synthetic Fibers (e.g., Polyester)

1. *Polymerization: Chemical process to create polymers.*

2. *Spinning: Extruding polymers through spinnerets to form fibers.*
3. *Drawing: Stretching fibers to align the polymers.*
4. *Weaving/Knitting: Interlacing fibers to create fabric.*
5. *Finishing: Processes to enhance properties such as strength, appearance, and performance.*

Other Examples of Chemistry in Everyday Life

The Expiration Date on Bottled Drinking Water:

- *The idea behind instilling an expiration on bottled drinking water is to standardize the packaging quality of it.*
- *What the actual expiration date signifies is if the expiration date is up, the taste of the water will be different as there is a chance of the chemicals in the packaging material ruining the quality of water.*

Major Discoveries

Scientist	Discovery
<i>Louis Pasteur</i>	<i>Vaccination, Pasteurization</i>
<i>Alexander Fleming</i>	<i>Discovery of enzyme lysozyme and antibiotic penicillin</i>
<i>Ernest Rutherford</i>	<i>Splitting of the atom, Discovery of the proton</i>
<i>Marie Curie</i>	<i>Discovery of Radium and Polonium</i>
<i>Dmitri Mendeleev</i>	<i>Periodic Table</i>
<i>Linus Pauling</i>	<i>Nature of the Chemical Bond, Vitamin C's importance</i>
<i>Antoine Lavoisier</i>	<i>Law of Conservation of Mass, Role of Oxygen in Combustion</i>
<i>Fritz Haber</i>	<i>Haber Process for Ammonia Synthesis</i>
<i>John Dalton</i>	<i>Atomic Theory, Law of Multiple Proportions</i>
<i>Richard Smalley, Robert Curl & Harold Kroto</i>	<i>Discovery of Fullerenes</i>
<i>Hermann Staudinger</i>	<i>Polymer Chemistry</i>
<i>Alfred Nobel</i>	<i>Invention of Dynamite</i>

3

CHAPTER

Basics of Everyday Physics

Measurement

Scalar Quantities:

- **Definition:** Quantities that have only magnitude and no direction.
- **Examples:** Mass, temperature, speed, distance, energy.
- **Characteristics:** Described by a single value; can be added or subtracted using simple arithmetic.

Vector Quantities:

- **Definition:** Quantities that have both magnitude and direction.
- **Examples:** Velocity, force, displacement, acceleration.
- **Characteristics:** Represented by arrows; require vector addition for combining; direction is crucial in describing them.

Every measurement has two parts:

- The first is a number (n) and the next is a unit (u).
- $Q = nu$.
- For Example, the length of an object = 40 cm.
- The number expressing the magnitude of a physical quantity is inversely proportional to the unit selected.

- If n_1 and n_2 are the numerical values of a physical quantity corresponding to the units u_1 and u_2 , then $n_1 u_1 = n_2 u_2$.
- For Example,
 - ✓ $2.8 \text{ m} = 280 \text{ cm}$
 - ✓ $6.2 \text{ kg} = 6200 \text{ g}$.

Fundamental Quantities

The quantities that are independent of other quantities are called fundamental quantities.

- The units that are used to measure these fundamental quantities are called fundamental units.
- There are four systems of units namely
 - ✓ C.G.S,
 - ✓ M.K.S,
 - ✓ F.P.S,
 - ✓ SI.
- The quantities that are derived using the fundamental quantities are called derived quantities.
- The units that are used to measure these derived quantities are called derived units.

Fundamental and Supplementary Physical Quantities in SI system

Fundamental Quantity	System of units		
	C.G.S.	M.K.S.	F.P.S.
Length	centimeter	Meter	foot
Mass	gram	Kilogram	pound
Time	second	Second	second

Physical quantity	Unit	Symbol
Length	Meter	m
Mass	kilogram	kg
Time	second	s
Electric current	ampere	A
Thermodynamic temperature	kelvin	K
Intensity of light	candela	cd
Quantity of substance	mole	mol

SI Units

- Most SI units are used in scientific research.
- SI is a coherent system of units.

Coherent System Of Units

- A coherent system of units is one in which the units of derived quantities are obtained as multiples or submultiples of certain basic units.
- SI system is a comprehensive, coherent and rationalized M.K.S. Ampere system (RMKSA system) and was devised by Prof. Giorgi.
- **Meter:** A meter is equal to 1650763.73 times the wavelength of the light emitted in vacuum due to electronic transition from $2p_{10}$ state to $5d_5$ state in Krypton-86.
 - ✓ But in 1983, 17th General Assembly of weights and measures adopted a new definition for the meter in terms of velocity of light.
 - ✓ According to this definition, a meter is defined as the distance traveled by light in vacuum during a time interval of $1/299,792,458$ of a second.

- **Kilogram:** The mass of a cylinder of platinum-iridium alloy kept in the International Bureau of weights and measures preserved at Sèvres near Paris is called one kilogram.
- **Second:** The duration of 9192631770 periods of the radiation corresponding to the transition between the two hyperfine levels of the ground state of cesium-133 atoms is called one second.
- **Ampere:** The current which when flowing in each of two parallel conductors of infinite length and negligible cross-section and placed one meter apart in vacuum, causes each conductor to experience a force of 2×10^{-7} newtons per meter of length is known as one ampere.
- **Kelvin:** The fraction of $1/273.16$ of the thermodynamic temperature of the triple point of water is called Kelvin.
- **Candela:** The luminous intensity in the perpendicular direction of a surface of a black body of area $1/600000 \text{ m}^2$ at the temperature of solidifying platinum under a pressure of 101325 Nm^{-2} is known as one candela.

➤ **Mole:** The amount of a substance of a system which contains as many elementary entities as there are atoms in 12×10^{-3} kg of carbon-12 is known as one mole.

➤ **Radian:** The angle made by an arc of the circle equivalent to its radius at the center is known as radian.

✓ $1 \text{ radian} = 57^{\circ} 17' 45''$.

➤ **Derived SI units with Special Names:**

Physical quantity	SI unit	Symbol
Frequency	hertz	Hz
Energy	joule	J
Force	newton	N
Power	watt	W
Pressure	pascal	Pa
Electric charge or quantity of electricity	coulomb	C
Electric potential difference and emf	volt	V
Electric resistance	ohm	Ω
Electric conductance	siemen	S
Electric capacitance	farad	F
Magnetic flux	weber	Wb
Inductance	henry	H
Magnetic flux density	tesla	T
Illumination	lux	Lx
Luminous flux	lumen	Lm

Important Measuring Instruments

Instrument	Function
Micrometer	Measures small dimensions with high precision (typically in the range of microns).
Vernier Caliper	Measures internal and external dimensions, as well as depth and step measurements.
Anemometer	Measures the speed and velocity of wind or airflow.
Balance (Analytical)	Measures the mass of objects with high precision.
Voltmeter	Measures the potential difference (voltage) between two points in a circuit.
Ammeter	Measures electric current in a circuit.

<i>Manometer</i>	<i>Measures the pressure of gases or liquids.</i>
<i>Seismometer</i>	<i>Detects and measures seismic waves caused by earthquakes or other ground motion.</i>
<i>Hygrometer</i>	<i>Measures the humidity level in the air.</i>
<i>Sphygmomanometer</i>	<i>Measures blood pressure.</i>
<i>Spectrophotometer</i>	<i>Measures the intensity of light absorbed by a sample at various wavelengths.</i>
<i>Tachometer</i>	<i>Measures the speed of rotation of an object (e.g., engine RPM).</i>
<i>Lux Meter</i>	<i>Measures light intensity in an area.</i>
<i>Altimeter</i>	<i>Measures altitude, typically in aviation and mountainous regions.</i>
<i>Pulse Oximeter</i>	<i>Measures oxygen saturation in blood.</i>

Everyday Equipments and Physics behind them

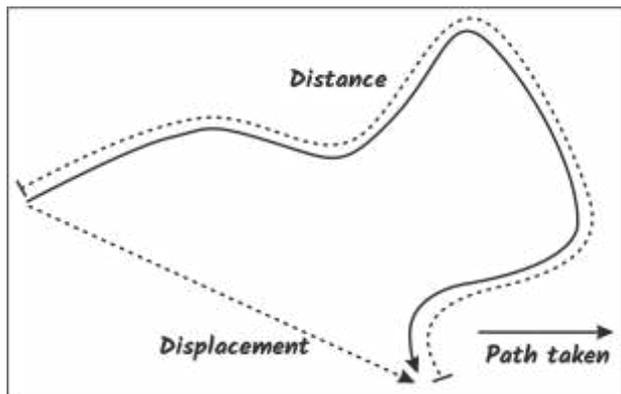
Equipment	Physical Phenomenon
<i>Stethoscope</i>	<i>Reflection of sound</i>
<i>Remote Control</i>	<i>Infrared Radiation</i>
<i>Microwave oven</i>	<i>Electromagnetic Waves</i>
<i>Refrigerator</i>	<i>Thermodynamics</i>
<i>Washing Machine</i>	<i>Centrifugal Force</i>
<i>Electric Fan</i>	<i>Electromagnetic induction</i>
<i>Light Bulb</i>	<i>Incandescence</i>
<i>Smartphone</i>	<i>Radio Waves, Touch sensitivity</i>
<i>Television</i>	<i>Electromagnetic Waves</i>
<i>Air Conditioner</i>	<i>Refrigeration Cycle</i>
<i>Electric Kettle</i>	<i>Electrical Resistance Heating</i>
<i>Camera</i>	<i>Optics (Lens Focusing)</i>
<i>Speaker</i>	<i>Electromagnetic Induction</i>
<i>Hair Dryer</i>	<i>Convection Heating</i>
<i>Computer</i>	<i>Semiconductor Electronics</i>
<i>Photovoltaic cell</i>	<i>Solar energy (Photoelectric Effect)</i>

Motion

- **An object is said to be in motion if it changes its position with time.**
- **A body which does not move is said to be at rest, motionless, or stationary.**

- **An object's state of motion or rest cannot change unless it is acted upon by a force.**
- **Described in terms of displacement, velocity, and displacement.**

Displacement



- Shortest distance from the initial to the final position of the object.
- Represents the length and direction of the straight path.
- Vector quantity as it has both magnitude and direction

Distance

- Scalar quantity measuring only the length of path.

Velocity

- Speed in a given direction.
- Describes only how fast an object is moving and direction of object's motion
- A vector quantity.
- Unit - meter per second (m/s).

Acceleration

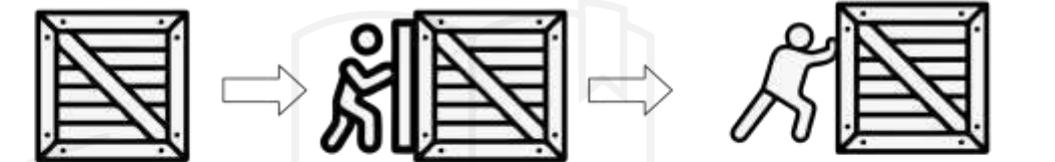
- Rate of change of velocity with time.
- Rate at which an object speeds up or slows down.
- Positive Acceleration: If the object speeds up.
- Negative Acceleration: If the object slows down.
- A vector quantity.
- SI unit: meter per second squares (m/s²).

Types of Motion

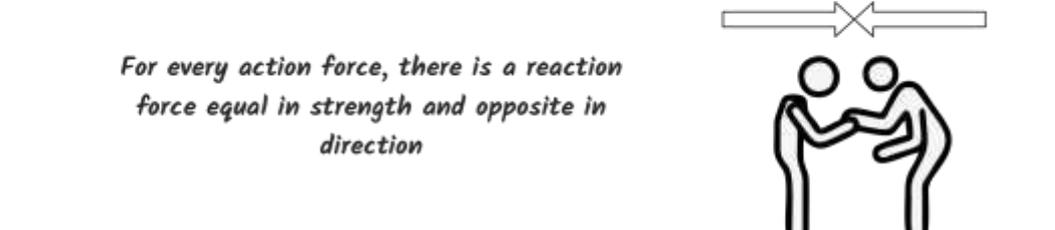
Oscillating Motion	<ul style="list-style-type: none"> ➤ Back and forth oscillation causes this motion ➤ If a thing repeats the motion cycle after a certain period is considered to be oscillating. ➤ Example: sprinkler system, the pendulum of a clock, sound waves.
Linear Motion (Uniform + Non Uniform)	<ul style="list-style-type: none"> ➤ Straight Line Path: The motion occurs along a straight line (either uniform or non-uniform). ➤ Velocity: In uniform linear motion, velocity remains constant, while in non-uniform motion, velocity changes. ➤ Acceleration: In uniform motion, acceleration is zero, while in non-uniform motion, acceleration may be constant or variable.
Uniform motion:	<ul style="list-style-type: none"> ➤ Constant Speed: The object moves at a constant speed along a straight path. ➤ Equal Distance in Equal Time: The object covers equal distances in equal intervals of time. ➤ No Acceleration: There is no change in the velocity or direction of motion.

<p>Non-uniform motion:</p>	<ul style="list-style-type: none"> ➤ Varying Speed: The speed of the object changes continuously over time. ➤ Unequal Distance in Equal Time: The object covers unequal distances in equal intervals of time. ➤ Acceleration/Deceleration: The object may speed up (acceleration) or slow down (deceleration) during its motion.
<p>Circular Motion</p>	<ul style="list-style-type: none"> ➤ Motion along a Circular Path: The object moves along a circle, maintaining a constant distance from a fixed point (center). ➤ Centripetal Force: A force acts towards the center of the circle to keep the object in its circular path. ➤ Constant Speed, Changing Velocity: The object may move at a constant speed, but its direction constantly changes, so velocity is not constant.

Laws of Motion

<p>Newton's First Law of Motion</p>	 <p>An object at rest will remain at rest</p> <p>Unless acted on by an unbalanced force</p> <p>An object in motion will continue with constant speed and direction unless acted on by unbalance force</p>
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<p>Newton's Second law of Motion</p>	<p>The acceleration of an object depends on the mass of the object and the amount of force of force applied</p>  <p>Force</p> <p>Acceleration</p>
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<p>Newton's Third law of Motion</p>	<p>For every action force, there is a reaction force equal in strength and opposite in direction</p> 
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Inertia:

- **Resistance of any physical object to any change in its velocity.**
- **Includes changes to the object's speed, or direction of motion.**
- **Tendency of objects to keep moving in a straight line at a constant speed or to remain in state of rest when no forces act upon them, according to the first law of motion.**

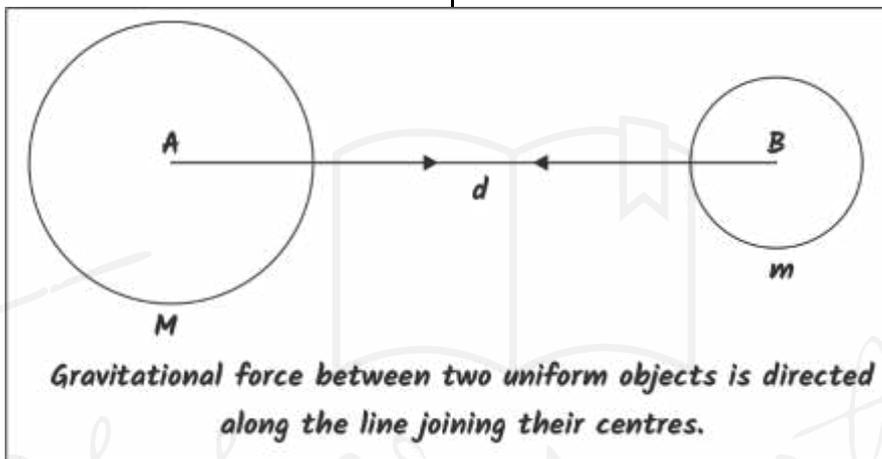
Gravity

- Force that attracts a body towards centre of earth, or towards any other physical body having mass.
- Every object that has mass exerts a gravitational pull or force on every other mass.
- Strength of this pull depends on the masses of objects
- Gets weaker with distance.
- Keeps planets in orbit around sun and moon around the Earth

- First discovered in 1687 by Sir Isaac Newton.

Universal law of gravitation:

- Every object in the universe attracts every other object with a force which is proportional to the product of their masses and inversely proportional to the square of the distance between them.
- The force is along the line joining the centres of two objects.



Formula:

$$F = \frac{G \times M \times m}{d^2}$$

- Here M and m = masses of the objects interacting
- d- distance between the center of the masses
- G -gravitational constant ($6.674 \times 10^{-11} \text{ m}^3 \cdot \text{kg}^{-1} \cdot \text{s}^{-2}$)

Free Fall due to Gravity

Free fall: Motion of an object under the influence of gravity alone, with no air resistance.

Acceleration due to gravity (g): Constant at 9.8 m/s^2 near Earth's surface, independent of mass.

Mass: The acceleration in free fall does not depend on the mass of the object.

Dropped object: Initial velocity (u) is zero when dropped from a height.

Thrown upwards: Final velocity (v) becomes zero at the highest point of the upward motion.

Same acceleration: All objects near Earth's surface experience the same acceleration due to gravity.

Energy

- **Capacity of a body to do work.**
- **SI unit:** Joule (J).

Forms of Energy

Kinetic Energy: Energy possessed by an object due to its motion.

Potential Energy: Energy stored in an object due to its position or state.

Thermal Energy: Energy related to the temperature of an object, due to the motion of its particles.

Conversion from one form to another

Energy Conversion	Instrument	Energy Form Converted
Kinetic → Potential	Elevators, Waterfalls	Kinetic to Potential Energy
Potential → Kinetic	Falling Object, Pendulum	Potential to Kinetic Energy
Chemical → Thermal	Stove, Combustion Engine	Chemical to Thermal Energy
Electrical → Thermal	Electric Heater, Toaster	Electrical to Thermal Energy
Electrical → Mechanical	Electric Motor, Fan	Electrical to Mechanical Energy
Mechanical → Electrical	Generator, Dynamo	Mechanical to Electrical Energy
Radiant → Chemical	Photosynthesis (in plants)	Radiant to Chemical Energy
Mechanical → Sound	Loudspeaker, Bell	Mechanical to Sound Energy

Chemical Energy: Energy stored in chemical bonds, released during chemical reactions.

Electrical Energy: Energy from the movement of electrons through a conductor.

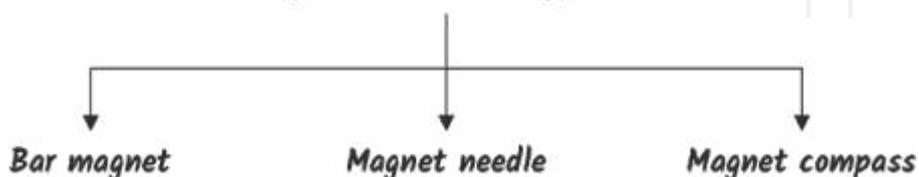
Nuclear Energy: Energy stored in the nucleus of atoms, released during nuclear reactions.

Radiant (Light) Energy: Energy carried by electromagnetic waves, including light.

Magnetism

Magnet:

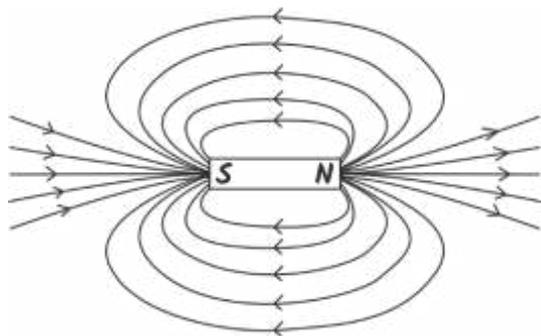
Type of artificial magnets



- **An object that attracts objects made of iron, cobalt and nickel.**
- **Use:**
 - ✓ in refrigerators.
 - ✓ in radio and stereo speakers.
 - ✓ in audio and video cassette players.
 - ✓ in children's toys and;
 - ✓ on hard discs and floppies of computers.

- **Properties:**
 - ✓ A freely suspended magnet always points towards north and south direction.
 - ✓ Pole which points toward north direction - north pole.
 - ✓ Pole which points toward south direction - south pole.
 - ✓ Like poles repel each other while unlike poles attract each other.

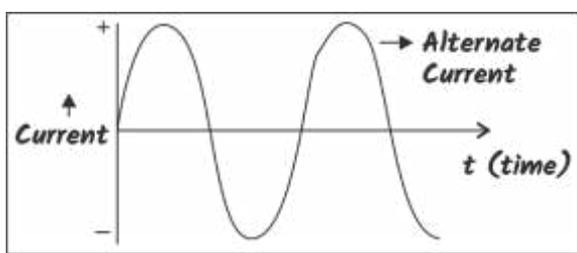
Magnetic field



- Influence of force surrounding a magnet.
- Force exerted by a magnet in a magnetic field detected using a compass or any other magnet.
- Represented by magnetic field lines.
- A quantity that has both direction and magnitude.
- Properties:
 - ✓ Inside magnet - direction of field lines- south pole to north pole. Thus magnetic field lines are closed curves.
 - ✓ Relative strength of magnetic field is shown by degree of closeness of field lines.
 - ✓ No two field-lines cross each other.

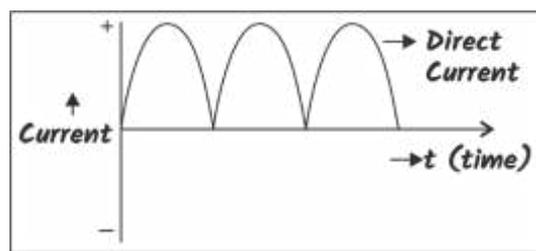
Electric Current

Alternate Current



- Current in which direction is changed periodically.
- Frequency of A.C in India is 50 Hz.
- Transmitted to a long distance without much loss of energy.

Direct Current



- Current that flows in one direction only.
- Electrochemical cells produce direct current.

Advantages of A.C over D.C

- Cost of generator of A.C << D.C.
- A.C easily converted to D.C.
- A.C controlled by use of choke - less loss of power whereas, D.C controlled using resistances - high energy loss.
- AC transmitted over long distances without much loss of energy.
- AC machines are stout and durable and do not need much maintenance.

Disadvantages of AC

- Cannot be used for electrolysis or showing electromagnetism as it reverses its polarity.
- More dangerous than DC.

Electromagnetic Spectrum

The electromagnetic spectrum encompasses all types of electromagnetic radiation, ranging from low-energy radio waves to high-energy gamma rays. It includes various wave types, such as radio, microwave, infrared, visible light, ultraviolet, X-rays, and gamma rays, classified by wavelength and frequency. These waves travel at the speed of light and differ in their energy, penetration ability, and practical applications.

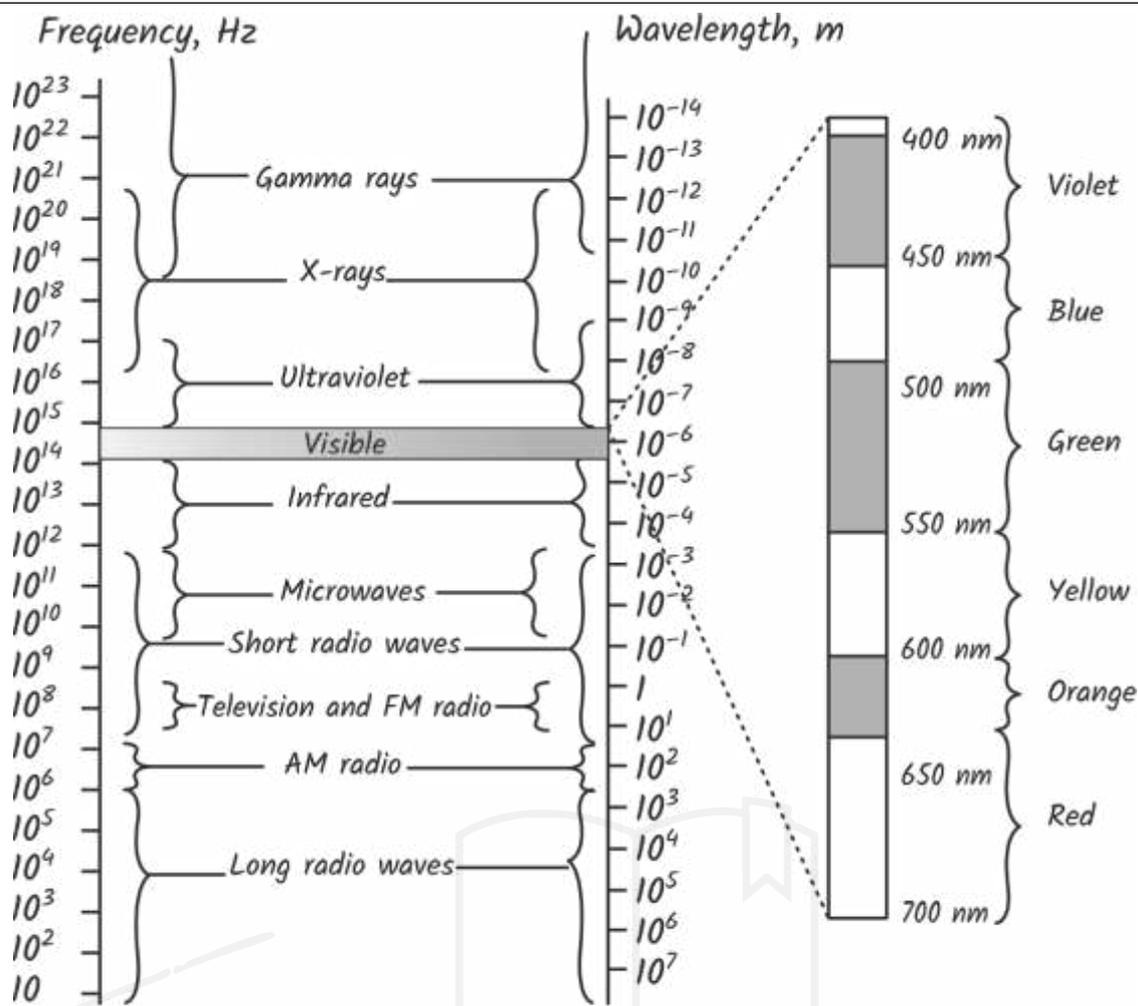


Figure: The electromagnetic spectrum, with common names for various part of it. The various regions do not have sharply defined boundaries.

Radio Waves	<ul style="list-style-type: none"> ➤ Used in radio (AM and FM bands) and television communications systems. ➤ Cellular phones use them to transmit voice communication in UHF band.
Microwaves	<ul style="list-style-type: none"> ➤ Suitable for radar systems used for aircraft navigation, speed guns used to time fast balls, tennis-serves and automobiles. ➤ Microwave oven use selective frequency of microwaves to match the resonant frequency of water molecules to efficiently transfer wave energy to kinetic energy of molecules. It raises the temperature of food containing water.
Infrared Waves	<ul style="list-style-type: none"> ➤ Infrared lamps used in physical therapy ➤ Maintains earth's average temperature through Greenhouse effect ➤ Infrared detectors are used in Earth Satellites ➤ Semiconductor light emitting diodes, emitting infrared lights are used in TV/AC remotes, video recorders and hi-fi systems. ➤ Snakes can detect infrared waves

Visible rays	➤ Helps us see different objects and different colours
Ultraviolet rays	<ul style="list-style-type: none"> ➤ Sun is an important source of UV-rays and most of it gets absorbed by the Ozone Layer in the atmosphere ➤ Exposure to UV radiations induces production of more melanin, causing skin tanning (Ordinary glass absorbs UV-rays thus, protect from tanning) ➤ UV is produced by welding arcs thus; welders wear special glass goggles or face masks for protection ➤ Used in LASIK eye surgery ➤ UV lamps used to kill germs in water purifiers
X-rays	➤ Used as a diagnostic tool in medicine and treatment of cancer
Gamma rays	➤ Used in medicine to destroy cancer cells

Utility of electro-magnetic waves based on their frequency

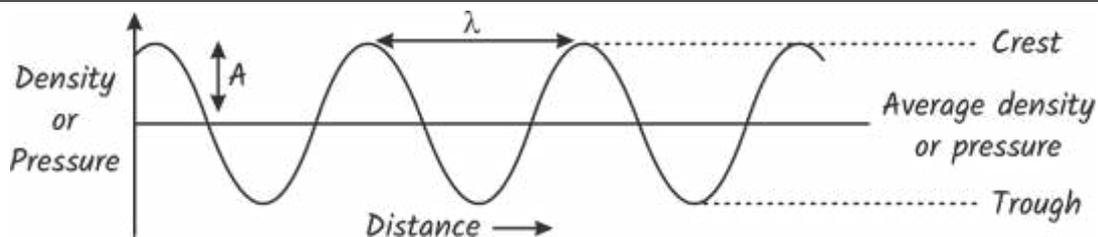
Frequency Band	Frequency Range	Mode of Travel	Examples
Low Frequency (LF)	30 KHz-300 KHz	Ground Waves	Am Radio
Medium Frequency (MF)	300 KHz-3 MHz	Ground and sky Waves	Am radio broadcasting
High frequency (Hf)	3 MHz-30 MHz	Sky Waves	Shortwave radio
Very high Frequency (VHF)	30 MHz-300s MHz	Space waves	Fm radio, television broadcasts
Ultra High Frequency (UHF)	300 Mhz-3 GHz	Space waves	Television Broadcasts, Mobile phones
Super High Frequency (SHF)	3 GHz-30 GHz	Space waves	Satellite communications, radar
Extremely High Frequency (EHF)	30 GHz-300 GHz	Space waves	Advanced radar Systems, experimental communications

Sound

- Sound is a form of energy which produces a sensation of hearing in our ears. Sound is a mechanical wave and needs a material medium like air, water, steel etc. for its propagation. It cannot travel through vacuum.

Important terms related to sound-

1. **Wavelength (Lemda)**-The distance between two consecutive compressions (C) or two consecutive rarefactions (R).
2. **Frequency**-The number of oscillations per unit time is the frequency of the sound wave



Propagation of Sound Waves

1. **Medium Requirement:** Sound requires a medium (solid, liquid, or gas) to propagate. It cannot travel through a vacuum, as there are no particles to transmit the vibrations.
2. **Mechanism of Propagation:** Sound waves propagate through the vibration of particles in the medium. These vibrations create compressions (high-pressure regions) and rarefactions (low-pressure regions) that move in the direction of the wave.
3. **Speed of Sound:** The speed of sound varies depending on the medium's density and elasticity. It travels faster in denser mediums like solids and slower in gases.
4. **Wavelength and Frequency:** The **wavelength** of sound depends on its frequency and the speed of propagation in the medium. As the frequency increases, the wavelength decreases (inverse relationship).
5. **Effect of Medium Change:**
 - ✓ **Speed and Wavelength:** When sound passes from one medium to another (e.g., from air to water), its speed and wavelength change because of the different properties of the media, like density and elasticity.
 - ✓ **Frequency:** The **frequency** of the sound wave typically **remains constant** when transitioning between media. It does not change because the source of the sound remains the same.

Types of Sound Waves:

1. **Infrasound:**
 - ✓ **Frequency:** Below 20 Hz.
 - ✓ **Features:** Cannot be heard by humans; used for detecting natural events like earthquakes.
2. **Audible Sound:**
 - ✓ **Frequency:** 20 Hz to 20,000 Hz.
 - ✓ **Features:** The range of sound audible to the human ear.
3. **Ultrasound:**
 - ✓ **Frequency:** Above 20,000 Hz.
 - ✓ **Features:** Used in medical imaging, cleaning, and industrial applications.
4. **Hypersound:**
 - ✓ **Frequency:** Above 1 GHz.
 - ✓ **Features:** Used in scientific research and high-frequency applications.

3. **Sonic boom** - When a sound, producing source (Bullets, Jets) moves with a speed higher than that of sound, it produces shock waves in air. These shock waves carry a large amount of energy. The air pressure variation associated with this type of shock waves produces a very sharp and loud sound called the "sonic boom". The shock waves produced by a supersonic aircraft have enough energy to shatter glass and even damage buildings.
4. **Reverberation**- The repeated reflection that results in the persistence of sound is called reverberation. Stethoscope works on this principle.
5. **Refraction of Sound Waves** - When a sound wave bends due to changes in its speed as it passes through a medium. The density of a gas decreases with the rise in temperature, inversely proportional.
6. **Diffraction of Sound Waves** - Ability of the sound waves to bend around obstacles is known as diffraction. For example, sound waves diffract around walls and door openings to carry sound from one room to another.

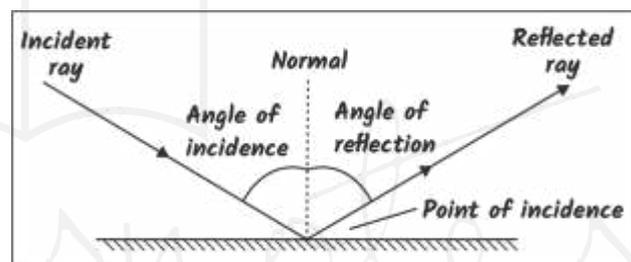
Optics

- **Branch of physics concerned with light and its behavioural pattern and properties.**
- **Used to describe behaviour of visible light, infrared light, and ultraviolet.**

Light

- **Form of energy in form of an electromagnetic wave that helps us to see objects.**
- **Wavelength: 400-700 nanometres.**
- **Primary source of light: Sun**
- **Properties:**
 - ✓ **Does not require any material medium to travel.**
 - ✓ **Travels in a straight line.**
 - ✓ **Dual nature-** travels as a wave as well as particle.
 - ✓ **Casts shadow.**

Reflection



- **one of the primary properties of light.**
- **Bouncing back of light** when it strikes a polished surface.
- **Incident light:** Light which falls on the surface.
- **Reflected light:** Light which bounces back after reflection.
- **Angle of incidence:** Angle between incident ray and normal.
- **Angle of reflection:** Angle between the reflected ray and the normal.

Mirror

- **Surface which can reflect the light.**

➤ **Types:**

1. **Plane Mirror:**

- Reflecting surface is a plane.

2. **Spherical Mirror:**

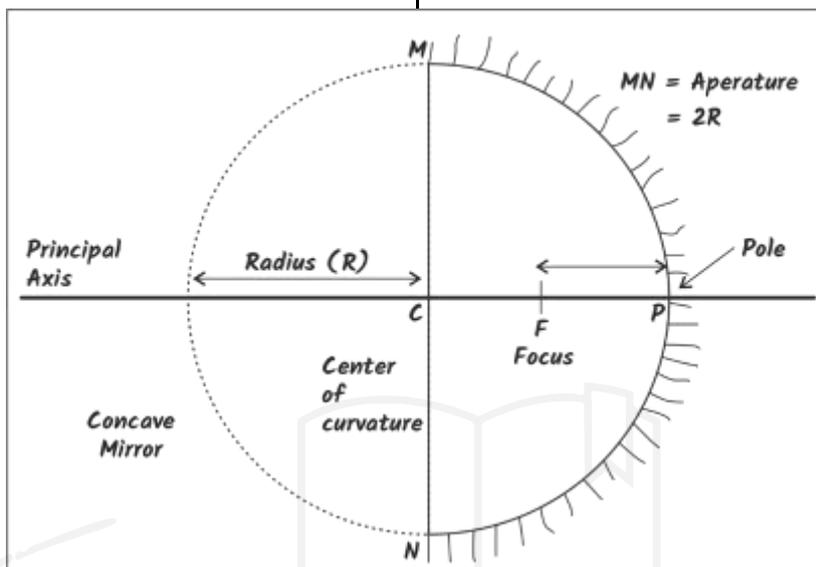
- Reflecting surface is part of the hollow sphere.
- 2 types:

A. **Convex mirror:**

- Reflecting surface is convex.
- Diverges light.

B. **Concave mirror:**

- Reflecting surface is concave.
- Converges the light.
- **Parameters of Mirror:**



✓ **Center of Curvature:**

- Centre of hollow sphere of which mirror is a part.

✓ **Radius of curvature:**

- Radius of hollow sphere of which mirror is a part.

✓ **Pole:**

- Centre of mirror (middle point).

✓ **Principal axis:**

- Line joining pole and center of curvature.

✓ **Aperture:**

- Size of mirror.

✓ **Principal Focus:**

- Point on principal axis, where all incident rays parallel to principal axis converge or diverge after reflection through mirror.

✓ **Focal Length:**

- Distance between pole and focus point.

- **Use of Concave Mirror:** Makeup mirror, reflector in torches, in headlights of cars and searchlights, doctor's head-mirrors, solar furnace, etc.

- **Use of Convex Mirror:** Rear view mirror in vehicles, as shop security mirrors, etc.

Refraction

- **Bending of light at the interface of two different mediums.**

- **If the velocity of light in medium is more, then medium is called optical rarer.**

- ✓ Eg, air or vacuum is more optical rarer.

- **If the velocity of light in medium is less, then medium is called optical denser.**

- ✓ Eg, glass is more denser than air.

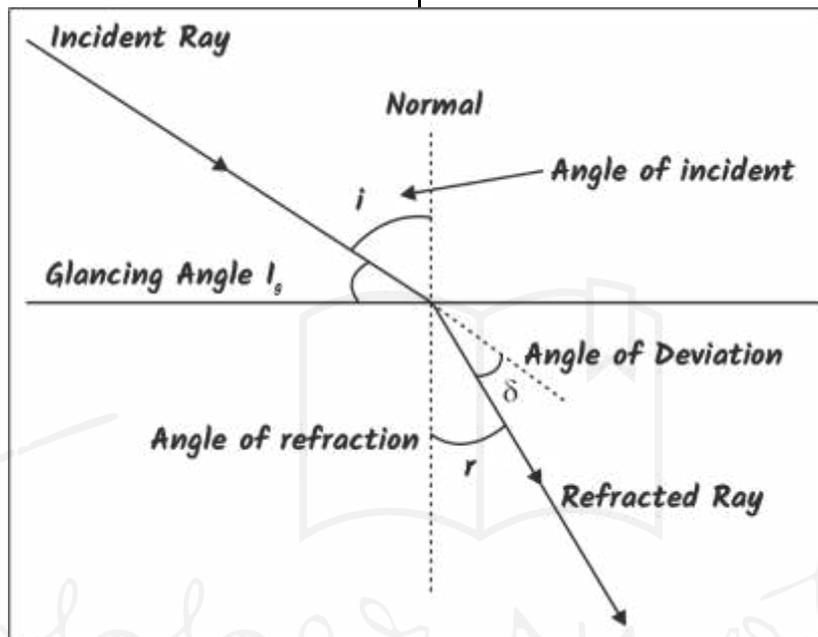
- **Refractive Index:**

- Represents amount or extent of bending of light when it passes from one medium to another.
- 2 types:
 - ✓ Relative refractive index
 - Refractive index of medium with respect to other medium
 - Refractive index of medium 1 wrt medium 2

$$= \frac{\text{Speed of light in medium 1}}{\text{Speed of light in medium 2}}$$

- ✓ Absolute refractive index
 - Refractive index of medium with respect to air or vacuum.
 - Absolute refractive index of medium (m)

$$= \frac{\text{Speed of light in air}}{\text{Speed of light in medium}}$$



- Incident ray: Incoming ray on the refracting surface.
- Refracted ray: An outgoing ray from the refracting surface.
- Angle of incidence (i): Angle between incident rays and perpendicular line (normal) at the point of incidence.
- Angle of refraction (r): Angle between refracted rays and perpendicular line (normal) at the point of incidence.

Lens

- Transparent refracting medium bounded by two surfaces in which at least one surface is curved.

- 2 types:
 - ✓ Convex lens/ converging lenses
 - Thicker at the centre than at the edges.
 - ✓ Concave lens/ Diverging lenses
 - Thinner at the centre than at the edges.

Total Internal Reflection (TIR)

- When a beam of light strikes water, a part of the light is reflected, and some part of the light is refracted.

Image formation by Concave Mirror

Position of Object	Position of Image	Image Size	Nature of Image	Ray Diagram
Within focus (Between P and F)	Behind the mirror	Enlarged	Virtual and erect	
At focus	At infinity	Highly Enlarged	Real and Inverted	
Between F and C	Beyond C	Enlarged	Real and Inverted	
At C	At C	Equal to object	Real and Inverted	
Between Infinity and C	Between F and C	Diminished	Real and Inverted	
At Infinity	At focus (F)	Highly Diminished	Real and Inverted	

Image formed by Convex Mirror

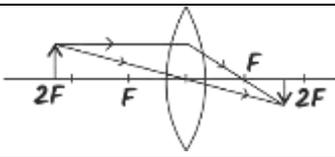
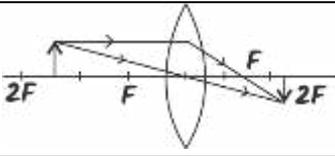
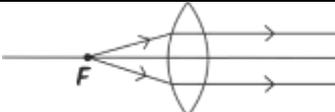
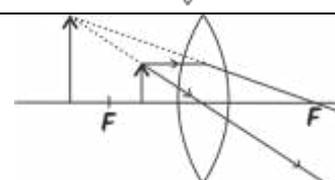
Position of Object	Position of Image	Image of Size	Nature of Image	Ray Diagram
Anywhere between pole P and Infinity	Behind the mirror between P and F	Diminished	Virtual and erect	
At infinity	Behind the mirror at Focus (F)	Highly Diminished	Virtual and erect	

Image formation by Concave Lens

Object Position	Image Position	Nature and Size of Image	Ray Diagram
At Infinity	At Focus (F)	Highly diminished, Virtual, Upright	
finite distance	Between Focus (F) and Optical Centre	Diminished, Virtual Upright	

Image formation by Convex Lens

Object Position	Image Position	Nature of the Image	Ray Diagram
Infinity	On Focus F2	Real and Inverted, Highly Diminished	
Beyond 2F1	Between F1 and F2	Real and Inverted, Diminished	

At 2F1	At 2F2	Real and Inverted, of same size	
Between F1 and 2F1	Beyond 2F2	Real and Inverted, enlarged	
At Focus F1	At infinity	Real and Inverted	
Between F1 and Optical Centre O	On the same side of the lens as the object	Real and Inverted, enlarges	

Nuclear Physics

Nuclear fission

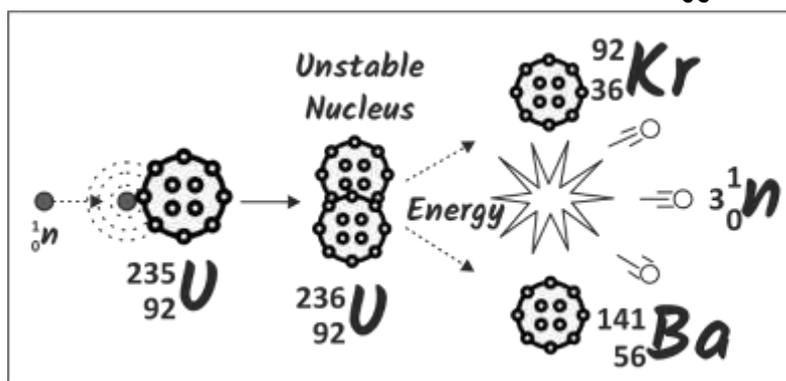
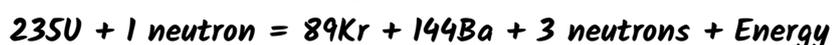
- Reaction where **nucleus of an atom splits into two or more smaller nuclei**, while releasing energy.
- **These extra neutrons hits** other surrounding U-235 atoms,

- ✓ which will also split and generate **additional neutrons** in a multiplying effect,
- ✓ thus **generating a chain reaction** in a fraction of a second.

- **Release of energy** each time the reaction occurs : in the **form of heat and radiation.**
- **The heat can be converted into electricity** in a nuclear power plant.
- **Most of the Nuclear power plants are nuclear fission based.**

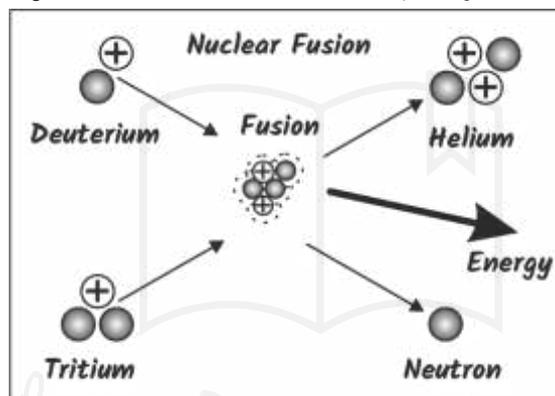
Fission of Uranium Atom

- Naturally occurring Uranium is in the form of its isotope U-238(around 99%) and rest in the form of U-235.
- **Only U-235 can undergo nuclear fission easily** to any great extent.
- **Enriched Uranium** : used in nuclear power applications whose **concentration varies from Low Enriched Uranium (LEU) having 3 to 5% enrichment to higher levels.**
- **When U-235 absorbs a slow moving neutron - a nuclear fission reaction takes place.**



Nuclear fusion

- Reaction in which two or more lighter nuclei join together to form one or more heavier elements.
- Products of fusion reactions : usually different atomic nuclei and sub-atomic particles such as neutrons and protons.
- Change in mass takes place between the reactants and products & manifested as either the release of energy or absorption of energy.
- Nuclear fusion is opposite to nuclear fission where the heavy nucleus splits apart.
- A large amount of heat and pressure is required for nuclear fusion reaction.
- Nuclear fusion - takes place in the sun and other active stars.
- In the Sun : hydrogen nuclei combine together to produce helium(Nuclear Fusion).
- Energy potential of nuclear fusion : 1st exploited in thermonuclear weapons, or hydrogen bombs etc.
- Tech to generate electricity from fusion - not developed yet.



Radiation

- It is termed as the energy travelling through space.
- Sunlight is one of the common forms of radiation that delivers heat, sunshine, and light.

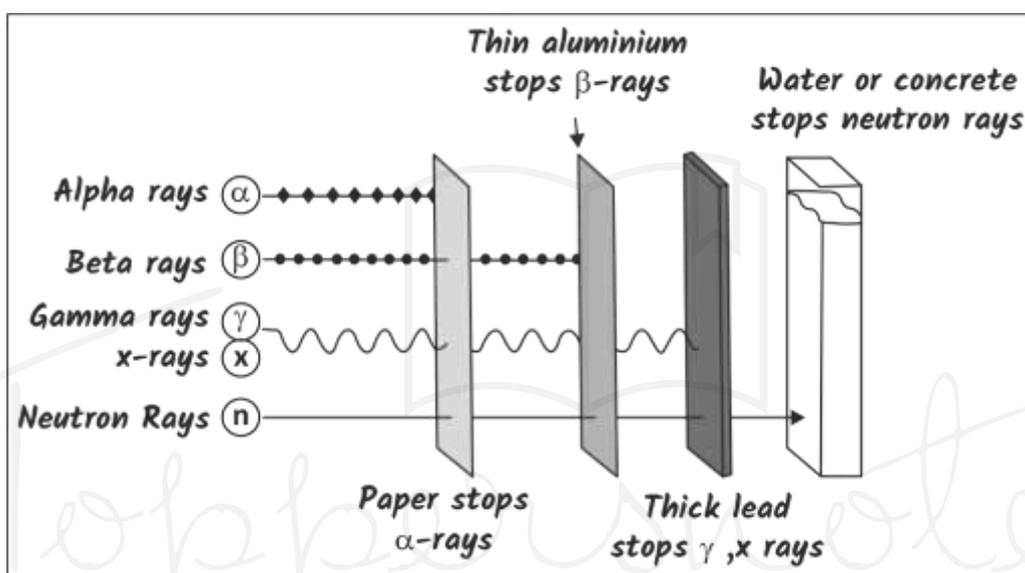
- Prolonged exposure to certain radiations can lead to health problems that can eventually lead to death.
- Beyond ultraviolet radiation there is higher-energy radiation exists and they are used in medicine.
- Humans - get these radiations in low doses(from space, air, Earth and rocks)

Types Of Radiation

Ionizing radiation	Non-ionizing radiation
<ul style="list-style-type: none"> ➤ A radiation with sufficient energy that produces ions in the matter at the molecular level. 	<ul style="list-style-type: none"> ➤ has insufficient energy to cause ionization. ➤ can produce heat (Ex. food cooked in a microwave oven). ➤ Upon interaction with human body may cause thermal injury or burns.

<ul style="list-style-type: none"> ➤ can remove tightly bound electrons from the orbit of an atom causing the atom to become charged or ionized. ➤ Upon interaction with human body may cause damage to DNA and denaturation of proteins. <p>Types of ionizing radiation</p> <ul style="list-style-type: none"> ➤ Alpha particles ➤ Beta particles ➤ Gamma rays ➤ X-rays 	<p>Types of non-ionizing radiation:</p> <ul style="list-style-type: none"> ➤ Ultraviolet radiation ➤ Visible light ➤ Infrared ➤ Microwave ➤ Radio waves ➤ Very Low Frequency (VLF) ➤ Extremely Low Frequency (ELF) ➤ Thermal radiation ➤ Black-body radiation
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Types of nuclear radiation



<p>α-rays</p>	<ul style="list-style-type: none"> ➤ Most energetic form of radioactive decay (has the greatest mass). <p>Features:</p> <ul style="list-style-type: none"> ➤ They are helium nuclei containing two protons and two neutrons. ➤ Due to large mass they travel relatively slowly (about 6% of the speed of light) but their high energy produces considerable ionisation. ➤ Lose energy over a short distance and do not penetrate far into matter (a piece of paper will block the radiation). ➤ An α-particle loses some of its energy each time it ionises another molecule.
<p>β-rays</p>	<ul style="list-style-type: none"> ➤ Very fast electrons (move at up to 98% of the speed of light). <p>Features:</p> <ul style="list-style-type: none"> ➤ They have a low mass (so high velocities & less energy than α-particles). ➤ They are emitted by nuclei that have too many unstable neutrons. ➤ These nuclei attain a more stable state (lower energy state) <ul style="list-style-type: none"> ✓ when a neutron changes into a proton and electron. ➤ The electron is immediately emitted from the nucleus as a β-particle.

γ-rays	<ul style="list-style-type: none"> ➤ Electromagnetic radiation of very high frequency. ➤ They have the highest power of penetration. ➤ Other electromagnetic spectrum components : include X-rays, ultraviolet, visible, infrared, microwave and radio waves. <p>Features:</p> <ul style="list-style-type: none"> ➤ carry a large amount of energy and can also travel via thick concrete and thin lead. ➤ least ionizing and very difficult to resist from entering the body. ➤ Often used in medical applications to treat cancer & sterilize medical devices.
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Radioactivity

- **A phenomenon of the disintegration of heavy elements into comparatively lighter emission in the form of radiations.**
- **A property exhibited by certain matter of emitting energy and subatomic particles spontaneously.**
- **An unstable nucleus : decomposes spontaneously, or decay, into a more stable configuration.**
- **Radioactive decay : a property of several naturally occurring elements & of artificially produced isotopes of the elements.**

Half life:

- **time required for one-half of any given quantity of the isotope to decay.**
- **Half-lives range from $>10^{24}$ years for some nuclei to $<10^{-23}$ seconds.**

Daughter:

- **product of a radioactive decay process**
- **may itself be unstable and will decay too.**
- **process continues until a stable nuclide has been formed.**

Occurrence of radioactivity

- **Some types of radioactivity occur naturally on Earth.**
- **Natural radioactivity includes species produced in the upper atmosphere by cosmic ray bombardment.**
- **few species have half-lives comparable to the age of the elements (about 6×10^9 years).**
- **For example : Uranium-238, Uranium-235, and Thorium-232, Potassium-40 etc.**

Radiocarbon Dating

1. **Definition:** Radiocarbon dating is a method used to determine the age of organic materials by measuring the amount of carbon-14 (C-14) they contain.
2. **Carbon-14 Formation:** Carbon-14 is a radioactive isotope of carbon formed in the atmosphere when cosmic rays interact with nitrogen-14 (N-14). This C-14 gets absorbed by living organisms through carbon dioxide during their lifetime.

3. **Principle:** When an organism dies, it stops absorbing carbon-14. The existing C-14 starts to decay at a known rate (half-life of about 5730 years). By measuring the remaining C-14 in a sample, scientists can estimate the time since the organism's death.

4. **Process:**

- ✓ **Sample Collection:** Organic material like wood, bone, or shell is collected.
- ✓ **Measurement:** The amount of C-14 is measured using techniques like Accelerator Mass Spectrometry (AMS).
- ✓ **Age Calculation:** The ratio of C-14 to C-12 (a stable isotope) is used to calculate the age of the sample.

Limitations for Dating Older Materials

1. **Half-Life of Carbon-14:** The half-life of C-14 is approximately 5730 years. After about 30,000 years (roughly five half-lives), the amount of C-14 remaining in a sample is extremely small, making it difficult to measure accurately.

2. **Low C-14 Levels:** For materials older than 30,000 years, the C-14 level becomes so low that it is challenging to distinguish it from background radiation and contamination, leading to less accurate results.

3. **Instrument Sensitivity:** Current instruments have limitations in detecting extremely low levels of C-14. This reduces the precision of age estimates for very old samples.

4. **Alternative Methods:** For dating materials older than 30,000 years, other methods like uranium-thorium dating or potassium-argon dating are often used, as they are more suitable for older samples due to their longer half-lives and different decay mechanisms.

Major Physical discoveries and Scientists associated

Scientist	Discovery
Wilhelm Conrad Roentgen	Discovery of X-Rays
Niels Bohr	Bohr Model of the Atom
Albert Einstein	Theory of Relativity, Photoelectric Effect
Michael Faraday	Electromagnetic Induction, Laws of Electrolysis
JJ. Thomson	Discovery of the Electron
Henri Becquerel	Discovery of Radioactivity
Edwin Hubble	Expanding Universe, Hubble's Law
Max Planck	Quantum Theory, Planck's Constant
Heinrich Hertz	Discovery of Electromagnetic Waves
Werner Heisenberg	Uncertainty Principle
Erwin Schrödinger	Schrödinger Equation, Quantum Mechanics
Paul Dirac	Quantum Mechanics, Quantum Field Theory

4

CHAPTER

Structure of Human Body

Cell

- **Simplest and most basic unit of life.**
- **Discovered:** Robert Hooke (1665)
- **All living things made up of cells- structural, functional, and biological unit of life.**

- **Has the ability to duplicate itself on its own.**
- **aka "building blocks of life."**

Cell Structure and its components

Cell Organelles

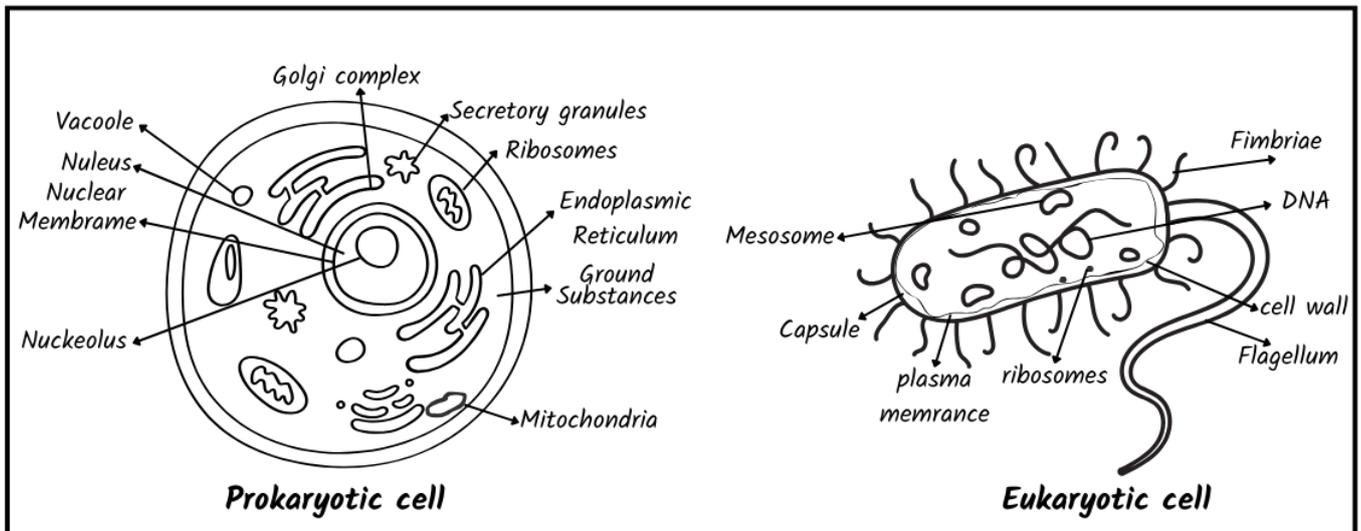
- **Present within a cell & perform certain specific functions to carry out life's processes.**

Plasma / Cell Membrane	<ul style="list-style-type: none"> ➤ Outermost covering of the cell ➤ Separates contents of cell from its external environment. ➤ A selectively permeable membrane as it allows entry and exit of some materials in and out of the cell.
Cell Wall	<ul style="list-style-type: none"> ➤ ONLY in plants ➤ Outside the plasma membrane. ➤ Mainly composed of cellulose. <ul style="list-style-type: none"> ✓ Cellulose: A complex substance - provides structural strength to plants.
Cytoplasm	<ul style="list-style-type: none"> ➤ Jelly-like substance present between cell membrane & nucleus. ➤ Fluid content inside plasma membrane. ➤ Contains many specialised cell organelles (mitochondria, golgi bodies, ribosomes, etc)
Nucleus	<ul style="list-style-type: none"> ➤ Contains chromosomes that contain information for inheritance of features from parents to next generation in form of DNA ➤ Plays a central role in cellular reproduction. ➤ Nuclear membrane- a double-layered covering on nucleus. <ul style="list-style-type: none"> ✓ Allows transfer of material from inside nucleus to its outside, i.e., to cytoplasm.
Nucleolus	<ul style="list-style-type: none"> ➤ Ribosome synthesis site regulating cellular activity and reproduction.

Gene	<ul style="list-style-type: none"> ➤ Unit of inheritance in living organisms.
Protoplasm	<ul style="list-style-type: none"> ➤ Entire content of a living cell [cytoplasm + nucleus]. ➤ aka living substance of the cell.
Chromosomes	<ul style="list-style-type: none"> ➤ Rod-shaped structures ➤ Visible only when the cell is about to divide. ➤ Contain information for inheritance of features from parents to next generation in the form of DNA (deoxyribo nucleic acid) ➤ Composed of DNA and Protein.
DNA molecules	<ul style="list-style-type: none"> ➤ Contains information necessary for constructing and organising cells. ➤ Functional segments of DNA - genes.
Vacuoles	<ul style="list-style-type: none"> ➤ Empty structure in cytoplasm ➤ Act as storage sacs for solid or liquid contents. ➤ Common in plant cells. ➤ Smaller in animal cells. ➤ Substances stored- amino acids, sugars, various organic acids and some proteins.
Endoplasmic Reticulum	<ul style="list-style-type: none"> ➤ A large network of membrane-bound tubes and sheets. ➤ 2 types : <ol style="list-style-type: none"> 1. Rough endoplasmic reticulum [RER] <ul style="list-style-type: none"> ✓ Has ribosomes attached to its surface. ✓ Ribosomes - sites of protein manufacture. 2. Smooth endoplasmic reticulum <ul style="list-style-type: none"> ✓ Helps in the manufacture of fat molecules, or lipids, important for cell function. ✓ Some of these proteins and lipids help in building the cell membrane k/a membrane biogenesis. ➤ Serve as channels for transport of materials between various regions of cytoplasm or between the cytoplasm and the nucleus. ➤ Also functions as a cytoplasmic framework providing a surface for some biochemical activities of cells.
Golgi Apparatus/ Complex	<ul style="list-style-type: none"> ➤ A system of membrane-bound vesicles arranged parallel to each other in stacks called cisterns.

	<ul style="list-style-type: none"> ➤ Packages and dispatches material synthesised near ER to various targets inside and outside the cell. ➤ Stores, modifies and packages products in vesicles. ➤ Involved in the formation of lysosomes. <ul style="list-style-type: none"> ✓ Membrane-bound sacs filled with digestive enzymes. ✓ Kind of waste disposal system of the cell. ✓ Help to keep the cell clean by digesting any foreign material as well as worn-out cell organelles.
Mitochondria	<ul style="list-style-type: none"> ➤ Aka powerhouse of the cell. ➤ Energy required for various chemical activities is released by mitochondria in the form of ATP (Adenosine Triphosphate) molecules. ➤ 2 membranes: <ul style="list-style-type: none"> ✓ Outer membrane- porous ✓ Inner membrane - deeply folded. <ul style="list-style-type: none"> ■ Folds create a large surface area for ATP-generating chemical reactions.
ATP	<ul style="list-style-type: none"> ➤ aka energy currency of the cell. ➤ Body uses energy stored in ATP for making new chemical compounds and for mechanical work.
Ribosomes	<ul style="list-style-type: none"> ➤ Site of protein synthesis. ➤ Polyribosomes or Polysomes: Several ribosomes may attach to a single mRNA and form a chain. ➤ Prokaryotes- ribosomes are associated with the plasma membrane of the cell.
Cilia and Flagella	<ul style="list-style-type: none"> ➤ Hair-like outgrowths of the cell membrane. ➤ Cilia - small structures which work like oars, causing the movement of either the cell or the surrounding fluid. ➤ Flagella - comparatively longer and responsible for cell movement. ➤ Prokaryotic bacteria have flagella but structurally different from eukaryotic flagella.
Centrosome and Centrioles	<ul style="list-style-type: none"> ➤ Centrosome- an organelle usually containing 2 cylindrical structures called centrioles. ➤ Surrounded by amorphous pericentriolar materials. ➤ Both the centrioles in a centrosome lie perpendicular to each other

Types of Cells



Prokaryotic Cell	Eukaryotic Cell
➤ Primitive/undeveloped nucleus.	➤ Has true or developed nucleus
➤ Size - 0.2 - 2.0 micrometers	➤ Size- 10- 100 micrometers.
➤ Simpler in structure	➤ More complex
➤ Organelles not membrane-bound	➤ Organelles membrane bound & specific in function.
➤ DNA arranged in circular shape	➤ DNA linear in shape
➤ Cytoplasm present, but lacks in most cell organelles.	➤ Consists of both cytoplasm and organelles
➤ Cell wall present.	➤ Usually, absence of cell wall here.
➤ Made of mucopeptide or peptidoglycan	➤ Made of cellulose
➤ Cell division - binary fission, transduction, conjugation, and transformation	➤ Cell division - mitosis
➤ Mitochondria absent	➤ Mitochondria present.
➤ Endoplasmic reticulum not present.	➤ Endoplasmic reticulum present.
➤ Ribosome present	➤ Ribosome present
➤ Plasmids commonly found. ✓ A small, circular, double-stranded DNA molecule distinct from a cell's chromosomal DNA. ✓ Naturally exist in bacterial cells.	➤ Plasmids very rarely found
➤ Only asexual reproduction.	➤ Both sexual and asexual reproduction.
➤ Have a single origin of replication	➤ Have multiple origins of replication
➤ Only 1 chromosome.	➤ Many chromosomes present
➤ Eg. Bacteria and Archaea.	➤ Eg. Plant and animal cells.

Plant and Animal Cells

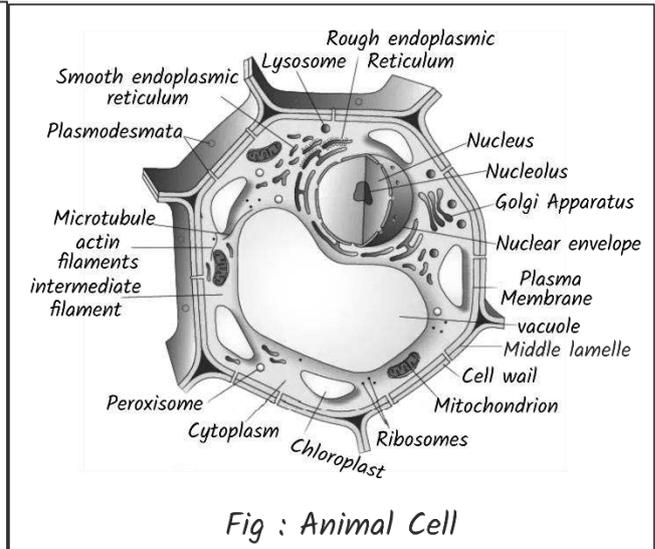
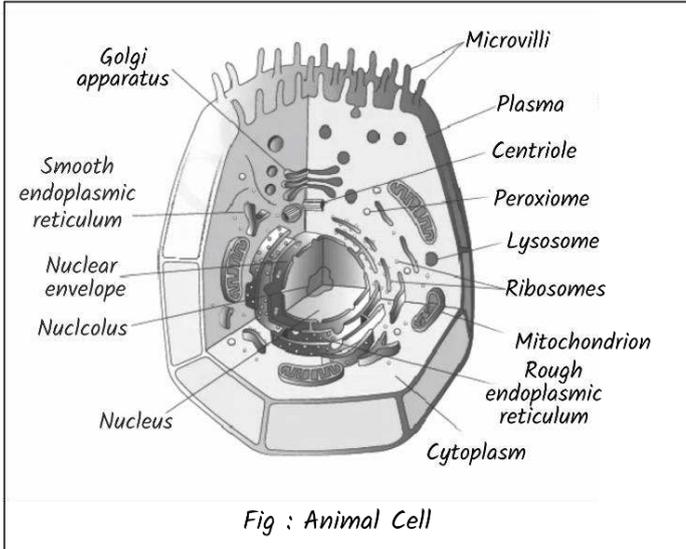


Fig : Animal Cell

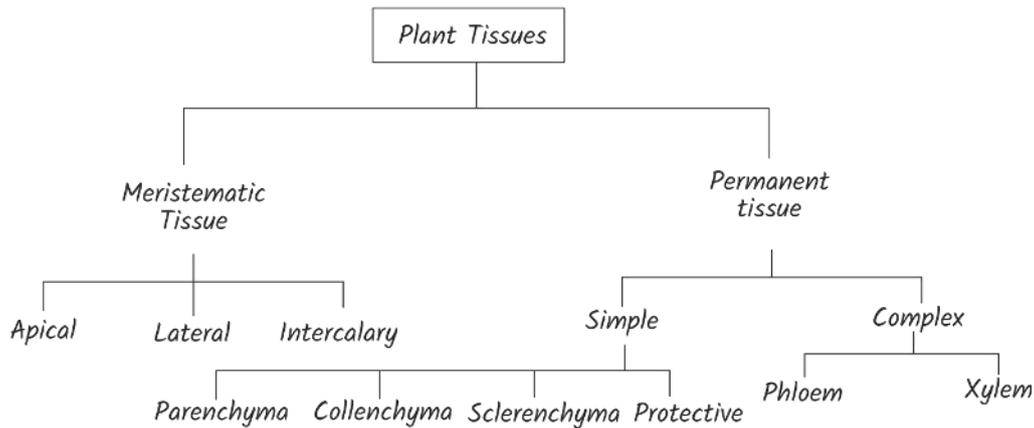
	Animal Cell	Plant Cell
Nucleus	Present	Present
Cilia	Present	Very rare
Shape	Round (irregular shape)	Rectangular (fixed shape)
Chloroplast	NO chloroplasts	Chloroplasts present
Cytoplasm	Present	Present
Endoplasmic Reticulum	Present	Present
Ribosomes	Present	Present
Mitochondria	Present	Present
Vacuole	One or more small vacuoles (much smaller than plant cells).	One large central vacuole taking up 90% of cell volume.

Tissues

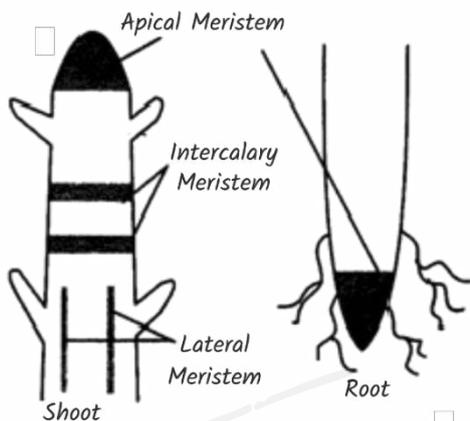
- A group of cells with similar shape and function.
- Group of (cells → Tissues → Organs → Organ systems).
- **Histology:** study of tissues.

Types of Tissues

1. Plant Tissues



On the basis of the dividing capacity, plant tissues are of two types:



A. Meristematic tissues

- Consist of actively-dividing cells.
- 3 types:
 - a. **Apical meristem:**
 - ✓ Present at the growing tips of stems and roots.
 - ✓ Increases the length of stems and roots.

b. Intercalary meristem:

- ✓ Present at the base of leaves or internodes.
- ✓ Longitudinal growth of plants.

c. Lateral meristem:

- ✓ Present on the lateral sides of the stems and roots.
- ✓ Increases thickness of stems and roots.

B. Permanent Tissues

- Formed when cells from meristematic tissues lose the ability to divide.

➤ 2 types:

a. Simple permanent tissue:

- ✓ Consist of only one type of cells.
- ✓ Types:

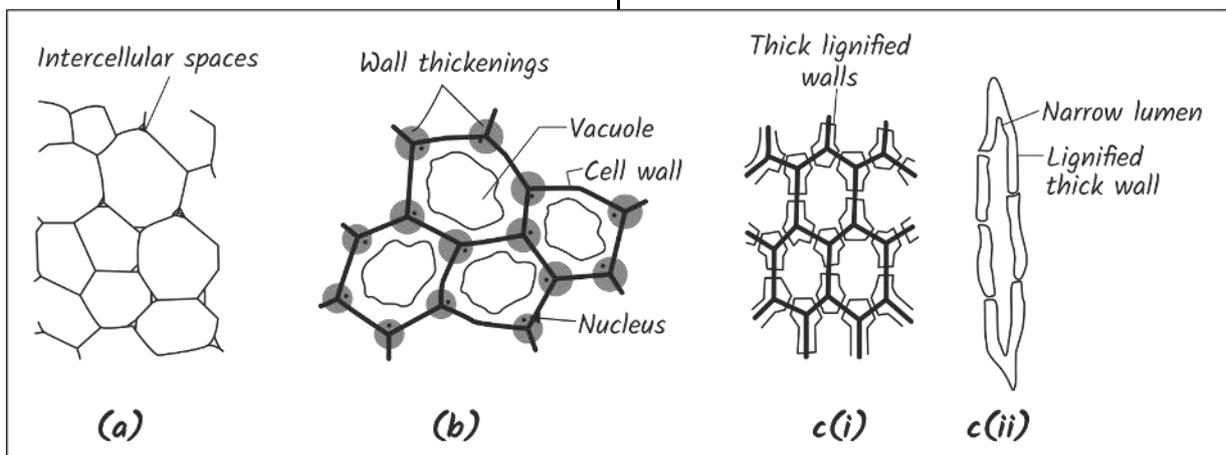


Fig : Various types of simple tissues : (a) Parenchyma (b) Collenchyma (c) Sclerenchyma (i) transverse section (ii) longitudinal section

- ✓ **Parenchyma:**
 - Composed of unspecialised living cells with relatively thin cell walls, intercellular space.
 - Present in soft parts of the plant.
 - Main function - storage.
- ✓ **Collenchyma:**
 - Composed of living and elongated cells with cell walls irregularly thickened at the corners.
 - No intercellular space.
 - Provides mechanical support and elasticity to plant - helps in bending of leaves and stems.
- ✓ **Sclerenchyma:**
 - Composed of long, narrow, and thick-walled cells.
 - Made up of dead cells.
 - No intercellular spaces.
 - Present in seeds, nuts, the husk of a coconut, fibres of jute etc.
- ✓ **Protective tissues:**
 - Protect the plant body by forming an outer layer.
 - 2 types:
 - ☞ **Epidermis:**
 - Covers the entire body of plant.
 - Protect plants from injury, germs and water loss.
 - Cells form a continuous layer without intercellular spaces.
 - ✓ **Cork Simple Tissues:**
 - Consist dead cells with no intercellular spaces.
 - Form the outer layer of old tree trunks.
 - Cells have a chemical - **suberin** in their walls that makes them impervious to gases and water.
 - Protects plants from injuries, germs and water loss.
 - **Lightweight** - used for making several products like bottle stoppers and shuttlecock.

Difference between parenchyma, collenchyma and sclerenchyma

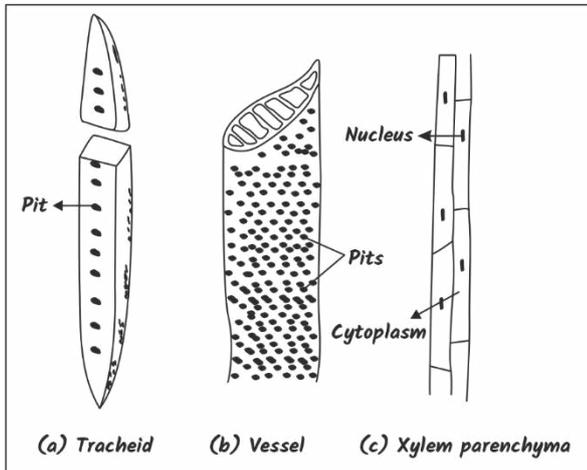
Features	Parenchyma	Collenchyma	Sclerenchyma
Cell shape	Isodiametric cells which are oval, spherical or polygonal shape.	Circular, oval or polyhedral	Variable in shape Fibres and sclereids
Cell wall	Thin cellulosic cell wall	Uneven thickening on their cell wall	Lignified secondary cell wall present.
Cytoplasm	Abundant	Present	Absent
Nucleus	Present (Living tissue)	Present (Living tissue)	Absent (Dead tissue)
Vacuoles	Large vacuole	Vacuolated	Absent
Intercellular spaces	Present	Absent	Absent
Occurrence	Basically packing tissue all soft part of plant-path cortex, medullary rays	Dicot stem, petiole and beneath the epidermis Absent in monocot and roots	Dicot hypodermis, bundle sheath, pericycle seed, pulp of fruits.

b. Complex permanent tissue:

- Made up of more than one type of cells (Conducting tissues.)

➤ Types:

✓ Xylem:



- Conducts water and minerals from roots to different parts of plant.
- 4 different types of cells:

☞ Tracheids

- Elongated angular dead cells mainly involved in conduction of water and minerals in gymnosperms.

☞ Vessels

- Advance element (generally found in angiosperms).
- Cylindrical tube like structures placed one above other end to end to form a continuous channel for efficient conduction of water.

☞ Xylem parenchyma —

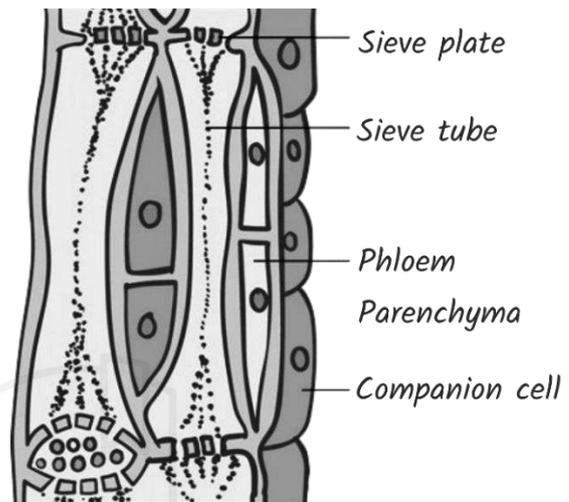
- Small & thick walled parenchymatous cells subjected for storage of starch (food).

☞ Xylem sclerenchyma

- Non-living fibres with thick walls and narrow cavities provide mechanical support.

Except xylem parenchyma all other xylem elements are dead.

✓ Phloem:



- Conducts food material from the leaves to the different parts of the plant.

■ 4 types of cells

☞ Sieve tubes:

- Slender tube like structures made up of elongated, thin walled cells placed end to end.
- End walls perforated by numerous pores, called as sieve plates.

☞ Companion cells

- Have dense cytoplasm and prominent nuclei.
- Sieve cells + companion cells = sister cells (originate from single mother cell).

☞ **Phloem fibre**

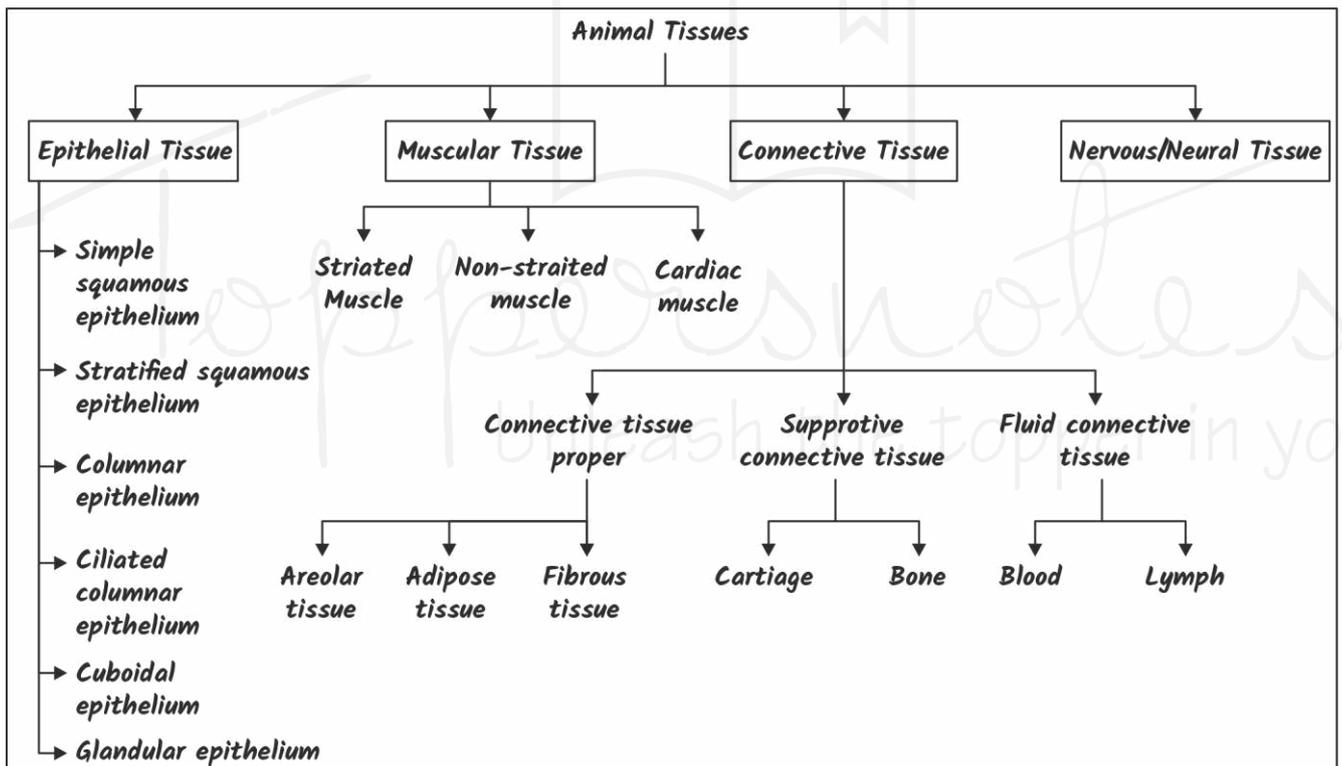
- **Mechanical support to sieve tubes.**

☞ **Phloem parenchyma**

- **Store food and help in radial conduction of food.**

Features	Xylem	Phloem
Cells: Living/ dead	Dead	Living
Cell walls: Thickness	Thick	Thin
Material	Lignin	Cellulose
Permeability	Impermeable	Permeable
Cross walls	None	Sieve Plates
Cytoplasm	None	Yes
Function	Carries water and salts	Carries sugar
Direction of flow	Upwards	Down and up
Special features	Fibres	Companion cells

Animal Tissues



➤ **4 types:**

A. Epithelial tissues:

- ✓ Always grow on some other types of tissue.

- ✓ Cells very close to each other and tissue rests on a non-cellular basement membrane.
- ✓ Consists of single layer of cells.
- ✓ Blood vessels absent and non-nervous in nature.

✓ *Covers all the organs and lines the cavities of hollow organs like stomach.*

✓ *Primarily protective in function.*

✓ *Types:*

a. Squamous epithelium:

- *aka pavement epithelium.*
- *Single layer of flat cells.*
- *Location: Lining of the mouth, oesophagus, lung, alveoli, etc.*

b. Cuboidal epithelium:

- *Found in kidney tubules, thyroid vesicles & in glands (salivary glands. sweat glands)*
- *Forms germinal epithelium of gonads (testes & ovaries).*
- *Involves absorption, excretion & secretion.*
- *Provides mechanical support*

c. Columnar epithelium:

- *Consists of elongated or column-like cells.*
- *Location: Inner lining of the intestine and gut.*
- *Function: secretion and absorption.*

d. Ciliated epithelium -

- *May be cubical or columnar.*
- *Cilia present on its free surface*
- *Helps in the movement of ova in the fallopian tube.*

B. Connective tissues

➤ *Cells are loosely spaced and embedded in an intercellular matrix.*

➤ *Specialised to connect various body organs.*

➤ **Types:**

✓ **Blood**

■ **Plasma:**

- *Fluid (liquid) matrix of blood.*
- *A yellowish liquid like material.*
- *Contains 3 types of blood cells suspended in it:*

■ **RBC - Red blood cells**

■ **WBC - White blood Cells**

■ **Platelets**

✓ **Bones:**

- *Forms the framework that supports the body.*
- *A strong and nonflexible tissue.*
- *Cells embedded in a hard matrix composed of calcium and phosphorus compounds.*

✓ **Ligaments:**

- *Connects 2 bones.*
- *Flexible or elastic in nature.*

✓ **Tendons:**

- *Bones connected to muscles by Tendons.*
- *Fibrous tissue with great strength but limited flexibility.*

✓ **Cartilage:**

- *Widely spaced cells.*
- *Solid matrix composed of proteins and sugars.*
- *Smoothens bone surfaces at joints*
- *Also present in the nose, ear, trachea and larynx.*

✓ **Areolar tissue:**

- Found in **skin and muscles**, around the **blood vessels, nerves**, etc.
- **Fills space inside organs**, supports **internal organs** and helps in **repair of tissues**.

✓ **Adipose tissue:**

- Found **between the internal organs** and **below the skin**.
- **Stores fats**.
- Acts as an **insulator**.

C. Muscular Tissue

- **Long fibre-like cells** called **muscle fibres**.
- Capable of **contraction or relaxation**.
- **Types:**

✓ **Striated muscles**

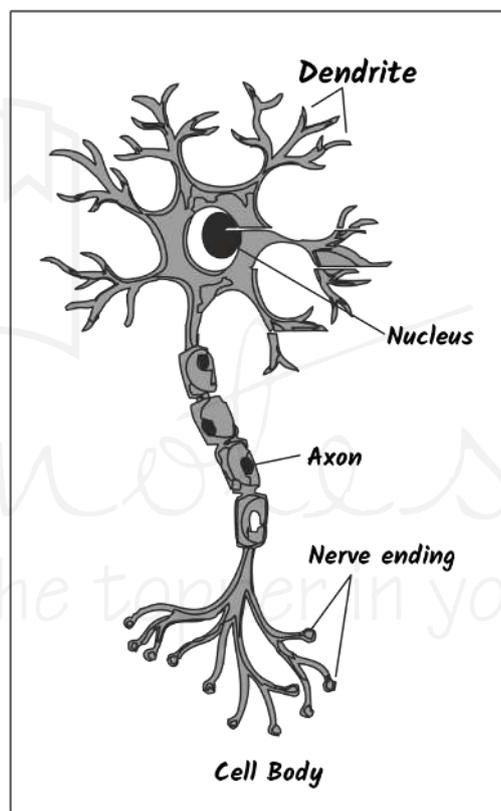
- aka **voluntary muscles** - under the control of one's will.
- **Muscle fibres or cells** are **multinucleated and unbranched**.
- **Each fibre** is enclosed by **thin membrane** which is called as **sarcolemma**.
- **Cytoplasm k/a sarcoplasm**.
- **Get tired and need rest**.

✓ **Cardiac muscles**

- **Involuntary muscles**.
- **Only found in the walls of heart**.
- **Uninucleated and branched**.
- **Branches are united by intercalated disc**.
- **Rhythmic contraction and relaxation** occurs throughout the life.

✓ **Non-striated / Involuntary / smooth muscles.**

- **Uninucleated and spindle shaped**.
- **Not enclosed by membrane** but many **fibres are joined together in bundles**.
- Found in the **walls of stomach, intestine, urinary bladder, bronchi, iris of eye** etc.
- Eg. **Peristaltic movements** in alimentary canal are brought about by **smooth muscles**.



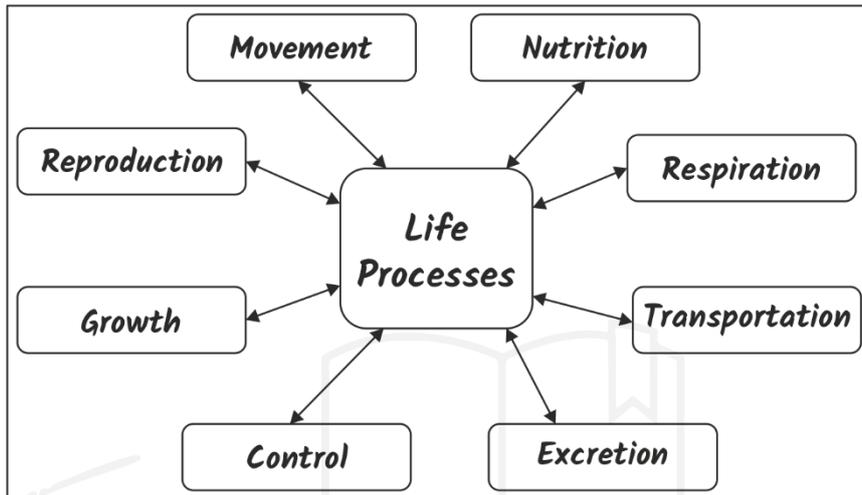
D. Nervous Tissue

- **Highly specialized tissue** due to which the **animals** are able to **perceive and respond** to the **stimuli**.
- **Functional unit** - nerve cell or **neuron**.
- **Cell body** - cyton - covered by **plasma membrane**.

- **Dendron** — Short hair like extensions rising from cyton - further subdivided into dendrites.
- **Axon** — Long, tail like cylindrical process with fine branches at the end - covered by a sheath.

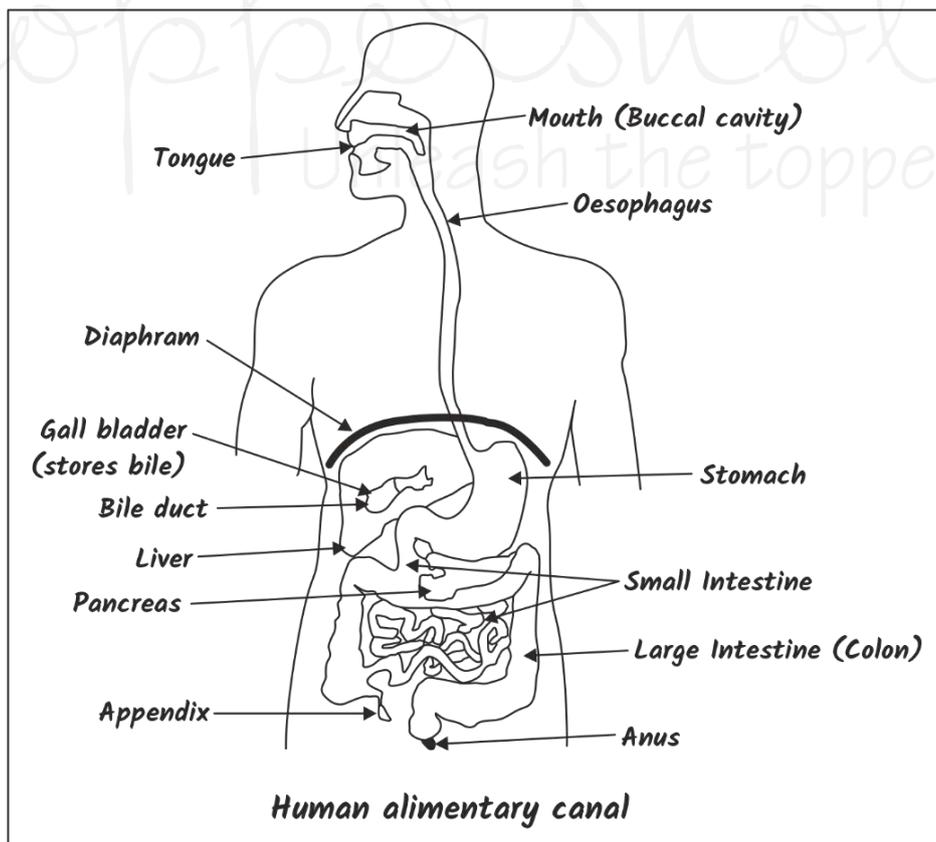
- **Synapse**- Axon of one neuron is very closely placed to the dendrons of another neuron to carry impulses from one to another neuron in the form of electrochemical waves- close proximity k/a synapse.

Life processes



- Process which are **necessary to sustain life on earth**.
- Eg- Digestion, Respiration, Circulation etc.

Nutrition in Human Beings / Digestive System



Components:

1. Alimentary Canal:

- Comprises of mouth, oesophagus, stomach, small intestine and large intestine.

2. Associated Glands:

- Salivary gland
- Gastric Glands
- Liver
- Pancreas

1. Ingestion:

- Food is ingested through the mouth.
- Put into the mouth with the help of hands.

2. Digestion:

Mouth or Buccal Cavity:

Mouth ↓	→	Intake of whole food
Teeth ↓	→	Chewing/grinding of food
Tongue ↓	→	Rolling of food + Tasting of food +
Salivary Glands ↓	→	Swallowing/pushing down of the food secrete saliva + Mucus Salivary Starch → Maltose Amylase (sugar) [Saliva]

- Mouth has teeth, tongue & salivary glands.
- Tongue - helps in turning over food so that saliva can be properly mixed in it.
- Teeth - help in breaking down food into smaller particles.

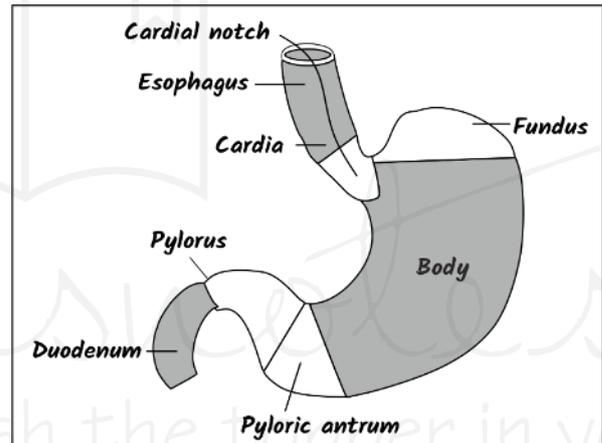
- Process of digestion starts in the mouth itself.

- ✓ Saliva contains an enzyme k/a salivary amylase/ptyalin that converts starch → sugar (sucrose/ maltose).

Oesophagus/ Food Pipe:

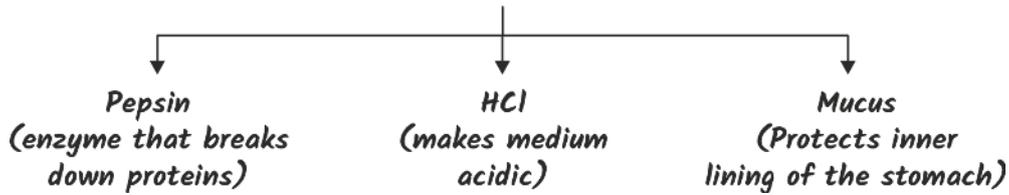
- Slightly digested food in the mouth is swallowed by the tongue.
- Goes down food pipe called oesophagus.
- Food enters the food pipe - walls of food pipe start contraction and expansion movements k/a peristaltic movement.
- Pushes the slightly digested food into the stomach.

Stomach



- A J-shaped organ.
- Highly muscular walls:
 - ✓ Churning the food.
 - ✓ Secrete hydrochloric acid that kills germs which may be present in food.
 - Makes medium inside stomach acidic that activates enzyme pepsin - partial digestion of protein.
 - ✓ Mucus secreted by walls of the stomach saves inner lining of stomach from getting damaged from hydrochloric acid

Stomach → Gastric glands secrete Gastric Juice
Gastric Juice

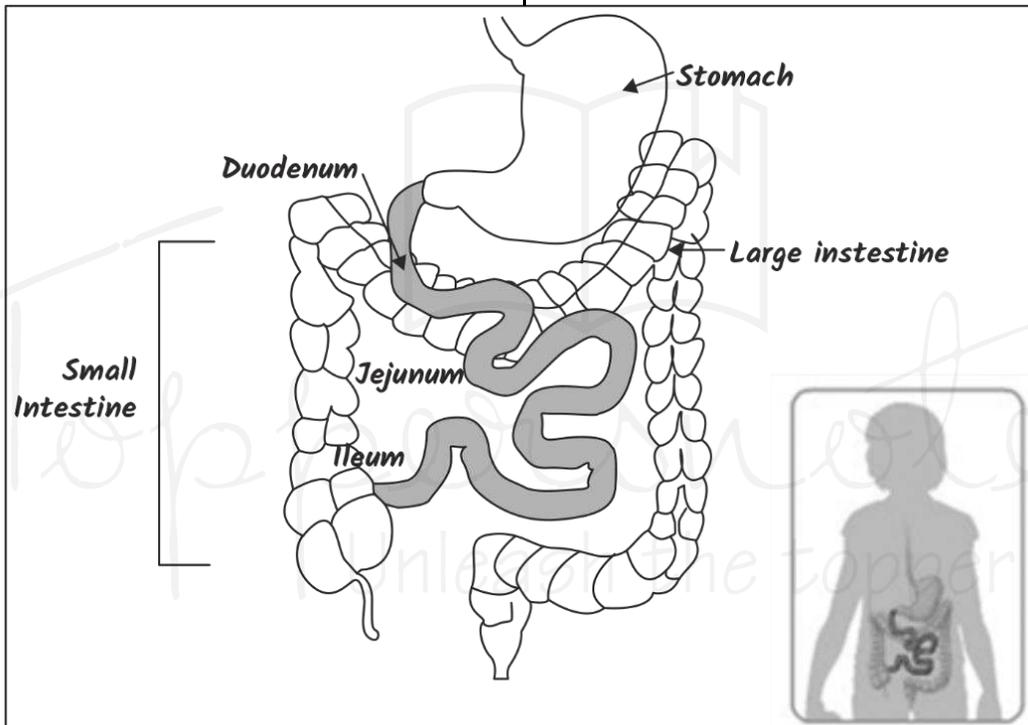


Small Intestine

The food from the stomach enters the small intestine. This is the longest part of the alimentary canal which is fitted into a compact space because of extensive coiling. The length of the small intestine differs in various animals depending on the food they eat.

Herbivores eating grass need a longer small intestine to allow the cellulose to be digested as it is harder to digest

Meat is easier to digest, hence carnivores like tigers have a shorter small intestine.



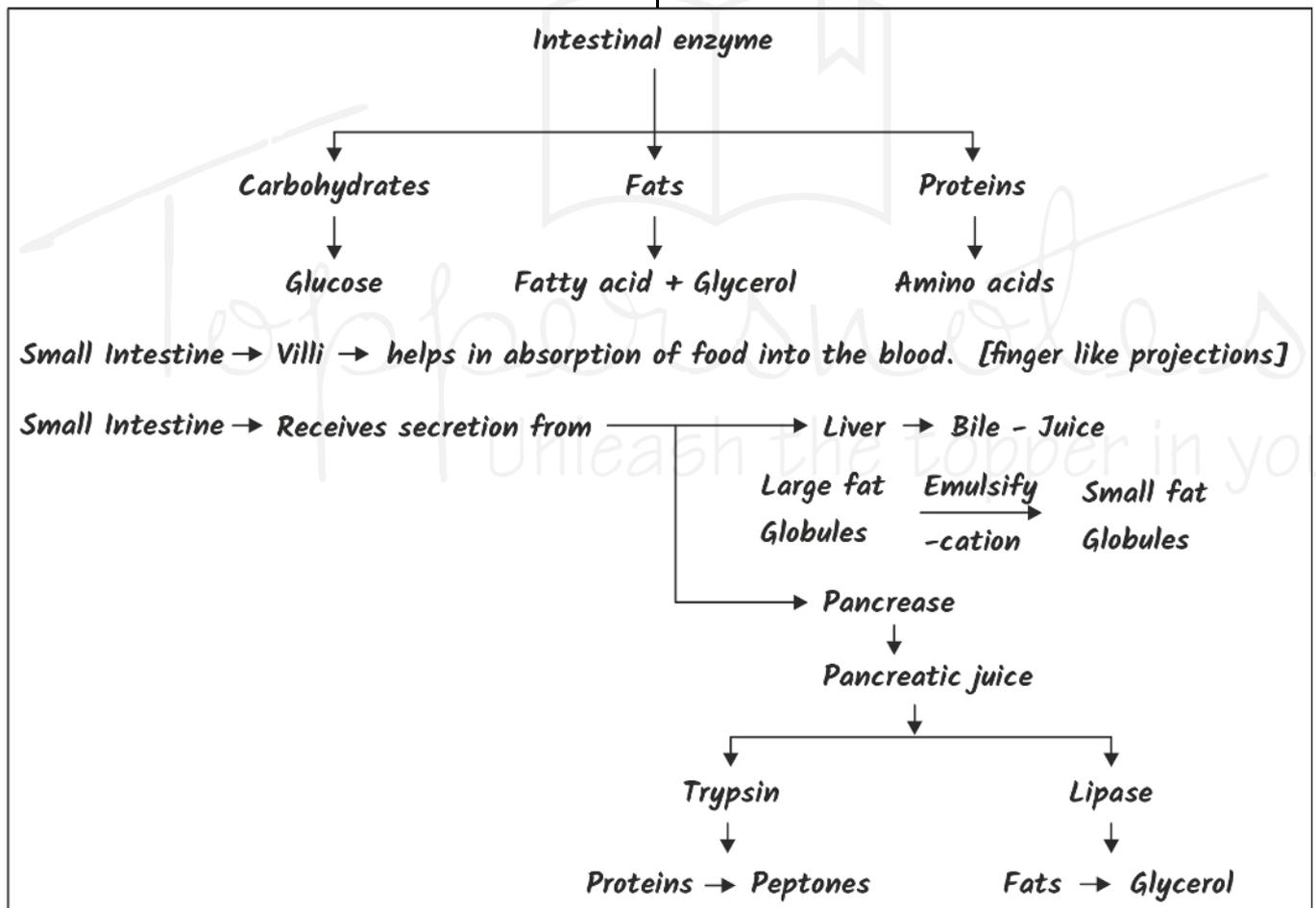
- A highly coiled tube-like structure.
- Longer than large intestine but its lumen is smaller than large intestine.
- 3 parts:
 - ✓ Duodenum
 - ✓ Jejunum
 - ✓ Ileum.
- From stomach, partially digested food enters small intestine.
- Largest part (about 6.5m) of the alimentary canal.
- Very narrow and arranged in the form of a coil .
- Site of complete digestion of food (like carbohydrates, proteins and fats)
- Receives secretion of two glands:

1. Liver

- **Secretes bile** - a greenish yellow liquid made in the liver and stored in gall bladder.
- **Functions of bile:**
 - ✓ **Makes acidic food from stomach alkaline** - pancreatic enzymes can act.
 - ✓ **Break fats present in food into small globules** making it easy for enzymes to act and digest them.

- **Secretes pancreatic juice** containing enzymes like **pancreatic amylase** for breaking down starch, **trypsin** for digesting proteins and **lipase** for breaking down emulsified fats.
- **Walls of small intestine contain glands** which secrete **intestinal juice**. Enzymes present convert **proteins into amino acids**, **complex carbohydrates into glucose** and **fats into fatty acids and glycerol**.
- **Convert large and insoluble food molecules into small water soluble molecules.**

2. Pancreas



3. Absorption:

- **Small intestine** - site of absorption of digested food.

- **Inner surface of small intestine** has numerous finger-like projections k/a villi.
- **Digested food absorbed through walls of small intestine** goes into our blood.

Villi:

- Finger like structures in the inner wall in ileum.
- Increase surface area inside ileum - facilitate optimum absorption.
- Reduce lumen of ileum so that food can stay for a longer duration in it, for optimum absorption.
- Digested food is absorbed by villi.

4. Assimilation:

- Blood carries digested and dissolved food to all parts of body.
- Assimilated as part of the cells and is utilised for obtaining energy, building up new tissues and the repair of old tissues.

5. Egestion:

- Unabsorbed food sent into large intestine - reabsorb water & salts.
- Rest is removed from the body via the anus.
- The exit of this waste material is regulated by the anal sphincter.

Large Intestine:

- Smaller than small intestine.
- Undigested food goes into the large intestine.
- Absorb excess water and salt.
- Undigested food then goes to the rectum - expelled out through the anus.

Respiration

- Involves 2 processes:

✓ **Breathing:** Intake of oxygen and release of CO₂.

✓ **Breakdown of simple food** in order to release energy inside the cell.

➤ An oxidation reaction in which carbohydrate is oxidized to produce energy.

➤ **Mitochondria** - site of respiration

➤ **Steps:**

1. Breaking down of glucose into pyruvate:

➤ In the cytoplasm.

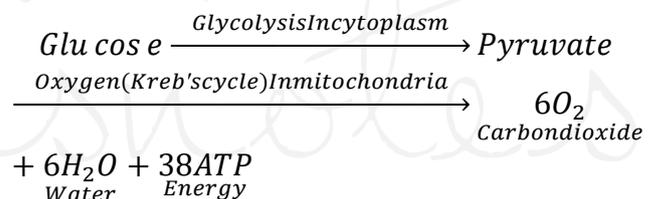
➤ Glucose (6 carbon molecule) broken down into pyruvic acid (3 carbon molecule).

2. Breaking down of Pyruvic Acid:

➤ In mitochondria

➤ Molecules formed depend on type of respiration:

1. Aerobic respiration:

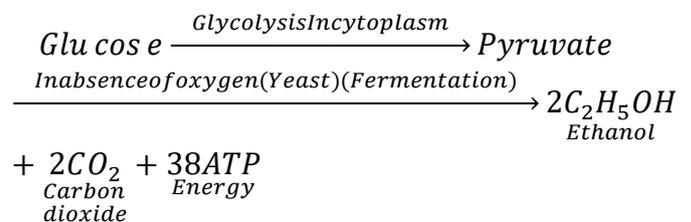


➤ Occurs in the presence of oxygen.

➤ Pyruvic acid → carbon dioxide.

➤ **Products:** Energy + water molecule

2. Anaerobic respiration:

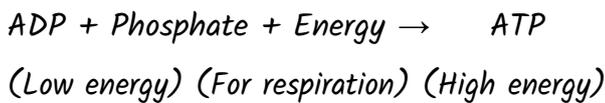


➤ Occurs in the absence of oxygen.

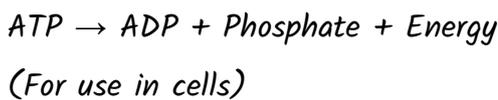
➤ **Products:**

✓ Pyruvic acid → ethyl alcohol or lactic acid.

- ✓ Ethyl alcohol - yeast or bacteria.
- ✓ Lactic acid - microbes / muscle cells.
- Storage of energy released during respiration:
 - ✓ Energy produced is stored as ATP molecules in cells of body.
 - ✓ Energy released during respiration used to make ATP molecules from ADP and inorganic phosphate.



- ✓ So, energy stored as ATP.
- ✓ When cell need energy, ATP broken down using water to release energy.

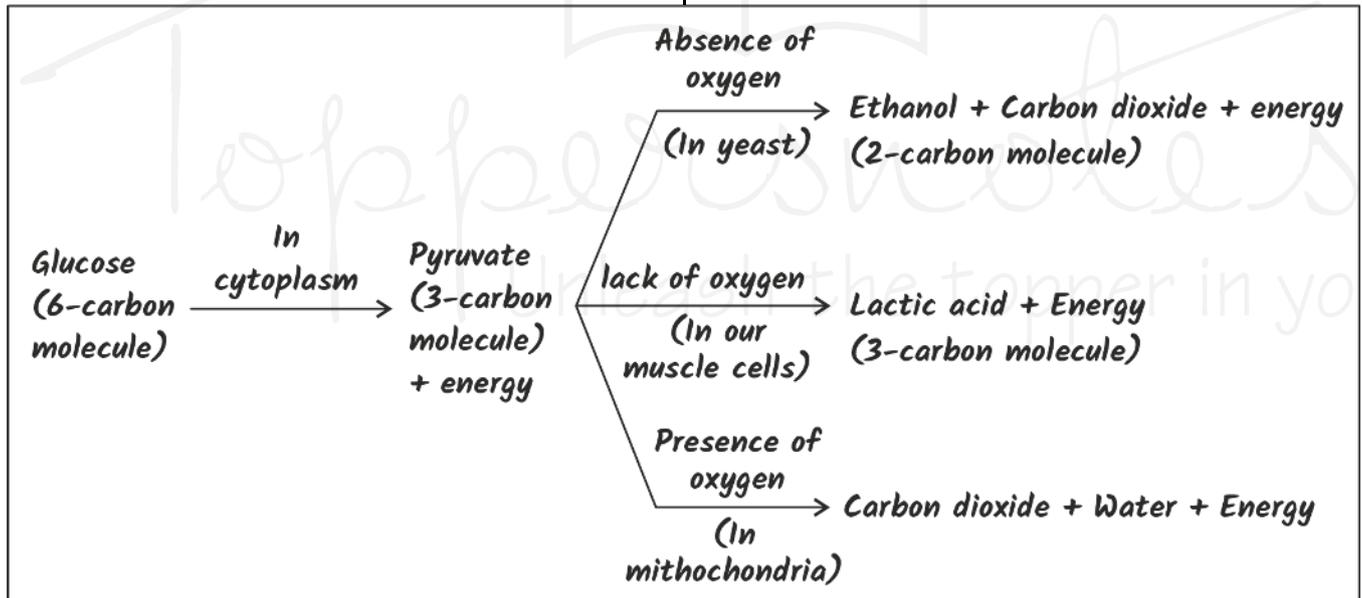


- ✓ ATP - energy currency of cells.

Breathing and Respiration

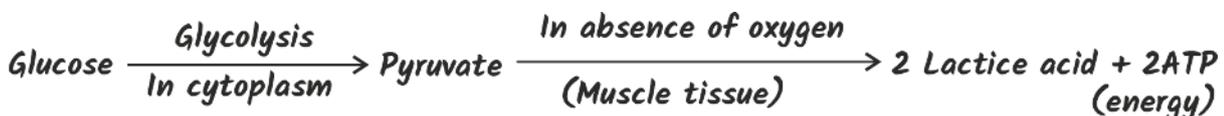
Breathing	Respiration
Mechanism by which organisms obtain oxygen from air and release carbon dioxide.	Includes breathing & oxidation in cells of organisms to release energy.
A physical process.	Physical + biochemical oxidation of food.
Involves the lungs of the organism.	Involves lungs and mitochondria of cells.

Various pathways of breakdown of glucose



Pain in leg muscles after vigorous activities:

- Due to vigorous exercise, demand for oxygen required by muscles increases.
- Lack of oxygen → anaerobic respiration → lactic acid → pain in the leg muscles.

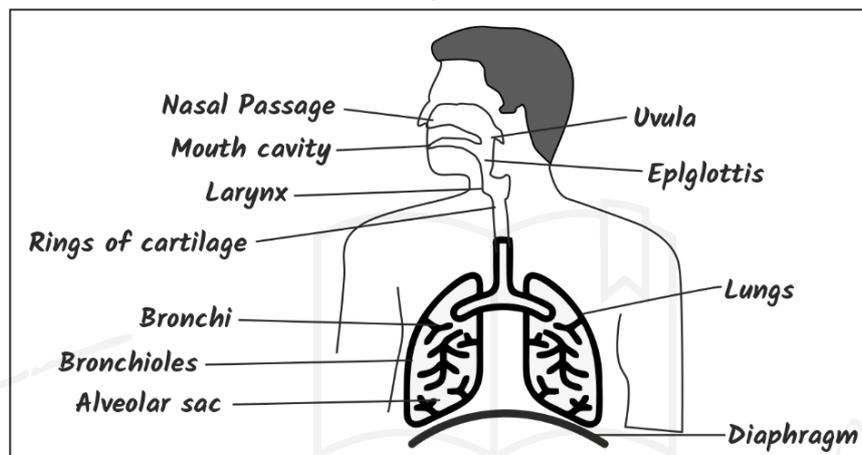


Various Modes of respiration in animals

- **Amoeba** - respiration by simple diffusion of gases through **cell membrane**.
- **Earthworms** - use their **skin** to absorb oxygen from air and remove carbon dioxide.
- **Aquatic animals** like fish, prawns and mussels - **gills**.
- **Insects** - tiny holes called **spiracles** and air tubes called **tracheae**.
- **Mammals**- **lungs**.

Respiration in Plants

- Plants respire through different parts like:
 - ✓ **Roots:** Have **root hair** that absorb oxygen from soil pores by diffusion.
 - ✓ **Barks:** have large holes k/a **Lenticels** that allows gas exchange between the atmosphere and the internal tissues.
 - ✓ **Leaves:** Have microscopic pores at the back k/a **Stomata**.



Respiration in humans

Main parts of human respiratory system:

1. Nostrils:

- ✓ 2 nostrils which converge to form a nasal passage.
- ✓ Inner lining of nostrils - hair and mucus secretion.
- ✓ Mucus and hair - filtering dust particles out from inhaled air.

2. Pharynx:

- ✓ A tube-like structure which continues after nasal passage.

3. Larynx:

- ✓ Comes after the pharynx.
- ✓ aka voice box.

4. Trachea:

- ✓ Composed of rings of cartilage which prevent collapse of trachea in absence of air.

5. Bronchi:

- ✓ A pair of bronchi comes out from the trachea, with one bronchus going to each lung.

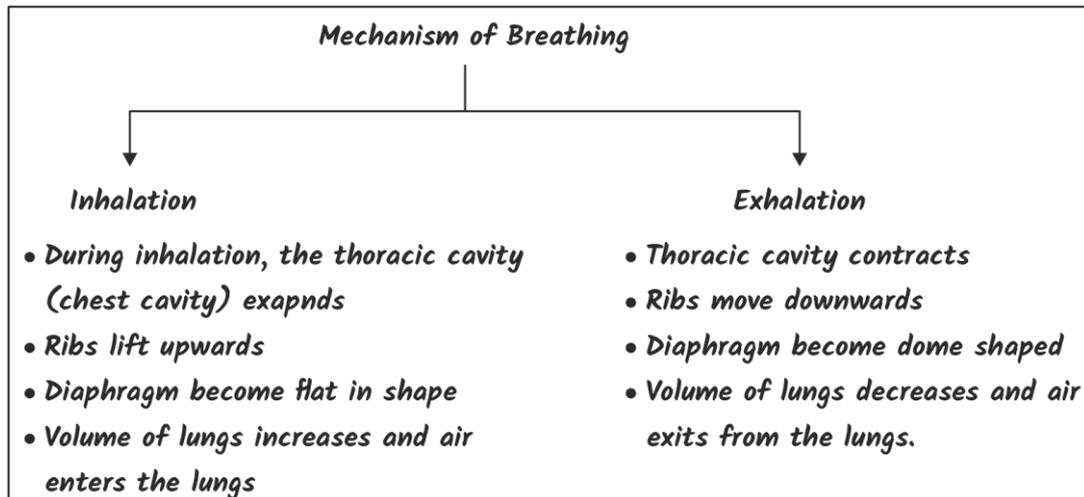
6. Bronchioles:

- ✓ A bronchus divides into branches and sub-branches inside the lung.

7. Alveoli:

- ✓ Air sacs at the end of bronchioles.
- ✓ Composed of a very thin membrane and is the place where blood capillaries open.
- ✓ Oxygen mixes with the blood and carbon dioxide exits from the blood.

Mechanism of breathing



Expiration (Exhalation)

- Expiration is the process of air moving from the lungs to the outside environment.
- It occurs when intra-pulmonary pressure exceeds atmospheric pressure.
- The diaphragm and intercostal muscles facilitate this process.
- A healthy individual breathes 12-16 times per minute.
- A spirometer measures breathing movements to assess pulmonary function.

Inspiration (Inhalation)

- Inspiration is the process of drawing air into the lungs from the external environment.
- It occurs when intra-pulmonary pressure is lower than atmospheric pressure.
- The diaphragm contracts and moves downward, while the external intercostal muscles lift the rib cage.
- A healthy person breathes 12-16 times per minute.
- Spirometry can be used to assess the volume and efficiency of the inspired air.

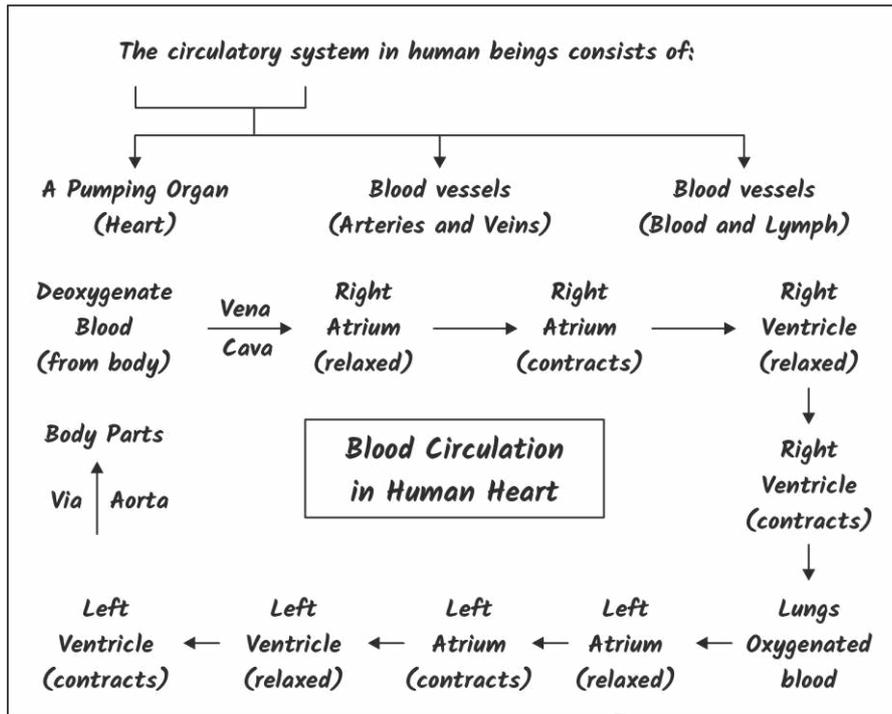
Carbon monoxide poisoning:

- **Carbon monoxide** - formed whenever a fuel burns in an insufficient supply of air.
- Eg, if coal is burned in a closed space, then a lot of carbon monoxide is formed.
- Haemoglobin has more affinity for carbon monoxide than oxygen,
- If carbon monoxide gas inhaled by a person, then it binds very strongly with haemoglobin and prevents it from carrying oxygen to brain and other parts.
- Lack of oxygen - person cannot breathe properly.
- If inhaled for a long time, fatal.

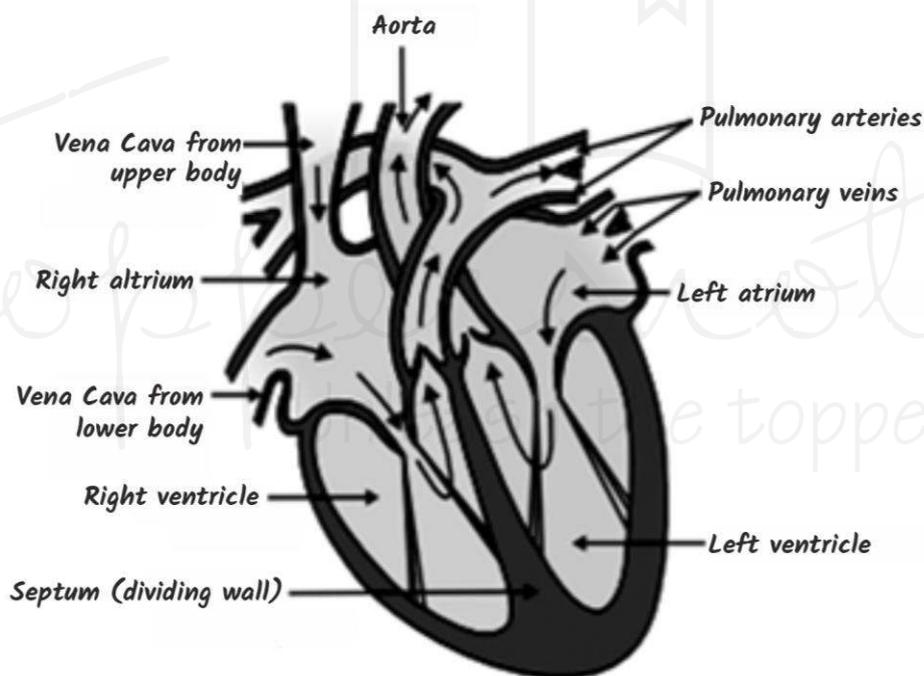
Transportation

- Movement of substances like water, waste products & nutrients from one place to another.

Human circulatory system:



1. Heart:



- A muscular organ composed of cardiac muscles.
- A pumping organ which pumps the blood.
- 4 chambers - right atrium, right ventricle, left ventricle and left atrium.
- **Systole:** Contraction of cardiac muscles.
- **Diastole:** Relaxation of cardiac muscles.

2. Arteries:

- Thick-walled blood vessels which carry oxygenated blood from heart to different organs.
- **Exceptions:** Pulmonary arteries - carry deoxygenated blood from heart to lungs.

3. Veins:

- **Thin-walled** blood vessels
- **Carry deoxygenated blood** from different organs to heart
- **Exception:** Pulmonary veins - carry oxygenated blood from lungs to the heart.
- **Valves present** in veins to prevent back flow of blood.

4. Capillaries:

- Blood vessels **having single-celled walls.**

5. Blood:

- A **connective tissue** which plays role of carrier for various substances in body.
- Composed of :

A. Blood plasma:

- ✓ A **pale coloured liquid** mostly composed of water.
- ✓ **Forms the matrix** of blood.

B. Blood cells:

a. Red Blood Corpuscles (RBCs):

- ✓ **Circular** in shape.
- ✓ **Contain a red coloured pigment** called haemoglobin.

- ✓ **No nucleus.**

- ✓ **Carry oxygen** to tissues and bring back carbon dioxide from tissues

b. White Blood Corpuscles (WBCs):

- ✓ **Colourless**
- ✓ **Irregular shape**
- ✓ **Prevent body** from infections by eating up germs or by producing antibodies to fight antigens.

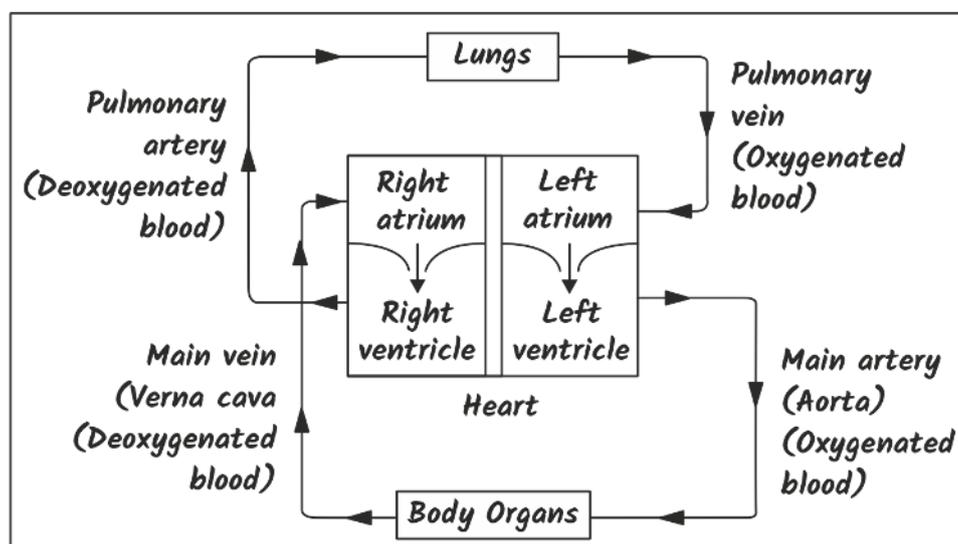
c. Platelets:

- ✓ **Very small fragments** of cells
- ✓ **No nuclei**
- ✓ **Clotting** of blood

6. Lymph:

- **RBCs are absent.**
- **Formed from fluid** which leaks from blood capillaries and goes to the intercellular space in the tissues.
- **Collected through lymph vessels** and finally return to blood capillaries.
- Also **plays an important role** in the immune system.

Double circulation



- Heart receives deoxygenated blood from different parts of body, and pumps this blood to lungs.
- Oxygenated blood from lungs returns to heart - pumped again into different parts of body.
- So, the blood passes twice through the heart making one complete round through the body k/a double circulation.

Single Circulation	Double Circulation
1. Blood flows through heart only once for completing one circulation. It is called single circulation E.G. Fishes 2. Eg.. Fishes 3. Pulmonary circulation is absent.	1. If the blood flows through heart two times for completion of one circulation. It is called double circulation. Eg. Mammals, birds 2. Pulmonary circulation is present

4. Single circulation is seen in fishes.	3. Heart consists of three of four chambers
	4. Double circulation occurs in frogs. Reptiles, birds and mammals.

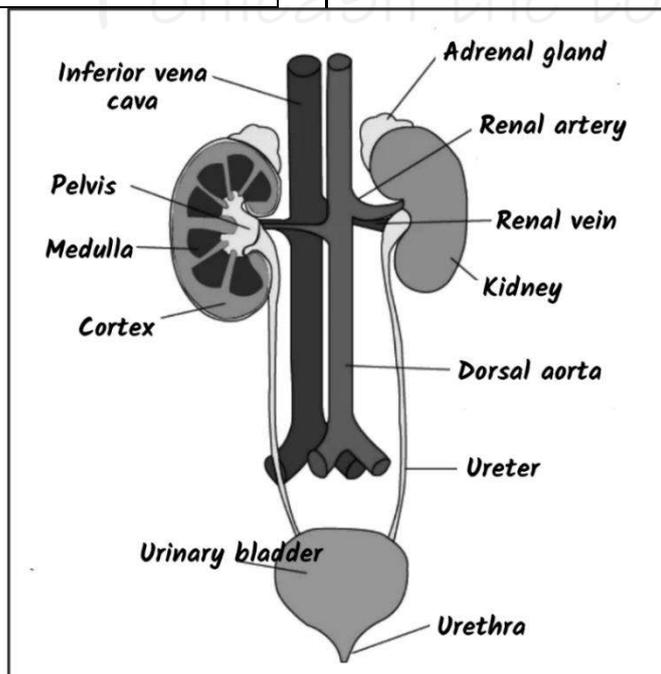
Excretion

Removal of harmful metabolic wastes from the body of organisms.

Excretion in organisms

- Unicellular organisms, like amoeba remove wastes by simple diffusion from body surface into surrounding water.
- Lower multicellular organisms like flat worms use flame cells while
- earthworms use nephridia for excretion.
- Higher multicellular organisms like fish, frogs, lizards, birds and humans use kidneys for excretion.

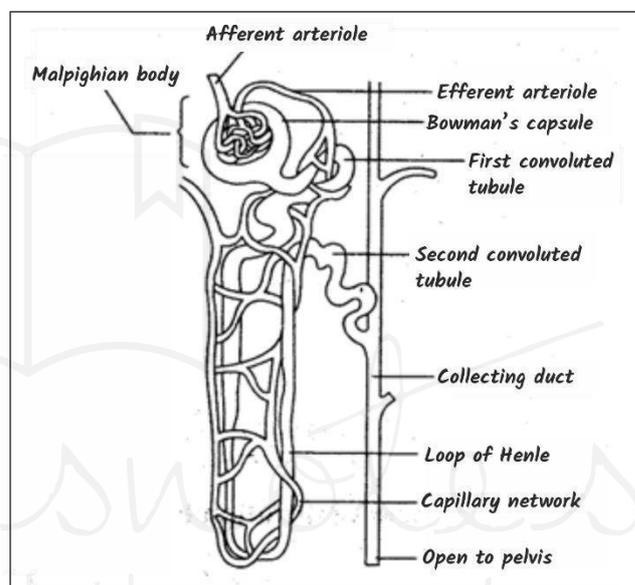
Excretion in Humans



Pair of Kidneys	<ul style="list-style-type: none"> ➤ Dark red, bean-shaped, 10 cm long, 6 cm wide ➤ Right side slightly lower in position due to liver. ➤ Acts as excretory organ ➤ Also control balance of water and mineral ions in the body. ➤ Divided into 2 parts: <ul style="list-style-type: none"> ✓ External region (comprises of a thick layer followed by fat layer) ✓ Internal region (comprises of renal cortex and renal medulla). <ul style="list-style-type: none"> ■ Medulla composed of conical masses of tissue leading to pelvis. ■ Cortex has a random arrangements of tiny tubules called nephrons.
Pair of Ureters	<ul style="list-style-type: none"> ➤ Tube-like structures arising from notch, i.e. hilum of each kidney ➤ Connect behind with the urinary bladder. ➤ Carry the urine produced to the urinary bladder.

Urinary bladder	<ul style="list-style-type: none"> ➤ Muscular sac-like structure. ➤ Stores urine temporarily. ➤ Opening guarded by muscular sphincters. ➤ Sphincters open at time of urination.
Urethra	<ul style="list-style-type: none"> ➤ Short muscular tube which expels urine out of the body.

Nephrons- Unit of excretion



- **Blood enters kidney through the renal artery, which branches into many capillaries associated with glomerulus.**
- **Water and solute transferred to nephron at Bowman's capsule.**
- **Proximal tubule - amino acids, glucose, and salts selectively reabsorbed and unwanted molecules added in the urine.**
- **Filtrate then moves down into loop of Henle, where more water is absorbed.**
- **Then, it moves upwards into distal tubule and finally to the collecting duct.**

- **Collecting duct** collects urine from many nephrons.
- **Urine formed** in each kidney enters a long tube called **ureter**.
- From **ureter** → **urinary bladder** → **urethra**.

Reproduction

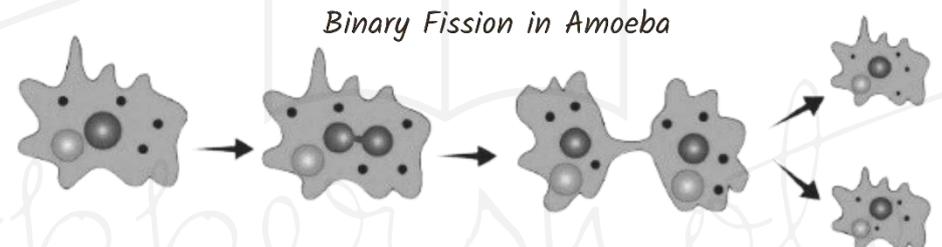
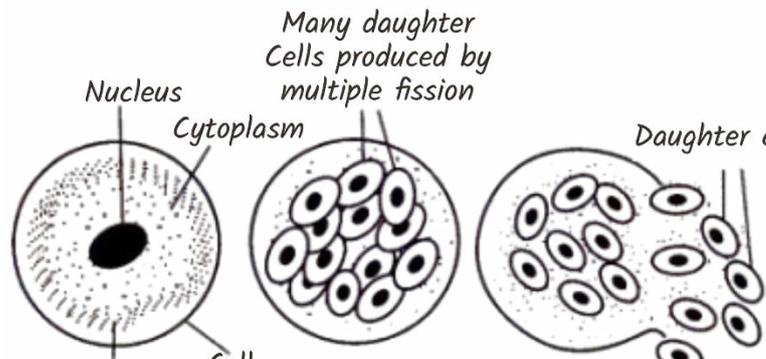
- A **biological process** by which an organism produces an offspring (biologically similar to the organism).
- Ensures the continuity of species, generation after generation.

- **Main feature of life on earth.**

- **2 types :**

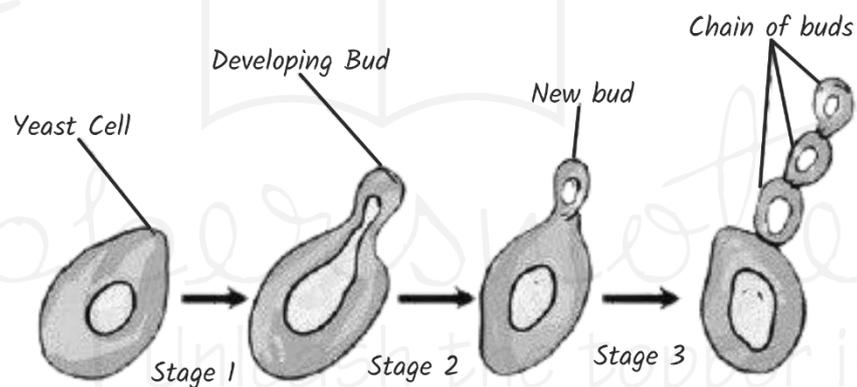
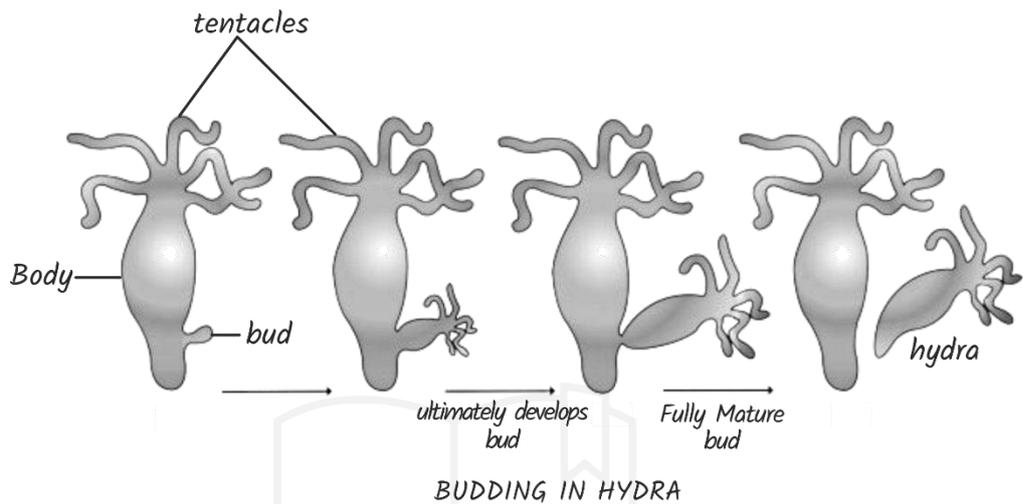
1. **Asexual Reproduction**

- Involves **only one parent**.
- **No formation and fusion of gametes**.
- **Young offsprings** almost identical to each other & parent.
- **Occurs during favourable environmental conditions** and when there is an abundance of food.
- **Faster method** of reproduction.
- **Types:**

<p>Binary Fission:</p>	<ul style="list-style-type: none"> ➤ In bacteria, protozoa. ➤ Process: Withdrawing of pseudopodia (false cavity) → Nuclear division → cytoplasmic division → 2 daughter cells formed <p style="text-align: center;">Binary Fission in Amoeba</p>  <p style="text-align: center;">Mother Amoeba Nucleus divided Cytoplasm divided Daughter amoeba</p> <ul style="list-style-type: none"> ➤ Cytokinesis: Division of cytoplasm. ➤ Karyokinesis: Division of Nucleus.
<p>Multiple Fission</p>	<ul style="list-style-type: none"> ➤ A single parent cell is divided into many daughter cells. ➤ Most common form of reproduction in protists and in some parasitic species. <p style="text-align: center;">Many daughter Cells produced by multiple fission</p>  <p style="text-align: center;">Nucleus Cytoplasm Cell Schizont</p> <p style="text-align: center;">Daughter cells release</p> <p style="text-align: center;">Multiple fission in Plasmodium</p>

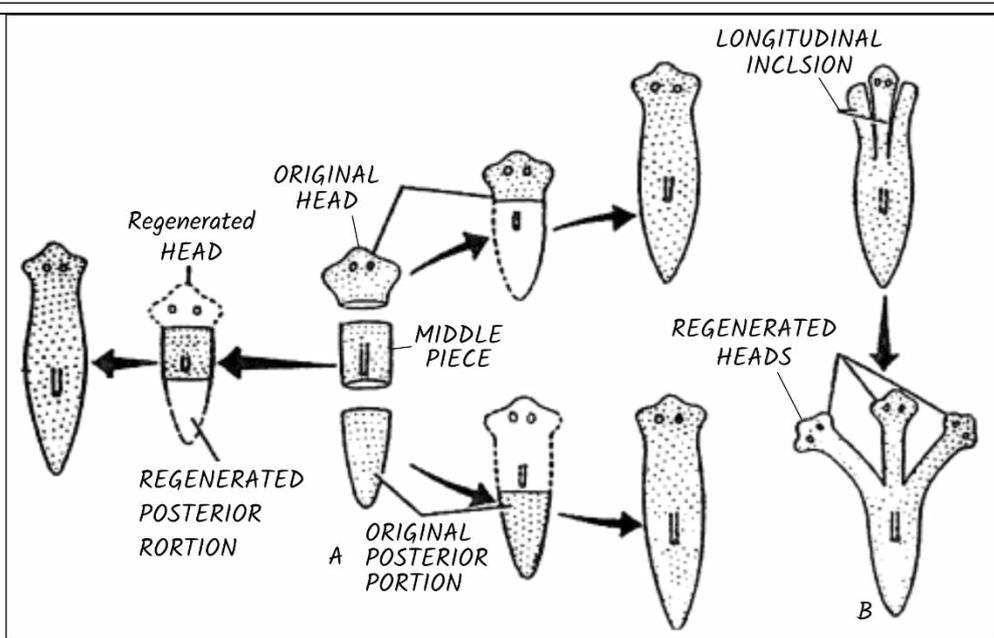
Budding

- A genetically identical new organism grows attached to body of parent and separates later on.
- A bud develops as an outgrowth due to repeated cell division at one specific site.
- Grows randomly.
- No specific order or direction they follow.
- Eg. in hydra and yeast

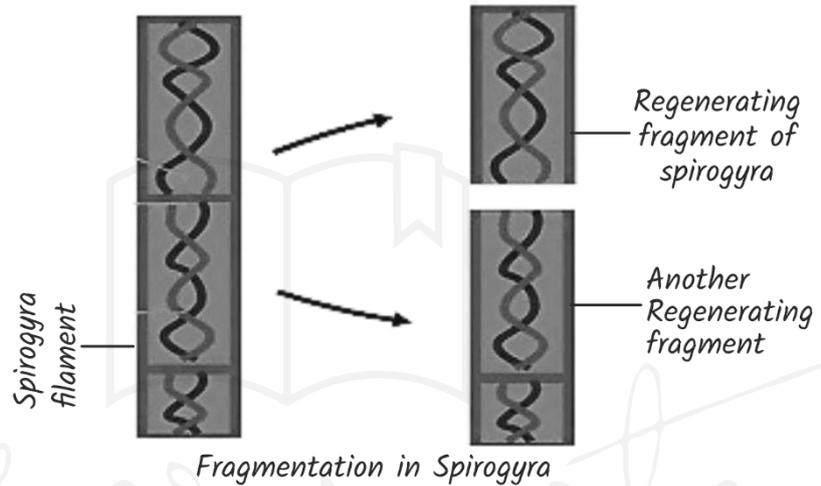


Regeneration

- Ability of organisms to develop their lost parts.
- Some organisms show have high regenerative capacity
- Eg. Planaria.
- Carried out by specialized cells which redivide to form a mass of cells from which different cells undergo changes to become different cell types and tissues.
- Occur in an organized sequence k/a development.



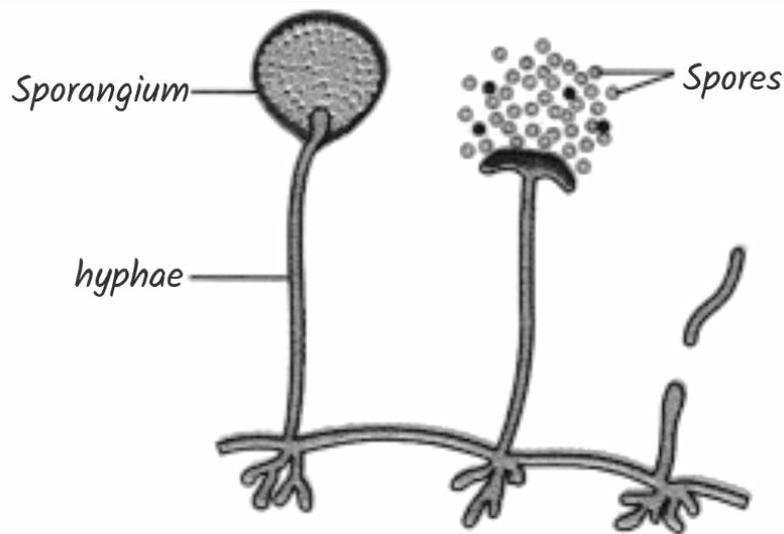
Fragmentation



- In multicellular organisms having relatively simple body organisation.
- Eg. Spirogyra- filamentous body.
- Each fragment has the capacity to form a new individual.
- All multicellular organisms cannot show cell-by-cell division as cells from tissues which form organs.
- Organs are placed at definite positions in the body.
- Hence, more complex methods of reproduction required.

Sporogenesis

- Spores are stored in sacs/ knob-like structures called Sporangia.
- When Sporangia burst; minute single-celled, thin or thick walled structures called spores are obtained.
- Under suitable conditions, they develop into a new Plant.
- Present at the top of the thread-like structures called hyphae.
- Dispersive, i.e. scattered by rain, wind or insects.
- Eg. Rhizopus



Spore formation in Rhizopus

Vegetative Propagation:

➤ Method by which plants reproduce by their vegetative parts such as roots, stems, and leaves.

➤ **Types:**

1. Natural vegetative propagation.

- ✓ Occurs when plants grow and develop naturally without any human interference.
- ✓ Vegetative plant structures arising from stem - rhizomes, bulbs, runners, tubers, etc.

✓ **Propagation:**

- **Stem** - eg. Mint
- **Roots** - eg. garlic
- **Leaves**- eg. Bryophyllum, Begonia etc
- **Bulbs** - eg. onions

2. Artificial vegetative propagation.

- ✓ Carried out by humans on the fields and laboratories.
- ✓ **Most common types** of vegetative reproduction occurring artificially include:
 - **Cutting**- eg. rose
 - **Grafting** -eg. apples, avocados
 - **Layering**- eg. pomegranate
 - **Tissue Culture** - developing small saplings from tissues of existing plants in a petri dish

2. Sexual reproduction

- Involves 2 individuals of two different sexes i.e. male and female.
- Male organism - produces male gametes i.e. sperms - small and motile
- Female organism - produces ova - large and store food.
- Male + female gametes = zygote.

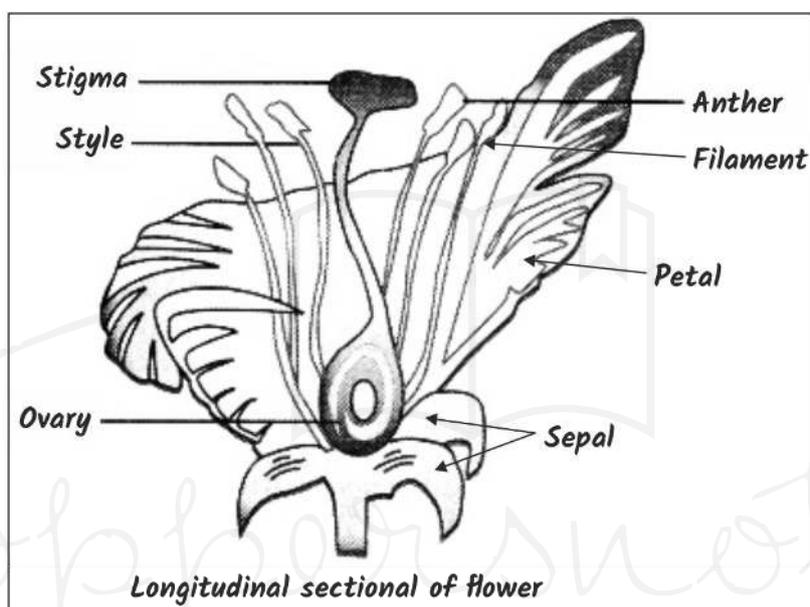
➤ Significance:

- ✓ Involves DNA of two different organisms - promotes diversity & genetic variations.
- ✓ Results in the origin of new species.

➤ Limitation:

- ✓ Involves combining DNA from two different organisms which may bring some undesirable features also.

Sexual reproduction in flowering plants



Parts of flower

- **Sepals** - green structures protecting inner parts when flower is in bud stage.
- **Petals** - colourful and attract the insects for pollination.
- **Stamens** -
 - ✓ Male reproductive part
 - ✓ Produce pollen grains (contain male gametes).
 - ✓ 2 parts—
 - Filament i.e. stalk
 - Anther i.e. swollen top part which has large number of pollen grains.

➤ Carpel

- Female reproductive part
- Produces ovules (contain female gametes).
- 3 parts—
 - ✓ Stigma - top sticky part and receives pollen grains during pollination.
 - ✓ Style - middle long part
 - ✓ Ovary - swollen part and contains ovules.
- Each ovule has an egg cell i.e. female gamete.

➤ Flowers :

- ✓ **Bisexual** -. having both stamens and carpels -**Mustard, China Rose (Hibiscus)**.
- ✓ **Unisexual** - having either stamens or carpels - **Papaya, Watermelon**.

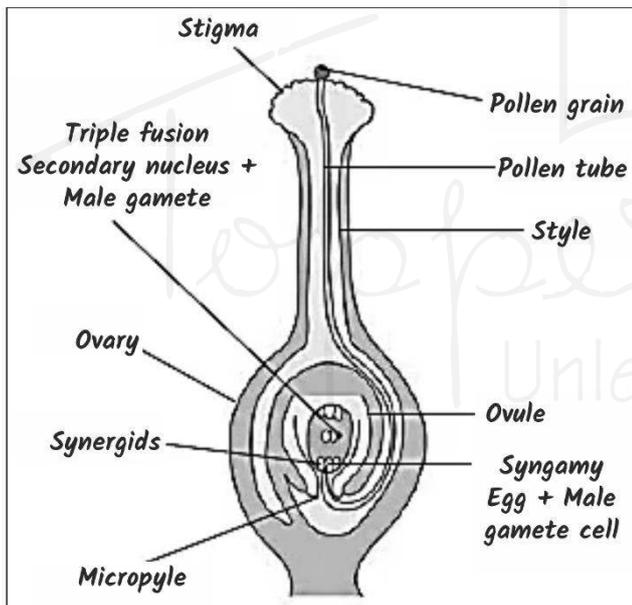
Pollination:

- **Process of transfer of pollen grains from anther to stigma of the flower.**
- **2 types:**

1. Self-pollination:

- ✓ **Transfer of pollen grains from anther to stigma of same flower or another flower of the same plant.**

2. Cross-pollination:



- ✓ **Transfer of pollen grains from anther to stigma of another flower or another flower of a different plant of the same species.**
- ✓ **Takes place by insects, birds, wind and water.**

Fertilization

- **Process of fusion of male and female gamete to form a zygote during sexual reproduction.**
- **Pollination is followed by fertilisation.**
- **Steps:**
 - ✓ **Pollen grains land on the stigma of the ovary.**
 - ✓ **Pollen tubes grow out of pollen grains, travel through the style and reach the ovary, through micro pyle.**
 - ✓ **Pollen tube has two male germ cells.**
 - ✓ **Each ovule has two polar nuclei and a female germ cell (egg).**
 - ✓ **Pollen tube releases two male germ cells inside ovule.**
 - ✓ **One fuses with female germ cell and forms a zygote which grows into the baby plant i.e. embryo k/a syngamy.**
 - ✓ **Other fuses with two polar nuclei k/a triple fusion.**
- **So in flowering plants two fusions take place during fertilisation k/a double fertilisation.**

Post-fertilisation

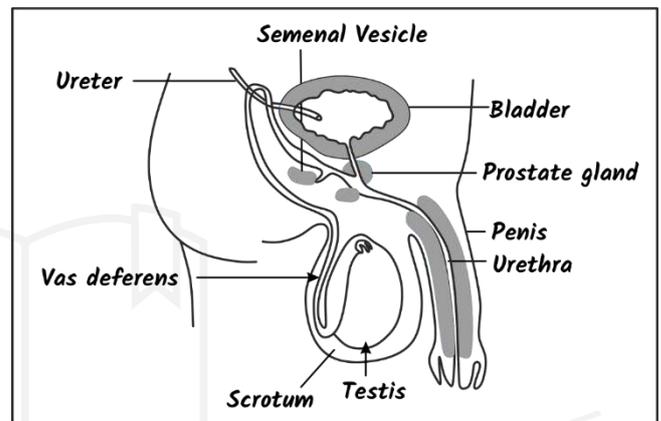
- **Zygote divides several times and forms an embryo inside the ovule.**
- **Ovule develops a tough coat and changes into the seed.**
- **Ovary grows rapidly and ripens to form a fruit.**
- **Petals, sepals, stamens, style and stigma shrivel and fall off.**

Reproduction in Human Beings

- **Method:** sexual reproduction.
- **Male -**
 - ✓ Produces male gametes called **sperms**.
 - Sperms have **tail** and are **motile**.
 - Produced in **large numbers** in **testes**.
 - **No food stored** .
- **Female -**
 - ✓ Produces female gametes called **ova**.
 - Ovum is **bigger, non-motile** and **only one ovary** produces **one ovum** in **one month**.
 - **Contain stored food**.
- **Both the gametes are microscopic, unicellular and have half the number of chromosomes than body cells.**
- Human beings become **reproductively active** from the onset of **puberty**.
- **Puberty-**
 - ✓ **Period during adolescence** when **rate of general body growth** begins to **slow down** and **reproductive tissues** begin to **mature**.
 - ✓ **Age of puberty in human males- 11 to 13 yrs** of age, while in **females - 10 to 12 yrs**. of age.
 - ✓ **Associated with physical, mental, emotional and psychological changes** in boys and girls occurring slowly k/a **secondary sexual characters**.
- **Eg.**
 - ✓ **Thick dark hair** start growing in **genital areas & armpits**.

- ✓ **Skin becomes oily** and **pimples** may appear on the **face**.
- ✓ **Boys - beard and mustache** start appearing, **voice** begins to **crack**, **reproductive organs** develop and start producing **releasing sperms**.
- ✓ **Girls - breast size** begins to **increase**, **skin of the nipples** darkens, **menstruation** starts.

- **Copulation:** act of **mating** between the male and female partner.



Male Reproductive System

Parts:

1. **A pair of testes.**
 - **Present outside the body** in a pouch k/a **scrotum**.
 - **Oval shaped**.
 - **Functions:**
 - ✓ Producing **testosterone** - a male sex hormone.
 - ✓ Producing **sperms** (spermatogenesis) - a carrier of man's genes.
2. **Scrotum**
 - **A sac of thick skin** that **protects and surrounds** the **testes**.
 - **Controls temperature of testes** since they have to be at a slightly lower temperature than body temperature for suitable sperm creation.

- **Muscles in the wall allow the testes to hang far from the body or shrink to pull them closer for protection and warmth.**

3. Epididymis:

- **A coiled tube that stores the sperms formed in testes.**

4. Vas deferens

- **A long tube connecting urethra & epididymis.**

5. Glands:

A. Seminal vesicles

- **A pair of glands found in male pelvis**
- **Produce many of the constituent ingredients of semen.**
- **Provide around 70% of total volume of semen.**

B. Prostate gland

- **Largest accessory gland in male reproductive system.**
- **Secretes proteolytic enzymes into semen, which breaks down clotting factors in the ejaculate.**
- **Allows the semen to remain in a fluid state, moving throughout the female reproductive tract for potential fertilisation.**

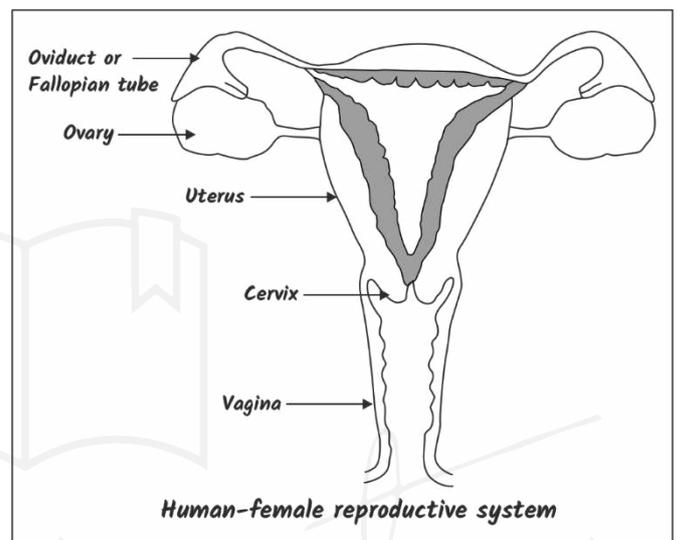
C. Bulbourethral glands / Cowper's glands

- **Pair of pea shaped exocrine glands located posterolateral to the membranous urethra.**
- **Contribute to final volume of semen by producing a lubricating mucus secretion.**

Semen = Sperms + Liquid part

6. Penis

- **Male external genitalia.**
- **Has 3 cylindrical spaces of erectile tissue.**
- **Becomes rigid when these spaces are filled with blood.**
- **Tissues help in the erection of the penis and facilitate insemination.**
- **Foreskin covers the enlarged end of the penis k/a glans penis.**



Female Reproductive System

Parts:

1. Ovaries

- **Main female sex organ.**
- **Produce female gamete 'ovum' and various hormones.**
- **Situated one on both the side of the lower abdomen.**
- **Connected to uterus and pelvic wall through ligaments.**
- **A thin covering of epithelium-encloses ovarian stroma.**
- **Ovarian follicle - basic unit of female reproductive system.**

2. Fallopian Tubes / oviducts

- A pair of muscular tubes and funnel-shaped structures
- Extend from right and left of the superior corners of uterus to edge of ovaries.
- Each tube is covered by cilia that functions by carrying the ovum to the uterus.

3. Uterus

- aka womb.
- A muscular, inverted pear-shaped organ.

➤ Wall has three layers-

- ✓ Inner glandular layer
- ✓ Middle thick layer
- ✓ Outer thin layer.

➤ Site of growth and development of fertilised egg.

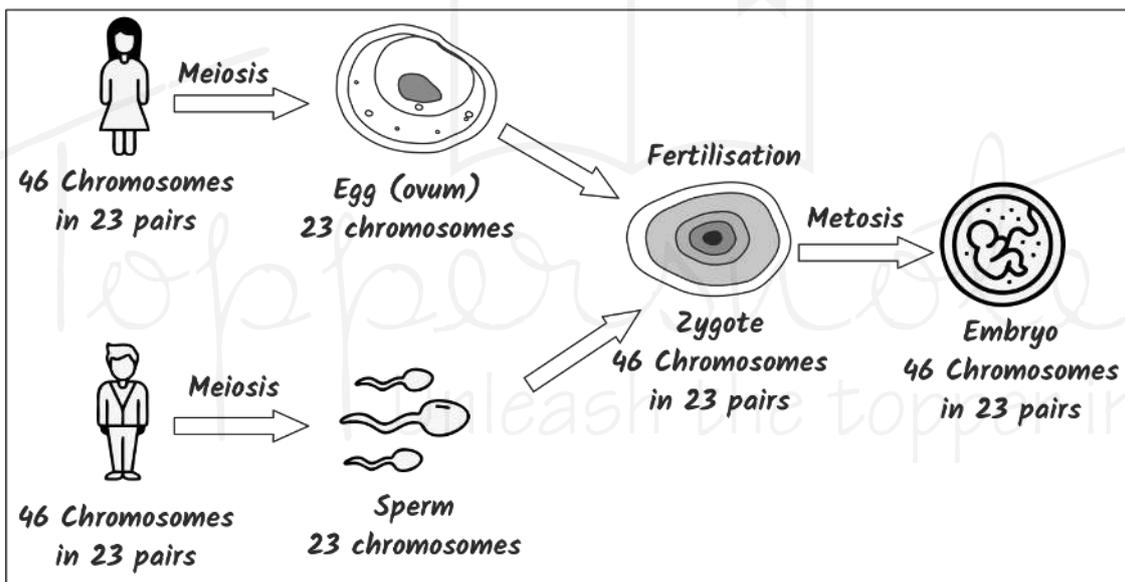
4. Cervix

- A narrow opening that connects uterus to vagina.

5. Vagina

- A muscular tube which starts at the lower end of uterus to outside.
- Cervical canal + vagina = birth canal.

Process of reproduction



- Sperms enter through vaginal passage by sexual intercourse.
- Travel upwards and reach oviduct where they fertilise the egg.
- Fertilised egg (zygote) starts dividing and form a ball of cells or embryo.
- Embryo implanted in lining of uterus - grow and develop organs to become foetus.

Table : Difference between Mitosis and Meiosis

Mitosis	Meiosis
One division	Two division
Number of chromosomes remain the same	Number of chromosomes is halved

Homologous chromosomes line up separately on the metaphase plate	Homologous chromosomes line up in pairs at the metaphase plate.
Homologous chromosome do not pair up	Homologous chromosome pair up to form bivalent
Chiasmata do not form and crossing over never occurs	Chiasmata form and crossingover occurs
Daughter cell are genetically identical	Daughter cell are genetically different from the parent cell
Two daughter cell are formed	Four daughter cells are formed

Menstruation

- **Loss of blood, mucous, unfertilized ovum and ruptured cells and tissues of endometrium through the vagina of the female.**
- **A 28-day cycle occurring in every reproductively active female (from puberty).**
- **Flow of blood - 2 to 8 days.**
- **If the ovum does not get fertilized, endometrium starts sloughing off and there is loss of blood and mucous etc. through the vagina.**
- **If ovum gets fertilized, endometrium becomes thick and spongy for nourishing the embryo and hence menstruation does not occur.**
- **A lady with a developing embryo in her womb is termed as pregnant.**

- **Beginning of menstruation at puberty - menarche.**
- **Stoppage of menstruation when the woman is 45-55 yrs of age - menopause.**

Types of fertilisation

Internal fertilization	External fertilization
It involves the fusion of the male and the female gamete inside the female body.	It involves the fusion of the male and the female gamete outside the female body.
Chances of the survival of the offspring are more. Therefore, a small number of eggs are produced	Chances of survival of the offspring are less. Therefore, a large number of eggs are produced
Humans, cows, hens are organisms showing internal fertilization	Fish, frog, starfish are organisms showing external fertilization.

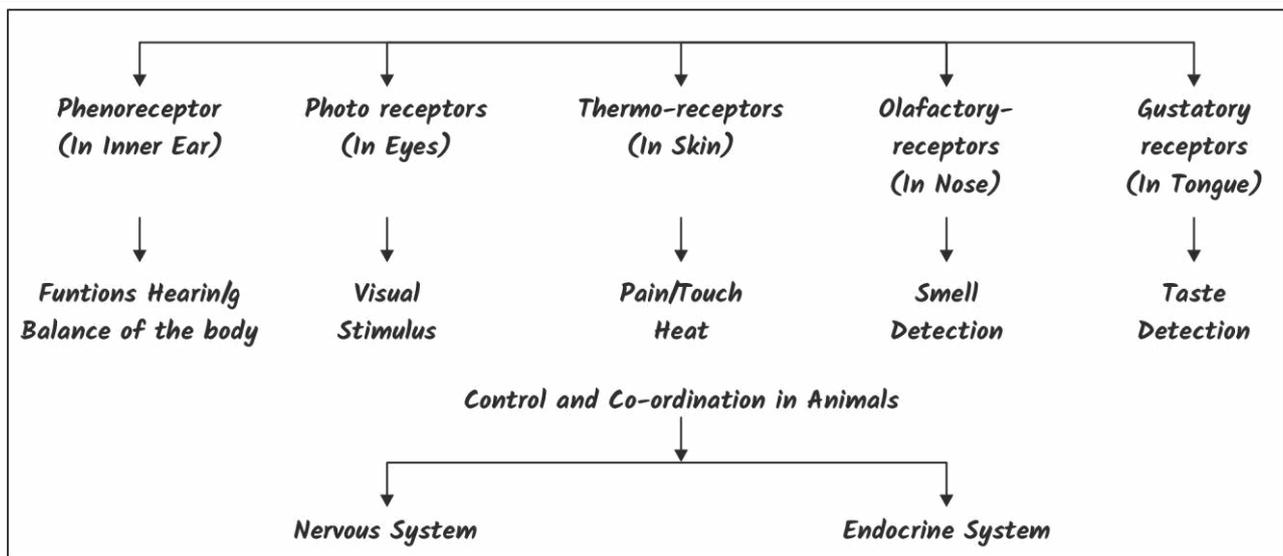
Control and Coordination

In animals

Nervous system and hormonal system are responsible for control and coordination.

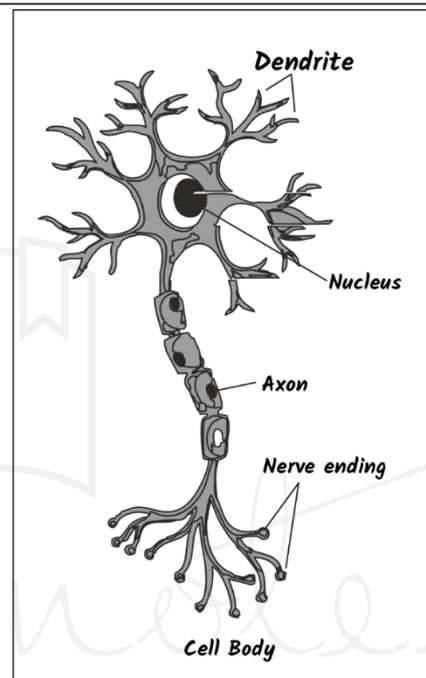
Receptors:

- **Specialized tips of nerve fibres that collect information to be conducted by nerves.**
- **In the sense organs of the animals.**
- **Types:**



1. Nervous System

- A highly complex regulatory system in animals.
- Coordinates actions & transmits sensory information and signals to/from the different parts of body.
- Neuron - structural and functional unit of entire system.
- Functions:
 - ✓ Receives information from the environment.
 - ✓ Receive the information from the various body parts.
 - ✓ Act accordingly through muscles and glands.
- Movement- ability of an organism to move a particular body part.
- Locomotion - ability of an organism to move its whole body from one place to another.



Neuron

- Structural and functional unit of the nervous system
- Coordinates and controls the complex actions in animals.
- Specialized cells responsible for transmission of nerve impulses.
- 3 parts-
 1. Axon-
 - ✓ Tail of the neuron.
 - ✓ Ends in fine hair-like structures k/a axon terminals which rely on nerve impulses

✓ **Axons** - myelinated or unmyelinated.

✓ **Impulse transmission** is faster in myelinated neurons.

2. Cyton/soma/cell body-

✓ **Star-shaped** having various hair-like structures k/a dendrites which receive the nerve impulses

3. Myelin Sheath-

✓ **An insulating sheath** on axon.

✓ **Insulates axon** against nerve impulse from its surroundings.

✓ **Dendrites** receive the impulse from other neurons.

✓ **Cyton** or Soma cells process the impulse- transmitted to the **Axon**. Gets transmitted either to other neurons or to muscles for taking necessary action.

➤ **Types :**

1. **Sensory** neurons- Receive the signals from a sense organ

2. **Motor** neurons- Send the signals to a gland or muscle

3. **Relay** or association neuron- Relay signals between a motor neuron and sensory neuron.

➤ **Synapse**

✓ **A microscopic gap** between two adjacent neurons.

✓ **A point contact** between terminal branches of axon of one neuron and with the dendrite of another neuron.

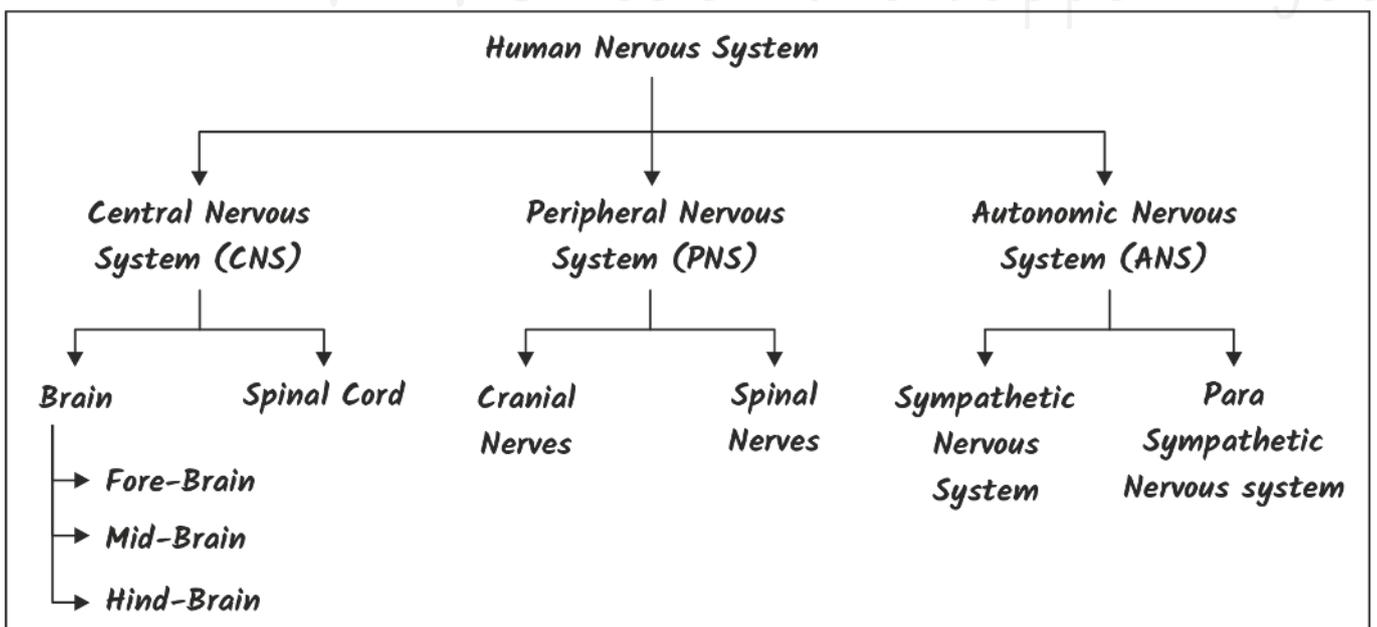
✓ **Convert electric signals** into chemicals that can cross over gap between axon and dendrite.

✓ **Chemical message** is passed to next neuron and converted back to the electrical signal for interpretation.

➤ **Neuromuscular Junction:**

✓ **Point** where a muscle fibre comes in contact with a motor neuron carrying nerve impulse from the control nervous system.

Human nervous system

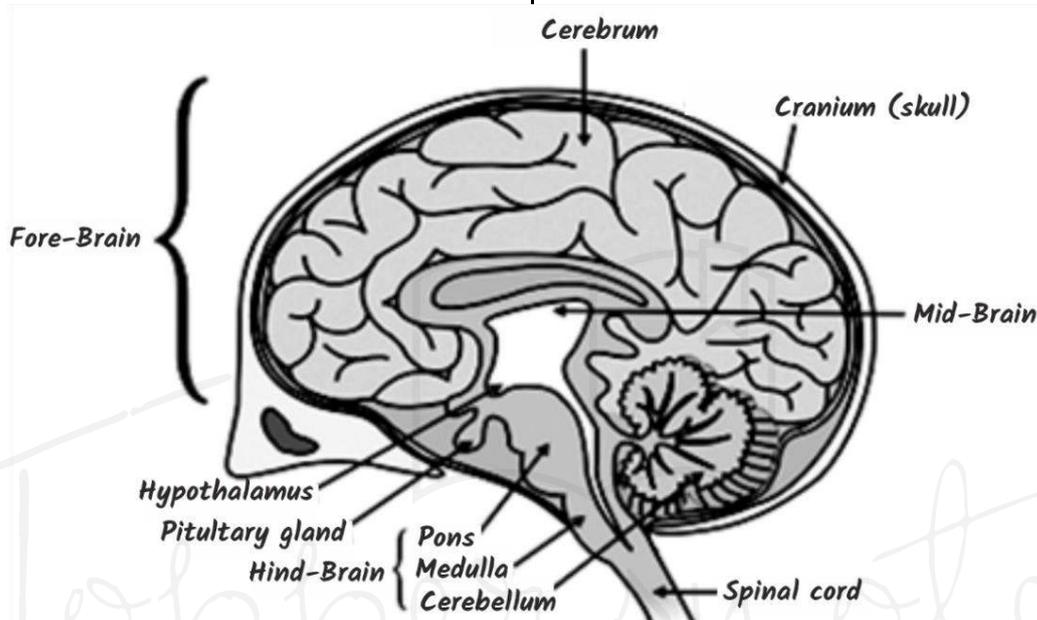


1. Central Nervous System:

- ✓ Brain + spinal cord.
- ✓ Brain controls all the functions in the human body.
- ✓ Spinal cord works as relay channel for signals between brain and peripheral nervous system.

- A highly complex organ mainly composed of nervous tissue.
- Tissues highly folded to accommodate a large surface area in less space.
- Covered by a 3-layered system of membranes k/a meninges.
- Cerebrospinal fluid filled between meninges cushions the brain against mechanical shocks.

Human Brain



➤ 3 parts:

1. Fore-brain:

- ✓ Composed of the cerebrum.
- ✓ Cerebrum- Largest part in human brains.
- ✓ Divided into 2 hemispheres k/a cerebral hemispheres.
- ✓ Functions:
 - Controls voluntary motor actions.
 - Site of sensory perceptions, like tactile and auditory perceptions.
 - Site of learning and memory.

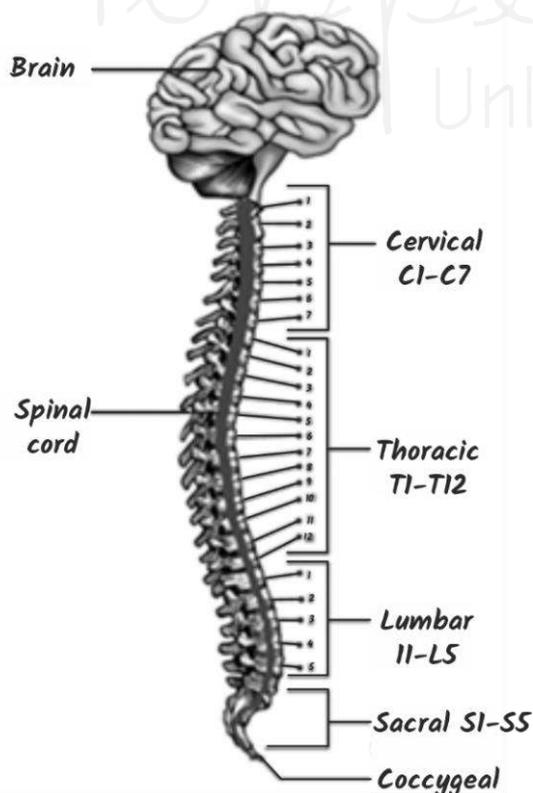
2. Mid-brain:

- ✓ Composed of the hypothalamus.
- ✓ Hypothalamus- lies at the base of the cerebrum.
- ✓ Controls sleep and wake cycle (circadian rhythm) of the body.
- ✓ Controls the urges for eating and drinking.

3. Hind-brain:

- ✓ Composed of cerebellum, pons, medulla, oblongata.
- ✓ Cerebellum- lies below cerebrum and at back of whole structure.
- Coordinates the motor functions.

- Eg. riding a bicycle, ensures perfect coordination between pedalling and steering control.
 - Controls posture and balance.
 - Controls the precision of voluntary action.
- ✓ **Medulla:** Forms brain stem, along with the pons.
- Lies at the base of brain and continues into spinal cord.
 - Controls various involuntary functions, like heart beat, respiration, etc.
 - Controls involuntary actions.
 - Eg: Blood pressure, salivation, vomiting.
- ✓ **Pons:**
- Relays impulses between lower cerebellum and spinal cord
 - Regulates respiration.



Spinal cord

1. Controls reflex actions and conducts messages between different parts of body and brain.
2. Reflex Action:
3. Sudden and involuntary response to stimuli.
4. Helps organisms to quickly adapt to an adverse circumstance that could cause bodily harm or even death.
5. Eg. Pulling our hands away immediately after touching a hot or cold object.
6. Reflex Arc:
7. Path through which nerve signals, involved in a reflex action, travel.

Receptor → Sensory neuron → Relay neuron → Motor neuron → Effector (muscle)

8. Peripheral Nervous System:
 - Cranial nerves + spinal nerves.
 - 12 pairs of cranial nerves coming out of brain and go to the organs in the head region.
 - 31 pairs of spinal nerves coming out of spinal cord and go to the organs which are below the head region.
9. Autonomous Nervous System:
 - Composed of a chain of nerve ganglion which runs along spinal cord.
 - Controls all the involuntary actions in the human body.

➤ 2 parts :

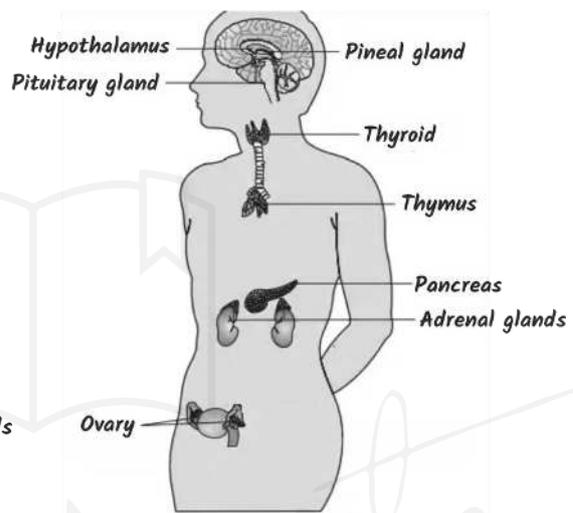
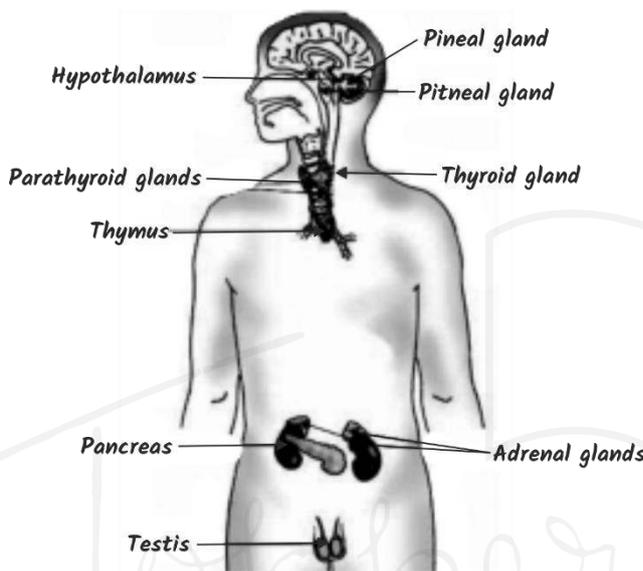
A. Sympathetic Nervous System:

- ✓ Increases activity of an organ as required.
- ✓ Eg. during running, there is an increased demand for oxygen by the body - fulfilled by an increased breathing rate and increased heart rate.

B. Parasympathetic Nervous System:

- ✓ Decreases the activity of an organ and thus has a calming effect.
- ✓ Eg. during sleep, breathing rate slows down and so does the heart rate.
- ✓ Helps in the conservation of energy.

2. Endocrine System



- Made up of interconnected glands that create hormones.
- Almost every cell, organ, and function in our body is influenced by the endocrine system.

- Aids - regulation of mood, growth and development, tissue function, metabolism, and sexual and reproductive functions.
- Also k/a ductless system as the endocrine glands secrete their hormones directly into bloodstream.

Hormones released by endocrine glands

Endocrine Gland	Location	Hormones Produced	Functions
Pituitary gland (aka master gland)	Base of brain	<ul style="list-style-type: none"> ➤ Growth hormone (GH). ➤ Thyroid stimulating hormone (TSH). ➤ Follicle stimulating hormone (FSH) 	<ul style="list-style-type: none"> ➤ GH stimulates growth. ➤ TSH stimulates the functioning of thyroid gland. ➤ FSH stimulates follicles during ovulation.

Thyroid Gland	Neck	➤ Thyroxine	➤ Controls general metabolism and growth in the body.
Adrenal gland	Above kidneys	➤ Adrenalin	➤ Prepares the body for emergency situations and hence is also called 'Fight and flight' hormone.
Pancreas	Near stomach	➤ Insulin	➤ Controls blood sugar level
Testis (male)	In Scrotum	➤ Testosterone	➤ Sperm production, development of secondary sexual characters during puberty.
Ovary (female)	Near uterus	➤ Oestrogen ➤ Progesterone	➤ Egg production, development of secondary sexual characters during puberty.

Genetics

- Study of principles and mechanism of heredity and variation.
- Gregor Johann Mendel - 'father of Genetics'.
- Inheritance -
 - ✓ Process by which characters are passed on from parent to progeny.
 - ✓ Basis of heredity.
- Variation
 - ✓ Degree by which progeny differ from their parents.
 - ✓ Arises due to:
 - Reshuffling of gene/chromosomes.
 - Crossing over or recombination
 - Mutation and effect of environment.

Important terms

- Chromosomes
 - ✓ Long thread-like structures present in nucleus of a cell.
 - ✓ Contain hereditary information of the cell in the form of genes.
- DNA
 - ✓ A chemical in chromosome which carries the traits in a coded form.
- Gene
 - ✓ Part of a chromosome which controls a specific biological function.
 - ✓ aka "unit of heredity".
- Contrasting characters:
 - ✓ A pair of visible characters like tall and dwarf, white and violet flowers, round and wrinkled seeds, green and yellow seeds etc.

➤ **Dominant trait:**

- ✓ **Character which expresses itself in a generation.**
- ✓ **Eg : Tallness is a dominant character in pea plant.**

➤ **Recessive trait:**

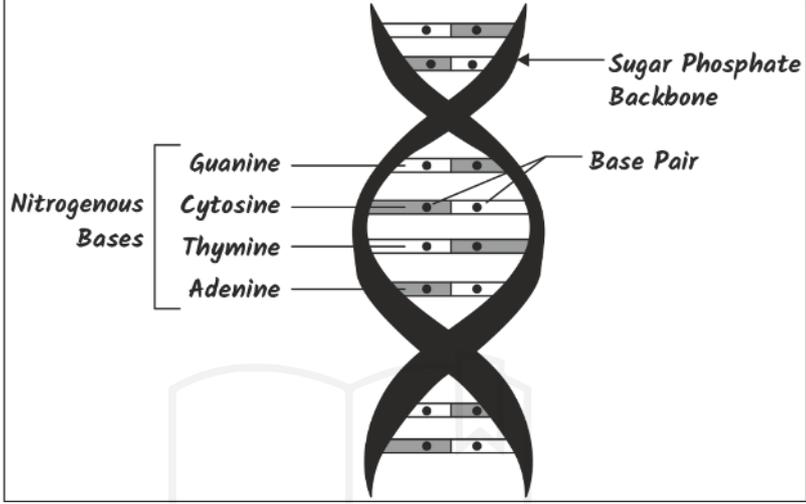
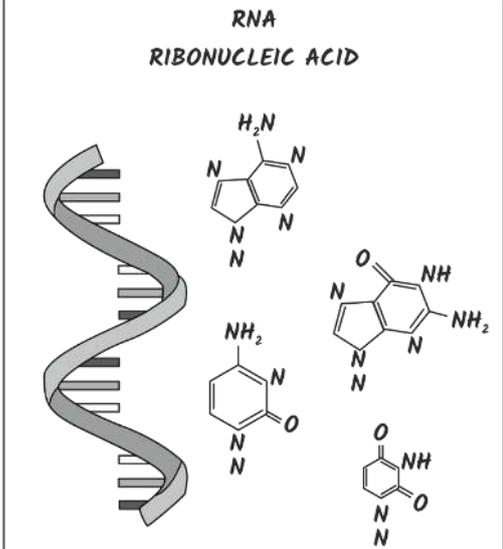
- ✓ **Character which does not express itself but is present in a generation.**
- ✓ **Eg. dwarfism in the pea plant.**

➤ **Genotype:**

- ✓ **Genetic make up of an individual.**

➤ **Phenotype:**

- ✓ **External appearance of the organism.**

<p>DNA or deoxyribonucleic acid</p>	 <ul style="list-style-type: none"> ➤ Hereditary material in humans and almost all other organisms. ➤ Nearly every cell in a person's body has the same DNA. ➤ Located in the cell nucleus & mitochondria (k/a mitochondrial DNA or mtDNA). ➤ Information in DNA is stored as a code made up of 4 chemical bases: adenine (A), guanine (G), cytosine (C), and thymine (T). ➤ Order of these bases determines information available for building and maintaining an organism.
<p>RNA (Ribonucleic acid)</p>	<p style="text-align: center;">RNA RIBONUCLEIC ACID</p> 

- A nucleic acid containing ribose.
- Directly involved in protein synthesis.
- Acts as a messenger conveying instructions from DNA for controlling the protein's synthesis.
- Also contain Adenine, Guanine and Cytosine like DNA.
- 4th base - Thymine in DNA and Uracil in RNA.
- A single stranded molecule.

Human anatomy

- Scientific study of the morphology of the adult human.
- Subdivided into :
 - ✓ Gross anatomy/ topographical anatomy/ regional anatomy/ anthropotomy)
 - Study of anatomical structures - seen by unaided vision.
 - ✓ Microscopic anatomy :
 - Study of minute anatomical structures assisted with microscopes,

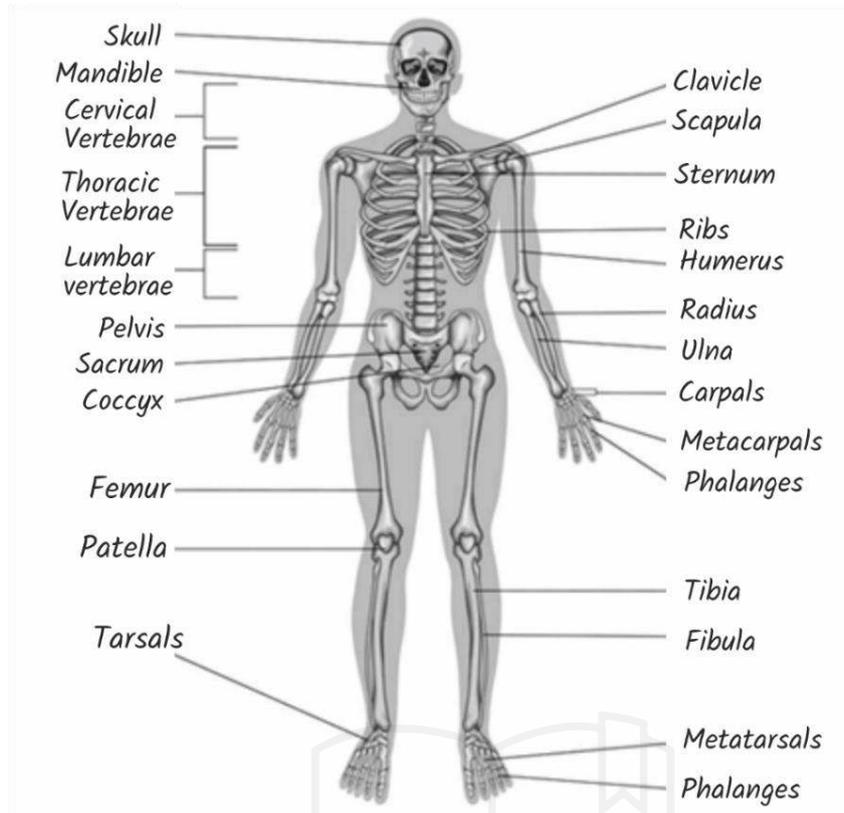
- Includes histology(study of tissues), and cytology(study of cells).

Muscular System

- Muscle - specialized tissue of mesodermal origin.
- [Mesodermal = middle layer of cells or tissues of an embryo, or the parts derived from this (e.g. cartilage, muscles, and bone)]
- About 40-50 % of body weight of a human adult contributed by muscles.
- Properties of muscles: excitability, contractility, extensibility and elasticity.

	Main features	Location	Type of cells
Skeletal muscles	<ul style="list-style-type: none"> ➤ Fibers : Striated, tubular and multi nucleated ➤ Volunatry ➤ Usually attached to skeleton 		
Smooth muscles	<ul style="list-style-type: none"> ➤ Fibers : Non striated spindle shaped, and uninucleated ➤ Involuntary ➤ Usually convering wall of internal ogans. 		
Cardiac muscle	<ul style="list-style-type: none"> ➤ Fibres : striated, branched and uninucleated. ➤ Involuntary ➤ Only covering wall of the heart 		

Skeletal System



- consists of a **framework of bones and a few cartilages** which are **206 in number**
- **Bone and cartilage** are **specialized connective tissues**.
- **Divisions:** the **axial** and the **appendicular skeleton**.
- **Axial skeleton** comprises **80 bones** distributed along the **main axis** of the body.
 - ✓ The **skull, vertebral column, sternum** and **ribs** constitute the **axial skeleton**.

Main Parts of the Skeletal System

Skull:

- **Protects the brain, supports facial structures, and houses sensory organs (eyes, ears, nose).**
- **Composed of cranial bones (protecting the brain) and facial bones (supporting the face).**

Mandible:

- **The lower jawbone, which is the only movable bone of the skull.**
- **Supports the lower teeth and plays a role in chewing and speaking.**

Cervical Vertebrae:

- **The first 7 vertebrae in the neck region.**
- **They provide support for the head and allow for its movement. The first cervical vertebra (Atlas) supports the skull, and the second (Axis) allows rotation of the head.**

Thoracic Vertebrae:

- **12 vertebrae located in the upper and mid-back.**
- **Attach to the ribs and provide stability to the upper body.**

Lumbar Vertebrae:

- The 5 vertebrae located in the lower back.
- Support much of the body's weight and allow for flexible movement of the torso.

Pelvis:

- The bony structure formed by the hip bones, sacrum, and coccyx.
- Supports the weight of the upper body when sitting and standing and facilitates movement.

Sacrum:

- A large, triangular bone at the base of the spine.
- Forms the back portion of the pelvis and connects the spine to the hip bones.

Coccyx:

- Commonly known as the tailbone, located at the end of the vertebral column.
- Provides support for the body when sitting.

Clavicle:

- Also known as the collarbone, it connects the arm to the body.
- Serves as a strut to keep the scapula in position and provides stability.

Scapula:

- The shoulder blade, which connects the upper arm to the trunk of the body.
- It provides attachment points for muscles and helps in the movement of the arm.

Sternum:

- The breastbone located in the center of the chest.
- Protects vital organs such as the heart and lungs.

Ribs:

- 12 pairs of curved bones that surround the chest.
- Protect internal organs such as the heart and lungs and assist with breathing.

Humerus:

- The upper arm bone.
- It connects the shoulder to the elbow and allows for a wide range of arm movements.

Radius:

- One of the two bones of the forearm, located on the thumb side.
- Allows for the rotation of the wrist and forearm.

Ulna:

- The longer of the two forearm bones, located on the side opposite the thumb.
- Provides structural support and helps in the movement of the elbow.

Carpals:

- The eight small bones that make up the wrist.
- Allow for the flexibility and movement of the hand.

Metacarpals:

- The five bones that form the middle part of the hand.
- Provide structure and support for the palm.

Phalanges (Hand):

- The bones of the fingers and thumb.
- Allow for fine motor control and grip.

Femur:

- The thigh bone, which is the longest and strongest bone in the human body.
- Supports the weight of the body and enables movement of the lower limbs.

Patella:

- The kneecap, located at the front of the knee joint.
- Protects the knee and aids in leg extension.

Tarsals:

- The seven bones that make up the ankle.
- Provide structural support and facilitate foot movement.

Tibia:

- The shinbone, which is the larger of the two bones in the lower leg.
- Supports the body's weight and allows movement of the foot and ankle.

Fibula:

- The smaller bone in the lower leg, located alongside the tibia.
- Provides support but does not bear much weight.

Metatarsals:

- The five bones that form the middle part of the foot.
- Provide structure and help with walking.

Phalanges (Foot):

- The bones of the toes.
- Facilitate movement and balance while walking.

Types of Joints in the Human Skeletal System

1. Fibrous Joints:

- ✓ **Structure:** Connected by dense connective tissue, typically immovable.
- ✓ **Examples:** Sutures of the skull, syndesmosis between the radius and ulna.

2. Cartilaginous Joints:

- ✓ **Structure:** Connected by cartilage, allowing limited movement.
- ✓ **Examples:** Intervertebral discs, pubic symphysis.

3. Synovial Joints:

- ✓ **Structure:** Most common and movable, with a fluid-filled synovial cavity.
- ✓ **Examples:**
 - **Ball-and-Socket Joints** (e.g., shoulder and hip)
 - **Hinge Joints** (e.g., elbow, knee)
 - **Pivot Joints** (e.g., between the first and second cervical vertebrae — **Atlas and Axis**)
 - **Saddle Joints** (e.g., thumb)
 - **Condyloid Joints** (e.g., wrist)
 - **Plane Joints** (e.g., between carpals in the wrist)

➤ Functions:

Support	<ul style="list-style-type: none">➤ To provide a solid framework to support and safeguard human body and its organs.➤ Helps in maintaining the overall shape of human body.
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Protection	<ul style="list-style-type: none"> ➤ Helps to protect internal organs and other delicate body organs, including brain, heart, lungs and spinal cord by acting as a buffer. ➤ Cranium (skull) protects brain and eyes, ribs protect heart and lungs and vertebrae (spine, backbones) protect spinal cord.
Movement	<ul style="list-style-type: none"> ➤ Bones provide basic structure for muscles to attach themselves onto so that our bodies are able to move. ➤ Tendons - tough inelastic bands that attach our muscle to that particular bone.
Storage	<ul style="list-style-type: none"> ➤ Cell matrix acts as our calcium bank by storing and releasing calcium ions into the blood cell when required.
Regulation of Endocrine glands	<ul style="list-style-type: none"> ➤ Important role in releasing hormones from endocrine glands for further requirement by the body for different metabolisms. ➤ Skeletal system also contributes to the regulation of blood sugar.

Immunity & Immune System

Immunity

- Overall ability of body to fight against disease causing microorganisms with the help of immune system.
- 2 types-
 1. **Innate immunity**
 - ✓ Occurs by birth.
 - ✓ **Non-specific type** of defense.
 - ✓ **Consists of various barriers** which prevent entry of microorganisms into the body.
 - ✓ 4 types of barriers.
 - A. **Physical** -
 - **Skin** - main barrier - prevents entry of micro-organisms
 - **Mucus** coating of epithelium - lines respiratory, gastrointestinal and urogenital tracts - help in trapping microbes.
 - B. **Physiological** -
 - **Acid** in stomach, **saliva** in mouth, **tears** from eyes.
 - C. **Cellular**
 - Certain types of **leukocytes (WBC)**, **monocytes** and **lymphocytes** in the blood as well as **macrophages** in tissues .
 - D. **Cytokine**-
 - **Virus-infected cells secrete proteins** called **interferons** which protect non-infected cells from further viral infection.

2. Acquired/ Adaptive immunity

- ✓ Develops during lifetime by exposure to suitable foreign agents like microorganisms.
- ✓ Pathogen specific and characterized by memory.
- ✓ 2 types:

A. Primary immune response

- When body first encounters a pathogen, it produces a response which takes long time to develop and of low intensity

B. Secondary immune response

- If the body encounters the same pathogen it produces highly intensified and quick response.

Antibody/ immunoglobulin

- A large, Y-shaped protein used by immune system to identify and neutralize foreign objects like pathogenic bacteria and viruses.

T cells (thymus cells) and B cells (bone marrow- or bursa-derived cells)

- Major cellular components of the

adaptive immune response.

- T cells - cell-mediated immunity
- B cells - humoral immunity (relating to antibodies).

Memory B cells (MBCs):

- A B-cell subtype formed within germinal centers following primary infection.
- Can survive for decades and repeatedly generate an accelerated and robust antibody-mediated immune response in the case of re-infection - secondary immune response).

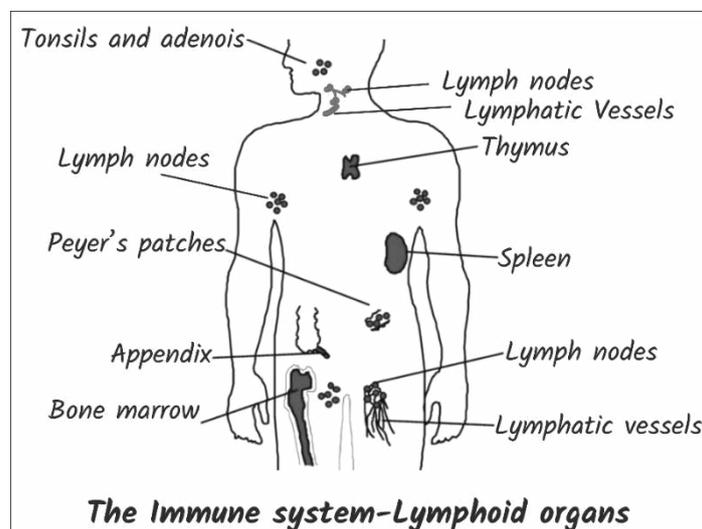
Helper T cells:

- Required for almost all adaptive immune responses.
- Help activate B cells to secrete antibodies and macrophages to destroy ingested microbes & killer T-cells to kill infected target cells.

Killer T cells:

- A T lymphocyte (a type of white blood cell) that kills cancer cells, cells infected (particularly with viruses), or cells damaged in other ways.

Parts of immune system:



- **Lymphoid Organs:**
 - ✓ Site of origin and maturation and proliferation of Lymphocytes
- **Bone marrow**
 - ✓ Main lymphoid organ where all blood cells including lymphocytes are produced.
- **Thymus -**
 - ✓ A lobed organ located near heart and beneath the breastbone-
 - ✓ Quite large at the time of birth but keeps reducing in size with age and by the time puberty is attained it reduces to a very small size.
 - ✓ Provides micro-environments for the development and maturation of T-lymphocytes.
- **Spleen**
 - ✓ A large bean shaped organ.
 - ✓ Mainly contains lymphocytes and phagocytes.
 - ✓ Acts as a filter of blood by trapping blood-borne microorganisms.
 - ✓ Has a large reservoir of erythrocytes.

- **Lymph nodes**
 - ✓ Small solid structures located at different points along the lymphatic system.
 - ✓ Trap microorganisms or other antigens, which happen to get into the lymph and tissue fluid.

Disorders of the Immune System

- **Allergic diseases -**
 - ✓ Hay fever, sinus disease, asthma, hives, dermatitis and eczema.
- **Autoimmune diseases**
 - ✓ Multiple sclerosis, autoimmune thyroid disease, type 1 diabetes, systemic lupus erythematosus, rheumatoid arthritis and systemic vasculitis.
- **Immunodeficiencies**
 - ✓ Inherited from a parent to the child.
 - ✓ Include primary immunodeficiency diseases like x-linked severe combined immunodeficiency (SCID), complement deficiencies, common variable immunodeficiency (CVID), etc
 - ✓ Diseases Caused By Viruses