

Science and Technology:

1. Nature and scope of Science and Technology, Relevance of S&T, National policy on S&T and innovations, Basics of everyday science, Human body, Public Health and Community Medicine, Food and Nutrition, Health Care. Institutes and Organization in India promoting integration of S&T and Innovation, their activities and contributions, Contribution of Prominent Indian Scientists.
2. Technology in Space and Defence: Evolution of Indian Space Programme, ISRO – its activities and achievements, various Satellite Programmes – DRDO-vision, mission and activities.
3. Energy requirement and efficiency: India's existing energy needs and deficit, India's energy resources and dependence, Renewable and Non-renewable energy resources, Energy Policy of India – Govt. Policies and Programmes, Energy Security and Nuclear Policy of India.
4. Environmental Science : Issues and concerns related to the environment, its legal aspects, policies and treaties for the protection of environment at the National and the International level, Environment protection for sustainable development. Biodiversity – its importance and concerns, Climate change, International initiatives (Policies, Protocols) and India's commitment, Western Ghats, Features, Characteristics and issues. Forest and wildlife –

Legal framework for Forest and Wildlife Conservation in India. Environmental Hazards, Pollution, Carbon Emission, Global Warming. Developments in Biotechnology, Green Technology and Nanotechnology.

BASICS OF EVERYDAY SCIENCE

Chemicals in Food

Colouring Agents:

- Colouring agents are substances added to food to impart or enhance colour.
- Synthetic dyes like tartrazine, sunset yellow, and brilliant blue are commonly used.
- Natural colouring agents like carotenoids (from fruits and vegetables) are also used.

Preservatives:

- Preservatives are added to food items to prolong their shelf life.
- Common examples include salt, sugar, vinegar, and synthetic chemicals like sodium benzoate.
- Pasteurization, a method of preserving milk, involves heating milk to destroy microorganisms.

Artificial Sweeteners:

- Artificial sweeteners are synthetic compounds used as sugar substitutes.
- Examples include aspartame, saccharin, and sucralose.

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- These sweeteners are intensely sweet, providing sweetness without the calories of traditional sugar.

Cleansing Agents

Soaps:

- Soaps are sodium or potassium salts of fatty acids, formed through saponification.
- Process: Heating fat with alkali (e.g., sodium hydroxide).
- Alkali used for soft soaps: Potassium hydroxide.

Synthetic Detergents:

Synthetic detergents are cleansing agents without soap content.

- Types: Anionic, cationic, and non-ionic detergents.
- Anionic detergents: Involved in household cleaning and toothpaste.
- Cationic detergents: Have germicidal properties.
- Non-ionic detergents: Do not contain ions, used in liquid dishwashing detergents.

Allotropes of Carbon

Crystalline Carbon:

- Diamond: Purest form, hardest material, high melting point, used in various industries.
- Graphite: Soft, slippery, good conductor of electricity and heat, used as a dry lubricant and in nuclear reactors.
- Graphene: Two-dimensional sheet of hexagonal rings,

extremely strong and conductive.

Fullerenes:

- Hollow, cage-like structures of carbon atoms, used in medicine as antimicrobial agents.
- Cylindrical fullerenes known as carbon nanotubes (CNTs) have various applications, including drug delivery and cancer treatment.

Amorphous Carbon:

- Includes coal, coke, and charcoal.
- Coal: Abundant fossil fuel, classified based on carbon content into peat, lignite, bituminous coal, and anthracite.

Polymers

Definition: Polymers are substances composed of a large number of repeating units called monomers. Examples include plastics, rubber, proteins, and starch.

Types of Polymers:

- PVC: Monomer - Vinyl Chloride
- Polythene: Monomer - Ethylene
- Natural rubber: Monomer - Isoprene
- Teflon: Monomer - Tetrafluoroethylene
- Bakelite: Monomers - Phenol, Formaldehyde

Plastics:

- Discovered by Alexander Parkes; the first synthetic plastic

was Bakelite developed by Leo Baekeland.

- Classified into thermoplastics and thermosetting plastics.
 - Thermoplastics: Soften on heating, harden on cooling (e.g., PVC, Nylon).
 - Thermosetting Plastics: Harden permanently on cooling, cannot be remoulded (e.g., Bakelite, Melamine-formaldehyde resin).

Uses of Different Plastics:

- Polythene: Packets, containers.
- PVC: Electrical wirings, plumbing, raincoats.
- Bakelite: Electrical plugs, switches, kitchen handles.
- Melamine-formaldehyde resin: Unbreakable crockery, firefighter uniforms.

Glass:

- Mixture of metallic silicates; known as "supercooled liquid."
- Types include soda glass, hard glass, borosilicate glass, and flint/optical glass.
- Hardened using borax; heat-resistant borosilicate glass known as Pyrex.

Transition Metal Compounds and Colours of Glass:

- Ferrous salt: Green
- Ferric salt: Yellow
- Cobalt salt: Blue
- Nickel salt: Red
- Cuprous oxide: Red

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- Cadmium sulphide: Yellow
- Uranium oxide: Yellow
- Manganese dioxide: Purple

Metals

Properties of Metals:

- Electropositive, hard, solids at room temperature.
- High melting points; tungsten has the highest melting point.
- Malleable and ductile; gold is the most malleable, platinum is the most ductile.
- Good conductors of heat and electricity, lustrous, and sonorous.

Metals in Biological Systems:

- Magnesium in chlorophyll, iron in haemoglobin, cobalt in vitamin B12, calcium is the most abundant metal in the human body.
- Zinc in insulin and tears.

Alloys:

- Mixtures of chemical elements, at least one being a metal, to enhance properties.
- Bronze was the first alloy used by humans.
- Examples include brass, bronze, solder, steel, nichrome, stainless steel, and Alnico.

Ores

Definition: Ores are metallic compounds found in the Earth's crust, from which metals can be economically, easily, and quickly extracted.

Metallurgy: The process of separating pure metals from their ores.

Impurities in Ores: Gangue.

Examples of Metals and their Ores:

- Aluminium: Bauxite, Cryolite, Kaolinite
- Iron: Haematite, Magnetite, Iron pyrites, Siderite
- Zinc: Zinc blend, Calamine
- Uranium: Pitchblende, Carnotite
- Titanium: Ilmenite, Rutile
- Mercury: Cinnabar
- Thorium: Monazite
- Lead: Galena
- Copper: Copper pyrites, Cuprite, Chalcocite, Chalcopyrite
- Tin: Cassiterite

Acids

Properties:

- $\text{pH} < 7$, sour taste, turn litmus paper red.
- Release H_2 gas with metals and CO_2 with carbonates.
- Hydrochloric acid (HCl) is present in intestinal juice; also known as 'Muriatic acid' or 'spirits of salt.'
- 'King of chemicals': Sulphuric acid, also known as 'Oil of vitriol.'

Industrial Preparation:

- Sulphuric acid: Contact process, catalysed by Vanadium Pentoxide.
- Nitric acid (HNO_3): Ostwald process.

Uses and Examples:

- Lactic acid in milk, malic acid in apples, oxalic acid in tomatoes, formic acid in ants, citric acid in oranges and lemons, tartaric acid in tamarind, hydrocyanic acid in tapioca.

Bases (Alkali)

Properties:

- $\text{pH} > 7$, bitter taste, turn litmus paper blue.
- Examples: Sodium Hydroxide (NaOH), Calcium Hydroxide (Ca(OH)_2), Ammonium Hydroxide (NH_4OH), Potassium Hydroxide (KOH), Ammonia (NH_3).

Industrial Uses:

- Manufacture of soap, detergent, ceramic products, and for sewage treatment.
- Caustic soda: Sodium hydroxide (NaOH), caustic potash: Potassium hydroxide (KOH), slaked lime: Calcium hydroxide (Ca(OH)_2).

Other Information:

- Magnesium hydroxide (Milk of magnesia) used in

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antacids.

- Industrial preparation of ammonia: Haber process, catalysed by spongy iron.

pH Values:

- Lemon juice: 2.4, vinegar: 4.2, coffee: 5, tea: 5.5, urine: 6, saliva: 6.4, pure water: 7, blood: 7.4, sea water: 8, baking soda: 8-9, ammonia: 11.

States of Matter

Definition: Matter is anything that has mass and occupies space.

States:

Solid: Definite shape and volume, particles tightly packed.

Liquid: Definite volume but no definite shape, particles less tightly packed.

Gas: No definite shape or volume, particles very loosely packed.

Plasma: Most abundant in the universe, consists of ions and electrons.

Bose-Einstein Condensate: Low-temperature state of matter, formed by bosons.

Fermionic Condensate: Superfluid state, formed by fermions.

Quark-Gluon Plasma: High-temperature state, consists of quarks and gluons.

Newly Discovered States:

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- Time Crystal
- Jahn Teller metal
- Exitonium
- Rydberg polarons

HUMAN BODY

- **STRUCTURE OF A CELL**
- **CLASSIFICATION OF ORGANISMS BASED ON CELLS**
 - **CELL DIVISION**
 - **CELLULAR RESPIRATION**
- ❖ **Cell is the structural and functional unit of all organisms**
- CONTRIBUTIONS OF SCIENTISTS**
 - ❖ **Robert Hooke :- Discovery of cell**
 - **The first book which describes a cell :- Micrographia
(Written by Robert Hooke in 1665)**
 - ❖ **Anton Van Leeuwenhoek :- Discovery of living cell**
 - ❖ **Robert Brown :- Discovery of cell nucleus (1831)**
 - ❖ **M.J.Schleiden :- Found out that a plant is made up of
cells
(1838)**
 - ❖ **Theodor Schwann :- Found out that the body of an
animal is
made up of cells (1839)**
 - ❖ **M.J.Schleiden and Theodor Schwann together
formulated
the 'Cell Theory'**
 - ❖ **Rudolf Virchow :- Explained that new cells arise only
from
existing cells (1858)**

❖ **Concepts of Cell theory :**

- The body of all organisms is made up of cells.
- Cells are the structural and functional units of organisms.

STRUCTURE OF A CELL

❖ **Major parts;**

- Cell membrane
- Cytoplasm
- Cell organelles

CELL MEMBRANE/ PLASMA MEMBRANE

❖ **Outermost covering of a cell**

- ❖ Cell membrane is mainly composed of lipids and proteins

Eg :- A Red blood cell (RBC) has about 52 per cent protein and 40 per cent lipids

- ❖ **Fluid Mosaic Model :- The model which explains the structure of plasma membrane.**

- ❖ **'Fluid mosaic model' was proposed by Singer and Nicolson (1972)**

- ❖ **Major function of plasma membrane :- Transportation of molecules**

- ❖ **Cell membrane is selectively permeable to some molecules**

CELL WALL

- ❖ **Outermost covering of a cell in plants and fungi which covers**

the cell membrane

❖ **Functions :-**

- **Protection of the cell from mechanical damage and infections**
 - **Provides shape to the cell**

CYTOPLASM

❖ **It is the semi-fluid substance that fills the inside of a cell.**

CELL ORGANELLES

❖ **An organelle is a subcellular structure that has one or more**

specific jobs to perform in the cell

Eg : Endoplasmic Reticulum

Golgi Bodies

Lysosome

Mitochondria etc.

1. ENDOPLASMIC RETICULUM (ER)

❖ **A network of tiny tubular structures scattered in the cytoplasm**

❖ **'Transportation Channels' of the cell**

❖ **Function :- Transportation of materials**

❖ **ER are of two types;**

- **Rough Endoplasmic Reticulum (RER)**
- **Smooth Endoplasmic Reticulum (RER)**

❖ **Rough endoplasmic reticulum (RER) :- Endoplasmic reticulum bearing ribosomes on their surface is called rough endoplasmic reticulum (RER)**

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- **Observed in the cells actively involved in protein synthesis and secretion**

❖ **Smooth Endoplasmic Reticulum (RER) :- Endoplasmic reticulum that lack ribosomes on their surface**

- **Major site for the synthesis of lipid**

2. GOLGI APPARATUS/GOLGI BODIES

❖ **Golgi body was discovered by Camillo Golgi**

❖ **It consists of many flat, disc-shaped sacs or 'cisternae' arranged parallel to each other**

❖ **Functions :-**

- **Packaging materials (enzymes, hormones etc.)**

- **Important site of formation of glycoproteins and glycolipids**

❖ **Known as the 'Traffic police' of the cell**

3. MITOCHONDRIA

❖ **mitochondrion is a double membrane-bound structure present**

in the cytoplasm.

❖ **The inner membrane forms a number of infoldings called the cristae.**

❖ **Known as the 'Powerhouse' of the cell**

❖ **Function :- Produce and store the cellular energy in the form**

of ATP (Adenosine triphosphate) molecules.

❖ **Abundantly seen in the cells of liver, brain and muscles where the energy requirement is high.**

4. VACUOLE

- ❖ **Sac that stores water, salts, excretory materials etc.**
- ❖ **Membranous covering of vacuole :- Tonoplast**

5. RIBOSOMES

- ❖ **Centre of protein synthesis in the cell.**
- ❖ **Known as the 'Protein Factory' of the cell.**
- ❖ **Present as two subunits within the cytoplasm.**
- ❖ **Discovered by George Palade (1953)**
- ❖ **Seen either attached to the endoplasmic reticulum or free in the cytoplasm.**

6. CENTROSOME

- ❖ **Present only in animal cells**
- ❖ **Composed of two cylindrical structures called centrioles**
- ❖ **Centrioles are arranged perpendicular to each other**
- ❖ **Function :- Helps in cell division**

7. LYSOSOMES

- ❖ **Membrane bound vesicular structures formed by the process of packaging in the golgi apparatus.**
- ❖ **Vesicles contain enzymes like lipase, protease etc.**
- ❖ **Destroys the foreign substances that enter the cell.**

8. NUCLEUS

- ❖ **Nucleus is the regulatory centre of a cell**
- ❖ **The synthesis of proteins is under the control nucleus**
 - ❖ **Parts of a Nucleus ;**
 - **Nuclear membrane**

- Nuclear pore
- Nucleoplasm
- Chromaticulum reticulum
 - ❖ Nuclear membrane :-
 - It is the double layered membrane that covers the nucleus.
 - The space between the two layers of nuclear membrane is called Perinuclear space.
 - ❖ Nuclear pore :-
 - Pores in the nuclear membrane
 - Helps in the conduction of materials to and from the nucleus.
 - ❖ Nucleoplasm :-
 - It is the fluid part of the nucleus
 - Contains Nucleolus and chromatin reticulum
 - ❖ Chromatin reticulum) :-
 - They are seen as a network in the nucleoplasm
 - Contains DNA (Deoxyribonucleic acid) and proteins
 - Protein present in Chromatin reticulum:- Histone
 - Basic functional unit of DNA :- Genes
 - DNAs are known as the Genetic material
 - During cell division, chromatin fibres condenses to form Chromosomes.
 - ❖ Nucleolus
 - They are spherical bodies, that play a major role in the synthesis of ribosomes.

CLASSIFICATION OF ORGANISMS

1. BASED ON THE NUMBER OF CELLS PRESENT IN THEIR BODY

- ❖ **Unicellular organisms :- Organisms having only one cell**
Eg: Amoeba, Paramecium, Euglena, Bacteria
- ❖ **Multicellular organisms :- Organisms whose body is made up of multiple cells**
Eg: Plants, Animals etc.

2. ON THE BASIS OF THE PRESENCE OF NUCLEUS IN THE CELL

- ❖ **Prokaryotes :- Organisms that lack a well defined nucleus**
Eg: Bacteria, mycoplasma, blue green algae etc.
- ❖ **Eukaryotes :- Organisms that have a well defined nucleus**
Eg: Plants, Animals, Amoeba etc.

CELL DIVISION:

Cell division is the process by which a parent cell divides into two or more daughter cells. It is essential for growth, development, and repair in multicellular organisms, as well as for reproduction in unicellular organisms. There are two main types of cell division: mitosis and meiosis.

Mitosis:

- Mitosis is a type of cell division that occurs in somatic cells (non-reproductive cells) and results in the production of two genetically identical daughter

cells.

- It consists of several stages: prophase, metaphase, anaphase, and telophase.
- During prophase, the chromatin condenses into visible chromosomes, and the nuclear membrane disintegrates.
- In metaphase, the chromosomes line up along the metaphase plate, and spindle fibres attach to the centromeres of each chromosome.
- Anaphase is characterised by the separation of sister chromatids, which are pulled to opposite poles of the cell by the spindle fibres.
- Telophase marks the end of mitosis, during which the nuclear membrane reforms around the separated chromosomes, and cytokinesis occurs, resulting in the division of the cytoplasm and the formation of two daughter cells.

Meiosis:

- Meiosis is a type of cell division that occurs in germ cells (cells that give rise to gametes) and results in the production of four genetically unique daughter cells, each with half the number of chromosomes as the parent cell.
- It consists of two rounds of division: meiosis I and meiosis II.
- Meiosis I is similar to mitosis but includes a step called crossing over, where homologous chromosomes exchange genetic material, increasing genetic diversity.

- Meiosis II is similar to mitosis and results in the separation of sister chromatids, producing four haploid daughter cells, each with a unique combination of genetic material.

CELLULAR RESPIRATION:

Cellular respiration is the process by which cells break down organic molecules, such as glucose, to produce ATP (adenosine triphosphate), the energy currency of the cell. It occurs in three main stages: glycolysis, the citric acid cycle (Krebs cycle), and oxidative phosphorylation (electron transport chain).

Glycolysis:

- Glycolysis takes place in the cytoplasm and involves the breakdown of glucose into two molecules of pyruvate.
- It generates a small amount of ATP and NADH (reduced form of nicotinamide adenine dinucleotide), which carries electrons to the electron transport chain.

Citric Acid Cycle (Krebs Cycle):

- The citric acid cycle occurs in the mitochondria and completes the oxidation of glucose by breaking down pyruvate into carbon dioxide.
- It generates NADH and FADH₂ (reduced form of flavin adenine dinucleotide), which carry electrons to the electron transport chain.

Oxidative Phosphorylation (Electron Transport Chain):

- Oxidative phosphorylation takes place in the inner

mitochondrial membrane and involves the transfer of electrons from NADH and FADH₂ to oxygen through a series of protein complexes.

- This transfer of electrons generates a proton gradient across the inner mitochondrial membrane, which drives the synthesis of ATP through ATP synthase.

NERVOUS SYSTEM

NEURONS/NERVE CELLS

Neurons, or nerve cells, are the building blocks of the nervous system. They are specialised cells capable of transmitting electrical impulses and are the functional units responsible for processing and transmitting information.

STRUCTURE OF A NEURON

- Cell body: Contains the nucleus and other organelles essential for the neuron's metabolic activities.
- Dendrites: Branch-like extensions that receive signals from other neurons and transmit them to the cell body.
- Axon: A long fibre that carries nerve impulses away from the cell body and towards other neurons or target cells.
- Synaptic Knob: Located at the end of the axon, it contains neurotransmitters responsible for transmitting signals to the next neuron or target cell.

SYNAPSE

A synapse is the junction between two neurons where communication occurs. Neurotransmitters released from the synaptic knob of one neuron transmit signals across the synaptic cleft to the dendrites or cell body of the next neuron.

TYPES OF NEURONS

- **Multipolar Neurons:** Have one axon and multiple dendrites, commonly found in the brain and spinal cord.
- **Bipolar Neurons:** Have one axon and one dendrite, typically found in sensory organs like the retina of the eye.
- **Unipolar Neurons:** Have a single process extending from the cell body, found in embryonic stages and specialised sensory neurons.
- **Sensory Neurons:** Transmit sensory information from receptors to the central nervous system (CNS).
- **Motor Neurons:** Transmit signals from the CNS to muscles or glands, controlling movement or glandular secretion.

GENERATION AND TRANSMISSION OF IMPULSE

Nerve impulses, or action potentials, are electrical signals generated and transmitted by neurons. When stimulated, changes in ion concentration across the neuron's membrane create an electrical gradient that propagates along the axon, transmitting the signal to other neurons or target cells.

NERVOUS SYSTEM DIVISIONS

- **Central Nervous System (CNS):** Comprises the brain and spinal cord, responsible for processing and integrating sensory information, and coordinating motor responses.

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- **Peripheral Nervous System (PNS):** Consists of nerves outside the CNS, including sensory and motor neurons. It transmits information between the CNS and the rest of the body.

AUTONOMIC NERVOUS SYSTEM

- **Sympathetic Nervous System:** Activates the body's fight-or-flight response, preparing it for stressful situations by increasing heart rate, dilating pupils, and redirecting blood flow to vital organs.
- **Parasympathetic Nervous System:** Counteracts the sympathetic response, promoting relaxation and conserving energy by slowing heart rate, constricting pupils, and enhancing digestion and nutrient absorption.

BRAIN

The brain is the command centre of the nervous system and is protected by the skull. It can be divided into three major parts:

Forebrain: Includes the cerebrum, thalamus, and hypothalamus.

- **Cerebrum:** Largest part responsible for voluntary actions, intelligence, memory, and imagination.
- **Thalamus:** Acts as a relay station for sensory information.
- **Hypothalamus:** Regulates body temperature, hunger, thirst, and other homeostatic functions.

Midbrain: Contains the cerebral aqueduct and corpora quadrigemina, involved in visual and auditory reflexes.

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Hindbrain: Comprises the pons, cerebellum, and medulla oblongata.

- Pons: Contains nerve fibres connecting different regions of the brain.
- Cerebellum: Coordinates muscular activities and maintains balance.
- Medulla Oblongata: Controls involuntary functions like heartbeat and breathing.

SPINAL CORD

The spinal cord is a continuation of the medulla oblongata and is protected by the vertebral column. It is responsible for coordinating movements and serves as the centre for reflex actions.

REFLEX ACTIONS

Reflex actions are involuntary responses to stimuli. They are coordinated by the spinal cord and occur without conscious thought. Reflex arcs are the pathways through which impulses travel during reflex actions.

NERVOUS SYSTEM DISORDERS

- Alzheimer's Disease: Characterised by the accumulation of insoluble proteins in neural tissues, leading to neuronal destruction and cognitive decline.
- Parkinson's Disease: Caused by the destruction of specialised brain cells and reduced dopamine production, resulting in movement difficulties and tremors.
- Epilepsy: Involves abnormal electrical activity in the brain,

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leading to seizures and disruptions in neurological function.

RESPIRATION

Respiration is the process by which organisms exchange gases with their environment. There are two types of respiration:

Aerobic Respiration: Occurs in the presence of oxygen and yields a higher amount of ATP.

Anaerobic Respiration: Occurs in the absence of oxygen and yields a lower amount of ATP.

RESPIRATION IN DIFFERENT ORGANISMS

- Amphibians, Reptiles, Birds, Mammals: Lungs
- Frog: Lungs and Skin
- Earthworm: Skin
- Plants: Stomata
- Insects: Trachea
- Scorpion: Book Lungs
- Fish: Gills
- Amoeba: Cell membrane

PARTS OF HUMAN RESPIRATORY SYSTEM

- Nostril
- Nasal Cavity
- Trachea (Windpipe)
- Bronchus

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- Bronchiole
- Alveoli
- Pleura
- Diaphragm

MECHANISM OF BREATHING

Breathing involves two main steps: inspiration (inhaling) and expiration (exhaling). It is facilitated by the diaphragm and intercostal muscles. During inspiration, the thoracic volume increases, causing air to move into the lungs. During expiration, the thoracic volume decreases, causing air to move out of the lungs.

EXCHANGE OF GASES

Gaseous exchange occurs in the alveoli of the lungs via simple diffusion. Oxygen moves from areas of higher partial pressure to lower partial pressure, while carbon dioxide moves in the opposite direction.

TRANSPORT OF GASES

- Transport of Oxygen: Majority of oxygen is transported by red blood cells (97%) in the form of oxyhemoglobin. A small amount is carried in a dissolved state in plasma (3%).
- Transport of Carbon Dioxide: Carbon dioxide is transported in three ways: as carbamino-haemoglobin (20-25%), as bicarbonate ions (70%), and in a dissolved state in plasma (7%).

OTHER FACTS

- The respiratory rate of a healthy human is typically 12-16 breaths per minute.
- Spirometer is used to measure the volume of air involved in breathing.
- Inhaled air contains approximately 21% oxygen and 0.04% carbon dioxide, while exhaled air contains about 16% carbon dioxide and 4-5% oxygen.

RESPIRATORY VOLUMES AND CAPACITIES

1. Tidal Volume (TV): The volume of air inspired or expired during a normal respiration. It typically ranges from 500 mL to 600-800 mL per minute.

2. Inspiratory Reserve Volume (IRV): The additional volume of air a person can inspire by a forcible inspiration, typically ranging from 2500 mL to 3000 mL.

3. Expiratory Reserve Volume (ERV): The additional volume of air a person can expire by a forcible expiration, typically ranging from 1000 mL to 1100 mL.

4. Inspiratory Capacity (IC): The maximum volume of air a person can inspire after a normal expiration. It is calculated as $IC = TV + IRV$.

5. Expiratory Capacity (EC): The maximum volume of air a person can expire after a normal inspiration. It is calculated as $EC = TV + ERV$.

6. Functional Residual Volume/Capacity (FRC): The volume of air that remains in the lungs after a normal expiration. It is calculated as $FRC = ERV + RV$.

7. Residual Volume (RV): The volume of air remaining in

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the lungs even after a forcible expiration, typically ranging from 1100 mL to 1200 mL.

8. Vital Capacity (VC): The maximum volume of air a person can breathe in after a forced expiration or breathe out after a forced inspiration. It is calculated as $VC = ERV + IRV + TV$. The vital capacity of a healthy human being ranges from 3-5 litres.

9. Total Lung Capacity (TLC): The total volume of air accommodated in the lungs at the end of a forced inspiration. It is calculated as $TLC = RV + TV + ERV$.

DISORDERS OF THE RESPIRATORY SYSTEM

Asthma: Difficulty in breathing causing wheezing due to inflammation of bronchi and bronchioles.

Emphysema: Rupture of alveoli due to the loss of elasticity, often caused by the deposition of toxic substances contained in tobacco.

Bronchitis: Inflammation of bronchi due to the deposition of tar, carbon monoxide, etc., from tobacco smoke, leading to mucus deposition and swelling of the lungs.

CIRCULATION OF BLOOD

The circulation of blood was discovered by William Harvey.

MAJOR CONSTITUENTS OF THE HUMAN CIRCULATORY SYSTEM

Blood

Blood Vessels

Heart

BLOOD

Blood is known as the "River of Life." The study of blood is called Haematology, and the process of formation of blood cells is termed Haemopoiesis. Its major functions include providing oxygen and nutrients to different body parts, providing immunity, and regulating body temperature.

COMPONENTS OF BLOOD

Human blood is composed of two main constituents:

Plasma

Formed Elements/Blood Cells

PLASMA

Plasma is the pale yellow-coloured fluid part of blood, constituting 55% of blood. It transports hormones and nutrients and regulates body temperature. Its major components include water (90-92%), proteins (7-8%), and other factors. Major plasma proteins include albumin, globulin, and fibrinogen.

FORMED ELEMENTS / BLOOD CELLS

Formed elements or blood cells constitute 45% of blood and are produced in the bone marrow. They include:

Red Blood Cells (RBC) / Erythrocytes

White Blood Cells (WBC) / Leucocytes

Platelets / Thrombocytes

RED BLOOD CELLS / ERYTHROCYTES

RBCs are disc-shaped blood cells, the most abundant in the human body. They lack a nucleus and have an average lifespan of 120 days. RBCs transport respiratory gases and contain haemoglobin, which binds oxygen. Anaemia is caused by low RBC levels, while polycythemia is caused by high levels.

WHITE BLOOD CELLS / LEUKOCYTES

WBCs contain a nucleus and provide immunity to the body. They have an average lifespan of 13-20 days. WBCs include neutrophils, basophils, eosinophils, monocytes, and lymphocytes, each with specific functions in immunity. Leukopenia is caused by low WBC levels, while leukaemia is caused by high levels.

PLATELETS / THROMBOCYTES

Platelets are cell fragments produced by megakaryocytes in the bone marrow. They aid in blood coagulation and have an average lifespan of 10 days. Thrombocytopenia is caused by low platelet levels.

BLOOD VESSELS

The study of blood vessels is called Angiology.

VEIN

Veins carry blood from different parts of the body back to the heart. They typically carry deoxygenated or impure blood,

except for the pulmonary vein, which carries oxygenated or pure blood from the lungs to the heart. The largest vein in the human body is the inferior vena cava.

ARTERY

Arteries carry blood from the heart to different parts of the body, usually oxygenated or pure blood, except for the pulmonary artery, which carries deoxygenated or impure blood from the heart to the lungs. The largest blood vessel in the human body is the aorta. Arteries have thick and elastic walls but do not contain valves. Blood in arteries flows at high speed and high pressure.

BLOOD CAPILLARY

Blood capillaries are thin vessels that connect arteries and veins. They have walls formed of a single layer of cells with minute pores. Capillaries lack valves and carry blood at low speed and low pressure.

LYMPH VESSEL

The lymphatic system is a network of tissues, vessels, and organs that transports lymph, a colourless, watery fluid. Tissue fluid, the fluid part of blood, exits into intercellular spaces through capillary walls, forming lymph when it enters lymph vessels. Lymph is considered the intermediary between blood and tissues. The spleen, the largest organ in the lymphatic system, is known as the "Blood Bank of the Human Body."

BLOOD GROUPS

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- Blood groups were discovered by Karl Landsteiner, based on the presence or absence of two surface antigens (A and B) on red blood cells (RBCs).
- Blood plasma may also contain two natural antibodies (A and B) corresponding to the antigens present on RBCs. The Rh factor determines whether a blood group is positive or negative.
- The most common blood type is O positive, while the least common is AB negative.
- The rarest blood group in the world is the Bombay group (hh), discovered by Y.M. Bhende.
- The universal donor is the O group, while the universal acceptor is the AB group.
- World Blood Donor Day is celebrated on June 14th, and National Voluntary Blood Donation Day is observed on October 1st.
- Agglutination occurs when incompatible blood groups are mixed during blood donation.

HEART

- The heart is the centre of the circulatory system, responsible for pumping blood needed by the body.
- It is the first organ to develop during embryonic development and is not affected by cancer.
- World Heart Day is observed on September 29th, and the study of the heart is known as cardiology.
- The first heart transplant surgery was performed by Christiaan Barnard on December 3, 1967, while India's

E ▶ ENTRI

first heart transplant surgery was conducted by Dr. Venugopal on August 3, 1994, marking National Heart Transplantation Day.

- The average weight of a human heart is approximately 250-300 grams. The medulla oblongata in the brain controls heart functions, and adrenaline is a hormone that stimulates the heart.

HEART CHAMBERS

The human heart has four chambers: two upper chambers called atria and two lower chambers called ventricles. Muscular walls called septa separate the atria and ventricles. The inter-atrial septum separates the right and left atria, while the inter-ventricular septum separates the ventricles. Valves present in the heart include cuspid valves and semilunar valves.

NODAL TISSUES

Nodal tissues found in the heart, particularly the sinoatrial node (SAN), initiate the contraction and relaxation of the heart, regulating the heartbeat rate. The SAN is often referred to as the "pacemaker of the heart."

CIRCULATION IN THE HUMAN HEART

Blood enters the right atrium from different parts of the body through the superior and inferior vena cavae, which carry deoxygenated blood. From the right atrium, blood flows into the right ventricle and then into the lungs through the pulmonary artery, where it picks up oxygen. Oxygenated blood

returns to the heart via the pulmonary veins, entering the left atrium and then the left ventricle. From there, oxygenated blood is pumped out to the rest of the body through the aorta.

DOUBLE CIRCULATION

The circulation of blood in the human body involves double circulation, comprising pulmonary circulation and systemic circulation. Pulmonary circulation starts from the right ventricle and ends in the left atrium, while systemic circulation starts from the left ventricle and ends in the right atrium.

PORTAL CIRCULATION

Portal circulation refers to the transport of blood from one organ to another without passing through the heart. An example is the hepatic portal system, where the hepatic portal vein carries blood from the intestine to the liver.

CARDIAC CYCLE / HEART BEAT

The cardiac cycle consists of two phases: systole, during which the heart chambers contract, and diastole, during which the heart chambers relax. The normal blood pressure in a healthy human is around 120/80 mm Hg. The heart rate is typically 72 beats per minute.

DISORDERS OF THE CIRCULATORY SYSTEM

- Disorders of the circulatory system include hypertension (high blood pressure), hypotension (low blood pressure)
- Thrombosis (blood clotting within blood vessels)

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- Atherosclerosis (buildup of fatty material in artery walls)
- Angina pectoris (chest pain due to insufficient blood flow to the heart muscles).

ENDOCRINE SYSTEM

- The endocrine system controls and coordinates body functions through the production of chemical substances called hormones.

PANCREAS

- The pancreas serves as both an exocrine and endocrine gland, producing hormones and enzymes.
- Islets of Langerhans are pancreatic cell clusters that produce hormones.
- The main hormones produced by the pancreas are insulin, produced by beta cells, and glucagon, produced by alpha cells. Insulin helps decrease blood glucose levels, while glucagon increases blood glucose levels.

INSULIN

Insulin, discovered by Frederick Banting and Charles Best, helps decrease blood glucose levels by enhancing cellular uptake and converting glucose into glycogen in the liver and muscles. It contains zinc and is considered a hypoglycemic hormone.

GLUCAGON

Glucagon increases blood glucose levels by converting stored glycogen into glucose and synthesising glucose from amino acids. It opposes the actions of insulin and is considered a hyperglycemic hormone.

DIABETES MELLITUS

Diabetes mellitus is a complex disorder characterised by prolonged hyperglycemia. Symptoms include glucose loss through urine, ketone body formation, and conditions like retinopathy. Type 1 diabetes results from defective insulin production, while type 2 diabetes arises from target cells' inability to use insulin effectively.

THYROID GLAND

The thyroid gland, located in the neck, produces hormones like triiodothyronine (T3), thyroxine (T4), and calcitonin. These hormones regulate metabolism, red blood cell formation, growth, and development. Iodine is essential for thyroid hormone synthesis, and conditions like hyperthyroidism and hypothyroidism can arise from hormone imbalances.

PARATHYROID GLAND

The parathyroid glands, located behind the thyroid gland, produce parathyroid hormone (PTH). PTH helps increase blood calcium levels by reabsorbing calcium from the kidneys and preventing calcium storage in bones. Tetany can occur due to PTH deficiency, resulting in involuntary muscle cramps.

PINEAL GLAND

The pineal gland, located in the brain, produces melatonin, regulating the sleep-wake cycle and daily rhythms of the body. It is also known as the "biological clock."

ADRENAL GLAND

- One pair of adrenal glands are present in a human body, one at the anterior part of each kidney.
- Exterior part: Cortex.
- Inner part: Medulla.
- Hormones secreted by the Adrenal cortex: Corticoids (e.g., Cortisol, Aldosterone)
 - Cortisol:
 - Helps in carbohydrate metabolism (Glucocorticoids).
 - Produces anti-inflammatory reactions and suppresses the immune response.
 - Stimulates RBC production.
 - Used to treat asthma and arthritis.
 - Disease caused by deficiency: Addison's disease.
 - Disease caused by overproduction: Cushing's syndrome.
 - Aldosterone:
 - Maintains salt-water balance in kidneys.
 - Maintains blood pressure.
 - Disease caused by overproduction: Conn's syndrome.
 - Disease caused by deficiency: Addison's disease.

Hormones produced by the adrenal medulla:

- Adrenaline (Epinephrine).
- Noradrenaline (Norepinephrine).
- Also known as Catecholamines.
- Function: Prepare body for action in emergency situations; also known as "Emergency hormone."

THYMUS GLAND

- Situated behind the sternum.
- Known as the 'Youth Gland'.
- Active during infancy, constricts at puberty.
- Hormone: Thymosin (Peptide hormone), also known as the 'Youth hormone'.
- Function: Controls activities and maturation of T lymphocytes for immunity.

PITUITARY GLAND

- Located below the hypothalamus in the brain as two lobes.
- Also known as the 'Master Gland'.
- Function: Production of Tropic Hormones.
- Hormones produced by the anterior pituitary (pars distalis):
 - Thyroid Stimulating Hormone (TSH).
 - Adrenocorticotrophic Hormone (ACTH).
 - Gonadotropic Hormone (GTH).
 - Somatotrophic Hormone (STH).
 - Prolactin.

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- TSH: Stimulates thyroid gland.
- ACTH: Stimulates adrenal cortex.
- GTH: Stimulates reproductive organs.
- Prolactin: Helps in milk production.
- STH: Promotes body growth.
- Hormones released by the posterior pituitary (Neurohypophysis):
 - Oxytocin.
 - Vasopressin.
- Endocrine gland producing Oxytocin and Vasopressin: Hypothalamus.

OXYTOCIN

- Facilitates uterine contractions and delivery.
- Facilitates lactation.

VASOPRESSIN

- Reabsorbs water in kidneys.
- Also known as 'Antidiuretic hormone' (ADH).
- Disease: Diabetes insipidus due to decreased production.

HYPOTHALAMUS

- Regulates synthesis and secretion of pituitary hormones.
- Hormones produced:
 - Releasing hormones: Stimulate pituitary hormone secretion (e.g., Gonadotropin releasing hormone -GnRH).
 - Inhibiting hormones: Inhibit pituitary hormone secretion (e.g., Somatostatin).§

OVARY

- Hormones: Estrogen and Progesterone (Steroid hormones).
- Estrogen Function: Controls secondary sexual characters, ovulation, menstrual cycle.
- Progesterone Function: Supports pregnancy, stimulates milk secretion.

TESTIS

- Hormones: Androgens (e.g., Testosterone).
- Androgen Function: Controls secondary sexual characters, sperm production.

HORMONES OF HEART

- Atrial Natriuretic Factor (ANF): Decreases blood pressure, causes blood vessel dilation.

HORMONES OF KIDNEY

- Erythropoietin: Stimulates RBC formation.

HORMONES OF GASTROINTESTINAL TRACT

- Peptide hormones:
 - Gastrin: Stimulates gastric acid secretion.
 - Secretin: Stimulates pancreas for bicarbonate secretion.
 - Cholecystokinin (CCK): Stimulates pancreatic enzyme and bile juice secretion.
 - Gastric inhibitory peptide (GIP): Inhibits gastric

secretion, involved in lipid metabolism.

DIGESTION

- Process: Conversion of complex food substances to simple absorbable nutrients.

Major Parts of Human Digestive System:

- Oral Cavity / Mouth
- Oesophagus
- Stomach
- Small Intestine
- Large Intestine

MOUTH

- Digestion begins here.
- Major salivary glands: Parotid, Submaxillary/ submandibular, Sublingual.
- Saliva contains mucus and enzymes.
- Enzymes in saliva: Salivary amylase, Lysozyme.
 - Function of Salivary amylase: Partially converts starch to maltose.
 - Optimum pH for salivary amylase: 6.8.
 - Function of Lysozyme: Destroys germs.
- Mucus makes food slimy for swallowing.

Teeth

- Study: Odontology.
- Permanent teeth: 32; Milk teeth: 20.

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- Wisdom teeth: Erupt after puberty.
- Dentition types: Diphyodont, Thecodont.
- Types of teeth: Incisors (8), Canine (4), Premolars (8), Molars (12).
- Main component: Calcium phosphate.
- Acid causing decay: Lactic acid.
- Filling cavities: Dental Amalgam.

Parts of Teeth

Enamel: Outermost, hardest part.

Dentine: Living tissue.

Pulp: Soft connective tissue with blood vessels, lymph ducts, nerve fibres.

Cementum: Connective tissue holding tooth in socket.

OESOPHAGUS

- Starts from the pharynx.
- Pharynx: Common path for food and air.
- Epiglottis: Prevents food entry into trachea.
- Peristalsis: Wave-like muscle contractions moving food.

STOMACH

- Store food for 4-5 hours.
- Content: Chyme (partially digested food and gastric juices).
- Gastric glands: Mucous neck cells, Peptic cells, Parietal / Oxyntic cells.
 - Components of gastric juice:
 - Pepsin: Converts protein to peptones partially.

- Protein not digested: Keratin.

Gastric lipase enzyme: Partially digests fat.

Hydrochloric acid: Destroys germs, regulates pH (1 - 3).

Mucus and bicarbonates: Protect stomach wall, neutralise acid

EXCRETION

- Process: Expelling waste products from the body due to metabolic activities.
- Major organ: Kidney.

Excretory Organs in Different Organisms

- Vertebrates: Kidney
- Insects: Malpighian tubules
- Earthworm: Nephridia
- Prawns: Antennal glands / Green glands
- Amoeba: Contractile vacuole

EXCRETORY ORGANS IN HUMANS

Organ	Function
Lungs	Excrete Carbon dioxide

Skin	Excrete water and minerals
Liver	Synthesis of urea
Kidney	Excrete urea and water

LIVER

- Largest internal and gland in the human body.
- Can regenerate.
- Known as the 'Chemical factory'.
- Cells: Hepatocytes.
- Study: Hepatology.
- Average weight: 1500 gm.
- Converts toxic substances into harmless ones.
- Example: Ammonia to urea via Ornithine cycle.
- Carbohydrate storage: Glycogen.
- Produces bile, proteins (Prothrombin, Albumin, Fibrinogen), heparin.
- Stores iron and Vitamin A.
- Requires Vitamin K.

Diseases of Liver

- Cirrhosis: Degenerative liver cells.
- Hepatitis: Liver inflammation.
- Variants: A, B, C, D, E, G.

E ▶ ENTRI

- Hepatitis B: Most dangerous.
- Transmission: Contaminated water (A, E), body fluids (B, C, D).

LIVER TRANSPLANT SURGERIES

- First successful: Thomas Starzl (1967).
- Kerala's first: S Sudhindran (2004).

KIDNEY

- Major excretory organ in humans.
- Bean-shaped, located on either side of the vertebral column.
- Left kidney is slightly higher than the right.
- Study: Nephrology.
- World Kidney Day: 2nd Thursday of March.
- Average weight: 150 gm.
- Function: Filtration of blood for waste removal, water balance, salt/electrolyte balance, pH regulation.

KIDNEYS AND ASSOCIATED PARTS

- Renal Artery: Carries blood into kidneys.
- Renal Vein: Carries filtered blood out.
- Urine: Carried to bladder via ureters, expelled through urethra.

INTERNAL STRUCTURE OF KIDNEY

- Nephron: Basic functional unit.
- Cortex: Outer, light-coloured part.

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- Medulla: Inner, dark-coloured part.
- Pelvis: Where urine flows into.

STRUCTURE OF NEPHRON

- Bowman's Capsule: Cup-shaped structure.
- Afferent Vessel: Enters Bowman's capsule.
- Efferent Vessel: Exits Bowman's capsule.
- Glomerulus: Bundle of capillaries within Bowman's capsule.
- Collecting Duct: Collects urine.
- Renal Tubule: Connects Bowman's capsule and collecting duct.
- Parts: Proximal Convoluted Tubule, Henle's Loop, Distal Convoluted Tubule.
- Peritubular Capillaries: Surround renal tubules.

FORMATION OF URINE

- Processes: Ultrafiltration, Reabsorption, Secretion.
- Ultrafiltration: Occurs at Glomerulus.
- Glomerular Filtration Rate (GFR): 127 ml/min.
- Components of glomerular filtrate: Water, ions, glucose, amino acids, vitamins, urea, uric acid, creatinine.
- Reabsorption: Maximum at Proximal Convoluted Tubule.
- Secretion: Excess components from blood to renal tubules.
- Collecting Duct: Absorbs excess water.
- Components of urine: Water (96%), Urea (2%), Sodium chloride, Potassium chloride, Calcium salts, Phosphate, Uric acid, Creatinine etc.

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- pH value of urine: 6.
- Pigment giving yellow colour: Urochrome.
- Amount of urea excreted daily: 20-30 gm.
- Controlling hormone: Vasopressin.

KIDNEY DISEASES

- Nephritis/Glomerulonephritis: Kidney inflammation.
- Renal Calculi: Kidney stones.
- Renal Colic: Pain due to kidney stone.
- Uremia: Accumulation of urea in blood.
- Diabetes Insipidus: Excess water loss.
- Hematuria: Blood in urine.
- Proteinuria: Proteins in urine.

Hemodialysis

- Blood purification for kidney malfunction.
- Anticoagulant used: Heparin.

Nephrectomy

- Surgical kidney removal.

KIDNEY TRANSPLANT

- First successful surgery: Dr. Joseph E. Murray

Skeletal System

BONES

- Framework of skeletal system.

ENTRI

- Total bones: 206 (adults), 300 (newborns).
- Study: Osteology.
- Cells: Osteoblasts, Osteoclasts, Osteocytes.
- Composition: Calcium phosphate, Calcium carbonate.
- Strength component: Calcium phosphate.
- Essential metal: Calcium.
- Water content: 25%.
- Vital vitamin: Vitamin D.
- Largest bone: Femur.
- Smallest bone: Stapes.
- Strongest bone: Femur.
- Weakest bone: Clavicle.

TYPES OF HUMAN SKELETON

Axial Skeleton

- Bones aligned along the body's main axis.
- Number of bones: 80.
- Components: Skull, Ribs, Vertebral column, Sternum.

Appendicular Skeleton

- Limb bones and girdles.
- Number of bones: 126.
- Components: Forelimbs, Hindlimbs, Pectoral girdle, Pelvic girdle.

JOINTS

- Meeting place of two bones.
- Aid bone movement.
- Study: Arthrology.

E ▶ ENTRI

- Components: Capsule, Synovial fluid, Cartilage, Ligaments.
- Types: Fibrous joints (immovable), Synovial joints (movable).
 - Ball and socket joint (maximum movement).
 - Hinge joint (movement in one direction).
 - Pivot joint (rotational movement).
 - Gliding joint (sliding movements).

SKELETAL DISORDERS

- Rheumatic Arthritis: Cartilage damage due to infection, injury, or degenerative changes.
- Osteoporosis: Brittle bones due to calcium and Vitamin D deficiency.
- Gout: Joint inflammation from uric acid crystal accumulation.

Muscle System

MUSCLES

- Study: Myology.
- Number of muscles: 639.
- Largest muscle: Gluteus Maximus.
- Smallest muscle: Stapedius.
- Longest muscle: Sartorius.
- Strongest muscle: Masseter.
- Weakest muscle: Stapedius.
- First muscle to develop after birth: Muscles of the neck.
- Brain part controlling muscle actions: Cerebellum.

E ▶ ENTRI

- Required ions for muscle activity: Calcium and Magnesium.

MUSCLE COMPONENTS

- Pigment giving muscle colour: Myoglobin.
- Instrument to record muscle contraction: Electromyograph.
- Muscle fatigue: Lactic acid buildup during intense exercise.
- Tetany: Rapid muscle spasms due to low blood calcium.
- Rigour Mortis: Muscle stiffening after death.
- Pigment storing oxygen: Myoglobin.
- Basic units: Muscle fibres.
- Bundle of fibres: Fascicles.
- Membrane covering fibres: Sarcolemma.
- Fluid in fibres: Sarcoplasm.
- Filaments responsible for striations: Actin, Myosin.
- Contractions explained by: Sliding Filament Theory.

TYPES OF MUSCLES

Skeletal Muscles

- Attached to bones.
- Cylindrical cells.
- Striated.
- Voluntary movements.

Smooth Muscles / Visceral muscles

- Internal organs, blood vessels.
- Spindle-shaped cells.
- Non-striated.

ENTRI

- Involuntary movements.

Cardiac Muscle

- Heart walls.
- Branched cells.
- Striated.
- Involuntary, continuous function

Reproductive System

REPRODUCTIVE CELLS

- Male reproductive cell: Sperm
- Female reproductive cell: Ovum
- Largest cell in the human body: Ovum
- Sperms produced in: Testes
- Ovum produced in: Ovary
- Mode of cell division for reproduction: Meiosis
- Number of chromosomes in gametes: 23

MALE REPRODUCTIVE SYSTEM

- Testis: Produces sperms and androgens.
- Leydig cells: Produce androgens within the testes.
- Vas deferens: Carries sperms from testes to ureter.
- Prostate gland: Produces secretion for sperm nutrition and movement.
- Penis: Deposition of sperms into the vagina.
- Scrotum: External sac holding testes, temperature 34°C.

FEMALE REPRODUCTIVE SYSTEM

E ▶ ENTRI

- Ovary: Produces ovum and female hormones.
- Ovulation: Release of mature ovum from the ovary.
- Hormones: Estrogen, Progesterone secreted by ovary.
- Fallopian tube: Carries ovum to uterus; fertilisation site.
- Uterus: Development of embryo.
- Vagina: Outlet from uterus.
- Fertilisation: Fusion of sperm with ovum.
- Zygote: Single-cell result of fertilisation, 46 chromosomes.
- Chromosome patterns: Females (XX), Males (XY).
- Zygote development: Mitosis within the uterus; differentiation into embryo.
- Placenta: Connects embryo to uterus; nutrient exchange.
- Amnion: Encloses embryo; filled with amniotic fluid.
- Amniotic fluid: Fluid within amnion.
- Genetic defect detection: Amniocentesis.
- Gestation period: 270-280 days.
- Pregnancy hormones: hCG, hPL, Relaxin.
- Uterus contraction hormone: Oxytocin.
- Initial milk: Colostrum.
- Milk secretion hormone: Prolactin.

MENSTRUATION

- Discharge of blood and mucosal tissue from the uterus.
- Occurs when fertilisation doesn't follow ovulation.
- First menstruation: Menarche.

SENSE ORGANS

STRUCTURE OF THE EYE

- Ophthalmology is the study of eyes.
- Vitamin A is required for healthy eyes.
- Persistence of vision is 1/16 sec.
- Short distance for clear vision is 25 cm.
- The Snellen chart is used to check eyesight.
- Braille script is used by blind people.

LAYERS OF THE EYE

Sclera: Outer layer, firmness to the eye, composed of connective tissue, includes cornea and conjunctiva.

Choroid: Middle layer, contains blood vessels, includes iris, pupil, lens, and ciliary muscles.

Retina: Innermost layer, image formation occurs, contains photoreceptor cells (rod and cone cells), includes yellow spot, blind spot, and optic nerves.

PARTS OF THE EYE

- **Iris:** Contains pigment melanin, regulates pupil size.
- **Pupil:** Aperture in the centre of the iris, adjusts size according to light intensity.
- **Lens:** Convex lens, adjusts focal length for near and far objects.
- **Ciliary Muscles:** Circular muscles around the lens, change lens curvature and focal length.

RETINA

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- Contains rod cells (low light vision) and cone cells (daylight and colour vision).
- Photopsin (iodopsin) in cone cells, rhodopsin in rod cells.
- Major parts: yellow spot (macula lutea), blind spot, optic nerves.

CHAMBERS OF THE EYE

Aqueous Chamber: Between cornea and lens, filled with aqueous fluid.

Vitreous Chamber: Between lens and retina, filled with vitreous fluid.

EYE DEFECTS AND DISEASES

- Night Blindness: Due to Vitamin A deficiency.
- Xerophthalmia: Dryness and opacity of conjunctiva and cornea due to prolonged Vitamin A deficiency.
- Colour Blindness: Inability to differentiate colours due to defects in cone cells.
- Glaucoma: Increased pressure within the eyes due to failure of aqueous humor reabsorption, called "The Silent Thief of Sight".

EAR

- Otology: Branch of science dealing with the study of ears.
- Functions: Hearing, Maintenance of body balance.
- Brain Parts: Cerebrum (hearing), Cerebellum (balance).
- STRUCTURE:

E ▶ ENTRI

- Outer Ear: Pinna, External Auditory Canal, Tympanic Membrane.
- Middle Ear: Ear Ossicles (Malleus, Incus, Stapes), Eustachian Tube.
- Inner Ear: Semicircular Canals, Vestibule, Cochlea.

SKIN

- Dermatology: Branch of medicine dealing with the skin.
- Function: Maintenance of body temperature.
- Pigment: Melanin.
- Substance: Sebum.
- Vitamin: Vitamin D.
- Disorders: Albinism, Psoriasis.

NOSE

- Rhinology: Branch dealing with the study of the nose.
- Brain Part: Cerebrum.
- Nerve: Olfactory Nerves.
- Disorders: Anosmia, Epistaxis.

TONGUE

- Papillae: Projected structures on the tongue.
- Taste Buds: Parts on papillae detecting taste.
- Receptors: Gustatory receptors.
- Primary Tastes: Sweet, Salty, Sour, Bitter, Umami

PUBLIC HEALTH

World Health Organization (WHO)

- Definition of health: Complete physical, mental, and social well-being.
- Established: April 7, 1948.
- Headquarters: Geneva, Switzerland.
- World Health Day: April 7.
- Themes of recent World Health Days: "Health for All" (2023), "Our Planet, Our Health" (2022), "Building a fairer, healthier world" (2021).
- Current Union Health Minister: Mansukh Mandaviya.
- Kerala Health Minister: Veena George.

IMPORTANT ACTS

Vaccination Act, 1880: Compulsory vaccination for children.

The Epidemics Disease Act, 1897: Prevent the spread of infectious diseases.

Drugs Control Act, 1950: Regulate the supply and sale of medicines.

The Prevention of Food Adulteration Act, 1954: Ensure clean and wholesome food.

The Mental Health Act, 1987: Protect the rights of mentally ill people.

Pre Natal Diagnostic Techniques Act, 1994: Prevent female foeticide.

Transplantation of Human Organs Act, 1994: Regulate organ transplantation.

The Cigarettes and other Tobacco Products Act (COTPA), 2003: Regulate tobacco products.

Food & Safety Standard Act, 2006: Ensure safe food supply.

NATIONAL HEALTH MISSIONS

- National Health Mission (NHM):
 - Aim: Provide quality healthcare, especially to rural areas, the poor, women, and children.
 - Sections: National Rural Health Mission (NRHM) and National Urban Health Mission (NUHM).
- National Vector Borne Disease Control Programme (NVBDCP):
 - Target: Control vector-borne diseases like malaria, dengue, chikungunya.
- Aam Aadmi Bima Yojana:
 - Provides insurance to landless rural families.
- ASHA (Accredited Social Health Activists):
 - Trained health workers for maternal and child care.
- Rashtriya Swasthya Bima Yojana (RSBY):
 - Provides health insurance to BPL families.
- Janani Shishu Suraksha Karyakram (JSSK):
 - Offers free delivery and healthcare for infants.
- Rashtriya Bal Swasthya Karyakram (RBSK):
 - Early detection and treatment of genetic disorders in children.
- Mission Indradhanush:
 - Vaccination program for all infants in India.
- Pradhan Mantri Suraksha Bima Yojana (PMSBY):
 - Insurance for accidental death and disability.
- Ayushman Bharat Scheme (ABS):

- Addresses health problems at primary, secondary, and tertiary levels.
- Ni-kshay Mitra:
 - Support for tuberculosis patients' medicine, food

KERALA HEALTH CARE MISSIONS

1. Arogya Jagratha: Campaign against communicable diseases.
2. Arogya Kiranam: Free treatment for under-18s with cancer, kidney, and heart diseases.
3. Thalolam: Financial aid for under-18s with terminal diseases.
4. Aswasakiranam: Monthly pension for inpatients, starting August 2, 2010.
5. Ashwas: Free dialysis treatment for kidney patients by Thiruvananthapuram District Panchayat.
6. Samashwasam: Monthly financial aid for BPL patients undergoing dialysis.
7. Ayurdalam: AIDS awareness project, first implemented in Koothali.
8. Ardram Mission: Improves infrastructure and services in government hospitals.
9. Amrutham Arogyam: Free diagnosis and treatment of lifestyle diseases for those above 30.
10. Aramam Arogyam: Raises awareness about medicinal plants in collaboration with MGNREGA.
11. Vayomitram: Health and social protection for people above 65.

12. Vayo Amrutham: Ayurvedic healthcare for inmates of Government Old Age Homes.
13. Vayo Madhuram: Free glucometers for diabetics above 60 from BPL category.
14. Mithai: Assistance for children with Type 1 diabetes.
15. Shruti Tarangam: Cochlear implants for hearing-impaired children.
16. Dhvani: Follow-up assistance post-cochlear implantation.
17. Kathoram: Solves hearing impairment in children.
18. Shravan: Provides hearing aids to the hearing-impaired.
19. Mizhi: Distributes free spectacles to visually impaired children.
20. Kazhcha: Provides smartphones to visually challenged women and youth.
21. Punarjyoti: Rehabilitation Center for Visually Impaired.
22. Nayanamrutam: Diagnosis and treatment of diabetic eye disease.
23. Matruyanam: Free travel home after delivery.
24. Mathru Jyoti: Financial assistance for differently abled mothers.
25. Mathru kavacham: COVID vaccine for pregnant women.
26. Ammamanass: Reduces psychological stress post-childbirth.
27. Rariram: Care for pregnant women, postnatal care, and newborn care.
28. Swanthanam: Home care for the bedridden.
29. Snehakoodu: Rehabilitation for mental health patients.

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30. Snehapoorvam: Monthly financial aid for children's education in case of parental death.
31. Snehasparsham: Monthly financial aid to single mothers.
32. Karunya Scheme: Medical assistance for economically backward people.
33. Karunya Deposit: Financial aid for education and health needs of physically or mentally challenged children.
34. Karunya Arogya Suraksha Yojana (KASP): Health cover for economically backward families.
35. Kerala Antimicrobial Resistance Strategic Action Plan (KARSAP): Prepares for emergencies due to antibiotic overuse.

KERALA HEALTH CARE MISSIONS

36. Sukrutham: Free cancer treatment for BPL individuals in hospitals, including medical colleges.
37. Cancer Suraksha Scheme: Support for poor children under 18 with cancer.
38. Hridayam: Free treatment for children under 18 with congenital heart defects.
39. Shalabham: Comprehensive health check-ups for newborns in government hospitals.
40. Shubhayatra: Initiative to reduce road accidents in Kerala.
41. SMILE (Seamless Medical Intervention for Lifecare Emergencies): Emergency treatment in road accidents by Kerala Police.

- 42.** Vazhikatti: First aid and medical assistance for travel-related accidents or illnesses.
- 43.** Pariraksha: Assistance for disabled individuals in emergencies.
- 44.** Anuyatra: Project for making Kerala a member-friendly state.
- 45.** Swavalamban Insurance: Comprehensive insurance for disabled persons and families.
- 46.** Niramaya: Health insurance for disabled persons up to Rs 1 lakh per annum.
- 47.** Sahajeevanam: Help centre for differently abled persons and families.
- 48.** Mrithasanjeevani: Organ donation from brain dead individuals.
- 49.** Aswamedham Programme: Home visit diagnosis for leprosy sufferers.
- 50.** ELSA (Eradication of Leprosy through Self Reporting and Awareness): Project to eradicate leprosy.
- 51.** Handkerchief Revolution: Scheme to prevent airborne diseases.
- 52.** Project Spectrum: Skill development for children with Autism.
- 53.** Kanivu: Food and medical care for isolated, bedridden, and mentally ill individuals.
- 54.** Ninavu: Suicide prevention project among children.
- 55.** Vimukthi: Project for a drug-free Kerala.
- 56.** Clean Campus Safe Campus: Drug-free campuses in Kerala.
- 57.** USHUS (Urban Slum Health Upliftment Scheme):

Healthcare for urban slum dwellers.

58. Jeevani: Mental health improvement among college students.
59. Seethalayam: Mental health and social empowerment of women.
60. Sampushta Keralam: Addressing malnutrition among women and children.
61. E-Health: Kerala Government's online health services portal.
62. Pratheeksha: Kerala's Marine Ambulance Service.
63. SAMRIDH: Quality healthcare in urban and tribal areas.
64. Asha Bhavan: Care for the homeless after psychiatric treatment.
65. MEDISEP (Medical Insurance for State Employees and Pensioners): Insurance scheme for government employees and pensioners.
66. SEHAT (Social Endeavour for Health and Telemedicine): Telemedicine

FOOD AND NUTRITION

MAJOR NUTRIENTS

- Water
- Carbohydrates
- Proteins
- Fats
- Vitamins
- Minerals

CLASSIFICATION OF NUTRIENTS

E ▶ ENTRI

- **Macronutrients:** Required in large amounts (e.g., carbohydrates, proteins, fats)
- **Micronutrients:** Required in small amounts (e.g., vitamins, minerals)

VITAMINS

- Organic substances required for good health
- Most vitamins obtained from food, cannot be synthesised in the body
- **Father of Vitamin Therapy:** Casimir Funk
- **First coined the term "Vitamin":** Casimir Funk
- **Essential vitamins:** 13
- Classified into fat-soluble and water-soluble vitamins

FAT-SOLUBLE VITAMINS

- Vitamins A, D, E, K
- Stored in liver and adipose tissues
- Include Retinol (Vitamin A), Calciferol (Vitamin D), Tocopherol (Vitamin E), Phylloquinone (Vitamin K)

WATER-SOLUBLE VITAMINS

- Cannot be stored in the body, must be supplied regularly through diet (except B12)
- Include B-group vitamins (B complex) and Vitamin C

VITAMIN A

- Scientifically known as Retinol
- Antixerophthalmic vitamin

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- Stored in the liver
- Converted from Carotene (Provitamin A)
- Functions: Vision, immune system, reproduction, cell building, tooth formation
- Sources: Liver, egg yolk, milk, leafy vegetables
- Deficiency diseases: Night blindness, Xerophthalmia, Phrynoderma

VITAMIN D

- Scientifically known as Calciferol
- "Sunshine Vitamin"
- Anti-rickets vitamin
- Steroid vitamin
- Functions: Calcium and phosphorus absorption, bone health
- Sources: Fish liver oils, egg yolk, milk
- Deficiency diseases: Rickets, Osteomalacia

VITAMIN E

- Scientifically known as Tocopherol
- Antisterility vitamin
- Known as the "beauty vitamin" and "anti-aging vitamin"
- Functions: Nervous tissue maintenance, reproduction, heart protection
- Sources: Eggs, butter, wheat germ, sunflower seeds
- Deficiency disease: Infertility

VITAMIN K

- Scientifically known as Phylloquinone

E ▶ ENTRI

- Coagulation vitamin, Antihemorrhagic vitamin
- Functions: Blood coagulation, liver function

- Sources: Green leafy vegetables, dairy products
- Deficiency disease: Bleeding

VITAMIN B1 (Thiamine)

- Also known as the "Morale vitamin"
- Functions: Carbohydrate and protein metabolism, normal nervous function, normal heart function
- Sources: Cereals, grains, wheat, oats
- Deficiency diseases: Beriberi (wet and dry), Wernicke-Korsakoff syndrome

VITAMIN B2 (Riboflavin)

- Also called Vitamin G
- Gives light yellow colour to milk
- Functions: Co-enzyme in biological reactions, cellular growth, cell respiration, skin health
- Sources: Liver, egg, milk
- Deficiency disease: Ariboflavinosis

VITAMIN B3 (Niacin or Nicotinic acid)

- Functions: Carbohydrate and fat metabolism, skin, intestinal tract, and nervous system function
- Sources: Liver, peanut, whole cereals, legumes, meat, fish

E ▶ ENTRI

- Deficiency disease: Pellagra (3 D disease - Diarrhoea, Dermatitis, Dementia)

VITAMIN B5 (Pantothenic acid)

- Functions: Energy release, RBC production
- Sources: Peanuts, cashews, milk, egg yolks
- Deficiency disease: Paraesthesia

VITAMIN B6 (Pyridoxine)

- Functions: Protein metabolism, niacin formation, glycogen release
- Sources: Meat, pulses, wheat
- Deficiency disease: Microcytic anaemia

VITAMIN B7 (Biotin or Vitamin H)

- Used in the ELISA test
- Functions: Carbohydrate and protein metabolism, skin and nervous system function
- Sources: Cereals, milk, egg yolk
- Deficiency Disease: Dermatitis

VITAMIN B9 (Folic Acid)

- Essential for RBC maturation
- Sources: Green leafy vegetables, fruits, nuts, beans, peas
- Deficiency disease: Megaloblastic anaemia

VITAMIN B12 (Cyanocobalamin)

- Functions: Synthesis of neurotransmitters, arterial wall

E ▶ ENTRI

protection

- Sources: Meat, fish, eggs
- Deficiency disease: Pernicious anaemia

VITAMIN C (Ascorbic Acid)

- First vitamin to be artificially synthesised
- Known as "Fresh food vitamin" and "Anti-cancer vitamin"
- Functions: Iron absorption, wound healing, immunity enhancement, healthy skin, gums, blood cells
- Sources: Citrus fruits like gooseberry, orange, lime, pineapple
- Deficiency disease: Scurvy

MINERALS

Introduction:

- Definition: Inorganic substances comprising 4-6% of adult body weight.
- Types:
 - Macrominerals: Required in large quantities (7 types).
 - Microminerals (Trace Minerals): Required in smaller amounts.

Macrominerals:

Calcium:

- Most abundant mineral in the body.
- Essential for bone and teeth health.
- Functions: Muscle contraction, blood clotting, nerve

ENTRI

impulse transmission.

- Sources: Dairy products, ragi, beans, peas.
- Deficiency Diseases: Osteoporosis, Osteomalacia, Tetany.

Iron:

- Found in haemoglobin.
- Functions: Oxygen transport, regulatory functions.
- Sources: Liver, meat, egg yolk, shellfish.
- Deficiency Disease: Anaemia, Siderosis (excess iron deposition).

Iodine:

- Required for thyroxine production.
- Functions: Oxygen consumption in tissues.
- Sources: Seafood, common salt, vegetables.
- Deficiency Diseases: Goiter, Cretinism.

Zinc:

- Present in insulin and tears.
- Functions: Enzyme constituent, DNA and protein synthesis.
- Sources: Meat, cereals, legumes.
- Deficiency: Growth retardation, genital development issues.

Microminerals (Trace Minerals):

- Copper: Essential for iron absorption.
- Fluorine: Prevents dental caries.
- Sodium and Potassium: Maintain water balance.
- Phosphorus: Builds bones and teeth.

CARBOHYDRATES

E ▶ ENTRI

- Definition: Main source of energy for the body.
- Energy Content: 4.2 Calories per gram.
- Types:
 - Monosaccharides: Glucose, fructose, galactose.
 - Disaccharides: Sucrose, maltose, lactose.
 - Polysaccharides: Starch, cellulose, glycogen.
- Sources: Fruits, cereals, tubers.
- Functions: Energy provision, structural support.
- Tests: Benedict's test (for glucose), Iodine test (for starch).
- Special Carbohydrates:
 - Lactose: Present in milk.
 - Fructose: Sweetest naturally occurring sugar.
 - Sucrose: Table sugar found in sugarcane.
 - Maltose: Present in barley.
- Clinical Significance: Glycogen serves as a storage form of glucose.

PROTEINS

- Definition: Building blocks of the body.
- Energy Content: 4.2 Calories per gram.
- Sources: Milk, meat, fish, eggs, grains, pulses.
- Functions: Growth, maintenance, enzymatic activity.
- Components: Amino acids.
- Digestion: Enzymes like pepsin, trypsin.
- Tests: Biuret test (for proteins).
- Special Proteins:
 - Casein: Present in milk.
 - Keratin: Forms hair and nails.
- Clinical Significance: Deficiency leads to conditions like

kwashiorkor.

FAT (LIPIDS)

- Definition: Energy-dense macromolecules.
- Energy Content: 9.3 Calories per gram.
- Sources: Meat, fish, dairy, oils.
- Components: Fatty acids, glycerol.
- Digestion: Enzyme lipase, aided by bile.
- Storage: Adipose tissue.
- Clinical Significance: Excess consumption linked to obesity and related

DISEASES

Introduction:

Diseases are caused by pathogens such as bacteria, viruses, fungi, and parasites. They affect various organs and systems in the body and can be transmitted through different means.

Bacterial Diseases:

- Tuberculosis (TB): *Mycobacterium tuberculosis*, airborne transmission.
- Leprosy: *Mycobacterium leprae*, direct contact transmission.
- Cholera: *Vibrio cholerae*, contaminated water or food.
- Tetanus: *Clostridium tetani*, soil-borne spores.
- Typhoid: *Salmonella typhi*, contaminated water or food.

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- Pneumonia: *Streptococcus pneumoniae*, respiratory droplets.
- Gonorrhoea: *Neisseria gonorrhoeae*, sexual transmission.
- Diphtheria: *Corynebacterium diphtheriae*, respiratory droplets.
- Botulism: *Clostridium botulinum*, contaminated food.
- Anthrax: *Bacillus anthracis*, contact with infected animals or spores.
- Plague: *Yersinia pestis*, fleas or direct contact with infected individuals.

Viral Diseases:

- HIV/AIDS: Human Immunodeficiency Virus, sexual transmission or blood contact.
- Influenza: Influenza virus, respiratory droplets.
- Dengue: Dengue virus, *Aedes* mosquito bite.
- Hepatitis: Hepatitis virus, contaminated water or food, or blood contact.
- Measles: Measles virus, respiratory droplets.
- Polio: Poliovirus, faecal-oral transmission.

Protozoan Diseases:

- Malaria: *Plasmodium* parasite, transmitted by *Anopheles* mosquitoes.
- Amoebiasis: *Entamoeba histolytica*, contaminated water or food.
- Leishmaniasis: *Leishmania* parasite, transmitted by sandflies.

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- Sleeping Sickness: Trypanosoma parasite, transmitted by tsetse flies.
- Chagas Disease: Trypanosoma cruzi, transmitted by triatomine bugs.

Worm Infections:

- Filariasis (Elephantiasis): Wuchereria bancrofti, transmitted by mosquitoes.
- Ascariasis: Ascaris roundworm, contaminated water or food.

Prevention and Treatment:

- Vaccination: DPT, BCG, and others.
- Antibiotics for bacterial infections.
- Antivirals for viral infections.
- Antimalarials for malaria.
- Hygiene practices and sanitation to prevent transmission.
- Vector control measures.
- Health education and awareness programs.

VIRAL DISEASES

Introduction:

Viral diseases are caused by pathogenic viruses and can affect various systems and organs in the body. They are often transmitted through direct contact, airborne particles, or vectors such as mosquitoes.

Major Viral Diseases:

AIDS (Acquired Immuno Deficiency Syndrome)

- Pathogen: HIV (Human Immunodeficiency Virus).
- Attacks the immune system.
- Transmission: Blood transfusion, sexual contact, mother-to-child transmission.
- Diagnostic tests: ELISA, Western blot.
- Treatment: Anti-retroviral therapy (ART).
- World AIDS Day: December 1.

Poliomyelitis (Polio)

- Pathogen: Poliovirus.
- Affects the nervous system.
- Transmission: Contaminated water or food.
- Vaccines: IPV, OPV.
- National Vaccination Day: March 16.

Hepatitis

- Inflammation of the liver caused by hepatitis viruses (A, B, C, D, E, G).
- Transmission: Contaminated food/water (A, E), body fluids (B, C, D).
- Hepatitis B is the most deadly variant.
- World Hepatitis Day: July 28.

Dengue Fever

- Pathogen: Flavivirus.
- Transmitted by Aedes mosquitoes.
- Diagnostic test: Tourniquet test.

Japanese Encephalitis

- Pathogen: Flavivirus.
- Affects the brain.
- Transmission: Culex mosquitoes.

ENTRI

Smallpox

- Pathogen: Variola virus.
- Transmission: Direct contact.
- Vaccine developed by Edward Jenner.

Measles

- Pathogen: Rubeola virus.
- Mainly affects the lungs.
- Transmission: Airborne.
- Vaccine: MMR.

Mumps

- Pathogen: Paramyxovirus.
- Affects the salivary glands.
- Transmission: Airborne.
- Vaccine: MMR.

SARS (Severe Acute Respiratory Syndrome)

- Pathogen: Coronavirus.
- Affects the respiratory system.
- Transmission: Airborne.

Swine Flu

- Pathogen: H1N1.
- Transmission: Airborne.
- First reported in Mexico.

Ebola

- Pathogen: Ebola virus (Filovirus).
- Transmitted by bats.
- First reported in Congo.

Rabies

- Pathogen: Rabies virus.
- Affects the nervous system.

- Vaccine developed by Louis Pasteur.

Diseases and Mosquitoes:

- Japanese encephalitis, Filariasis, Yellow fever, Dengue fever, Chikungunya, Zika are transmitted by mosquitoes (Culex or Aedes).

Fungal Diseases:

Ringworm

- Pathogens: Microsporum, Trichophyton, Epidermophyton.
- Skin disease causing round, red blisters.
- Transmission: Contact.

Athlete's Foot

- Fungal infection on the sole of the foot and between the toes.
- Transmission: Contact with contaminated water or soil.

ORGANISATIONS AND INSTITUTIONS

Council of Scientific and Industrial Research (CSIR):

- Established in 1942.
- Headquartered in New Delhi.
- Prime Minister serves as the Chairman.
- Vice Chairman: Dr. Jithendrasingh.
- Comes under the Ministry of Science and Technology.

Department of Biotechnology (DBT):

- Established in 1986 during the 7th Five Year Plan.
- Regional Centre for Biotechnology: Faridabad.
- National Institute of Animal Biotechnology: Hyderabad.
- Centre for DNA Fingerprinting and Diagnostics: Hyderabad.
- Kalam Institute of Health Technology: Visakhapatnam.
- National Institute of Immunology: New Delhi.
- National Center for Cell Science: Pune.
- National Brain Research Centre: Haryana.
- National Agri-Food Biotechnology Institute: Punjab.

Rajiv Gandhi Centre for Biotechnology (RGCB):

- Established in 1990.
- Located in Thiruvananthapuram (Trivandrum).

Indian Institute of Science (IISc):

- Founded in 1909.
- Headquarters in Bangalore.
- Tata Research Institute is associated with IISc.

Indian Academy of Sciences:

- Established in 1934.
- Headquarters in Bangalore.
- Founded by CV Raman.
- Ministry of Earth Sciences:
- Established on January 29, 2006.
- Headquarters in New Delhi.

Indian Council of Agricultural Research (ICAR):

- Founded on July 16, 1929.
- The central agricultural minister serves as the President.
- Comes under the Ministry of Agriculture.
- Publishes the Indian Journal of Animal Research.

The National Academy of Sciences:

- Established in 1930.
- Founded by Meghnath Saha.
- Originally known as The Academy of Science of United Provinces of Agra and Oudh.

National Remote Sensing Centre (NRSC):

- Established in 1974.
- Headquarters in Hyderabad.
- August 12 is observed as National Remote Sensing Day.
- NRSC came under ISRO on September 1, 2008.

SCIENCE AND TECHNOLOGY

Space Technology Overview

Indian Space Research Organisation (ISRO):

- Established on August 15, 1969, headquartered in Bengaluru.
- Vision: Harness space technology for national development and pursue space science research and planetary exploration.

ENTRI

- Managed by the Department of Space (DOS), which reports to the Prime Minister of India.
- Key Objectives: Develop space technology and its applications for national needs.
- Major Space Systems: INSAT (for communication, television broadcasting, meteorological services), Indian Remote Sensing Satellites (IRS) system (for resources monitoring and management).
- Satellite Launch Vehicles: Polar Satellite Launch Vehicle (PSLV) and Geosynchronous Satellite Launch Vehicle (GSLV).
- Vikram Sarabhai Space Centre (Thiruvananthapuram): Design and development of launch vehicles.
- ISRO Satellite Centre (Bangalore): Design and development of satellites.
- Liquid Propulsion Systems Centre (LPSC): Development of liquid stages, including cryogenic stages.
- Space Applications Centre (SAC) (Ahmedabad): Development of sensors for communication and remote sensing satellites.
- National Remote Sensing Centre (NRSC) (Hyderabad): Reception, processing, and dissemination of remote sensing satellite data.
- Satish Dhawan Space Centre (SDSC) or Sriharikota Range (SHAR) (Andhra Pradesh): Rocket launch centre, integration of launchers.

Types of Orbits

- Low Earth Orbit (LEO): Low altitude (around 100 miles or

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160 km), used for satellite systems like navigation (e.g:GPS) and satellite phones.

- Geostationary Orbit (GEO): High altitude (over 22,000 miles or 36,000 km), used for broadcasting television, communications satellites.
- Elliptical Orbit: Satellite orbits with an elliptical shape, rather than circular.

Gravity and Satellite Orbits:

- As satellites orbit the Earth, they are affected by the gravitational force pulling them towards the Earth's center. This gravitational force is balanced by the centrifugal force generated by the satellite's motion. When these two forces are balanced, the satellite remains in a stable orbit without gaining or losing altitude.
- The altitude of the orbit determines the strength of the gravitational pull. Satellites in low Earth orbit (LEO) experience stronger gravitational pull and thus must travel faster to maintain their orbit. Conversely, satellites in higher orbits experience weaker gravitational pull and travel at slower velocities.

Here are the main types of satellite orbits:

Low Earth Orbit (LEO):

- Altitude: 500 - 2000 km above Earth's surface.
- Number of Satellites Required to Cover Earth: 40 - 80.
- Orbital Period: 10 - 40 minutes.
- Comments: Often used for polar orbits.

Medium Earth Orbit (MEO):

- Altitude: 2000 - 35,786 km.
- Number of Satellites Required: 8 - 20.
- Orbital Period: 2 - 8 hours.

High Earth Orbits:

- Altitude: Above 35,786 km.
- Number of Satellites Required: 3.
- Orbital Period: 24 hours.

Geosynchronous Orbit (GEO):

- Altitude: 35,786 km.
- Number of Satellites Required: 3.
- Orbital Period: 24 hours.
- Comments: Orbits once a day, not necessarily in the same direction as Earth's rotation.

Geostationary Orbit:

- Altitude: 35,786 km.
- Number of Satellites Required: 3.
- Orbital Period: 24 hours.
- Comments: Orbits once a day and moves in the same direction as Earth's rotation, appearing stationary above the same point on the Earth's surface. Can only be above the Equator.

Launch Vehicles:

Launch vehicles, or launchers, are used to carry spacecraft into space. India's ISRO has developed several launch vehicles:

Polar Satellite Launch Vehicle (PSLV):

- Third-generation launch vehicle equipped with liquid

stages.

- Notable missions: Chandrayaan-1 (2008), Mars Orbiter Spacecraft (2013).

Geosynchronous Satellite Launch Vehicle (GSLV):

- Largest launch vehicle developed by India.
- Fourth-generation launch vehicle with three stages.

Augmented Satellite Launch Vehicle (ASLV):

- Program designed to augment payload capacity for Low Earth Orbits (LEO).

GSLV Mk III:

- Three-stage heavy-lift launch vehicle capable of carrying 4-ton class satellites into Geosynchronous Transfer Orbit (GTO).

Reusable Launch Vehicle – Technology Demonstrator (RLV-TD):

- Technological endeavour towards developing a fully reusable launch vehicle for low-cost access to space.
- Successfully flight-tested on May 23, 2016.

Scramjet Engine:

- Uses hydrogen as fuel and atmospheric oxygen as oxidizer.
- First experimental mission successfully conducted on August 28, 2016, towards realizing an Air Breathing Propulsion System.

Spacecraft Missions

Aryabhata

- First Indian satellite.

ENTRI

- Launched on April 19, 1975.
- Weight: 360 kg.

Bhaskara 1

- Launched on June 7, 1979.
- Weight: 442 kg.

Bhaskara 2

- Launched on November 20, 1981.

Rohini

- Launched on July 18, 1980.
- Weight: 35 kg.

SLV 3 (Satellite Launch Vehicle 3)

- Launched on June 19, 1981.
- First successful launch vehicle developed by India.

APPLE (Ariane Passenger Payload Experiment)

- First Indian communication satellite.
- Launched on June 19, 1981.

INSAT 2A

- Launched on July 10, 1992.
- Utilized Arian 4 launch vehicle.

INSAT 3DR

- Launched on September 8, 2016.
- Weight: 2211 kg.
- GSLV F 05 launch vehicle.

SROSS (Stretched Rohini Satellite series)

- Launched on March 24, 1987.

IRS 1A (Indian Remote Sensing satellite 1A)

- Launched on March 17, 1988.

IRS P4

- Launched on May 26, 1999.

ENTRI

- Utilised PSLV C2 launch vehicle.

Kalpana 1

- Launched on September 12, 2002.
- Utilised PSLV C4 launch vehicle.

Cartosat-1

- Launched on May 5, 2005.
- Utilised PSLV C6 launch vehicle.

Cartosat-2

- Launched on January 10, 2007.
- Part of the Cartosat-2 series.

RISAT (Radar Imaging Satellite)

- Launched on April 26, 2012.
- Utilised PSLV C19 launch vehicle.

SARAL Satellite:

- Launch Date: February 25, 2013
- Collaboration: Joint mission between India and France
- Launch Vehicle: PSLV C20

JUGNU Satellite:

- Significance: First nano satellite
- Launch Date: October 12, 2011
- Developed by: Indian Institute of Technology (IIT) Kanpur

NIUSAT Satellite:

- Launch Date: June 23, 2017
- Launch Vehicle: PSLV C38
- Associated Program: Indian Remote Sensing Satellite (IRS) P6

ResourceSat-1:

- Launch Date: October 17, 2003
- Launch Vehicle: PSLV C5

ResourceSat-2:

- Launch Date: April 20, 2011
- Launch Vehicle: PSLV C36

TES (Technology Experiment Satellite):

- Launch Date: October 22, 2001
- Launch Vehicle: PSLV C3

MEGHA-TROPIQUES Satellite:

- Launch Date: October 12, 2011
- Launch Vehicle: PSLV C18
- Collaboration: Joint project between India and France

Chandrayaan-1:

- Launch Date: October 22, 2008
- Launch Vehicle: PSLV-C11
- Objectives:
 - High-resolution remote sensing of the moon's surface
 - Provide a three-dimensional atlas of the Moon
 - Conduct chemical and mineralogical studies for mapping the lunar surface
 - Test the impact of a sub-satellite on the lunar surface
- Key Discoveries: Traces of water and water ice on the

moon, detection of various minerals

- Mission Duration: Lasted for 312 days until communications were lost on August 28, 2009

Chandrayaan-2:

- Launch Date: July 22, 2019
- Launch Vehicle: GSLV Mk III
- Objectives: Topographical research and mineralogical studies on the Moon's origin and evolution
- Key Components: Lunar orbiter, Vikram lander, Pragyaan lunar rover
- Main Aim: Trace the location and abundance of lunar water on the moon's surface
- Significance: Targeted the unexplored South Polar region of the Moon

Chandrayaan-3:

- Project Director: P. Veeramuthu Vel
- Launch Vehicle: GSLV Mark III

Mars Orbiter Mission (Mangalyaan):

- Launched by ISRO on November 5, 2013.
- Reached Mars orbit on September 24, 2014.
- India's first interplanetary mission.
- ISRO became the fourth space agency to reach Mars.
- Cost-effective mission, costing only 450 crore rupees.
- Won the prestigious 2015 Space Pioneer Award.
- Joint NASA-ISRO Synthetic Aperture Radar (NISAR) mission planned.

Aditya-L1 Mission:

- ISRO's inaugural Solar Mission launched using PSLV-C57 rocket.
- Aims to study the Sun from a distance of 1.5 million kilometres.
- ISRO's second astronomy observatory-class mission after AstroSat.
- Planned to be placed in a halo orbit around the Lagrangian point 1 (L1) of the Sun-Earth system.
- Objectives include studying the solar corona, photosphere, chromosphere, and solar wind.

Significance of Exploring the Sun:

- Enhances understanding of the solar system's dynamics.
- Helps in predicting space weather and its impacts on Earth.
- Contributes to advances in solar physics and astrophysics.
- Provides insights for fusion energy research and improving satellite operations.

AMAZONIA 1 (PSLV C51):

- Weighing 637 kg, launched by PSLV C51.
- Belongs to the Brazilian National Institute for Space Research (INPE).
- Injected into a sun-synchronous polar orbit at an altitude of 758 km.
- Aimed at monitoring deforestation in the Amazon region

and analysing agriculture in Brazil.

Gaganyaan Mission:

- Mission by ISRO involving three flights into orbit.
- Includes two unmanned flights and one human spaceflight.
- The Orbital Module will carry three Indian astronauts, including a woman.
- The orbit will be at an altitude of 300-400 km from Earth for 5-7 days.
- Significance includes enhancing science and technology levels, inspiring youth, involving multiple agencies and industries, and promoting industrial growth and social benefits

PSLV C 37:

- Launched on February 15, 2017.
- Project Director: B Jayakumar.

GSAT 9:

- Launched on May 5, 2017.

PSLV C21:

- Launched on September 9, 2012.
- Marks the 100th mission of PSLV.

Astrosat:

- Observatory mission launched on September 28, 2015.

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- Weight: 1515 kg.

HysIS:

- Launched on November 29, 2018.

NAVIC (IRNSS Series):

- IRNSS 1A: Launched on PSLV C22.
- IRNSS 1B: Launched on PSLV C24.
- IRNSS 1C: Launched on PSLV C26.
- IRNSS 1D: Launched on PSLV C27.
- IRNSS 1E: Launched on PSLV C31.
- IRNSS 1F: Launched on PSLV C32.
- IRNSS 1G: Launched on PSLV C33.
- IRNSS 1I: Launched on PSLV C41.
- IRNSS 1H: Launched on PSLV C39.

EMISAT:

- Launched on April 1, 2019.
- Collaboration between DRDO and ISRO.
- Radar detection mission.

GEMINI:

- Gagan Enabled Mariner's Instrument for Navigation and Information.

RLV-TD (Reusable Launch Vehicle – Technology Demonstrator):

- One of the most technologically challenging endeavours of ISRO.

ENTRI

- Aimed at developing essential technologies for a fully reusable launch vehicle.
- Launched on May 23, 2016.

GSLV MARK III:

- Launched on December 18, 2014.

Mission Shakti:

- Conducted by DRDO and ISRO.
- India became the fourth country to test an anti-satellite weapon (ASAT) on March 27, 2019.
- Operation code named Mission Shakti.
- Targeted a satellite in low Earth orbit using a kinetic kill vehicle.

NSIL (NewSpace India Limited):

- Commercial arm of the Indian Space Research Organisation (ISRO).
- Responsible for enabling Indian industries to undertake high-technology space-related activities.
- Focuses on promoting and commercially exploiting products and services from the Indian space program.

SSLV (Small Satellite Launch Vehicle):

- Developed by ISRO.
- Weighs 110 tons.
- Designed as a small and cost-effective launch vehicle for small satellite deployment.

KALAMSAT V2:

- Developed by SPACE KIDS INDIA, Chennai.
- Weighs 1.26 kg.
- Launched on PSLV C44.

GSAT 7A:

- India's first defence satellite.
- Launched on GSLV MARK II F 11 on December 19, 2018.
- Weight: 2250 kg.

K2-236b (EPIC 211945201b):

- Exoplanet discovered by India.

GISAT 29:

- High-weighted satellite launched by India.
- Launched on November 14, 2018, using GSLV MARK III D2.

South Asia Satellite:

- Also known as GSAT-9.
- Launched on May 5, 2017, using GSLV F09.

INSAT (Indian National Satellite System):

- National satellite system of India.
- Deployed using GSLV.
- Began with INSAT 1B in 1983.

Navigation Systems:

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- GPS: United States.
- GLONASS: Russia.
- GALILEO: European Union.
- BEIDOU: China.
- IRNSS: India (Indian Regional Navigation Satellite System).

SCIENCE AND TECHNOLOGY- Defence

DRDO (Defence Research and Development Organisation):

- Established in 1958.
- Responsible for developing India's defence technology.
- Conducts research, monitoring, regulation, and administration of India's Defence Research and Development programme.
- Started the first major project in surface-to-air missiles (SAM) called Project Indigo in the 1960s, which was later discontinued without full success.

Types of Military Missiles:

- Cruise Missile:
 - Unmanned self-propelled guided vehicle.
 - Sustains flight through aerodynamic lift.
 - Types include subsonic, supersonic, and hypersonic.
- Ballistic Missile:

- Follows a ballistic trajectory.
- Carries a large payload.
- Classified based on range as short-range, medium-range, intermediate-range, and intercontinental ballistic missiles.

Classification based on Propulsion:

- Solid Propulsion:
 - Uses solid fuel (e.g., aluminium powder).
 - Easily stored and handled.
- Liquid Propulsion:
 - Uses liquid fuel (e.g., hydrocarbons).
 - Fueling and handling are complex but allows for precise control.
- Hybrid Propulsion:
 - Combines advantages of solid and liquid propulsion systems.
- Ramjet:
 - Achieves compression of intake air by forward speed.
 - Uses injected and ignited fuel.
- Scramjet:
 - Combustion occurs at supersonic air velocities.
 - Typically uses hydrogen fuel.
- Cryogenic:
 - Uses liquefied gases stored at very low temperatures (e.g., liquid hydrogen and liquid oxygen).

Integrated Guided Missile Development Program (IGMDP):

- Conceptualised by Dr. APJ Abdul Kalam.
- Aimed at attaining self-sufficiency in missile technology.
- Developed missiles include Prithvi, Trishul, Akash, Nag, and Agni series.

Agni Series:

- Medium-to-long range, nuclear-capable ballistic missiles.
- Developed under the IGMDP.
- Agni-I was the first tested missile in 1989.

Indian Ballistic Missile Defence Programme:

- Initiative to develop a multilayered ballistic missile defence system.
- Consists of two interceptor missiles: Prithvi Air Defence (PAD) and Advanced Air Defence (AAD) Missile.
- Successfully tested PAD missile in November 2006, making India the fourth country with an anti-ballistic missile system.

Prithvi Missile Series:

- Prithvi I: Short-range surface-to-surface ballistic missile (150 km), developed in 1994 for the Indian Army under IGMDP.
- Prithvi II: Short-range surface-to-surface ballistic missile (350 km).
- Prithvi III (Dhanush): Developed for the Indian Navy, with a range of 350 km.

Agni Missile Series:

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- Agni missiles are medium-to-long range, nuclear-capable surface-to-surface ballistic missiles.
- Agni-I: Developed under IGMDP, with a range of 700-1250 km, tested in 1989.
- Agni-II: Surface-to-surface ballistic missile with a range of 2000+ km.
- Agni-III: Intermediate Range Ballistic Missile (IRBM).
- Agni-IV: IRBM, surface-to-surface ballistic missile.
- Agni-V: India's first international ballistic missile, with multiple independently targetable re-entry vehicle (MIRV) capability.
- Agni-VI: Planned MIRV-capable missile.

Akash Missile:

- Surface-to-air missile with a range of 30 km.
- Updated version: Akash 1S.
- New version: Akash NG, introduced in 2021.

Trishul Missile:

- Short-range surface-to-air missile with a range of 9 km.
- Currently not available.

Nag Missile:

- Fire-and-forget anti-tank guided missile.
- Surface-to-surface missile with a range of 4 km.
- Deployed on NAMICA (Nag Missile Carrier).

Other Missiles:

- Druvastra, Rudram, Shourya, Agni-P, Prithvi-2:
Additional missile systems mentioned.

Sindhu Netra:

- Indian ocean observatory satellite launched on Feb 28, 2021, by DRDO using PSLV C51 from Sriharikota.

BrahMos Missile:

- Jointly developed by India and Russia.
- Named after the Brahmaputra and Moscow rivers.
- Fastest supersonic cruise missile, named by APJ Abdul Kalam.
- Launched by the Indian Navy on March 5, 2022.
- Range: 290 km, with a speed of 2.8-3.0 Mach.
- Features fire-and-forget capabilities.
- Two stages: solid fuel rocket booster and liquid fuel ramjet.

Nirbhay Missile:

- Subsonic cruise missile with a speed of 0.7-0.9 Mach.

Sagarika (K-15) Missile:

- Ballistic missile with a range of 700-750 km, deployed on submarines.

Dhanush Missile:

- Naval version of the Prithvi II missile, with a range of 350 km.

ASTRA Missile:

- Air-to-air missile designed for use with SU-30 MKI aircraft.

PRAHAR Missile:

- Surface-to-surface missile developed indigenously by DRDO, capable of carrying multiple warheads.

Shourya Missile:

- Supersonic surface-to-surface missile with a range of 700-1000 km.

Hammer Missile:

- Procured by the Indian Air Force from France.

S 400 Missile System:

- Acquired from Russia.

DRDO Developments:

- Single Crystal Blade technology.
- Lightweight bulletproof jackets.
- ASMI pistol developed jointly by DRDO and the Indian Army.
- INS Chennai is equipped with BrahMos missiles.
- Integrated Test Range.
- SANT Anti-Tank missile.
- RAKSHITA project by DRDO and CRPF.
- Arjun Mk-1A tank.
- K4 missile.
- SMART Torpedo.
- MR-SAM missile developed in collaboration with Israel.
- HSTDV (Hypersonic Technology Demonstrator Vehicle).
- Agni Prastha, India's missile park.

SCIENCE AND TECHNOLOGY- ENERGY REQUIREMENT AND EFFICIENCY

Energy Needs and Deficits:

- India has a high energy demand, with electricity usage reaching 905 kWh.

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- The usage of gas and oil in India accounts for only 0.6% and 0.4%, respectively.
- Rural areas often lack access to electricity.
- Annual energy consumption in India amounts to 32514 peta joules.
- In 2020-21, India had an energy deficit of 0.4%.
- Electricity distribution saw a growth of 12.8% in 2021-22, while electricity demand increased by 14.78%.
- As of March 31, 2022, India's annual coal stock stood at 25.6 million tons, and the national grid had a cumulative inter-regional transmission capacity of 1,12,250 MW.

International Energy Agency (IEA):

- The IEA is an autonomous inter-governmental organisation established within the OECD framework.
- Founded in 1974 to ensure oil supply security, especially after the 1973-1974 oil crisis.
- Comprises 31 member countries and eleven association countries.
- India joined the IEA in 2017 as an Associate member.
- IEA publishes reports like the World Energy Outlook, World Energy Balances, Energy Technology Perspectives, World Energy Statistics, and Net Zero by 2050.

Energy Consumption and Sources:

- India ranks 4th globally in energy consumption, following China, the USA, and the EU.
- Coal accounts for the largest share of energy consumption in India at 45.34%, followed by crude oil

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(32.76%), water, nuclear, and renewable energy sources (14.30%), natural gas (7.60%), and lignite (1.48%).

- The fertiliser industry and electricity generation are the major sectors consuming energy, with shares of 25.12% and 17.19%, respectively.

Indian Gas Exchange (IGX) and Coal Trade:

- The Indian Gas Exchange (IGX) was established in 2020 to facilitate trading in natural gas.
- City gas distribution (CGD) covers approximately 70% of India.
- India ranks 2nd globally in coal trade.

Natural Resources:

- Resources that exist without human intervention, including sunlight, atmosphere, water, land, minerals, vegetation, and animal life.
- Valued for commercial, industrial, aesthetic, scientific, and cultural purposes.

Sources of Energy:

Conventional:

- Includes fossil fuels like coal, oil, and natural gas.

Non-Conventional:

- Includes renewable sources like solar, wind, hydro, geothermal, biomass, and tidal energy.

Conventional Energy:

- Non-Renewable:
 - Includes fossil fuels found underground, such as coal, oil, and natural gas.
- Renewable:
 - Includes sources like solar, wind, hydro, geothermal, biomass, and tidal energy.

Non-Conventional Energy Sources:

Coal Bed Methane (CBM):

- Pure methane extracted from coal seams.

Shale Gas:

- Mixture of methane, ethane, propane, and butane extracted from sedimentary rocks.
- Abundant shale reserves exist in India.

Characteristics of Different Energy Sources:

- Nuclear Energy:
 - Fuel: Nuclear fission and fusion.
 - Advantages: No air pollution, fuel-efficient.
 - Limitations: High construction cost, security concerns, nuclear waste disposal.
- Hydropower:
 - Advantages: Clean energy source, high capacity.
 - Limitations: Disruption of ecosystems, habitat loss, high developmental costs.
- Solar Energy:

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- Advantages: Environmentally friendly, abundant availability.
- Limitations: Storage limitations, dependence on weather conditions, high equipment costs.
- Wind Energy:
 - Advantages: Pollution-free, freely available.
 - Limitations: Intermittent availability, visual pollution, hazard to birds.
- Tidal Energy:
 - Advantages: Free and clean energy.
 - Limitations: Expensive structures, disrupts estuarine flow, concentrates pollutants.
- Geothermal Energy:
 - Advantages: Environmentally friendly.
 - Limitations: Odorous gases, corrosive minerals, toxic to fish.
- Biomass Energy:
 - Advantages: Renewable, abundant availability.
 - Limitations: Air pollution, habitat destruction, bulky transportation.

Biomass:

- Derived from plant and animal waste.
- Can be used directly or converted into biofuels like ethanol, methanol, biodiesel, and biogas.
- Advantages include carbon-neutral combustion and abundance.
- Disadvantages include air pollution, transportation challenges, and land use conflicts.

Geothermal Energy:

- Natural heat from the Earth's interior.
- Utilised for electricity generation and heating.
- Environmental impacts include air and water pollution, habitat disturbance, and maintenance issues.

Energy Policy of India

BEE (Bureau of Energy Efficiency):

- Established: March 1, 2002.
- Headquarters: Seva Bhavan.

Energy Conservation Building Code:

- Introduced: May 27, 2007.
- Joint effort of BEE and Ministry of Power.

Standards & Labelling Scheme:

- Implemented: May 2006.
- Supervised by Susheel Kumar Schindae.

DDUGJY (Deen Dayal Upadhyaya Gram Jyoti Yojana):

- Launched: July 25, 2015.
- Led by Ministry of Power.
- Spearheaded by Piyush Goyal.

GARV Mobile App:

- Introduced under Energy Conservation Act 2001.
- Enacted: September 29, 2001.
- Amended in 2010.

UJALA (Unnat Jyoti by Affordable LEDs for All):

- Initiated: January 5, 2015.
- Focuses on promoting LED lighting.

Saubhagya Scheme:

- Launched: September 5, 2017.

- Aimed at providing electricity to all households.

National Solar Mission:

- Commenced: January 11, 2010.
- Led by Manmohan Singh.

PMUY (Pradhan Mantri Ujwala Yojana):

- Started: May 1, 2016.
- Initially in Uttar Pradesh.
- Championed by Narendra Modi.

Sahaj Scheme:

- Introduced: August 30, 2015.

UDAY (Ujwal DISCOM Assurance Yojana):

- Rolled out: November 2015.

Perform Achieve and Trade (PAT):

- Implemented by BEE on July 4, 2012.

ZED (Zero Effect, Zero Defect):

- Promotes energy-efficient manufacturing practices.

URJA GANGA Project:

- Launched: October 2016 by GAIL.

Give It Up Campaign:

- Part of NMEEE.

One Nation One Grid:

- Part of Integrated Power Development Scheme.

Street Lighting National Programme:

- Part of FAME initiative.

FAME (Faster Adoption and Manufacture of Hybrid and Electric Vehicles):

- Part of National Electric Mobility Mission Plan, promoting e-mobility.

ENERGY SECURITY AND NUCLEAR POLICY OF INDIA

ENERGY SECURITY

- Energy usage is very high

NUCLEAR POLICY

- Jawaharlal Nehru
- Atomic energy commission- 1948
- Homi J bhaba
- Dept of Nuclear energy- 1954

Nuclear Doctrine of India

- 2003 jan 4
- No first use of nuclear weapon
- Commanding Authority- Nuclear command Authority
- 2 parts:- Political council, executive council
- 3 phases for indian nuclear policy
 - Phase 1- 1947-74
 - Phase 2-1974-98
 - Phase 3- After 1998

Department of Atomic energy

- 1954 aug 3
- Jawaharlal nehru- head
- Mumbai, maharashtra
- AEC, AERB
- 'Atoms in the service of nation'

BARC

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- 1954 Jan 3
- AEET- Atomic energy establishment in Trombay- 1st name
- 1967- BARC -renamed

RRC

- 1971
- Kalpakkam, TN

Raja Ramanna Center for Advanced Technology

- 1984 Feb 19
- Indore, MP

Atomic minerals directorate for exploration and research

- 1949 July 29
- New Delhi, now Hyderabad

IAEA- International Atomic Energy Agency

- 1957 July 29
- India- 1957 member

POKHRAN 1

- India's first Atom bomb experiment
- 1974 May 18, Indira Gandhi
- Rajaramanna- Father of Indian atom bomb
- Smiling Buddha, NSG(Nuclear Suppliers Group)

POKHRAN 2

- 2nd Nuclear experiment of India

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- Operation Shakti
- 1998 may 11-13
- AB Vajpayee
- R Chidambaram
- APJ Abdul Kalam
- 5 bombs- shakthi 1, shakthi 2, shakthi 3, shakthi 4, shakthi 5

CIRCUS

- CANADA INDIA REACTOR UTILITY SERVICES
- Canada

MTCR

- 1987
- MISSILE TECHNOLOGY CONTROL REGIME
- 35 Member nations
- 2016-india

Variable Energy Cyclotron Center

- Kolkata- HQ
- Atom bomb- 1st- USA-1945
- USSR-2nd-1949
- UK-3rd-1952
- France-4th- 1960
- China-5th- 1964

Environmental Science:

- Ecology: Study of interactions between organisms and their surroundings
 - Introduction of the term "Ecology" by Ernst Haeckel
 - Father of Ecology: Alexander von Humboldt
 - Father of Modern Ecology: Eugene Odum
 - Father of Indian Ecology: Prof. R. Misra
 - Mother of the Modern Environmental Movement: Rachel Carson
 - Author of "Silent Spring," focusing on the negative effects of chemical pesticides like DDT
- Biosphere: Part of the Earth where life exists
 - Producers: Make their own energy-dense food through photosynthesis (e.g., green plants)
 - Consumers: Depend on other organisms for food (e.g., animals)
- Food Chain: Sequence of organisms where nutrients and energy pass as one organism eats another
 - Two types: Grazing Food Chain and Detritus Food Chain
 - Trophic Levels: Specific positions occupied by organisms in a food chain
 - Amount of energy transferred to each trophic level: 10%
- Population Interactions:
 - Predation
 - Competition
 - Mutualism
 - Commensalism
 - Parasitism (Total Parasites and Semi Parasites)

Sustainable development

- Sustainable development is a developmental approach.
- It aims to meet the needs of the present generation.
- Future Consideration: Without compromising the ability of future generations to meet their own needs.
- This definition was given by the Brundtland Commission.
- Specifically, it was articulated in the report titled "Our Common Future" in 1987.
- Emphasises the need to balance economic growth, social progress, and environmental protection.
- Focuses on ensuring long-term sustainability and well-being for all.

UN Conference on Sustainable Development (Rio+20) in 2012:

- Resulted in a document outlining clear and practical steps for sustainable development implementation.
- Adoption of SDGs:
 - The 17 Sustainable Development Goals (SDGs) and 169 targets were adopted by the United Nations in 2015.
 - They serve as a universal call to action to end poverty, protect the planet, and ensure peace and prosperity for all by 2030.
- Effective Date:
 - SDGs came into effect on January 1, 2016.
- Pillars of Sustainability:
 - Sustainability is based on three pillars: environmental, social, and economic.

BIODIVERSITY

Deforestation:

- National Forest Policy 1988 mandates 33% forest cover in India, but actual forest and tree cover is 24.62%.
- Russia has the most forest coverage globally, followed by Brazil. India ranks 10th.
- State with the largest forest coverage: Madhya Pradesh.
- State with the highest percentage of forest cover: Mizoram (85.41%).
- State with the lowest forest coverage: Haryana.
- India State Forest Survey report published by the Forest Survey of India, headquartered in Dehradun. First report published in 1987.
- Causes of Deforestation:
 - Commercial or industrial agriculture.
 - Construction of buildings, roads, and infrastructure.
 - Population growth.
 - Natural calamities.
- Mode of cultivation causing deforestation: Slash-and-burn agriculture (Jhum cultivation).
- Effects of Deforestation:
 - Increased atmospheric carbon dioxide.
 - Soil erosion.
 - Desertification.
 - Species extinction.
- Legislation:
 - Indian Forest Act - 1927.

- Forest Conservation Act - 1980.
- World Forest Day: March 21.
 - Themes: 2021 - Forest restoration: the path to recovery and welfare, 2022 - Forests and sustainable production and consumption, 2023 - Forests and Health.

Movements related to forest conservation:

Bishnoi Movement:

- Occurred in Khejarli village, Rajasthan, in 1731.
- Leader: Amrita Devi.

Chipko Movement:

- Aimed to protect trees on Himalayan slopes.
- Occurred in Chamoli, Uttarakhand, in 1973.
- Leader: Sunderlal Bahuguna.

Jungle Bachao Andolan:

- Formed against Bihar government's decision to cut native sal trees.
- Occurred in Singhbhum District, Bihar, in the early 1980s.
- Leaders: Tribals of Singhbhum district.

Appiko Movement:

- Occurred in Karnataka in 1983.
- Leader: Panduranga Hegde.

POLICIES AND TREATIES FOR THE PROTECTION OF ENVIRONMENT NATIONAL LEVEL

Articles:

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- Article 48A: Endeavor to protect and improve the environment and safeguard forests and wildlife.
- Article 51A(g): Duty of every citizen to protect and improve the natural environment, including forests, lakes, rivers, and wildlife.

Laws for the Protection of Environment:

Indian Forest Act: 1927.

Wild Life (Protection) Act: 1972.

Water (Prevention and Control of Pollution) Act: 1974.

Forest Conservation Act: 1980.

Air (Prevention and Control of Pollution) Act: 1981.

Environment Protection Act: 1986.

National Environment Appellate Authority Act: 1997.

Biomedical Waste (Management & Handling) Rules: 1998.

Environment (Siting for Industrial Projects) Rules: 1999.

Municipal Solid Wastes (Management & Handling) Rules: 2000.

The Ozone Depleting Substances (Regulation and Control) Rules: 2000.

Noise Pollution (Regulation and Control) Rules: 2000.

Biodiversity Act: 2002.

National Green Tribunal Act: 2010.

Environment Protection Act, 1986:

- Came into force on November 19, 1986, post the Bhopal gas tragedy.
- Establishes the Genetic Engineering Appraisal Committee (GEAC).

- Aims:
 - Implementing decisions from the UN Conference on Human Environment.
 - Enacting laws for environmental protection.
 - Imposing penalties for endangering the environment, safety, and health.

National Environment Appellate Authority Act, 1997:

- Enacted on January 30, 1997.
- Establishes a National Environment Appellate Authority to hear appeals related to environmental protection under the Environment Protection Act, 1986.

National Green Tribunal Act, 2010:

- Aims to create a tribunal for expeditious disposal of cases related to environmental protection and conservation.
- Enacted on May 5, 2010.
- National Green Tribunal:
 - Founded on October 18, 2010.
 - Headquartered in Delhi.
 - Aims for effective disposal of environmental protection cases.
 - Current Chairperson: Prakash Shrivastava (former: Lokeshwar Singh Pant).

POLICIES, TREATIES AND ORGANISATIONS FOR THE PROTECTION OF ENVIRONMENT INTERNATIONAL LEVEL

Organisations:

IUCN (International Union for Conservation of Nature):

- Formed in 1948, headquartered in Gland, Switzerland.
- Publisher of the Red Data Book which records endangered species.
- India has been a member since 1969.
- Dr. M. S. Swaminathan was the first Indian President (1984-90).
- Current President: Razan Al Mubarak (UAE).

WWF (World Wide Fund for Nature):

- Founded in 1961, headquartered in Gland, Switzerland.
- Works in wilderness preservation and reducing human impact on the environment.
- Publisher of the Living Planet Report.
- Symbolised by the Giant Panda.

Greenpeace:

- Founded in 1971 in Vancouver, Canada; headquartered in Amsterdam, Netherlands.
- Known for its environmental campaigns and direct actions.
- Iconic ship: Rainbow Warrior.

UNEP (United Nations Environment Programme):

- Established in 1972, headquartered in Nairobi, Kenya.
- Executive Director: Inger Andersen.

Green Belt Movement (GBM):

- Founded in 1977 by Wangari Maathai, headquartered in Nairobi, Kenya.
- Focuses on afforestation and water conservation.

Green Cross International:

- Established in 1993 by Mikhail Gorbachev, headquartered in Geneva, Switzerland.
- Focuses on sustainable development and environmental security.

Treaties and Conventions:

Ramsar Convention:

- Intergovernmental treaty for conservation and wise use of wetlands.
- Signed in 1971, entered into force in 1975.
- India signed in 1982, with 75 Ramsar Sites.

Vienna Convention (1985):

- Commitment to protect human health and the environment from ozone layer depletion.
- Signed in 1985, effective in 1988.
- India ratified in 1991.

Basel Convention:

- Aims to reduce movements of hazardous waste between nations.
- Adopted in 1989, entered into force in 1992.
- India has been a member since 1992.

United Nations Conferences:

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United Nations Conference on the Human Environment (UNCHE):

- Stockholm Conference in 1972, created UNEP.

United Nations Conference on Environment and Development (UNCED):

- Rio Conference or Earth Summit in 1992.
- Established the Commission on Sustainable Development.

WESTERN GHATS

The Western Ghats, also known as Sahyadri, is a mountain range along the western coast of India, spanning several states and hosting rich biodiversity. Here's a summary of its features and conservation efforts:

Features of the Western Ghats:

- Spans several states including Gujarat, Maharashtra, Goa, Karnataka, Kerala, and Tamil Nadu.
- Approximately 30% of India's flora and fauna are found here.
- Home to at least 325 globally threatened species.
- Recognized as one of the world's eight 'hottest hotspots' of biological diversity.
- Included in UNESCO's World Heritage List in 2012.
- Known by different names in different regions: Nilgiri malai (Tamil Nadu), Sahyadri (Maharashtra and Karnataka), Sahya Parvatham (Kerala).

Geographical Features:

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- **Average length: 1600 km.**
- **Average width: 100 km.**
- **Average height: 1200 m.**
- **Highest Peak: Anamudi (2695m) in Kerala.**

Rivers Originating from Western Ghats:

- **Flowing westward: Periyar, Bharathappuzha, Netravati, Sharavathi, Mandovi, etc.**
- **Flowing eastward: Godavari, Krishna, Kaveri, etc.**

Conservation Efforts:

Gadgil Committee:

- **Also known as the Western Ghats Ecology Expert Panel (WGEEP).**
- **Recommended designating the entire hill range as an Ecologically Sensitive Area (ESA) and divided the region into three zones.**
- **Prohibited new dams and thermal power plants in Ecologically Sensitive Zone 1.**
- **Emphasised a bottom-up approach involving local authorities.**

Kasturirangan Committee:

- **High-Level Working Group (HLWG) appointed to review the Gadgil report.**
- **Recommended bringing only 37% of the total area under ESA, with fewer restrictions compared to the Gadgil report.**
- **Prohibited certain activities like sand mining, quarrying, and thermal power plants in ESA.**

Oommen V Oommen Committee:

- **Appointed by the Kerala government to study the Kasturirangan report.**
- **Recommended changes in clauses related to Environmentally Fragile Land (EFL) and exclusion of residential areas from ecologically sensitive areas.**

Ozone Layer Depletion:

- **Ozone: Chemical formula O_3 , formed from dioxygen (O_2) by the action of ultraviolet (UV) light, discovered by Christian Friedrich Schönbein.**
- **Ozone Layer: Found in the stratosphere, considered the protective umbrella of Earth.**
- **Function: Acts as a shield absorbing ultraviolet radiation from sunlight.**
- **Discoverers of the ozone layer: Charles Fabry and Henri Buisson.**
- **Characteristics: Pale blue color, thickness measured in Dobson units (DU).**
- **World Ozone Day: September 16.**
- **Themes for World Ozone Day: 2021 - “Montreal Protocol - Keeping us, our food and vaccines cool”, 2022 - “Global cooperation protecting life on earth”, 2023 - “Montreal Protocol - fixing the ozone layer and reducing climate change”.**

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- Ozone Layer Depletion: Decrease in ozone concentration in a particular region, mainly caused by Chlorofluorocarbons (CFCs).
- Discovery of CFCs: Thomas Midgley.
- Release of CFCs: Solvents, spray aerosols, refrigerators, air conditioners.
- Residence time of CFCs: Estimated between 40 and 150 years.
- Component causing ozone depletion: Chlorine (Cl).
- Impact: One chlorine atom can destroy over 100,000 ozone molecules before being removed from the stratosphere.
- Other ozone-depleting substances: HCFCs, HBFCs, halons, methyl bromide, carbon tetrachloride, methyl chloroform.
- Montreal Protocol: International treaty to phase out production of ozone-depleting substances.
 - Adopted on September 16, 1987.
 - Came into force on January 1, 1989.
 - Signed by 197 countries.
 - India signed on June 19, 1994.
 - First UN treaty to achieve universal ratification.

Pollution:

- Definition: Any undesirable change in physical, chemical, or biological characteristics of air, land, water, soil, etc.
- Pollutants: Agents causing undesirable changes.
- Etymology: Derived from the Latin word 'Polluere'.

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- India's Pollution Status: Ranked 8th most polluted country in 2022.
- Environmental Legislation:
 - Environment (Protection) Act: Enacted in 1986.
 - Pollution Control Act: Passed in India in 1974.
- Pollution Control Boards:
 - Central Pollution Control Board (CPCB): Established on September 22, 1974, headquartered in New Delhi.
 - Kerala State Pollution Control Board: Formed on September 12, 1974, headquartered in Thiruvananthapuram.
- National Pollution Control Day: December 2.

Classification of Pollutants:

- Depending on Existence in Nature:
 - Quantitative Pollutants: Naturally present substances become pollutants when their concentration increases (e.g., CO₂).
 - Qualitative Pollutants: Human-made substances causing pollution (e.g., pesticides, insecticides).
- Depending on Form in Environment:
 - Primary Pollutants: Formed and emitted directly from sources (e.g., smoke, dust, nitric oxide).
 - Secondary Pollutants: Formed in the atmosphere by chemical reactions of primary pollutants (e.g., smog, ozone, sulphur trioxide).

Persistent Organic Pollutants (POPs):

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- Definition: Hazardous chemicals threatening human health and ecosystems.
- Characteristics: Persist for a long time, accumulate in living organisms through the food chain, toxic to humans and wildlife.
- Stockholm Convention:
 - Global treaty signed in 2001 for protection against POPs.
 - Came into force on May 17, 2004.
 - India ratified on January 13, 2006.
 - Ratified by 186 countries.
- The 12 'Dirty Pollutants':
 - Aldrin, Chlordane, DDT, Dieldrin, Endrin, Heptachlor, Mirex, Toxaphene, Hexachlorobenzene, PCBs (Polychlorinated biphenyls), Dioxins, Furans.

Air Pollution:

- Definition: Presence of any solid, liquid, or gaseous substance, including noise, in the atmosphere.
- Major Air Pollutants:
 - Oxides of Sulphur, Nitrogen, and Carbon
 - Hydrogen sulphide (H₂S)
 - Hydrocarbons
 - Smog
 - Particulate matter
- Criteria Pollutants:
 - Carbon monoxide
 - Sulphur dioxide
 - Nitrogen dioxide

Lead

Particle pollutants

Ground-level Ozone

- Agency setting limits for criteria pollutants: Environmental Protection Agency (EPA).

Different Air Pollutants:

Carbon Monoxide:

- Produced from exhaust of internal combustion engines and incomplete combustion.
- Reduces oxygen-carrying capacity of blood.

Carbon Dioxide:

- Mainly from volcanic eruptions and fossil fuel combustion.
- Major contributor to global warming.

Particulate Pollutants:

- Solid particles and liquid droplets in the air (e.g., dust, dirt, soot).
- Sources include industries, vehicles, power plants.
- Size ranges from 0.001 to 500 micrometers.
- PM 2.5 causes the greatest harm to human health.
- Electrostatic Precipitator used for control.

Sulphur Dioxide (SO₂):

- Emissions from fossil fuel combustion and volcanic activity.
- Contributes to smog and acid rain, leading to lung diseases.

Oxides of Nitrogen (NO_x):

- Produced by burning of fuels, causes smog and acid rain.

Lead:

- Found in petrol, diesel, lead batteries, paints.
- Causes nervous system damage, digestive problems, and cancer.

Ground Level Ozone:

- Formed by reactions between NO_x and volatile organic compounds.
- Sources include vehicles and industries.

Protection from Air Pollution:

- **Legislation:** Air (Prevention and Control of Pollution) Act enacted in India on March 29, 1981.
- **Initiatives:**
 - **Breathe India:** Action plan by NITI Aayog for combating air pollution in ten most polluted cities.
 - **First railway station with Oxygen parlours in India:** Nasik.

Water Pollution:

- **Definition:** Addition of undesirable substances to water, degrading its quality and rendering it unfit for use.
- **Major Water Pollutants:**
 - Organic wastes
 - Toxic metals
 - Fertilisers and pesticides
 - Radioactive materials
 - Industrial cooling water

Types of Water Pollutants:

Biological Pollutants: Pathogens such as bacteria, viruses, protozoa.

Chemical Pollutants: Organic and inorganic substances, biocides (e.g., DDT, PCBs), metals, phosphates, nitrates.

Physical Pollutants: Hot water, oil spills.

Dissolved Oxygen (DO):

- Decreases with organic and inorganic waste presence.
- DO below 8.0 mg/L considered contaminated, below 4.0 mg/L highly polluted.
- Dead Zone: Area with very low dissolved oxygen levels.

Biochemical Oxygen Demand (BOD):

- Measure of organic matter in water.
- Amount of oxygen needed by bacteria to decompose organic wastes.
- Greater BOD indicates higher pollution potential.

Chemical Oxygen Demand (COD):

- Total oxygen required to break down organic and inorganic matter by chemical oxidation.
- Always higher than BOD, more accurate.

Algal Bloom:

- Rapid increase in algae population due to nutrient enrichment.

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- Causes water discoloration, deteriorates water quality, and fish mortality.
- Examples: Terror of Bengal - Water Hyacinth.

Eutrophication:

- Natural ageing of a lake due to nutrient enrichment.
- Accelerated by pollutants from human activities.
- Results in the lake turning into land over centuries.

Biological Magnification:

- Increase in concentration of toxic substances in successive trophic levels of a food chain.

Diseases Associated with Water Pollution:

- Cholera, diarrhoea, dysentery, hepatitis, typhoid, polio, leptospirosis.
- Minamata Disease: Mercury poisoning from industrial wastewater.

Water Pollution Control:

- Water (Prevention and Control of Pollution) Act - 1974.
- Namami Ganga project - initiated in 2014.
- Ganga Action Plan - initiated in 1986.
- Bioremediation: Use of microorganisms to remove contaminants.
- World Water Day: March 22.

- Themes: 2021 - 'Valuing water', 2022 - 'Groundwater: Making the Invisible Visible', 2023 - 'Accelerating change'.

Noise Pollution:

- Definition: Unpleasant and undesirable sound causing discomfort.
- Major Sources: Industries, transportation.
- After Effects: Hearing loss, muscle contraction, cracks in walls.
- Measurement: Intensity measured in decibels (dB).
- Pollution Threshold: Noise above 120 dB.
- Noise Limit in Hospitals: 40 dB.
- Legislation:
 - Air (Prevention and Control of Pollution) Act, 1981 amended in 1987 to include noise.
 - Noise Pollution (Regulation and Control) Rules - 2000.
- International Noise Awareness Day: Last Wednesday of April.
- Green Muffling: Technique to reduce noise pollution by planting rows of trees or shrubs.

Soil Pollution:

- Definition: Addition of substances adversely affecting soil's properties and productivity.
- Pollutants: Agricultural pollutants, fertilisers, pesticides, industrial wastes, radioactive materials.

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- Effects: Reduced fertility, crop yield, groundwater pollution, health problems.
- World Soil Day (WSD): December 5.
 - Themes: 2021 - “Halt soil salinization, enhance soil production”, 2022 - 'Soils: Where food begins'.

Conventions Related to Pollution:

Stockholm Convention:

- Aim: Protection from Persistent Organic Pollutants (POPs).
- Signed: May 22, 2001.
- Came into force: May 17, 2004.
- Ratified by India: January 13, 2006.
- Ratified by 186 countries.

Rotterdam Convention:

- Aim: Promote shared responsibilities in international trade of hazardous chemicals.
- Signed: September 10, 1998.
- Came into force: February 24, 2004.
- Ratified by India: May 24, 2005.
- Ratified by 165 countries.

CLIMATE CHANGE **CARBON EMISSION** CLIMATE CHANGE

Natural Factors:

Continental Drift: Movement of continents affecting climate patterns.

Volcanic Eruptions: Release of gases and particles into the atmosphere impacting climate.

Changes in Earth's Orbit: Alterations in Earth's orbit affecting the amount of solar radiation received.

Anthropogenic Factors:

Greenhouse Gases: Mainly from human activities, leading to the greenhouse effect.

Atmospheric Aerosols: Particles in the atmosphere impacting temperature.

Consequences of Climate Change:

Increased atmospheric temperature.

Glacier melting.

Rising sea levels.

Ocean acidification.

Droughts.

Ecosystem disruptions.

International Initiatives:

Intergovernmental Panel on Climate Change (IPCC):

Provides reports on global climate change.

United Nations Framework Convention on Climate Change (UNFCCC): Aims to stabilize greenhouse gas concentrations.

Climate and Clean Air Coalition (CCAC): Focuses on treating short-lived climate pollutants.

Global Climate Change Alliance (GCCA): Supports developing countries in integrating climate change into

policies.

India's Response:

National Action Plan on Climate Change (NAPCC): Aims to counter climate change through various missions.

National Green Corps (NGC): Engages children in environmental education through school eco-clubs.

Carbon Emission and Carbon Footprint:

- Carbon Emission: CO₂ released into the atmosphere, mainly from burning fossil fuels.
- Carbon Footprint: Total greenhouse gases released by human activities.

Carbon Offset, Sequestration, Credit, and Tax:

- Carbon Offset: Reducing emissions to compensate for carbon footprint.
- Carbon Sequestration: Trapping and storing atmospheric carbon dioxide.
- Carbon Credit: Tradable permit allowing emission of a certain amount of greenhouse gases.
- Carbon Tax: Levied fee on fossil fuels based on emissions.

Global Warming:

- Global warming is a phenomenon leading to an increase in the average temperature near the surface of Earth.

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- Major contributing factors: Greenhouse gases, primarily CO₂.
- Contribution of Greenhouse Gases in Global Warming:
 - CO₂: 60%
 - Methane (CH₄): 20%
 - CFCs: 14%
 - N₂O: 6%
- Effects of Global Warming:
 - Impact on ecosystems and biodiversity
 - Sea level rise
 - Extreme weather events
 - Disruption of agricultural patterns
- Measures to Reduce Global Warming:
 - Reduce the use of fossil fuels
 - Increase energy efficiency
 - Reduce deforestation
 - Population control
- Kyoto Protocol:
 - International agreement aimed at reducing greenhouse gas emissions significantly
 - Adopted on December 11, 1997
 - Came into force on February 16, 2005
 - India signed on August 26, 2002
 - Gases mentioned in the Kyoto Protocol include CO₂, CH₄, N₂O, HFCs, PFCs, SF₆
 - Protocol ended in 2012
- Paris Agreement:
 - Replaced the Kyoto Protocol
 - Adopted on December 12, 2015

- Entered into force on November 4, 2016
- India signed on October 2, 2016
- Involves 195 parties

DEVELOPMENTS IN BIOTECHNOLOGY

BIOTECHNOLOGY

Introduction:

Biotechnology utilises bio-organisms or enzymes to produce products and processes beneficial to humans.

Father of Biotechnology: Karoly Ereky

Types of Biotechnology:

Red Biotechnology: Medical applications.

Green Biotechnology: Agricultural applications.

White Biotechnology: Industrial applications.

Blue Biotechnology: Marine-related applications.

Core Technique: Genetic Engineering

Genes:

- Basic units of inheritance located on DNA.
- Discovered by Friedrich Miescher.
- Double helical structure discovered by James Watson and Francis Crick.

Genetic Engineering:

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- Alters genetic material using various techniques.
- Father: Paul Berg.
- Gene editing: Introduces, deletes, or replaces DNA fragments.

Recombinant DNA Technology:

- Used to produce recombinant DNA.
- Processes involved: Creation, transfer, cloning.
- Recombinant DNA: Modified DNA formed by introducing foreign DNA into vector DNA.

Tools of Recombinant DNA Technology:

Restriction enzymes: Cut DNA at specific sites.

DNA ligase: Joins DNA fragments.

Cloning vectors: Carry foreign DNA.

Host organism: Receives recombinant DNA.

Applications of Biotechnology:

1. Agriculture:

- Increased yield, enhanced nutrition, reduced chemical use.
- Genetically Modified Organisms (GMOs), e.g., Bt crops.

2. Medicines:

- Recombinant therapeutics, e.g., insulin.
- Gene therapy for disease treatment.

3. Molecular Diagnosis:

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- Techniques include PCR and ELISA.
- Detects diseases like HIV and mutations in genes.

4. Transgenic Animals:

- Modified animals for various purposes.
- Study of physiology, diseases, and biological products.

Other Biotechnological Techniques:

- DNA fingerprinting, bioremediation, bioaugmentation.

Institutions and Agencies:

- Department of Biotechnology (DBT), Genetic Engineering Appraisal Committee (GEAC).
- Institutes include NIPGR, IGIB, RGCB, CDFD, NIAB, NIBG, RCB, NABI.

NANOTECHNOLOGY AND GREEN TECHNOLOGY:

Nanotechnology involves manipulating matter at atomic, molecular, and supramolecular scales.

Key Concepts:

- Nanomaterials: Sized from 1 - 100 nm, exhibit unique properties.
- Nanostructure: High surface area-to-volume ratio, quantum effects.
- Term Origin: Greek "nanos," meaning "dwarf."
- Coined by: Professor Norio Taniguchi.

- Pioneers: Richard Feynman (Father), Prof. C.N.R. Rao (India).
- Key Book: "Engines of Creation" by Eric Drexler.
- Nanotechnology Magazine: Nano Digest.
- Example Material: Fullerene (C60).

Fullerene:

- Allotrope of carbon discovered in 1985.
- Forms: C60 (Buckminsterfullerene), C70, C80, etc.
- Applications: Biomedicine, drug delivery, catalysis, cosmetics.

Carbon Nanotubes (CNTs):

- Cylindrical fullerenes, aka buckytubes.
- Properties: High conductivity, strength, elasticity.
- Applications: Energy storage, filtration, drug delivery.

Applications of Nanotechnology:

- Nanotech detectors, nanochips for medical diagnostics.
- Nanocarriers for drug delivery, nanoparticles for brain treatment.
- Nanosponges for toxin removal, NanoFlares for cancer detection.

Nanotechnology in India:

- Nano Science and Technology Initiative (NSTI) since 2001.
- Nano Mission (NSTM) launched in 2007 by DST.

- ICONSAT: International Conference on NanoScience and NanoTechnology.

GREEN TECHNOLOGY

Definition:

- Application of science and technology to create environmentally sustainable products and services.

Examples:

- LED Lighting, biofuels, electric vehicles, solar panels, vertical farming.

Types of Green Technology:

Green Energy: From renewable natural sources.

Green Building: Environmentally responsible structures.

Green Chemistry: Minimizes hazardous substances.

Green Nanotechnology: Produces nanomaterials without harm.

Green Energy:

- Comes from sunlight, wind, rain, tides, etc.
- Renewable and naturally replenished.

Green Building:

- Environmentally responsible design and construction.
- Rating Systems: LEED, GRIHA.

Green Chemistry:

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- Design of products and processes minimizing hazardous substances.
- Father: Dr. Paul Anastas.

Green Nanotechnology:

- Produces nano-products without harming the environment.
- Focuses on safer chemical use and labeling

