

LIST OF PUBLICATIONS 2014-15

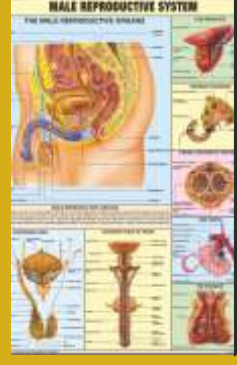
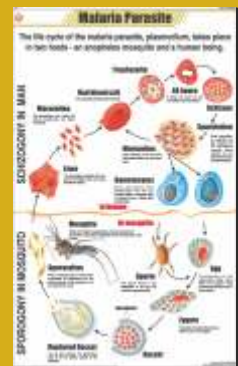
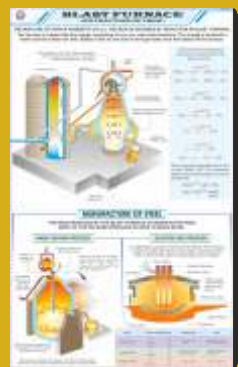
Math

Science

Medical

Social Studies

Primary



Students are able to infer meanings from the pictures quicker than from text. This well known fact itself is the testimony of importance of charts and maps for teaching. Our charts and maps produced under the expert guidance catalyse the understanding of large and complex topics.

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STB01 : Plant Kingdom

Plant Kingdom

The classification of plants was first proposed by Linnaeus. As suggested by Eichler (1833), on the basis of presence of flowers and seeds, the plant kingdom is divided into two sub-kingdoms - **Cryptogams** and **Phanerogams**.

Cryptogams are non-flowering and seedless plants.

- Thallophyta**: Thallophytes are those organisms that lack a true stem, root or leaves and possess a thallosystem.
- Bryophyta**: Bryophytes are the first land plants. They are non-flowering and seedless. They have a gametophyte that is leafy and anchored to the ground by rhizoids.
- Phanerogams** are of two kinds: **Gymnosperms** and **Angiosperms**.
- Gymnosperms**: These are non-flowering plants that bear seeds in woody cones. They have needle-like leaves and are mostly evergreen.
- Angiosperms**: These are flowering plants that bear seeds in a fruit. They have broad leaves and are mostly deciduous.

STB02 : Typical Plant

Typical Plant

Plants can be divided into two broad categories - non-flowering and flowering plants.

Non-Flowering Plants

Plants such as algae, mushrooms and mosses do not bear flowers. These are called non-flowering plants.

Flowering Plants

Most flowering plants bear two kinds of flowers - **actinomorphic** and **zygomorphic**.

Other Methods of Classification

Plants are classified based on various criteria:

- On the Basis of Size**: Tall (trees), Medium (shrubs), Small (herbs).
- On the Basis of Habitat**: Aquatic (algae), Terrestrial (mosses, ferns, gymnosperms, angiosperms).
- On the Basis of Reproduction**: Asexual (mosses, fungi), Sexual (ferns, gymnosperms, angiosperms).

STB03 : Typical Plant Cell

Typical Plant Cell

Cell Wall: A thick, rigid layer that surrounds the cell, providing structural support and protection.

Plasma Membrane: A thin, flexible layer that separates the cell from its environment.

Cytoplasm: The fluid-filled space inside the cell, containing various organelles.

Nuclear Envelope: A double membrane that surrounds the nucleus, with nuclear pores.

Mitochondria: The powerhouses of the cell, where energy is produced through cellular respiration.

Endoplasmic Reticulum: A network of membranes that synthesizes and transports proteins and lipids.

Lysosomes: Small, spherical organelles that contain digestive enzymes.

Vacuole: A large, fluid-filled organelle that maintains turgor pressure and stores waste products.

STB04 : Plant Cell Organelles

Plant Cell Organelles

Chloroplast: The site of photosynthesis, where light energy is converted into chemical energy.

Central Vacuole: A large, central vacuole that occupies most of the cell's volume, maintaining turgor pressure.

Plasma Membrane: The boundary of the cell, regulating the entry and exit of substances.

Cell Wall: The rigid outer layer that provides structural support.

Nucleus: The control center of the cell, containing genetic material.

Mitochondrion: The site of cellular respiration, producing energy for the cell.

Endoplasmic Reticulum: The site of protein and lipid synthesis.

Lysosome: The site of intracellular digestion.

Vacuole: The site of storage and waste disposal.

STB05 : Plant Tissues

Plant Tissues

Tissues are any kind of cellular fabric that occurs in a living being's body. Usually a body has several kinds of tissues which can be distinguished on the basis of their functions.

Meristematic Tissue

These are the tissues in which the cells are capable of undergoing cell division throughout their life.

Permanent Tissue

These are the tissues in which the cells are no longer dividing. They are specialized for specific functions.

Simple Permanent Tissue

- Parenchyma**: The most common type of simple permanent tissue, involved in photosynthesis and storage.
- Collenchyma**: Provides mechanical support to the plant parts.
- Sclerenchyma**: Provides rigidity and strength to the plant parts.
- Xylem**: Transports water and minerals from roots to other parts of the plant.
- Phloem**: Transports organic nutrients from leaves to other parts of the plant.

Complex Permanent Tissue

- Xylem**: Composed of tracheids, vessels, and xylem parenchyma.
- Phloem**: Composed of sieve tubes, companion cells, and phloem parenchyma.

Secretory Tissue

- Laticiferous Tissue**: Produces and transports latex.
- Glandular Tissue**: Produces and secretes substances like enzymes and hormones.

STB06 : Plant Cell Mitosis

Plant Cell Mitosis

Mitosis is a kind of cell division in which the chromosomes are duplicated and distributed equally to the daughter cells. It occurs in somatic cells.

I. Interphase: The cell grows and DNA is replicated.

II. Prophase: Chromosomes condense and the nuclear envelope breaks down.

III. Prometaphase: The nuclear envelope is completely broken down.

IV. Metaphase: Chromosomes align at the equatorial plate.

V. Anaphase: Sister chromatids separate and move to opposite poles.

VI. Telophase: Nuclear envelopes reform around the two sets of chromosomes.

STB07 : Plant Cell Meiosis

Plant Cell Meiosis

Meiosis is a type of cell division that results in four daughter cells, each with half the number of chromosomes as the parent cell.

Meiosis I (Reductional Division):

- Prophase I**: Chromosomes condense and synapse.
- Metaphase I**: Homologous chromosomes align at the equatorial plate.
- Anaphase I**: Homologous chromosomes separate.
- Telophase I**: Nuclear envelopes reform.

Meiosis II (Equational Division):

- Prophase II**: Chromosomes condense again.
- Metaphase II**: Chromosomes align at the equatorial plate.
- Anaphase II**: Sister chromatids separate.
- Telophase II**: Nuclear envelopes reform, resulting in four haploid daughter cells.

STB08 : T.S. Stem-Monocot

T.S. Stem-Monocot

MAIZE STEM

Microscopic View labels:

- Epidermis**: The outermost layer of cells.
- Hypodermis**: A layer of cells just below the epidermis.
- Phloem**: Tissue that transports organic nutrients.
- Metaxylem**: Water-conducting tissue.
- Primary xylem lacunae (water cavity)**: Large, open spaces in the xylem.
- Ground tissue**: The bulk of the stem.

As seen under the Microscope: Shows the arrangement of vascular bundles in a scattered pattern.

STB09 : T.S. of Dicot Stem (Sunflower)

T.S. OF DICOT STEM (Sunflower)

Major Characteristics of Dicot Stem

1. Cortex and pith are well-differentiated.
2. Endodermis may be present in some of the plants.
3. Number of vascular bundles is relatively less (than monocot) and they are arranged in a ring.
4. Vascular bundles are open and generally lack bundle sheath.

Labels: Epidermis, Cuticle, Starch Grains, Sclerenchyma (Hard Part), PERICYCLE, Phloem, Cambium, Metaxylem, Protoxylem, Metaxylem, Pith, Metastyle Rays, Pith.

Diagrammatic Transverse Section of Dicot Root (a part cellular)

Major Characteristics of Dicot Roots

1. No. of vascular bundles varies from 2 - 4 (rarely to 6).
2. Pith is poorly developed at first.
3. Lateral roots, vascular cambium and cork cambium originate from well-developed vascular tissue.
4. Cambium develops later during secondary growth.

Gram (Cicer arietinum)

STB10 : T. S. Root - Monocot

T.S. Root - Monocot

Monocot Root

In this, the central part of the ground tissue is very large and well developed. For example, in the roots of plants like maize, grain, orchids, grass and lily.

Transverse Section of a Portion of Maize Root

Labels: Root Hair, Epidermis, Cortex, Endodermis, Pericycle, Protoxylem, Phloem, Metaxylem, Pith.

Monocot Root Cross Section

STB11 : T. S. of Dicot Root

T. S. of Dicot Root

Labels: Root hair, Epidermis, Cortex, Endodermis, Pericycle, Metaxylem, Protoxylem, Phloem, Pith.

Major Characteristics of Dicot Roots

1. No. of vascular bundles varies from 2 - 4 (rarely to 6).
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Gram (Cicer arietinum)

STB12 : T. S. Leaf - Monocot

T. S. Leaf - Monocot

T.S. of a Monocot Leaf

Monocot leaf is mostly lobed. It is equally illuminated on both the surfaces.

Labels: Cuticle, Bulliform Cells, Mesophyll, Bundle Sheath, Epidermis, Stoma, Guard Cell, Epidermis, Bulliform Cells, Bundle Sheath, Epidermis, Stoma, Guard Cell.

T.S. of C4 Grass Leaf

In the leaves of C4 grasses, the mesophyll cells and bundle sheath cells typically form two concentric layers around the vascular bundles. The compactly arranged bundle sheath cells of the C4 grasses are very large parenchyma cells that contain many large conspicuous chloroplasts.

Labels: Cuticle, Bulliform Cells, Epidermis, Bundle Sheath, Mesophyll Cells, Bundle Sheath, Epidermis, Bulliform Cells.

T.S. of C3 Grass Leaf

In the leaves of C3 grasses, the mesophyll cells and bundle sheath cells are not concentrically arranged. The relatively small cells of the parenchymatous bundle sheaths in these plants have rather small chloroplasts. In C3 grasses, more than four small mesophyll cells intervene between adjacent bundle sheaths.

Labels: Epidermis, Bulliform Cells, Mesophyll Cells, Bundle Sheath, Epidermis, Bulliform Cells.

STB13 : T. S. Leaf - Dicot

T. S. Leaf - Dicot

T.S. of Dicot Leaf (Mango)

Dicot leaf is dorsiventral. A dorsiventral leaf is more strongly illuminated on the upper surface than the lower surface. In the internal structure, there is a good deal of difference between the two sides.

Labels: Epidermis, Cuticle, Bulliform Cells, Mesophyll, Bundle Sheath, Epidermis, Bulliform Cells.

T.S. of Hydrophytic Dicot Plant Leaf

Water lily, a magnolia, floats on the surface of water and has stomata in the upper epidermis only. Vascular tissue is much reduced, especially the xylem. The spongy parenchyma consists of several layers of cells above the spongy parenchyma. The large intercellular spaces add buoyancy to this floating leaf.

Labels: Epidermis, Cuticle, Bulliform Cells, Mesophyll, Bundle Sheath, Epidermis, Bulliform Cells.

T.S. of Xerophytic Dicot Plant Leaf

Various cactuses, a xerophyte, have very thick cuticle, covering the multiple epidermis on the upper and lower surfaces of the leaf. The stomata and lenticels are restricted to insolated portions of the lower epidermis, called stomatal crypts.

Labels: Epidermis, Cuticle, Bulliform Cells, Mesophyll, Bundle Sheath, Epidermis, Bulliform Cells.

STB14 : Types of Leaves

Types of Leaves

Serpate Leaves

Consider a single leaf that is an entire leaf. It is divided into several leaflets by a central vein. The leaflets are attached to the central vein by short petioles.

Opposite Leaves

Leaf stalks are attached to the stem at right angles to each other.

Helicophyll

Many dicot leaves are twisted. Twisting of leaves in some stems is an adaptive device to avoid the effects of wind.

Phyllotaxy

Phyllotaxy can be defined as the mode of arrangement of leaves on a stem.

1. Alternate type
2. Whorled type
3. Opposite type

Parallel Venation

How is it possible to recognize the characteristic of many monocotyledonous leaves?

1. Parallel Venation
2. Parallel Convergence
3. Parallel Divergence

Retiulate Venation

1. Reticulate Unlobate
2. Reticulate Convergence
3. Reticulate Divergence

STB15 : Root Systems

Root Systems

TAP ROOT SYSTEM

Taproot develops from the radicle of the seed which forms the primary root. It grows vertically downwards from which smaller lateral roots branch. These roots may further branch to form rootlets. Example: carrot, radish and mango.

FIBROUS ROOT SYSTEM

A root system in which both primary and lateral roots are finely divided without an unbranched primary root. It is usually formed by the moderately branching roots growing from the stem. Most monocots have a fibrous root system. Grasses are an example of fibrous root systems.

ADVENTITIOUS ROOT SYSTEM

Some roots arise from parts of the plant other than the radicle. Such roots are called adventitious roots. Mosses and aquatic plants have hanging roots coming out of the lower nodes of stem. These are called stilt roots. Hanging roots of banyan tree are also an example of adventitious roots.

STB16 : Structure of Flower

Structure of Flower

Flower is a modified shoot meant essentially for the reproduction of the plant.

Parts of a Typical Flower

Symmetry of Flower

Flower

Floral Diagram

Position of Floral Organs on the Thalamus

Hypogynous

Perigynous

Epigynous

STB17 : Calyx and Corolla

Calyx and Corolla

CALYX MODIFICATIONS
The outermost green and leaf like floral whorl consisting of sepals is calyx. However, it is modified into following forms in some plants.

Pappus Example - <i>Sonchus, Euphorbia</i>	Spurred Example - <i>Delphinium</i>	Leafy Example - <i>Mussaenda</i>
Spinous Example - <i>Trapa</i>	Hood Like Example - <i>Asclepias</i>	Blabiate Example - <i>Ocimum, Salvia</i>

SHAPES OF COROLLA
The second coloured and leafy floral whorl consisting of petals is corolla. Following are the common shapes of corolla.

Cruciform Example - <i>Brassicaceae</i>	Caryophyllaceous Example - <i>Caryophyllaceae</i>	Rosaceous Example - <i>Rose</i>	Campanulate Example - <i>Cassia, Coccinia, Wikstroemia</i>
Tubular Example - <i>Solanum, Hibiscus</i>	Bilabiate Example - <i>Ocimum, Salvia</i>	Hypocriteform Example - <i>Moraceae, Solanaceae</i>	Rotato Example - <i>Rubiacaceae, Solanaceae</i>
Infundibuliform Example - <i>Passiflora, Solanum</i>	Personate Example - <i>Asclepias</i>	Ligulate Example - <i>Solanum, Solanaceae</i>	Papilionaceous Example - <i>Phaseolus, Labium</i>

STB18 : Inflorescences

Inflorescences

RACEMOSE INFLORESCENCES

Raceme Inflorescence axis is upright, elongated and bears axillary flowers (e.g. Mustard)	Panicle Inflorescence axis is branched & flowers are borne axillary or alternately (e.g. Sunflower)	Spike Stems are upright but flowers have no stalks
Catkin It is a spike with unisexual flowers. The inflorescence axis is long and pendulous (e.g. Mulberry)	Spadix It is a spike with fleshy axis surrounded by a protective bract (e.g. <i>Amorpha, Callitriche</i>)	Corymb The axis is erect and the lower flowers have longer stalks than the upper ones. Thus all flowers come to the same level (e.g. <i>Geranium, Ranunculus</i>)

CYMOSE INFLORESCENCES

Monocephal Scorpioid The main axis is upright and bears a terminal raceme (e.g. <i>Passiflora, Solanum</i>)	Monocephal Helicoid The main axis is upright and bears a terminal raceme (e.g. <i>Passiflora, Solanum</i>)	Dichasial Two main branches develop at the base of the main axis (e.g. <i>Passiflora, Solanum</i>)	Polychasial More than two main branches develop at the base of the main axis (e.g. <i>Passiflora, Solanum</i>)
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STB19 : Fruits

Fruits

The ovary undergoes changes immediately after fertilization to transform into a fruit.

TRUE FRUIT: When only ovary takes part in the formation of fruit.

FALSE FRUIT: When the other floral parts such as thalamus, calyx, etc. form a major part of the fruit.

PARTS OF A FRUIT
Pollen tube scars, Endocarp, Epicarp, Mesocarp, Pericarp

CLASSIFICATION OF FRUITS

Dry
Dehiscent (Pea/Pot), Indehiscent (Wheat), Sclerochorp (Oakleaf Nut)

Fleshy
Drupe (Mango), Berry (Tomato), Pome (Apple), Poin (Watermelon), Hesperidium (Lemon), Sorocarp (Pineapple)

AGGREGATE FRUITS
Cluster of Follicles (Strawberry), Cluster of Achenes (Blueberry), Cluster of Drupe (Raspberry)

COMPOSITE FRUITS
Syconium (Fig), Sorocarp (Jack Fruit)

STB20 : The Seed : Structure and Germination

The Seed: Structure and Germination

TYPICAL STRUCTURE OF A SEED

CONDITIONS NECESSARY FOR GERMINATION
Oxygen, Water, Temperature

EPIGEAL GERMINATION
Germination of pea seed

HYPOGEAL GERMINATION
Germination of mung bean

STB21 : Germination of Seed - Bean & Pea

Germination of Seed - Bean & Pea

Germination of Pea Seed (Hypogeal)

- Only radicle is not covered out of the soil surface.
- Theropod cotyledons pushing the plumule out of the soil.
- The cotyledons grow upward and the first root comes out of the cotyledons.
- The radicle forms the primary root which is soon replaced by secondary fibrous roots.

Germination of Bean Seed (Epigeal)

Cotyledons are brought above the ground due to the elongation of the hypocotyl.

STB22 : Dispersal of Fruits & Seeds

Dispersal of Fruits & Seeds

Fruits and Seeds can not move independently from one place to another. They are transported to new areas by the external agencies according to which their dispersal is categorised into following types:

Dispersal by Wind

Light Weight & Minute Seeds Light & very small seeds of plants.	Winged Seeds & Fruits Winged seeds are present in many trees and plants. These help them to float in air.
Balloon Like Appendages Some plants develop long, thin, balloon-like appendages that help them to float in air.	Parachute Mechanism Some plants have seeds with a parachute-like structure that helps them to float in air.

Dispersal by Animals

Hooked Fruits & Seeds Some plants have seeds with hooks that help them to attach to the fur of animals.	Sticky Fruits & Seeds Some plants have seeds with sticky substances that help them to attach to the fur of animals.
Eddible Fruits & Seeds Some plants have seeds that are eaten by animals, which helps in dispersal.	Dispersal by Explosion Some plants have seeds that are dispersed by the explosion of the fruit.

STB23 : Photosynthesis

Photosynthesis

Process of manufacturing food by green plants with the help of water, carbon dioxide, sunlight and chlorophyll is called photosynthesis. Oxygen is released in this process.

$$6CO_2 + 12H_2O \xrightarrow{\text{Light Chlorophyll}} C_6H_{12}O_6 + 6H_2O + 6O_2$$

Requirements for Photosynthesis

- Light**
Batches a pot on green plant, wrap one leaf in black paper and keep the plant in sunlight for 3-4 days. Decolourise the leaf by boiling it in alcohol. The covered part does not turn blue-black while the uncovered part turns blue-black.
- Chlorophyll**
Decolourise a plant with boiling alcohol. Put it in argenticum for 3-4 days. Take a leaf from that plant and decolourise it by boiling it in alcohol. The originally green part turns blue-black while the originally white part remains white.
- Carbon Dioxide**
Place a leaf of a plant in a test tube containing KOH solution to absorb CO₂. Leave it in sunlight for 3-4 days. Test the leaf with iodine solution. The portion of leaf inside the test tube remains colourless. The other portion turns blue-black. This shows that CO₂ is necessary for photosynthesis.

STB24 : Plant Diseases

Plant Diseases

Black Rot of Crucifers Caused by <i>Alternaria brassicicola</i>	Late Blight of Potato Caused by <i>Phytophthora infestans</i>	Bacterial Wilt of Tomato Caused by <i>Burkholderia solanaceae</i>
Hill Bunt (Stunt) of Wheat Caused by <i>Tilletia tritici</i>	Brown Spot of Rice Caused by <i>Blumeria oryzae</i>	Tobacco Mosaic Virus Disease Caused by Tobacco Mosaic Virus
Leaf (Brown) Rust of Wheat Caused by <i>Puccinia striiformis</i>	Yellow Mosaic of Chilli Caused by <i>Tomato Yellow Leaf Curl Virus</i>	Red Rot of Sugarcane Caused by <i>Fusarium moniliforme</i>
Bacterial Blight of Cowpea Caused by <i>Burkholderia fabae</i>	Powdery Mildew of Wheat Caused by <i>Blumeria tritici</i>	Leaf Curl of Chilli Caused by <i>Tomato Yellow Leaf Curl Virus</i>

STB25 : Reproduction in Plants

Reproduction in Plants

VEGETATIVE REPRODUCTION IN PLANTS

Commonly called cloning, vegetative reproduction is the asexual propagation of plants in which the new plants are called cuttings. It functions on the principle that each cell has the same DNA.

TUBER (Potato): A tuber is a thickened, fleshy part of the stem or root. It stores food and can grow into a new plant.

OFFSET (Pineapple): Offsets are small plants that grow from the base of the parent plant. They can be separated and planted to grow new plants.

CORM (Colocasia): A corm is a short, vertical stem with a swollen base. It stores food and can grow into a new plant.

LEAF BUD (Sedum): Leaf buds are small plants that grow from the leaf axils of the parent plant. They can be separated and planted to grow new plants.

BULB (Onion): A bulb is a short, vertical stem with a swollen base. It stores food and can grow into a new plant.

RHIZOME (Banana): A rhizome is a horizontal stem that grows underground. It stores food and can grow into a new plant.

ROOTING (Mint): Rooting is the process of a stem cutting developing roots when placed in water or soil. The rooted cutting can then be planted to grow a new plant.

REPRODUCTION BY SPORE FORMATION

Found in Bryophytes and Pteridophytes

Spores are small, single-celled reproductive units that can grow into a new plant. They are produced by the sporophyte and can be dispersed by wind or water.

SEXUAL REPRODUCTION OF FLOWERING PLANTS

FLOWER: The flower is the reproductive part of a flowering plant. It contains the male and female reproductive organs.

POLLINATION: Pollination is the transfer of pollen from the anther to the stigma of the same or another flower. It is a prerequisite for fertilization.

PERTELLIZATION: Fertilization is the fusion of a male gamete (sperm) and a female gamete (egg) to form a diploid zygote. This process results in the formation of a new plant.

SEED GERMINATION: A seed is a small, dormant plant that can grow into a new plant. It contains an embryo and a food supply. Germination is the process of a seed growing into a new plant.

STB26 : Pollination

Pollination

The transfer of pollen from the anther of a flower to the stigma of the same or another flower is known as pollination. Pollination is a prerequisite for fertilization.

ACCORDING TO SOURCE OF POLLEN

Autogamy (Self-pollination): This occurs when pollen is transferred from the anther to the stigma of the same flower.

Allogamy (Cross-pollination): This occurs when pollen is transferred from the anther of one flower to the stigma of another flower.

ACCORDING TO MEDIUM OF POLLINATION

Self-pollination: This occurs when pollen is transferred from the anther to the stigma of the same flower.

Cross-pollination: This occurs when pollen is transferred from the anther of one flower to the stigma of another flower.

ACCORDING TO MEDIUM OF POLLINATION

Self-pollination: This occurs when pollen is transferred from the anther to the stigma of the same flower.

Cross-pollination: This occurs when pollen is transferred from the anther of one flower to the stigma of another flower.

STB27 : Double Fertilization

Double Fertilization

The process of double fertilization involves the joining of a female gametophyte with two male gametes (sperm). A pollen grain pushes its pollen tube through the micropyle to release two sperm. One sperm fertilizes the egg cell to form a diploid zygote and the other sperm combines with the two polar nuclei to form a triploid nucleus (some plants may form polyploid nuclei).

Megasporogenesis (egg development)

Microsporogenesis (sperm development)

Double Fertilization

1. A pollen grain lands on the stigma and germinates, forming a pollen tube that grows down the style towards the ovary.

2. The pollen tube releases two sperm cells and a vegetative cell.

3. One sperm cell fertilizes the egg cell to form a diploid zygote.

4. The other sperm cell fertilizes the two polar nuclei to form a triploid nucleus.

STB28 : Artificial Vegetative Propagation

Artificial Vegetative Propagation

Tissue Culture: Tissue culture, or micropropagation, is the asexual propagation of plants in vitro. It functions on the principle that each cell has the same DNA.

Cuttings: Cuttings are small pieces of a plant that can be used to grow a new plant. They can be taken from the stem, leaf, or root.

A. Leaf cutting: A leaf cutting is a small piece of a leaf that can be used to grow a new plant.

B. Stem cutting: A stem cutting is a small piece of a stem that can be used to grow a new plant.

Layering: Layering is the process of a stem cutting developing roots when placed in water or soil. The rooted cutting can then be planted to grow a new plant.

A. Simple layering: Simple layering is the process of a stem cutting developing roots when placed in water or soil. The rooted cutting can then be planted to grow a new plant.

B. Air layering: Air layering is the process of a stem cutting developing roots when placed in water or soil. The rooted cutting can then be planted to grow a new plant.

Grafting: Grafting is the process of joining two plants together. The cambium of the upper part must line up with the cambium of the lower part. The union must be kept from drying out until the graft "takes".

STB29 : Stem Modification

Stem Modification

UNDERGROUND STEM MODIFICATION

Tuber (Potato): A tuber is a thickened, fleshy part of the stem or root. It stores food and can grow into a new plant.

Bulb (Onion): A bulb is a short, vertical stem with a swollen base. It stores food and can grow into a new plant.

Rhizome (Banana): A rhizome is a horizontal stem that grows underground. It stores food and can grow into a new plant.

Stem modification is a form of vegetative propagation. It is a process by which a stem cutting develops roots when placed in water or soil. The rooted cutting can then be planted to grow a new plant.

STEM MODIFICATION

Stem modification is a form of vegetative propagation. It is a process by which a stem cutting develops roots when placed in water or soil. The rooted cutting can then be planted to grow a new plant.

STEM MODIFICATION

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STB30 : Root Modification

Root Modification

MODIFICATION OF TAP ROOT

Carrot: A carrot is a taproot that has been modified to store food.

Beetroot: A beetroot is a taproot that has been modified to store food.

Radish: A radish is a taproot that has been modified to store food.

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STB31 : Hydrophytes

Hydrophytes

External Features

- Roots are completely absent or poorly developed.
- Stem is long, slender, and buoyant.
- Leaves are large and flat, and are often arranged in whorls.
- Flowering stems are long, slender, and are often supported by long, thin, leafless stems called peduncles.
- The leaves of emergent and submerged hydrophytes are anisostichous.

Anatomical Characters

- All hydrophytes show presence of large air cavities. The main air cavities are called aerenchyma.
- Hydrophytes have a small root system.
- Stems are short and stout.
- Stems are short and stout.

Submerged and Floating Hydrophytes

Submerged Hydrophyte: These plants are found in shallow water and have long, thin, leafless stems called peduncles. They have small, round, leaf-like structures called bracts.

Floating Hydrophyte: These plants have long, thin, leafless stems called peduncles. They have large, flat, leaf-like structures called leaves. The leaves are often arranged in whorls.

STB32 : Mesophytes

Mesophytes

GENERAL DESCRIPTION

- Mesophytes are the plants that grow under average conditions of temperature and moisture.
- The soil in which they grow is neither very dry nor very wet.
- The temperature of the air is neither too hot nor too cold.
- Mesophytes are the plants that grow under average conditions of temperature and moisture.

EXTERNAL FEATURES

- The root system is well developed.
- Leaves are broad and are provided with a thick cuticle.
- The stem is short, and is not branched.
- There is an alternation of leaves.

ANATOMICAL CHARACTERS

- Mesophytes have a well-developed root system.
- Leaves are broad and are provided with a thick cuticle.
- The stem is short, and is not branched.
- There is an alternation of leaves.

Banyan: A banyan tree is a large, spreading tree with many aerial roots. It is a mesophyte.

Chrysanthemum: A chrysanthemum is a flowering plant with many small, yellow flowers. It is a mesophyte.

Pea: A pea plant is a climbing plant with many small, yellow flowers. It is a mesophyte.

Mango: A mango tree is a large, spreading tree with many small, yellow flowers. It is a mesophyte.

STB33 : Xerophytes

Xerophytes

Xerophytes occur in regions where the amount of water in the soil is very less.

External Features of Xerophytes

- The root system is well developed, probably branched and extensively spread.
- Thorns occur in a great number.
- Thick waxy cuticle is present.
- Leaves are small, succulent, or fleshy.
- Stems may also be fleshy and usually covered with wax.
- Stems (when stem-modified stems) are present in Opuntia where there is a leaf the stem called phylloclad. In Asparagus and there is the leaf the stem formed by the leaf called cladode.
- Lanceolate leaf with hard in Sarcocolla.
- Lanceolate leaf with hard in Tithonia.
- Leaves are smaller in size and reduced in Monarda.
- Lanceolate leaf with hard in Monarda.

Anatomical Characters of Xerophytes

- Reduction in the rate of transpiration.
- Presence of leaves which are small or succulent.
- Presence of thick cuticle on leaf and stem surfaces.
- Reduced internal respiration.
- Reduced root system.
- A thick covering of hairs on epidermal and internal surfaces.
- Indivisible stomata are only a few and always small.
- Reduced leaves like cladodes and stem leaves are well developed.
- Variable flower arrangement in large amount.

STB34 : Insectivorous Plants

Insectivorous Plants

The autotrophic plants growing in nitrogen deficient conditions and fulfilling their nitrogen requirement by digesting insects. They are divided into four groups on the basis of insect trapping mechanism.

Plants with sensitive glandular hairs on the surface of leaves secreting sweet sticky liquid.

Plants having sensitive trigger hairs on the leaf surface.

Plants with leaves modified into pitfalls.

Plants having segmented leaves with some of the segments modified into bladders.

STB35 : Fungi

Fungi

Fungus is a unique group of organisms that includes moulds, yeasts, rusts, smuts, mushrooms and toadstools.

Classification of Fungi

- Basid Mycelia
- Sac Fungi
- Club Fungi
- Imperfect Fungi

Symbiotic Relationships

- Coralloid Lichens
- Pelican Lichens
- Psoralea Lichens
- Mycorrhiza

Economic Importance

- Antibiotics: Penicillin, Streptomycin, Tetracycline, Chloramphenicol, Vancomycin, etc.
- Food: Bread, Beer, Wine, etc.
- Wood: Decay, Preservation, etc.
- Alcoholic Fermentation: Beer, Wine, etc.
- Worms: Silkworm, etc.
- Genetic Studies: etc.

Harmful Effects

- Spoilage of Food
- Spoilage of Goods
- Allergic Fungi
- Diseases

Fungal Diseases (Plants)

- Potato Blight
- Wheat Rust
- Corn Smut
- Rust
- Downy Mildew
- Sugarcane Red Rot

Fungal Diseases (Humans)

- Ringworm
- Dandruff
- Aspergillus
- Foot Fungus
- Rhinitis
- Thrush

STB36 : Algae

Algae

Algae are chlorophyll bearing thalloid plants. The study of algae is known as algology. Professor M.C.P. Iyengar is known as father of Modern Indian Algology.

Classification

- Unicellular: Rhodospirillum rubrum, Chlorella, etc.
- Multicellular:
 - Phaeophyta (Brown Algae)
 - Rhodophyta (Red Algae)
 - Chlorophyta (Green Algae)
 - Charophyta (Charophytes)
 - Cryptophyta (Cryptophytes)
 - Alveolates (Dinoflagellates, etc.)

Uses

- Single-cell protein
- Biogas
- Food
- Alcohol
- Bioplastics
- Water treatment
- Pharmaceuticals
- Bioremediation
- Biotechnology
- Bioremediation
- Bioremediation
- Bioremediation
- Bioremediation

Harms

- Red tide
- Algal bloom
- Algal bloom
- Algal bloom
- Algal bloom
- Algal bloom
- Algal bloom
- Algal bloom
- Algal bloom
- Algal bloom

STB37 : Viruses

Viruses

Dr. W. Stanley: He was the first one to isolate virus from infected tobacco leaf.

Classification based on shape

- Spherical (Icoshedral)
- Cubical
- Helical
- Spiral
- Complex

Classification based on composition

- Double-stranded DNA
- Single-stranded DNA
- Double-stranded RNA
- Single-stranded RNA

Classification based on their hosts

- Animal viruses
- Plant viruses
- Bacteriophages
- Invertebrate viruses

Classification based on covering

- Enveloped
- Non-enveloped

Virus diseases

- Animal diseases: Influenza, Mumps, Measles, etc.
- Plant diseases: Tobacco Mosaic, etc.

STB38 : Bacteria

Bacteria

Prokaryotes, more traditionally known as bacteria, belong to Kingdom Monera. The bacteria exist in almost every place on Earth. Bacteria range in size from 1 to 10 micrometres in length and from 0.7 to 1.3 micrometres in width.

Classification of Bacteria

- Eubacteria
- Cyanobacteria
- Archaeobacteria
- Protozoobacteria

Cell Shape

- Rod-like Bacilli
- Spherical Cocci
- Spiral Spirilla
- Comma-shaped Vibrios

Respiration in Bacteria

- Aerobic (requires oxygen)
- Anaerobic (does not require oxygen)

Chemical Nature of Cell Wall

- Gram-Positive (Blue)
- Gram-Negative (Red)

Bacterial Growth and Reproduction

- Binary Fission
- Conjugation
- Spore Formation

Useful Activities

- Decay of Organic Waste
- Nitrogen Fixation
- Biogas Production
- Antibiotics
- Genetic Engineering
- Food Preservation
- Bioremediation

Some Bacterial Diseases

- Typhoid
- Food Poisoning
- Amoebiasis
- Cholera
- Leprosy
- Bacterial Dysentery
- Scarlet Fever
- Botulism
- Whooping Cough
- Strep Throat
- Bacterial Meningitis
- Red Stain of Eggplant

STB39 : Life Cycle of Fern

Life Cycle of Fern

Ferns are spore producing plants that alternate generations.

SPOROPHYTES
Sporangia or spore cases, appear on the back of leaf (the fern fronds).

COMMON BRACKEN
Common bracken ferns thrive in woods and fields.

SPORES
The spore cases are initially covered by curled-over leaf edges. When they burst open, spores fly out in all directions.

FERTILIZATION
Sperm from the antheridium swim to the archegonium.

GAMETOPHYTE
The spores grow into heart-shaped gametophytes called prothallia.

STB40 : Life Cycle of Moss

Life Cycle of Moss

The life cycle of a moss is dominated by the green, leafy gametophyte (haplophase). The sporophyte (diplophase) consists only of the ascending stalk and capsule.

SPOROZYTE (Diplophase)
Sporophyte

GAMETOPHYTE (Haplophase)
Gametophyte

Fertilization
Fertilization

Meiosis
Meiosis

STB41 : Spirogyra

Spirogyra

Spirogyra is a filamentous freshwater green alga having spiral arrangement of the chloroplast. There are more than 400 species of Spirogyra in the world.

Kingdom	Plantae
Sub-Kingdom	Thallophyta
Class	Chlorophyceae
Order	Conjugales
Family	Zygnematales
Genus	Spirogyra

Reproduction

Vegetative reproduction takes place by the process of fragmentation.

Asexual: Known only in some species. Includes diagrams for A. Asexual, B. Aplanospores, and C. Aplanospores.

Sexual: Lateral conjugation and Sexual Lateral conjugation. Includes diagrams for A. Sexual Lateral, B. Sexual Lateral, and C. Sexual Lateral.

Sexual: Scalariform conjugation and Germination of Zygospore. Includes diagrams for A. Scalariform conjugation, B. Scalariform conjugation, C. Scalariform conjugation, and D. Germination of Zygospore.

STB42 : Life Cycle of a Mushroom

Life Cycle of a Mushroom

Mushrooms are unable to photosynthesize. Mushrooms feed off-decaying matter, such as rotting logs, fallen leaves, and wilted grass. Some, however, grow on live plants, and others thrive on nutrient-rich animal droppings. They develop in all sorts of environments, especially damp and poorly lit places. They reproduce by means of spores. Mushrooms have relatively simple structures with no roots, stems or leaves. Their cell walls contain the polysaccharide chitin. The fruiting body consists of a stalk (pedicel) made of densely packed hyphae which are attached to a basal mycelium and crowned with a broad cap (pileus). The cap protects the delicate spore-bearing layer.

The death cap is a beautiful but poisonous mushroom that grows in open woods. Poisonous mushrooms such as the death cap are commonly called.

Underneath the cap, the gills bear the basidia and the spores.

Spores: Spores germinate if the temperature is and - stress.

Secondary mycelia: Secondary mycelia form a mass, which grows.

Primary mycelia: Primary mycelia of different sexes fuse to form.

Secondary mycelium: Secondary mycelium and spores for the next cycle.

When the spores germinate, they form primary mycelia.

STB43 : Leaf Modifications

Leaf Modifications

Leaves are the most important vegetative organs borne on the stems for photosynthesis. However, some plant species have leaves with adaptation to perform various functions other than photosynthesis.

TENDRILS Modified for climbing. Pea Plant	SPINES Modified to decrease water loss. Cactus	THORNS Modified for defence. Rose
BRACTS Modified with colorful pigmentation to attract pollinators. Poinsettia, Bougainvillea	FLESHY LEAVES Modified to store food, water and minerals. Ice Plant, Succulent	ADHESIVE DISC Modified for attachment mechanism and referred to as an involucre. Mimulus
REPRODUCTIVE LEAF Modified for sexual reproduction to form new floral leaves. Kalimeris, Plant Leaf	PHYLLODE Petioles are modified into flattened green leaf structures to perform photosynthesis. Acaena, Acaena	INSECTIVORY Modified to trap insects to absorb the plant's essential nutrients. Venus Fly Trap

STB44 : Parasitic Plants

Parasitic Plants

Parasitic plants are vascular plants with specialised organs (Haustorium) that penetrate the tissues of other vascular plants (Hosts) and absorb water, minerals and sometimes products of photosynthesis.

HOLOPARASITES

These are also known as "Totipolar parasites" because they are not completely parasitic. They are capable of both photosynthesis and parasitism. Holoparasites lack both photosynthetic and root system.

RAFFLESIA Rafflesia	IVY BROOMRAPE Ivy Broomrape	CUSCUTA Cuscuta
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HEMIPARASITES

These are also known as "Facultative parasites" because they are not completely parasitic. They are capable of both photosynthesis and parasitism. Hemiparasites lack the food system.

INDIAN TWENTYBRUSH Indian Twentybrush	MISTLETOE Mistletoe	OWT'S CLOVER Owt's Clover
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STB45 : Mucor - Structure & Reproduction

Mucor - Structure & Reproduction

Mucor is a saprophytic fungus which grows on stale moist bread, rotten fruits, decaying vegetables, animal dung and other organic media. It is composed of a mass of white, delicate, cottony threads known as mycelium. It is always very much branched but is coenocytic (une Septate and multinucleate). Each individual thread of the mycelium is known as the hypha (pl. hyphae).

Asexual Reproduction (Sporangia)

Development of Sporangium and Formation of Spores.

Sexual Reproduction

Sexual reproduction only under certain conditions, particularly when the food supply becomes exhausted.

Sexual Stages in the Formation of Zygospore:

1. Plasmogamy
2. Karyogamy
3. Meiosis
4. Zygospore formation

STB46 : Regions of the Root

Regions of the Root

Root is the descending organ of the plant. Primary root is the direct prolongation of the radicle. Root ends in and is protected by the root cap. Root bears unicellular hairs in a cluster all over the tender part of the young root. Lateral roots are endogenous. Nodes and Internodes are absent in the root.

Region of Maturation: Cells of this region undergo maturation and differentiation into various types of primary tissues which gradually merge into the region of secondary tissues. This region produces root hairs and lateral roots.

Region of Elongation: Cells in this region undergo rapid elongation and expansion and are responsible for growth of the root.

Region of Cell Division: Cells here undergo repeated cell divisions. Hence this region is also called meristematic region. It contributes to the formation of the root cap and the root apex region.

Root Cap: A soft cap or thimble to protect the tender apex of the root as it makes its way through the soil.



STZ01 : Animal Kingdom

Animal Kingdom

Animals are classified into several phyla on the basis of their levels of cell organisation and presence or absence of notochord and body cavity.

Phylum Porifera These are primitive animals. They have no definite body plan. They are made up of many different components called organs.	Phylum Coelenterata These include jellyfish, sea anemones, and hydras. They have a body cavity called a gastrovascular cavity.	Phylum Mollusca These include snails, slugs, and squids. They have a soft body and a mantle.	Phylum Platyhelminthes These include flatworms like planarians, tapeworms, and flukes. They have a flat body and no body cavity.
Phylum Annelida These include earthworms, leeches, and polychaetes. They have a segmented body and a body cavity.	Phylum Arthropoda These include insects, spiders, and crustaceans. They have a jointed body and a body cavity.	Phylum Nematoda These include roundworms like pinworms and threadworms. They have a long, thin body and a body cavity.	Phylum Chordata These include humans, monkeys, and other mammals. They have a notochord and a body cavity.

STZ02 : Animal Cell

Animal Cell

The cell is the smallest unit of life that can exist independently. It consists of a nucleus surrounded by the cytoplasm with a central vacuole. The nucleus is the main structure in which DNA is stored in chromosomes. Animal cells are made up of many different components called organelles.

- Plasma Membrane:** The outermost boundary of the cell.
- Nuclear Envelope:** The double membrane surrounding the nucleus.
- Nucleus:** The control center of the cell.
- Nucleolus:** A dense region within the nucleus.
- Ribosome:** Small structures that synthesize proteins.
- Endoplasmic Reticulum:** A network of membranes for protein synthesis.
- Golgi Apparatus:** A series of stacked sacs for processing and transport.
- Lysosome:** Organelles that break down waste.
- Cilia and Flagella:** Hair-like structures for movement.
- Chromatin Material:** DNA and associated proteins.
- Cytoplasm:** The fluid medium inside the cell.
- Mitochondria:** Organelles that produce energy.
- Micronutrients and Microfilaments:** Small molecules and fibers for cell structure.

STZ03 : Animal Cell Organelles

Animal Cell Organelles

STZ04 : Animal Tissues

Animal Tissues

Tissues are groups of cells having a common origin and performing similar functions. Animal tissues are classified into four groups - Epithelial, Connective, Muscular and Nervous tissues.

- Epithelial Tissues:** Covering and lining tissues. Includes squamous, cuboidal, and columnar epithelium.
- Connective Tissues:** Support and bind other tissues. Includes blood, bone, and adipose tissue.
- Muscular Tissues:** Contractile tissues for movement. Includes skeletal, smooth, and cardiac muscle.
- Nervous Tissues:** Transmit electrical impulses. Includes neurons and neuroglia.

STZ05 : Animal Cell Mitosis

Animal Cell Mitosis

Mitosis is the process of cell division in which identical daughter cells are produced. During mitosis the DNA is duplicated and the chromosome number is doubled, so new cells contain the same amount of DNA as the original cell. The main purpose of mitosis is to produce new cells for growth and repair.

- INTERPHASE:** Cell enlarges and gathers proteins. Replication of DNA takes place.
- EARLY PROPHASE:** Chromatin fibers condense to form chromosomes. Nuclear envelope dissolves.
- LATE PROPHASE:** Sister chromatids separate and move toward opposite poles.
- METAPHASE:** Chromosomes align at the equatorial plate.
- ANAPHASE:** Sister chromatids separate and move toward opposite poles.
- TELOPHASE:** Chromosomes reach the poles and nuclear envelopes reform.
- CYTOKINESIS:** Division of cytoplasm to form two daughter cells.

STZ06 : Animal Cell Meiosis

Animal Cell Meiosis

Meiosis is a type of cell division that results in four daughter cells, each with half the number of chromosomes as the parent cell. It is essential for the production of gametes.

- MEIOSIS - I:**
 - PROPHASE - I:** Homologous chromosomes pair up (synapsis).
 - METAPHASE - I:** Pairs of homologous chromosomes align at the equator.
 - ANAPHASE - I:** Homologous chromosomes separate.
 - TELOPHASE - I:** Two haploid cells are formed.
- MEIOSIS - II:**
 - PROPHASE - II:** Chromosomes condense again.
 - METAPHASE - II:** Chromosomes align at the equator.
 - ANAPHASE - II:** Sister chromatids separate.
 - TELOPHASE - II:** Four haploid daughter cells are formed.

STZ07 : Gametogenesis in Animals

Gametogenesis in Animals

Gametogenesis is the process of forming gametes. It includes oogenesis (formation of egg) and spermatogenesis (formation of sperm).

- Oogenesis:** One large egg cell and three small polar bodies are produced from one primary oocyte.
- Spermatogenesis:** Four equal-sized sperm cells are produced from one primary spermatocyte.

STZ08 : Fertilization in Animals

Fertilization in Animals

Fertilization is the fusion of a male gamete (sperm) and a female gamete (egg) to form a zygote. It involves the sperm penetrating the egg's protective layers and the fusion of their nuclei.



STZ09 : Protozoa

Protozoa

The term Protozoa was coined by Goldfuss in 1823. The phylum protozoa includes the unicellular organisms that have animal-like characteristics. The word protozoa literally means 'first animals' or 'primitive animals'. The phylum Protozoa is divided, according to the structures they possess for locomotion into four classes.

Rhizopoda

Protozoa that move by means of pseudopodia are classified as Rhizopoda.
 For e.g., amoeba. Amoeba is a single-celled protozoan that can constantly change its shape. Some of these also cause amoebic dysentery in humans.

Metastigophora

Protozoa that move by means of flagella are classified as Metastigophora.
 For e.g., Euglena, Paramecium, etc. Euglena is considered as a link between the plant kingdom and the animal kingdom. Giardia causes dysentery in human beings.

Ciliophora

Protozoa that move by means of cilia are classified as Ciliophora.
 For e.g., Paramecium.

Sporozoa

Protozoa that do not possess locomotory organs are classified as Sporozoa.
 For e.g., Plasmodium vivax.

STZ10 : Amoeba

Amoeba

Amoeba is one of the simplest living animals, consisting of a single cell and belonging to the protozoa group.

Cell Membrane
 is a thin layer of lipid and protein that surrounds the body of the amoeba. It is covered by a thin, wavy, wavy membrane for body.

Cytoplasm
 is present in the body of the amoeba. It is a clear, colorless, granular fluid. It is the site of various metabolic activities.

Contractile Vacuole
 is a large, clear, spherical structure. It is used for the removal of excess water and the storage of food.

Pseudopodium
 Pseudopodia or false feet help the amoeba to move through the medium and to feed. The pseudopodia are also used to engulf food. It is a clear, colorless, granular fluid. It is the site of various metabolic activities.

Food Vacuole
 is a large, clear, spherical structure. It is used for the removal of excess water and the storage of food.

Nucleus
 is the most important part of the cell. It is a large, clear, spherical structure. It is used for the removal of excess water and the storage of food.

Nutrition in Amoeba

Reproduction in Amoeba

STZ11 : Malaria Parasite

Malaria Parasite

The life cycle of the malaria parasite, plasmodium, takes place in two hosts - an anopheles mosquito and a human being.

SCHIZOGONY IN MAN

SPOGONY IN MOSQUITO

STZ12 : Paramecium

Paramecium

Paramecium is a unicellular organism that belongs to the phylum Ciliophora. It is a single-celled organism that can move by means of cilia. It is a green, oval-shaped organism with two flagella at each end.

Paramecium ciliated

Division

Leontodon

Reproduction in Paramecium

STZ13 : Hydra

Hydra

Hydra is a simple coelenterate, commonly found in freshwater ponds and streams.

Parts of Hydra Cut Away and Sectioned to Show Structure

Longitudinal Section of the Body Wall

Asexual Reproduction

Sexual Reproduction

Developmental Stages of the Hydra

STZ14 : Liver Fluke

Liver Fluke

Liver Fluke (Opisthorchis sinensis) is a parasitic flatworm that infects humans, dogs, and cats. It is a small, flat, leaf-shaped parasite that lives in the bile ducts of its hosts.

Liver Fluke (Opisthorchis sinensis) Anatomy

Life Cycle of Liver Fluke (Opisthorchis sinensis)

STZ15 : Tapeworm

Tapeworm

Tapeworm is a parasitic flatworm that infects humans and other animals. It is a long, flat, ribbon-like parasite that lives in the small intestine of its hosts.

Morphology of Taenia Solium

Scolex and Hook

T. S. of Mature Proglottis

Reproductive Organs in Mature Proglottis

Characteristics

Excretory System

Arrangement of Reproductive Ducts

Gravid Proglottis

STZ16 : Roundworm (Ascaris)

Roundworm (Ascaris)

Roundworm (Ascaris) is a parasitic roundworm that infects humans and other animals. It is a long, cylindrical, segmented parasite that lives in the small intestine of its hosts.

Side View

Ventral View (Dissected)

Female ASCARIS

Lips

Reproductive Organs

Excretory System

Alimentary Canal

Nervous System



STZ17 : Hookworm

Hookworm

Characteristics of Hookworm

- The intestinal nematode parasites attach to the internal wall of human or animal host blood vessels.
- Female worms lay eggs in the soil.
- There is a large lateral capsule with 2 pairs of large teeth placed ventrally, and a pair of sharp teeth dorsally forming incisors for penetrating host tissues.
- Eggs possess with furrow lines and tubercles on the surface.
- The proventriculus helps in the digestion of the blood.
- Adult female parasites cause itching and inflammation at the site, which primarily infection were prevented.
- They cause severe anemia in adults and retard physical and mental development in children.

Hookworms Embryo (Four celled)

Hookworm (Male)

Bursa of Male

Long Passage of Hookworm

STZ18 : Life History of Mosquito

Life History of Mosquito

Mosquitoes complete their life cycle in stagnant water. The life cycle of a mosquito consists of four stages – egg, larvae, pupa and adult.

A female mosquito has needle like parts of the mouth. It feeds on blood around water. It can develop several carriers of diseases like malaria.

A female mosquito lays her eggs in or around water. It can develop several hundred eggs at each blood meal.

Within 7-10 days, larvae change to pupae. The growing mosquito stands on still water for a few minutes to dry its wings and then, flies away.

The eggs hatch within 24-48 hours and are commonly known as 'wigglers' because they wriggle up and down from the surface of water.

STZ19 : Life Cycle of Butterfly

Life Cycle of Butterfly

Metamorphosis of a Monarch Butterfly

Adult Butterfly
Adults live for only a short time. They cannot fly. They only drink through their straw-like spiral proboscis. They will fly, mate, and reproduce.

Egg
The adult female lays an egg that will later be fertilized by the male.

Green Pupa
The caterpillar attaches itself to a twig and forms a hard outer shell.

Emergence
A fully grown adult butterfly emerges from the chrysalis.

Full Grown Larva
The larva thus produced feeds on protein diet & grows rapidly. At the end of growth phase, it molts and becomes a pupa.

STZ20 : Life History of Housefly

Life History of Housefly

Adult
A housefly has reached to full size when it comes out of the pupal case. In about 2-3 days, the adult housefly is able to reproduce. Houseflies ingest only liquid food. They regurgitate saliva onto solid food to dissolve it.

Puparium
The pupa does not feed and remains inactive inside the pupal case. The larva continues to change and takes on the shape of the adult housefly. In another 3-4 days, the adult housefly becomes an adult.

Eggs
Adult female lays many eggs that will later be fertilized by the male.

Full Grown Larva
The larva thus produced feeds on protein diet & grows rapidly. At the end of growth phase, it molts and becomes a pupa.

STZ21 : Life History of Frog

Life History of Frog

Frogs are amphibians meaning that they can live both in water and on land. There are 24 different families of frogs which contain more than 3800 species.

Eggs
Frogs lay their eggs in large masses, called spawn, in fresh and still water.

Tadpole
The tadpoles hatch from the eggs without shells.

Froglet
The tadpoles, after breathing from the gills, start breathing from the lungs. Their tails help them to swim.

Adult Frog
All adult frogs jump using its hind legs and swim using its webbed feet. An adult frog can survive on land.

Young Frog
Over a period of 10 weeks, the tail is absorbed and finally disappears. The frog can now leave the water.

Full Sized Tadpole
Within the next three months, the external gills disappear and the internal gills develop. Legs also start developing slowly.

Old Tadpole
Tadpoles develop external gills and a long swimming tail with no limbs, initially they look like fish.

STZ22 : Human Blood

Human Blood

FUNCTIONS OF BLOOD

- Transportation of oxygen, carbon dioxide, nutrients, hormones, heat, and wastes.
- Regulation of pH, body temperature, and water content of cells.
- Protection against blood loss through clotting and against disease through phagocytic white blood cells and antibodies.

BLOOD FLOWING IN BLOOD VESSEL

COMPONENTS OF BLOOD

Plasma (55-60%)
When it is in liquid form, it is called plasma. It is composed of water, electrolytes, and proteins.

Buffy Coat (1-2%)
It consists of white blood cells and platelets.

Red Blood Cells (RBCs) (45-47%)
They are the most numerous cells in blood.

BCC STRUCTURE

Erythrocytes
They are the most numerous cells in blood. They are biconcave in shape and lack a nucleus.

Leucocytes
They are white blood cells. They are larger than erythrocytes and have a nucleus.

Platelets
They are small, disc-shaped cells that help in blood clotting.

BLOOD GROUP

Blood Type	Antigen	Antibody	Can Receive Blood From	Can Donate Blood To
A	A	B, AB	A, O	A, AB
B	B	A, AB	B, O	B, AB
AB	A, B	None	A, B, AB, O	AB
O	None	A, B, AB	A, B, AB, O	O

BLOOD CLOTTING

Blood clotting is a process by which blood changes from a liquid to a solid state. It is a complex process involving the action of various clotting factors.

STZ23 : Body's Defence

Body's Defence

Ability of the body to fight against disease causing organisms is called **immunity**. **White Blood Cells** or **Leucocytes** are the cells of the immune system defending the body against both infectious diseases and foreign materials.

FUNCTIONS OF LEUCOCYTES

- Phagocytosis: They engulf and destroy pathogens.
- Antibody production: They produce antibodies that bind to and neutralize pathogens.
- Cell-mediated immunity: They directly attack and destroy infected cells.

TYPES OF LEUCOCYTES

Neutrophils: They are the most numerous white blood cells. They are involved in the inflammatory response.

Lymphocytes: They are involved in the adaptive immune response. They produce antibodies and kill infected cells.

Monocytes: They differentiate into macrophages and dendritic cells. They are involved in phagocytosis and antigen presentation.

Eosinophils: They are involved in the defense against parasitic infections and allergic reactions.

Basophils: They release histamine and other inflammatory mediators. They are involved in allergic reactions.

VACCINATION

Vaccination is the administration of antigenic material (the vaccine) to produce immunity to a disease. Vaccines can prevent from the effects of infection by a pathogen.

STRUCTURE OF AN ANTIBODY MOLECULE

Antibodies are Y-shaped proteins that bind to antigens. They are composed of two heavy chains and two light chains.

BODY'S IMMUNE MECHANISM (ACQUIRED IMMUNITY)

The immune system recognizes and destroys pathogens. It involves the activation of T cells and B cells.

STZ24 : Harmful Insects

Harmful Insects

Locust
Locusts are destructive crop pests. They cause major agricultural damage.

Bedbug
They cause skin rashes, allergies & psychological effects.

Flea
They cause skin itching, dermatitis, and transmit various diseases like typhus, plague, and bubonic plague.

Termite
They cause great damage to agricultural products, buildings and wooden structures.

Rice Weevil
They cause damage to harvested and stored grains. They lay eggs in the heads of the grains.

Silverfish
They cause damage to fish, ornamentals, sugary foodstuffs, carpets, clothes, bookshelves etc.

Sandfly
They are vectors of Leishmaniasis. Also causes other diseases.

Female Aedes Mosquito
They transmit dengue and yellow fever.

Housefly
They are vectors of various diseases like typhoid, cholera, dysentery, salmonellosis etc.



STZ33 : Cockroach - II (Blood Circulation, Respiratory & Nervous System)

Cockroach-II (Blood Circulation, Respiratory & Nervous System)

Circulatory System of Cockroach

- Heart: 13-segmented, dorsal, with 13 pairs of lateral hearts.
- Open circulatory system with haemolymph.
- Anterior and posterior blood reservoirs.

Working of the Valves

- Anterior valves: Allow blood to flow forward into the heart.
- Posterior valves: Allow blood to flow backward into the heart.

Respiratory System of Cockroach

- Tracheal system: A network of branching tubes.
- Tracheal spiracles: Openings on the body wall for gas exchange.
- Septal trachea: Connects the main tracheal tubes.

Autonomic or Sympathetic Nervous System

- Central nervous system: Brain and ventral nerve cord.
- Peripheral nervous system: Nerves extending to various body parts.
- Autonomic ganglia: Control involuntary functions.

Tracheal Spiracle of Cockroach

- Structure: Consists of a valve and a tube.
- Function: Allows air to enter the tracheal system.

A Central & Peripheral Nervous System

- Brain: Located at the anterior end.
- Ventral nerve cord: Runs along the bottom of the body.
- Autonomic ganglia: Paired structures on either side of the nerve cord.

STZ34 : Cockroach - III (Digestion, Excretory, Skin & Muscles)

Cockroach-III (Digestion, Excretory, Skin & Muscles)

Digestive System

- Salivary gland: Produces saliva.
- Salivary reservoir: Stores saliva.
- Midgut: Site of digestion.
- Malpighian tubules: Excretory organs.
- Rectum: Final part of the digestive tract.

Excretory System

- Malpighian tubules: Collect waste from the blood.
- Rectum: Excretes waste.

Structure of Integument

- Epidermis: Outermost layer.
- Cuticle: Protective layer.
- Subcuticle: Layer below the cuticle.

Ultrastructure of Epicuticle

- Chitin: Structural polysaccharide.
- Protein: Provides strength.
- Wax: Waterproofing agent.

Muscles

- Longitudinal muscles: Control body movement.
- Circular muscles: Control body shape.

STZ35 : Vertebrate Classes

Vertebrate Classes

Principal classes of vertebrates having living representation are -

CLASS - PISCIFORMES <ul style="list-style-type: none"> Cold blooded vertebrates. They lay eggs in water. They have gills throughout their life. They are aquatic. 	CLASS - MONOTREMATA <ul style="list-style-type: none"> They lay eggs. They have a cloaca. They are mammals.
CLASS - AMPHIBIA <ul style="list-style-type: none"> They have a dual life cycle. They have gills in their larval stage. They have lungs in their adult stage. They are cold blooded. 	CLASS - MAMMALIA <ul style="list-style-type: none"> They are warm blooded. They have a placenta. They have a four chambered heart. They have a diaphragm. They have a brain with a cerebrum. They have a neocortex.
CLASS - REPTILIA <ul style="list-style-type: none"> They are cold blooded. They have a scaly skin. They have a three chambered heart. They have a diaphragm. They have a brain with a cerebrum. They have a neocortex. 	CLASS - AVES <ul style="list-style-type: none"> They are warm blooded. They have a four chambered heart. They have a diaphragm. They have a brain with a cerebrum. They have a neocortex.

STZ36 : Sense Organs

SENSE ORGANS

Human sense organs contain receptors that relay information through sensory neurons to the appropriate places within the nervous system.

Receptors Present in Sense Organs

- EYE - "SIGHT"**: Rods and cones.
- EAR - "SOUND"**: Cochlea and vestibular system.
- TONGUE - "TASTE"**: Taste buds.
- SKIN - "TOUCH"**: Mechanoreceptors and thermoreceptors.
- NOSE - "OLFACTION"**: Olfactory receptors.

STZ37 : General Dissection of Rabbit

General Dissection of Rabbit

Rabbits are mammals in the family Leporidae of the order Lagomorpha. There are eight different genera in the family.

Dissection of a Female Rabbit (a mammal)

- External structures: Ears, eyes, nose, mouth, tail.
- Internal structures: Heart, lungs, stomach, liver, intestines, reproductive system.

STZ38 : Neuron

Neuron

Structure of a Neuron

- Dendrites: Receive signals.
- Cell body: Contains nucleus.
- Axon: Transmits signals.
- Synaptic knob: Connects to another neuron.

The Synapse

- Chemical synapse: Involves neurotransmitters.
- Electrical synapse: Direct contact between cells.

Types of Neurons

- Bipolar Neuron
- Unipolar Neuron
- Multipolar Neuron

STZ39 : Early Development of Frog

Early Development of Frog

1. 2-Cell Stage

2. 4-Cell Stage

3. 8-Cell Stage

4. Late Blastula

5. Early Gastrula in Section

6. Early Gastrula

7. Gastrula in Section

8. Late Gastrula

9. Older Embryo with Neural Groove Closed

10. Older Embryo in Section

STZ40 : Frog's Morphology & Internal Structure

Frog's Morphology & Internal Structure

Dorsal View

Ventral View

Internal Structure of Frog

- Heart: Three-chambered.
- Lungs: Paired.
- Stomach: Large.
- Intestines: Coiled.
- Reproductive organs: Testes and ovaries.

SCIENCE AND TECHNOLOGY
 Charts on Zoology
 Laminated Art, Size 58 x 90 cm (In English only)

STC01 : Atoms and Atomic Structure

Atoms and Atomic Structure

Atoms are the building blocks of matter.

Bohr's Atomic Model suggested that electrons revolve around the nucleus in different energy levels or shells. These shells are represented either by numbers 1, 2, 3, 4, 5 and 6 or by letters K, L, M, N, O and P. The electrons do not lose their energy as long as they keep moving in their energy levels.

The electrons orbiting the nucleus of an atom can absorb energy and move from a normal orbit to a higher one.

Mass number = protons + neutrons. It is represented by A.

Atomic mass is the average of mass number of naturally occurring isotopes of an atom.

In 1912, Max Planck introduced atomic number called as atomic number. It is equal to the number of protons present inside the nucleus of an atom. It is represented by Z.

The mass number and atomic number are shown as superscript and subscript respectively on the left side of the symbol of that element.

23
11 Na

STC02 : Chemical Reactivity of An Element

Chemical Reactivity of An Element

The metals, which can lose electrons more readily to form positive ions are more reactive. The more reactive metals displace the less reactive metal from its salt solution. The less reactive metals do not lose electrons easily. Gold is the most reactive metal. Gold is the least reactive metal.

Relative Reactivity of Metals

K, Potassium
Na, Sodium
Mg, Magnesium
Al, Aluminium
Zn, Zinc
Fe, Iron
Pb, Lead
H, Hydrogen
Cu, Copper
Ag, Silver
Au, Gold

Most reactive
Least reactive

When 10 ml of dilute HCl is added to each piece of magnesium, aluminium, zinc, lead and copper, the rate of bubble formation decreases in the order Mg > Al > Zn > Pb > Cu.

$Zn + CuSO_4 \rightarrow ZnSO_4 + Cu$

When a piece of zinc is placed in copper sulphate solution, reddish brown particles of copper settle at the bottom of the container.

$Mg + 2HCl \rightarrow MgCl_2 + H_2$

$Zn + 2HCl \rightarrow ZnCl_2 + H_2$

No reaction takes place when a piece of copper is placed in the zinc sulphate solution.

$Pb + 2HCl \rightarrow PbCl_2 + H_2$

No reaction takes place. Therefore there is no bubble formation in the case of copper.

STC03 : Chemical Reaction and its Characteristics

Chemical Reaction and its Characteristics

A chemical reaction is a phenomenon of formation of new substances.

$CH_3COOH + NaOH \rightarrow CH_3COONa + H_2O$

1. Evolution of Gas

Carbon reacts with water irregularly to produce hydrogen gas.

$2H_2O + 2Na \rightarrow 2NaOH + H_2$

2. Change of Colour

Colours change due to the formation of new products. When some iron filings are placed in a blue coloured solution of copper sulphate, a green coloured solution of ferrous sulphate is formed along with copper.

$CuSO_4(aq) + Fe(s) \rightarrow Cu(s) + FeSO_4(aq)$

3. Formation of Precipitates

When sodium hydroxide is added to an aqueous solution of ferric chloride, a brown coloured precipitate is formed.

$FeCl_3(aq) + 3NaOH(aq) \rightarrow Fe(OH)_3(s) + 3NaCl(aq)$

4. Change of State

Electrolysis of water gives hydrogen and oxygen gases.

$2H_2O(l) \rightarrow 2H_2(g) + O_2(g)$

5. Release of Heat

Reaction which involves absorption of heat are called endothermic reactions.

$CaCO_3 + H_2O \rightarrow Ca(OH)_2 + Heat$

Reaction which involve absorption of heat are called endothermic reactions.

$CaO + 2H_2O \rightarrow Ca(OH)_2 + Heat$

6. Absorption of Heat

When carbon and sulphur are heated, heat is absorbed in the reaction.

$C + S \rightarrow CS_2$

STC04 : Classification of Chemical Reactions

Classification of Chemical Reactions

Combination Reaction

In a combination reaction two or more substances combine to give a single substance.

$2H_2 + O_2 \rightarrow 2H_2O$

Decomposition Reaction

A compound splits up into two or more substances in a decomposition reaction.

$2H_2O \rightarrow 2H_2 + O_2$

Displacement Reaction

In a displacement reaction, the more reactive element displaces the less reactive element.

$CuSO_4 + Zn \rightarrow ZnSO_4 + Cu$

Double Decomposition Reaction

In a double decomposition reaction, two compounds exchange their ions to give two new compounds.

$AgNO_3 + NaCl \rightarrow AgCl + NaNO_3$

Redox Reaction

In redox reactions, both oxidation and reduction take place at the same time.

Oxidation Reaction

Oxidation involves loss of electrons or an increase in oxidation state.

Reduction Reaction

Reduction involves gain of electrons or a decrease in oxidation state.

Exothermic Reaction

The formation of new bonds from oxygen and hydrogen is an exothermic reaction, as it releases heat.

$2H_2 + O_2 \rightarrow 2H_2O + Heat$

Endothermic Reaction

Decomposition of an element into hydrogen and oxygen is an endothermic reaction, as it absorbs heat.

$2H_2O \rightarrow 2H_2 + O_2 + Heat$

STC05 : Valencies of Elements

Valencies of Elements

Valency → Capacity of a single atom or radical to combine with other atoms or radicals to form a stable molecule. Valency of an element depends on the number of valence electrons.

Hydrogen has 1 valence electron
Carbon has 4 valence electrons
Nitrogen has 5 valence electrons
Oxygen has 6 valence electrons
Aluminium has 3 valence electrons

Z	Element	Sym.	Valency
1	Hydrogen	H	+1, -1
2	Helium	He	0
3	Lithium	Li	+1
4	Beryllium	Be	+2
5	Boron	B	+3, -3
6	Carbon	C	+4, -4
7	Nitrogen	N	+3, -2, -1, +1, +2, -3, -4, -5
8	Oxygen	O	+2, -2
9	Fluorine	F	-1, +1
10	Neon	Ne	0
11	Sodium	Na	+1
12	Magnesium	Mg	+2
13	Aluminium	Al	+3
14	Silicon	Si	+4, -4
15	Phosphorus	P	+3, -3, +5, -5
16	Sulphur	S	+2, -2, +4, -4, +6, -6
17	Chlorine	Cl	+1, -1, +2, +3, +4, +5, +7
18	Argon	Ar	0
19	Potassium	K	+1
20	Calcium	Ca	+2
21	Scandium	Sc	+3
22	Titanium	Ti	+2, +3, +4
23	Vanadium	V	+2, +3, +4, +5
24	Chromium	Cr	+2, +3, +6
25	Manganese	Mn	+2, +3, +4, +6, +7
26	Iron	Fe	+2, +3, +6
27	Cobalt	Co	+2, +3, +4
28	Nickel	Ni	+2, +3, +4
29	Copper	Cu	+1, +2, +3
30	Zinc	Zn	+2
31	Gallium	Ga	+3
32	Germanium	Ge	+2, +4
33	Arsenic	As	+3, +5
34	Selenium	Se	+2, +4, +6
35	Bromine	Br	+1, +3, +4, +5
36	Krypton	Kr	0
37	Rubidium	Rb	+1
38	Strontium	Sr	+2
39	Yttrium	Y	+3
40	Zirconium	Zr	+2, +3, +4
41	Niobium	Nb	+2, +3, +4, +5
42	Molybdenum	Mo	+2, +3, +4, +5, +6
43	Technetium	Tc	+3, +4, +5, +6, +7
44	Ruthenium	Ru	+2, +3, +4, +5, +6, +7, +8
45	Rhodium	Rh	+1, +2, +3, +4, +5, +6, +7, +8
46	Palladium	Pd	+2, +3, +4, +5, +6

Valency Mechanism

The way by which the elements combine with each other to attain a stable electronic configuration.

- By forming ionic bond.
- By forming covalent bond.
- By forming co-ordinate bond.

STC06 : Chemical Bonding

Chemical Bonding

The attractive force which holds various constituents (atoms, ions etc.) together in different chemical species is a chemical bond.

COVALENT BONDING

In covalent bonding, atoms share their electrons with other atoms. When only one electron pair is shared, a single covalent bond is formed. Similarly a double bond or triple bond is formed when two pairs or three pairs of electrons are shared respectively.

IONIC BONDING

When an atom loses or gains electron it becomes electrically charged ion. An ionic bond is formed when ions with opposite charges are held together by electrical attraction and form an ionic lattice. In ionic salt (NaCl), sodium atom loses an electron to form an positive ion, while the chlorine atom gains an electron to form a negative ion.

METALLIC BONDING

Metal atoms have relatively free electrons in their outer shells. In metallic bonding, a lattice is formed where all the metal atoms share their outer electrons to form a sea of delocalised mobile electrons.

HYDROGEN BONDING

In polar covalent molecules involving hydrogen, the slightly positive hydrogen atom of one molecule is held to almost the slightly negative ends of two neighbours. This type of attraction is hydrogen bonding. It is a very weak sort of chemical bond.

STC07 : Combustion

Combustion

Combustion is the process of burning of a substance in the presence of oxygen to liberate energy in the form of heat and light. A substance which helps in burning of combustible substances is known as supporter of combustion. Oxygen is a supporter of combustion while nitrogen is a non-supporter.

Substances which burn in air to produce heat and light are called **Combustible Substances**.

Substances that do not burn easily are called **Non Combustible Substances**.

Combustion of solids yield carbon dioxide, heat and light.

$C + O_2 \rightarrow CO_2 + \text{heat} + \text{light}$

The chemical reaction of combustion of a substance containing carbon is as follows:

$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O + \text{heat} + \text{light}$

When magnesium burns in air, magnesium oxide is produced.

$2Mg + O_2 \rightarrow 2MgO + \text{heat} + \text{light}$

When hydrogen burns in air, water is produced.

$2H_2 + O_2 \rightarrow 2H_2O + \text{heat} + \text{light}$

Ignition Temperature

A combustible substance starts burning only when it is heated to a certain minimum temperature called the ignition temperature. Three requirements for ignition to take place are:

- A combustible substance.
- A supporter of combustion such as oxygen.
- Heat to raise the temperature of the combustible substance to the ignition temperature.

Types of Combustion

- 1. Rapid Combustion**
Combustion in which a large amount of heat and light are produced for a short time is called rapid combustion.
- 2. Slow Combustion**
Combustion at a low rate and over a long period of time is called slow combustion.
- 3. Explosion**
Combustion, in which a very large amount of heat and light are released in the form of heat, light and sound in a very short period of time is called explosion.
- 4. Complete Combustion**
Combustion in the presence of sufficient oxygen to burn the highest value of the substance is called complete combustion. e.g. Burning of carbon in pure oxygen.
 $C + O_2 \rightarrow CO_2$
- 5. Incomplete Combustion**
Combustion in the presence of insufficient supply of oxygen is called incomplete combustion. e.g. Incomplete combustion of carbon produces carbon monoxide.
 $2C + O_2 \rightarrow 2CO$

STC08 : Separation of Substances

Separation of Substances

Separation of substances is required to get a pure and clean substance for our use. Substances can be purified through various means. Some of them have been discussed below:

Distillation

Distillation is used to separate pure liquid from a mixture by heating the mixture.

Fractional Distillation

The mixture of liquids having different boiling points are separated by this method of fractional distillation.

Loading

The process of sedimentation is enhanced by the process of loading.

Filtration

To use the process of filtration while making tea, coffee, etc. a filter paper is used to filter the tea, coffee, etc.

Evaporation and Crystallisation

Evaporation and crystallisation is used to obtain solids from their solutions.

Churning

In the process of churning, a butter is used to separate cream from milk and curd.

Magnetic Separation

Magnetic separation is used to separate iron filings from a mixture.

Sedimentation and Decantation

Analysis of sand and water is separated by the process of sedimentation and decantation.

Centrifugation

When a liquid containing insoluble material is heated, the insoluble material settles at the bottom. This is done due to their property of settling down on being heated.

Sieving

Sieving is used to separate components of different sizes. A sieve can be used to separate small particles from a mixture.

Winnowing

Winnowing is used when one of the components is heavier than the other.

Sublimation

We can separate the mixture of iodine and common salt by the process of sublimation. Iodine sublimates directly from solid into vapour on heating.

Separating Funnel

The immiscible liquids are separated using a separating funnel.

STC09 : Atmosphere and Composition of Air

Atmosphere and Composition of Air

The atmosphere is a thick layer of gaseous matter that surrounds Earth. It has been divided into five major layers.

- TROPOSPHERE:** It extends up to 10 km from the surface of Earth. It contains 75% of the air. The temperature decreases as we go up. It is the layer where most weather phenomena occur.
- STRATOSPHERE:** It extends from 10 km to 50 km. The temperature increases with height. It is the layer where commercial aircraft fly.
- MESOSPHERE:** It extends from 50 km to 85 km. The temperature decreases with height. It is the layer where meteors burn up.
- IONOSPHERE:** It extends from 85 km to 1000 km. It contains ionized particles and is responsible for the reflection of radio waves.
- EXOSPHERE:** It extends from 1000 km to outer space. It contains a few atoms and molecules.

Composition of Air

All materials need only oxygen and nitrogen but also a variety of other gases such as carbon dioxide, water vapour, ozone, and noble gases. In addition to these are smaller quantities of dust particles, smoke particles, bacteria, microorganisms, ultraviolet radiation, and cosmic rays.

Major Gases: Nitrogen (78.1%), Oxygen (20.9%), Argon (0.93%), Carbon Dioxide (0.04%).

Other Gases: Water vapour, Ozone, Methane, Nitrous oxide, Hydrogen, Helium, Neon, Krypton, Xenon.

Carbon Dioxide

It is a colorless, odorless gas. It is essential for photosynthesis in plants. It is also a greenhouse gas.

Noble Gases

These are chemically inert gases. They include Helium, Neon, Argon, Krypton, Xenon, and Radon.

Water Vapour

It is present in the atmosphere in varying amounts. It is responsible for the formation of clouds and rain.

STC10 : Occurrence and Forms of Carbon

Occurrence and Forms of Carbon

Occurrence of Carbon

In Free State: It is found in nature as diamond, graphite, and coal.

In Fossil Fuels: It is found in coal, petroleum, and natural gas.

In Combined Form: It is found in carbonates, such as limestone, marble, and chalk.

In Living Forms: It is found in carbohydrates, natural polymers, etc.

Different Forms of Carbon

CRYSTALLINE AND AMORPHOUS FORMS OF CARBON

CRYSTALLINE FORM: DIAMOND, GRAPHITE, FULLERENE, CHIRAL, LAMP GLASS, COKE, GAS CHARCOAL.

AMORPHOUS FORM: WOOD CHARCOAL, BIRD CHARCOAL, SUGAR CHARCOAL.

Properties of Carbon:

- It is a non-metal.
- It is a poor conductor of electricity.
- It is very hard.
- It is stable at high temperatures.

STC11 : Carbon Dioxide and Carbon Monoxide

Carbon Dioxide and Carbon Monoxide

CARBON DIOXIDE (CO₂)

Preparation: Heating of calcium carbonate with dilute hydrochloric acid.

$$\text{CaCO}_3 + 2\text{HCl} \rightarrow \text{CaCl}_2 + \text{H}_2\text{O} + \text{CO}_2$$

Properties of CO₂:

- Colorless and odorless gas.
- Slightly soluble in water.
- Turns limewater milky.
- Acid rain forming gas carbonic acid and bicarbonates.

Uses of CO₂:

- Carbonated soft drinks.
- Fire extinguishers.
- Greenhouse gas.
- Refrigerant.

CARBON MONOXIDE (CO)

Preparation: Heating of carbon with concentrated sulfuric acid.

$$\text{C} + 2\text{H}_2\text{SO}_4 \rightarrow \text{CO}_2 + 2\text{SO}_2 + 2\text{H}_2\text{O}$$

Properties of CO:

- Colorless and odorless gas.
- Highly soluble in water.
- Turns blue nickel sulfate solution black.
- Acid rain forming gas carbonic acid and bicarbonates.

Uses of CO:

- Reduction of metal ores.
- Welding.
- As a fuel.

STC12 : Carbonates and Bicarbonates

Carbonates and Bicarbonates are the salts of carbonic acid.

CARBONATES

Sodium Carbonate (Na₂CO₃): Used in glass, paper, and soap industries.

Calcium Carbonate (CaCO₃): Found in limestone, marble, and chalk.

BICARBONATES

Sodium Bicarbonate (NaHCO₃): Used in baking powder, soda water, and fire extinguishers.

Carbon Dioxide: Formed as a byproduct in the manufacture of sodium carbonate and bicarbonate.

STC13 : Sulphur

Sulphur

Extraction of Sulphur (Frasch Process)

Sulphur is mined from underground deposits using super-heated water and compressed air in the Frasch process.

Structure of Sulphur Molecule

Sulphur exists as S₈ rings and S₂ molecules.

Rhombohedral Sulphur

It is the most stable form of sulphur at room temperature.

Monoclinic Sulphur

It is formed when rhombohedral sulphur is heated above 95.5°C.

Effect of Heat on Sulphur

On heating, sulphur changes from a yellow solid to a red liquid and finally to a colorless gas.

Vulcanisation of Rubber

It is the process of heating natural rubber with sulphur to form cross-links between polymer chains, making it stronger and more elastic.

STC14 : Mole Concept

Mole Concept

The word 'mole' is derived from the Latin word 'moles', which means pile, heap or mass.

Every mole of any element has the same number of atoms in it.

One mole is the amount of a substance that contains as many particles or entities as there are atoms in exactly 12 gm (or 0.012 kg) of the ¹²C isotope.

AVOGADRO NUMBER: Knowing that 1 mole of carbon weighs 12g, the number of atoms in it is equal to 6.022×10^{23} .

This number is known as Avogadro Constant and is denoted by **N**.

ELEMENT	ATOMIC MASS [amu]	1 MOLE = 1 GRAM ATOM (approx. 6.02×10^{23} atoms)
Al	27.0	27.0 g
C	12.0	12.0 g
O	16.0	16.0 g
S	32.0	32.0 g
H	1.008	1.008 g

AVOGADRO'S HYPOTHESIS: Equal volumes of all gases, under the same conditions of temperature and pressure, contain the same number of molecules.

CHARGE ON AN ELECTRON: $e = 1.6 \times 10^{-19}$ coulombs.

MOLE CONCEPT: A mole of electrons is 6.02×10^{23} electrons and is called the Faraday (F). In electrical units one Faraday is equal to 96,500 coulombs of charge.

STC15 : Composition of Water by Weight

Composition of Water by Weight

Method used by Berzelius, Davy and Dumas to find Composition of Water by Weight:

They found that the combining ratio by weight of hydrogen to oxygen is 1:8.

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STC16 : Different Kinds of Cells

Different Kinds of Cells

Galvanic Cell: Converts chemical energy into electrical energy.

Dry Cell: A common type of primary cell used in flashlights.

Car Battery: A secondary cell used in automobiles.

Rechargeable Cell: Can be used repeatedly by recharging.

Sodium Sulphur Battery: A high-temperature battery.

Solar Cell: Converts solar energy into electrical energy.

Fuel Cell: Converts chemical energy from a fuel and an oxidant into electricity.

Mercury-Zinc Button Cell: A small, long-lasting primary cell.

STC17 : Electroplating and Corrosion

Electroplating and Corrosion

Electroplating is the coating of an electrically conductive object with a layer of metal using electrical current. The result is a thin, smooth, even coat of metal on the object. The layer of deposited metal is usually from 5×10^{-4} cm to 1×10^{-2} cm thick.

Basic rules for electroplating an object with metal M:

- The object must be made the cathode.
- The electrolyte must be a solution of a salt of metal M.
- The anode is made of a strip of metal M.

Gold Plating Cell

Silver Electroplating

EXAMPLES OF CORROSION

The breaking down of essential properties in a material due to chemical reactions with its surroundings is called Corrosion.

- Rusting of Iron
- Silver articles become black when exposed to air
- Green coating on copper vessels

Mechanism of Rusting

Factors Involved in Rusting

STC18 : Cement and Concrete

Cement and Concrete

Preparing Portland Cement

The limestone provides calcium oxide and Clay provides silica, alumina and ferric oxide) are powdered, mixed with water and carbonated. Heat this material is heated in a large rotary kiln at 2500°F. The clinker so formed is then cooled and ground to a fine powder in a ball mill. Gypsum (CaSO₄·2H₂O) is added during the grinding process to delay setting time of cement. Finally the powdered cement is packed in waterproof bags.

Composition of Cement

CaO	60 - 70%
SiO ₂	20 - 25%
Al ₂ O ₃	5 - 10%
Fe ₂ O ₃	2 - 5%

Concrete

Concrete is a hardened building material created by combining sand, gravel, cement, chemical additives and water.

Connecting Concrete With Water

When water is mixed into cement, hydration occurs. The hydrated cement surrounds the aggregate particles and hardens to provide maximum strength.

Structure of Concrete

Types of Reinforced Concrete Foundations

- Reinforced Concrete Pillars
- Reinforced Concrete Slabs
- Reinforced Concrete Beams
- Reinforced Concrete Columns

Applications of Cement & Concrete

- Reinforced Concrete Pipes
- Concrete Road
- Masonry Wall
- Bridge

STC19 : Manufacture of Glass

Manufacture of Glass

Manufacturing of Standard Soda-Lime-Silica Glass

Raw ingredients are fed into the furnace. The temperature around 1400°C melts the raw materials which then combine to form molten glass. The molten glass is made to float on a stream of moving water. The water is kept in a shape to create the atmosphere to prevent the formation of crystal spots. The glass is cooled forward by rollers which take it through different temperatures zones until cooling is completed.

Glass Routing

A job is dropped into the mould. Compressed air forces the glass into the shape of the mould. The heated glass bottle is cooled slowly so that it does not break.

Raw Materials

Sand	72.6%
Soda Ash	13.0%
Limestone	3.4%
Dolomite	4.8%
Alumina	2.8%

Coloured Glass

- Cobalt Glass
- Chromic Glass
- Olive Green
- Red Glass

Lead Crystal Glass

Laminated Glass

Photochromatic Glass

STC20 : Alkanes

Alkanes

ALKANES are the chemical compounds that consist only of the elements carbon (C) and hydrogen (H). They are also called saturated hydrocarbons because the carbon atoms in them are linked by single bonds.

General Formula : C_nH_{2n+2}

Methane Molecule

Methane is the simplest alkane. It has a tetrahedral structure with all H-C-H bond angles of 109.5°.

NOMENCLATURE

Names of alkane series of hydrocarbons end in 'ane'. The prefix tells the number of carbon atoms in the chain.

Details of Early Members of Alkane Series

Name	Molecular Formula	No. of Carbon Atoms	Boiling Point (°C)	Physical State at Room Temp.
Methane	CH ₄	1	-164	gas
Ethane	C ₂ H ₆	2	-87	gas
Propane	C ₃ H ₈	3	-42	gas
Butane	C ₄ H ₁₀	4	0	gas
Pentane	C ₅ H ₁₂	5	+30	liquid

Applications of Alkanes

- Petroleum Refinery
- Petrol Pump
- Vehicle Run on Petrol
- LPG
- CNG-Station
- Cooking Gas
- CNG Bus

STC21 : Alkenes

Alkenes

Alkenes are unsaturated hydrocarbons containing at least one double bond. They are also known as olefins (oil forming).

General Formula : C_nH_{2n} (n ≥ 2)

Functional group : C=C

Ethene is the simplest alkene commonly known as ethylene.

Structure and IUPAC Name of Few Members

Molecular Formula	Structure	IUPAC Name
C ₂ H ₄	CH ₂ =CH ₂	Ethene
C ₃ H ₆	CH ₂ =CH-CH ₃	Propene
C ₄ H ₈	CH ₂ =CH-CH ₂ -CH ₃	But-1-ene
C ₄ H ₈	CH ₃ -CH=CH-CH ₃	But-2-ene
C ₅ H ₁₀	CH ₂ =CH-CH=CH-CH ₃	Penta-1,3-diene
C ₅ H ₁₀	CH ₂ =C(CH ₃)-CH ₂ -CH ₃	2-Methylprop-1-ene

Preparation

- From partial reduction of alkynes
- Acidic dehydration of alcohols
- Dehydrohalogenation
- Dehalogenation of vicinal dihalides

Application of Alkenes

- Use-1: PVC insulation tapes
- Use-2: Squash bottles, Water bottles
- Use-3: Egg cartons, disposable plastic glass
- Use-4: Dustbin
- Use-5: Buckets

STC22 : Alkynes

Alkynes

Alkynes are unsaturated hydrocarbons containing at least one triple bond.

Functional Group : C≡C

General Formula : C_nH_{2n-2}

3-D Structure of Simplest Alkyne Ethyne (Acetylene)

NOMENCLATURE: In common system, alkynes are named as derivatives of acetylene. In IUPAC system they are named as derivatives of corresponding alkanes replacing 'ane' by suffix 'yne'. The position of the triple bond is indicated by the first triple bonded carbon.

Common & IUPAC Names of Few Members

Value of n	Mol. Formula	Structure	Common Name	IUPAC Name
2	C ₂ H ₂	H-C≡C-H	Acetylene	Ethyne
3	C ₃ H ₄	CH ₃ -C≡C-H	Methylacetylene	Propyne
4	C ₄ H ₆	CH ₃ -CH ₂ -C≡C-H	Ethylacetylene	But-1-yne

Preparation

- From Calcium Carbide
- From Vicinal Dihalides

Use-1: Alkynes are used as a starting material for drugs and dyes.

Use-2: Acetylene is used in welding of steel and metal.

Use-3: Used as starting material for manufacturing large number of organic compounds such as chloroacetylene, vinyl chloride and acrylic polymers.

Applications of Alkynes

- In Alcoholic Beverages
- In Gough Syrups
- In Digestive Syrups
- In Antiseptic Lotions

STC23 : Alcohols

Alcohols

Alcohols are organic compounds in which a hydroxyl group (-OH) is bound to a carbon atom of an alkyl or substituted alkyl group.

General Formula : C_nH_{2n+2}O

Nomenclature: Alcohols are named by substituting 'ol' of alkane with the suffix 'ol'. Position of substituents is indicated by numerals.

Common and IUPAC Names of Some Alcohols

Formula	Common Name	IUPAC Name
CH ₃ -OH	Methyl alcohol	Methanol
CH ₃ -CH ₂ -CH ₂ -OH	n-Propyl alcohol	Propan-1-ol
CH ₃ -CH(OH)-CH ₃	Isopropyl alcohol	Propan-2-ol
CH ₃ -CH ₂ -CH ₂ -CH ₂ -OH	n-Butyl alcohol	Butan-1-ol
CH ₃ -CH ₂ -CH(OH)-CH ₃	tert-Butyl alcohol	2-Methylpropan-2-ol

PREPARATION

- From Alkenes
- Reduction of Aldehydes and Ketones
- Reduction of Carboxylic Acids

USES OF ALCOHOL (ETHANOL)

- In Alcoholic Beverages
- In Gough Syrups
- In Digestive Syrups
- In Antiseptic Lotions

STC24 : Esters

Esters

Esters are sweet smelling chemical compounds derived from an alcohol (one containing an -OH group) and a hydroxyl compound such as an alcohol or phenol. Most common esters used to derive esters are carboxylic acids (R-COOH).

GENERAL FORMULA

$$R-C(=O)-OR'$$

(R and R' are any alkyl or aryl group)

NOMENCLATURE

- Name the alkyl from the alcohol - O-
- Name the acid with the C=O with -ate

SOME COMMON ESTERS

NAME	FORMULA	USES
Ethyl methanoate	HCOOC ₂ H ₅	Flavouring
Methyl propylacetate	CH ₃ COOC ₂ H ₅	Perfume
Ethyl butanoate	CH ₃ CH ₂ COOC ₂ H ₅	Perfume
Methyl propanoate	CH ₃ CH ₂ COOCH ₃	Flavouring
Diethyl carbonate	CH ₃ COOC ₂ H ₅	Perfume

PREPARATION

Fischer Esterification: Carboxylic acids react with alcohols in presence of a few drops of concentrated sulphuric acid to produce esters. For example:

$$CH_3COOH + C_2H_5OH \xrightarrow{H_2SO_4} CH_3COOC_2H_5 + H_2O$$

Applications of Esters

- Esters are used for making perfumes.
- Esters react with sodium hydroxide to form soaps (saponification).
- Phenylacetate (a transparent plastic) is a long chain ester.
- Esters give flowers and fruits their pleasant fragrances and flavours.
- Diacetin, a long chain ester is used for making fabrics.

STC25 : Organic Acids

Organic Acids

Organic acids are organic compounds with acidic properties. Most common organic acids are carboxylic acids having COOH group.

NOMENCLATURE

(i) Common names end with -oic and have been derived from Latin or Greek names of their natural sources. Example: Formic acid, Lactic acid, Acetic acid, Citric acid, Oxalic acid.

(ii) In IUPAC system aliphatic carboxylic acids are named by replacing the ending -e in the name of the corresponding alkane with -oic acid .

NAMES AND STRUCTURE OF SOME CARBOXYLIC ACIDS

Structure	Molecular Formula	Common Name	IUPAC Name
$\text{H}-\text{C}(=\text{O})-\text{OH}$	HCOOH	Formic Acid	Methanoic Acid
$\text{H}-\text{C}(=\text{O})-\text{CH}_2-\text{OH}$	HCOOH	Acetic Acid	Ethanoic Acid
$\text{H}-\text{C}(=\text{O})-\text{CH}_2-\text{CH}_2-\text{OH}$	$\text{C}_2\text{H}_4\text{O}_2$	Propionic Acid	Propanoic Acid
$\text{H}-\text{C}(=\text{O})-\text{CH}_2-\text{CH}_2-\text{CH}_2-\text{OH}$	$\text{C}_3\text{H}_6\text{O}_2$	Butanoic Acid	Butanoic Acid

STRUCTURE OF CARBOXYL GROUP

$\text{H}-\text{C}(=\text{O})-\text{OH} \leftrightarrow \text{H}-\text{C}(\text{O}^-)=\text{OH}^+$

Applications of Organic Acids

- Acetic acid is used in vinegar.
- Formic acid is used in leather industry.
- Benzoic acid is used in perfumes.
- Aspirin is made from salicylic acid.
- Carbonic acid is used in soft drinks.

STC26 : Soaps and Detergents

Soaps and Detergents

SOAPS

Soaps are sodium or potassium salts of long chain fatty acids, e.g. stearic, oleic and palmitic acids. Soaps containing sodium salt are formed by heating fat with an aqueous sodium hydroxide solution. This process is called saponification.

$$\text{CH}_3(\text{CH}_2)_{17}\text{COOH} + \text{NaOH} \rightarrow \text{CH}_3(\text{CH}_2)_{17}\text{COONa} + \text{H}_2\text{O}$$

DETERGENTS

Detergents are synthetic soaps. They are sodium or potassium salts of synthetic detergents. They are formed by the reaction of synthetic detergents with sodium hydroxide or potassium hydroxide.

CLEANSING ACTION

Soaps and detergents clean by forming micelles. The hydrophobic tails of soap molecules surround the dirt particles, while the hydrophilic heads face outwards, allowing them to be washed away by water.

PROBLEM WITH HARD WATER

Hard water contains calcium and magnesium ions. These ions react with the soap to form insoluble scum, which does not lather. Synthetic detergents do not form scum with hard water.

STC27 : Plastics

Plastics

Thermoplastics

Arrangement of molecular units is linear or slightly branched.

PVC (Polyvinyl chloride)

Prepared by polymerization of vinyl chloride.

Polythene

Prepared by polymerization of ethene.

Thermosetting plastics

Arrangement of molecular units is cross-linked or heavily branched.

Bakelite

Prepared by the reaction of phenol and formaldehyde.

Melamine

Prepared by the reaction of melamine and formaldehyde.

STC28 : Synthetic Fibres

Synthetic Fibres

Synthetic fibre is a chain of molecules known as monomers which form polymers.

Characteristics

1. Dry up quickly
2. Durable
3. Less expensive
4. Easy to maintain

Nylon

Strong, elastic, light, lustrous and easy to wash.

Prepared by condensation polymerization of hexamethylenediamine and adipic acid under high pressure & temperature.

Rayon

Obtained by chemical treatment of wood pulp. Similar to that of silk (also called artificial silk).

When mixed with cotton, it is used to make bed sheets.

When mixed with wool, it is used to make carpets.

Polyester

Example: Terylene

Prepared by heating a mixture of ethylene glycol and terephthalic acid at 420-480 K in presence of zinc oxide-antimony trioxide catalyst.

Acrylic

Resembles natural wool.

Example: Polyacrylonitrile

Prepared by addition polymerization of acrylonitrile in presence of peroxide catalyst.

STC29 : Blast Furnace (Extraction of Iron)

BLAST FURNACE (EXTRACTION OF IRON)

The main ore of iron is haematite (Fe_2O_3). The iron is obtained by reduction in blast furnace. The furnace is loaded with the charge consisting of iron ore, coke and limestone. The charge is stirred to make sure the acids mix well. Blasts of hot air are sent in through holes near the bottom of the furnace.

Following are the significant reactions occurring within the blast furnace:

$$\text{Fe}_2\text{O}_3 + 3\text{CO} \rightarrow 2\text{Fe} + 3\text{CO}_2$$

$$\text{FeO} + \text{CO} \rightarrow \text{Fe} + \text{CO}_2$$

$$\text{Fe}_2\text{O}_3 + 3\text{C} \rightarrow 2\text{Fe} + 3\text{CO}$$

$$\text{FeO} + \text{C} \rightarrow \text{Fe} + \text{CO}$$

$$\text{Fe}_2\text{O}_3 + 3\text{H}_2 \rightarrow 2\text{Fe} + 3\text{H}_2\text{O}$$

$$\text{FeO} + \text{H}_2 \rightarrow \text{Fe} + \text{H}_2\text{O}$$

$$\text{Fe}_2\text{O}_3 + 3\text{Al} \rightarrow 2\text{Fe} + \text{Al}_2\text{O}_3$$

$$\text{FeO} + \text{Al} \rightarrow \text{Fe} + \text{Al}_2\text{O}_3$$

MANUFACTURE OF STEEL

The iron produced by the blast furnace is known as pig iron. Most of the pig iron produced is used to make steel.

BASIC OXYGEN PROCESS

Impure iron is melted in a converter. The converter is tilted and the molten iron is poured into a ladle. The ladle is tilted and the molten iron is poured into a steel-making furnace.

ELECTRIC ARC PROCESS

An alternative process, known as the Electric Arc Furnace, is used to make steel from scrap metal. Currently about 25% of the world's steel is produced by this method.

STC30 : Aluminium Metallurgy

Aluminium Metallurgy

Aluminium extraction is done in two phases: Bayer's process of refining bauxite ore to obtain alumina & Hall-Heroult process of smelting the alumina to get pure aluminium.

BAYER'S PROCESS

- 1. CRUSHING**: Bauxite ore is mechanically crushed.
- 2. DIGESTION**: Crushed bauxite is digested with sodium hydroxide solution to form sodium aluminate and insoluble impurities.
- 3. FILTRATION**: The insoluble impurities are filtered out.
- 4. PRECIPITATION**: The filtrate is treated with carbon dioxide to precipitate aluminium hydroxide.
- 5. WASHING**: The precipitate is washed with water to remove sodium ions.
- 6. DRYING**: The washed precipitate is dried to form alumina.

HALL-HEROULT PROCESS

Alumina is dissolved in molten cryolite. The solution is electrolysed in a cell. Pure aluminium is deposited at the cathode.

Uses of Aluminium

- Packaging
- Aircraft Industry
- Construction
- Household

STC31 : Copper Metallurgy

Copper Metallurgy

IMPORTANT ORES OF COPPER

Copper pyrite (CuFeS_2), Chalcocite or copper glance (Cu_2S), Malachite green ($\text{Cu}_2(\text{OH})_2\text{CO}_3$).

CONCENTRATION

The first step in the extraction of copper is concentration. This is done by froth-flotation process.

ROASTING

Sulphur is oxidized to SO_2 and impurities are removed as volatile oxides.

SMELTING

The roasted ore is mixed with silica and silica (used as flux) and is introduced into a blast furnace. The hot air is blown and FeO is converted into molten slag.

REFINING OF COPPER

Copper metal is purified from molten waste through electrolysis. The waste is introduced into anode. The anode is dissolved through the molten waste. Most of the impurities are left behind in the anode sludge.

ELECTROLYSIS OF COPPER

Copper metal is purified from molten waste through electrolysis. The waste is introduced into anode. The anode is dissolved through the molten waste. Most of the impurities are left behind in the anode sludge.

Uses of Copper

- Computer Chip
- Medical Wiring
- Copper Tapping & Wiring
- Copper Coins
- Household

STC32 : Extraction of Zinc

Extraction of Zinc

Worldwide, 60% of the zinc is mined from sulphide ore deposits mainly ZnS . After grinding the ore, froth flotation is used to get an ore concentrate. Lead is simultaneously extracted along with zinc.

Zinc is Extracted Using Two Processes

- 1. Roasting**, which involves the preparation of zinc oxide from ore concentrate.
- 2. Pyrometallurgical Process**, which further reduces zinc oxide with carbon or carbon monoxide at 900°C into the metal, which is distilled as zinc vapour. The zinc vapour is collected in a condenser.

Refining of Zinc

Zinc is refined by electrolysis. The impure zinc is used as anode and pure zinc is deposited at the cathode.

STC33 : Preparation of Sodium Hydroxide (NaOH)

Preparation of Sodium Hydroxide (NaOH)

Preparation of NaOH in Castner Kellner Cell

NaOH is commercially prepared by the electrolysis of sodium chloride in Castner Kellner Cell which has mercury as cathode and carbon as anode. A sodium amalgam is formed which is treated with water to give sodium hydroxide and hydrogen gas.

$$2\text{Na-Amalgam} + 2\text{H}_2\text{O} \rightarrow 2\text{NaOH} + 2\text{H}_2 + \text{H}_2$$

At cathode :
 $\text{Na}^+ + e^- \rightarrow \text{Na-amalgam}$

At anode :
 $\text{Cl}^- \rightarrow \frac{1}{2} \text{Cl}_2 + e^-$

Preparation of Sodium Carbonate (Ammonia Soda or Solvay Process)

Solvay process produces soda ash (Na_2CO_3) from brine and limestone. Calcium chloride is its major by product.

Principle Reaction:

- $\text{NH}_3 + \text{H}_2\text{O} + \text{CO}_2 \rightarrow \text{NH}_4\text{HCO}_3$
- $\text{NH}_4\text{HCO}_3 + \text{NaCl} \rightarrow \text{NaHCO}_3 + \text{NH}_4\text{Cl}$
- $\text{NaHCO}_3 + \text{NaCl} \rightarrow \text{Na}_2\text{CO}_3 + \text{H}_2\text{O}$
- $\text{NH}_4\text{Cl} + \text{CaO} \rightarrow \text{NH}_3 + \text{CaCl}_2 + \text{H}_2\text{O}$

STC37 : Preparation of Ammonia & Haber Process

Preparation of Ammonia & Haber Process

Natural Occurrence

Ammonia (NH_3) is produced by the natural decomposition of animal and plant matter in nature. It also occurs in the soil in the form of ammonium salts.

Laboratory Preparation of Ammonia

Ammonia gas is usually prepared in the laboratory by gently heating ammonium chloride (NH_4Cl) and slaked lime [Ca(OH)_2].

$$2\text{NH}_4\text{Cl}(s) + \text{Ca(OH)}_2(s) \xrightarrow{\text{Heat}} \text{CaCl}_2(s) + 2\text{NH}_3(g) + 2\text{H}_2\text{O}(g)$$

Manufacture of Ammonia by Haber Process

STEPS IN THE HABER PROCESS

- Hydrogen is obtained from methane and steam.
- Nitrogen is obtained from air.
- The two gases (N_2 & H_2) are mixed in ratio 1:3.
- Mixture is compressed to about 200 bar and heated to high temperature.
- Mixture is then goes to reactor containing beds of hot iron. The iron catalyses the reaction:
 $\text{N}_2(g) + 3\text{H}_2(g) \rightleftharpoons 2\text{NH}_3(g)$
- Mixture of N_2 , H_2 & NH_3 leaves the converter. It is cooled to condense ammonia. The N_2 and H_2 are pumped back to the converter.
- Ammonia is stored as liquid under pressure.

STC34 : Preparation of Nitrogen & Nitric Acid

Preparation of Nitrogen & Nitric Acid

LABORATORY PREPARATION OF NITROGEN

Nitrogen is prepared by heating a mixture of ammonium chloride and sodium nitrite in the ratio 4:3 by mass with a small quantity of water. The presence of water prevents ammonium chloride from subliming without heated.

$$2\text{NH}_4\text{Cl} + \text{NaNO}_2 \rightarrow \text{N}_2 + 2\text{NaCl} + 2\text{H}_2\text{O}$$

MANUFACTURE OF NITROGEN

Commercially nitrogen is prepared by compression of air, a process known as Cryogenic (low temperature) Distillation.

LABORATORY PREPARATION OF NITRIC ACID

In laboratory nitric acid is prepared by reacting sodium nitrate or potassium nitrate (KNO_3) or sodium nitrite (NaNO_2) with H_2SO_4 sulphuric acid (H_2SO_4) and distilling the mixture. Nitric acid boils at 83°C .

$$\text{HNO}_3 + \text{H}_2\text{SO}_4 \rightarrow \text{H}_2\text{NO}_3 + \text{HSO}_4$$

$$2\text{HNO}_3 \rightarrow \text{N}_2\text{O}_4 + \text{H}_2\text{O}$$

MANUFACTURE OF NITRIC ACID (OSTWALD'S PROCESS)

- Primary Oxidation:** Catalytic oxidation of NH_3 takes place by atmospheric oxygen.
 $4\text{NH}_3 + 5\text{O}_2 \xrightarrow{\text{Pt}} 4\text{NO} + 6\text{H}_2\text{O}$
- Secondary Oxidation:** Purification of nitrogen dioxide. Nitric oxide formed is further transformed to a stable dimer where it coexists with oxygen for N_2O_4 .
 $2\text{NO} + \text{O}_2 \rightleftharpoons 2\text{NO}_2$
- Formation of HNO_3 :** Nitrogen dioxide from secondary oxidation chamber is introduced into a special absorber tower to dissolve water soluble acids.
 $3\text{NO}_2 + \text{H}_2\text{O} \rightarrow 2\text{HNO}_3 + \text{NO}$

STC38 : Preparation of O_2 and Liquefaction of Air

Preparation of O_2 and Liquefaction of Air

Laboratory Preparation of Oxygen

BY HEATING COMPOUNDS CONTAINING OXYGEN

$2\text{KClO}_3 \rightarrow 2\text{KCl} + 3\text{O}_2$

BY ELECTROLYSIS OF WATER

$2\text{H}_2\text{O} \rightarrow 2\text{H}_2 + \text{O}_2$

Manufacture of Oxygen by Liquefaction of Air

The air is distilled into liquid air, which is cooled at the top. Nitrogen (with some hydrogen and neon) is collected at the top. Oxygen (with some argon and neon) is collected at the bottom.

MAJOR STEPS IN THE PROCESS

- Air is filtered to remove dust.
- Mixture of CO_2 is removed.
- Air is compressed at about 200 atmospheres.
- Compressed air is cooled & passed into coils contained in a chamber.
- Compressed air is allowed to expand in the chamber, cooling the coils.
- Expanded gas is returned to the compressor with suitable refrigeration and compression steps resulting finally in liquefaction of the compressed air at a temperature of -196°C .
- Liquid air is allowed to warm to distil first the light gases, then the nitrogen, leaving liquid oxygen.
- Multiple fractionations will produce 99.5 percent peroxide-free O_2 .

STC35 : Prep. of Chlorine and Hydrochloric Acid

Prep. of Chlorine and Hydrochloric Acid

Laboratory Preparation of Chlorine

Chlorine is prepared in laboratory by heating manganese dioxide with a mixture of common salt and conc. sulphuric acid.

$$4\text{NaCl} + \text{MnO}_2 + 4\text{H}_2\text{SO}_4 \rightarrow \text{MnCl}_2 + 4\text{NaHSO}_4 + 2\text{H}_2\text{O} + \text{Cl}_2$$

Large Scale Manufacture of Chlorine

Chlorine is mostly obtained as a by product during the manufacture of caustic soda, by the electrolysis of brine or molten sodium chloride.

Preparation of Hydrochloric Acid

Glauber prepared hydrogen chloride in 1545 by heating common salt with sulphuric acid. This also serves as a laboratory method to prepare it.

$$\text{NaCl} + \text{H}_2\text{SO}_4 \rightarrow \text{NaHSO}_4 + \text{HCl}$$

$$\text{NaHSO}_4 + \text{NaCl} \rightarrow \text{Na}_2\text{SO}_4 + \text{HCl}$$

Industrially hydrogen chloride gas is made by burning hydrogen in chlorine.

$$\text{H}_2(g) + \text{Cl}_2(g) \rightarrow 2\text{HCl}(g)$$

Hydrogen chloride gas so formed is dissolved in water to form hydrochloric acid.

To dissolve the Hydrogen Chloride gas safely in water a filter funnel is placed in water instead of delivery tube.

Discharging Hydrogen Chloride Gas in Water

Water getting saturated (pH 1)

Water getting saturated (pH 1)

STC39 : Preparation of H_2 and CO_2

Preparation of H_2 and CO_2

HYDROGEN

Laboratory Preparation

Laboratory preparation involves reaction

$$\text{Metal} + \text{Acid} \rightarrow \text{Salt} + \text{Hydrogen}$$

$$\text{Zn}(s) + 2\text{HCl}(aq) \rightarrow \text{ZnCl}_2(aq) + \text{H}_2(g)$$

Commercial Manufacture

Steam Re-forming of Natural Gas

Methane in natural gas is reacted with steam in a reversible reaction to produce hydrogen.

$$\text{CH}_4(g) + \text{H}_2\text{O}(g) \rightleftharpoons \text{CO}(g) + 3\text{H}_2(g)$$

CO produced is used to reduce unreacted steam to produce more hydrogen.

$$\text{CO}(g) + \text{H}_2\text{O}(g) \rightleftharpoons \text{H}_2(g) + \text{CO}_2(g)$$

CARBON DIOXIDE

Complete combustion of carbon and carbon containing fuels in excess of air produces most of the carbon dioxide.

$$\text{C}(s) + \text{O}_2(g) \rightarrow \text{CO}_2(g)$$

$$\text{CH}_4(g) + 2\text{O}_2(g) \rightarrow \text{CO}_2(g) + 2\text{H}_2\text{O}(g)$$

Laboratory Preparation

In the laboratory it is conveniently prepared by the

$$\text{CaCO}_3(s) + 2\text{HCl}(aq) \rightarrow \text{CaCl}_2(aq) + \text{CO}_2(g) + \text{H}_2\text{O}(l)$$

Commercial Manufacture

CO_2 is produced as a by-product in a lime kiln where limestone (calcium carbonate) is decomposed to produce lime.

$$\text{CaCO}_3(s) \rightarrow \text{CaO}(s) + \text{CO}_2(g)$$

STC36 : Prep. of Sulphur Dioxide & Sulphuric Acid

Prep. of Sulphur Dioxide & Sulphuric Acid

PREP. OF SULPHUR DIOXIDE

IN LABORATORY

SO_2 is readily generated by treating a sulphite with dil. sulphuric acid.

$$\text{SO}_3^{2-}(aq) + 2\text{H}^+(aq) \rightarrow \text{H}_2\text{O}(l) + \text{SO}_2(g)$$

INDUSTRIAL PRODUCTION

Industrially it is produced as a by-product of the roasting of sulphide ores. The gas as produced is dried, separated under pressure and stored in steel cylinders.

$$4\text{FeS}_2(s) + 11\text{O}_2(g) \rightarrow 2\text{Fe}_2\text{O}_3(s) + 8\text{SO}_2(g)$$

USES OF SULPHUR DIOXIDE

- Used to bleach wool, silk and wood pulp.
- Used as a food preservative and disinfectant.
- Used in the manufacture of sulphuric acid.
- Liquid SO_2 is used as a solvent to dissolve chemicals.

THICK FUMING LIQUID CALLED OLEUM ($\text{H}_2\text{S}_2\text{O}_7$)

$$\text{SO}_2(g) + \text{H}_2\text{SO}_4(l) \rightarrow \text{H}_2\text{S}_2\text{O}_7(l)$$

PRODUCTION OF SULPHURIC ACID

STEPS IN THE CONTACT PROCESS

- Burned in air to form SO_2 .
- Blended with more air.
- Passed over four separate beds of catalyst (V_2O_5) at 450°C .
- Absorption of SO_3 in concentrated sulphuric acid to form oleum.
- Blended carefully with water to get pure sulphuric acid.

CONCENTRATED SULPHURIC ACID, H_2SO_4

$$\text{H}_2\text{O}(l) + \text{H}_2\text{S}_2\text{O}_7(l) \rightarrow 2\text{H}_2\text{SO}_4(l)$$

USES OF SULPHURIC ACID

- Manufacture of Fertilizers
- Metallurgical Applications
- Tanning Leather
- Paints and Pigments

STC40 : Manufacture of Bleaching Powder

Manufacture of Bleaching Powder

Bleaching powder is a dirty white amorphous solid with a pungent smell of chlorine.

CHEMICAL COMPOSITION

Bleaching powder is actually a mixture of Calcium Hypochlorite, Calcium Chloride, Water and some Slaked Lime.

$$\text{Ca(OCl)}_2 \cdot \text{CaCl}_2 \cdot \text{Ca(OH)}_2 \cdot 2\text{H}_2\text{O}$$

INDUSTRIAL PRODUCTION

On industrial scale, it is manufactured in Hasenclever Plant or in Bachmann's Plant.

Raw Materials

- Slaked Lime
- Chlorine Gas

Reactions Involved

$$2\text{Ca(OH)}_2 + 2\text{Cl}_2 \rightarrow \text{Ca(OCl)}_2 + \text{CaCl}_2 + 2\text{H}_2\text{O}$$

Manufacture of Bleaching Powder - HASENCLEVER PLANT

The plant consists of a number of horizontal cylinders, provided with rotating shafts with blades. Slaked lime is dropped into the topmost cylinder. The revolving blades allow the downward movement of slaked lime into the other cylinders. Chlorine gas is introduced into the bottommost cylinder. The counter currents allow a thorough contact of the raw materials and complete conversion into bleaching powder.

Manufacture of Bleaching Powder - BACHMANN'S PLANT

Bachmann's plant consists of vertical tower made of cast iron. The tower is provided with a hopper at the top, two fans near the base (one for chlorine and other for hot air) and an inlet for waste gases near the top.

- The tower is fitted with eight shelves at different heights each equipped with rotating rollers.
- The slaked lime is introduced through the hopper.
- Slaked lime comes in contact with chlorine.
- Bleaching powder is collected in a bin at the base.

STC41 : Manufacture of Phosphorus

Manufacture of Phosphorus

Production of White Phosphorus

Phosphate rock is heated to 1200-1500°C with sand and coke to produce vaporized P₄, which is subsequently condensed into a white powder under water.

The main reactions involved are:-

$$\text{Ca}_3(\text{PO}_4)_2 + 3\text{SiO}_2 \xrightarrow{1200-1500^\circ\text{C}} 3\text{CaO} + \text{SiO}_2 + 2\text{P}_4$$

$$3\text{CO} + \text{SiO}_2 \xrightarrow{1200-1500^\circ\text{C}} 3\text{CO}_2 + \text{Si}$$

$$\text{Ca}_3(\text{PO}_4)_2 + \text{SiO}_2 \xrightarrow{1200-1500^\circ\text{C}} 3\text{CaO} + \text{SiO}_2 + 2\text{P}_4$$

Sand acts as a flux, converting CaO formed into slag: $\text{CaO} + \text{SiO}_2 \rightarrow \text{CaSiO}_3$

Phosphorus vapor & CO to condenser from where white phosphorus is distilled by condensing with water.

Converting White Phosphorus into Red Phosphorus

Red phosphorus is formed by heating white phosphorus to 250°C.

STC42 : Crystal Lattices

Crystal Lattices

A regular three dimensional arrangement of points in space at which the atoms, molecules or ions of a crystal occur, is a crystal lattice.

Unit cell is the smallest portion of a crystal lattice which, when repeated in different directions, generates the entire lattice. A unit cell is characterized by:

- Its dimensions along the three edges, a, b and c. These edges may or may not be mutually perpendicular.
- Angles between the edges, α (between b and c), β (between a and c) and γ (between a and b). Thus, a unit cell is characterized by six parameters, a, b, c, α, β and γ.

A portion of a three dimensional cubic lattice and its unit cell.

Characteristics of a unit cell.

Crystal System	Primitive Unit Cells	Packing	Void Ratio	Examples
Cubic	Simple Cubic (SC), Face-Centered Cubic (FCC), Body-Centered Cubic (BCC)	Simple Cubic, Face-Centered, Body-Centered	50%, 74%, 68%	NaCl, Zinc blende, White tin, Si, Ge, CdCl ₂
Tetragonal	Simple Tetragonal, Body-Centered Tetragonal	Simple Tetragonal, Body-Centered Tetragonal	52%, 68%	Fluorite, CaF ₂ , Ti, Sn
Orthorhombic	Simple Orthorhombic, Body-Centered Orthorhombic, Face-Centered Orthorhombic	Simple Orthorhombic, Body-Centered Orthorhombic, Face-Centered Orthorhombic	48%, 52%, 68%	Monoclinic sulphur, KNO ₃ , BaSO ₄
Hexagonal	Simple Hexagonal, Body-Centered Hexagonal	Simple Hexagonal, Body-Centered Hexagonal	52%, 68%	Graphite, ZnS, CaF ₂
Trigonal	Simple Trigonal, Body-Centered Trigonal	Simple Trigonal, Body-Centered Trigonal	52%, 68%	Calcite, Silicic acid
Monoclinic	Simple Monoclinic, Base-Centered Monoclinic	Simple Monoclinic, Base-Centered Monoclinic	52%, 68%	Monoclinic sulphur, Na ₂ SO ₄ , H ₂ O
Triclinic	Simple Triclinic	Simple Triclinic	52%, 68%	K ₂ Cr ₂ O ₇ , CaSO ₄ , H ₂ O, H ₂ SO ₄

STC43 : Close Packed Structures

Close Packed Structures

Close packing of particles leave minimum vacant space in solids.

Close Packing in Two Dimensions

Square Close Packing (AAA)
Coordination number is 4.

Hexagonal Close Packing (ABAB)
Coordination number is 6.

Close Packing in Three Dimensions

Three dimensional close packing from two dimensional square close packed layers.

Three dimensional close packing from two dimensional hexagonal close packed layers.

Tetrahedral & Octahedral voids are generated in a stack of two layers of close packed spheres.

Tetrahedral Voids

Top view, Exploded side view, Tetrahedron (geometrical shape).

Octahedral Voids

Top view, Exploded side view, Octahedron (geometrical shape).

Covering Tetrahedral Voids Hexagonal Close Packed Structures

Stacked view showing stacking of layers of spheres, Geometry of layer, 4 layers stacked in ABCA.

Covering Octahedral Voids Cubic Close Packed Structures

Stacked view showing stacking of layers of spheres, Geometry of face, 4 layers stacked in ABCA.

STC44 : Sodium Chloride Crystal

Sodium Chloride Crystal

Formation of sodium chloride involves transfer of electron from chlorine atom to sodium atom. Chloride anions and Sodium cations thus formed are arranged in a regular lattice occupying all the octahedral holes. Each ion is surrounded by six ions of the other kind. This arrangement is known as cubic close packed (ccp).

Crystal Structure: Pushing one layer against another in an ionic crystal brings ions of the same charge next to each other. The repulsive force forces the layers apart.

FCC Arrangement: Each face-centered lattice point gives equally one-half contribution, in addition to the corner lattice points, giving a total of 4 atoms per unit cell (8x1/8 + 6x1/2 = 4).

NaCl Statistics	
Formula	NaCl
Crystal System	Cubic
Lattice Type	Face-Centered
Space Group	Fm3m, No. 225
Cell Parameters	a = b = c = 0.357 nm, z = 4
Atomic Positions	Cl: 1, 1/2, 1/2, 3/2, 3/2, 3/2, 3/2, 3/2, 3/2, 3/2, 3/2, 3/2, 3/2, 3/2, 3/2, 3/2
Density	2.165 g/cm ³
Melting Point	801°C
Alloying Elements	Alloys: none known, see table below.
Interstitial Compounds	H ₂ , N ₂ , O ₂ , CO, Fe, Pt, Si, Sn, Ag, Au, Cu, Ni, Zn

Ball Crystals and Dissociation: In water solution and chlorine ions dissociate from the crystal. The +ve sides of the polar water molecules are attracted to the -ve chloride ions and the -ve sides are attracted to the +ve sodium ions. This breaks up the lattice.

STC45 : Acids, Bases and Salts

Acids, Bases and Salts

ACIDS

Acids are the substances that are sour in taste, change blue litmus to red and give H⁺ (hydrogen ion) when dissolved in water. Acids have a pH less than 7.

Acids are soluble in water. Acids are corrosive. Acids are sour in taste. Acids change blue litmus to red. Acids give H⁺ ions when dissolved in water. Acids have a pH less than 7.

BASES

Bases are substances that are bitter to taste, soapy to touch, change red litmus blue and give OH⁻ (hydroxyl ion) when dissolved in water. An aqueous solution of a base is referred to as an alkali. Bases have a pH greater than 7.

Bases are soluble in water. Bases are bitter to taste. Bases are soapy to touch. Bases change red litmus to blue. Bases give OH⁻ ions when dissolved in water. Bases have a pH greater than 7.

SALTS

Salt is produced because of neutralization.

Zinc + nitric acid → zinc nitrate + hydrogen gas
 $\text{Zn} + 2\text{HNO}_3 \rightarrow \text{Zn(NO}_3)_2 + \text{H}_2$

Sulfuric acid + sodium hydroxide → sodium sulfate + water
 $\text{H}_2\text{SO}_4 + 2\text{NaOH} \rightarrow \text{Na}_2\text{SO}_4 + 2\text{H}_2\text{O}$

Acids + bases → salts + water
 $\text{HCl} + \text{NaOH} \rightarrow \text{NaCl} + \text{H}_2\text{O}$

Neutralization in Every Day Life: Antacid, Soap, Baking soda, etc.

STP01 : Motion

MOTION

An object is said to be in motion with respect to certain other objects if its position continuously changes with respect to these objects.

LINEAR MOTION

All parts of a body move with the same speed in a straight or curved line.

Rectilinear Motion

Body changes its position in a straight line with respect to time.

Curvilinear Motion

Body changes its position with respect to time on a curved path.

ROTATIONAL MOTION

Distance of the moving object remain constant from a fixed point which lies on its axis.

OSCILLATORY MOTION

To and fro movement along the same path is known as oscillatory motion or simply oscillation.

PERIODIC MOTION

Motion which repeats itself after regular interval of time is known as periodic motion.

STP02 : Changes Around Us

CHANGES AROUND US

SLOW CHANGE

Changes which take place over a long period.

- 1. Growth of plants
- 2. Ripening of fruits
- 3. Change in seasons
- 4. Change in hair color
- 5. Change in eye color
- 6. Change in skin color
- 7. Change in shape of nose
- 8. Change in shape of ears
- 9. Change in shape of lips
- 10. Change in shape of mouth
- 11. Change in shape of feet
- 12. Change in shape of hands
- 13. Change in shape of fingers
- 14. Change in shape of toes
- 15. Change in shape of nails
- 16. Change in shape of hair
- 17. Change in shape of skin
- 18. Change in shape of eyes
- 19. Change in shape of lips
- 20. Change in shape of mouth
- 21. Change in shape of feet
- 22. Change in shape of hands
- 23. Change in shape of fingers
- 24. Change in shape of toes
- 25. Change in shape of nails

FAST CHANGE

Changes which take place over a short period.

- 1. Boiling of water
- 2. Burning of paper
- 3. Freezing of water
- 4. Melting of ice
- 5. Dissolving of sugar
- 6. Rusting of iron
- 7. Change in color of leaves
- 8. Change in color of flowers
- 9. Change in color of fruits
- 10. Change in color of hair
- 11. Change in color of skin
- 12. Change in color of eyes
- 13. Change in color of lips
- 14. Change in color of mouth
- 15. Change in color of feet
- 16. Change in color of hands
- 17. Change in color of fingers
- 18. Change in color of toes
- 19. Change in color of nails

REVERSIBLE CHANGE

Processes in which the original substance is recovered after the change.

NON-REVERSIBLE CHANGE

Processes in which the original substance is not recovered after the change.

PERIODIC CHANGE

Changes which occur after fixed intervals of time.

NON-PERIODIC CHANGE

Changes which do not occur after fixed intervals of time.

DESIRED CHANGE

Changes which are beneficial to us.

NON-DESIRED CHANGE

Changes which are harmful to us.

PHYSICAL CHANGE

Changes in which the physical properties of substances remain unchanged.

CHEMICAL CHANGE

Changes in which the chemical properties of substances are changed.

STP03 : Metric Weights & Measures

Metric Weights & Measures

Metric system is a decimalized system of measurement. It is the official system of measurement now and is known as the International System of Units (abbreviated as SI).

SI Base Units

Unit	Symbol	Quantity
metre	m	length
kilogram	kg	mass
second	s	time
ampere	A	electric current
kelvin	K	temperature
candela	cd	luminous intensity
mole	mol	amount of substance

Standard Prefixes For the Units of Measure

Prefix	Symbol	Multiples	Prefix	Symbol	Sub-multiples
deca	da	10 ¹	deci	d	10 ⁻¹
hecto	h	10 ²	centi	cm	10 ⁻²
kilo	k	10 ³	milli	m	10 ⁻³
mega	M	10 ⁶	micro	μ	10 ⁻⁶
giga	G	10 ⁹	nano	n	10 ⁻⁹
tera	T	10 ¹²	pico	p	10 ⁻¹²
petta	P	10 ¹⁵	femto	f	10 ⁻¹⁵
exa	E	10 ¹⁸	atto	a	10 ⁻¹⁸
zetta	Z	10 ²¹	zepto	z	10 ⁻²¹
yotta	Y	10 ²⁴	yocto	y	10 ⁻²⁴

Multiples and Submultiples of Units

Length

- 1 centimetre = 0.01 metre
- 1 decimetre = 0.1 metre
- 1 kilometre = 1000 metres
- 1 hectometre = 100 metres
- 1 decametre = 10 metres
- 1 hectometre = 100 metres
- 1 kilometre = 1000 metres

Weight (Mass)

- 1 milligram = 0.000001 kilogram
- 1 centigram = 0.00001 kilogram
- 1 decigram = 0.0001 kilogram
- 1 gram = 0.001 kilogram
- 1 kilogram = 0.001 kilogram
- 1 hectogram = 0.1 kilogram
- 1 megagram = 1000 kilogram
- 1 gigagram = 1,000,000 kilogram

Time

- 1 second = 1/3600 day
- 1 minute = 60 seconds
- 1 hour = 60 minutes
- 1 day = 24 hours
- 1 year = 365 days
- 1 decade = 10 years
- 1 century = 100 years
- 1 millennium = 1000 years

Area

- 1 square centimetre = 0.0001 square metre
- 1 square decimetre = 0.01 square metre
- 1 square metre = 1 square metre
- 1 square kilometre = 1,000,000 square metre
- 1 square hectometre = 10,000 square metre
- 1 square decametre = 100 square metre

Volume and Capacity (Liquid and Dry)

- 1 cubic centimetre = 0.000001 cubic metre
- 1 cubic decimetre = 0.001 cubic metre
- 1 cubic metre = 1 cubic metre
- 1 cubic kilometre = 1,000,000,000 cubic metre
- 1 litre = 0.001 cubic metre
- 1 kilolitre = 1000 litres
- 1 hectolitre = 100 litres
- 1 decalitre = 10 litres
- 1 decalitre = 10 litres

STP04 : Measurements

Measurements

Comparing unknown quantities with some known fixed quantities of same kind are measurements. Measurement is expressed in two parts.

Weight of a Sack of Wheat is 98 kg

98 - numerical indicating the magnitude
kg - name of the unit

Parts of Body Used For Measurements

Crude ways of measurements always give incorrect results.

Standard System of Units of Measurements

Standard ways of measurements always give exact results.

System	Length	Mass (Weight)	Time
IPS	foot	pound	second
CGS	centimetre	gram	second
MKS	metre	kilogram	second
SI	metre	kilogram	second

Measuring Length

Properly place the scale along the length to be measured.

Measuring Mass

Standard weights and balances are used to measure mass of an object.

Measuring Small Thickness

- Stacking
- Measuring height
- Averaging height to know thickness

Measuring Time & Temperature

We use a thermometer to measure temperature. Clocks are used to measure time.

Measuring Irregular Surface Area

By putting paper on the surface and tracing it on a graph paper. Count number of squares to find area of the surface required.

Measuring Volume of Irregular Objects

Water Displacement Method

STP05 : Sound

Sound

Sound is a vibration transmitted through solid, liquid or gas medium. It is a mechanical energy which produces a sensation of hearing. Ears are the receiver of sound. Sound is measured in decibels.

Generation of sound waves

Propagation of sound waves

Ears perceive sound

Measurement of different sounds on a decibel scale (dB)

Sound	Decibel (dB)
Normal hearing	0
Whispering	20
Normal conversation	60
Normal hearing	100
Normal hearing	120
Normal hearing	130

Characteristics of Sound

- 1. Loudness
- 2. Pitch
- 3. Quality

Sonic Boom

Ultrasound & Echo

STP06 : Wave Motion

Wave Motion

Transference of energy in a medium or through a vacuum due to the oscillation caused by a disturbance is called wave motion.

Transverse Wave

Particles of a medium oscillate at right angle to the direction of propagation of a wave.

Longitudinal Wave

All longitudinal waves are mechanical waves.

Particles of a medium oscillate in the direction of propagation of the wave.

Examples of Wave Motion

- 1. Ripples on the surface of water
- 2. Sunlight propagating in sky
- 3. Sound

STP07 : Simple Machine

Simple Machine

Simple machine is a device that changes the amount, distance, or direction of the force needed to do work in order to gain a Mechanical Advantage.

Lever

A lever is a simple machine that is used to push, pull, or lift things called loads from a fixed point called the fulcrum.

Pulley

Pulley is used to change the direction of an applied force or to gain a mechanical advantage. Fixed pulley system does not create a mechanical advantage.

Wedge

A wedge is a triangular shaped tool. It can be used to separate two objects or portions of an object, lift an object, or hold an object in place.

Inclined Plane

The inclined plane is a flat surface whose ends are at different heights. The inclined plane allows the same work to be done with a smaller force exerted over a greater distance.

Screw

A screw is a shaft with threads formed on its surface. A screw can convert a rotational force (torque) to a linear force and vice versa.

Wheel & Axle

A wheel and axle is a modified lever of the first class in which larger wheel (or outside) rotates around the smaller wheel (axis).

STP08 : Lever

LEVER

A lever is a simple machine. Three main components of a lever are:

- Fulcrum:** A point at which the lever rests or is pivoted which the lever can rotate.
- Load or Resistance:** It is the object to be moved or the object on which force is applied.
- Effort:** It is the force which is applied on lever or on load to move it.

Lever Of The First Class

In lever of the first kind the fulcrum lies between the effort and the load.

Lever Of The Second Class

In lever of the second class the load comes between the effort and the fulcrum.

Lever Of The Third Class

In lever of the third class the effort comes between the load and the fulcrum.

STP09 : Principle of Archimedes

Principle of Archimedes

Body immersed in a fluid is buoyed up by a force equal to the weight of the displaced fluid. This force enables the object to float or at least seem lighter.

Examples of Archimedes Principle:

- Floating Log:** Log floats because its density is less than water. It weighs less and hence floats.
- Sinking Rock:** The rock sinks because its density is greater than water.
- Floating Ship:** The ship floats because the average density of ship is less than that of water.
- Balloons Rise High:** Hot air balloons rise because the balloon's density is less than density of surrounding air.

STP10 : Pascal's Law

Pascal's Law

Pascal's law, established by French mathematician Blaise Pascal, states that pressure exerted anywhere in a confined incompressible fluid is transmitted equally in all directions throughout the fluid such that the pressure ratio remains the same.

$$\Delta P = \rho g(\Delta h)$$

Where:

- ΔP is the hydrostatic pressure (in Pascal).
- ρ is the fluid density (in kg/m³).
- g is acceleration due to gravity (in m/s²).
- Δh is the height of fluid above the point of

Applications:

- Used in Artesian Wells, Water Towers, and Dams:** Shows water levels in connected tubes.
- Hydraulic Press:** A small force on a small piston creates a larger force on a larger piston.
- Used for Amplifying the Force of the Driver's Foot in the Braking System:** Shows how a small force on a master cylinder is multiplied at the brake pads.

STP11 : Reflection of light

Reflection of light

Laws of Reflection

- The incident ray, the reflected ray and the normal ray, all lie in the same plane.
- The angle of incidence is equal to the angle of reflection.
- The reflected ray and the incident ray are on the opposite sides of the normal ray.

Image Formation by Plane Mirrors

- Image produced is upright.
- Image is virtual.
- Size of image & object is same.
- Distance of the image and the object from the mirror is same.
- Image is laterally inverted.

Image Formation by Spherical Mirrors

- Concave Mirror:** Image is highly diminished, erect and virtual (when object is between pole and focus); Image is enlarged, erect and virtual (when object is between focus and center of curvature); Image is highly diminished, inverted and real (when object is beyond center of curvature).
- Convex Mirror:** Image is always erect and virtual, and highly diminished.

STP12 : Refraction Through a Glass Slab

Refraction Through a Glass Slab

Lateral Displacement of a Light Ray: The emergent ray is always parallel to the incident ray. The lateral displacement increases as the thickness of the slab increases.

Refractive Index of a Glass Slab: $n = \frac{c}{v}$ where c is speed of light in air and v is speed of light in glass.

Refraction of Light Through Different Media: Shows light rays bending towards the normal when entering a denser medium and away from the normal when entering a rarer medium.

Total Internal Reflection: Occurs when light travels from an optically denser medium to a rarer medium at an angle greater than the critical angle.

STP13 : Refraction Through Prisms

Refraction Through Prisms

Dispersion of White Light Through a Prism

White light splits into seven colors (VIBGYOR) when passed through an equilateral prism.

Normal Dispersion: Dispersion through a prism follows the order given by VIBGYOR.

Angular Dispersion: Dispersion through a prism follows the order given by VIBGYOR.

Refractive Index of a Prism

$n = \frac{\sin i}{\sin r}$

Rainbow

A rainbow is produced by the dispersion of sunlight by tiny water droplets in the atmosphere.

STP14 : Refraction of Light Through Lenses

Refraction of Light Through Lenses

Image Formation by Convex Lens

- Object beyond 2F:** Real, inverted, and highly diminished image.
- Object at 2F:** Real, inverted, and same size image.
- Object between F and 2F:** Real, inverted, and enlarged image.
- Object at F:** No image formed.
- Object between P and F:** Virtual, erect, and enlarged image.

Image Formation by Concave Lens

- Object anywhere:** Virtual, erect, and highly diminished image.

STP15 : Optical Instruments

OPTICAL INSTRUMENTS

- Slide Projector:** Uses a convex lens to project a real, inverted, and enlarged image.
- Telescope:** Uses two convex lenses to view distant objects.
- Magnifying Glass:** Uses a convex lens to form a virtual, erect, and enlarged image.
- Camera:** Uses a convex lens to form a real, inverted, and diminished image on a film.
- Periscope:** Uses two plane mirrors to see objects from a distance.

STP16 : Microscope

Microscope

Compound Microscope: Two lenses are used for larger magnification. The objective lens forms a real, inverted, and magnified image of the object. The eyepiece lens further magnifies this image.

Ray Diagram for Compound Microscope: Shows the path of light rays through the objective and eyepiece lenses.

STP17 : Telescope

TELESCOPE

The Telescope is used to provide angular magnification of distant objects. It has an objective lens and an eyepiece lens. The objective has a large focal length and a much larger aperture than the eyepiece. Light from a distant object enters the objective and a real image is formed at its second focal point. The eyepiece magnifies this image producing a final inverted image.

A Refracting Telescope

Telescope can be categorized as astronomical and terrestrial. Refracting telescope can be used both for terrestrial and astronomical observations. The magnifying power m is the ratio of the angle β subtended at the eye by the final image to the angle α which the object subtends at the lens or the eye. Hence

$$m = \frac{\beta}{\alpha} = \frac{L}{f_e}$$

Length of the telescope tube is

$$L = f_o + f_e$$

A Reflecting Telescope (Cassegrain)

STP18 : Eye and its Defects

Eye and its Defects

TRANSVERSE SECTION OF EYEBALL

Presbyopia

- Some of the aged people are unable to see nearby objects clearly.
- New part produced inside eye is not able to contract enough to increase its focal length.

CAUSE
1. Reduced elasticity of eye muscles.
2. Decreasing flexibility of the eye lens.

REMEDY
1. Use of suitable convex lens.

Cataract

- Clouding of eye's lens.
- Long time exposure to ultraviolet light.
- Advanced age.

REMEDY
1. Cataract Surgery.

Myopia

- Person cannot see distant objects clearly. They appear blurred.
- Image is formed in front of retina.
- Image is blurred due to converging.

CAUSE
1. Excess length of the eye ball (eye).
2. Excess curvature of the eye ball.

REMEDY
1. Concave lens of appropriate strength.

Hypermetropia

- Person cannot see nearby objects clearly. They appear blurred.
- Image is formed behind the retina.
- Image is blurred due to diverging.

CAUSE
1. Short length of the eye ball (eye).
2. Short curvature of the eye ball.

REMEDY
1. Convex lens of appropriate strength.

Astigmatism

- Person cannot see all directions of light clearly. They appear blurred.
- Image is formed in different directions.
- Image is blurred due to irregular curvature.

REMEDY
1. Cylindrical lens of appropriate strength.

STP19 : Electric Current - Sources - Effects

Electric Current - Sources - Effects

Electric current is defined as the rate at which charge flows.

SOURCES

VOLTAIC CELL

It is a cell that can produce electric current by itself.

It consists of two dissimilar metal plates (electrodes) immersed in an electrolyte. The two plates are connected with a copper wire with a bulb in between. The bulb glows because of the electric current flowing through it.

The copper and zinc plates are called electrodes. Zinc is the negative electrode or the cathode and the copper is the positive electrode or the anode. The copper electrode is at a higher potential than the zinc electrode.

HEATING AND LIGHTING EFFECTS

The heating effect of electric current is used in a large number of domestic and industrial appliances. The lighting effect of electric current is used in a variety of lamps. All the lighting appliances use the heating effect. They normally contain a heating element or filament, made of a material which gets heated on passing electric current through it. The heating effect is also used in electric fuses, which prevent any damage to electric circuit in high voltage. The fuse is made of a material which has a low melting point and breaks the circuit which automatically stops any supply of electricity.

DANIEL CELL

It was constructed by J.J. Daniel. It is made in a copper vessel that contains a solution of copper sulphate. A porous pot filled with dilute sulphuric acid or zinc sulphate is kept in the copper vessel. The copper rod from the cathode and the zinc rod dipped into the acid of the porous pot serve as electrodes.

The reactions that take place in the cell are:

$$\text{Zn} \rightarrow \text{Zn}^{2+} + 2e^-$$

$$\text{Cu}^{2+} + 2e^- \rightarrow \text{Cu}$$

Overall reaction: $\text{Zn} + \text{Cu}^{2+} \rightarrow \text{Zn}^{2+} + \text{Cu}$

CHEMICAL EFFECT

The electric current can also bring a chemical change. This property is widely used in electroplating. Electrolysis is used in electroplating, that is, coating a thin layer of metal over another metal to make it look attractive, for example, gold plating on silver and jewelry. Electrolysis is also done to protect some metals. For example, iron is protected from rusting by coating a thin layer of nickel or chromium on it. Copper electroplating can be done similarly.

DRY CELL

It overcomes the problems caused by liquid chemicals. This cell is commonly used in torches and electronic appliances. The zinc container serves as the negative electrode of the cell or the cathode. The carbon rod acts as the positive electrode or the anode. The electrolyte is in the form of a paste of ammonium chloride and zinc chloride.

The reaction that takes place is:

$$\text{Zn} + 2\text{MnO}_2 + 2\text{NH}_4\text{Cl} \rightarrow \text{Zn}^{2+} + 2\text{Mn}_2\text{O}_3 + 2\text{NH}_3 + 2\text{Cl}^-$$

These ammonium ions remove electrons from carbon anode to which electrons flow in from the external circuit.

MAGNETIC EFFECT

The current flowing in a wire produces the magnetic effect. A coil of wire with a current flowing through it acts like a magnet. One of its ends acts like the North Pole. If such a coil is freely suspended it will align itself in the geographic North-South direction.

STP20 : Static Electricity

Static Electricity

Electrical charge at rest on a body is termed as Static Electricity. Two kinds of electric charges are there - Positive (+) and Negative (-).

Charging by Friction

When two different materials are rubbed against each other, they become charged. Rubbing creates positive charges. Rubbing creates negative charges. Rubbing creates positive charges. Rubbing creates negative charges.

Like Charges Repel

Two objects with the same type of charge (both positive or both negative) repel each other.

Unlike Charges Attract

Two objects with opposite types of charge (one positive and one negative) attract each other.

Electroscope

It is used to detect the presence of electric charge on a body. It consists of a metal rod with a metal cap at the top and a metal plate at the bottom. The metal plate is connected to the metal rod. The metal rod is connected to the metal cap. The metal plate is connected to the metal rod. The metal rod is connected to the metal cap.

Van de Graaff Generator

It is used to produce high voltage static electricity. It consists of a large metal dome on a rubber belt. The rubber belt is driven by a motor. The motor is connected to the rubber belt. The rubber belt is connected to the metal dome. The metal dome is connected to the rubber belt.

Electrostatic Induction

It is the process of charging a body without touching it. It is done by bringing a charged object near a neutral object. The charged object induces opposite charges on the neutral object. The neutral object is then grounded. The grounded object is then charged.

Photocopier

It works on the principle of static electricity and the attraction of unlike charges. It consists of a drum, a toner, and a paper. The drum is charged. The toner is attracted to the drum. The toner is then transferred to the paper. The paper is then heated. The heated paper is then cooled. The cooled paper is then ejected.

Lightning Spark

Lightning is a giant static discharge. It occurs when a large amount of static electricity builds up in a cloud. The static electricity is then discharged to the ground. The discharge is called a lightning spark.

STP21 : Current Electricity

Current Electricity

Flow of electric charges through a conductor constitutes current electricity.

Mobile Electrons Are Responsible For Electric Current

The free electrons in a conductor are responsible for electric current. They move from the negative terminal to the positive terminal. The movement of electrons is called electric current.

Voltaic Cell

It is a cell that can produce electric current by itself. It consists of two dissimilar metal plates (electrodes) immersed in an electrolyte. The two plates are connected with a copper wire with a bulb in between. The bulb glows because of the electric current flowing through it.

Wiring of a Plug

It is used to connect a plug to a socket. It consists of three wires: live, neutral, and earth. The live wire is connected to the live terminal of the socket. The neutral wire is connected to the neutral terminal of the socket. The earth wire is connected to the earth terminal of the socket.

Conventional Current

It is the flow of positive charges. It is opposite to the direction of electron flow. It is used to describe the direction of current in a circuit.

Electric Circuit Inside a Torch

It consists of a battery, a bulb, and a switch. The battery is connected to the bulb. The bulb is connected to the switch. The switch is connected to the battery.

Transmission of Electricity

It is the process of transmitting electric power from a power station to a consumer. It is done by using high voltage transmission lines. The power station is connected to the transmission lines. The transmission lines are connected to the consumer.

Electric Circuit in a House

It consists of a main switch, a meter, and various appliances. The main switch is connected to the meter. The meter is connected to the main switch. The main switch is connected to the various appliances.

STP22 : Ohm's Law & Electrical Resistance

Ohm's Law & Electrical Resistance

Ohm's Law

Georg Simon Ohm found out the relationship between the current flowing in a metallic wire and the potential difference across its terminals. This relationship is called Ohm's Law. He stated that the current flowing through a metallic conductor is directly proportional to the voltage across its ends if the temperature and other conditions are constant.

$$I \propto V$$

i.e. $V = IR$ where V = Potential Difference
 I = Current
or $V/I = \text{Constant}$
or $V/I = R$

Where R is a constant called Resistance. Its SI unit is Ω (ohm).

Factors Affecting Resistance

LENGTH

Resistance of the conductor is directly proportional to its length.

AREA OF CROSS-SECTION

Resistance of the conductor is inversely proportional to its area of cross-section.

MATERIAL

Resistance of the conductor depends upon the nature of its material.

TEMPERATURE

Resistance also depends upon the temperature of the conductor.

Resistance of a System of Resistors

Series Combination

The combination of resistors in series is called series combination. In this combination, the current is the same in all resistors. The total resistance is the sum of individual resistances.

$$R_{\text{total}} = R_1 + R_2 + R_3 + \dots$$

Parallel Combination

The combination of resistors in parallel is called parallel combination. In this combination, the voltage is the same across all resistors. The total resistance is the reciprocal of the sum of the reciprocals of individual resistances.

$$\frac{1}{R_{\text{total}}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \dots$$

STP23 : Electric Circuit's Component Symbols

Electric Circuit's Component Symbols

Standard symbols are used to represent various components in an electric circuit. These symbols are used to draw circuit diagrams.

Electric Cell

Battery

Switch (Open)

Switch (Closed)

A Wire Joiner

Wires Crossing Without Joining

Bulb

Resistor

Variable Resistance (Rheostat)

Ammeter

Voltmeter

Fuse

STP24 : Magnetism

Magnetism

The main cause of ferromagnetism is the presence of many conducting substances (such as iron and nickel) in the outer shells of the central core inside the Earth. Due to rotation of earth around its axis, the outer shells of the Earth are in motion. This motion induces electric current in the outer shells of the Earth. This electric current produces a magnetic field. This magnetic field is called the Earth's magnetic field.

Earth's Magnetic Field

The Earth's magnetic field is a dipole field. It has two poles: North and South. The North Pole is located near the geographic North Pole. The South Pole is located near the geographic South Pole. The magnetic field lines emerge from the North Pole and enter the South Pole.

Magnetic Compass

It is used to find the direction. It consists of a magnetized needle. The needle is placed on a pivot. The needle is free to rotate. The needle always points towards the North Pole.

Artificial Magnet

It is a magnet that is made by a person. It can be made by rubbing a bar magnet against a piece of iron. The iron piece becomes magnetized. The magnetized iron piece is called an artificial magnet.

Natural Magnet

It is a magnet that is found in nature. It is made of a mineral called magnetite. Magnetite is a form of iron oxide. It is found in the Earth's crust.

Types of Artificial Magnets

Bar Magnet

Cylindrical Magnet

Disc Magnet

Ring Magnet

Wire Magnet

Temporary and Permanent Magnets

Temporary magnets lose their magnetism when the external magnetic field is removed. Permanent magnets retain their magnetism even after the external magnetic field is removed.

Theory of Magnetism

Magnetism is caused by the motion of electric charges. It is a result of the magnetic force between moving charges. The magnetic force is a vector force. It is attractive between opposite charges and repulsive between like charges.

Repulsion - Sure Test of Magnetism

Two magnets repel each other if they have like poles facing each other. This is a sure test of magnetism. Two magnets attract each other if they have unlike poles facing each other.

Van Allen Radiation Belts

They are regions of charged particles trapped by the Earth's magnetic field. They are located in the Earth's outer atmosphere. They are named after James Van Allen, who discovered them.

Magnetic Field

It is the region around a magnet where its magnetic influence can be felt. It is a vector field. The magnetic field lines emerge from the North Pole and enter the South Pole.

STP25 : Properties of a Magnet, Making a Magnet

Properties of a Magnet, Making a Magnet

Making an Electromagnet
To make an electromagnet, wind a coil of wire around a soft iron core. When current flows through the coil, the iron core becomes magnetized and attracts magnetic materials.

Single-Touch Method
Stroke a bar magnet along the length of the iron wire in one direction only. Repeat this several times. The wire becomes magnetized.

Double-Touch Method
Stroke a bar magnet across the iron wire in opposite directions. Repeat this several times. The wire becomes magnetized.

Solenoid
A coil of wire is called a solenoid. When current flows through it, it acts like a magnet. The direction of the magnetic field is given by the right-hand rule.

Properties of Magnet

- Two suspended magnet repels each other if both have like poles.
- A suspended magnet repels one pole and attracts the other.
- Like poles repel each other and unlike poles attract each other.

Proper Storage and Handling of Magnet

Magnetic Circuits

Repulsion Between Like Poles

STP26 : Electromagnetism

Electromagnetism

Electric current through a wire generates a magnetic field which is called electromagnetism. It describes the relationship between electricity and magnetism.

Oersted's Experiment
In 1820, Oersted first discovered the link between magnetism and electric current when he found that a magnetic needle gets deflected when placed near a current-carrying conductor.

Magnetic Field of a Current-Carrying Conductor

Maxwell's Right Hand Grip Rule
If a current-carrying wire is held in the palm of the right hand, with the fingers pointing in the direction of the current, the thumb points in the direction of the magnetic field.

Fleming's Left Hand Rule (motor effect)
If the forefinger, middle finger, and thumb of the left hand are extended at right angles to each other, the forefinger points in the direction of the magnetic field, the middle finger in the direction of the current, and the thumb in the direction of the motion of the conductor.

Applications

- ELECTRIC BELL
- ELECTRIC MOTOR
- SIMPLE ELECTROMAGNET

STP27 : Electromagnetic Induction

Electromagnetic Induction

Faraday and Henry discovered that a magnetic field can be used to produce a current.

Induction using a bar magnet
When a permanent magnet is being moved towards or away from a coil, an electromotive force (EMF) is induced in the coil. This EMF causes a current to flow in the coil if it is connected to a circuit.

Self-Induction
In a circuit, the increasing current in the coil gives rise to a changing magnetic field. This field induces an EMF in the coil itself, which opposes the original current. This is called self-induction.

Mutual Induction
When two coils are placed near each other, a change in current in one coil induces an EMF in the other coil. This is called mutual induction.

Fleming's Right Hand Rule (induced current direction)
If the thumb points in the direction of the motion of the conductor, the forefinger in the direction of the magnetic field, and the middle finger in the direction of the induced current.

Applications

- Generator
- Transformer
- Induction Cooker
- Induction Heater

STP28 : Electric Motor

Electric Motor

An electric motor converts electrical energy to mechanical energy.

Working of a Simple DC Motor

- Current flows through the coil and the field of the permanent magnet forces the coil to rotate.
- The coil continues to rotate and its vertical side carries it beyond the vertical.
- The coil continues to rotate and its vertical side carries it beyond the vertical.
- On passing the vertical, the commutator reverses the connections to the brushes and also the current in the coil. This causes the coil to spin continuously.

Commercial Electric Motor
Simple electric motor produces a low turning effect. Commercial motors give a much better performance for the following reasons:

- The current-carrying coils having large number of turns wound on a soft iron core are used in them.
- The soft iron core plus the coils are called the armature. Armature when magnetized increases the strength of the magnetic field. This enhances the power of the motor.
- The pole pieces of the magnet enclose the coil and are curved to make a radial magnetic field. This keeps the turning effect of the maximum.

Simple AC Motor

Applications of Electric Motor

- Blender
- Fan
- Washing Machine

STP29 : Electric Bell

Electric Bell

There are various types of electric bells, including the single-stroke bell, the trembler bell, the buzzer and a continuously ringing bell, but all depend on the attraction exerted by an electromagnet on a soft iron armature. A typical single-stroke bell circuit is shown here.

When the switch is pressed, the current begins to flow. The solenoid gets magnetized and attracts the hammer which strikes the gong and the bell rings.

The movement of the armature breaks the contact and the current stops flowing. The electromagnet loses its magnetism and the armature returns back to its original position. This completes the circuit once again and the action is repeated. As a result, the bell continues to ring as long as the push-button is pressed.

STP30 : Electric Generator

Electric Generator

In an electric generator, mechanical energy is used to rotate a conductor coil in a magnetic field to produce electricity. It is based on the principle of electromagnetic induction explained by the Faraday's law.

A.C. Generator
The rotation of a rectangular coil rotating between the poles of a permanent magnet. The ends of the coil are joined to two slip rings on the coil and against which carbon brushes pass. The rotating coil cuts the magnetic field lines and a voltage is induced in it. The induced current that produced reverses every half turn due to slip rings.

D.C. Generator
An A.C. Generator becomes a D.C. Generator if the slip rings are replaced by a split-ring commutator. As the coil rotates the commutator changes the connections every half turn, so the current that is generated flows in one direction only.

STP31 : Dynamo

Dynamo

Dynamo Principle
Dynamo works on electromagnetic principles. It converts mechanical rotation into pulsed DC through the use of a commutator. It consists of a stationary magnet to provide a constant magnetic field, and a set of rotating windings which turn within the field to produce the electric current.

Bicycle Bottle Dynamo
Bottle dynamo operates with a roller placed on the axle of a bicycle tyre. The movement of the bottle tyre turns the roller which spins a magnet inside a fixed coil. Electricity is generated in the coil by electromagnetic induction.

The First Dynamos

FARADAY'S DISC DYNAMO
The first dynamo invented by Michael Faraday in 1831 was a copper disc that rotated between the poles of a magnet.

PIRI'S COMMUTATED DC DYNAMO
In 1832, Hippolyte Piri built a dynamo based on Faraday's principles. He used a spinning permanent magnet whose north and south poles passed by a piece of zinc wrapped with insulated wire. To convert the AC to DC, Piri invented a commutator.

STP32 : Force

Force

A force is a push or pull that changes the motion, size or shape of an object.

Effects of Force

- Change the direction of motion:** A ball is thrown and its direction is changed by a force.
- Stop motion:** A moving car is stopped by a force.
- Change speed:** A car is accelerated or decelerated by a force.
- Change direction:** A ball is thrown and its direction is changed by a force.
- Change shape or size:** A ball is compressed or stretched by a force.

Combining Force
Two separate forces acting on an object can be combined to produce a resultant force. This is done by the triangle rule or the parallelogram rule.

STP33 : Friction

Friction

Friction is the component of the contact force parallel to the surfaces in contact, which opposes impending or actual relative motion between the two surfaces.

STATIC FRICTION	KINETIC FRICTION	ROLLING FRICTION
Opposes impending relative motion	Opposes relative motion during rolling	Opposes relative motion during rolling
$f_s \leq \mu_s N$	$f_k = \mu_k N$	$f_r = \mu_r N$

Where μ_s , μ_k , and μ_r are respectively the coefficients of static friction, kinetic friction & rolling friction, N is the normal force. Also,

$$\mu_r < \mu_k < \mu_s$$

ADVANTAGES		DISADVANTAGES
Helps to Write	Produces Heat	Causes Wear and Tear
Helps to Apply Brakes	Helps to Walk	Causes Skin Abrasions

INCREASING FRICTION	REDUCING FRICTION	
Spiking the Shoes	Using Ball Bearing	Lubricating With Oil
Grooving the Tyres	Using Powder	

STP34 : Gravitation

Gravitation

Universal Law of Gravitation

Everybody in the universe attracts every other body with a force which is directly proportional to the product of their masses & inversely proportional to the square of the distance between them.

$$F_g = \frac{GM_1M_2}{r^2}$$

Where, G is the universal gravitational constant. M_1 and M_2 are masses of two objects. r is the distance between two masses.

Gravitational Constant G

Henry Cavendish's Torsion Balance provided the first measurement of the gravitational constant G. Currently accepted value of G is $6.67 \times 10^{-11} \text{ Nm}^2/\text{kg}^2$.

Acceleration Due To Gravity

Gravitational acceleration at a point in space is given as

$$g = \frac{GM}{r^2}$$

Acceleration due to gravity of the earth, $g = 9.8 \text{ m/s}^2$

Weight

Weight is a force caused by the gravitational attraction.

$$W = mg$$

Weight equals mass times gravitational acceleration. Also, Weight of the object on the moon = $\frac{1}{6}$ Weight of the object on the earth.

Weightlessness

When an object is in free fall, it is weightless.

STP35 : Moment and Couple

Moment and Couple

Moment (Torque)

The turning effect of a force is called a moment. The moment of a force is also called a Torque. It depends on

- the magnitude of the force (bigger force means greater moment),
- the perpendicular distance of the force from the Pivot (further the force acts from the pivot, the greater is its moment).

$$\text{Moment of Force (Torque)} = \text{Force} \times \text{Moment Arm}$$

$$(\tau) = (F)(d)$$

SI Unit of Moment is Newton meter (Nm) Dimension $[ML^2T^{-2}]$

The Principles of Moment

Example 1: $\tau = F \times d$
 Example 2: $\tau = 0$
 Example 3: $\tau = F \times d \cos(\theta)$
 Example 4: Equilibrium (Balanced) $\tau_1 = \tau_2$, $F_1 \times d_1 = F_2 \times d_2$

Couple

A special case of moments where two anti-parallel forces (F_1 & F_2) separated by a distance 'd' cause an object to rotate.

Applications of a Couple

STP36 : Work and Power

Work and Power

WORK

If a body is displaced with a given force, a certain amount of work is done.

$$W = (F \cos \theta) d = f \cdot d$$

Unit: Joule (J) Dimension: $[ML^2T^{-2}]$

Amount of work is greater when displacement is greater for the same force applied.
 Amount of work is greater when force applied is greater for the same displacement.

SPECIAL CASES FOR WORK DONE

- When $\theta = 0^\circ$ Maximum work is done.
- When $\theta = 90^\circ$ No work is done.
- When $d = 0$ No work is done.
- When $f = 0$ No work is done.

POWER

Time rate at which work is done.

$$P = \frac{W}{t} = \frac{f \cdot d}{t} = f \cdot v$$

Unit: watt (W) 1 horsepower = 746 watt

STP37 : Nuclear Fusion

Nuclear Fusion

ASTROPHYSICAL NUCLEAR FUSION

Proton-Proton (pp) Chain in Sun

Four hydrogen nuclei combine to form a nucleus with a release of 26.7 MeV of energy.

$$4^1_1\text{H} + 2e^- \rightarrow ^4_2\text{He} + 2\nu + 6\gamma + 26.7\text{MeV}$$

CNO Cycle in Massive Stars

C-12 acts as a nuclear catalyst.

CONTROLLED FUSION

TOKAMAK: The most researched device for producing controlled thermonuclear fusion.

HYDROGEN BOMB

Superficial fusion is desirable of normal density. Detonation of small atomic bomb creates the temperatures to trigger the hydrogen bomb explosion. The inward travelling shock wave thus produced compresses deuterium & tritium. These nuclei undergo fusion at temperatures over 5×10^7 °C.

STP38 : Nuclear Fission

Nuclear Fission

When a massive nucleus ($A > 200$) breaks apart into smaller nuclei, there is a slight loss of mass, which comes in the form of enormous energy according to Einstein's equation $E = mc^2$. Such process is called Nuclear Fission. Uncontrolled nuclear fission chain reaction releases enormous energy as in atom bombs.

NEUTRON INDUCED NUCLEAR FISSION

When a neutron hits fissionable nucleus, it causes fission, the fissionable nucleus splits into two fission products, releasing additional neutrons.

CONTROLLED NUCLEAR FISSION

The source of energy in nuclear reactors is controlled nuclear fission.

BREEDING PLUTONIUM-239

U-238 is first transformed into fissionable Uranium-235, which decays to Pu-239.

SPONTANEOUS FISSION

Uranium-238 decays into Thorium-234 and an alpha particle.

ENRICHMENT OF THE NUCLEAR FUEL

Trailing uranium released to form yellow cake (80% uranium). Uranium hexafluoride is separated into enriched uranium and depleted uranium. Enriched uranium is used as fuel rods containing uranium pellets.

STP39 : Nuclear Reactor

Nuclear Reactor

Pressurized Water Reactor

Pressurized water reactor use ordinary water under high pressure (superheated water) as coolant to remove heat generated, and as the moderator to thermalize the neutron flux. The primary coolant loop is kept under high pressure to prevent the water from boiling, hence the name. PWRs are the most common type of power producing nuclear reactors.

Fast Nuclear Reactor

The fast reactor has no moderator and therefore water cannot be used as a coolant. Also the fuel is more concentrated so a coolant with the best neutron to fission ratio which does not require a moderator. Control rods are often not used.

STP40 : Radioactivity

Radioactivity

The atoms of unstable chemical elements try to rearrange themselves to make more stable atoms. In the process, they give off tiny bundles of radiations. This process is called radioactivity. Radioactivity is both harmful (damages or destroys the tissues) and useful (used to make nuclear energy, preserve food and in the treatment of cancer) to us in everyday life.

Types of Radioactive Radiation

- Alpha Decay:** $^A_ZX \rightarrow ^{A-4}_{Z-2}Y + ^4_2\text{He}$
- Beta Minus Decay:** $^A_ZX \rightarrow ^A_{Z+1}Y + e^- + \bar{\nu}_e$
- Beta Plus Decay:** $^A_ZX \rightarrow ^A_{Z-1}Y + e^+ + \nu_e$
- Gamma Decay:** $^A_ZX^* \rightarrow ^A_ZX + \gamma$

Radioactive Carbon Dating

Archaeologists find the age of fossils by measuring amount of radioactive isotope of carbon-14 in it. When an organism dies, the stores of carbon-14 decrease. Because of radioactive decay, every half of its mass in 5730 years, a period termed half life of carbon-14 element. By comparing the amount of carbon-14 in a modern sample, with their fossil counterparts and knowing the rate of carbon-14 decay, scientists can calculate with fair accuracy the age of the fossil.

Decay of Uranium-238

Uranium-238 decays into Thorium-234, which decays into Protactinium-234, which decays into Uranium-234, which decays into Thorium-230, which decays into Radium-226, which decays into Radon-222, which decays into Polonium-218, which decays into Lead-214, which decays into Bismuth-214, which decays into Polonium-214, which decays into Lead-210, which decays into Bismuth-210, which decays into Polonium-210, which decays into Lead-206.

STP41 : Radio Telescope

Radio Telescope

Radio Telescope is an astronomical instrument consisting of a radio receiver and an antenna system that is used to detect radio frequency radiations emitted by extraterrestrial sources. Because radio wavelengths are much longer than those of visible light, radio telescopes must be very large in order to attain the resolution of

Astronomical Interferometers

Interferometers combine images from several radio telescopes to make one image that looks like it was taken from one large dish.

Ornt (Pune)

Only Radio Telescopes (ORT)

Largest Radio Telescope (Arecibo, Puerto Rico)

STP42 : X-Rays

X-Rays

Stream of high energy photons having wavelength in the range from 0.01 to 10 nanometers are X-rays. X-rays are also called as Roentgen Radiations.

CHARACTERISTICS

- They are electromagnetic waves.
- They are not deflected by magnetic and electric fields.
- They affect photographic plates.
- They ionize the gases through which they pass.
- Depending on their wavelengths, X-rays penetrate through different depths.

PRODUCTION OF X-RAYS

X-ray Tube

In an X-ray tube, the electrical potential (up to 100 kV) between the cathode and the anode heats the filament to several thousand °C to create a stream of free electrons. Electrons from the cathode are accelerated towards the anode. X-rays are generated when these electrons give up some of their energy when they interact with the anode.

Work done W in transferring charge Q through p.d. V is

$$W = Q \times V$$

USES

- Medical Imaging
- X-ray Crystallography
- Security Scanners

STP43 : Television

Television

Picture Tube

Guided by a magnetic field and fired out of three electron guns, electron beams that correspond to colours in a TV image strike millions of dots of fluorescent compound on inside of the screen.

The electronic signals from the studio are sent to a transmitting station. Here they are amplified, and sent out from the transmitting mast.

Color Triplets

Arranged in lines, red, green, and blue are the electron beams, single beam at a time. A grid behind the screen keeps the beams from overlapping.

The aerial picks up the signal. The signal is then split into its three parts. The three signals are sent as beams of electrons to the screen, where they are focused on coloured phosphors. The phosphors glow brightly when a signal hits them.

STP44 : Multistage Rocket

Multistage Rocket

Multistage rockets can be used to increase efficiency and acceleration.

The Stage Principle

To propel a significant payload into the earth's orbit, staging is generally employed in using three or more stages. Each stage is a self-contained unit with its own engine and fuel tanks. The stages are stacked on top of each other. As each stage is used up, it is jettisoned, and the next stage is ignited. This has the effect of reducing the weight of the rocket, making it lighter and more efficient.

Chemical Rocket Types

- Liquid
- Solid
- Hybrid

Components of Rocket System

- Propellant
- Engine
- Structure
- Guidance
- Control

Engine Operation

Before that, the fuel is burned. The reaction goes on only if the oxygen of the main stage is exhausted. The rocket is still retained with the booster and sustainer, their fuel completely exhausted. The booster is jettisoned.

STP45 : Windmill

Windmill

A TYPICAL WINDMILL

Windmill converts wind energy into rotational motion by means of adjustable blades.

The Principle of Windmill

When the wind strikes across the blades of a windmill, it exerts a force on them. This rotates the shaft of the windmill to do a variety of works.

USES OF WINDMILL

- Wind Power to Mills
- Wind Power to Pumps
- Wind Power to Sails
- Electricity Generation

MODERN ERA WINDMILL - A WIND TURBINE

Horizontal Axis Wind Turbine

Vertical Axis Wind Turbine

STP46 : Petrol Engine

Petrol Engine

FOUR STROKE PETROL ENGINE

Four stroke petrol engine (internal combustion engine) is used in cars, motorcycles, trucks, aircraft, construction machinery and many others. The four stroke engine refers to intake, compression combustion (power), and exhaust strokes.

The cycle begins at Top Dead Center, when the piston is farthest away from the axis of the crankshaft. A stroke refers to the full travel of the piston from Top Dead Center to Bottom Dead Center.

1 INTAKE STROKE

The piston descends from the top of the cylinder to the bottom of the cylinder, reducing the pressure inside the cylinder. A fuel and air mixture is forced by atmospheric pressure into the cylinder through the intake valve. The intake valve then closes.

2 COMPRESSION STROKE

With both intake and exhaust valves closed, the piston returns to the top of the cylinder compressing the fuel-air mixture.

3 POWER STROKE

While the piston is close to top dead center, the compressed air-fuel mixture is ignited by a spark plug. The resulting pressure from the combustion of the mixture forces the piston back down toward bottom dead center with tremendous force.

4 EXHAUST STROKE

During the exhaust stroke, the piston once again returns to top dead center with the exhaust valve is open. This action forces out the combustion products from the cylinder by pushing the spent fuel-air mixture through the exhaust valve.

STP47 : Steam Engine

Steam Engine

A practical device which transforms heat energy of steam

Simple Steam Engine Working

Principle - Steam occupies a larger space than occupied by the same amount of water. Therefore, it exerts greater pressure on the walls of the cylinder. Steam when expands, pushes the piston fitted with the cylinder. The motion of the piston can now be made to move any object by suitably connecting it to the piston. The expanding steam loses its heat energy and condenses to water. The piston then falls back. Letting the cooled steam out of the cylinder, and reintroducing fresh hot steam into it, entire cycle could be made to repeat as long as desired.

STAGE 1

Steam enters the cylinder, pushing the piston down. The piston is connected to a crankshaft, which converts the linear motion into rotational motion.

STAGE 2

The piston moves up, pushing the steam back into the cylinder.

STAGE 3

The piston moves down again, pushing the steam back into the cylinder.

One of The First Steam Locomotives (1825)

STP48 : Diode

Diode

Diode is a two-terminal electronic component that conducts electric current in only one direction. Diode is usually made from semiconductor materials. Silicon and Germanium are the most common semiconductors used to make diodes.

TYPES OF DIODES & SYMBOLS

- Zener Diode
- Tunnel Diode
- Schottky Diode
- Varactor / Varicap Diode
- Photodiode
- Germanium Diode
- Laser Diode (a type of photodiode)

Light Emitting Diode (LED)

Laser Diode (a type of photodiode)

VI characteristic of a Zener Diode

VI characteristics of a Zener Diode

VI characteristics of a Photodiode

STP49 : Universe - I (Life Cycle of a Star)

Universe-I (Life Cycle of a Star)

A cloud of gas and dust collapses because of gravitational forces, to form up to 1000 stars and planets like our sun. Each star and planet has its own life cycle.

- 1. PROTOSTAR** A protostar has a dense, glowing core of dust.
- 2. PROTOSTAR** A protostar has a dense, glowing core of dust.
- 3. PROTOSTAR** A protostar has a dense, glowing core of dust.
- 4. PROTOSTAR** A protostar has a dense, glowing core of dust.
- 5. PROTOSTAR** A protostar has a dense, glowing core of dust.
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- 8. PROTOSTAR** A protostar has a dense, glowing core of dust.
- 9. PROTOSTAR** A protostar has a dense, glowing core of dust.
- 10. PROTOSTAR** A protostar has a dense, glowing core of dust.

STP50 : Universe II (Comets & Meteors)

Universe II (Comets & Meteors)

Comets

A comet is an icy celestial body in solar system made of dust and ice mixed together.

Structure of a Comet: Nucleus, Coma, Tail, Dust, Gas, and Ion.

Formation of Comet's Tail and Head: The head is the nucleus, the tail is the coma, and the tail is the ion tail.

Comets originate in the Kuiper Belt or Oort Cloud.

Meteors

Meteoroid: A small celestial piece of dust, rock, ice or metal moving through space.

Meteor: The ionized streak caused by a meteoroid scouring Earth's atmosphere. It is commonly called a shooting star.

Meteorite: It is a meteor that has reached the Earth's surface.

Types of Meteorites: Achondrites, Chondrites, Iron, Murchisonite, Pallasite.

Meteorite Strike: A meteorite hitting the Earth's surface.

Most meteoroid have their origin in Asteroid Belt.

STP51 : Star Map

Star Map

MAP OF NORTHERN HEAVEN

MAP OF SOUTHERN HEAVEN

STP52 : Newton's Laws of Motion

Newton's Laws of Motion

Every object continues to be in its state of rest or of motion unless acted upon by an external unbalanced force.

Newton's First Law of Motion

Newton's first law of motion, defines how the velocity of a body which remains a change in its state of rest or of uniform motion, it is therefore sometimes called Galileo's Law of Inertia.

Everyday Observations Based on Newton's First Law of Motion:

- Dust particles start coming out of a cushion when it is shaken with a stick. Dust Particles Remain at Rest.
- Passenger in moving car moves forward when car stops. Passenger Remains in Station.
- When a tree is shaken vigorously its fruits & leaves fall down. Fruits & Leaves Remain at Rest.

Newton's Second Law of Motion

The rate of change of momentum of a body is directly proportional to the applied force, and takes place in the direction in which the force acts.

Force = $\frac{\text{Change in Momentum}}{\text{Time Taken}} = F = \frac{m(v-u)}{t} = F = m \times a$

Newton's Third Law of Motion

Whenever one body exerts a force (action) on another body, the second body exerts an equal and opposite force (reaction) on the first body.

When a bullet is fired from a gun, the force exerted by the gun backwards is equal to the force exerted by the bullet forwards.

When a runner runs on the ground he pushes the ground backwards and the ground pushes him forward.

Equal and opposite reaction force of the downward gases produced by the rapid burning of fuel pushes the rocket upwards with a great speed.

STG01 : The Cell Theory

The Cell Theory

Unicellular and Multicellular Organisms

As proposed by Schwann (1804-1881) and Theodore Schwann (1810-1882) and modified by Rudolf Virchow (1858), The Cell Theory may be summarised as:

- All living things are composed of one or more cells.
- All cells arise from pre-existing cells.
- All cells are basically alike in chemical composition and metabolic activities.
- The function of an organism as a whole is the outcome of the activities and interactions of the constituent cells.

A cell representing the cellular level in unicellular organisms (single-celled) performs all the functions in a living organism whereas in multicellular organisms (many-celled), the cell constitutes the basic structural and functional unit of a living organism, like the bricks in a building.

Types of Cells

In general, two types of cells are recognised. These are as follows:

1. Prokaryotic

These are single in structure. Their nucleus is simple. The DNA is simple and circular. All membrane-bound organelles are absent. The nuclear membrane, nucleolus and cytoplasmic streaming are also absent.
 Example: Bacteria cell

2. Eukaryotic

These have a membrane bound nucleus enclosed by a nuclear envelope. The DNA is complex and linear. Example: Animal and plant cells.

Unicellular Organisms

A unicellular organism is a unit structure of life, which is capable of leading an independent life. Each unicellular organism is capable of completing all the functions within the cell itself. Some of these unicellular organisms are given below:

Amoeba is a protist which locomotes by pseudopodia and reproduces asexually by binary fission.

Paramecium reproduces by binary or multiple fission and conjugation. Locomotion is by cilia.

Bacteria is present in soil, air and water and is living beings parasitic.

Fungi is present in the upper layers of soil water. It is a source of food for large marine animals.

Multicellular Organisms

These organisms which consist of aggregation of many cells and some of which become specialised to perform essential functions of the are called multicellular organisms. Levels of organisation in a multicellular organism are given below:

STG02 : DNA

DNA

Deoxyribonucleic acid (DNA) is the most important constituent of chromosomes. DNA carries all genetic information.

DNA has a long chain of nucleotides.

DNA structure was first suggested by James Watson and Francis Crick in 1953.

3 DNA Structure (microscopic view)

2 DNA Structure (microscopic view)

Double Helix DNA Structure (Diagrammatic view)

Nitrogenous Base

Purines	Pyrimidines
Adenine, Guanine	Cytosine, Thymine

Two polynucleotide chains are in the form of a double helix. Each strand has a backbone of sugar and phosphate molecules joined with each other. Nitrogenous bases are attached to sugar molecules and base on one complementary strand. It bonds with a specific base of the opposite strand i.e., A-T, C-G. This pairing is called complementary pairing.

Nucleotide DNA

Nucleotide is the structural unit of DNA. A nucleotide has a nitrogenous base, a pentose sugar and a phosphate group.

STG03 : RNA

RNA

Ribonucleic Acid (RNA) is a copy of the DNA strand. In RNA, the pentose sugar is ribose and not deoxyribose as in DNA. It contains uracil in place of thymine. RNA is responsible for protein synthesis in the cell. Three major classes of cellular RNAs are Ribosomal RNA (rRNA), Messenger RNA (mRNA) and Transfer RNA (tRNA).

Ribosomal RNA (rRNA): They are found in the ribosomes where protein synthesis occurs.

Messenger RNA (mRNA): It is produced in the nucleus and carries information for the synthesis of proteins. For each protein there is a specific mRNA.

Transfer RNA (tRNA): It is a much smaller molecule than the mRNA. It collects amino acids from cytoplasm for protein synthesis.

RNA consists of a long chain of nucleotides. It usually has single strand.

Each RNA molecule contains sugar, ribose, phosphate acid and one of the four bases: adenine, guanine, cytosine or uracil.

RNA gets genetic information from DNA and uses this information to direct the synthesis of proteins.

A strand of RNA is synthesized from a DNA template, which determines the synthesis of proteins.

RNA is the genetic material in all plant viruses and some animal viruses.

STG04 : Levels of Organisation

Levels of Organisation

In the living world there are different levels of organisation. The highest level of organisation of the individual level is an organism. The highest level of living organisation is biosphere (including all living beings in the world). Biosphere includes all the ecosystems which are large and small geographical regions.

Different levels of organisation in the living world (atomic level to biosphere level)

STG05 : Origin of Life

Origin of Life

Organic monomers form space. Organic polymers. Organic molecules. Inorganic molecules from Earth. Coacervates.

In 1953, Miller and Urey set up a reaction chamber containing a mixture of gases mainly hydrogen, methane, ammonia and water. For a week they kept the mixture circulating and bombarding it with continuous discharge of sparks. By the end of the week, they found organic molecules had formed including many kinds of amino acids. The results show that all the building blocks in living systems can form under abiotic conditions.

Steps in Origin of Life

- Abiotic synthesis of organic monomers
- Abiotic synthesis of polymers
- Formation of coacervates
- Origin of life

Various types of prokaryotes and then eukaryotes evolved eventually. Some prokaryotes became oxygen producing photosynthesizers.

STG06 : Cellular Respiration

Cellular Respiration

1. GLYCOLYSIS

Glucose is broken down into pyruvate through a series of reactions in the cytoplasm.

2. KREBS TCA CYCLE

Pyruvate enters the mitochondrion and is converted to Acetyl CoA, which enters the Krebs cycle.

3. ELECTRON TRANSPORT CHAIN

Electrons from NADH and FADH₂ are passed through a series of proteins in the inner mitochondrial membrane to oxygen, which is reduced to water.

STG07 : Animal Husbandry

Animal Husbandry

Systematic rearing, caring and improvement of domestic animals is called Animal Husbandry.

Important Steps Involved in Animal Husbandry

- Breeding:** Breeding is the method of producing animals with desired characteristics. This includes the following methods: Cross Breeding, Inbreeding, and Selective Breeding.
- Feeding:** Animals require a balanced diet for their health, growth and development. Different kinds of animals require different kinds of feed. The different requirements are discussed below:
 - Feed for Cattle:** Cattle require a diet rich in carbohydrates, protein, and vitamins. They are fed with green fodder, dry matter, and concentrates.
 - Feed for Poultry:** Poultry require a diet rich in protein and energy. They are fed with green fodder, dry matter, and concentrates.
 - Feed for Sheep and Goats:** Sheep and goats require a diet rich in protein and energy. They are fed with green fodder, dry matter, and concentrates.
- Shedding:** Shedding of animals with undesirable characteristics is done to improve the quality of the breed.
- Health:** Proper rearing and management of animals require that health is given as top priority.
 - Milk Cattle:** Healthy milk giving animals are the one and health is the most important factor in dairy farms. These animals are called High Yielding Friesian Cattle. Continuous rearing for health.
 - Poultry:** Rearing of birds for food is called poultry. Chickens are the most common variety of poultry.
 - Apiculture:** Rearing of honey bees is called apiculture. Honey bees are reared for honey and beeswax.
 - Fisheries:** Rearing of fish on a large scale is called fisheries. They serve as a major source of food.
 - Sericulture:** Rearing of silkworms to breed as mulberry. It is done to obtain silk from the silkworms.

STG08 : Economic Plants

Economic Plants

Many plants are cultivated for their various economical values and are classified under the following categories:

Cereals	Pulses
Vegetables	Fruits & Nuts
Fibre Crops	Oil Seeds
Spices	Timber
Beverages	Decorative Plants & Flowers
Sugar Crops	Medicinal Plants

STG09 : Basic Agricultural Practices

Basic Agricultural Practices

Cultivation of plants is known as agriculture.

Preparation of Soil

Ploughing
The process of turning over and breaking up soil with the help of a plough or tillage implement.

Leveling
The physical soil levelling process is done by using a levelling machine.

Manuring
The process of adding organic or inorganic substances to the soil to improve its fertility and productivity.

Sowing and Transplantation

Sowing with Machine
The process of sowing seeds into the soil using a sowing machine.

Transplantation
The process of moving a young plant from one place to another.

Irrigation

The process of supplying water to the plants in a controlled manner.

Application of Fertilisers and Manures

The process of adding nutrients to the soil to improve its fertility and productivity.

Plant/Tree	Manure	Manure to be applied
1. Wheat	1. Compost	1. Nitrogen
2. Rice	2. Cow dung	2. Phosphorus
3. Cotton	3. Farmyard manure	3. Potassium
4. Sugarcane	4. Green manure	4. Nitrogen

Weeding

The process of removing weeds from the soil.

Mechanical Methods
1. Hand weeding
2. Hoeing
3. Mowing

Biological Methods
1. Crop rotation
2. Mulching

Chemical Methods
1. Weedicides

Protection of Crops

Harvesting
The process of gathering the matured crops from the field.

Threshing
The process of separating the grain from the chaff.

Winnowing
The process of separating the grain from the chaff by using wind.

Storage
The process of storing the harvested crops for a long time.

STG10 : Medicinal Plants - 1

Medicinal Plants-1

1. ALOE VERA Aloe Vera is a succulent plant with thick, fleshy leaves. It is used to treat burns, wounds, and skin conditions.	2. GINGER Ginger is a rhizome plant with long, thin leaves. It is used to treat nausea, vomiting, and indigestion.	3. GARLIC Garlic is a bulbous plant with long, thin leaves. It is used to treat high blood pressure, heart disease, and cholesterol.
4. TURMERIC Turmeric is a rhizome plant with long, thin leaves. It is used to treat inflammation, pain, and skin conditions.	5. PEPPERMINT Peppermint is a herbaceous plant with long, thin leaves. It is used to treat respiratory conditions, headaches, and digestive issues.	6. EUCALYPTUS Eucalyptus is a tree with long, thin leaves. It is used to treat respiratory conditions, headaches, and digestive issues.
7. GINKGO BILOBA Ginkgo biloba is a tree with fan-shaped leaves. It is used to improve memory and cognitive function.	8. GINSENG Ginseng is a root plant with long, thin leaves. It is used to improve energy, vitality, and overall health.	9. GINKGO BILOBA Ginkgo biloba is a tree with fan-shaped leaves. It is used to improve memory and cognitive function.
10. GINKGO BILOBA Ginkgo biloba is a tree with fan-shaped leaves. It is used to improve memory and cognitive function.	11. GINKGO BILOBA Ginkgo biloba is a tree with fan-shaped leaves. It is used to improve memory and cognitive function.	12. GINKGO BILOBA Ginkgo biloba is a tree with fan-shaped leaves. It is used to improve memory and cognitive function.

STG11 : Medicinal Plants - 2

Medicinal Plants-2

13. GINKGO BILOBA Ginkgo biloba is a tree with fan-shaped leaves. It is used to improve memory and cognitive function.	14. GINKGO BILOBA Ginkgo biloba is a tree with fan-shaped leaves. It is used to improve memory and cognitive function.	15. GINKGO BILOBA Ginkgo biloba is a tree with fan-shaped leaves. It is used to improve memory and cognitive function.
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STG12 : Energy Needs

Energy Needs

Energy is required to perform different tasks.

Hydro Energy

Energy derived from the movement of water.

Chemical Energy

Energy stored in the bonds of chemical compounds.

Solar Energy

Energy derived from the sun.

Wind Energy

Energy derived from the movement of air.

Geothermal Energy

Energy derived from the heat of the Earth's interior.

Nuclear Energy

Energy derived from the nucleus of an atom.

Sound Energy

Energy derived from the vibration of particles.

Light Energy

Energy derived from the sun or other light sources.

STG13 : Fossil Fuels

Fossil Fuels

The term 'fossil' refers to parts of dead plants and animals that have been preserved in nature for thousands of years. These fossils which are used to obtain energy in any form are called fossil fuels. For eg., coal, petroleum, etc.

Types of Fossil Fuels

Solid Fuels
Wood, coal, and peat are important solid fuels. Coal is a major source of energy for electricity and steel production.

Liquid Fuels
Petroleum is the most important liquid fuel. It is also a source of kerosene, petrol, and diesel. Benzene and alcohol are other important liquid fuels.

Gaseous Fuels
Natural gas, the gas that is formed naturally along with petroleum deposits, is the most common type of gaseous fuel. Water gas and other gaseous fuels are also important.

Characteristics of a Good Fuel

1. A good fuel should not burn very slowly.
2. It should have a high calorific value.
3. It should be easy to store, transport, and handle.
4. It should have a convenient ignition temperature.
5. It should have a moderate combustion rate.

Coal

Coal is a fossil fuel that is formed from the remains of dead plants and animals that have been preserved in nature for thousands of years.

Petroleum

Petroleum is a fossil fuel that is formed from the remains of dead plants and animals that have been preserved in nature for thousands of years.

STG14 : Petroleum & Natural Gas

Petroleum & Natural Gas

Petroleum is a fossil fuel that is formed from the remains of dead plants and animals that have been preserved in nature for thousands of years.

Fractionating Column

The process of separating petroleum into different products based on their boiling points.

Product	Boiling Point
Gasoline	30-200°C
Kerosene	150-300°C
Diesel	250-350°C
Heavy oil	350-500°C
Residue	500°C+

Uses of Petroleum Products

Gasoline
Used for transport vehicles.

Kerosene
Used for lighting and heating.

Diesel
Used for heavy transport vehicles.

Heavy oil
Used for industrial purposes.

Residue
Used for paving roads.

STG15 : Renewable Sources of Energy

Renewable Sources of Energy

Renewable energy is energy that can be used again and again.

Solar Energy

Energy derived from the sun.

Hydroelectric Energy

Energy derived from the movement of water.

Geothermal Energy

Energy derived from the heat of the Earth's interior.

Wind Energy

Energy derived from the movement of air.

Tidal Energy

Energy derived from the movement of water.

STG16 : Nuclear Energy

Nuclear Energy

Energy derived from the nucleus of an atom.

Nuclear Energy Power Plant

A power plant that uses nuclear energy to generate electricity.

Sources of Nuclear Energy

Atomic Bomb
A nuclear weapon that uses nuclear energy to destroy targets.

Hydrogen Bomb
A nuclear weapon that uses nuclear energy to destroy targets.

Uses of Nuclear Energy

1. Nuclear energy is used to produce electricity.
2. Nuclear energy is used in medicine.
3. Nuclear energy is used to create nuclear weapons.

Effects of Nuclear Radiation

Nuclear radiation can be harmful to humans and the environment.

STG17 : Bio - Gas

BIO - GAS

Animal and plant wastes are easily digested by anaerobic micro-organisms in the presence of water, to produce gases such as methane, carbon dioxide, hydrogen and hydrogen sulphide. This mixture of gases is called biogas. Biogas can be burned to gas-stoves to give heat. It can also be used for electricity and for running engines. Two practical designs of biogas plants have been generally used: The Fixed Dome Type and The Floating Gas Holder Type.

FIXED-DOME TYPE BIO-GAS PLANT

FLOATING GAS-HOLDER TYPE BIO-GAS PLANT

USES OF BIO-GAS

STG18 : Nitrogen Cycle

Nitrogen Cycle

Nitrogen cycle is a process of nitrogen passing through the ecosystems. Nitrogen is taken up by plant roots in the form of nitrate, which is converted into protein by plant tissues. This nitrogen is utilized by the animals including the human beings. The dead plants and animals and their excreta pass nitrogen back to the soil.

Conversion of Nitrogen into Nitrates	Utilisation of Nitrogen by Plants and Animals	Return of Nitrogen to Soil
 The soil of thunderstorms contains nitrate ions which are high-molecular nitrogen-fixing bacteria.	 Plants absorb nitrate ions from the soil through their roots with the help of root nodules in leguminous plants.	 Bacteria and fungus feed on animal and plant wastes, which decompose nitrogenous substances.
 Farmers plough the soil to mix nitrates and other nutrients with soil.	 From excreting nitrogenous wastes.	 Soil also absorbs nitrogen from animal and plant wastes.
 Nitrogen fertilizers are used in agriculture to increase the nitrogen content of soil.	 Nitrogenous wastes are excreted by animals.	 The soil of the forest floor is rich in nitrogenous substances which are used by the organisms.

STG19 : Oxygen Cycle

Oxygen Cycle

Uses of Oxygen

STG20 : Carbon Cycle

Carbon Cycle

The percentage of carbon dioxide in air is around 0.03% by volume. A series of processes taking place in the atmosphere keep this value almost constant. Carbon Cycle is the sequence, which maintains the balance between the formation and removal of carbon.

Release of Carbon Dioxide	Utilisation of Carbon Dioxide
 Volcanic eruption.	 Photosynthesis by plants.
 Respiration by plants and animals.	 Decomposition of organic wastes in soil.
 Combustion of fossil fuels.	 Photosynthesis in water.
 Respiration in water.	 Photosynthesis in air.
 Combustion of fossil fuels.	 Photosynthesis in air.

STG21 : Fire and Fire Extinguishers

Fire and Fire Extinguishers

Combustion is a chemical reaction in which a fuel is rapidly oxidized. Three things required to sustain a fire are oxygen, fuel and ignition temperature. To kill a fire one or more of these three things need to be taken away.

Classification of Fires

There are five classes of fire according to the kind of material burning. These are as follows:

CLASS A: Involves ordinary combustibles like paper, wood, cloth, plastic, waste etc.	CLASS B: Involves inflammable liquids like petrol, kerosene, oil, alcohol, etc.	CLASS C: Involves inflammable gases like LPG, CNG, etc.	CLASS D: Involves flammable metals like magnesium, titanium, potassium, etc.	CLASS E: Involves electrical appliances.
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Use of Fire Extinguishers - PASS

Just follow **PASS** to learn how to use a fire extinguisher:

- Pull the locking pin.
- Aim the nozzle at the base of the fire.
- Squeeze the trigger.
- Sweep the extinguisher discharge from side to side over the area of the fire.

Types of Fire Extinguishers

Water based Extinguisher This is the most commonly used fire extinguisher for class A and class B fires. It could cause the combustible substance to catch fire again if the water reaches the supply of oxygen.	Foam Type Fire Extinguisher This fire extinguisher is used for class A and class B fires. This fire extinguisher uses aluminium sulphate and sodium bicarbonate to produce foam of carbon dioxide to put off fire. A substance named urea is added to the sodium bicarbonate solution to add foam to carbon dioxide.
Soda Acid Fire Extinguisher This fire extinguisher is used for class A, B and C fires. This fire extinguisher contains a metal container that holds a solution of sodium bicarbonate and a glass bottle containing sulphuric acid. When we press the handle, the bottle breaks and the acid comes in contact with sodium bicarbonate to produce carbon dioxide and water which is used to extinguish fire.	Carbon Tetrachloride Fire Extinguisher This fire extinguisher is used for class C fires. This fire extinguisher releases vapour of carbon tetrachloride, a non-combustible substance. The vapour acts as the combustible substance and cuts off the supply of oxygen to the fire.

STG22 : Soil - A Natural Resource

Soil - A Natural Resource

A natural resource is anything that comes from the earth to us and is used by us. Soil is our most important natural resource. We use it in the following ways:-

Food and Shelter By supporting the growth of plants, soil provides us with food and materials for clothing and shelter.	Minerals Minerals are extracted from soil and used for making medicines, fertilizers, pigments, etc. Minerals obtained from soil are phosphate and coal.	Building material Clay is used for making pots, bricks, tiles and pottery.	Underground water Water that seeps into soil is stored underground as ground water. This water is used for drinking and agricultural purposes.
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Soil Erosion

The process of carrying away soil by water, wind and other agents from one place to another is called soil erosion.

Types of Soil Erosion

Soil Conservation

The process of protecting soil from any damaging activity and making it suitable for cultivation. Soil conservation can be done by following:

Soil Pollution

Leaching of soil fertility or degradation of its characteristics is called soil pollution. Soil pollution is caused due to:

STG23 : How Soil is Formed and Soil Profile

How Soil is Formed and Soil Profile

Science which deals with the study of soil is called Pedology. When Earth was formed, the ground was mostly solid rock. The rocks partly changed into soil due to weathering. Weathering is breaking of huge rocks into smaller pieces by the action of natural forces.

Physical Weathering

WEAR
In summers whenever there is the covering of rocks, they expand. This expansion and contraction weakens the rocks and breaks them into smaller pieces.

WIND
Wind along with water rolls the small pieces of rock. As they bang against the ground and each other, they break into smaller pieces and form soil.

FLUCTUATION IN TEMPERATURES
Large variation in temperature also causes weathering. The rocks expand during the day and contract during the night. This expansion and contraction weakens the outer layer of rocks leading them to crack and crumble.

Biological Weathering

LIVING ORGANISMS
When the roots of trees grow through rocks, they exert great pressure on the rocks breaking them into smaller pieces, thereby forming soil.

Lichens and mosses grow on the surface of rocks and produce acids responsible for weathering of rocky surfaces. These acids and produce fine soil particles in cracks of rocks. Different insects and worms also help in the formation of soil.

Chemical Weathering

WEATHERING ROCKS
In hot and humid areas, the minerals in rocks react with oxygen to form their respective oxides. These oxidized rocks are called laterite soil.

Soil Profile

GENERAL SOIL PROFILE

Uppermost Layer (O-Horizon) Also called topsoil, it is the layer of humus or partially decomposed organic matter with little soil. This substance is rich in nutrients and is called topsoil.	Parent Rock (C-Horizon) Below the B horizon the top soil is also called parent rock. It is the material from which the soil is formed.
Top Soil (A-Horizon) It is also called subsoil. Humus present in this soil is less than in the top soil. The top soil is rich in nutrients and is called topsoil.	Bed Rock (R-Horizon) Bed rock is the hardest layer that lies below the parent rock. It is made of igneous and sedimentary rocks.
Subsoil (B-Horizon) Subsoil is the layer below the top soil. It is also called subsoil. It is the material from which the soil is formed.	

STG24 : Types of Soils in India

Types of Soils in India

Soil is the most important natural resource. We depend on it for our needs, especially food. India is rich in natural resources such as soil and the rich variety of soil increases the vegetation and food products. India has six main types of soils.

INDIA REGUR SOIL Found in arid and semi-arid regions of Rajasthan, Gujarat, Madhya Pradesh, Karnataka, Andhra Pradesh, etc. It is a black soil. It is rich in calcium and magnesium. It is used for growing cotton and sugarcane.	INDIA ALLUVIAL SOIL Found in plains of northern, north-eastern, eastern and southern parts of India. It is a soil formed by the deposition of sediments. It is rich in nutrients and is used for growing wheat, rice, etc.
INDIA RED SOIL Found in the eastern regions of India, Tamil Nadu, parts of Rajasthan, Gujarat, Karnataka, Andhra Pradesh, etc. It is a soil formed by the weathering of igneous rocks. It is rich in iron and is used for growing cotton, sugarcane, etc.	INDIA BLACK SOIL Found in the western regions of India, Maharashtra, Madhya Pradesh, Karnataka, Andhra Pradesh, etc. It is a soil formed by the weathering of basaltic rocks. It is rich in calcium and magnesium. It is used for growing cotton and sugarcane.
INDIA DESERT SOIL Found in the western part of Rajasthan. It is a soil formed by the weathering of igneous rocks. It is rich in calcium and magnesium. It is used for growing wheat, etc.	INDIA ARID SOIL Found in the western part of Rajasthan. It is a soil formed by the weathering of igneous rocks. It is rich in calcium and magnesium. It is used for growing wheat, etc.

STG25 : Food Chain in Forest Ecosystem

Food Chain in Forest Ecosystem

A Simple Food Chain in Forest

A Food Web in Forest

STG26 : Solar Cooker

Solar Cooker

The solar cookers are safest and cheapest mode of cooking. They utilize solar energy to cook the food. Depending upon the method in which the solar energy is utilized in the solar cookers, they are divided into various types.

Box Type Solar Cooker

Parabolic Type Solar Cooker

Panel Type Solar Cooker

STG27 : Water Harvesting

Water Harvesting

Water Harvesting is a way to capture the rain water when it rains, store that water above ground or direct it into a well or into a tank. This happens naturally in open rural areas. But in congested, over-populated metropolitan cities, we need to create methods to capture the rain water.

The total amount of water that is received in the form of rainfall over an area is called rainwater endowment of the area. Out of this amount that can be effectively harvested is called the Water Harvesting Potential.

Water Harvesting Potential = Rainfall (mm) × Collection Efficiency

Flow Chart Showing Ways of Water Harvesting

Water Harvesting in a Town

Water Harvesting in a Village

Water harvesting can serve the following purposes:

- Provide drinking water.
- Provide irrigation water.
- Increase groundwater recharge, when floods and overloading of sewage treatment plants.
- Reduce seawater ingress in coastal areas.

STG28 : Purification of Water

Purification of Water

BOILING
It is a simple method of water purification. Boiling kills many bacteria and micro-organisms.

DISTILLATION
99.9% pure water can be obtained by distillation. It involves boiling of water to produce water vapours. The vapours on cooling condense as a pure liquid.

FILTRATION
Slow sand filters are used for treating raw water to produce a potable product. Apart from impurities, it also removes 90-98% bacteria.

CHLORINATION
Chlorination is one of the most common and relatively cheap method of water purification. Chlorine tablets deactivate most of the micro-organisms.

REVERSE OSMOSIS
R.O. is used to purify water on large scale to remove salts and impurities in order to improve the colour, taste or properties of fluid. Mechanical pressure is applied to impure water to force pure water through a semi-permeable membrane.

DOMESTIC R.O. SYSTEM

STG29 : Poultry

Poultry

Subspecies Breed

Exotic Breeds

POULTRY FEEDS

EQUIPMENTS REQUIRED

MARKING UNDER BROODERS

FEED FORMULAE Parts in 100 kg

Ingredients	Part 1	Part 2	Part 3
Cracked maize	18	12	20
Wheat	18	12	20
Groundnut cake	10	10	10
Cracked rice	10	10	10
Cracked sorghum	10	10	10
Cracked millet	10	10	10
Cracked jowar	10	10	10
Cracked bajra	10	10	10
Cracked ragi	10	10	10
Cracked kodo	10	10	10
Cracked mochi	10	10	10
Cracked foxtail	10	10	10
Cracked barnyard grass	10	10	10
Cracked finger millet	10	10	10
Cracked little millet	10	10	10
Cracked proso millet	10	10	10
Cracked browntop millet	10	10	10
Cracked guinea millet	10	10	10
Cracked barnyard grass	10	10	10
Cracked finger millet	10	10	10
Cracked little millet	10	10	10
Cracked proso millet	10	10	10
Cracked browntop millet	10	10	10
Cracked guinea millet	10	10	10

DISEASE TABLE

Disease	Major Symptoms
Ascariasis	Weight loss, diarrhoea, anaemia, emaciation, weakness, depression, cough, sneezing, and watery eyes.
Brucellosis	Weakness, depression, emaciation, cough, sneezing, and watery eyes.
Coccidiosis	Diarrhoea, weakness, depression, emaciation, cough, sneezing, and watery eyes.
Salmonellosis	Diarrhoea, weakness, depression, emaciation, cough, sneezing, and watery eyes.
Colibacillosis	Diarrhoea, weakness, depression, emaciation, cough, sneezing, and watery eyes.
Septicemia	Diarrhoea, weakness, depression, emaciation, cough, sneezing, and watery eyes.
Septicemic colitis	Diarrhoea, weakness, depression, emaciation, cough, sneezing, and watery eyes.
Septicemic enteritis	Diarrhoea, weakness, depression, emaciation, cough, sneezing, and watery eyes.
Septicemic enterocolitis	Diarrhoea, weakness, depression, emaciation, cough, sneezing, and watery eyes.
Septicemic proctocolitis	Diarrhoea, weakness, depression, emaciation, cough, sneezing, and watery eyes.
Septicemic coloproctitis	Diarrhoea, weakness, depression, emaciation, cough, sneezing, and watery eyes.

TOO HOT
If the chicks move away from the heat source and are chirping, the temperature is too warm.

TOO COOL
If too many chicks huddle under the brooder, the temperature is too cold.

STG30 : Sericulture

Sericulture

Life Cycle of Silkworm (Bombyx Mori)

There are four different species of silkworms:

1. Mulberry
2. Tassar
3. Muga
4. Eri

Stages of Production

STG31 : Apiculture

Apiculture

QUEEN HONEY BEE

ARTIFICIAL BEE HIVE

LIFE CYCLE OF HONEY BEE

HONEY EXTRACTOR

HONEY EXTRACTION AND PACKAGING PROCESS

BEE WAGGLE DANCE

STG32 : Food Pyramid

Food Pyramid

Food pyramid is a pyramid-shaped nutrition guide divided into sections to show the recommended intake for each food group.

FATS, OILS AND SWEETS (USE SPARINGLY)

MEAT, MEAT SUBSTITUTES AND OTHER PROTEIN SOURCES (2-3 SERVINGS)

FRUITS (2-3 SERVINGS)

BREADS, GRAINS AND OTHER STARCHES (4-6 SERVINGS)

VEGETABLES (3-4 SERVINGS)

MILK AND MILK PRODUCTS (2-3 SERVINGS)

WATER (8 SERVINGS)

COMPONENTS OF FOOD

BALANCED DIET

It is a diet which contains all the nutrients in proper amounts to help in normal growth and development.

STG33 : Microorganisms

Microorganisms

Microorganisms are the living organisms around us which require magnification to see and resolve their structures. Microorganisms have a high degree of adaptability and can survive in almost all kinds of environments like hot springs, ice-cold waters, saline waters, desert or even marshes. Microorganisms are grouped as bacteria, fungi, protozoa, algae and viruses.

Bacteria

Fungi

Algae

Viruses

Protozoa

STG34 : Mutation

Mutation

A mutation occurs when a DNA gene is damaged or changed in such a way as to alter the genetic message carried by that gene.

TYPES OF MUTATION

INSERTION

A section of DNA is inserted.

DUPLICATION

A section gets multiplied.

DELETION

A section of DNA is deleted.

INVERSION

Reversing the order of a chromosomal segment.

TRANSLOCATION

Transfer of a part from one chromosome to another.

FRAME SHIFT

Deleting or inserting a nucleotide shifts the reading frame.

POINT MUTATION

Change in a single nucleotide.

SILENT - has no effect on the protein sequence.

MISSING - results in an error substitution.

STOP - substitution stops code for an amino acid.

STG35 : Enzymes

Enzymes

Enzymes are globular proteins with enormous catalytic power with which they greatly enhance the rate of almost all specific reactions. They do this by lowering the activation energy. Activation energy is the minimum energy required to initiate a chemical reaction.

Structure

Active site: The region on an enzyme where substrate molecules bind and undergo a chemical reaction.

Mechanism of Enzyme

$E + S \rightleftharpoons ES \rightarrow EP \rightarrow E + P$

Enzyme Lower the Activation Energy of a Reaction

Classification of Enzyme

- Oxidoreductases / Oxidoreductases
- Transferases
- Hydrolases
- Lipases

Factors Affecting Enzyme Activity

Temperature

pH

Change in Substrate Concentration

Binding of Specific Chemicals to Enzymes

STG36 : DNA Replication

DNA Replication

DNA Replication is a biological process in which each of the two strands of DNA molecule serves as template for the formation of complementary strands. The process is SEMICONSERVATIVE REPLICATION.

INITIATION

The origin of replication site is recognized by initiator protein called **Dna A**.

ELONGATION

Helicase unwinds the DNA helix. Single stranded binding proteins (SSB) bind to the unpaired DNA strands and prevent them from reannealing. Topoisomerase helps relieve the strain on the remaining DNA.

RNA primase gets attached to the 5' prime end of the template strand by RNA primase.

TERMINATION

At termination site, the replication terminates and two daughter DNA strands are formed.

For your requirements of items for Science lab, please ask for our separate catalogue.

Human Physiology, Food & Nutrition, Diseases, Yogasan Charts

SCIENCE AND TECHNOLOGY
General Science Charts
Laminated Art, Size 58 x 90 cm (In English only)

PT03S : Modern Periodic Table of the Elements

MODERN PERIODIC TABLE OF THE ELEMENTS

LONG FORM

GROUPS: IA, IIA, IIIA, IVA, VA, VIA, VIIA, VIIIA, 0

PERIODS: 1, 2, 3, 4, 5, 6, 7

LEGEND:

- Metals:** Blue, Green, Yellow, Orange, Red, Pink, Purple, Grey
- Nonmetals:** Light Blue, Light Green, Light Yellow, Light Orange, Light Red, Light Purple
- Metalloids:** Yellow-Green, Yellow-Orange, Orange-Red, Red-Purple, Purple-Blue

INDEX: Lists elements by atomic number (1-118) and name.

PT07S : Mendeleev's Periodic Table

MENDELEEV'S PERIODIC TABLE

THE PROPERTIES OF ELEMENTS ARE A PERIODIC FUNCTION OF THEIR ATOMIC MASSES.

RESULTS OF MENDELEEV'S CLASSIFICATION OF ELEMENTS

- Mendeleev's periodic law predicted the existence of some elements that had not been discovered at that time.
- Mendeleev's periodic table could predict the properties of several elements on the basis of their position in the periodic table.
- Mendeleev's periodic table could accommodate some gaps when they were discovered.

ANOMALIES OF MENDELEEV'S CLASSIFICATION OF ELEMENTS

- The position of hydrogen could not be explained.
- Wrong order of atomic masses of some elements could not be explained.
- A correct position could not be assigned to hydrogen in the periodic table.

PERIOD	GROUP I R ⁺ O	GROUP II RO	GROUP III R ³⁺ O ³⁻	GROUP IV RH ⁴⁺ RO ²⁻	GROUP V RH ⁵⁺ R ³⁺ O ³⁻	GROUP VI RH ⁶⁺ RO ³⁻	GROUP VII RH ⁷⁺ R ²⁺ O ³⁻	GROUP VIII RO ³⁻
1	Hydrogen (H) = 1.008							
2	Lithium (Li) = 6.938	Beryllium (Be) = 9.012	Boron (B) = 10.81	Carbon (C) = 12.011	Nitrogen (N) = 14.007	Oxygen (O) = 15.999	Fluorine (F) = 18.998	
3	Sodium (Na) = 22.99	Magnesium (Mg) = 24.31	Aluminium (Al) = 26.98	Silicon (Si) = 28.09	Phosphorus (P) = 30.974	Sulphur (S) = 32.06	Chlorine (Cl) = 35.453	
4	Potassium (K) = 39.102	Calcium (Ca) = 40.08	Scandium (Sc) = 44.96	Titanium (Ti) = 47.88	Vanadium (V) = 50.94	Chromium (Cr) = 52.00	Manganese (Mn) = 54.94	Iron (Fe) = 55.85, Cobalt (Co) = 58.93, Nickel (Ni) = 58.71
5	Copper (Cu) = 63.54	Zinc (Zn) = 65.37	Gallium (Ga) = 69.72	Germanium (Ge) = 72.58	Arsenic (As) = 74.92	Selenium (Se) = 78.96	Bromine (Br) = 79.906	
6	Rubidium (Rb) = 85.47	Strontium (Sr) = 87.62	Yttrium (Y) = 88.91	Zirconium (Zr) = 91.22	Niobium (Nb) = 92.91	Molybdenum (Mo) = 95.94	Technetium (Tc) = 98	Ruthenium (Ru) = 101.07, Rhodium (Rh) = 102.91, Palladium (Pd) = 106.4
7	Silver (Ag) = 107.87	Cadmium (Cd) = 112.40	Iodine (I) = 126.90	Tin (Sn) = 118.71	Antimony (Sb) = 121.75	Tellurium (Te) = 127.60	Iodine (I) = 126.90	
8	Caesium (Cs) = 132.90	Barium (Ba) = 137.34	Lanthanum (La) = 138.91	Cerium (Ce) = 140.12				
9								
10			Ytterbium (Yb) = 173.04	Hafnium (Hf) = 178.49	Tantalum (Ta) = 180.95	Tungsten (W) = 183.85		Osmium (Os) = 190.2, Iridium (Ir) = 192.2, Platinum (Pt) = 195.09
11	Gold (Au) = 196.97	Mercury (Hg) = 200.59	Thallium (Tl) = 204.37	Lead (Pb) = 207.19	Bismuth (Bi) = 208.98			
12				Thorium (Th) = 232.04		Uranium (U) = 238.03		

(In the formulae for oxides and hydroxides, the letter 'R' is used to represent any of the elements in the groups.)

CL01S : Laboratory Safety

LABORATORY SAFETY

Key Safety Rules:

- Wear eye protection at all times.
- Use fume hoods for volatile chemicals.
- Never eat or drink in the lab.
- Use proper disposal methods for waste.
- Know the location of safety equipment (eyewash, fire extinguisher).

CL02S : Laboratory Techniques

LABORATORY TECHNIQUES

Key Techniques:

- Proper use of glassware (burets, flasks, beakers).
- Distillation and reflux setups.
- Filtration and decantation.
- Accurate weighing and volume measurement.

CL03S : pH Colour Chart



CL04S : Laboratory First Aid

LABORATORY FIRST AID

Report all Accidents, Injuries and Spills Immediately!!!

Emergency Procedures:

- Chemical Burns to Eye:** Flush with water for 15 minutes.
- Chemical Burns to Body:** Remove contaminated clothing.
- Cuts and Bruises:** Apply first aid and seek medical attention.
- Fainting or Collapse:** Lay person flat and call for help.
- Electric Burn:** Turn off power and seek medical help.
- Minor Thermal Burns:** Cool with water and cover with a clean cloth.
- Poisoning:** Do not induce vomiting; call poison control.
- Glass Piece in Skin:** Do not remove; seek medical attention.
- Foreign Matter in Eyes:** Flush with water and seek medical attention.
- Clothes on Fire:** Stop, drop, and roll; seek medical attention.

GE01S : Pedigree Analysis - 1

PEDIGREE ANALYSIS - 1

STANDARD SYMBOLS AND SAMPLE PEDIGREES

Standard symbols used in Pedigree Analysis

- Male (square)
- Female (circle)
- Unaffected (white)
- Affected (shaded)
- Carrier (circle with a dot)
- Proband (square with a star)
- Consanguinity (double line)
- Stillborn (square with a diagonal line)
- Adopted (square with a dashed border)
- Deceased (square with a diagonal line)
- Sex unspecified (diamond)
- Unknown status (circle with a question mark)

SAMPLE PEDIGREES

Pedigree 1 : Inheritance of an autosomal dominant trait

Pedigree 2 : Inheritance of an autosomal recessive trait

Pedigree 3 : Inheritance of an X-linked recessive trait

GE05S : Pedigree Analysis - 5

PEDIGREE ANALYSIS - 5

X-LINKED RECESSIVE INHERITANCE

Pedigree of Hypophosphatasia

Pedigree of Deoxy Lactate

Legend:
 Affected individual (shaded)
 Normal individual (white)
 Carrier (circle with a dot)
 Affected male (shaded square)
 Normal male (white square)
 Affected female (shaded circle)
 Normal female (white circle)
 Carrier female (circle with a dot)
 Affected individual with consanguinity (square with a star and double line)
 Normal allele (white)
 Affected allele (shaded)

GE02S : Pedigree Analysis - 2

PEDIGREE ANALYSIS - 2

MITOCHONDRIAL INHERITANCE

Myotonic Dystrophy Pedigree

Tongue Curler Pedigree

Legend:
 Affected individual (shaded)
 Normal individual (white)
 Affected male (shaded square)
 Normal male (white square)
 Affected female (shaded circle)
 Normal female (white circle)
 Affected allele (shaded)
 Normal allele (white)

GE06S : Pedigree Analysis - 6

PEDIGREE ANALYSIS - 6

Y-LINKED TRAITS : HYPERTRICHOSIS

Nitochondrial Inheritance : Pedigree

Legend:
 Affected individual (shaded)
 Normal individual (white)
 Affected male (shaded square)
 Normal male (white square)
 Affected allele (shaded)
 Normal allele (white)

GE03S : Pedigree Analysis - 3

PEDIGREE ANALYSIS - 3

MITOCHONDRIAL RECESSIVE TRAIT

Inheritance of Attached Ear Lobe

Inheritance of Sickle Cell Anemia

Legend:
 Affected individual (shaded)
 Normal individual (white)
 Affected male (shaded square)
 Normal male (white square)
 Affected female (shaded circle)
 Normal female (white circle)
 Affected allele (shaded)
 Normal allele (white)

GE07S : Homologous Organs Animals

HOMOLOGOUS ORGANS - ANIMALS

Comparative anatomy and morphology shows similarities in the pattern of bones of forelimbs of different vertebrates. Though these forelimbs perform different functions in these animals, they have similar anatomical structure. Hence, in these animals, the same structure developed along different directions resulting in divergent evolution. These structures are homologous and hence, common ancestry.

HUMAN FORELIMB

DOLPHIN FORELIMB

TURTLE FORELIMB

BIRD FORELIMB

BAT FORELIMB

HORSE FORELIMB

GE04S : Pedigree Analysis - 4

PEDIGREE ANALYSIS - 4

X-LINKED RECESSIVE TRAIT

Haemophilia Pedigree

Colour Blindness Pedigree

Legend:
 Affected individual (shaded)
 Normal individual (white)
 Carrier (circle with a dot)
 Affected male (shaded square)
 Normal male (white square)
 Affected female (shaded circle)
 Normal female (white circle)
 Carrier female (circle with a dot)
 Affected allele (shaded)
 Normal allele (white)

GE08S : Analogous Organs - Animals

ANALOGOUS ORGANS - ANIMALS

Wings of Birds, Butterfly, Bat and Pterosaur are not anatomically similar structures though they perform similar functions. They are the result of convergent evolution.

WINGS OF BAT

WINGS OF BIRD

WINGS OF BUTTERFLY

WINGS OF PTEROSAUR

GENETICS AND EVOLUTION CHARTS

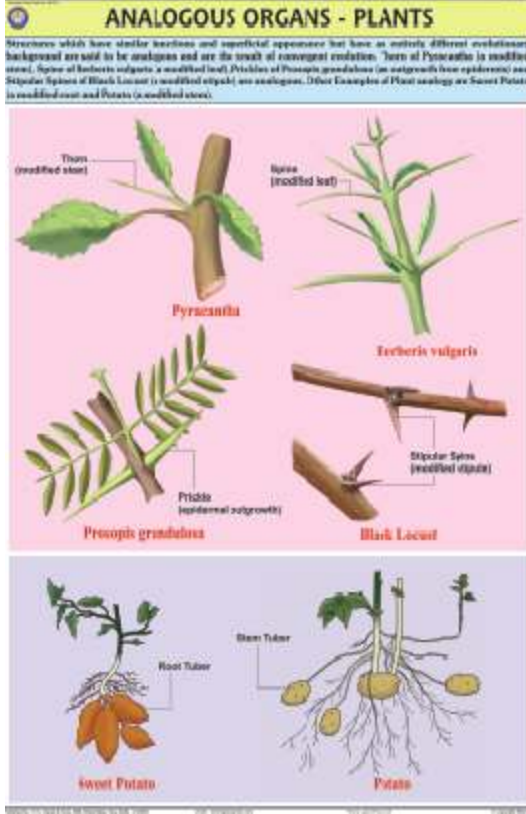
A set of 13 charts

Synthetic, Size 70 x 100 cm (In English only)

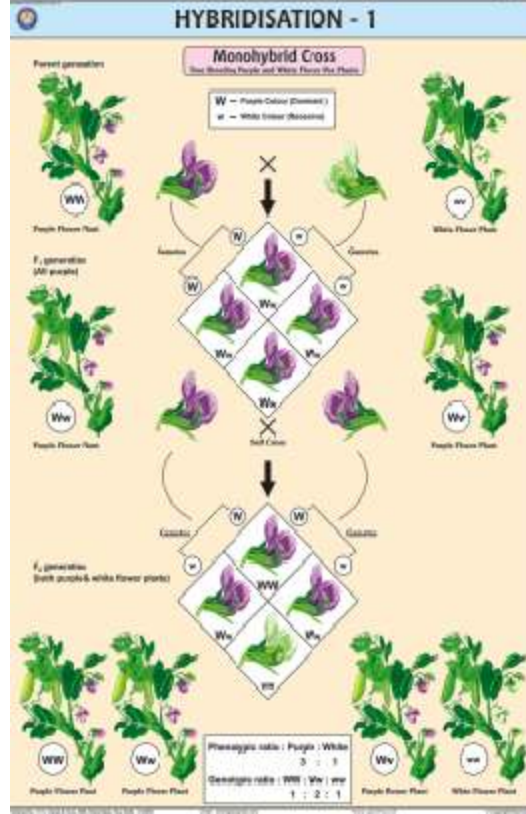
GE09S : Homologous Organs - Plant



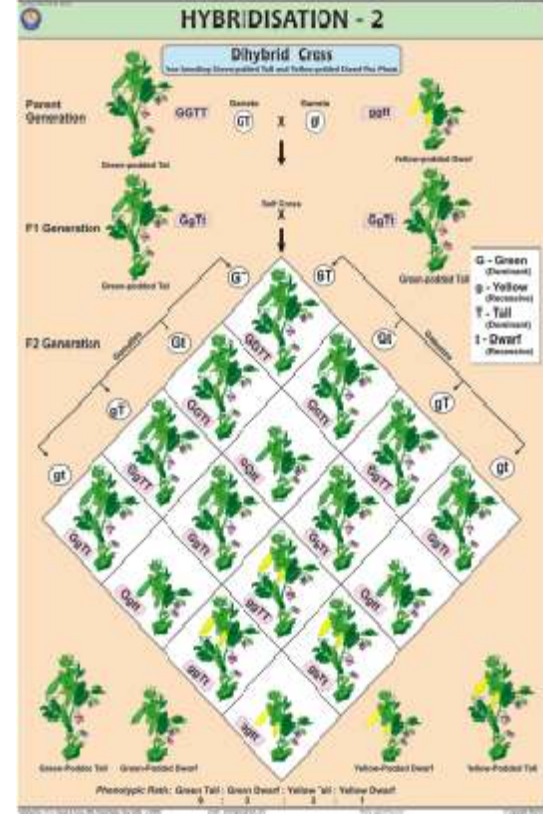
GE10S : Analogous Organs - Plants



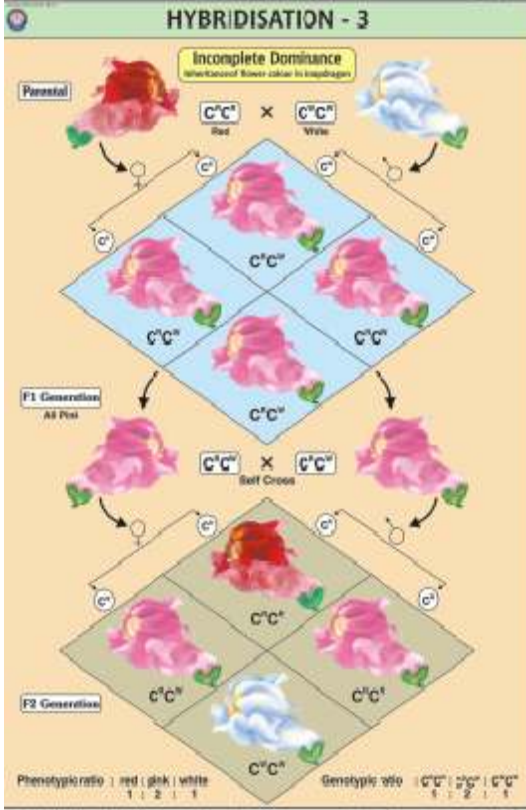
GE11S : Hybridisation - 1



GE12S : Hybridisation - 2



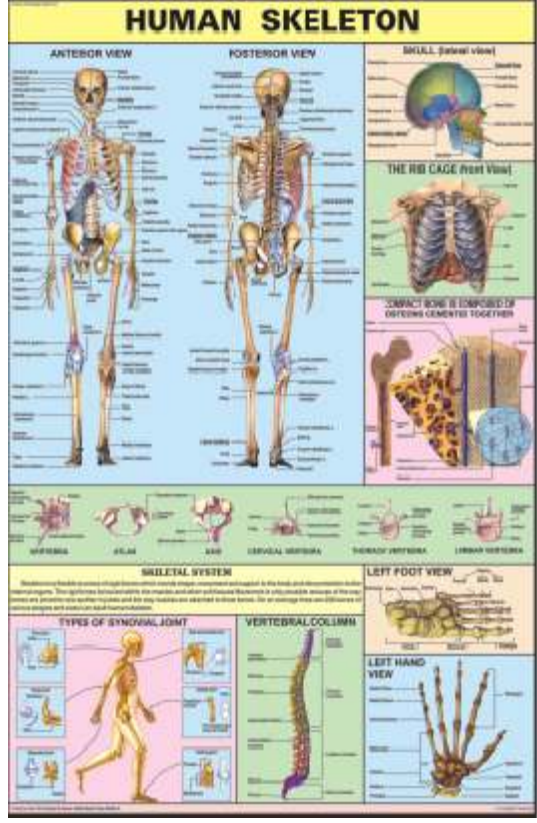
GE13S : Hybridisation - 3



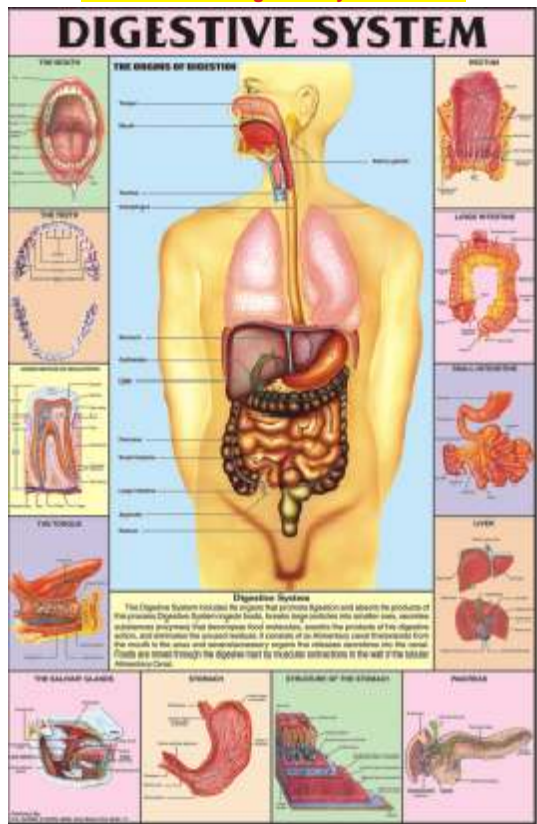
HUMAN PHYSIOLOGY CHARTS

A set of 31 charts
Synthetic , Size 70 x 100 cm (In English only)

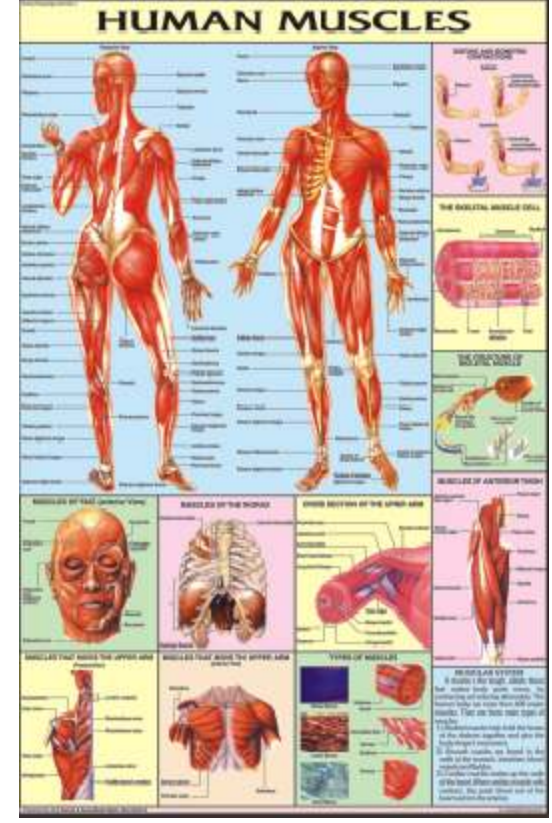
HP01S : Human Skeleton



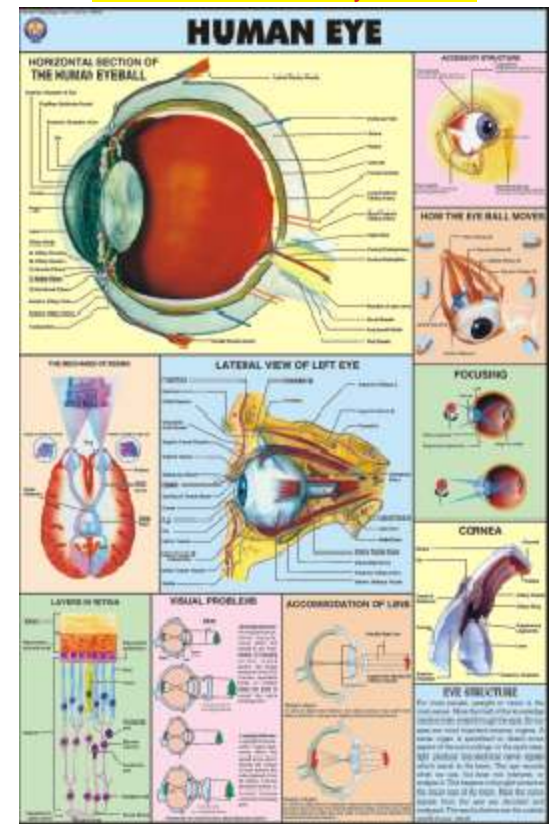
HP05S : Digestive System



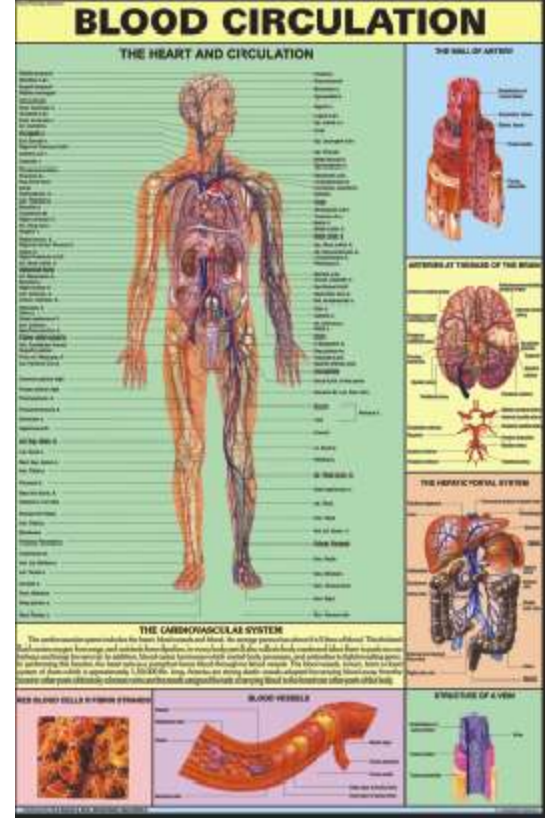
HP02S : Human Muscles



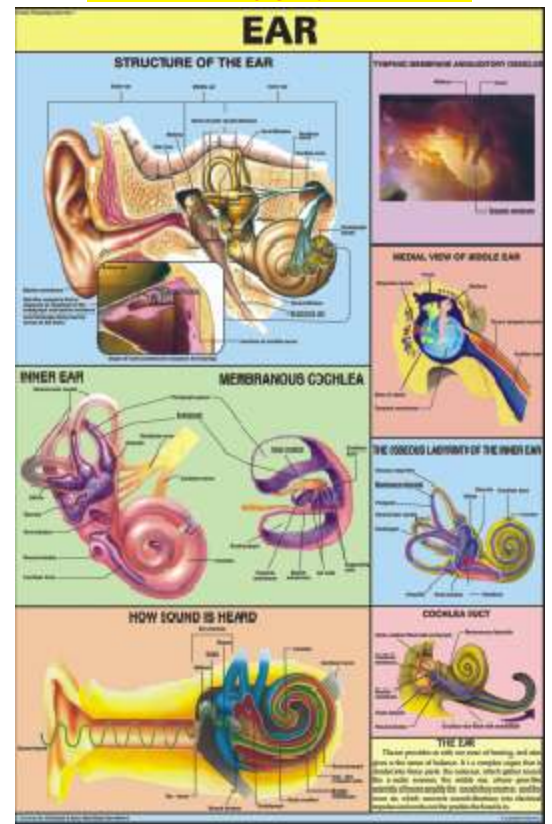
HP06S : Human Eye



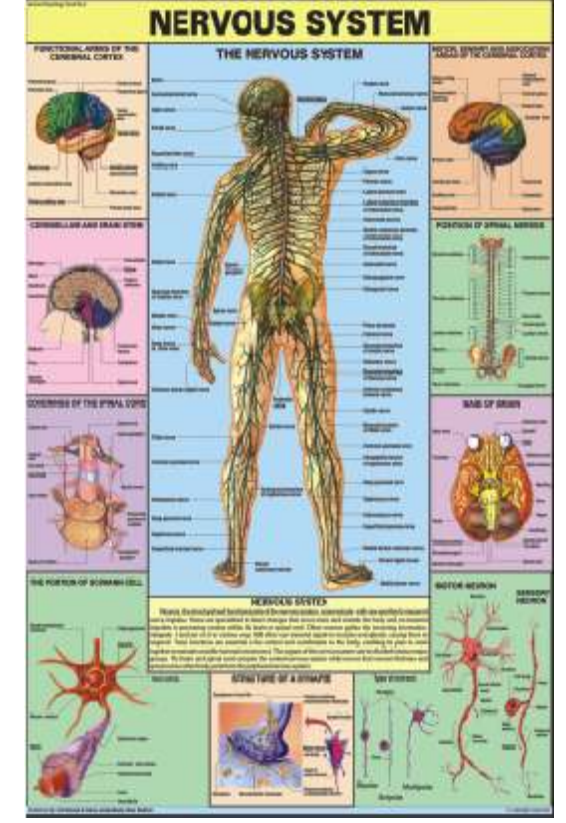
HP03S : Blood Circulation



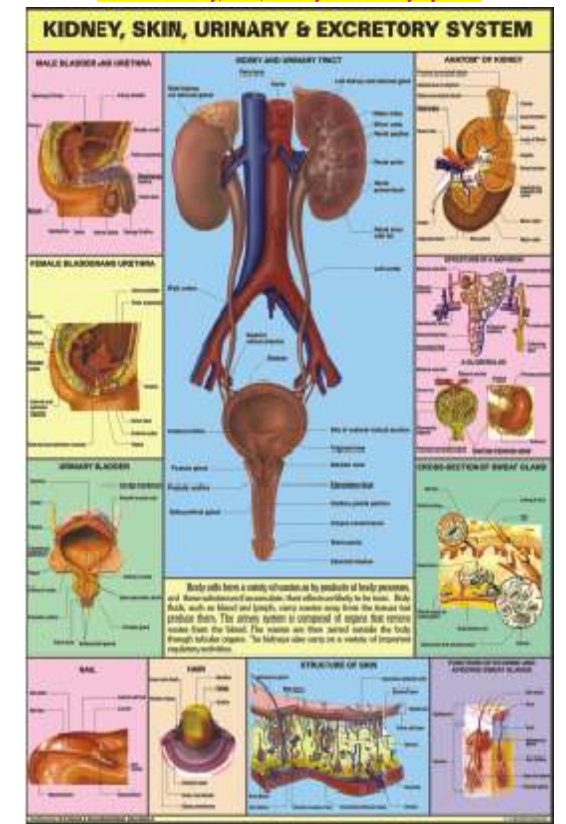
HP07S : Ear



HP04S : Nervous System



HP08S : Kidney, Skin, Urinary & Excretory System



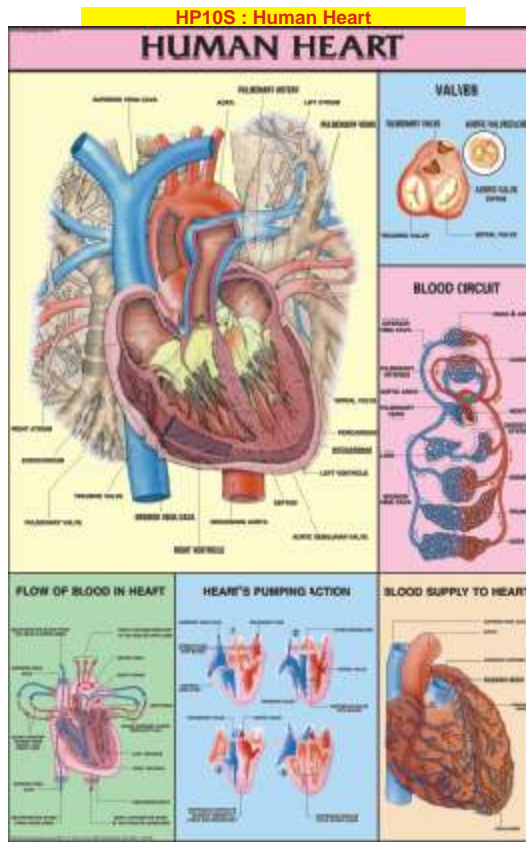
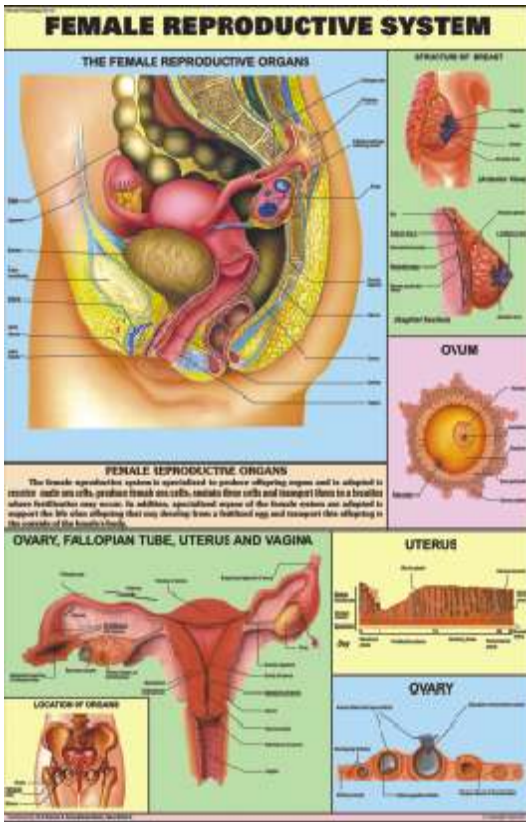
HUMAN PHYSIOLOGY CHARTS

A set of 31 charts

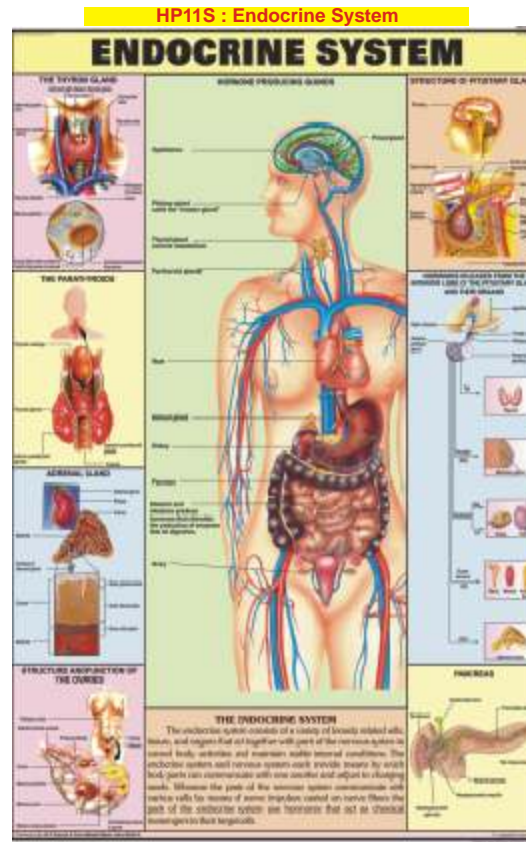
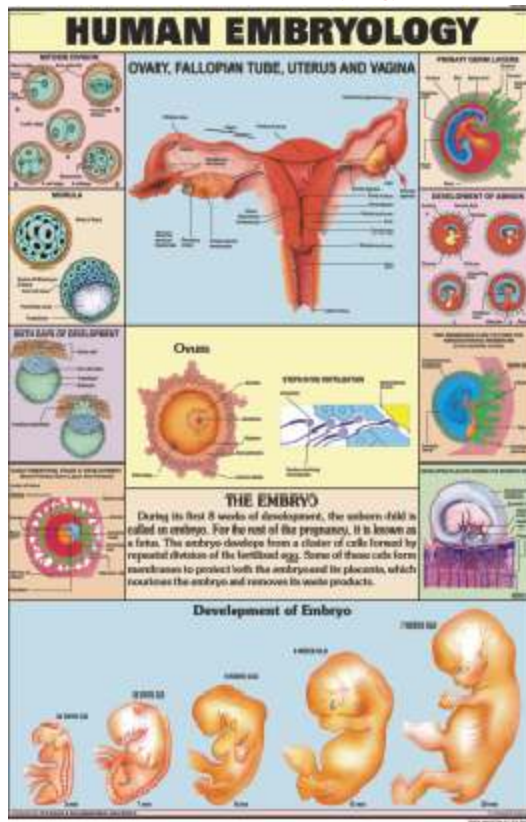
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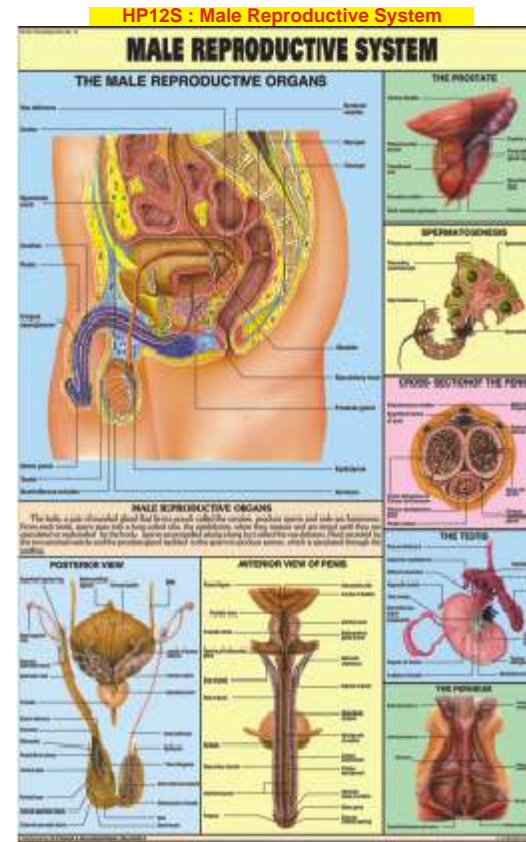
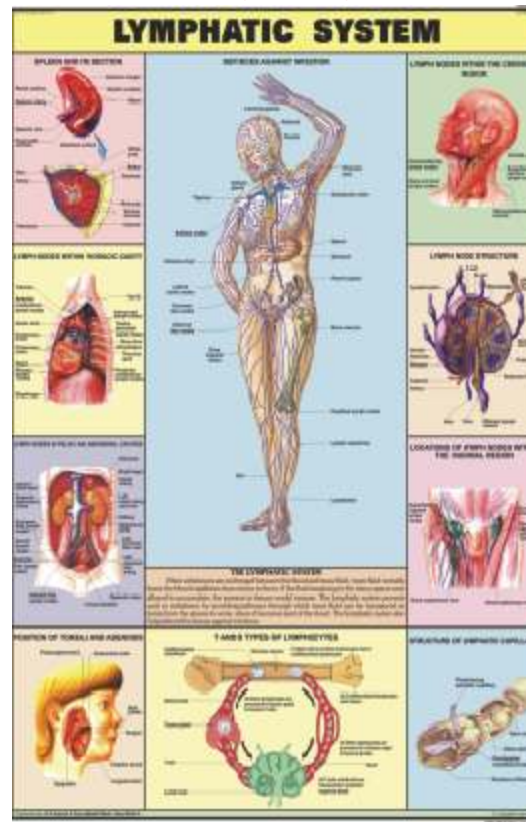
HP13S : Female Reproductive System



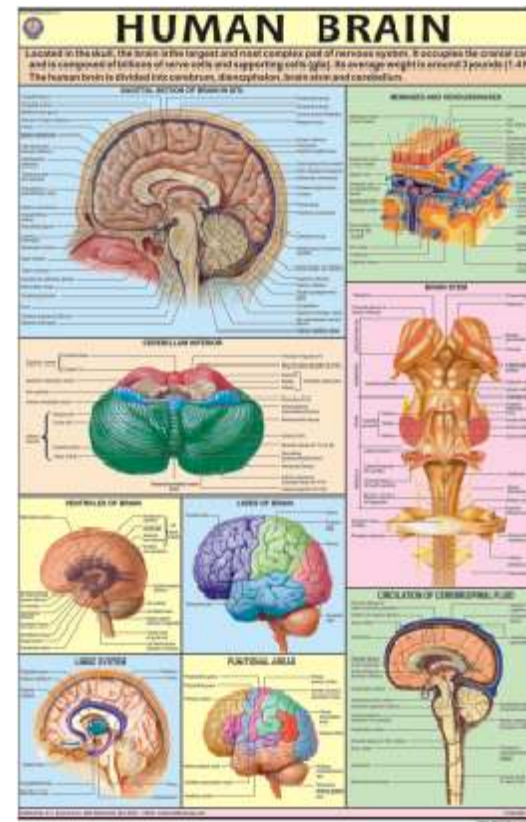
HP14S : Human Embryology



HP15S : Lymphatic System



HP16S : Human Brain



HUMAN PHYSIOLOGY CHARTS

A set of 31 charts
Synthetic, Size 70 x 100 cm (In English only)

HP17S : Human Teeth

HUMAN TEETH

Teeth are vertical keratinized appendages to the jaw bones and with special attachments to the jaws. Humans develop two sets of teeth in a normal lifetime. The first set, in mammals, are known as the deciduous, primary or baby teeth. The secondary or permanent set, comprising 32 teeth, begins to erupt in the late teens and the age of 20 years. There are 16 teeth in each jaw.

STRUCTURE OF THE MOUTH

TEETH-STRUCTURE

TEETHING

TYPES OF TEETH

MANDIBULAR DENTAL ARCADE

MARILLARY AND MANDIBULAR TEETH (SUPERIOR - Lateral aspect)

ROOT CANAL THERAPY

HP18S : Pregnancy And Birth

PREGNANCY AND BIRTH

Pregnancy is the state of having a developing fetus in the uterus which extends from conception to labor terminated.

Pregnancy takes approximately 283 days from the first day of last menstrual period (approximately 267 days from conception).

Perfission and Penetration of Blastocyst

Development of Chorion and Amnion

Placenta

STAGES OF LABOUR (PARTURITION)

Amniotic Sacs

HP19S : Human Kidney

HUMAN KIDNEY

Right Kidney (Superior)

Left Kidney (Superior)

Blood Vessels in Parenchyma of Kidney

Renal Capsule

Renal Artery

Renal Vein and Vein in Iliac

HP20S : Urinary Tract

URINARY TRACT

The urinary system regulates the volume and composition of fluids in the body and excretes waste products and excess fluid. Urine produced and filtered from the blood by the kidneys for excretion in the urine, which descends through the ureters to the bladder. Urine is stored here until a convenient time, then the muscles at the bladder contract, allowing it to be expelled from the body through the urethra.

Female Urinary Tract (Superior section)

Female Urinary Tract (Inferior section)

Male Bladder

Male Urinary Tract (Superior section)

Male Urinary Tract (Inferior section)

HP21S : Human Skull

HUMAN SKULL

The skull houses the brain, and a part of the vestibular apparatus, sensory organs, and the respiratory tract. It is composed of the brain, facial bones, and cranial base. The skull is divided into the neurocranium and viscerocranium.

Skull (Anterior)

Skull (Posterior)

Skull (Lateral)

Skull (Superior)

Skull (Inferior)

Skull (Medial)

Skull (Lateral)

Skull (Superior)

Skull (Inferior)

HP22S : Ear, Nose & Throat

EAR, NOSE & THROAT

The ear has two main functions: to receive and transmit sound waves to the brain and to maintain equilibrium. The nose is the respiratory organ for air entering the body. The throat is the passage for food and air.

FRONTAL SECTION OF EAR

ROSTRAL SECTION OF EAR

PERIPHERAL SECTION OF EAR

ORBIT AND EYE

NOSE AND SINUSES

THROAT

ORIGIN OF CHORDS

ORIGIN OF CHORDS

ORIGIN OF CHORDS

HP23S : Liver, Gallbladder & Pancreas

LIVER, GALLBLADDER & PANCREAS

LIVER (Anterior)

LIVER (Dorsal)

LIVER LOBULE

GALLBLADDER AND BILIARY DUCT SYSTEM

PANCREAS

PANCREAS

PANCREAS

PANCREAS

PANCREAS

PANCREAS

HP24S : Human Lungs

HUMAN LUNGS

The lungs are soft, spongy, reddish organs located in the thoracic cavity. They are covered by the pleural membrane and are separated from the heart by the mediastinum. The lungs are divided into lobes and bronchi.

LUNGS

BRANCHES OF THE BRONCHIAL TREE

LYMPH VESSELS AND NODES OF LUNG

INTRAPLEURAL BLOOD CIRCULATION

NEURONIC FUNCTIONS OF THE LUNG

CROSS-SECTION OF ALVEOLUS

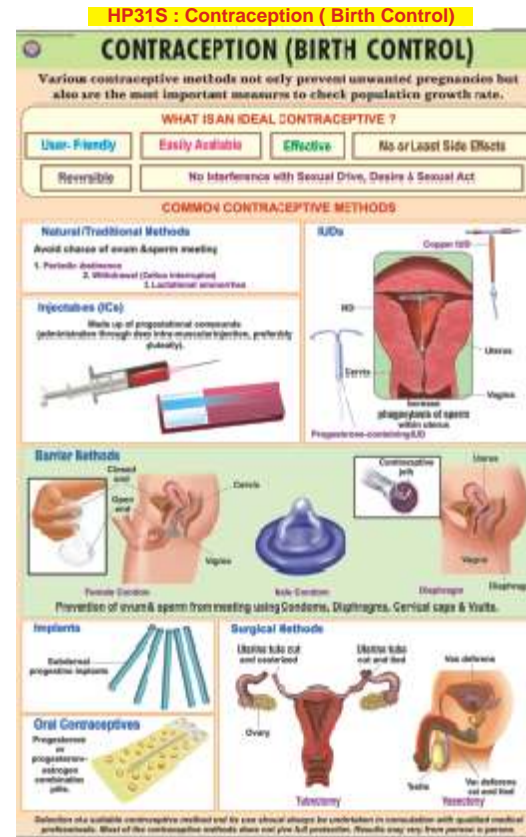
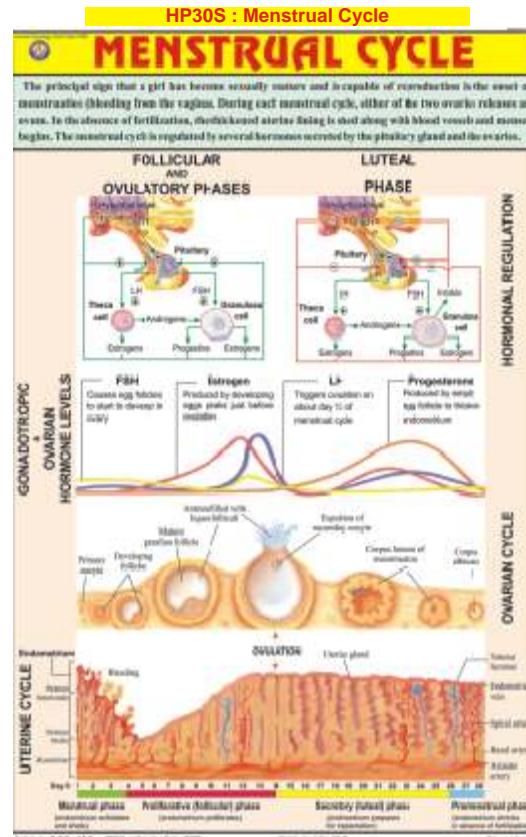
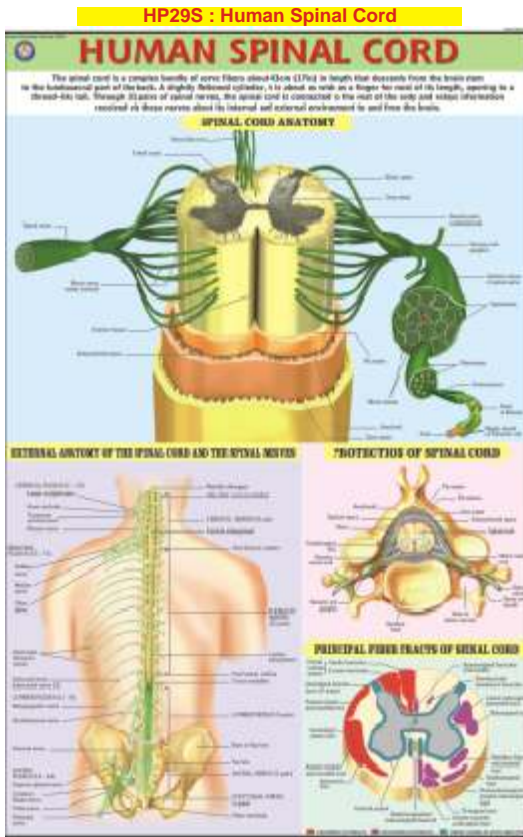
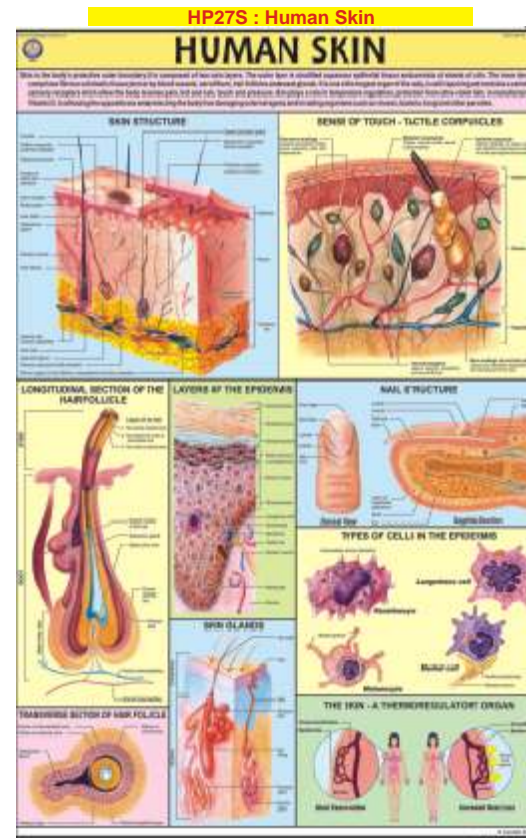
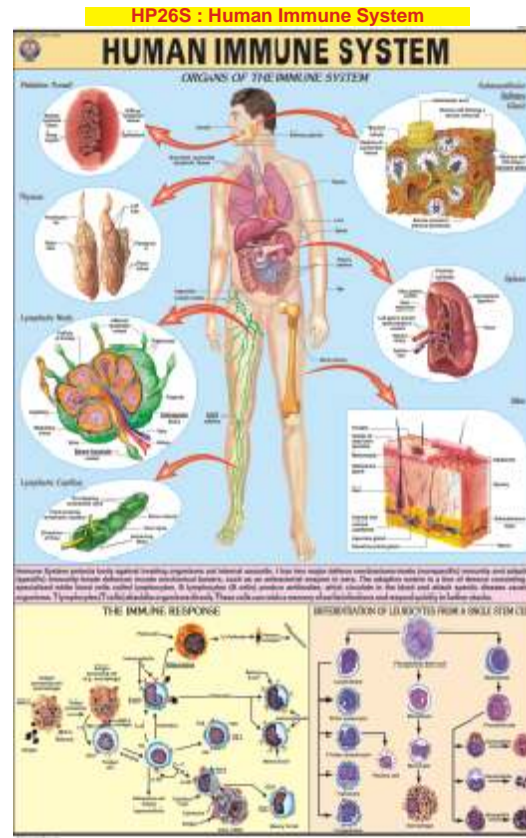
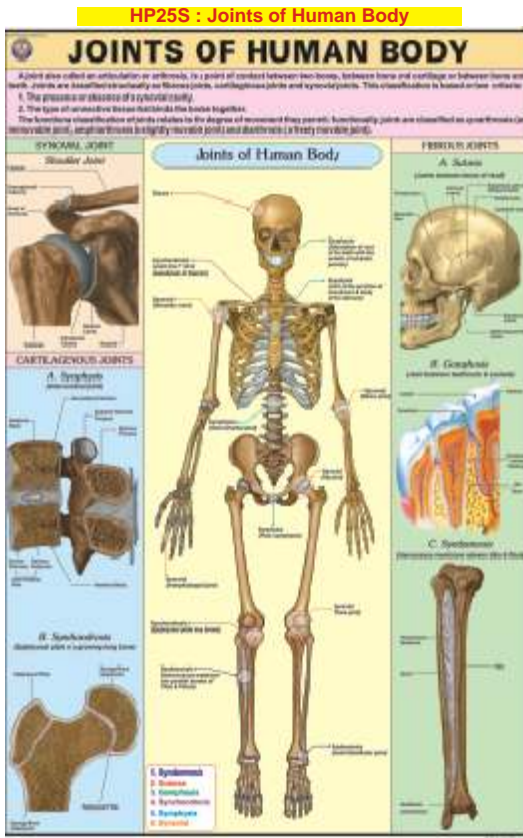
MEDIAL VIEW OF RIGHT LUNG

MEDIAL VIEW OF LEFT LUNG

HUMAN PHYSIOLOGY CHARTS

A set of 31 charts

Synthetic, Size 70 x 100 cm (In English only)



Human Physiology Charts
 The first fifteen charts of this series are also available in size 70 x 100 cm, Laminated, english - hindi combined.

Human Physiology Charts
Small size
 The first ten charts of this series are also available in size 50 x 75 cm, Laminated, english - hindi combined.

LIFE SKETCH OF SCIENTISTS

A set of 20 charts

Laminated, Size 45 x 57 cm (In English and Hindi Separately)

LSS04 : Birbal Sahni



Birbal Sahni 1891-1949

PALAEOBOTANIST

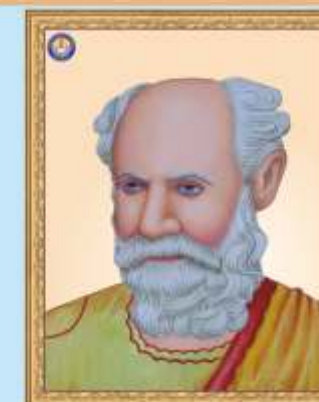
Birbal Sahni was the first child of Prof. Birbal Sahni and Shri. Sahni was born on November 16, 1891 at Sahni, near Patkote, in India. He followed a career path in geology. During his career, Sahni and his team had to go to the mountains to collect rocks, plants and fossils. These rocks were used to reconstruct the past and predict the future of the Earth. He was also a member of the Indian Civil Service. He took this job as his career.

After graduating from Punjab University, Lahore in 1913, he secured his Ph.D. from London University in 1915. Subsequently, he took up research in India, London and Brazil. He was the first Indian to study fossils in India. He was elected Fellow of the Royal Society of London. He was elected Vice-President of paleontological section of IAS and IAS International Geological Congress in 1938 and 1935 respectively. In 1940 he was elected as foreign honorary member of the American Academy of Arts and Sciences.

In 1938, Birbal started working in 1921 for work done at Birbal Sahni University as a professor. He was the first Indian to study invertebrate fossils in India. He discovered new genera of plants like *Protocladonia*, *Protocladonia*, *Protocladonia*, *Protocladonia*. He also discovered a new group of fossil *Campanulites* called *Pachylites*. Some of the paleontological studies have given support to the continental drift theory. He found that the age of the rock ranges from 60 to 80 million years old and not about 100 million years as believed till then. He found that *Devonian* trees in *Phillips* (Pakistan) were very hard, about 60 million years old. Sahni had a love for nature and his drawings are available in *Sketches* in 1930. He has written on the technique of using codes to reconstruct the past. He was awarded the Nehru Award for the Environment in 1971.

He established the Institute of paleontology. The foundation stone of the building was laid on 2nd April 1939 by Jawahar Lal Nehru. Unfortunately he was killed on the night of 9th and 10th April 1949. His institute is today known as the Birbal Sahni Institute of paleontology.

LSS03 : Archimedes



Archimedes 287 B.C. - 212 B.C.

MATHEMATICIAN & PHYSICIST

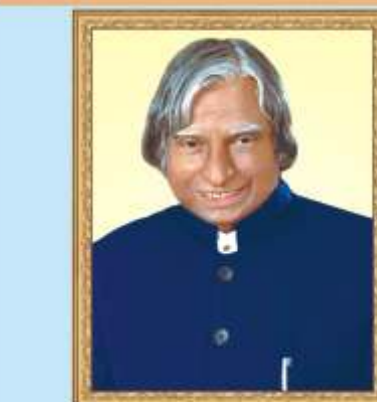
Archimedes was born on the eastern coast of Syracuse near Sicily in 287 B.C. The Hellenistic mathematician and physicist was related to Hieronymus of the ruling family of Syracuse. His father Phidias was an astronomer. He was an excellent swimmer whose arms were his compasses and his legs that influenced the world in many ways. He made his discovery in his bathtub and the crown was of pure gold.

Archimedes went to Alexandria, a great center of learning for mathematics and studied under mathematicians of great caliber like Eratosthenes and others who were skilled under Euclid. He studied other subjects like astronomy and mechanics. He was the first to report to his king that he had discovered his Eureka in the bath. He had a great passion for mathematics and designed a series of mechanical devices that brought him great fame. The most famous invention of his, which is still used today in Archimedes' screws. This screw was used to raise water from canals for irrigation. He was known for his compound pulley system used in his many tools such as cranes. He has also been credited with the invention of the planetarium during the first Punic War. It is said that Archimedes used a large group of mirrors to reflect sunlight onto the Roman ships to cause fire.

He discovered his famous Archimedes Principle, a classic work in hydrostatics while bathing in the bath. He discovered that the volume of the displaced fluid was equal to the volume of the object. He also discovered the principle of the screw. He was also the first to identify the concept of center of gravity. He gave an exact description of the spiral of Archimedes and his invention of the screw. He also discovered the method of exhaustion for the determination of the surface area and volume of curved surfaces and solids. He worked on the figure of a mathematical proof beyond the laws of the world. He proved that the area of a circle is equal to the area of a right-angled triangle whose base is the circumference and height is the radius.

Archimedes was killed in 212 B.C. by a Roman soldier during the second Punic War. He was killed while doing a mechanical demonstration on the sand. Despite orders that Archimedes should be taken alive and treated well, he would become involved when he was taken to Rome for study and then his death.

LSS02 : Dr. A. P. J. Abdul Kalam



DR. A. P. J. ABDUL KALAM

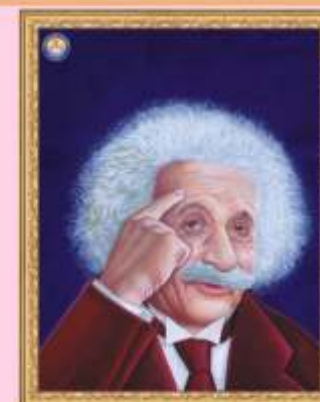
Missile Man

Often referred to as the Missile Man of India, Dr. Avul Paki Jamsheduddin Abdul Kalam has made the country self-reliant in missile technology and space technology. He was born on 15th October, 1931 in Rameswaram, Tamil Nadu. His father, Avudhu Pagan, a simple religious worker, was a fish trader. At a young age, Kalam was fascinated by the flight of kites and rockets. He started drawing rockets in his school days. He was a member of the Air Force Club and participated in various inter-school competitions. He was a member of the Air Force Club and participated in various inter-school competitions.

In 1955, Kalam joined the Defence Research and Development Organisation as a Junior Scientific Assistant. He developed a project for the development of a rocket engine. He was involved in the development of the Rohini missile. He was involved in the development of the Rohini missile. He was involved in the development of the Rohini missile. He was involved in the development of the Rohini missile. He was involved in the development of the Rohini missile.

For his great service to nation, government and community, he was awarded the Bharat Ratna in 1997. He was awarded the Bharat Ratna in 1997. He was awarded the Bharat Ratna in 1997. He was awarded the Bharat Ratna in 1997. He was awarded the Bharat Ratna in 1997.

LSS01 : Albert Einstein



ALBERT EINSTEIN 1879-1955

PHYSICIST

The greatest intellect of all times, Albert Einstein revolutionized our understanding of matter, space and time with his two great theories of relativity. Einstein explored the foundations of quantum mechanics and showed that quantum Theory of Radiation is a close approximation of his more exact Theory of Relativity. Einstein, with his extraordinary insight into the workings of nature, also conclusively established the equivalence of mass and energy. Einstein's investigations related to several properties of light such as the photoelectric effect led to the development of the Photon Theory which led to explain the photoelectric effect, the discovery which earned him the Nobel Prize for Physics.

Albert Einstein was born in Ulm, Germany, to a Jewish family on 14th March, 1879. He was not a very bright student from the start though he developed his extraordinary intellectual powers, all thanks to two profits. After getting the diploma from Swiss Federal Polytechnic School in Zurich in 1900, he started working for some time. Later he accepted the post of technical assistant on the Swiss Patent Office in Bern. The same year he accepted his Swiss citizenship. During his stay at Patent Office, he worked on theoretical physics using his spare time and produced much of his revolutionary work. In 1905, Einstein published three seminal papers on Brownian Motion, the Photoelectric Effect and Special Theory of Relativity. As a result, he was appointed as a junior professor at the University of Zurich in 1908. At his home country, he became Doctoral Candidate of Philosophy in 1911 and then in Zurich in 1913. In 1914 he was appointed director of the Kaiser Wilhelm Physikalische Institut in Berlin, he became a German citizen in 1919. Einstein predicted his General Theory of Relativity which is published in 1916 that the light rays are bent by gravity. When his theory was proved right through eclipse in 1919, he became world famous.

He remained in Berlin until 1933 after which he moved to the United States and worked in Princeton as a visiting professor. He returned to the United States to work as a professor at Princeton University. He worked at Princeton until his death on 18th April, 1955. He was awarded the Nobel Prize for Physics in 1921. He was awarded the Nobel Prize for Physics in 1921. He was awarded the Nobel Prize for Physics in 1921.

LSS08 : Homi Jehangir Bhabha



Homi Jehangir Bhabha 1909-1966

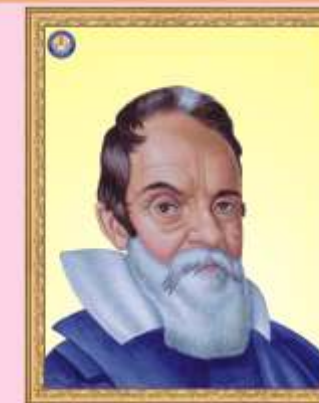
PHYSICIST

Development of atomic energy and nuclear power in India were the main interests of Homi Jehangir Bhabha. He was a pioneer in the field of nuclear physics and was instrumental in the establishment of the Atomic Energy Commission in India. He was instrumental in the establishment of the Atomic Energy Commission in India. He was instrumental in the establishment of the Atomic Energy Commission in India.

In 1918 he studied in India, then he went to the U.S. to study physics at the Massachusetts Institute of Technology, Cambridge and then at the University of California, Berkeley. He was instrumental in the establishment of the Atomic Energy Commission in India. He was instrumental in the establishment of the Atomic Energy Commission in India.

He got a job in the Atomic Energy Commission as a senior scientist in 1947. He was instrumental in the establishment of the Atomic Energy Commission in India. He was instrumental in the establishment of the Atomic Energy Commission in India.

LSS07 : Galileo Galilei



Galileo Galilei 1564-1642

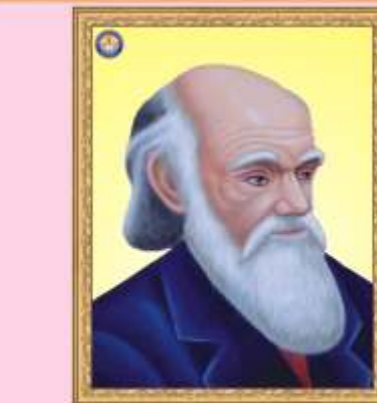
ASTROPHYSICIST

Galileo Galilei is credited with the initiation of the scientific revolution in the 17th century. His work brought the modern scientific methods of observing nature to replace the tradition of Aristotle and his followers. He used his inventions to study the motion of objects. He used his inventions to study the motion of objects. He used his inventions to study the motion of objects.

Galileo was born in Pisa, in the Grand Duchy of Tuscany, on 15th February, 1564. He received his early education from a private tutor. In 1581, he studied at the University of Pisa. He received his doctorate in 1589. He was instrumental in the establishment of the Atomic Energy Commission in India. He was instrumental in the establishment of the Atomic Energy Commission in India.

Galileo was instrumental in the establishment of the Atomic Energy Commission in India. He was instrumental in the establishment of the Atomic Energy Commission in India.

LSS06 : Charles Robert Darwin



Charles Robert Darwin 1809-1882

Naturalist

Charles Robert Darwin was an eminent English naturalist who laid the foundation of modern evolutionary theory with his scientific research of the gradual development of forms of life through natural selection over the time from common origin. He was instrumental in the establishment of the Atomic Energy Commission in India. He was instrumental in the establishment of the Atomic Energy Commission in India.

Darwin was born in Shrewsbury, Shropshire, England on 12th February, 1809. He was the fifth child of Robert Darwin, a wealthy doctor and banker. Darwin was educated at the University of Edinburgh and then at the University of Cambridge. He was instrumental in the establishment of the Atomic Energy Commission in India. He was instrumental in the establishment of the Atomic Energy Commission in India.

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LSS05 : Chandrasekhara Venkata Raman



Chandrasekhara Venkata Raman 1888-1970

PHYSICIST

C.V. Raman was the Indian physicist who was awarded the Nobel Prize for his discovery known as the Raman Effect. He discovered that light is scattered by the molecules in air, liquid or solid as well as in a change in its wavelength. He was instrumental in the establishment of the Atomic Energy Commission in India. He was instrumental in the establishment of the Atomic Energy Commission in India.

Raman was born in Tumkur (now Tenali) in Andhra Pradesh on 7th November, 1888. He was a brilliant student from the start. He was instrumental in the establishment of the Atomic Energy Commission in India. He was instrumental in the establishment of the Atomic Energy Commission in India.

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