ENGLISH MEDIUM

VIDYA ICS

We Nurture Dreams...

2024-25

SCIENCE & TECHNOLOGY

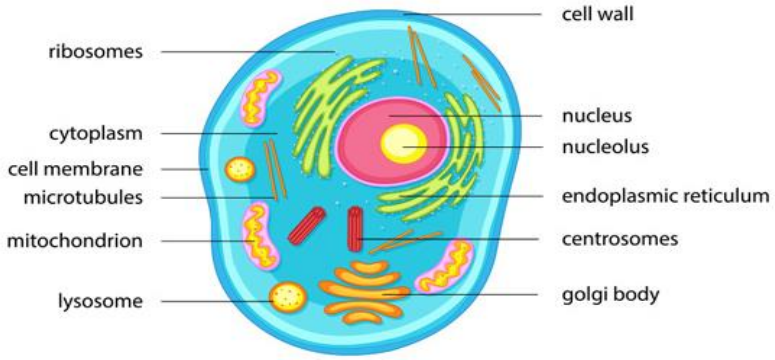
942-574-4877 www.vidyaics.com icsvidya@gmail.com

Table of Content

1. Cells

Definition: Cells are the basic structural, functional, and biological units of all living organisms. They are often referred to as the building blocks of lifebecause they are the smallest units capable of performing all life processes.

- **Discovery**: The term "cell" was coined by Robert Hooke in 1665 when heobserved cork cells under a microscope and noted their resemblance to small rooms or "cells."
- **Study**: The study of cells is known as Cytology, a branch of biology thatexamines cell structure, function, and behaviour.



Contributors

- **Robert Hooke**: Introduced the term "cell" in his work "Micrographia,"which described the microscopic structures he observed.
- **Robert Brown**: Discovered the cell nucleus in 1831, noting its centralrole in the cell's structure.

Cell Theory

- **Founders**: The Cell Theory was developed by Theodor Schwann, MatthiasSchleiden, and Rudolf Virchow in the 19th century.

Principles

- **All living organisms are composed of cells**: This principle asserts that cells are the fundamental building blocks of all life forms, from single-celled organisms to complex multicellular entities.
- **A cell is the basic unit of life**: Cells are the smallest units that exhibit all characteristics of life, including metabolism, growth, and reproduction.
- **All cells arise from pre-existing cells**: This principle emphasizes that new cells are produced by the division of existing cells, highlighting the continuity of life.

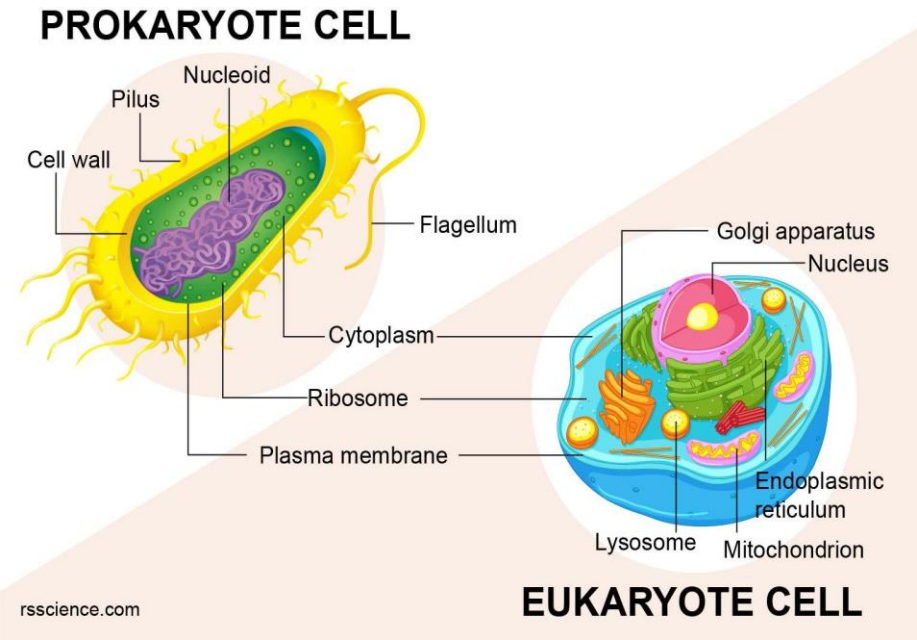
Modern Version

- **Energy flows within cells**: Cells are dynamic environments whereenergy is transferred and utilized through metabolic processes andcellular activities.
- **Genetic information is passed from one cell to another**: Hereditary information is

transmitted through DNA during cell division, ensuring the continuity of genetic traits.

- **All cells have a similar chemical composition**: Despite diversity in cell types, all cells share a common set of biochemical components, including proteins, lipids, carbohydrates, and nucleic acids.

Types of Cells



1. Prokaryotic Cells

- **Characteristics**

- **Primitive, underdeveloped cells**: These cells lack a well-definednucleus and membrane-bound organelles, making them simpler in structure compared to eukaryotic cells.
- **Found in unicellular organisms**: Examples include bacteria, blue-green algae (cyanobacteria), and mycoplasma.
- **Generally small (0.1-5 µm)**: Prokaryotic cells are typicallysmaller than eukaryotic cells, reflecting their simpler organization.
- **Lack a well-defined nucleus**: The genetic material is located ina nucleoid region rather than a membrane-bound nucleus.
- **Absence of membrane-bound organelles**: Prokaryotic cells donot have organelles such as mitochondria or chloroplasts.
- **Contains a single chromosome**: Prokaryotic cells have a singlecircular chromosome.
- **Cell division by fission or budding**: Reproduction occurs through binary fission or budding, processes that do not involvemitosis.
- **Mitochondria are absent**: Prokaryotic cells lack mitochondria, and energy production occurs across the cell membrane.

2. Eukaryotic Cells

- **Characteristics**:
  - **Complete, developed cells**: Eukaryotic cells have a complexstructure with a well-defined nucleus and membrane-boundorganelles.
  - **Found in unicellular and multicellular organisms**: Examples include plants, animals, fungi, and protists.
  - **Generally large (>5 µm)**: Eukaryotic cells are usually larger than prokaryotic cells, reflecting their more complex internal organization.
  - **Presence of a well-defined nucleus**: The nucleus, enclosed by a nuclear membrane, contains the cell's genetic material.
  - **Presence of membrane-bound organelles**: Eukaryotic cells have organelles such as mitochondria, endoplasmic reticulum,Golgi apparatus, and lysosomes.
  - **Multiple chromosomes**: Eukaryotic cells have multiple linear chromosomes organized within the nucleus.
  - **Cell division by mitosis or meiosis**: Eukaryotic cells divide through mitosis for growth and repair or meiosis for sexualreproduction.
  - **Mitochondria are present**: Mitochondria, the energy-producing organelles, are found in eukaryotic cells.

Prokaryotic Cells	Eukaryotic Cells
These are primitive cells (under developed).	These are complete cells (developed).
Found only in Unicellular organisms	Found in both - Unicellular AMulticellular
Size of the cell is generally small. (0.1-5 um).	Size of cell is generally large (> 5 um).
Lack a well-defined nucleus.	Nucleus is present
Membrane bound cell organelles are absent.	Membrane bound cell organelles arepresent.
It contains only one chromosome.	It contains more than one chromosome.
Cell division takes place by fission orbudding.	Cell division by mitosis or meiosis.
Mitochondria is absent.	Mitochondria is present.
Bacteria, blue-green algae, mycoplasma,etc.	plants, animals, fungi, etc.

Cell Structures

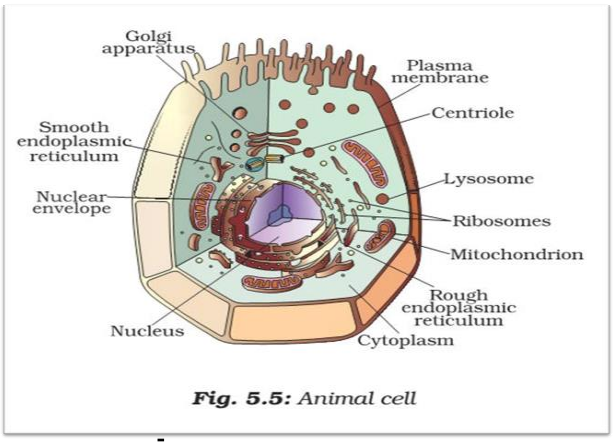


Fig. 5.5: Animal cell

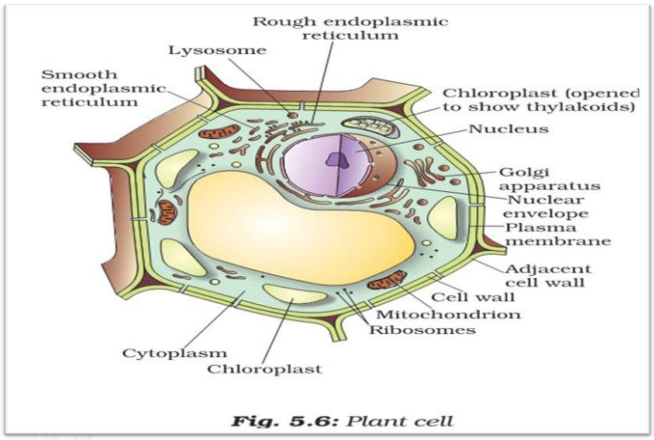


Fig. 5.6: Plant cell

1. **Cell Wall**
   - **Location**: Present only in plant cells, some fungi, and bacteria.
   - **Composition**: Composed primarily of cellulose in plants, chitin in fungi, and peptidoglycan in bacteria.
   - **Function**: Provides structural support, shape, and rigidity to the cell;freely permeable to water and nutrients.

2. **Cell Membrane**
   - **Also Called**: Plasma membrane.
   - **Location**: Present in both animal and plant cells.
   - **Composition**: Composed of a phospholipid bilayer with embeddedproteins; thin, elastic, and double-layered.
   - **Function**: Acts as a selectively permeable barrier that regulates the movement of substances into and out of the cell.

3. **Protoplasm**
   - **Definition**: The living substance within the cell, excluding the cellwall.

   Types
   - **Cytoplasm**: The gel-like fluid outside the nucleus that contains organelles and other cellular components.
   - **Nucleoplasm**: The semi-fluid substance within the nucleus that contains the genetic material and nucleolus.

4. **Mitochondria**
   - **Also Called**: Powerhouse of the cell.
   - **Characteristics**: Surrounded by a double-membrane structure; theinner membrane folds into cristae; contains its own DNA.

- **Function**: Produces ATP (adenosine triphosphate), the primary energy carrier in cells; involved in cellular respiration.

5. **Golgi Bodies**
   - **Function**: Acts as the cell's packaging and distribution center; processes and modifies proteins and lipids from the ER; synthesizes lysosomes.
   - **Location in Plants**: More numerous and known as dictyosomes; involved in the transport and modification of cellular materials.

6. **Lysosomes**
   - **Characteristics**: Membrane-bound sac-like structures containing digestive enzymes.
   - **Function**: Facilitates intracellular digestion by breaking down waste materials and cellular debris; also referred to as "suicidal bags" due to their role in apoptosis (programmed cell death).
   - **Note**: Lysosomes are absent in mammalian red blood cells.

7. **Plastids**
   - **Location**: Found exclusively in plant cells and some algae.
   - **Types**:
   - **Chloroplasts**: Known as the "kitchen of the cell," responsible for photosynthesis; contain chlorophyll and other pigments.
   - **Chromoplasts**: Contain pigments like carotene (orange) and lycopene (red); responsible for color in fruits and flowers.
   - **Leucoplasts**: Colorless plastids found in roots; specialized in storing starch, oils, and proteins.

8. **Vacuoles**
   - **Characteristics**: Fluid-filled organelles bounded by a single membrane; can vary in size.
   - **Function**: Stores nutrients, waste products, and toxic substances; plays a role in maintaining turgor pressure and osmoregulation.
   - **Size**: Typically larger in plant cells; smaller in animal cells.

9. **Endoplasmic Reticulum (ER)**
   - **Structure**: A complex network of membranous tubules and sacs extending throughout the cytoplasm; continuous with the nuclear envelope.
   - **Function**: Facilitates the synthesis, folding, modification, and transport of proteins and lipids.

Types:
   - **Smooth ER**: Lacks ribosomes; involved in lipid synthesis, metabolism, and detoxification.

- **Rough ER**: Studded with ribosomes; primarily involved in protein synthesis and processing.

10. **Ribosomes**
    - **Characteristics**: Composed of ribonucleic acid (RNA) and proteins; can be found as free ribosomes or attached to the rough ER.
    - **Function**: Synthesizes proteins by translating mRNA into polypeptides; ofien referred to as the "factory of proteins."
    - **Types**:
    - **80S Ribosomes**: Found in eukaryotic cells; larger and morecomplex.
    - **70S Ribosomes**: Found in prokaryotic cells; smaller andsimpler.

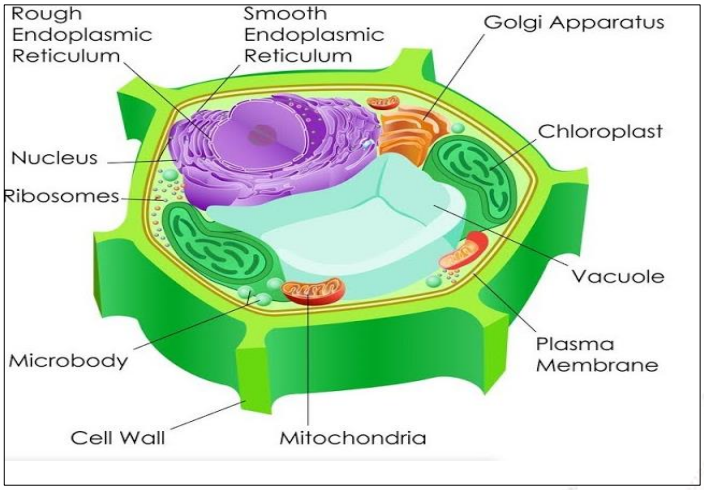
11. **Nucleus**
    - **Also Called**: Control room of the cell.
    - **Characteristics**: Enclosed by a double-membraned nuclear envelope; contains chromatin and nucleolus.
    - **Function**: Regulates all cellular activities, including growth, metabolism, and reproduction; houses genetic material (DNA andRNA).

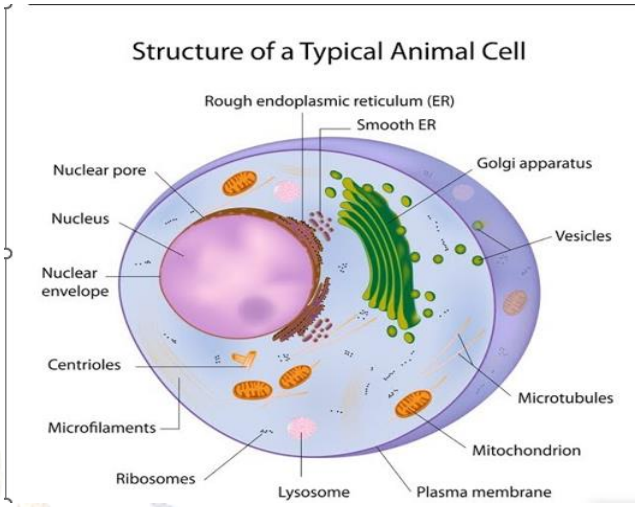
    Parts:
    - **Nuclear Membrane**: Double-layered membrane that separatesthe nucleus from the cytoplasm.
    - **Chromatin**: Complex of DNA and histone proteins; visible aschromosomes during cell division.
    - **Nucleolus**: Dense structure within the nucleus involved in ribosomal RNA (rRNA) synthesis and ribosome assembly.
    - **Nucleoplasm**: Semi-fluid substance within the nucleus.

12. **Centrosome**
    - **Location**: Present only in animal cells.
    - **Characteristics**: Non-membrane-bound structure composed of a pairof centrioles.
    - **Function**: Organizes microtubules and facilitates cell division byforming the mitotic spindle.

13. **Chromosomes**
    - **Characteristics**: Thread-like structures composed of DNA and associated proteins; become visible as distinct rod-shaped structuresduring cell division.
    - **Function**: Carry genetic information necessary for inheritance;functional segments of DNA are called genes, which encode for specific traits.

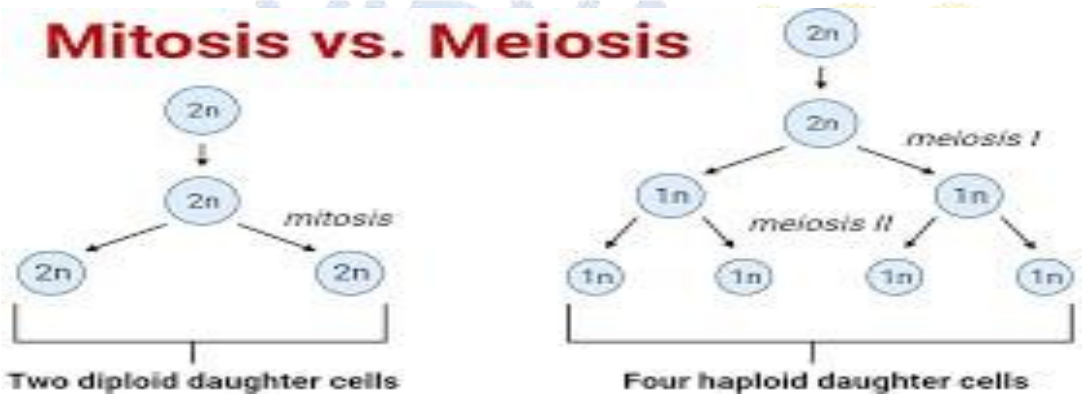
Difference between Plant Cell and Animal Cell





Plant cell	Animal cell
Having fixed shape	Having irregular shape
Larger in size	Smaller in size
Cell wall is present	Absent
Plastids are present	Absent
Vacuoles are of larger size	Smaller size
Food stored in the form of starch	Glycogen
Centrosome is absent	Present

Cell Division



1. **Mitosis**
   - **Definition**: Mitosis is a type of cell division that produces two genetically identical daughter cells, each with the same number ofchromosomes as the parent cell.
   - **Purpose**: Facilitates growth, tissue repair, and asexual reproduction inorganisms.

Stages

- **Prophase**: Chromatin condenses into visible chromosomes;spindle fibers form; nuclear envelope breaks down.
- **Metaphase**: Chromosomes align at the cell's equatorial plane;spindle fibers attach to centromeres.
- **Anaphase**: Chromatids are pulled apart toward opposite polesof the cell.
- **Telophase**: Chromatids reach the poles; nuclear envelopesreform around each set of chromosomes; chromosomes decondense.
- **Cytokinesis**: Division of the cytoplasm, resulting in two distinctdaughter cells.
  - **Outcome**: Two genetically identical diploid cells with the samechromosome number as the original cell.

2. Meiosis

- **Definition**: Meiosis is a specialized type of cell division that reduces the chromosome number by half, resulting in four genetically diversehaploid daughter cells.
- **Purpose**: Essential for sexual reproduction, producing gametes (spermand eggs) with genetic variation.

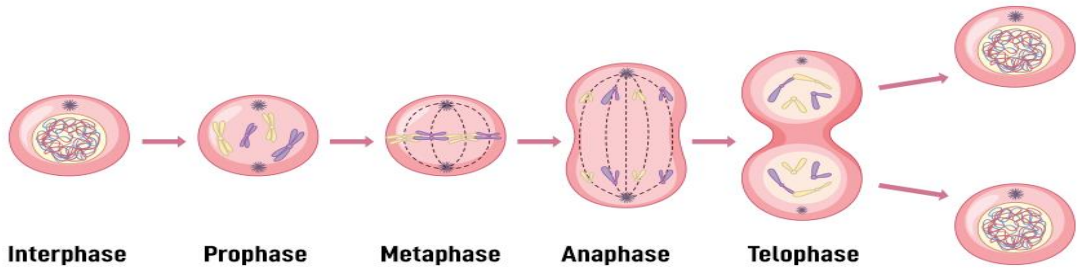
Stages

Meiosis I

- **Prophase I**: Homologous chromosomes pair up andexchange genetic material through crossing-over.
- **Metaphase I**: Homologous chromosome pairs align at thecell's equatorial plane.
- **Anaphase I**: Homologous chromosomes are separatedand pulled toward opposite poles.
- **Telophase I**: Chromosomes reach the poles; nuclearenvelopes may reform; cell divides into two.

Meiosis II

- **Prophase II**: Chromosomes condense; spindle fibers form in each of the two daughter cells.
- **Metaphase II**: Chromosomes align at the equatorial planeof each cell.
- **Anaphase II**: Sister chromatids are separated and movedto opposite poles.
- **Telophase II**: Chromatids reach the poles; nuclearenvelopes reform; cells divide into four.
  - **Outcome**: Four genetically diverse haploid cells, each with half thechromosome number of the original cell.



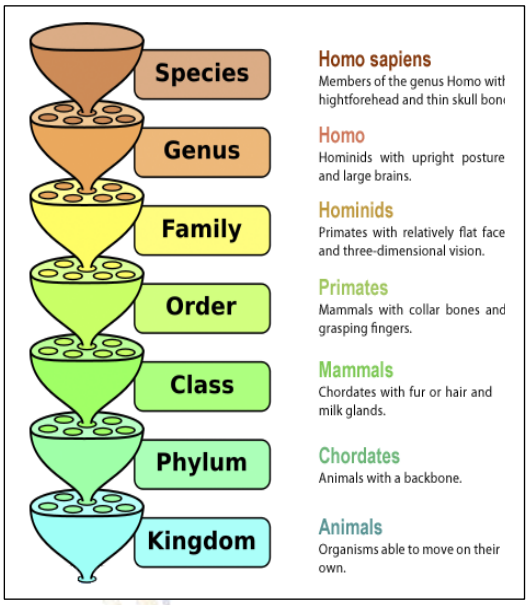
2. Diversity in Living Organisms

Introduction to Biodiversity

- **Diversity in Living Organisms**: Refers to the wide variety of life forms on Earth, differing in size, shape, habitat, nutrition, and reproduction.
- **Environments**: Includes aquatic, terrestrial, desert, forest, grassland, and icy regions.
- **Classification**: The process of grouping organisms based on similarities and differences.

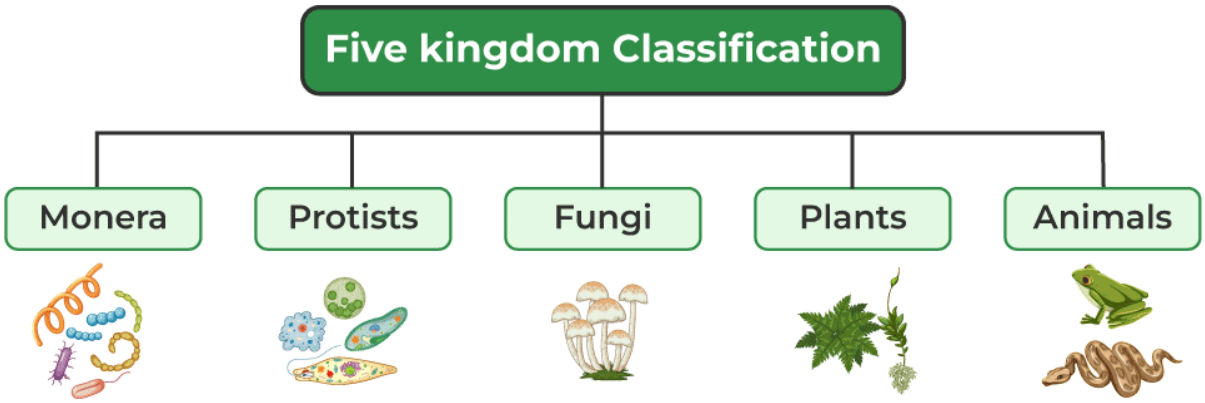
Hierarchical Classification System

- **Developed by**: Carolus Linnaeus.
- **Levels of Classification**: Organisms are classified in a hierarchy of taxonomic levels, from broad to specific:
  1. Kingdom
  2. Phylum
  3. Class
  4. Order
  5. Family
  6. Genus



Classification Systems

- **Two-Kingdom Classification (by Carolus Linnaeus):**
  - **Plants**: Autotrophic organisms that produce their own food via photosynthesis.
  - **Animals**: Heterotrophic organisms that depend on other organisms for food.
- **Five-Kingdom Classification (by R.H. Whittaker):**
  - **Monera**: Comprises prokaryotic organisms like bacteria, which lack a true nucleus.
  - **Protista**: Includes single-celled eukaryotes, such as amoebas and algae.
  - **Fungi**: Consists of eukaryotic organisms like mushrooms, which absorb nutrients from decaying organic matter.
  - **Plantae**: Encompasses all multicellular plants, which carry out photosynthesis.
  - **Animalia**: Comprises all multicellular animals, which rely on other organisms for nutrition.

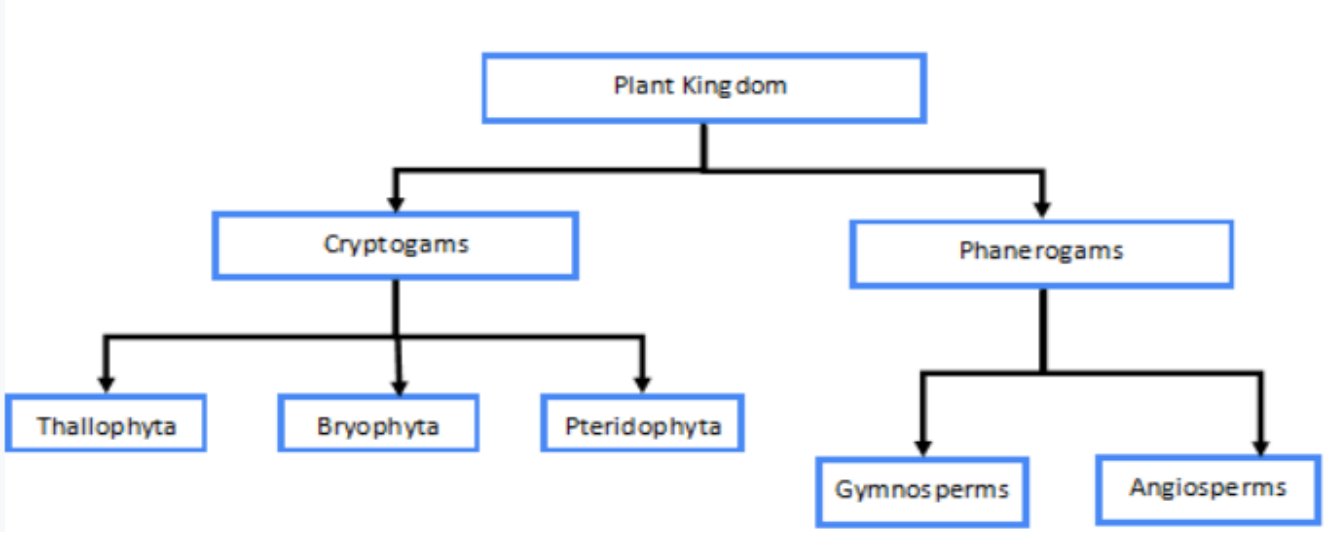


Characteristics of the Five Kingdoms

- **Kingdom Monera**:
  - Prokaryotic, Unicellular, lacking a true nucleus.
  - **Mode of Nutrition**: Can be autotrophic or heterotrophic.
  - **Examples**: Bacteria, Cyanobacteria, Mycoplasma.

- **Kingdom Protista**:
  - Unicellular Eukaryotes.
  - **Mode of Nutrition**: Can be autotrophic or heterotrophic.
  - **Locomotion**: Use structures like pseudopodia, cilia, or flagella for movement.
  - **Examples**: Amoeba, Paramecium, Euglena.
- **Kingdom Fungi:**
  - Eukaryotic, Multicellular (except yeast).
  - **Mode of Nutrition**: Saprophytic, obtaining nutrients from decomposing organic material.
  - **Cell wall**: Composed of chitin.
  - **Examples**: Yeast, Aspergillus, Mushrooms.
- **Kingdom Plantae:**
  - Multicellular Eukaryotes, Autotrophic.
  - **Cell wall**: Made of cellulose, aiding in structural support.
  - Examples: Ferns, Pine trees, Mango trees.
- **Kingdom Animalia:**
  - Multicellular Eukaryotes, Heterotrophic.
  - **Lack of Cell Walls**: Distinguishes them from plants and fungi.
  - **Examples**: Humans, Dogs, Insects.

Classification of Kingdom Plantae



- ***Classification Based on:***
  - **Body Structure**: Complexity of the plant body.
  - **Vascular System**: Presence or absence of specialized tissue for water and nutrient transport.
  - **Seed Formation**: Whether seeds are produced and if they are enclosed within a fruit.
- **Subgroups:**

1) **Thallophyta** : Simple, non-differentiated plant body; mostly aquatic (e.g., Algae).
2) **Bryophyta**: Non-vascular plants with root-like, stem-like structures; known as amphibians of the plant kingdom (e.g., Mosses).
3) **Pteridophyta**: Vascular plants without seeds; differentiated into root, stem, and leaves (e.g., Ferns).
4) **Gymnosperms**: Seed-producing plants with naked seeds, typically evergreen (e.g., Pines, Cycads).
5) **Angiosperms**: Flowering plants with seeds enclosed within fruits; largest group (e.g., Roses, Mango trees).

- **Cryptogams**: Non-flowering, non-seed bearing plants (e.g., Thallophyta, Bryophyta, Pteridophyta).
- **Phanerogams**: Flowering, seed-bearing plants (e.g., Gymnosperms, Angiosperms).

Classification of Kingdom Animalia

- Introduction: Kingdom Animalia is the most diverse kingdom, encompassing all animals, which are multicellular, eukaryotic organisms. Animals differ from plants and fungi as they lack chlorophyll and cell walls, and they rely on other organisms for nutrition (heterotrophy).

Body Structure and Complexity

- Animals range from simple, non-differentiated forms to highly complex organisms with specialized organ systems.
- They are characterized by their ability to move, a feature absent in plants and most fungi.

Subdivisions of Kingdom Animalia

The animal kingdom is divided into multiple phyla based on body design, level of organization, and other distinguishing features. Below are the main phyla with examples and key characteristics:

1. **Phylum Porifera (Sponges):**
   - **Structure**: Simplest multicellular animals with porous bodies and a lack of true tissues and organs.
   - **Habitat**: Primarily marine environments.
   - **Key Features**: Sessile (non-motile), have a skeleton made of spicules.
   - Examples: Spongilla, Sycon.

2. **Phylum Coelenterata (Cnidaria)**
   - **Symmetry**: Radially symmetrical with a hollow body cavity.
   - **Body Forms**: Can exist as polyps (e.g., Hydra) or medusae (e.g., Jellyfish).
   - **Special Features**: Possess specialized cells called cnidocytes for capturing prey.
   - Examples: Corals, Sea anemones.

3. **Phylum Platyhelminthes (Flatworms)**
   - **Structure**: Dorsoventrally flattened, bilaterally symmetrical bodies.
   - **Habitat**: Many are parasitic in nature.
   - **Body Organization**: Triploblastic, but lack a true body cavity (acoelomates).
   - Examples: Tapeworm, Planaria.

4. **Phylum Nematoda (Roundworms)**
   - **Body Shape**: Cylindrical and tapered at both ends.
   - **Symmetry**: Bilaterally symmetrical and triploblastic.
   - **Significance**: Many are parasitic, causing diseases in humans and animals.
   - Examples: Ascaris, Wuchereria.

5. Phylum Annelida (Segmented Worms)

- **Structure**: Segmented bodies with repeating units.
- **Symmetry**: Bilaterally symmetrical, with a true coelom.
- **Habitat**: Found in marine, freshwater, and terrestrial environments.
- Examples: Earthworm, Leech.

6. Phylum Arthropoda (Jointed-Leg Animals)

- **Distinguishing** Features: Possess jointed appendages, an exoskeleton made of chitin, and a segmented body.
- **Symmetry**: Bilaterally symmetrical.
- **Diversity**: The largest phylum, including insects, arachnids, and crustaceans.
- Examples: Spiders, Butterflies, Crabs.

7. Phylum Mollusca

- **Body Structure**: Soft-bodied, often with a hard external shell.
- **Symmetry**: Bilaterally symmetrical.
- **Circulatory** System: Usually possess an open circulatory system.
- Examples: Snails, Octopus.

8. Phylum Echinodermata

- **Structure**: Spiny-skinned animals with radial symmetry in adults.
- **Skeleton**: Composed of calcium carbonate plates.
- **Habitat**: Exclusively marine.
- Examples: Starfish, Sea urchins.

9. Phylum Hemichordata

- **Unique Feature**: Possess a structure similar to a notochord called a stomochord.
- **Symmetry**: Bilaterally symmetrical.
- **Circulatory System**: Open, with gills for respiration.
- Examples: Balanoglossus, Saccoglossus.

10. Phylum Chordata

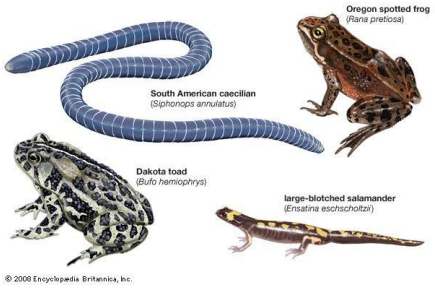
- **Structure**: Animals with a notochord, dorsal nerve cord, and pharyngeal slits at some stage in their life cycle.

Subphylum Vertebrata

Includes animals with a backbone.

- **Class Pisces (Fishes)**
  - **Habitat**: Aquatic environments, both freshwater and marine.
  - **Body Covering**: Skin covered with scales or plates.
  - **Respiration**: Through gills.
  - **Circulatory System**: Two-chambered heart, adapted for life in water.
  - **Reproduction**: Most species lay eggs.
  - Examples: Sharks, Salmon, Goldfish.

- **Class Amphibia (Amphibians)**
  - **Habitat**: Can live both in water and on land; often rely on moist environments.
  - **Respiration**: Through gills during the larval stage and lungs in adulthood; some respiration occurs through the skin.
  - **Circulatory System**: Three-chambered heart.
  - **Body Covering**: Moist, glandular skin.
  - **Reproduction**: Typically lay eggs in water.
  - **Examples**: Frogs, Salamanders, Newts.



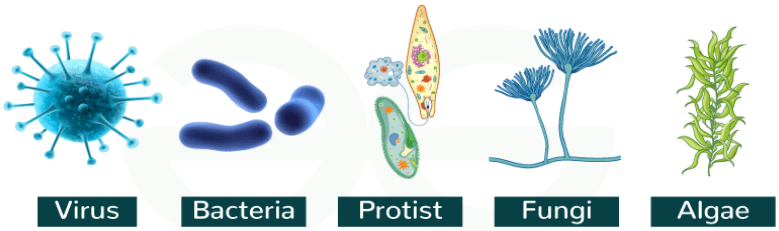
- **Class Reptilia (Reptiles)**
  - **Habitat**: Primarily terrestrial, though some species are aquatic.
  - **Body Covering**: Dry skin with protective scales.
  - **Respiration**: Exclusively through lungs.
  - **Circulatory System**: Usually a three-chambered heart, except for crocodiles, which have a four-chambered heart.
  - **Reproduction**: Lay eggs with leathery shells.
  - Examples: Snakes, Lizards, Turtles, Crocodiles.
- **Class Aves (Birds)**
  - **Habitat**: Wide range, from terrestrial to aerial environments.
  - **Body Covering**: Feathers, which aid in flight and insulation.
  - **Respiration**: Through lungs, with an efficient system of air sacs.
  - **Circulatory System**: Four-chambered heart.
  - **Reproduction**: Lay hard-shelled eggs.
  - Examples: Eagles, Sparrows, Penguins.
- **Class Mammalia (Mammals)**
  - **Habitat:** Diverse environments, including terrestrial, aquatic, and aerial.
  - **Body Covering**: Hair or fur covering the body.
  - **Respiration**: Through lungs.
  - **Circulatory System**: Four-chambered heart.
  - **Reproduction:** Most are viviparous, giving birth to live young; females have mammary glands to produce milk.
  - Examples: Humans, Whales, Bats, Lions.

3. Microorganisms

Microorganisms : Tiny Powerhouses of Life

An organism that can be seen only through a microscope. Microorganisms include bacteria, protozoa, algae, and fungi. Although viruses are not considered living organisms, they are sometimes classified as microorganisms.

- **Microscopic Size**: Invisible to the naked eye; require a microscope to be seen.
- **Diverse Forms**: Includes bacteria, viruses, fungi, protozoa, and algae.
- **Reproduction**: Rapid reproduction through binary fission, budding, or spore formation.
- **Ubiquitous Presence**: Found in various environments, including extreme conditions.
- **Metabolic Diversity**: Utilize different energy sources like light, chemicals, or organic matter.



Classification of Microorganisms

➢ Bacteria

- **Discovered by**: Antony Van Leeuwenhoek
- **Unicellular and Prokaryotic**: Single-celled organisms without a true nucleus.
- **Cell Structure**: Cell wall made of peptidoglycan; may have flagella.
- **Reproduction**: Binary fission; can exchange genetic material.
- **Roles**: Aid in digestion, nitrogen fixation, and antibiotic production.
- Examples: Rhizobium, Azotobacter, Lactobacillus.

➢ Fungi

- **Cell Structure**: Can be unicellular or multicellular; cell wall made of chitin.
- **Heterotrophic**: Depend on external sources for nutrients.
- **Decomposers**: Break down dead organic matter.
- Examples: Yeasts, molds, mushrooms.
- **Applications**: Useful (e.g., yeast, penicillin) and harmful (e.g., ringworm).

➢ Viruses

- **Discovered by**: Dmitri Ivanovsky
- **Non-Cellular**: Composed of proteins, nucleic acids, and lipids.
- **Reproduction**: Only active within host cells.
- Examples: Influenza virus (flu), HIV/AIDS.

➢ Protists

- **Unicellular and Microscopic**: Single-celled organisms, distinct from plants and animals.
- **Nutritional Modes**: Autotrophic (photosynthesis) or heterotrophic.
- **Reproduction**: Primarily through binary fission or budding.
- Examples: Amoeba, diatoms, slime molds.
- **Ecological Role**: Oxygen production, nutrient recycling.

- **Algae**
  - **Study:** Phycology
  - **Autotrophic**: Can be unicellular or colonial; photosynthetic.
  - **Uses:** Food (e.g., Ulva), manure, medicine (e.g., laminaria for iodine).
  - **Harmful Effects**: Water bloom, red tide.

3. Diseases Caused by Microorganisms

- **Bacterial Diseases**: Tuberculosis, Cholera, Typhoid, Botulism, Pneumonia, Meningitis.
- **Viral Diseases**: HIV/AIDS, Common Cold, Hepatitis B, Chickenpox, Measles, Rabies, COVID-19.
- **Protist Diseases**: Malaria, Sleeping Sickness, Kala Azar.
- **Fungal Diseases**: Ringworm, Athlete's Foot, Asthma.

4. Importance of Microorganisms

- **Nutrient Cycling**: Decompose organic matter (e.g., Nitrosomonas in nitrogen cycle).
- **Soil Fertility**: Enhance nutrient uptake (e.g., Glomus fungi in roots).
- **Disease Prevention**: Maintain gut health (e.g., Lactobacillus).
- **Bioremediation**: Clean up pollutants (e.g., Pseudomonas).
- **Food Production**: Fermentation (e.g., yeast in bread).
- **Medicine Production**: Antibiotics (e.g., Penicillium notatum).
- **Agricultural Benefits**: Nitrogen fixation (e.g., Rhizobium).
- **Biogas Production**: Methane generation from anaerobic bacteria.
- **Climate Regulation**: Affect CO2 levels (e.g., marine phytoplankton).

4. Nutrition in Plants & Animals

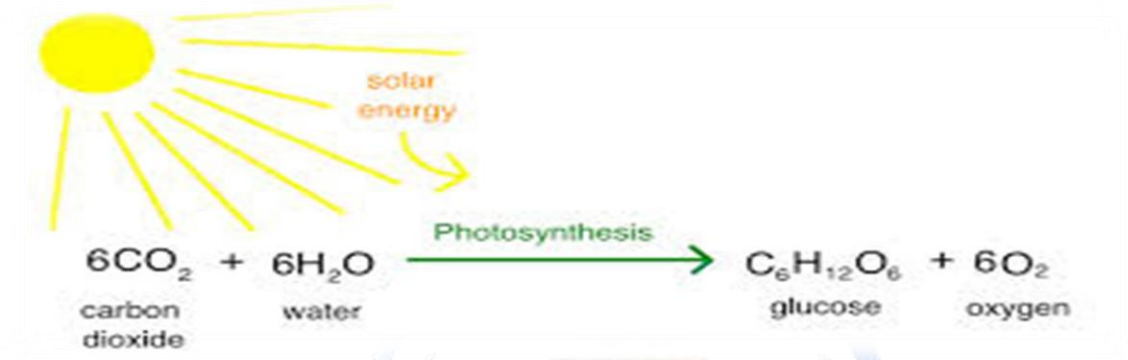
Nutrition

- **Definition**: Process of obtaining and utilizing food for growth, maintenance, and health.
- **Categories**: Autotrophic (self-feeding) and heterotrophic (feeding on others).

Nutrition in Plants: Photosynthesis

Photosynthesis is a biological process used by plants, algae, and some bacteria to convert light energy, usually from the sun, into chemical energy stored in molecules of glucose.

This process is fundamental to life on Earth, as it provides the primary source of organic matter for almost all organisms and releases oxygen into the atmosphere.



- **CO_2**: Carbon dioxide absorbed from the atmosphere.
- **H_2O**: Water absorbed from the soil.
- **$C_6H_{12}O_6$:** Glucose (a type of sugar used for energy and growth).
- **O_2**: Oxygen released as a byproduct.

Sites of Photosynthesis

Chloroplasts: Photosynthesis occurs in the chloroplasts of plant cells. Chloroplasts are specialized organelles that contain chlorophyll and other pigments necessary for capturing light energy.

Structure :

- **Double Membrane**: Outer and inner membranes surround the chloroplast.
- **Thylakoids**: Membrane-bound sacs within the chloroplast. Thylakoids are organized into stacks called granum.
- **Stroma**: Fluid-filled space surrounding the thylakoids.

Steps of Photosynthesis

Light-Dependent Reactions (Occur in Thylakoid Membranes):

1. **Photon Absorption**: Chlorophyll and other pigments in the thylakoid membranes absorb light energy.
2. **Water Splitting**: Light energy is used to split water molecules (H_2O) into oxygen (O_2), protons (H^+), and electrons.
3. **Electron Transport Chain** (ETC): Excited electrons travel through a series of proteins embedded in the thylakoid membrane, creating a flow of energy.
4. **ATP and NADPH Formation**: The energy from the electron transport chain is used to convert ADP and inorganic phosphate (Pi) into ATP and to reduce $NADP^+$ to NADPH.
   - **ATP**: Adenosine Triphosphate, an energy carrier.
   - **NADPH**: Nicotinamide Adenine Dinucleotide Phosphate, a reducing agent.

Light-Independent Reactions (Calvin Cycle, Occur in the Stroma):

1. **Carbon Fixation**: CO_2 is fixed into a 5-carbon sugar molecule (ribulose bisphosphate, RuBP) by the enzyme RuBisCO.
2. **Reduction Phase**: ATP and NADPH from the light-dependent reactions are used to convert into a sugar molecule.

Factors Affecting Photosynthesis

- **Light Intensity**: Affects the rate of photosynthesis up to a certain point; too much light can damage the chlorophyll.
- **Carbon Dioxide Concentration**: Increased CO_2 levels generally increase the rate of photosynthesis.
- **Water Availability**: Essential for the light-dependent reactions; water stress can limit photosynthesis.
- **Temperature**: Affects enzyme activity; too high or too low temperatures can reduce the efficiency of photosynthesis.
- **Pigments**: Chlorophyll a is the primary pigment, but chlorophyll b and carotenoids also play roles in capturing light energy.

Significance of Photosynthesis

- **Foundation of Life**: Provides the base of the food chain for most ecosystems by converting solar energy into chemical energy.
- **Oxygen Production**: Supplies oxygen necessary for respiration in animals and other aerobic organisms.
- **Carbon Cycle**: Plays a crucial role in regulating atmospheric CO_2 levels and thus impacts global climate.

Additional Concepts

- **Photorespiration:** A process where RuBisCO fixes oxygen instead of carbon dioxide, which can decrease the efficiency of photosynthesis.
- **C4 Photosynthesis**: A variant of photosynthesis found in some plants (e.g., maize, sugarcane) that is adapted to high temperatures and low CO_2 concentrations.
- **CAM Photosynthesis**: Found in succulents and other desert plants; opens stomata at night to reduce water loss and fixes CO_2 into organic acids.
- **Photosynthesis**: Plants produce food using sunlight, CO_2, and water.
- **Site**: Chloroplasts (Thylakoids and Stroma).
- **Key Factors**: Sunlight, CO_2, water, pigments, RuBisCO enzyme, temperature.

Nutrient Absorption in Plants

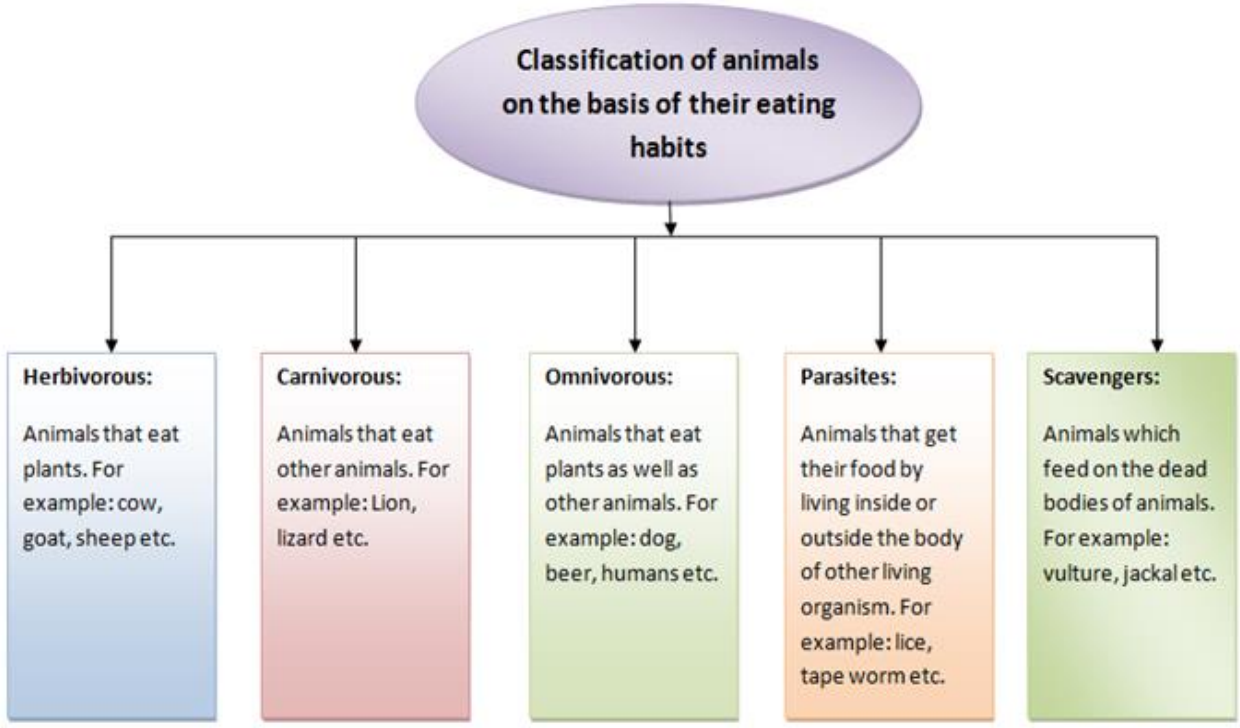
- **Macronutrients**: Needed in large quantities (e.g., Nitrogen, Phosphorus).
- **Micronutrients:** Needed in smaller amounts (e.g., Iron, Zinc).

Significance of Photosynthesis

- **Foundation of Life**: Provides food, regulates carbon cycle, and produces oxygen.

Nutrition in Animals

- **Ingestion**: Intake of food.
- **Digestion**: Breakdown of food into smaller, absorbable components.
- **Absorption:** Nutrients absorbed into the bloodstream.
- **Assimilation**: Utilization of nutrients.
- **Egestion**: Elimination of waste.

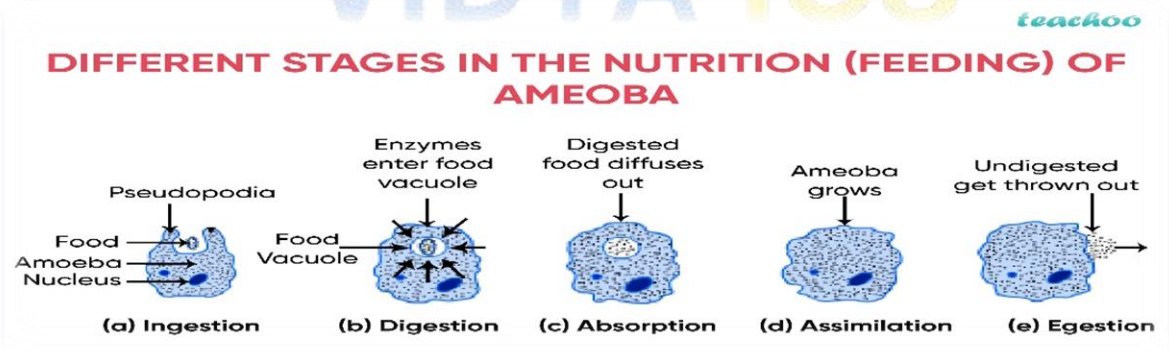


Types of Nutrition in Animals

- **Filter Feeding**: Nutrients from suspended particles (e.g., fish).
- **Deposit Feeding**: Nutrients from soil particles (e.g., earthworms).
- **Fluid Feeding**: Consumes fluids (e.g., mosquitoes).
- **Bulk Feeding**: Eats whole organisms (e.g., humans, lions).

Nutrition in Amoeba

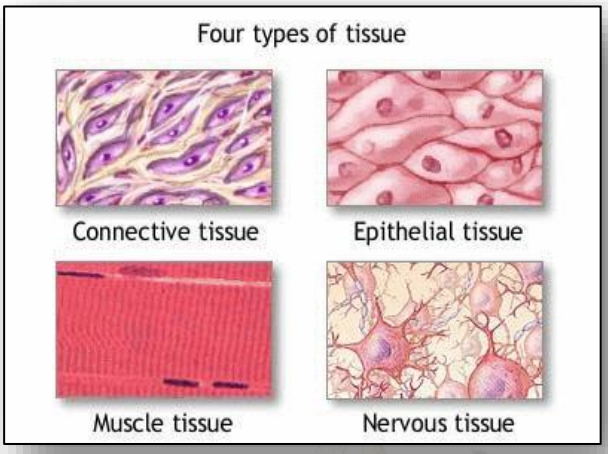
- **Ingestion**: Uses pseudopodia to engulf food.
- **Digestion**: Occurs inside food vacuoles.
- **Absorption**: Nutrients diffuse into the cytoplasm.
- **Egestion**: Waste expelled through the cell membrane.



5. Animal Tissues and Blood Group Systems

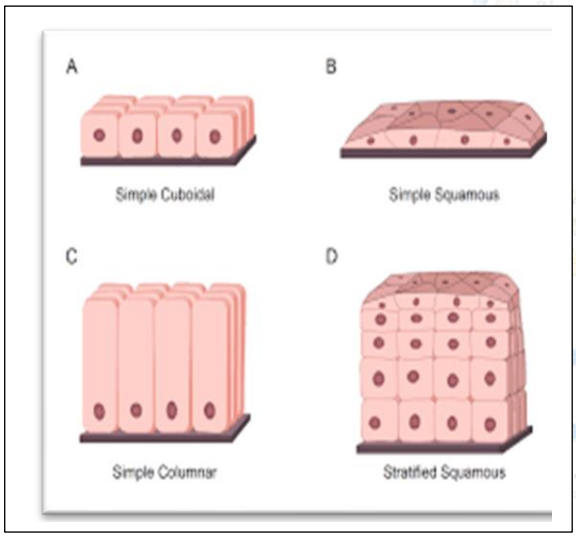
Tissue

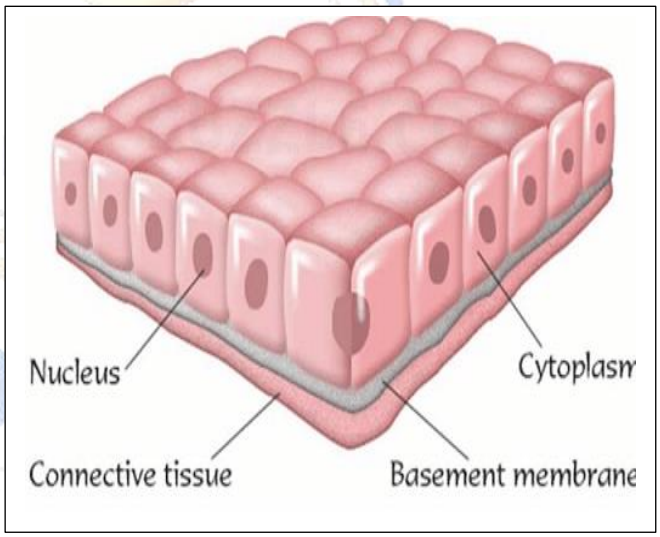
- **Definition**: A group of identical cells combined with intercellular substance to perform a specialized role in multicellular organisms.



Types of Animal Tissues

1. Epithelial Tissue:

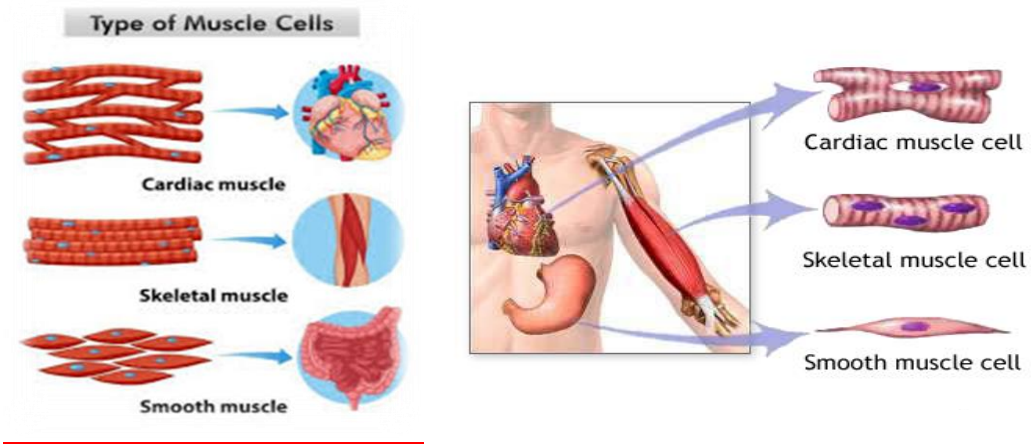




- **Protective Layer**: Functions as a protective covering, consisting of one or more cell layers.
- **Shape**: Flat, column, cuboid.
- **Cell Arrangement**: Cells are closely packed, forming continuous sheets with intercellular junctions.

- **Functions:**
  - **Squamous Epithelium**: Shields underlying organs from mechanical injury, drying, and germ entry. Involved in excretion and gaseous exchange.
  - **Cuboidal Epithelium**: Provides mechanical support. Plays roles in absorption and excretion.
  - **Columnar Epithelium**: Offers protection to underlying tissues.
  - **Ciliated Epithelium:** Assists in moving mucus, urine, eggs, sperms, etc.
  - **Examples**: Skin, lining of body cavities, ducts, and tubes.

2. Muscular Tissue



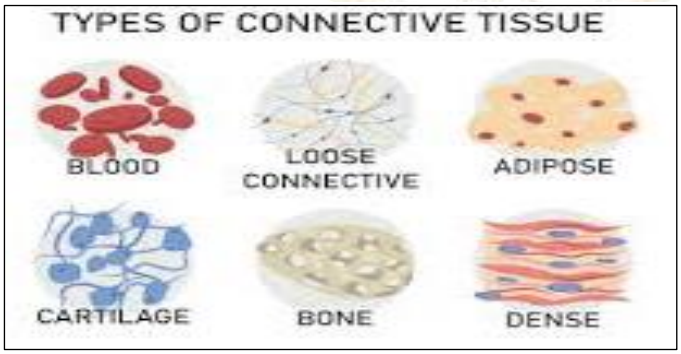
Characteristics

- **Structure**: Composed of long, elongated cells known as muscle fibers.
- **Arrangement**: Muscle fibers are arranged parallel to each other.
- **Contractile Proteins**: Contain specialized proteins that contract and relax in a specific direction, enabling movement and locomotion.

Types of Muscle Tissue

- **Striated Muscle (Skeletal Muscle)**: Facilitates movement of body parts (e.g., arms, legs, neck).
- **Non-Striated Muscle (Smooth Muscle)**: Facilitates involuntary actions such as food passage, air flow, blood circulation, and urinary bladder movements.
- **Cardiac Muscle**: Responsible for the beating of the heart and pumping of blood.

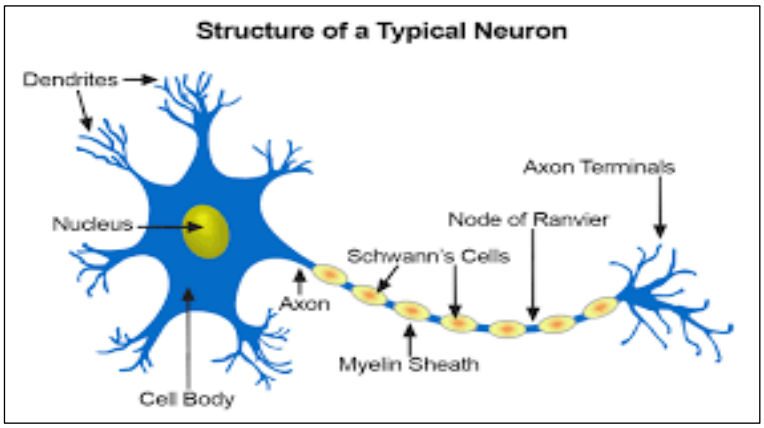
3. Connective Tissue:



Function: Connective tissues bind and join tissues, ensuring proper functioning of different organs.

- **Types of Connective Tissue:**
  - **Tendons**: Connects muscles to bones.
  - **Ligaments**: Connects bones to bones.
  - Blood: The only fluid connective tissue.
  - **Areolar Tissue**: Supports internal organs and helps repair tissues.
  - **Adipose Tissue**: Stores fat, acts as an insulator.
  - **Cartilage**: Absorbs stress, provides flexibility, smoothens joint surfaces.
  - **Vascular Tissue**: Transports nutrients, regulates body functions, defends against infections, and aids in clotting.

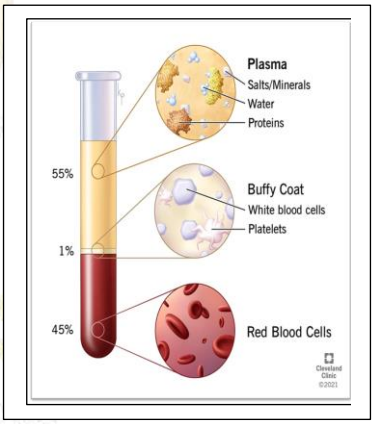
4. Nervous Tissue



- **Characteristics:**
  - Controls the body's response to changing conditions.
  - Specialized for rapid transmission of stimuli across the body.
- **Main Components:**
  - **Neurons**: Structural and functional units of the nervous system. Excitable cells that transmit electrical impulses.
  - **Neuroglia**: Found in the brain and spinal cord. Provide support to neurons and nerve fibers.
  - Neurosecretory Cells: Act as endocrine organs, releasing chemicals directly into the blood from their axons.

Blood

Definition: Blood is a fluid connective tissue that circulates throughout the body, delivering oxygen and nutrients to cells and tissues while removing waste products like carbon dioxide.
Composition: Blood constitutes about 8% of an adult's body weight, with an average adult having around 5-6 liters of blood.



Components of Blood

1. Plasma:

- **Description**: Pale yellow liquid making up about 55% of blood.
- **Contents**: Contains water, salts, nutrients, enzymes, proteins (including serum globulin, serum albumin, and fibrinogen).
- **Function**: Responsible for transportation of digested food, hormones, etc., from one part to another part of the body.

2. Blood Cells:

Red Blood Cells (RBCs or Erythrocytes)

- **Hemoglobin:** An iron-rich protein giving blood its red color.
- **Production**: Produced in the bone marrow and are the most abundant cells in the blood.
- **Life Span**: 20 to 120 days; destroyed in the liver.
- **Function**: Transport oxygen from the lungs to tissues and organs and carry carbon dioxide back to the lungs for exhalation.
- **Nucleus**: No nucleus present.

- **Associated Disease**: Anemia (deficiency of hemoglobin).

White Blood Cells (WBCs or Leucocytes)

- **Description**: Colorless blood cells.
- **Formation**: Formed in bone marrow.
- **Life Span**: 2 to 4 days.
- **Nucleus:** Nucleus is present.
- **Function**: Play a key role in the immune system by fighting infections and foreign pathogens like bacteria and viruses.

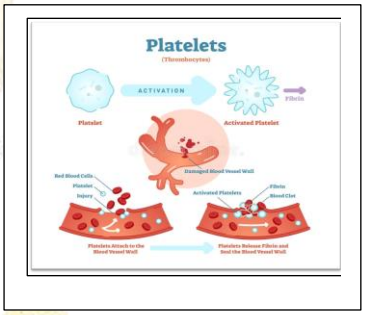
Types:

1. Granulocytes:

- **Neutrophils**: 60-65% of WBCs. Destroy bacteria and act as first responders to infections.
- **Eosinophils**: 2-3% of WBCs. Combat parasitic infections and are involved in allergic reactions.
- **Basophils**: Least common, making up 0.5-1% of WBCs. Release histamine and other chemicals during allergic reactions.

2. Agranulocytes

- **Monocytes**: 6-8% of WBCs. Clean up dead cells and protect against pathogens by migrating to infection sites.
- **Lymphocytes:** B-lymphocytes and T-lymphocytes; essential for immune response, producing antibodies and destroying infected cells.



Platelets (Thrombocytes)

- **Description**: Tiny disc-shaped cells.
- **Formation**: Formed in bone marrow.
- **Life Span**: 3 to 5 days.
- **Nucleus**: No nucleus present.
- **Function**: Play a crucial role in blood clotting and wound healing.
  Prevent excessive bleeding by forming clots at injury sites.

Blood Vessels

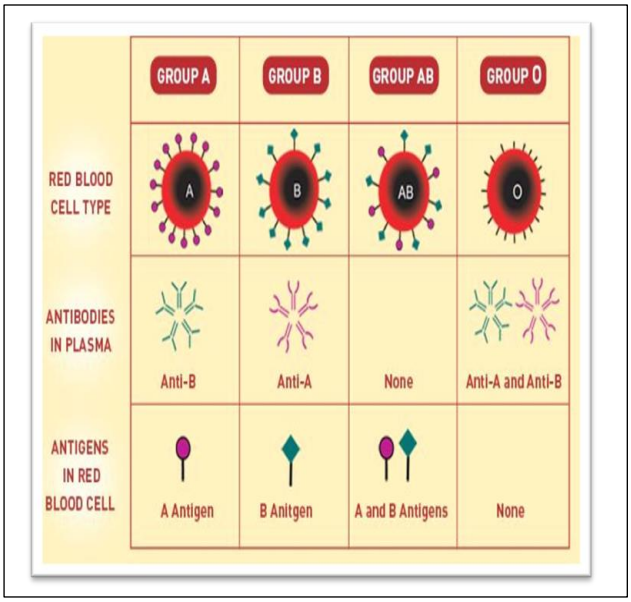
- **Types**

- **Arteries**: Carry oxygen-rich blood away from the heart.
- **Veins**: Carry deoxygenated blood back to the heart.
- **Capillaries**: Connect arteries and veins, facilitating the exchange of oxygen, nutrients, and waste between blood and tissues.

Functions of Blood

- **Transport**: Carries oxygen from the lungs to tissues and carbon dioxide from tissues to the lungs, along with nutrients, hormones, and waste products throughout the body.
- **Regulation**: Helps regulate body temperature, pH levels, and fluid balance.
- **Protection**: Defends against infections through white blood cells and antibodies; involved in clotting to prevent blood loss.
- **Nutrient Distribution**: Delivers essential nutrients like glucose, amino acids, and fatty acids to cells.
- **Waste Removal**: Transports waste products like urea and carbon dioxide to excretory organs for elimination.

Major Blood Group Systems



ABO Blood Group System:

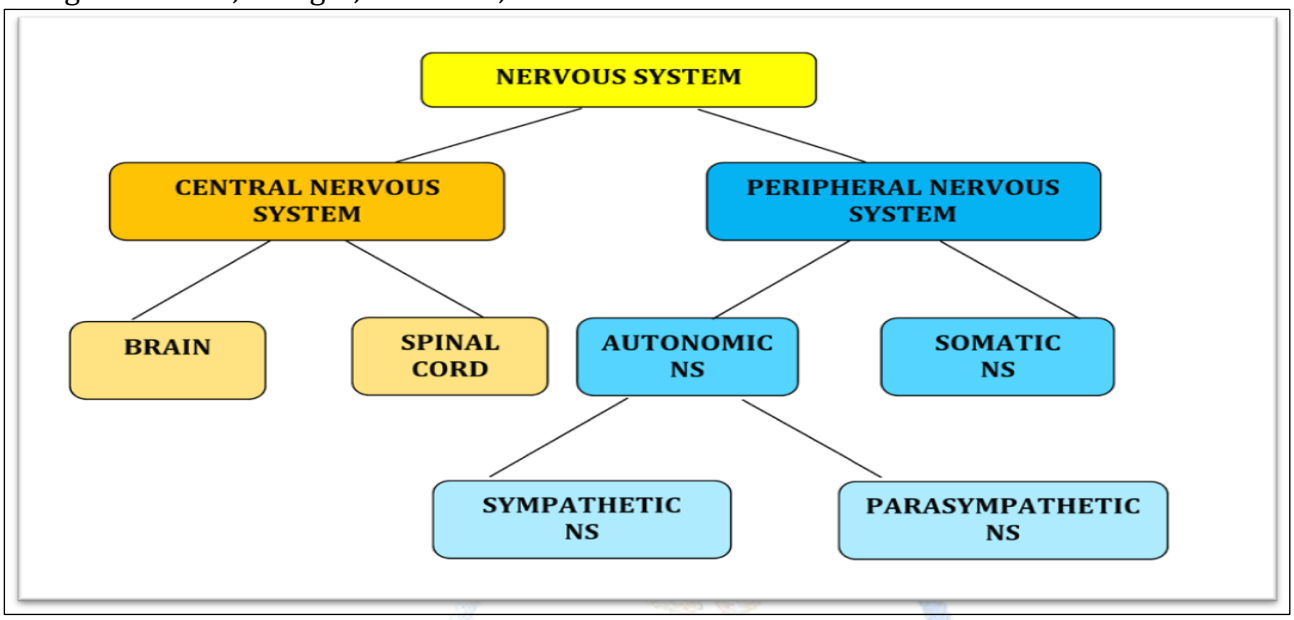
- **Type A:**
  - **Antigens**: A antigens on red blood cells.
  - **Antibodies**: Anti-B antibodies in plasma.
- **Type B:**
  - **Antigens**: B antigens on red blood cells.
  - **Antibodies**: Anti-A antibodies in plasma.
- **Type AB:**
  - **Antigens**: Both A and B antigens on red blood cells.
  - **Antibodies**: No antibodies in plasma.
  - **Key Fact**: Universal recipient.
- **Type O:**
  - **Antigens**: No antigens on red blood cells.
  - **Antibodies**: Both anti-A and anti-B antibodies in plasma.
  - **Key Fact**: Universal donor.

Rh Blood Group System:

- Rh-Positive (Rh+): Presence of Rh (D) antigen on red blood cells.
- Rh-Negative (Rh-): Absence of Rh (D) antigen on red blood cells.

6. Nervous System in Human Beings

The nervous system is a complex network of nerves and cells (neurons) responsible for transmitting signals between different parts of the body. It coordinates and controls various bodily functions, including movement, thought, sensation, and autonomic activities.



Components of the Nervous System :-

1. Central Nervous System (CNS)

- **Brain:**
  - Control center of the nervous system, located within the skull.
- **Spinal Cord:**
  - Transmits signals between the brain and the rest of the body.
  - Controls reflex actions.

2. Peripheral Nervous System (PNS)

- **Definition**: Consists of all nerves outside the CNS, including cranial nerves (originating from the brain) and spinal nerves (originating from the spinal cord).
- **Functions:**

Somatic Nervous System:

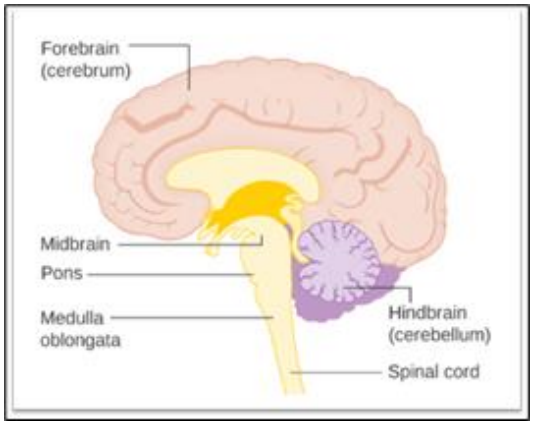
- Controls voluntary movements of the skeletal muscles.

Autonomic Nervous System:

- Regulates involuntary body functions like heartbeat, digestion, and respiration.
- Divisions of the Autonomic Nervous System:

- **Sympathetic Nervous System**: Prepares the body for 'fight or flight' responses during stressful situations.
- **Parasympathetic Nervous System**: Promotes 'rest and digest' functions, conserving energy during restful states.

Human Brain



- **Protection**: Covered by meninges membrane and encased in the cranium, surrounded by cerebrospinal fluid (CSF).
- **Weight**: 1.0 - 1.5 kg.
- **Composition**: Primarily composed of neurons, with an estimated 86-100 billion neurons.
- **Role:** Central to thoughts, interpretation, and control of body movements.
- **Skull Composition**: Consists of 22 bones—8 cranial and 14 facial bones—providing frontal, dorsal, and lateral protection.
- **Cerebrospinal Fluid (CSF)**
  Fills hollow spaces, cushions the brain, and circulates within the skull and spinal cord.

Parts of the Brain

1. Forebrain

- **Cerebrum:**
  - Most developed and largest part of the brain.
  - Manages memory, consciousness, intelligence, and sensory interpretation.
- **Thalamus:**
  - Center for sensing cold, pain, and heat.
- **Hypothalamus:**
  - Located below the thalamus.
  - Regulates body temperature, mood, emotions, appetite, heart rate, and other autonomic functions.
  - Center for thirst, hunger, love, and hate.

2. Midbrain

- **Tectum**: Controls reflex movements of the neck, eyes, and head; relays sensory information from the ears.
- **Tegmentum:** Connects with the spinal cord, thalamus, and cerebral cortex; involved in reflex actions, body movements, and attention.
- **Functions**: Controls vision and hearing.

3. Hindbrain

- **Cerebellum**
  - Second-largest part of the brain.
  - Maintains body balance.

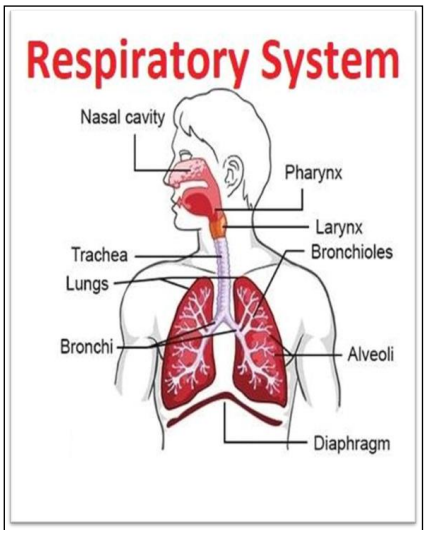
- **Medulla Oblongata**
  - Located in the lowest brain region.
  - Controls autonomic functions like heartbeat, respiration, sneezing, and digestion.
- **Pons**
  - Positioned between the medulla and midbrain.
  - Regulates respiration and sleep cycles.

Spinal Cord

- **Location**: Extends from the posterior region of the Medulla Oblongata.
- **Function:**
  - Center for reflex actions.
  - Carries impulses between the brain and the rest of the body.

7. Respiratory System

The respiratory system consists of organs and tissues involved in gas exchange. It allows the uptake of oxygen from the atmosphere and the release of carbon dioxide generated during aerobic respiration. This process, also known as breathing or external respiration, ensures that cells receive oxygen and eliminate carbon dioxide.



Features of the Human Respiratory System:

- **Oxygen Transport**: Inhaled oxygen is transported to various body parts and used to metabolize glucose at the cellular level through a series of chemical reactions.
- **ATP Generation**: The breakdown of glucose releases energy, which is stored in the form of ATP (adenosine triphosphate).

Parts of the Respiratory System and Their Functions:

1) External Nostrils:

Function: Allow the intake of air into the respiratory system.

2) Nasal Chamber:

Structure: Lined with hair and mucus.
Function: Filters air to remove dust and dirt, and adds moisture

3) Pharynx:

Function: Acts as a common passageway for air and food, located behind the nasal chamber.

4) Larynx (Voice Box):

Nickname: Soundbox.
Function: Houses the vocal cords, essential for sound production.

5) Trachea (Windpipe):

Structure: Extends from the larynx and is supported by C-shaped cartilaginous rings.
Function: Maintains an open airway; bifurcates into two bronchi, each leading to a lung.

6) Epiglottis:

Structure: Flap-like structure.
Function: Covers the glottis to prevent food from entering the windpipe during swallowing.

7) Bronchi:

Function: The trachea divides into the left and right bronchi, which carry air to each lung.

8) Bronchioles:

Function: Smaller branches of the bronchi that further divide into finer channels.

9) Alveoli:

Structure: Balloon-like structures.
Function: The bronchioles terminate in alveoli, where gas exchange occurs between air and blood.

10) Lungs:

Structure: A pair of sac-like structures covered by a double-layered membrane known as the pleura.
Function: Facilitate gas exchange and are protected by the pleural membrane, which reduces friction during breathing.

Types of Respiration:

1) Aerobic Respiration:

- **Definition:** Cellular respiration that occurs in the presence of oxygen to produce energy.
- Chemical Equation– Glucose($C_6H_{12}O_6$) + Oxygen($6O_2$) → Carbon dioxide($6CO_2$) + Water($6H_2O$)+ Energy (ATP)

2) Anaerobic Respiration:

- **Definition:** Cellular respiration that occurs in the absence of oxygen to produce energy.
- **Process**: Typically occurs in some microorganisms and muscle cells during intense exercise.
- Chemical Equation– Glucose($C_6H_{12}O_6$) → Alcohol 2(C_2H_5O H) + Carbon dioxide 2(CO_2) + Energy (ATP)
- In human muscle cells, anaerobic respiration produces lactic acid instead of alcohol
- Glucose ($C_6H_{12}O_6$)→Lactic Acid ($2C_3H_6O_3$)+Energy (ATP)

Process of Respiration

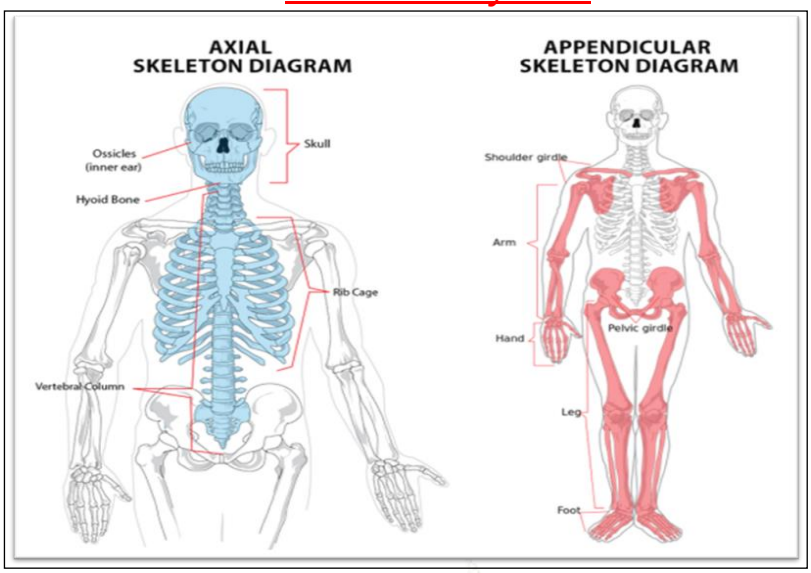
1) External Respiration:

- **Ventilation (Breathing)**
  - **Inhalation**: Oxygen is brought into the respiratory system.
  - **Exhalation**: Carbon dioxide is expelled from the respiratory system.
- **Gas Exchange:**
  - **In the Lungs**: Oxygen diffuses into the blood; carbon dioxide diffuses out of the blood.
  - **In the Gills**: Oxygen diffuses into the blood; carbon dioxide diffuses out into the water.

2) Internal Respiration

- Internal respiration refers to the metabolic processes that occur within cells to produce energy. It involves the following stages:
  - **Glycolysis:**
    - ✓ Takes place in the cytoplasm.
    - ✓ Does not require oxygen.
    - ✓ Occurs in anaerobic respiration.
    - ✓ Glucose→ Pyruvic acid + 2 ATP
  - **Krebs Cycle (Citric Acid Cycle):**
    - ✓ Takes place in the mitochondria.
    - ✓ Requires oxygen.
    - ✓ Oxidation of Pyruvic Acid into water, CO_2 and energy (36 ATP)
    - ✓ It produces maximum energy (36 ATP).

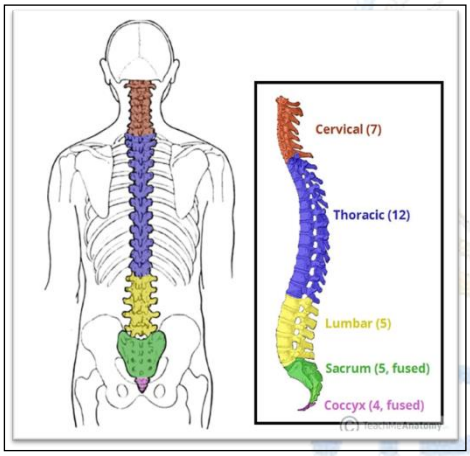
8. Skeletal System

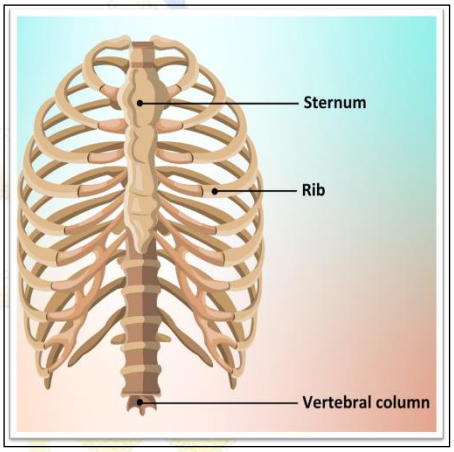


The skeletal system is a complex structure that provides support, protection, and movement. It consists of bones, cartilage, ligaments, and other connective tissues.

Divisions of the Skeletal System:

1) Axial Skeleton





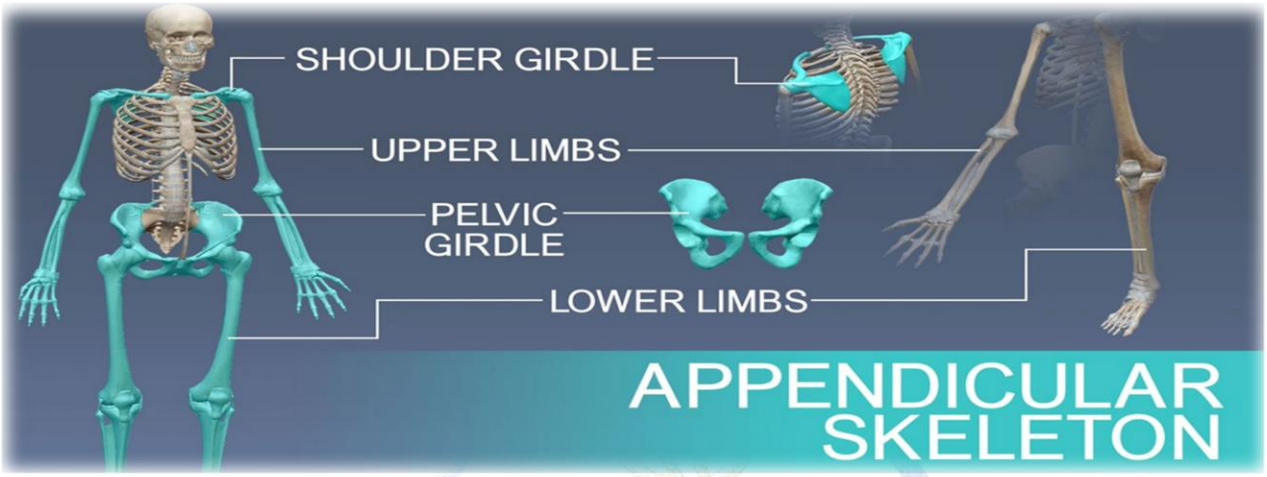
- Forms the main axis of the body.
- Consists of 80 bones, including the skull, vertebral column, and bones of the chest.

- **Skull:**
  - Consists of 29 bones.
  - 8 bones protect the brain (cranium).
  - 14 bones make up the face.
  - 6 bones in the ear.
  - 1 hyoid bone in the throat.

- **Vertebral Column (Backbone):**
  - Made up of 33 vertebrae.
  - Found at the back of humans, resembling a thick rod.
  - All vertebrae are joined by intervertebral discs.
  - The 1st vertebra (Atlas) holds the skull and provides flexibility to the neck and body.

- **Ribs**
  - 12 pairs (24 ribs) in the body.
- **Sternum**
  - A single bone that connects all the ribs together.
  - Located in the middle of the chest.

2) Appendicular Skeleton

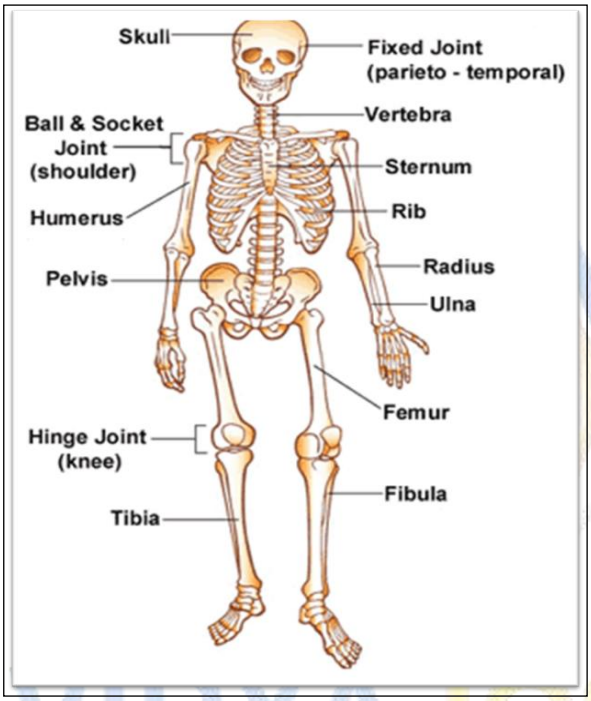


- Consists of 126 bones.
- Provides the body with a definite shape and a basis for muscle attachment.
- Supports the limbs and connects them to the axial skeleton.

- **Pectoral Girdle (Shoulder Girdle)**
  - Clavicles (Collarbones): Connects the arms to the body, stabilizes shoulder movement.
  - Scapulae (Shoulder Blades): Provides attachment for muscles, enabling arm movement.
- **Upper Limbs**
  - Humerus: The upper arm bone, connecting the shoulder to the elbow.
  - Radius and Ulna: The two forearm bones, enabling wrist and arm rotation.
  - Carpals (Wrist Bones): Eight small bones forming the wrist.
  - Metacarpals (Hand Bones): Five bones forming the palm.
  - Phalanges (Finger Bones): Bones of the fingers.
- **Pelvic Girdle (Hip Girdle)**
  - Hip Bones: Connects the spine to the lower limbs, supports body weight, and protects pelvic organs.
- **Lower Limbs**
  - **Femur (Thigh Bone):** The longest and strongest bone, connecting the hip to the knee.
  - **Patella (Kneecap):** Protects the knee joint.
  - **Tibia and Fibula**: The two bones of the lower leg, supporting weight and enabling ankle movement.
  - **Tarsals (Ankle Bones)**: Seven bones forming the ankle.
  - **Metatarsals (Foot Bones**): Five bones forming the arch and sole of the foot.
  - **Phalanges (Toe Bones):** Bones of the toes.

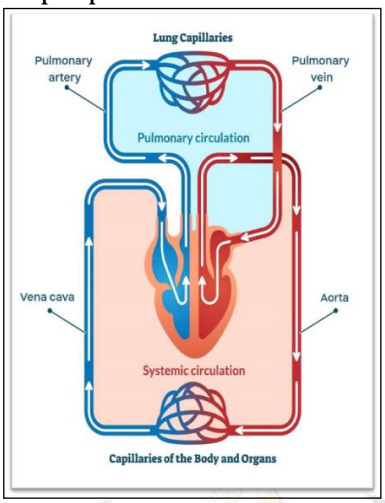
Main Functions of the Skeletal System

1) **Support**: Provides a structural framework for the body, supporting soft tissues and giving the body its shape.
2) **Protection**: Protects vital organs, such as the brain (encased in the skull), heart, and lungs (protected by the rib cage), and the spinal cord (protected by the vertebral column).
3) **Movement**: Works in conjunction with the muscular system to facilitate movement by serving as points of attachment for muscles.
4) **Mineral Storage**: Stores essential minerals such as calcium and phosphorus, which can be released into the bloodstream as needed.
5) **Blood Cell Production**: The red bone marrow within certain bones produces blood cells in a process called hematopoiesis.
6) **Energy Storage**: Yellow bone marrow stores fat, which serves as an energy reserve.



9. Human Circulatory System

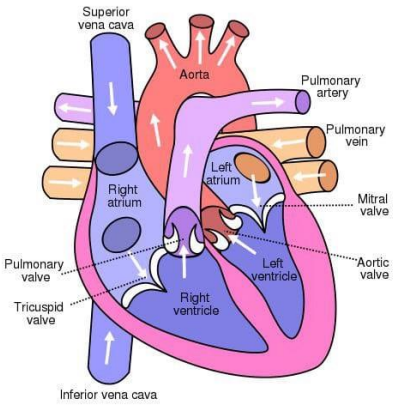
The circulatory system, also known as the cardiovascular system, is vital for transporting blood, nutrients, oxygen, and other essential substances throughout the body. This system ensures that every cell receives the necessary materials for proper function.



Main Components of the Circulatory System

1) Heart

- **Function**: Central pump that drives blood circulation.
- **Structure**:
  - **Four Chambers:**
    - ✓ **Right Atrium**: Receives deoxygenated blood from the body.
    - ✓ **Right Ventricle**: Pumps deoxygenated blood to the lungs.
    - ✓ **Left Atrium**: Receives oxygenated blood from the lungs.
    - ✓ **Left Ventricle**: Pumps oxygenated blood to the body.
    - ✓ **Right Side**: Pumps deoxygenated blood to the lungs.
    - ✓ **Left Side**: Pumps oxygenated blood to the rest of the body.



2) Blood Vessels

- **Types:**
  - **Arteries**: Carry oxygen-rich blood away from the heart.
  - **Veins**: Return oxygen-depleted blood to the heart.
  - **Capillaries**: Facilitate exchange of gases, nutrients, and wastes between blood and tissues.

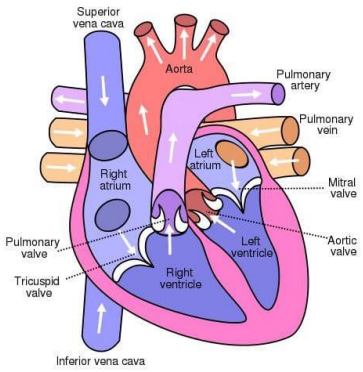
3) Blood

- **Components:**
  - **Red Blood Cells**: Transport oxygen and carbon dioxide.
  - **White Blood Cells**: Defend against infections.
  - **Platelets**: Aid in blood clotting.
  - **Plasma**: Liquid part carrying nutrients, hormones, and wastes.

Importance of the Circulatory System

- **Oxygen Supply**: Delivers oxygen to cells for energy production.
- **Nutrient Distribution**: Transports essential nutrients.
- **Waste Removal**: Removes carbon dioxide and metabolic wastes.
- **Immune Defense**: Distributes white blood cells to combat infections.
- **Temperature Regulation**: Maintains body temperature by distributing heat.

Structure of the Heart



- **Four Chambers**
  - **Right Atrium**: Receives deoxygenated blood.
  - **Right Ventricle**: Pumps it to the lungs.
  - **Left Atrium**: Receives oxygenated blood.
  - **Left Ventricle**: Pumps it to the body.
- **Valves:** Ensure correct blood flow and prevent backflow.
  - **Tricuspid Valve**: Between right atrium and ventricle.
  - **Pulmonary Valve**: Between right ventricle and pulmonary artery.
  - **Mitral Valve**: Between left atrium and ventricle.
  - **Aortic Valve**: Between left ventricle and aorta.

Blood Circulation Path

1) Pulmonary Circulation

- **Right Atrium**: Receives deoxygenated blood.
- **Right Ventricle**: Pumps blood to the lungs via the pulmonary artery.
- **In Lungs**: Blood picks up oxygen and releases carbon dioxide.

2) Systemic Circulation:

- **Left Atrium**: Receives oxygen-rich blood from the lungs.
- **Left Ventricle**: Pumps oxygenated blood to the body via the aorta.

3) Cycle Repeats:

- **Diastole**: Heart relaxes, filling with blood for the next cycle.
- **Rate:** Normally beats 60-100 times per minute.

Heartbeat and Electrical System

- **SA Node**: Natural pacemaker that initiates heartbeats.
- **AV Node**: Delays the impulse, ensuring proper chamber filling before ventricular contraction.

Blood Pressure

- **Definition**: The force blood exerts on arterial walls during circulation.
- **Normal Range:**
  - ✓ **Systolic**: Less than 120 mmHg (pressure during heartbeats).
  - ✓ **Diastolic**: Less than 80 mmHg (pressure between heartbeats).
  - ✓ **Normal**: Less than 120/80 mmHg.

10. Human Digestive System

(Nutrition in humans)

The human digestive system is an intricate and highly coordinated network of organs and structures designed to convert the food we consume into energy and essential nutrients that sustain life.

Digestive Process Steps

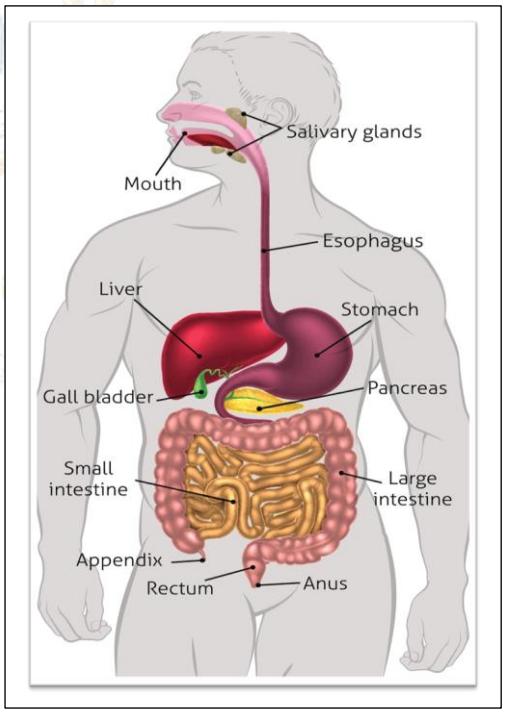
1) **Ingestion**: The intake of food through the mouth, followed by chewing and mixing with saliva to form a bolus.
2) **Mixing and Movement**: Food is propelled through the GI tract by coordinated muscular contractions (peristalsis) and mixing movements.
3) **Secretion**: Digestive juices and enzymes are secreted by various organs, including the stomach, liver, pancreas, and intestines, to chemically break down food.
4) **Digestion**: The mechanical and chemical breakdown of food into smaller, absorbable molecules. Proteins are broken down into amino acids, carbohydrates into simple sugars, and fats into fatty acids and glycerol.
5) **Absorption**: The process by which the nutrients from digested food are absorbed through the walls of the small intestine into the bloodstream or lymphatic system. Water and electrolytes are absorbed in the large intestine.
6) **Excretion**: The elimination of indigestible substances and waste products from the body through defecation.

The digestive system is divided into two main components: the gastrointestinal (GI) tract and accessory organs such as the liver, pancreas, and gallbladder.

Components:

1) Gastrointestinal Tract (GI Tract)

The GI tract is a continuous, hollow tube extending from the mouth to the anus, where digestion and absorption occur.



Mouth

The process of digestion begins in the mouth, where food is mechanically broken down by chewing (mastication). Saliva, secreted by the salivary glands, contains the enzyme amylase (also known as ptyalin), which initiates the breakdown of Carbohydrates into simpler sugars.

Pharynx

A muscular passage that serves as a pathway for both food and air, the pharynx connects the mouth to the esophagus. It plays a dual role in the digestive and respiratory systems.

Esophagus

A muscular tube that conveys food from the pharynx to the stomach through a series of coordinated contractions known as peristalsis. The esophagus ensures that food reaches the stomach efficiently, without backflow.

Stomach

The stomach acts as a temporary storage chamber where food is mixed with gastric juices. These juices contain hydrochloric acid and digestive enzymes, such as pepsin and renin, which further break down proteins into smaller molecules called peptones. The acidic environment also kills harmful bacteria ingested with food.

- **Mucous**: A protective layer that lines the stomach, preventing the acidic gastric juices from damaging the stomach's inner walls.
- **Hydrochloric Acid**: Produced by the oxyntic cells, it creates an acidic environment for enzymes to function and kills ingested pathogens.

Small Intestine

The small intestine is the primary site for digestion and absorption of nutrients.

It is divided into three sections: the duodenum, jejunum, and ileum, each with specialized functions.

- **Duodenum**: The first segment, where bile from the liver and pancreatic juice mix with the food. Bile emulsifies fats, making them easier to digest, while pancreatic enzymes such as trypsin, amylase, and lipase continue the breakdown of proteins, carbohydrates, and fats, respectively.
- **Jejunum**: The middle section, where most nutrient absorption occurs. The inner surface of the jejunum is lined with villi and microvilli, which greatly increase the surface area for absorption. Enzymes such as maltase, sucrase, and lactase aid in the final stages of carbohydrate digestion.
- **Ileum**: The last part of the small intestine, where the remaining nutrients are absorbed. The ileum also plays a crucial role in absorbing vitamin B12 and bile salts, which are recycled back to the liver.

Large Intestine

The large intestine, also known as the colon, is responsible for absorbing water and electrolytes from the indigestible remnants of food. It compacts these remnants into feces, which are eventually excreted from the body.

- **Colon**: The main section of the large intestine, where beneficial bacteria break down some of the remaining food components, producing vitamins like K and B12.
- **Rectum:** The terminal segment of the large intestine, where feces are stored before being expelled through the anus during defecation.

2) Accessory Organs

These organs assist the digestive process by producing and storing digestive juices, enzymes, and bile.

Liver

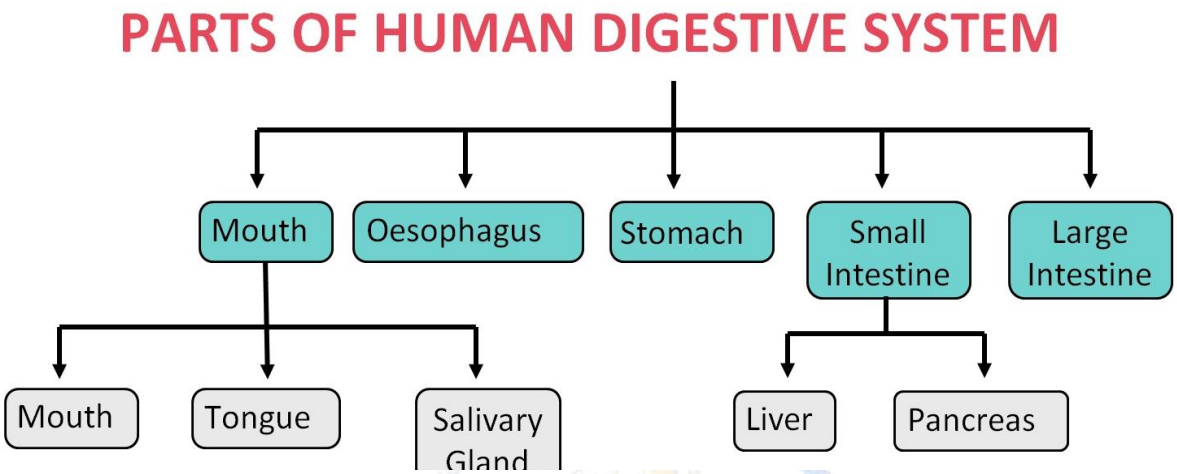
The liver is the largest internal organ and serves multiple functions. It produces bile, a digestive fluid that emulsifies fats, making them easier to digest. The liver also detoxifies chemicals and metabolizes drugs, converting harmful substances like ammonia into urea, which is excreted by the kidneys.

Gallbladder

A small, pear-shaped organ located beneath the liver, the gallbladder stores and concentrates bile produced by the liver. When food enters the small intestine, the gallbladder releases bile into the duodenum to aid in fat digestion.

Pancreas

The pancreas has both endocrine and exocrine functions. It produces digestive enzymes (amylase, trypsin, and lipase) that are secreted into the small intestine to break down carbohydrates, proteins, and fats. Additionally, the pancreas releases bicarbonate to neutralize the acidic chyme entering the small intestine from the stomach.



Functions of digestive system:-

- **Conversion of Food**: Transforms complex food substances into energy and essential nutrients that the body can absorb and utilize.
- **Waste Elimination**: Discards indigestible and waste materials from the body, ensuring the system remains efficient and healthy.

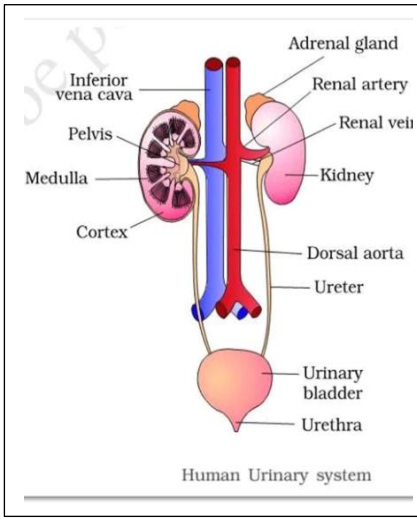
11. Human Excretory System

The excretory system is vital for maintaining the body's internal environment by removing waste products and excess substances, thus ensuring homeostasis. It prevents the accumulation of harmful substances, which could lead to toxicity and disrupt bodily functions.

Components:

Kidneys

The kidneys are the primary excretory organs, essential for filtering blood, removing waste products, and regulating the body's fluid balance.



Human Urinary system

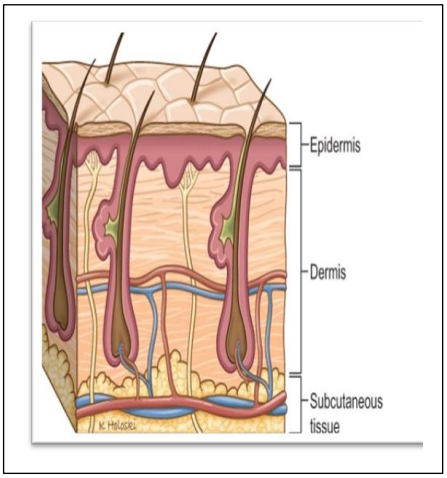
- **Location:**
  The kidneys are a pair of bean-shaped organs located in the retroperitoneal space on either side of the spine, just below the ribcage.

- **Composition**
  - **Cortex**: The outer layer of the kidney, containing the glomeruli and nephrons, where blood filtration occurs.
  - **Medulla**: The inner layer, organized into pyramid-shaped structures called renal pyramids. These collect urine from the nephrons and channel it into the renal pelvis.
  - **Ureter**: A muscular tube that transports urine from the kidney to the bladder.
  - **Nephrons**: The functional units of the kidney, with each kidney containing approximately 1 to 1.5 million nephrons. Each nephron filters blood, reabsorbs essential nutrients, and excretes waste as urine.
  - **Renal Pelvis**: A funnel-shaped structure that collects urine from the renal pyramids and passes it into the ureter.

- **Functions:**
  - **Filtration of Blood**: The kidneys filter waste products, toxins, and excess ions from the blood, forming urine.
  - **Regulation of Blood Pressure**: The kidneys adjust sodium and water excretion, producing renin, which regulates blood pressure.
  - **Electrolyte Balance**: The kidneys maintain the balance of key electrolytes, such as sodium, potassium, and calcium, which are critical for nerve function and muscle contraction.
  - **Acid-Base Balance**: By managing hydrogen ions and bicarbonate, the kidneys regulate the pH of the blood, maintaining it within a narrow, healthy range.
  - **Red Blood Cell Production**: The kidneys produce erythropoietin, a hormone that stimulates the production of red blood cells in the bone marrow.
  - **Detoxification**: The kidneys filter out harmful substances and ensure their excretion through urine.
  - **Water Balance**: The kidneys regulate the body's hydration by controlling urine concentration and volume, adjusting it according to the body's needs.

Skin

The skin is the largest organ of the human body and plays a crucial role in excretion through sweat, while also serving as a protective barrier.



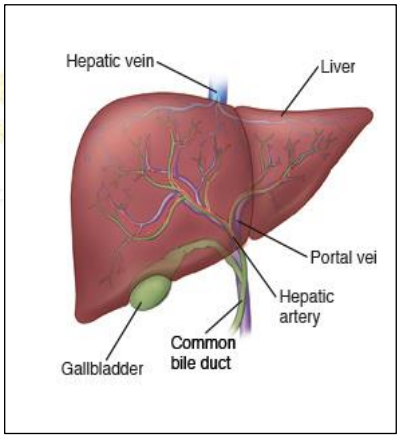
- **Location**
  The skin covers the entire body, providing an interface between the internal environment and the external world.

- **Composition**
  - **Epidermis**: The outermost layer, composed of keratinocytes that produce keratin, providing a waterproof barrier. Melanocytes in the epidermis produce melanin, which gives skin its color and protects against UV radiation.
  - **Dermis**: The middle layer, located beneath the epidermis, contains collagen and elastin fibers that provide strength and elasticity. It also houses blood vessels, nerve endings, hair follicles, and sweat glands.
  - **Hypodermis (Subcutaneous Layer)**: The deepest layer, composed of fat cells (adipocytes) that store energy and provide insulation. Connective tissue in this layer anchors the skin to underlying structures like muscles and bones.

- **Functions**
  - Protection: The skin acts as a physical barrier against environmental hazards, such as pathogens, chemicals, and mechanical injuries.
  - Thermoregulation: Sweat glands in the skin excrete sweat, which cools the body through evaporation. Blood vessels in the skin dilate or constrict to release or conserve heat.
  - Excretion: The skin excretes metabolic waste products, such as urea, salts, and water, through sweat, helping to regulate the body's fluid balance and remove toxins.

Liver

The liver is a vital organ that plays a significant role in metabolism, detoxification, and waste excretion.

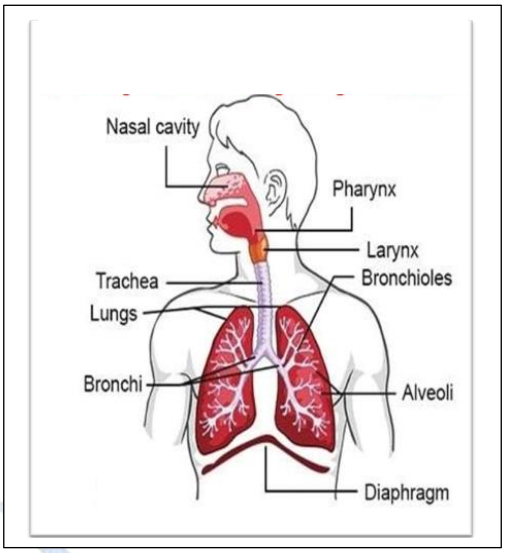


- **Location**:
  The liver is located in the upper right quadrant of the abdomen, beneath the diaphragm and above the stomach.
- **Structure:**
  - Right & Left Lobes: The liver is divided into two main lobes, the right being larger than the left, separated by the falciform ligament.
  - Hepatocytes: The functional cells of the liver, responsible for carrying out the organ's metabolic and detoxifying activities.

- **Functions:**
  - **Bile Production**: The liver produces bile, which is stored in the gallbladder and released into the small intestine to aid in the digestion of fats.
  - **Detoxification**: The liver detoxifies harmful substances, such as alcohol, drugs, and metabolic waste products, converting them into less harmful compounds like urea, which are excreted by the kidneys.
  - **Blood Clotting**: The liver produces clotting factors essential for blood coagulation, preventing excessive bleeding.

- **Metabolism of Fats**: The liver synthesizes and breaks down fats, storing them as energy reserves or converting them into other forms of energy.
- **Storage of Vitamins and Minerals**: The liver stores essential vitamins (A, D, E, K, and B12) and minerals (iron and copper), releasing them as needed by the body.

Lungs



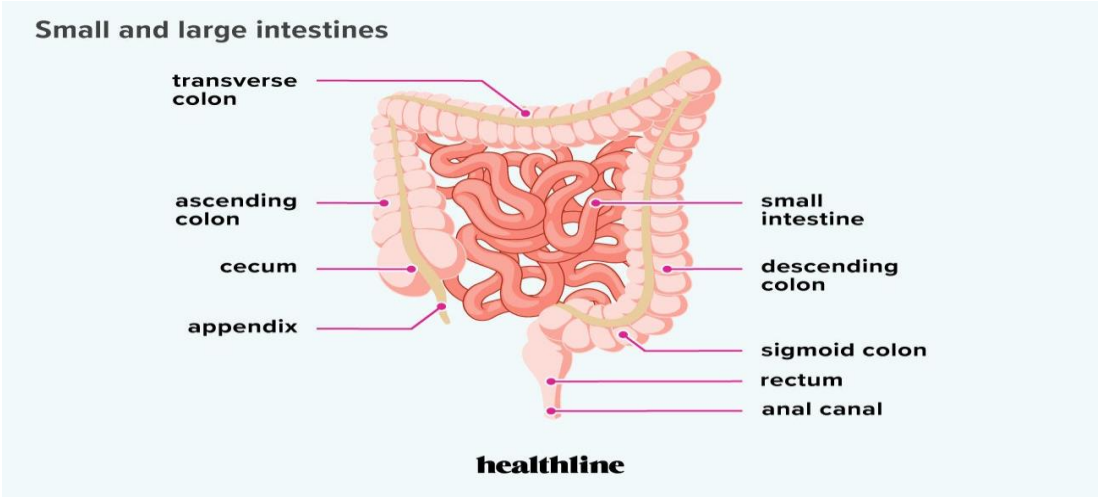
The lungs are the primary organs of the respiratory system, responsible for gas exchange and the excretion of carbon - dioxide and water vapor.

- **Location:**
  The lungs are located in the thoracic cavity, protected by the ribcage, and separated by the mediastinum, which houses the heart.
- **Function:**
  - **Gas Exchange**: The primary function of the lungs is to exchange oxygen and carbon dioxide between the blood and the air. Oxygen from inhaled air diffuses into the blood, while carbon - dioxide, a waste product of metabolism, diffuses from the blood into the alveoli and is exhaled.
  - **Excretion**: The lungs remove carbon dioxide and water vapor, which are waste products of cellular respiration, maintaining the body's acid-base balance.

Intestines

The intestines are a vital part of the digestive system, responsible for nutrient absorption and waste excretion.

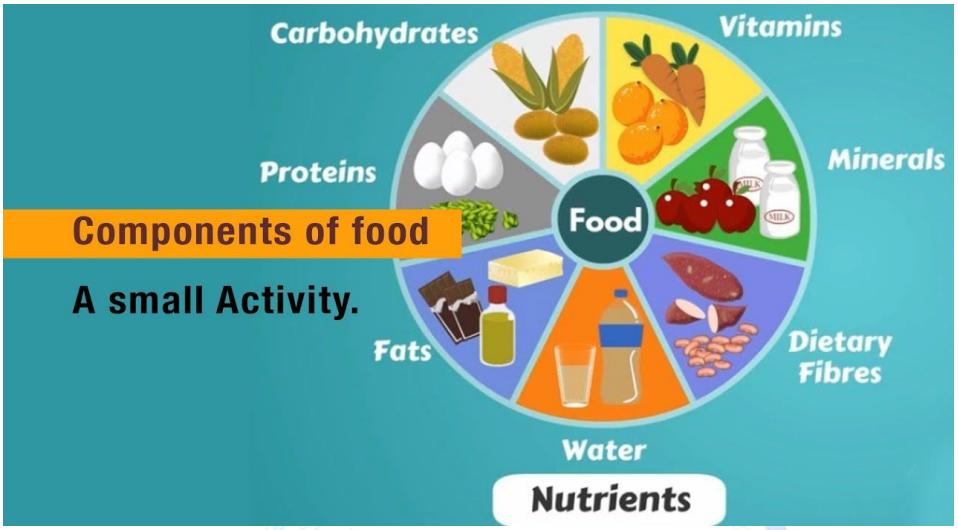
- **Location:**
  The intestines occupy the abdominal cavity, with the small intestine connecting the stomach to the large intestine.
- **Functions:**
  - **Small Intestine**: The primary site for the digestion and absorption of nutrients, with enzymes breaking down food into absorbable molecules.
  - **Large Intestine**: The large intestine absorbs water and electrolytes, converting the remaining indigestible food matter into feces, which are excreted through the rectum and anus.



12. Balanced Diet & Deficiency Diseases

A balanced diet is the cornerstone of good health, providing the body with essential nutrients in the right proportions to support overall well-being, energy levels, and proper bodily functions. It involves a variety of food groups, each contributing unique benefits to maintain health.

Components of a Balanced Diet



- **Carbohydrates**: The primary source of energy, vital for physical and mental activities.
- **Proteins**: Essential for growth, repair, and maintenance of tissues.
- **Fats**: Important for energy storage, hormone production, and nutrient absorption.
- **Vitamins**: Organic compounds that support various biochemical functions.
- **Minerals**: Inorganic elements that play crucial roles in structural and regulatory functions.
- **Fiber**: Aids in digestion and helps prevent chronic diseases.
- **Water**: Vital for hydration, temperature regulation, and waste elimination.

Key Factors Affecting a Balanced Diet

- **Age**: Nutritional needs evolve across different life stages, from infancy to old age.
  - Children: Require nutrients for growth and development.
  - Adults: Need balanced intake to maintain energy and prevent chronic diseases.
  - Elderly: Focus on nutrients that support bone health and cognitive function.
- **Gender**: Men and women have differing nutrient requirements due to factors like muscle mass and reproductive health.
  - **Women**: May need more iron and calcium, especially during menstruation, pregnancy, and menopause.
  - **Men**: Often require more calories and protein for muscle maintenance.
- **Activity Level**: Higher levels of physical activity increase the need for calories and certain nutrients.
  - **Athletes**: Require additional protein and carbohydrates for muscle repair and energy.
  - **Sedentary Individuals**: Should focus on nutrient-dense, lower-calorie foods to prevent weight gain.
- **Health Conditions**: Chronic diseases and health conditions may necessitate specific dietary adjustments.

- **Diabetes**: Emphasis on low-glycemic index foods to manage blood sugar levels.
- **Hypertension**: Focus on reducing sodium intake and increasing potassium.
- **Heart Disease**: Prioritize healthy fats, such as omega-3 fatty acids, and reduce saturated and trans fats.

- **Lifestyle**: Stress, sleep patterns, and daily routines influence dietary choices and nutrient absorption.
  - ***Stress***: Can lead to emotional eating or poor food choices.
  - **Sleep**: Poor sleep may affect hunger hormones, leading to overeating.
- **Cultural Preferences**: Cultural norms and traditions shape food choices and dietary patterns.
  - Mediterranean Diet: Rich in fruits, vegetables, whole grains, and healthy fats.
  - **Asian Diet**: Emphasizes rice, vegetables, fish, and tofu.
- **Economic Status**: Financial constraints can impact the availability and diversity of nutritious foods.
  - **Low-Income**: May lead to reliance on inexpensive, calorie-dense, nutrient-poor foods.
  - **Affluent**: Access to a wide variety of fresh, nutrient-rich foods.
- **Education**: Awareness and knowledge about nutrition play a crucial role in making informed food choices.
  - **Nutritional Labels**: Understanding can help make healthier choices.

Importance of a Balanced Diet

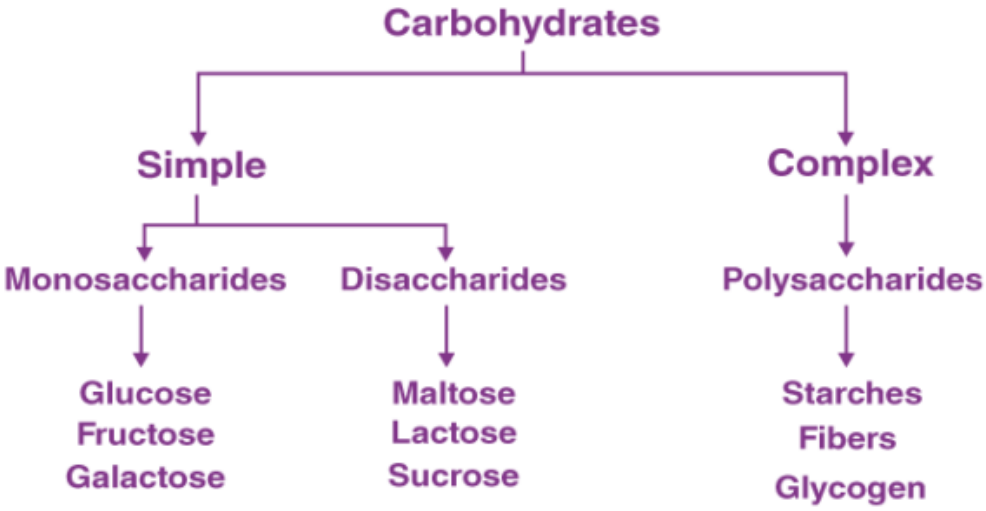
- **Promotes Health**: Provides the essential nutrients needed to prevent deficiencies and chronic diseases.
- **Boosts Immunity**: Strengthens the immune system, reducing the risk of infections and illnesses.
- **Maintains Weight**: Helps manage body weight, preventing obesity and related health issues.
- **Enhances Energy Levels**: Provides steady energy for daily activities and mental clarity.
- **Supports Growth and Development**: Crucial for physical and mental growth, especially in children and adolescents.
- **Improves Mental Health**: A balanced diet can reduce the risk of mental health disorders like depression and anxiety.
- **Aids in Longevity**: Contributes to a longer, healthier life by reducing the risk of age-related diseases.

Nutrients and Their Roles

Nutrients are substances in food that support growth, repair, and maintenance of the body. They include macronutrients (carbohydrates, proteins, fats) and micronutrients (vitamins, minerals), each fulfilling specific functions for health.

Carbohydrates

Carbohydrates are organic compounds made up of carbon, hydrogen, and oxygen. They are the body's main energy source, fueling all physical and mental activities.



Types of Carbohydrates

- **Simple Carbohydrates**
  - Monosaccharides: Single sugar units (e.g., glucose, fructose, galactose).
  - Disaccharides: Two sugar units (e.g., sucrose, lactose, maltose).
- **Complex Carbohydrates**
  - Oligosaccharides: Short chains of sugar units (e.g., maltodextrin).
  - Polysaccharides: Long chains of sugar units (e.g., starch, glycogen, cellulose).

Sources: Fruits, honey, table sugar, dairy products, whole grains, vegetables, legumes.

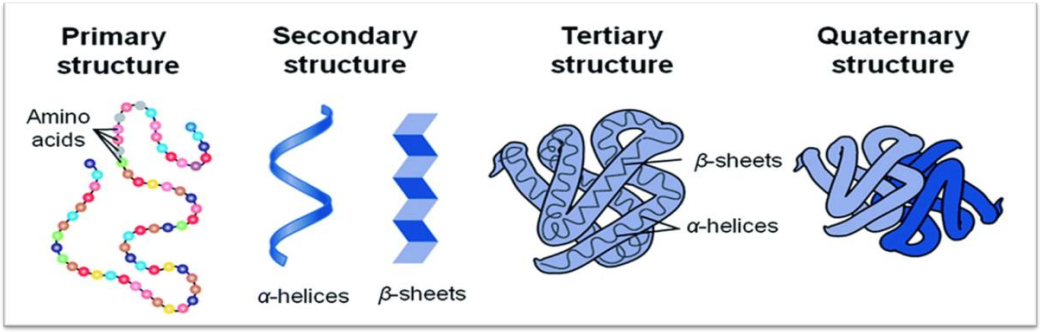
Functions:

- Energy Supply: Carbohydrates are the primary source of energy for body functions and physical activity.
- **Digestive Health**: Dietary fiber from complex carbohydrates aids in digestion, prevents constipation, and supports gut health.
- **Mental Function**: Provides energy to the brain, enhancing cognitive functions and concentration.

Diseases Due to Deficiency:

- **Hypoglycemia**: Low blood sugar levels can cause fatigue, dizziness, and confusion.
- **Constipation**: Lack of dietary fiber can lead to digestive issues, including constipation and bloating.

Proteins



Proteins are large, complex molecules made up of amino acids. They are essential for the structure, function, and regulation of the body's tissues and organs.

Types of Proteins:

- **Simple Proteins**
  - Albumins: Found in egg white, milk, and blood plasma.
  - Globulins: Found in blood plasma and seeds.
  - Histones: Associated with DNA in the nucleus.
- **Conjugated Proteins**
  - **Glycoproteins**: Proteins with carbohydrates, found in cell membranes.
  - **Lipoproteins**: Proteins with lipids, important for fat transport.
  - **Hemoglobin**: Carries oxygen in blood; composed of globin and heme (iron group).
- **Derived Proteins**
  - **Peptides**: Short chains of amino acids.
  - **Proteoses and Peptones**: Intermediate products of protein digestion.

Sources of Proteins

- **Animal Sources**: Meat, fish, eggs, dairy products. These are complete proteins containing all essential amino acids.
- **Plant Sources**: Legumes, nuts, seeds, tofu, soybeans. These are generally incomplete proteins; combining different plant sources provides all essential amino acids.

Functions:

Protein	Functions
Collagen	Intercellular ground substance
Trypsin	Enzyme
Insulin	Hormone
Antibody	Fights infectious agents
Receptor	Sensory reception (smell, taste, hormone, etc.)
GLUT-4	Enables glucose transport into cells

- **Digestion**: Proteins, especially digestive enzymes, facilitate the breakdown of food into nutrients.
- **Movement**: Myosin, a protein in muscles, enables muscle contraction for movement.
- Structure and Support: Keratin, a structural protein, forms hair, nails, and skin.
- Immune Response: Antibodies are proteins that help fight infections.

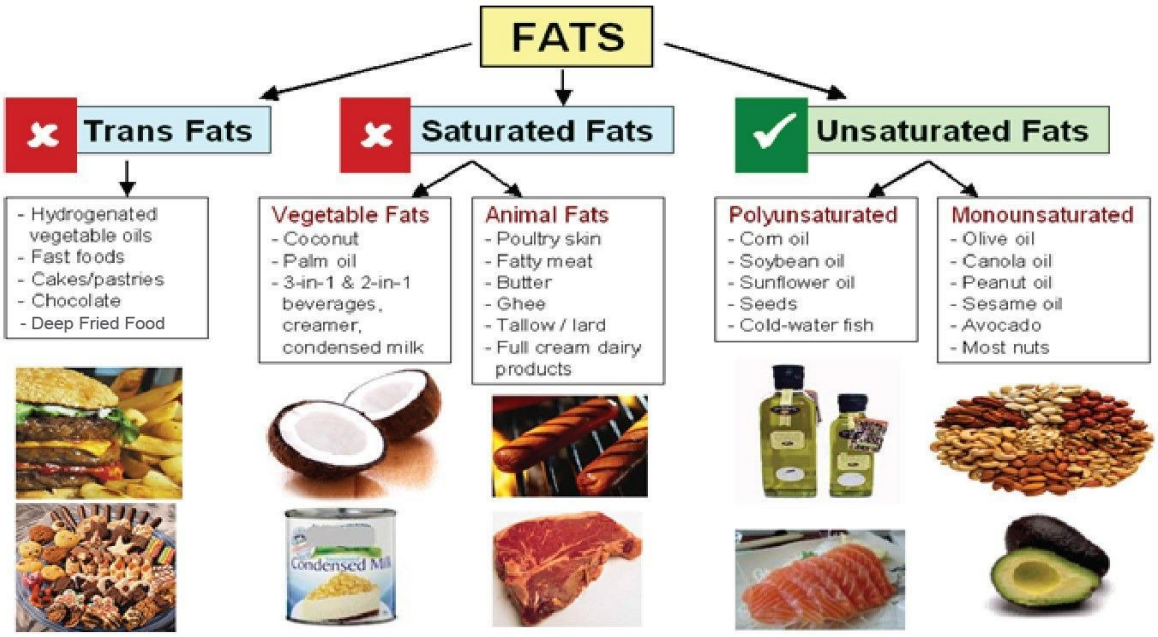
Diseases Due to Protein Deficiency

- **Kwashiorkor**: A severe protein deficiency leading to edema, an enlarged liver, and thin, weak muscles.
- **Marasmus**: A condition resulting from severe calorie and protein deficiency, characterized by extreme weight loss and muscle wasting.

Fats

Fats are a type of lipid and a macronutrient composed of fatty acids and glycerol. They are crucial for energy storage, cellular function, and absorption of fat-soluble vitamins (A, D, E, and K).

Types of Fats:



- **Saturated Fats:**
  - **Sources**: Animal products (meat, butter, cheese), coconut oil, palm oil.
  - **Health Impact**: High intake is linked to increased cholesterol levels and a higher risk of heart disease.

- **Unsaturated Fats:**

  Monounsaturated Fats:
  - **Sources**: Olive oil, avocados, nuts.
  - **Health Impact**: Can help reduce cholesterol and lower heart disease risk.

- **Polyunsaturated Fats:**
  - **Sources**: Fish, flaxseeds, walnuts.
  - **Health Impact**: Includes essential fatty acids like omega-3 and omega-6, beneficial for heart health and reducing inflammation.

- **Trans Fats**
  - **Sources**: Processed foods, baked goods, margarine.
  - **Characteristics**: Created by hydrogenating vegetable oils, making them more solid and shelf-stable.
  - **Health Impact**: Raises cholesterol and increasing heart disease risk.

Functions

- ✓ **Energy Storage**: Fats are the body's most concentrated energy source, providing 9 calories per gram.
- ✓ **Cell Structure**: Phospholipids, a type of fat, are a key component of cell membranes.
- ✓ **Insulation and Protection**: Fats insulate body organs against shock and maintain body temperature.
- ✓ **Vitamin Absorption**: Essential for absorbing fat-soluble vitamins (A, D, E, K).
- ✓ **Hormone Production**: Fats are precursors for steroid hormones like estrogen and testosterone.

Sources of Fats

- Animal Sources: Meat, dairy products, fatty fish.
- Plant Sources: Olive oil, nuts, seeds, avocados, coconut oil.
- Processed Foods: Margarine, snack foods, baked goods, fried foods.

Diseases Due to Excess or Imbalance in Fats:

- **Cardiovascular Disease**: Excessive intake of saturated and trans fats increases the risk of heart attack and stroke.
- **Obesity**: Overconsumption of high-fat foods contributes to weight gain, increasing the risk of type 2 diabetes, hypertension, and joint problems.
- **Fatty Liver Disease**: High fat intake, particularly of unhealthy fats, can lead to fat accumulation in the liver, causing inflammation and damage.

Vitamins

Vitamins are organic compounds required in small amounts for various metabolic processes. They are divided into two categories: fat-soluble and water-soluble.

Types of Vitamins:

- **Fat-Soluble Vitamins**: Stored in the body's fatty tissues and liver; they include:
  - **Vitamin A**: Essential for vision, immune function, and skin health.
    - **Sources**: Carrots, sweet potatoes, spinach, liver.
    - **Deficiency**: Leads to night blindness and dry skin.
  - **Vitamin D**: Crucial for calcium absorption, bone health, and immune support.
    - **Sources**: Sunlight, fortified foods, fatty fish, egg yolks.
    - **Deficiency**: Causes rickets in children and osteomalacia in adults.

- **Vitamin E**: An antioxidant that protects cells from damage and supports immune function.
  - **Sources**: Nuts, seeds, spinach, sunflower oil.
  - **Deficiency**: Can lead to nerve and muscle damage, vision problems.
- **Vitamin K**: Important for blood clotting and bone health.
  - **Sources**: Leafy greens, broccoli, Brussels sprouts.
  - **Deficiency**: Causes excessive bleeding and increases the risk of osteoporosis.

- **Water-Soluble Vitamins**: Not stored in the body and need to be consumed regularly; they include:
  - **Vitamin C**: Necessary for the synthesis of collagen, absorption of iron, and immune function.
    - **Sources**: Citrus fruits, strawberries, bell peppers, broccoli.
    - **Deficiency**: Leads to scurvy, characterized by bleeding gums, weakness, and bruising.
  - **B-Vitamins**: ***A group of vitamins*** that play a crucial role in energy metabolism, red blood cell formation, and neurological function.
    - B1 (**Thiamine**)**:** Found in whole grains, nuts, and seeds; deficiency causes beriberi.
    - B2 (**Riboflavin**): Found in eggs, dairy, and green vegetables; deficiency leads to skin disorders and anemia.
    - B3 (**Niacin**): Found in meat, fish, and whole grains; deficiency results in pellagra.
    - B5 (**Pantothenic Acid**): Found in meat, whole grains, and legumes; deficiency is rare but can cause fatigue and irritability.
    - B6 (**Pyridoxine**): Found in poultry, fish, and bananas; deficiency can lead to anemia and neurological issues.
    - B7 (**Biotin**): Found in eggs, nuts, and seeds; deficiency can cause hair loss and skin rashes.
    - B9 (**Folate**): Found in leafy greens, legumes, and fortified cereals; essential during pregnancy to prevent neural tube defects.
    - B12 (**Cobalamin**): Found in animal products like meat and dairy; deficiency leads to pernicious anemia and neurological disorders.

Minerals

Minerals are inorganic elements essential for a variety of bodily functions, including building bones, making hormones, and regulating heartbeat.

Important Minerals

Macro minerals (> 100 mg/day)*	Micro minerals (<100 mg/day)*
Calcium	Iron
Phosphorus	Zinc
Magnesium	Copper
Sulfur	Iodine
Sodium*	Fluoride
Potassium*	Manganese
Chloride*	Selenium
	Chromium
	Molybdenum

1) **Calcium**: Necessary for strong bones and teeth, muscle function, and nerve transmission.
   a) **Sources**: Dairy products, leafy greens, fortified foods.
   b) **Deficiency**: Leads to osteoporosis, a condition characterized by brittle bones.

2) **Iron**: Vital for hemoglobin formation and oxygen transport in the blood.
   a) **Sources**: Red meat, legumes, spinach, fortified cereals.
   b) **Deficiency**: Causes anemia, leading to fatigue, weakness, and shortness of breath.

3) **Potassium**: Regulates fluid balance, muscle contractions, and nerve signals.
   a. **Sources**: Bananas, potatoes, beans, spinach.
   b. **Deficiency**: Results in hypokalemia, causing muscle weakness, cramps, and irregular heartbeat.

4) **Magnesium**: Supports muscle and nerve function, regulates blood pressure, and aids in bone development.
   a) **Sources**: Nuts, seeds, whole grains, leafy greens.
   b) **Deficiency**: Leads to hypomagnesemia, causing muscle cramps, mental disorders, and heart issues.

5) **Zinc**: Essential for immune function, wound healing, DNA synthesis, and cell division.
   a) **Sources**: Meat, shellfish, legumes, seeds.
   b) **Deficiency**: Leads to growth retardation, hair loss, diarrhea, and impaired immune function.

6) **Phosphorus**: A key component of bones and teeth, and important for energy metabolism.
   a) **Sources**: Meat, dairy, nuts, legumes.
   b) **Deficiency**: Can cause weakness, bone pain, and impaired growth.

7) **Iodine**: Crucial for thyroid function and brain development.
   a) **Sources**: Iodized salt, seafood, dairy products.
   b) **Deficiency**: Causes goiter, hypothyroidism, and intellectual disabilities in children.

8) Sodium: Helps maintain fluid balance, supports nerve function, and aids in muscle contractions.
   a) **Sources**: Table salt, processed foods, dairy products.
   b) **Deficiency**: Leads to hyponatremia, causing headaches, confusion, seizures, and muscle cramps.

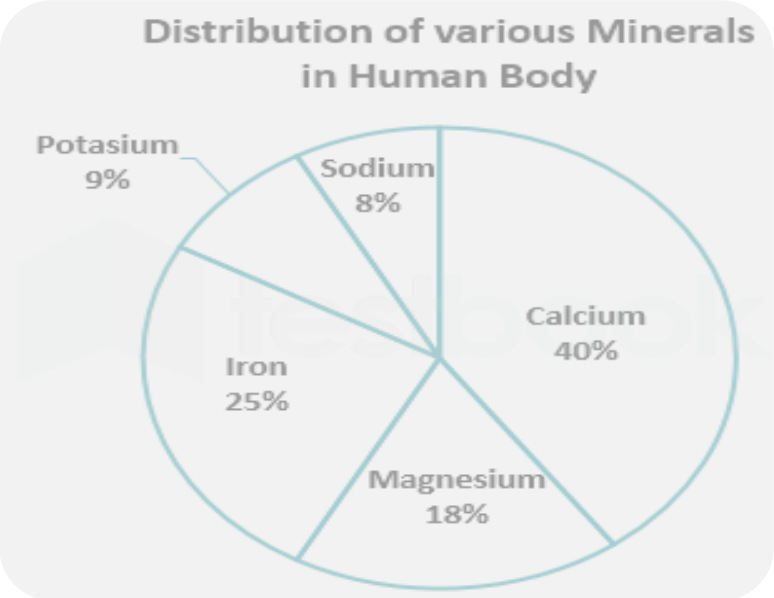
9) **Copper**: Important for red blood cell formation, immune function, and collagen synthesis.
   a) **Sources**: Shellfish, nuts, seeds, whole grains.
   b) **Deficiency**: Causes anemia, bone abnormalities, and immune system issues.

10) **Selenium**: Acts as an antioxidant, protects cells from damage, and supports thyroid function.
   a) **Sources**: Brazil nuts, seafood, meat, eggs.
   b) **Deficiency**: Can lead to Keshan disease (a type of heart disease), immune dysfunction, and cognitive decline.

Diseases Due to Mineral Deficiency

- **Calcium Deficiency**: Leads to osteoporosis and increased fracture risk.
- **Iron Deficiency**: Causes anemia, leading to fatigue, weakness, and cognitive impairments.
- **Potassium Deficiency**: Results in muscle weakness, cramps, and irregular heart rhythms.
- **Magnesium Deficiency**: Can cause muscle cramps, mental disorders, and cardiovascular issues.
- **Zinc Deficiency**: Leads to impaired immune function, hair loss, and delayed wound healing.
- **Phosphorus Deficiency**: Causes weakness, bone pain, and impaired growth.

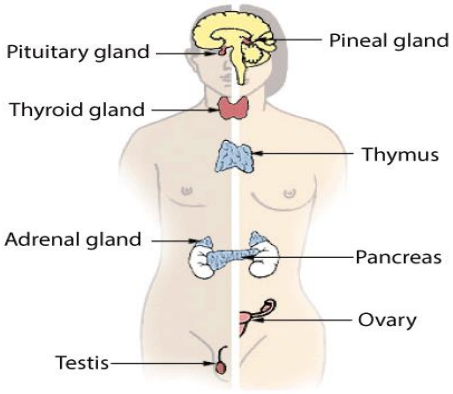
- **Iodine Deficiency**: Results in goiter, and developmental issues in children.
- **Copper Deficiency**: Leads to anemia, bone abnormalities, and immune dysfunction.



13. Endocrine System and Hormones

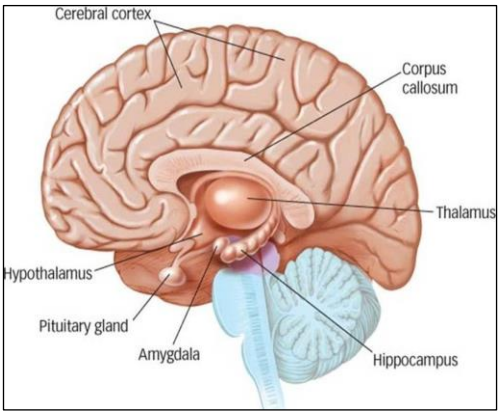
1. Endocrine System

The endocrine system is a complex network of glands that release hormones directly into the bloodstream. These hormones act as chemical messengers, traveling through the circulatory system to target organs and tissues, where they regulate various physiological processes.



Major Endocrine Glands:-

1) Hypothalamus



- **Location**: Forebrain, just below the thalamus
- **Functions**: Acts as a crucial link between the nervous and endocrine systems.
- It controls the Pituitary gland by secreting hormones that stimulate or inhibit pituitary hormone release. This regulation affects various physiological processes, including temperature control, hunger, and sleep.

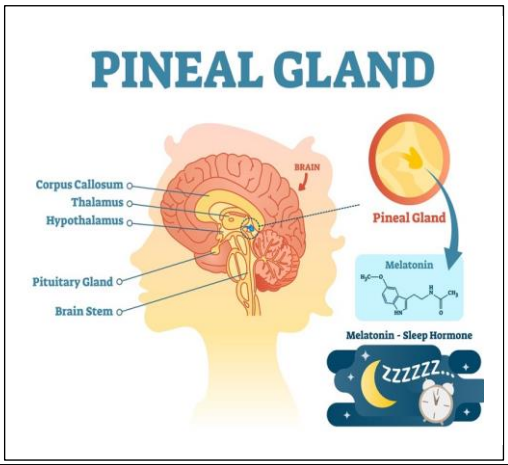
2) Pituitary Gland

- **Location**: At the base of the brain,
- **Functions**: Often termed the "master gland" because it controls other endocrine glands. It releases hormones that regulate growth, metabolism, and reproductive functions.

Hormones

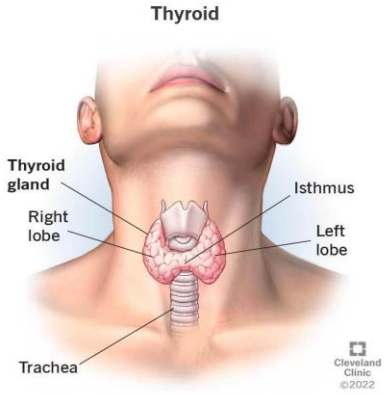
1. STH- REGULATES GROWTH OF BODY
2. TSH- stimulate Thyroid gland
3. MSH– to protect skin
4. GTH- to control functions of gonads
5. ADH- control water balance of body
6. LTH- secretion of milk

3) Pineal Gland



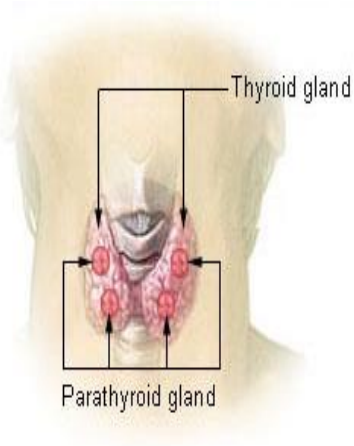
- **Location**: Located in the epithalamus, near the center of the brain between the two hemispheres
- **Functions**: Known as the "third eye," it secretes melatonin, a hormone that influences sleep patterns and regulates the body's internal clock or circadian rhythm.
- Melatonin levels increase in response to darkness and decrease with light.

4) Thyroid Gland



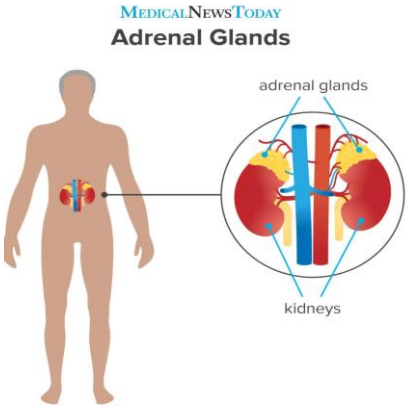
- **Location**: Anterior to the trachea, below the larynx
- **Functions:** Produces thyroid hormones T4 (Thyroxine) and T3 (Triiodothyronine), which are crucial for regulating metabolism, energy levels, and body temperature. It also plays a role in maintaining healthy skin, hair, and nails.
- **Common Disorders**: Goitre (enlarged thyroid), Thyroid cancer, Hypothyroidism, and Hyperthyroidism.

5) Parathyroid Glands



- **Location**: Embedded in the posterior surface of the thyroid gland
- **Functions**: Secretes parathyroid hormone (PTH), which is essential for regulating calcium levels in the blood and bone health.
- Proper calcium balance is crucial for nerve function, muscle contraction, and bone strength.
- **Disorders**: Excessive PTH can cause bone demineralization, leading to conditions such as osteoporosis, and may also contribute to kidney stone formation.

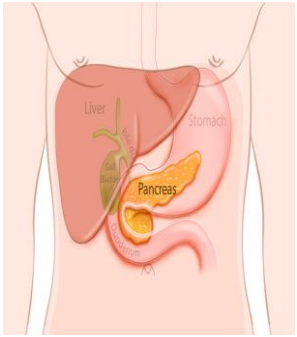
6) Adrenal Glands



- **Location**: Positioned on top of each kidney
- **Functions**: Composed of two parts:

Adrenal Cortex: Produces steroid hormones like cortisol (regulates metabolism and stress response) and aldosterone (controls blood pressure and sodium balance).
Adrenal Medulla: Secretes adrenaline, which are involved in the body's fight-or-flight response, increasing heart rate, blood flow to muscles, and glucose levels.

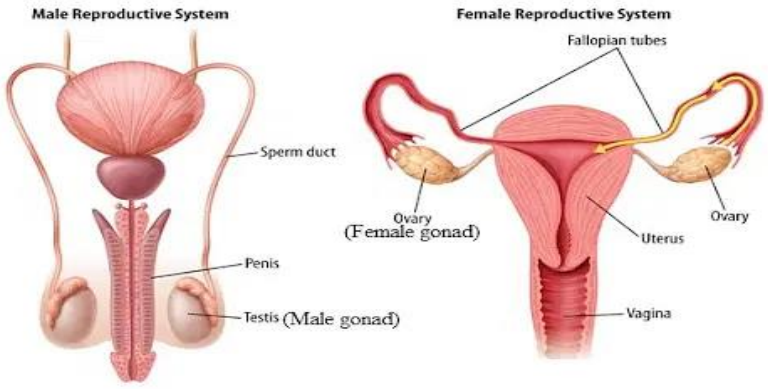
7) Pancreas



- **Location**: Situated behind the stomach
- **Functions**: Exhibits both endocrine and exocrine functions:

Endocrine Function: Secretes insulin and glucagon to regulate blood glucose levels, balancing energy supply and storage.
Exocrine Function: Produces digestive enzymes (amylase, lipase, proteases) that are released into the small intestine to aid in digestion.

8) Gonads



- **Location**: Ovaries in females, testes in males

Functions:

Ovaries: Produce estrogen and progesterone, hormones that regulate female reproductive functions, menstrual cycle, and secondary sex characteristics such as breast development and body fat distribution.

Testes: Produce testosterone, which is vital for the development of male sex characteristics (e.g., facial hair, deep voice), muscle growth, and sperm production.

2. Exocrine System

The exocrine system consists of glands that release their products through ducts either onto the body's surface or into body cavities. These glands play essential roles in various physiological processes, including digestion and thermoregulation.

Examples of ***Exocrine Glands****:*

1) Sweat Glands

- **Function**: Secrete sweat, a fluid that helps regulate body temperature through evaporative cooling. Sweat also excretes waste products like urea and salts.

2) Salivary Glands

- **Function**: Produce saliva, which contains enzymes (such as amylase) that begin the digestion of carbohydrates, lubricates food for easier swallowing, and maintains oral hygiene by washing away bacteria.

3) Pancreas (Exocrine Function)

- **Function**: Releases digestive enzymes into the small intestine via ducts. These enzymes break down carbohydrates, proteins, and fats, facilitating nutrient absorption.

14. Organic Farming

Organic farming is an eco-friendly agricultural practice that emphasizes the cultivation of crops and raising livestock through sustainable methods. It prioritizes soil health, biodiversity, and ecological balance by avoiding synthetic chemicals and relying on natural processes and inputs.

Current Status of Organic Farming in India

Global Ranking

- **Farmers**: India ranks 1st globally with 30% of the world's organic producers.
- **Agricultural Land**: India ranks 5th in terms of organic agriculture land.
- **Area Under Cultivation**: Only 2% of India's net sown area is under organic cultivation.

Top States by Area

- **Largest Area (Certified)**: Madhya Pradesh, Maharashtra, Gujarat.
- **Fully Organic State**: Sikkim – the world's first fully organic state.

Components of Organic Farming

1. **Soil Management**: Utilizes compost, green manure, and crop rotation to enhance fertility and maintain healthy soil.
2. **Water Management**: Focuses on efficient irrigation, rainwater harvesting, and moisture retention.
3. **Crop Diversity**: Encourages crop rotation, intercropping, and diverse planting to prevent pests and soil depletion.
4. **Pest and Weed Management**: Employs natural predators, biological control, and manual weeding.
5. **Livestock Management**: Promotes humane treatment of animals, natural feed, and avoidance of synthetic hormones.
6. **Nutrient Management**: Uses bio-fertilizers and recycles organic waste to provide nutrients to crops.

Importance of Organic Farming

1. **Environmental Sustainability**: Reduces pollution, conserves water, and promotes biodiversity.
2. **Healthier Food**: Produces food free from synthetic chemicals with higher nutritional value.
3. **Soil Health**: Improves fertility and structure using natural practices.
4. **Climate Change Mitigation**: Lowers carbon footprint and enhances carbon sequestration.
5. **Support for Local Economies**: Boosts rural employment and supports local markets.
6. **Biodiversity Conservation**: Maintains diverse ecosystems and natural habitats.
7. **Animal Welfare**: Ensures humane treatment without growth hormones or antibiotics.
8. **Reduced Chemical Exposure**: Minimizes health risks from synthetic pesticides.
9. **Enhanced Soil Water Retention**: Aids in drought resistance by improving soil moisture retention.
10. **Promotion of Traditional Knowledge**: Preserves sustainable farming techniques passed through generations.

Scope of Organic Farming in India

1. **Rising Domestic Demand**: Increasing health awareness fuels demand for organic products.
2. **Export Potential**: Organic exports from India reached USD 1.04 billion in 2020-21.
3. **Government Support**: Programs like PKVY and NPOP offer financial aid, certification, and market access.
4. **Agro-Climatic Diversity**: India's varied climates support a wide range of organic crops, from cereals to spices.
5. **Employment Generation**: Organic farming provides jobs in rural areas, especially in traditional farming regions.
6. **Leadership in Organic Farming**: India leads globally in the number of organic farmers, offering potential for growth.
7. **Sustainable Agriculture**: Promotes long-term environmental sustainability.
8. **Tourism Opportunities**: Organic farming can enhance eco-tourism in rural regions.
9. **Increased Farmer Income**: Organic products fetch higher prices, improving farmer earnings.
10. **Niche Markets**: Opportunities for organic products such as medicinal plants, herbal teas, and organic cotton.

Challenges in Organic Farming

1. **High Initial Costs**: Transitioning to organic farming requires significant investments in inputs and infrastructure.
2. **Lower Yields:** Organic farming typically has lower yields in the initial years.
3. **Lack of Awareness**: Many farmers are unaware of organic practices and their benefits.
4. **Certification Difficulties**: Organic certification is complex, time-consuming, and costly for small farmers.
5. **Limited Market Access**: Finding markets for organic products can be difficult in regions with low demand.
6. **Inadequate Infrastructure**: Lack of proper storage, processing, and transport facilities can lead to post-harvest losses.
7. **Pest and Disease Management**: Organic pest control requires more labor and knowledge than conventional methods.
8. **Market Fluctuations**: Organic product prices can be volatile, impacting profitability.

Measures to Promote Organic Farming

1. **Financial Incentives**: Subsidies for organic certification, inputs, and infrastructure.
2. **Awareness Campaigns**: Educate farmers on organic practices and benefits.
3. **Simplified Certification**: Make the certification process more accessible and affordable.
4. **Market Development**: Establish organic markets and e-commerce platforms.
5. **Organic Seed Availability**: Ensure access to high-quality organic seeds.
6. **Integrated Farming Systems**: Promote mixed farming for sustainable agriculture.
7. **Consumer Awareness**: Educate consumers about the benefits of organic products.

Government Schemes to Promote Organic Farming

1. **Paramparagat Krishi Vikas Yojana (PKVY)**: Supports cluster-based organic farming and offers financial aid for inputs and certification.
2. **Mission Organic Value Chain Development for North East Region (MOVCDNER)**: Promotes organic farming in the Northeast, focusing on value chain development.
3. **Jaivik Kheti Portal**: An e-commerce platform connecting organic farmers with consumers.
4. **Soil Health Card Scheme**: Provides soil health information to reduce the need for chemical fertilizers.
5. **PM-PRANAM**: Encourages reduced usage of chemical fertilizers in agriculture.

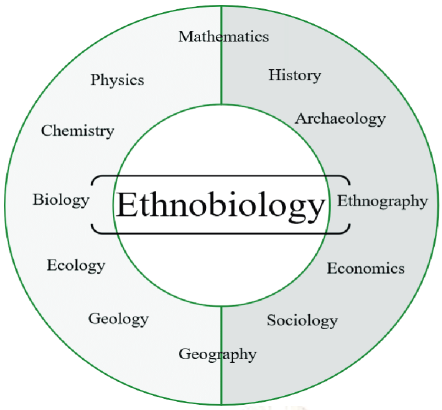
Institutions Involved

- **ICAR** (Indian Council of Agricultural Research): Established in 1929, it leads agricultural research in India.
- **NABARD** (National Bank for Agriculture and Rural Development): Founded in 1982 to support rural development and farming.
- **APEDA** (Agricultural and Processed Food Products Export Development Authority): Promotes exports of organic produce.
- **FSSAI** (Food Safety and Standards Authority of India): Regulates food safety and standards, including organic products.

15. Ethnobiology

What is Ethnobiology?

- Ethnobiology is the study of the relationships between people and their natural environment, particularly how human societies interact with plants, animals, and ecosystems.
- It is an interdisciplinary field combining biology, anthropology, archaeology, ecology, and linguistics.



Key Focus Areas in Ethnobiology

1. **Ethnobotany –** The study of how people use plants (e.g., for food, medicine, rituals, clothing).
2. **Ethnozoology –** The study of human interactions with animals (e.g., domestication, hunting, cultural symbolism).
3. **Ethnoecology –** Examines how cultural groups understand and interact with their surrounding ecosystems.
4. **Traditional Ecological Knowledge (TEK) –** Indigenous knowledge systems about the environment, accumulated over generations.

Ethnobiology and Traditional Knowledge

Importance of Traditional Knowledge:

- Traditional knowledge plays a crucial role in conservation, sustainable practices, and biodiversity management.
- Indigenous communities have a deep understanding of local ecosystems, developed over millennia.

Examples of Traditional Ecological Knowledge (TEK):

1. **Agricultural practices**: Rotational farming, companion planting, and crop diversity to maintain soil health.
2. **Medicinal knowledge**: Use of plants like willow bark for pain relief (source of modern aspirin).
3. **Animal behaviour**: Knowledge of seasonal migrations, breeding patterns, and behaviour used for hunting and domestication.

Why Preserve Traditional Knowledge?

- **Cultural Heritage**: TEK is part of the cultural identity of many indigenous groups.
- **Conservation**: Sustainable practices rooted in traditional knowledge help preserve biodiversity.
- **Medical and Scientific Discovery**: Traditional knowledge of plants and animals can lead to new medical treatments and scientific innovations.

Methods in Ethnobiology Research

Key Methods in Ethnobiological Research:

1. **Fieldwork and Participant Observation:**
   - Researchers spend extended time in communities, learning about traditional knowledge through observation and interviews.
2. **Interviews and Oral Histories:**
   - Researchers document knowledge passed down orally, such as plant uses, animal behavior, and ecological management techniques.
3. **Ethnographic and Linguistic Analysis:**
   - Language provides insight into how cultures classify and understand the natural world (e.g., names for plants/animals in indigenous languages).
4. **Ethnoarchaeology:**
   - The study of artifacts, ecological remains, and settlement patterns to understand ancient human-environment interactions.
5. **Collaborative Approaches:**
   Researchers often work with indigenous communities to ensure that traditional knowledge is respected, preserved, and applied ethically.

Applications of Ethnobiology

1. **Conservation Efforts**
   Utilizes traditional ecological knowledge to develop sustainable conservation strategies and protect biodiversity.
   Example: The Kayapo tribe in the Amazon rainforest uses a sustainable method to protect forests, which has informed global conservation policies.
2. **Medicinal Research**
   Investigates traditional remedies derived from plants and animals to discover potential pharmaceutical applications.
   Example: The use of the Madagascar periwinkle in traditional medicine led to the development of vincristine and vinblastine, drugs used to treat cancer.
3. **Cultural Preservation**
   Documents and preserves indigenous knowledge and practices, safeguarding cultural heritage and traditional ecological practices.
   Example: The recording of traditional Hawaiian agricultural techniques has helped preserve ancient methods of water management.
4. **Agricultural Practices**
   Enhances sustainable farming by integrating indigenous agricultural knowledge, including traditional crop management and land use techniques.
   Example: The "Three Sisters" planting method used by Native American tribes - growing maize, beans, and squash together—optimizes soil nutrients and enhances yields naturally.

5. **Ecosystem Management**
   Applies indigenous resource management practices to maintain and restore ecosystems sustainably, adapting to environmental changes.
   Example: Indigenous fire management in Australia has been incorporated into broader strategies to reduce wildfire risk and enhance biodiversity.

6. **Wildlife Management**
   Incorporates indigenous methods for managing wildlife populations and mitigating conflicts between humans and wildlife.
   Example: Maasai communities in Kenya use traditional practices to coexist with wildlife while protecting their livestock from predators.

7. **Environmental Education**
   Enriches educational programs by providing insights into traditional environmental knowledge, raising awareness on biodiversity and conservation issues.
   Example: Educational programs in schools often include lessons from indigenous cultures on sustainable practices and plant usage.

8. **Climate Resilience**
   Leverages indigenous knowledge to enhance community-based approaches for resilience to extreme weather events and climate change impacts.

9. **Sustainable Development**
   Merges traditional knowledge with modern technologies and practices to promote environmentally and culturally sustainable development.

10. **Cultural Tourism**
    Promotes ecotourism that highlights traditional ecological knowledge and practices, providing economic benefits to local communities.

11. **Resource Conflict Resolution**
    Applies indigenous knowledge and traditional approaches to resolve conflicts over natural resources, promoting fair and sustainable management.

Challenges and Ethical Considerations in Ethnobiology

Challenges in Ethnobiology:-

1. **Loss of Traditional Knowledge**:
   - As globalization and modernization increase, traditional knowledge is at risk of being lost, especially when indigenous groups are displaced.

2. **Language Extinction:**
   - Many indigenous languages, which hold vital ethnobiological knowledge, are endangered or extinct.

3. **Environmental Degradation:**
   - Habitat loss, deforestation, and climate change threaten ecosystems and the traditional ways of life connected to them.

Ethical Considerations

1. **Cultural Sensitivity:**
   - Ethnobiologists must ensure that research respects indigenous cultures and does not exploit their knowledge for commercial or scientific gain without consent.

2. **Intellectual Property Rights:**
   - Protecting the intellectual property rights of indigenous communities is essential, ensuring they benefit from any commercial applications of their knowledge.

3. **Community Collaboration:**
   - Ethnobiologists should work collaboratively with local communities, ensuring that research benefits them and aligns with their cultural values.

Notable Case Studies in Ethnobiology

1. **The Amazon Rainforest**
   - Indigenous groups in the Amazon have practiced sustainable agriculture, medicine, and forest management for centuries. Their traditional ecological knowledge is vital for preserving biodiversity and mitigating deforestation.

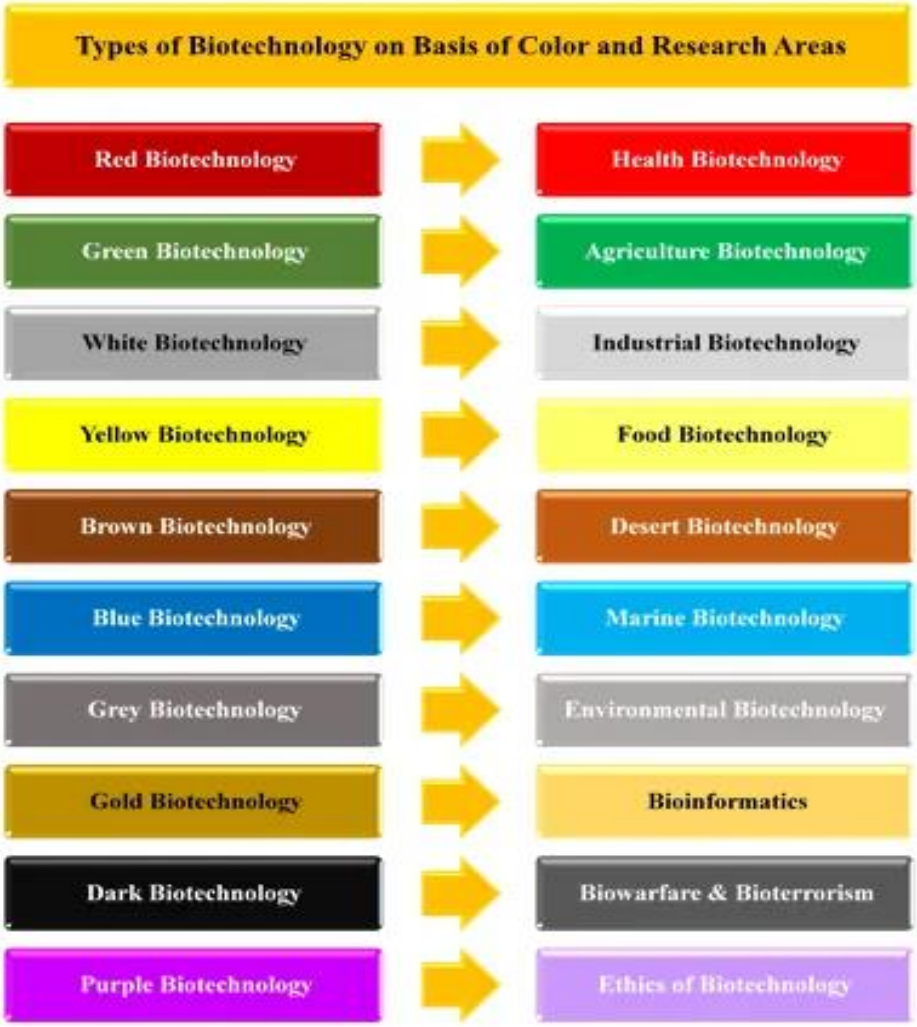
2. **The Kalahari Bushmen**
   - The San people of the Kalahari Desert have intricate knowledge of local plant and animal life, including plants used for water storage in harsh desert conditions.

3. **Himalayan Medicinal Plants**
   - In the Himalayas, traditional knowledge of medicinal plants is used by local healers, and this ethnomedicine is a source of new research for pharmaceuticals.

4. **The Inuit and Climate Change**
   - The Inuit people in the Arctic have traditional knowledge of ice patterns, animal migrations, and weather forecasting. This knowledge is essential in understanding and adapting to climate change in polar regions.

16. Biotechnology

Biotechnology refers to the use of biological systems, organisms, or derivatives to develop products and processes across multiple sectors like medicine, agriculture, and industry, with a focus on enhancing human life and the environment.



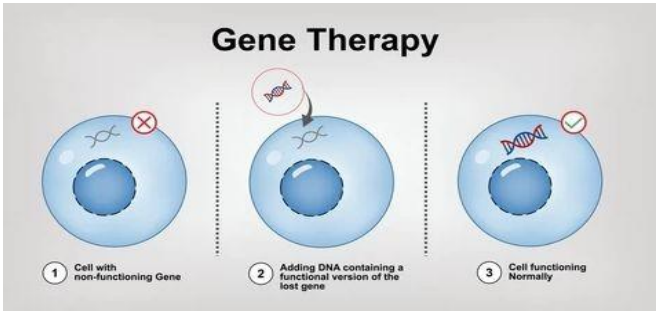
Uses of Biotechnology in Various Sectors

1. Health & Medicine

- **Diagnostics:**
  - PCR (Polymerase Chain Reaction): Detects infections like COVID-19 by amplifying small amounts of DNA/RNA for accurate diagnosis.
  - Blood testing
  - Oximeter, etc.
- **Drug Development:**
  - Vaccines: Covaxin, Covishield, and Rotavac
  - developed using biotechnological tools.

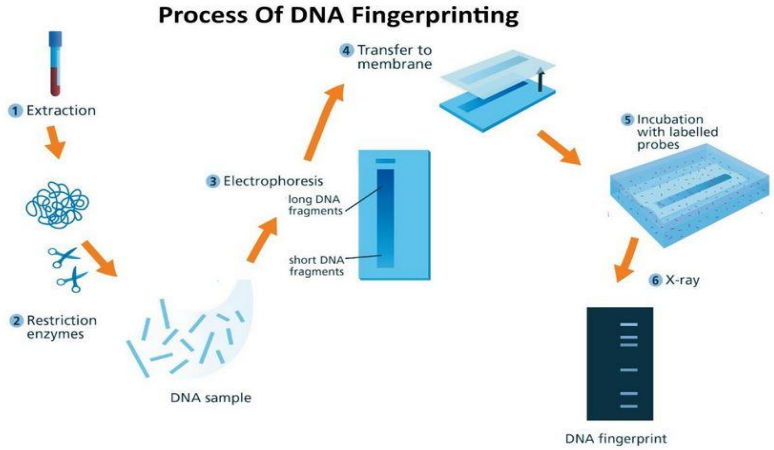
Gene Therapy

- Definition: Involves modifying or replacing faulty genes to treat genetic disorders.



DNA Fingerprinting

- **Definition**: A forensic technique used to identify individuals based on their unique DNA profiles.
- **Applications**: Criminal investigations, paternity testing, and disaster victim identification.

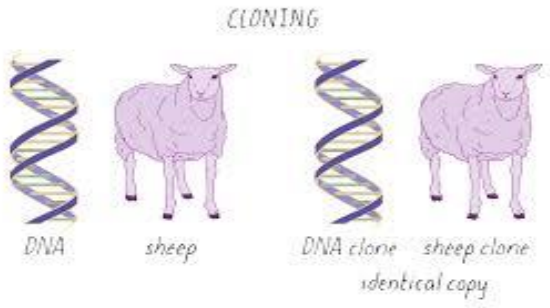


Cloning

Definition: Producing identical genetic copies of an organism.

Types

- Reproductive Cloning: Producing a genetic duplicate of an organism (e.g., Dolly the Sheep, the first mammal cloned in 1996).
- Therapeutic Cloning: Producing cloned cells for medical use, such as growing tissues or organs for transplantation.



Stem Cell Therapy

- Definition: Uses stem cells to repair or replace damaged tissues or organs.
- Types of Stem Cells:
  - Embryonic Stem Cells: Can differentiate into any cell type (pluripotent).
  - Adult Stem Cells: Limited differentiation potential but used for tissue repair.
- Applications: Treating conditions like spinal cord injuries, Parkinson's disease, and leukaemia (e.g. bone marrow transplants).

2. Agriculture

- **Genetically Modified (GM) Crops**
  - **BT Cotton**: Engineered to produce toxins that protect against bollworm infestation.
  - **Golden Rice**: Engineered to produce beta-carotene, addressing Vitamin A deficiency.
- **Biofertilizers**
  - Microorganisms like Rhizobium and Azolla enhance soil nutrient content, reducing reliance on chemical fertilizers.
- **Biopesticides**
  - Use naturally occurring organisms like Bacillus thuringienesis (Bt) for pest control without harming the environment.
- **Tissue Culture**
  Enables mass propagation of disease-free plants, widely used in banana and orchid cultivation.
- **Hydroponics & Aeroponics**
  Advanced soil-less cultivation techniques that optimize plant growth using nutrient-rich water (hydroponics) or air (aeroponics).

3. Horticulture

- **Improved Plant Varieties**
  Genetic engineering produces plants with enhanced disease resistance, better fruit quality, and longer shelf life (e.g., Flavor Savr tomato, the first GM crop for commercial use).
- **Post-Harvest Management**
  Biotechnology improves methods for extending the shelf life of perishable goods (e.g., controlled ripening of fruits using ethylene inhibitors).

- **Disease Management**
  Genetic modification helps plants resist diseases like bacterial wilt and fungal infections, improving yields.

4. Animal Husbandry

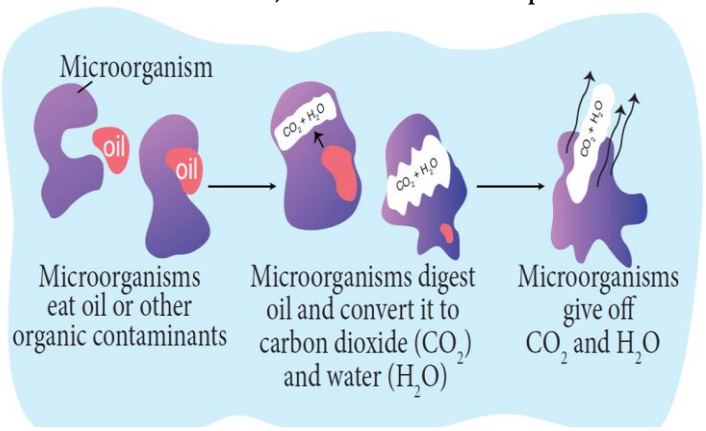
- **Genetic Improvement**
  - **CRISPR-Cas 9**: Used for precision breeding, enhancing desirable traits in livestock like growth rates and disease resistance.
  - Example: Genetically modified cows that produce hypoallergenic milk.
- **Biopharming**
  Genetically modified animals, such as goats, produce therapeutic proteins in their milk, such as Antithrombin III, used to prevent blood clotting.
- **Reproductive Technologies**
  - **Artificial Insemination**: Widely used in cattle to improve milk production.
  - **Cloning**: Helps preserve endangered species and improve livestock breeds.

5. Industry

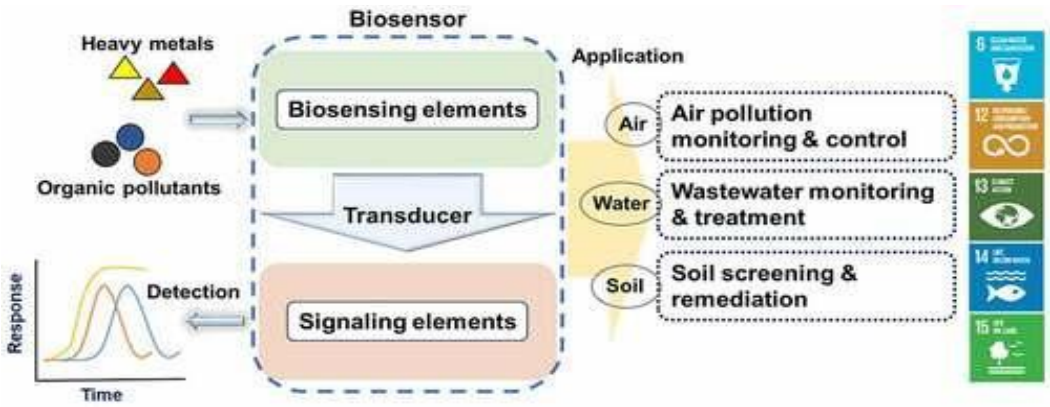
- **Bioprocessing**
  - Utilizes microorganisms like yeasts to produce bioethanol, a renewable fuel.
  - Example: Yeast fermentation is used in beer brewing and bread making.
- **Biopolymers**
  Develops biodegradable plastics from renewable biological sources like corn starch, reducing environmental pollution.
- **Enzyme Production**
  - Enzymes like lipase and protease are used in detergents for better stain removal.
- **Biofuel Production**
  - Converts agricultural biomass into bioethanol and biodiesel, reducing carbon emissions (e.g., ethanol-blended fuel for vehicles).

6. Environment

- **Bioremediation**
  - Uses microorganisms to clean up environmental contaminants like oil spills.
  - Example: Oil Zapper, a microbial consortium, breaks down oil spills in marine environments.



- **Biosensor**
  - **Cell-Free Biosensors**: Detect pollutants like heavy metals by using DNA or protein-based sensors.
  - **Whole-Cell Biosensors**: Utilize living cells to sense and report environmental pollutants.



- **Waste Management**
  - Biotechnology processes, such as anaerobic digestion, treat and recycle organic waste, generating biogas for energy.

- **Climate Change Mitigation**
  - Biotechnology enhances carbon sequestration through bio-engineered plants and microorganisms, reducing greenhouse gas emissions.

- **Bio-toilets**
  - Converts human waste into compost using microbial action, providing sanitation solutions for remote areas.

17. Biofuels

Biofuels are hydrocarbon fuels (solid, liquid, or gaseous) that are derived from organic matter such as plants, animal waste, and industrial residues. These fuels serve as a renewable energy source and can be used as alternatives to fossil fuels in various sectors, particularly transportation.

Key Advantages of Biofuels

- **Renewable**: Biofuels are produced from renewable sources like plants, agricultural waste, and other organic matter.
- **Reduced Carbon Emissions**: When compared to conventional fossil fuels, biofuels generally emit fewer greenhouse gases, contributing to lower overall carbon footprints.
- **Energy Security**: Utilizing locally sourced biomass helps reduce reliance on imported fossil fuels, enhancing national energy independence.
- **Versatility**: Biofuels can be produced in solid, liquid, or gas forms, catering to a wide range of applications.

Types of Biofuels

1. Solid Biofuels

- **Wood**: Used in traditional stoves and modern biomass power plants.
- **Manure**: Dried animal waste is often used as a solid biofuel, especially in rural areas.

2. Liquid Biofuels

- **Bioethanol**: Produced through the fermentation of sugar-rich crops like corn and sugarcane, bioethanol is often blended with gasoline to create cleaner-burning fuel.
- **Biodiesel:** Made from vegetable oils, animal fats, or recycled cooking oils, biodiesel can be used in diesel engines, often blended with petroleum diesel.

3. Gaseous Biofuels

- Biogas: Created through the anaerobic digestion of organic matter such as agricultural waste, manure, and sewage. It primarily consists of methane and carbon dioxide and can be used for heating, electricity generation, or as vehicle fuel.

Sources of Biofuels

Biofuels can be produced from a variety of sources, including:

- **Biomass**: Plant materials like corn, sugarcane, and wood.
- **Vegetable Oils**: Oils extracted from crops such as soybeans, rapeseed, and palm.
- **Waste Feedstocks**: Organic waste materials like used cooking oil, animal fats, and municipal solid waste.

Environmental Impact of Biofuels

- **Lower Carbon Emissions**: Biofuels generally emit less CO_2 compared to fossil fuels, making them a more sustainable option.
- **Reduced Air Pollution**: In addition to lowering greenhouse gas emissions, biofuels tend to produce fewer pollutants such as sulfur oxides and particulate matter.
- **Renewable Source**: Unlike finite fossil fuels, biofuels are derived from renewable resources that can be replenished seasonally.

Generations of Biofuels

1. First Generation Biofuels

- **Source**: Derived primarily from food crops like corn, sugarcane, and soybeans.
- **Challenges:** These biofuels are often criticized for creating competition between fuel production and food supply, raising concerns about food prices and availability. This is commonly referred to as the "food vs. fuel" issue.

2. Second Generation Biofuels

- **Source**: Produced from non-food crops such as switchgrass, agricultural residues, and waste materials.
- **Benefits**: More sustainable than first-generation biofuels, these alternatives do not compete directly with food production and offer improved energy efficiency.

3. Third Generation Biofuels

- **Source**: Derived from algae, which is considered a highly renewable and efficient feedstock.
- **Advantages**: Algae-based biofuels have higher energy yields and require less land and water compared to traditional biofuel sources.

4. Fourth Generation Biofuels

- **Source**: These biofuels are produced using advanced technologies that capture and store CO_2 during the production process.
- **Impact**: Fourth-generation biofuels offer the potential for a carbon-negative impact, as they not only reduce CO_2 emissions but also help remove CO_2 from the atmosphere.

Benefits and Challenges of Biofuels

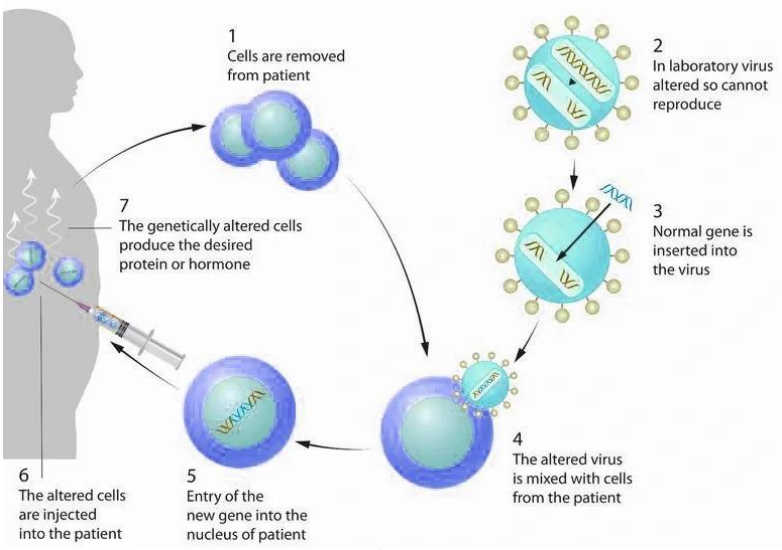
Benefits:-

- **Renewable**: Can be continuously produced from organic materials.
- **Lower Emissions**: Significantly reduces greenhouse gas emissions compared to fossil fuels.
- **Energy Security**: Reduces dependence on imported oil, promoting energy self-sufficiency.
- **Economic Opportunities**: Creates new industries and jobs, particularly in rural and agricultural areas.

Challenges:-

- **Land Use**: Large-scale biofuel production can require significant amounts of land, potentially leading to deforestation and habitat loss.
- **Water Consumption**: Some biofuel crops, like corn, demand high water usage, which may strain local water resources.
- **Energy Balance**: The energy required to produce and process biofuels can sometimes outweigh the environmental benefits, particularly for first-generation biofuels.

18. Gene Therapy



Gene therapy is a technique designed to alter the genetic makeup of cells to treat or prevent diseases. It involves introducing a functional gene to replace or compensate for a defective, disease-causing gene.

Key Features:

- **Purpose**: Introduce a healthy gene to fix defective genes.
- **Approaches**:
  - Replace mutated genes with healthy copies.
  - Inactivate malfunctioning genes.
  - Introduce entirely new genes to aid in fighting diseases.

Gene Therapy Approaches

Gene therapy involves modifying the genetic material of cells either inside (in vivo) or outside (ex vivo) the body.

- **In Vivo**: Direct delivery of therapeutic genes to patient cells inside the body.
- **Ex Vivo**: Cells are modified outside the body and then reintroduced into the patient.

Key Approaches

- **Gene Replacement**: Replace malfunctioning genes.
- **Gene Editing**: Modify genetic material to fix errors (e.g., CRISPR-Cas9).
- **Gene Inhibition**: Silence or deactivate harmful genes.

Types of Gene Therapy

Somatic Cell Gene Therapy

- Affects only the targeted somatic (non-reproductive) cells.
- Changes are not passed on to future generations.

Germline Gene Therapy

- Involves modifying egg or sperm cells, resulting in changes that are inherited by future generations.
- Ethical Status: Banned in most countries due to ethical concerns.

Cell Sources in Gene Therapy

- **Autologous**: The patient's own cells are used.
- **Allogeneic**: Cells from a donor are used.

Gene therapy uses various methods to deliver and manipulate genes.

Technique	Methodology/Tools	Applications	Limitations
Viral Vectors	Use engineered viruses to deliver genes (e.g., AAV, retrovirus)	Long-term expression, high efficiency	Immunogenicity, limited cargo capacity
Non-Viral Methods	Use electroporation or chemical carriers to deliver DNA/RNA	Safer, non-immunogenic	Lower efficiency
CRISPR-Cas9	Gene editing using RNA-guided nuclease	Precise and flexible editing	Off-target effects, delivery challenges
Zinc Finger Nucleases	Engineered nucleases targeting specific sequences	Gene knockout or correction	Lower efficiency than CRISPR
TALENs	Fused DNA binding proteins used for precise cleavage	Gene editing for various conditions	Complex and technically challenging

Applications of Gene Therapy

Gene therapy shows potential for long-term solutions to various diseases, often with just one dose.

Key Areas of Application

- **Genetic Disorders**: Sickle cell anemia, muscular dystrophy, hemophilia.
- **Cancer:** CAR-T therapy, tumor growth inhibition, targeting cancer-specific antigens.
- **Neurodegenerative Diseases**: Alzheimer's, Parkinson's, ALS (delivering nerve growth factors).

Challenges and Ethical Considerations

While gene therapy offers immense promise, it also raises safety, ethical, and logistical challenges.

Safety Risks

- Immune responses to viral vectors.
- Risk of cancer due to insertional mutagenesis.
- Off-target effects in gene editing.

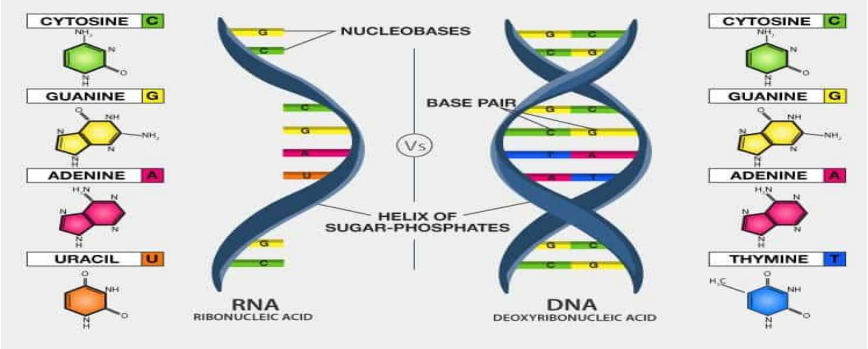
Ethical Concerns

- **Germline Gene Therapy**: Editing embryos could be misused for non-medical enhancements.
- **Privacy Risks**: Potential genetic discrimination.
- **Accessibility:** High costs may limit availability to certain populations.
- **Long-Term Impact**: Uncertainty about effects on future generations.

Recent Advances in Gene Therapy

- **CRISPR and Base Editors**: Enabling precise gene editing for diseases like sickle cell.
- **AAV Virus Capsids**: Improved delivery to specific tissues.
- **Nanoparticle Delivery**: Emerging as a safer, non-viral option.
- **Optogenetics**: Allows external control of gene expression using light.

19. DNA Fingerprinting



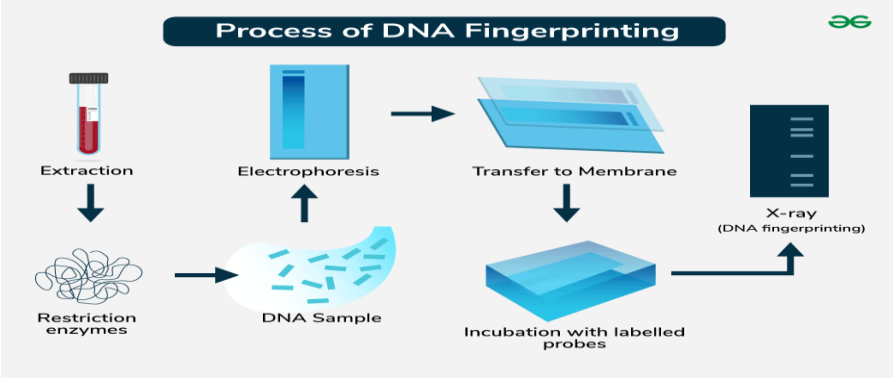
What is DNA Fingerprinting?

- DNA Fingerprinting is a technique used to identify individuals by analyzing variations at the DNA level.
- DNA (Deoxyribonucleic Acid) carries genetic instructions for an organism's development and functioning.
- Each individual, except identical twins, has a unique DNA fingerprint.

Principle Behind DNA Fingerprinting

- While over 99% of human DNA is identical, highly variable regions called Variable Number Tandem Repeats (VNTRs) and Short Tandem Repeats (STRs) differ between individuals.
- DNA Fingerprinting analyzes these regions to create a genetic profile.

Process of DNA Fingerprinting



Steps Involved in DNA Fingerprinting:

1. **Sample Collection**
   DNA is extracted from biological tissues like blood, bones, hair, semen, or buccal swabs.

2. **DNA Extraction**
   Chemical processes are used to purify the extracted DNA sample.

3. **PCR Amplification**
   The purified DNA is amplified using Polymerase Chain Reaction (PCR), targeting specific STR regions.

4. **Separation**
   The amplified DNA fragments are separated by size using gel electrophoresis.

5. **Detection**
   Fluorescent dyes help visualize DNA fragments, which appear as bands on the gel.

Applications of DNA Fingerprinting

1. Forensics

- DNA Fingerprinting is used in criminal investigations (e.g., Shraddha Walkar case) to compare crime scene DNA with suspect profiles.

2. Paternity Testing

- DNA Fingerprinting helps establish biological relationships, particularly in legal matters like custody and inheritance.

3. Victim Identification

- It is used to identify victims in cases of accidents, disasters, and wars by matching remains to relatives' DNA.

4. Wildlife Forensics

- Helps combat poaching by analyzing animal DNA from bones, blood, or skins and matching it to species or individuals.

5. Anthropology

- DNA is used to study ancient populations, migrations, and reconstruct genetic relationships.

6. Agriculture

- DNA Fingerprinting assists in livestock breeding by determining pedigree and susceptibility to diseases.

7. Disease Identification

- Used in diagnosing inherited disorders such as Huntington's disease, sickle cell anemia, cystic fibrosis, etc.

Limitations of DNA Fingerprinting

1. Not 100% Conclusive

- Though highly accurate, DNA fingerprinting isn't always absolute, and other evidence may be needed in court cases.

2. Contamination

- External DNA can unintentionally contaminate samples, leading to incorrect results.

3. Mixed Samples

- When a DNA sample contains multiple contributors, separating individual profiles becomes challenging.

4. Cost

- DNA Fingerprinting requires expensive equipment and trained personnel, making it less accessible in developing countries.

5. Partial Profiles

- Degraded samples may lead to incomplete DNA profiles, making analysis difficult.

DNA Fingerprinting in India

Government Initiatives to Promote DNA Technology:-

➔ Institutions:

- Centre for DNA Fingerprinting & Diagnostics (Hyderabad)
- Central Forensic Science Laboratory (Kolkata)
- DNA Analysis Centre (Chandigarh)
- Centre for Cellular and Molecular Biology (Hyderabad)
- National Bureau of Plant Genetic Resource (NBPGR) (New Delhi)
- National Institute of Plant and Genetic Research (NIPGR) (New Delhi)

Legislative Initiatives:

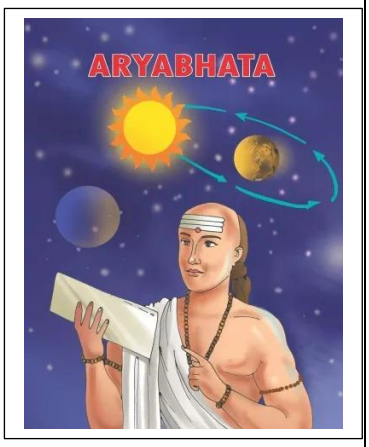
DNA Technology (Use and Application) Regulation Bill, 2019:

- Objective: To establish the identity of individuals, strengthen the criminal justice system, and build institutional frameworks.
- Proposal for the creation of DNA Data Banks and a DNA Regulatory Board.
- Bill withdrawn due to concerns addressed by the Criminal Procedure (Identification) Act, 2022.

20. Contributions of Ancient Indian Scientists

1. Aryabhata (476–550 CE)

Aryabhata was an influential mathematician and astronomer from ancient India whose works laid the groundwork for later scientific advancements in both fields.



Key Works:

- **Aryabhatiya**: A comprehensive text covering arithmetic, algebra, trigonometry (both plane and spherical), quadratic equations, and the construction of a table of sines.
- **Arya Siddhanta**: Focused on astronomical calculations and instruments such as gnomons (shanku-yantra) and water clocks.

Contributions to Astronomy:

- Proposed that the Earth rotates on its axis (west to east) and orbits the Sun.
- Scientifically explained eclipses through the Earth's and Moon's shadows.
- Calculated the Earth's circumference at 39,968 km, closely matching the modern value (40,072 km).

Contributions to Mathematics:

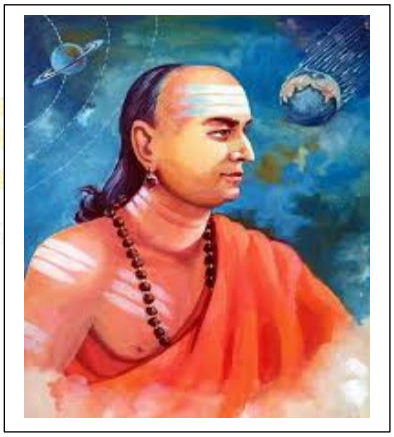
- Decimal System: Aryabhata introduced the decimal system and used zero as a placeholder.
- Pi (π): Calculated the value of π (3.1416), very close to the modern approximation.
- Geometric Calculations: Correctly formulated methods for calculating the areas of triangles and circles.
- Developed one of the earliest methods for constructing a sine table.

Legacy:

- Aryabhata's calculations continue to influence the preparation of the Panchangam (Hindu calendar).
- Numerous honors in his name, including India's first satellite *Aryabhata*, the *Aryabhata Award*, and the *Aryabhatta Research Institute*.

2. Varahamihira (505–587 CE)

Varahamihira was a renowned astronomer, mathematician, and astrologer known for his encyclopedic works that significantly contributed to various scientific fields.



Key Works:

- **Pancha Siddhantika**: A summary of five pre-Christian era astronomical treatises, including the *Surya Siddhanta*.
- **Brihat Samhita**: An encyclopedic work covering planetary movements, natural phenomena, and sciences such as ecology and meteorology.

Contributions to Astronomy:

- Advanced and compiled five major astronomical theories, including *Surya Siddhanta* and *Romaka Siddhanta*.
- Described Mars in detail, including the presence of water and iron, later confirmed by modern space research.
- Provided accurate predictions about underground water and the value of the equinox.

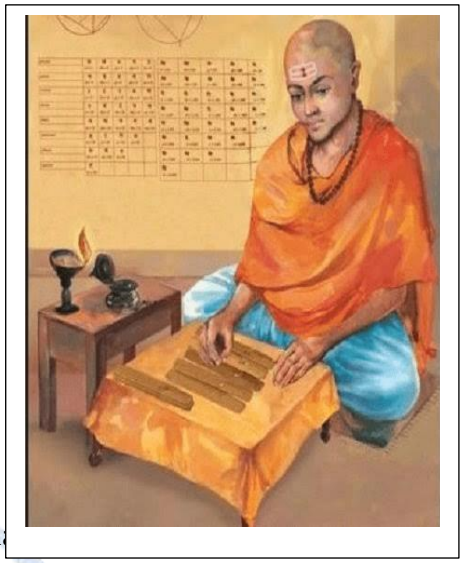
Contributions to Mathematics:

- Developed trigonometric formulas and enhanced sine tables.
- Explored the properties of zero and negative numbers.

Contributions to Astrology:

- Revolutionized astrological methods, including chart analysis and predictive techniques that shaped astrology for centuries.

3. Brahmagupta (598–668 CE)



Brahmagupta made notable advances in mathematics and astronomy, particularly in geometry and number theory. He is credited with introducing zero as a digit in mathematics.

Key Works:

- **Brahmasphutasiddhanta (628 CE)**: A vast treatise on mathematics and astronomy, covering topics like planetary motions and time computation.
- **Khandakhadyaka**: Focused on astronomical calculations.

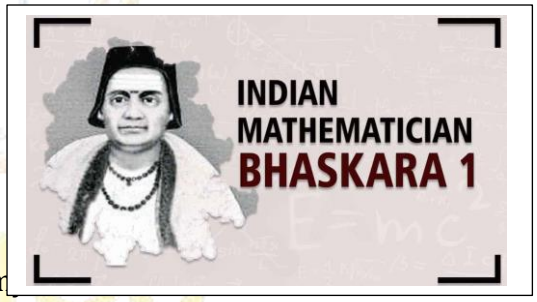
Contributions to Mathematics:

- Provided solutions for general linear and quadratic equations.
- Developed methods for computing cube and square roots.
- Introduced zero as a digit and explored its applications in mathem

Contributions to Astronomy:

- Claimed that planets possess their own motion of revolution.
- Critiqued earlier astronomical theories, including those of Aryabhata, on topics such as Earth's rotation and eclipse causes.

4. Bhaskara I (7th Century CE)



Bhaskara I was a prominent mathematician and astronomer who built upon Aryabhata's work, particularly in the fields of trigonometry and calculus.

Key Works:

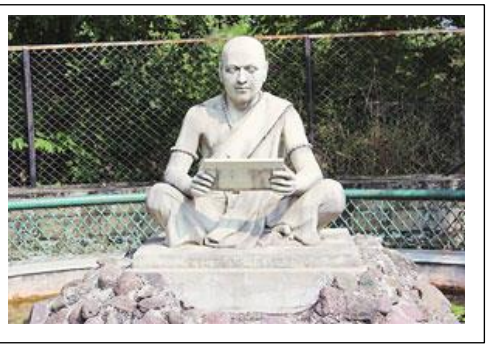
- **Aryabhatiya Bhashya (629 CE)**: A detailed commentary on Aryabhata's work.
- **Mahabhaskariya**: A treatise on Indian mathematical astronom
- **Laghubhaskariya:** A concise version of his earlier work, focusing on astronomical topics.

Contributions:

- Advanced calculus and trigonometry.
- Refined the value of the sine function and was among the first to use the Hindu-Arabic decimal system.

- **Legacy:**
- His critiques and expansions on Aryabhata's theories had a lasting influence on both Indian mathematics and astronomy.

5. Bhaskara II (Bhaskaracharya) (12th Century CE)



Bhaskara II was one of the greatest mathematicians and astronomers of medieval India, known for his comprehensive work in both disciplines.

Key Works:

- **Siddhanta Shiromani**: A monumental work divided into four parts:

- **Lilavati:** Focused on arithmetic and geometry.
- **Bijaganita**: A treatise on algebra.
- **Graha Ganita**: Deals with planetary calculations.
- **Goladhyaya**: Covers spherical astronomy.

Contributions to Mathematics:

- Pioneered the principles of differential calculus and its application in astronomy.
- Proved the Pythagorean theorem and solved indeterminate linear and quadratic equations.

Contributions to Astronomy:

- Accurately calculated the apparent orbital periods of the Sun, Mercury, Venus, and Mars.
- Introduced spherical trigonometry for astronomical calculations.

Legacy:

- Recognized as one of the greatest mathematicians of medieval India.
- The *Bhaskara II satellite* was named in his honor by ISRO in 1981.

Summary of Key Contributions:

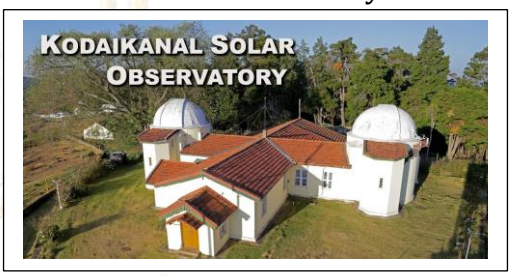
Scientist	Key Works	Contributions	Legacy
Aryabhata	Aryabhatiya, Arya Siddhanta	Decimal system, value of Pi, Earth's rotation	Aryabhata satellite, Panchangam, Aryabhatta Award, ARIES Institute
Varahamihira	Pancha Siddhantika, Brihat Samhita	Trigonometric formulas, Mars' water & iron	Major advancements in astronomy, astrology, and sciences
Brahmagupta	Brahmasphutasiddhanta, Khandakhadyaka	Introduction of zero, algebra solutions	Zero's role in mathematics, critique of previous astronomical theories
Bhaskara I	Aryabhatiya Bhashya, Mahabhaskariya	Calculus, trigonometry, decimal system	Refined Aryabhata's work, use of the sine function
Bhaskara II	Siddhanta Shiromani	Differential calculus, spherical trigonometry	Bhaskara II satellite, contributions to mathematics and astronomy

21. Ancient and Modern Observatories in India

1. Jantar Mantar


- **Locations**: New Delhi, Jaipur, Mathura, Ujjain, Varanasi
- **Built**: Between 1724 and 1735
- **Commissioned by**: Maharaja Jai Singh II
- ***Key Features:***
  - Ancient instruments for tracking celestial movements.
  - Large sundials for measuring time with high precision.
  - Architectural brilliance designed to observe astronomical positions of planets, moon, and sun.
  - Jaipur's Jantar Mantar houses the world's largest stone sundial, *Samrat Yantra*.
- ***Significance*:** These structures were built to improve the accuracy of astronomical tables and predict celestial events. They highlight India's historical contributions to observational astronomy.

2. Kodaikanal Solar Observatory



- **Location**: Kodaikanal, Tamil Nadu
- **Established**: 1899
- **Managed by**: Indian Institute of Astrophysics (IIA)
- ***Key Features:***
  - A significant repository of solar data, with over a century's worth of observations of the sun.
  - Instruments for observing solar activity such as sunspots and solar flares.
- **Significance:** One of the oldest solar observatories globally, it remains a crucial center for solar physics research, contributing to a deeper understanding of solar cycles and activity.

3. Indian Astronomical Observatory

- **Location**: Hanle, Ladakh
- **Established**: 2001
- Managed by: Indian Institute of Astrophysics (IIA)
- ***Key Features:***
  - One of the world's highest optical telescopes, located at an altitude of 4,500 meters (14,764 feet).
  - Equipped with the *Himalayan Chandra Telescope* and the *Himalayan Faint Object Spectrograph* for deep space observation.
- **Significance**: Among the world's top 10 highest observatories, its remote location provides excellent visibility for astronomical research, including studies of star formation, galaxies, and distant celestial bodies.

4. Bihar Astronomical Observatory

- **Location**: Langat Singh College, Bihar
- **Established**: 1916
- ***Key Features:***
  - The first observatory in Eastern India.
  - Features classical telescopes and equipment used for astronomical education and observation.
- **Significance**: Recognized as an endangered heritage observatory by UNESCO, it serves as a symbol of early 20th-century astronomical education and research in India.

5. Vainu Bappu Observatory

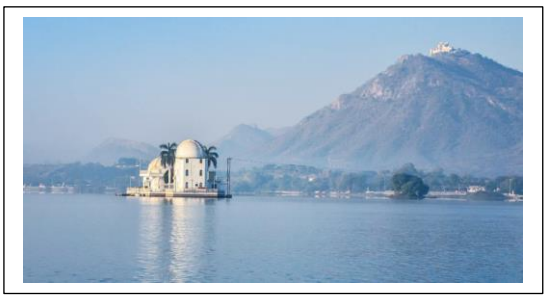
- **Location:** Javadi Hills, near Kavalur, Tamil Nadu
- **Named after**: Indian astrophysicist Vainu Bappu
- ***Key Features:***
  - Equipped for a range of research, including stellar evolution, planetary systems, and star clusters.
  - Played a pivotal role in the discovery of rings around Uranus and a new satellite of Jupiter.

6. Aryabhatta Research Institute of Observational Sciences (ARIES)

- **Location**: Manora Peak, Nainital, Uttarakhand
- **Named after**: Indian mathematician and astronomer Aryabhatta
- **Key Features:**
  - Specializes in optical and near-infrared astronomy.
  - Equipped with a 3.6-meter Devasthal *Optical Telescope*, the largest in India.

7. Udaipur Solar Observatory

- **Location**: Udaipur, Rajasthan
- **Established**: 1975
- **Managed by**: Physical Research Laboratory (PRL), Ahmedabad
- **Key Features:**
  - Located on an island in Fateh Sagar Lake, providing stable atmospheric conditions.
  - Equipped to study solar flares, prominences, and other solar phenomena.



8. Giant Metrewave Radio Telescope (GMRT)

- **Location:** Pune, Maharashtra
- **Established**: 1995
- **Key Features:**
  - One of the largest radio telescopes operating at meter wavelengths.
  - Used to study a wide range of radio phenomena, including pulsars, radio galaxies, and quasars.
- **Significance**: GMRT is one of the most powerful radio telescopes in the world and has played a crucial role in international collaborations, contributing to major discoveries in radio astronomy.

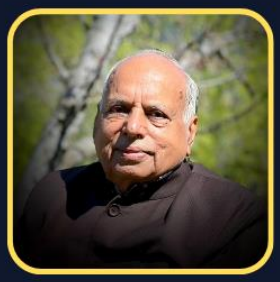
9. Mount Abu InfraRed Observatory (MIRO)

- **Location**: Gurushikhar, Mount Abu, Rajasthan
- **Established**: 1994
- **Managed by**: Physical Research Laboratory (PRL), Ahmedabad
- ***Key Features:***
  - Excellent for infrared observations due to its high-altitude location and dry climate.
- **Significance**: MIRO is one of the leading infrared observatories in India, contributing to studies of infrared astronomy, stellar evolution, and exoplanet research.

VIDYA ICS

We Nurture Dreams...

मार्गदर्शक



Suresh Jain
EX-I.A.S.

Shailendra Singh
Addl. Collector (A.D.M)

Robin Jain
Dy. S.P.

Vandana Jain
Joint Collector

Shubham Sharma
Joint Collector

Dipika Jain
C.T.I. (Commercial Tax)

In Collaboration With

Dir : Amit Jain
THE CORE IAS, DELHI

Dir : Sudarshan Lodha
TARGET UPSC, PUNE

THE CORE IAS

TARGET UPSC
The Lead You Need