Notes: Edited and Illustrated
by Rupam Baidya

First Edition Of
Digital Notes

Biology

By Rahul Sharma

@barracksbuddy @barracksbuddy

AIM TO EMPOWER YOU NOT TO MAKE YOU DEPENDENT

BIOLOGY

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1. Biomolecules

Biomolecules

- Biomolecules are organic compounds essential for life.
- They play key roles in the structure, function, and regulation of cells, tissues, and organs in living organisms.

Metabolism

- Metabolism encompasses all chemical reactions occurring within an organism to maintain life.
    - **Catabolism**: Breaks down complex molecules into simpler ones, releasing energy.
    - **Anabolism**: Builds complex molecules from simpler ones, requiring energy.

Classification of Biomolecules

- Biomolecules are divided into:
    - **Macromolecules**
        - Proteins
        - Carbohydrates
        - Lipids
        - Nucleic Acids
    - **Micronutrients**
        - **Minerals**: Essential inorganic elements like calcium, potassium, and iron that support bodily functions such as bone formation and nerve function.
        - **Vitamins**: Organic compounds required in small amounts, like vitamin C, vitamin D, and B vitamins. They act as coenzymes, support immune function, and maintain overall health.

Carbohydrates

- Carbohydrates (hydrates of carbon) are organic compounds composed of carbon (C), hydrogen (H), and oxygen (O).
- Primarily produced by plants, they are a major source of energy for living organisms.
- Carbohydrates vary in taste; while many are sweet, not all exhibit sweetness.
- Carbohydrates are often referred to as saccharides.

Classes of Carbohydrates:

- **Monosaccharides**: Simple sugars consisting of one unit, such as glucose and fructose.
- **Disaccharides**: Composed of two monosaccharide units, like maltose, sucrose, and lactose.
- **Polysaccharides**: Complex carbohydrates made up of multiple monosaccharide units.

Important Examples:

- **Glucose**: A natural sweetener found in honey and fruits.
- **Fructose**: Another natural sugar present in fruits.
- **Ribose**: A sugar component in DNA and RNA.

Key Disaccharides:

- **Maltose**: Found in malted foods and beverages.
- **Sucrose**: Commonly known as table sugar, used industrially.
- **Lactose**: Present in milk and dairy products.

Polysaccharides:

- **Starch**: A storage form of energy in plants.
- **Glycogen**: The storage form of glucose in animals, mainly found in the liver and muscles.
- **Cellulose**: A structural component of plant cell walls, providing rigidity.

Amino Acids:

- Building blocks of proteins.
- Structure includes:
  - Amino group ($-NH_2$)
  - Carboxyl group ($-COOH$)
  - Variable side chain (R group)

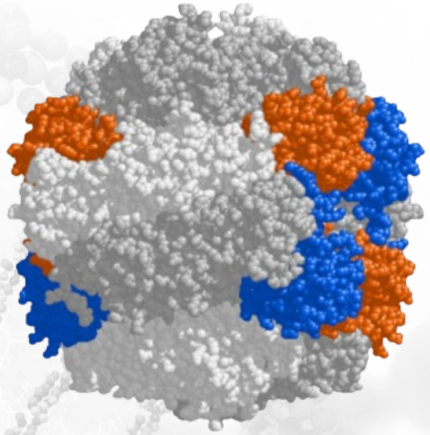
- **Peptides**:
  - Chains of amino acids linked by peptide bonds.
- **Proteins**:
  - Long chains of amino acids.
  - All proteins are polymers of amino acids (polypeptides).

Characteristics of Proteins:

- **Most Abundant Biomolecules**:
  - Proteins are among the most prevalent biomolecules in living organisms.
- **Sources of Protein**:
  - Found in plant and animal foods, including:
    - Meat
    - Dairy
    - Legumes
    - Nuts
- **Importance in Growth**:
  - Essential for growth, repair, and maintenance of body tissues.

Key Proteins:

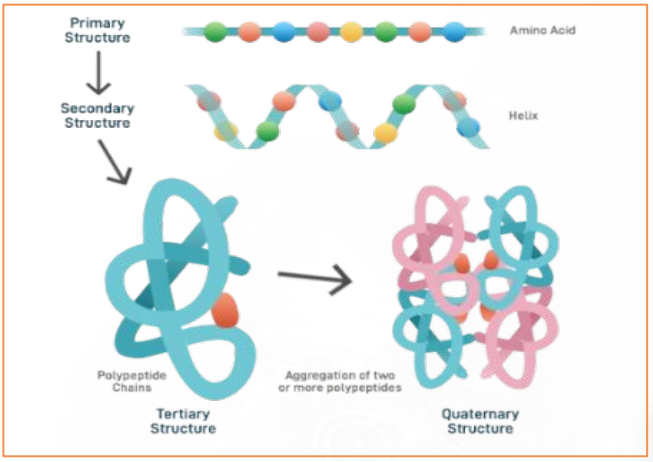
- **Collagen**:
  - Most abundant animal protein.
  - Provides structural support to tissues and organs.
- **Rubisco**:
  - Most abundant protein in the biosphere.
  - Crucial enzyme for the carbon fixation process in photosynthesis.



RubisCO (3D representation)

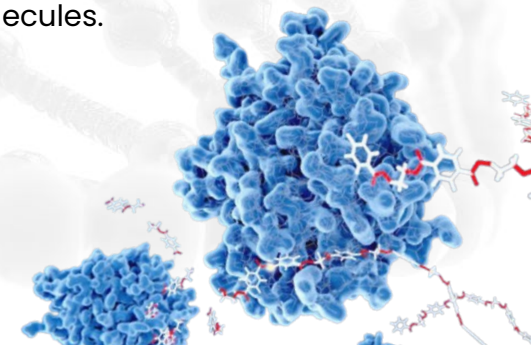
Roles of Proteins:

- **Cell Transport**:
  - Function as transporters, moving substances across cell membranes.
- **Enzymes**:
  - Catalyze biochemical reactions.
  - Speed up processes like digestion.
- **Fibers**:
  - Structural proteins like collagen provide strength and support to tissues.
- **Immunity**:
  - Antibodies are proteins that help defend against pathogens.
- **Hormones**:
  - Proteins like insulin act as hormones to regulate physiological processes.



Enzymes:

- **Biological Catalysts**:
  - Accelerate chemical reactions in living organisms.
- **Composition**:
  - Most enzymes are proteins.
  - Some enzymes are made of RNA (known as ribozymes).
- **Functions**:
  - Essential for various biological processes.
  - Play a crucial role in digestion by breaking down food into simpler molecules.



Lipids:

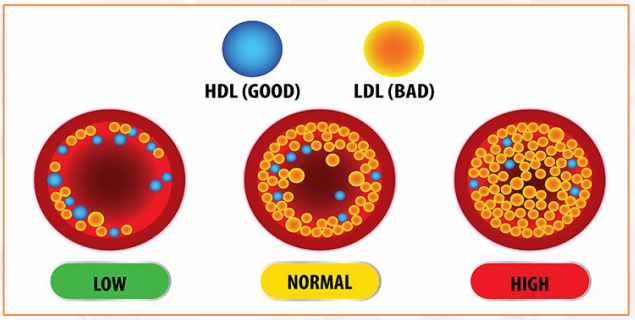
- Diverse group of hydrophobic molecules.
- Primarily composed of fatty acids and cholesterol.
- Crucial roles in energy storage, cell membrane structure, and signaling within the body.

- **Characteristics**:
  - **Composition**:
    - Fatty acids: Long hydrocarbon chains.
    - Cholesterol: A type of sterol found in animal cell membranes.
  - **Hydrophobic Nature**:
    - Insoluble in water.
    - Soluble in organic solvents like alcohol and ether.
- **Roles in Cells**:
  - **Cell Membrane Structure**:
    - Fundamental components of cell membranes.
    - Phospholipids form the lipid bilayer, providing structural integrity and fluidity.
  - **Signaling**:
    - Some lipids act as signaling molecules.
    - Steroid hormones derived from cholesterol regulate various physiological processes.

- **What Are Fats?**:
  - **Definition**:
    - Fats are triglycerides, consisting of three fatty acids linked to a glycerol molecule.
    - Major form of energy storage in the body.
  - **Energy Storage**:
    - Store more than twice the energy per gram compared to carbohydrates and proteins.
    - Dense energy source.
  - **Insulation and Protection**:
    - Help insulate the body.
    - Protect vital organs with a cushioning effect.
  - **Vitamin Absorption**:
    - Essential for the absorption of fat-soluble vitamins (A, D, E, and K).

- **Types of Fats**:
  - **Saturated Fats**:
    - Contain no double bonds between carbon atoms.
    - Solid at room temperature.
    - Found in animal products like butter and ghee.
    - Can increase LDL cholesterol levels, contributing to heart disease.
  - **Unsaturated Fats**:
    - Contain one or more double bonds.
    - Usually liquid at room temperature.
    - Found in plant oils (e.g., olive oil) and fish oils.
    - Beneficial for heart health; can reduce LDL cholesterol.
    - Have a shorter shelf life.
- **Trans Fats**:
  - **Formation**:
    - Produced through hydrogenation, adding hydrogen to unsaturated fats to make them more solid.
    - Increases shelf life.
  - **Health Impact**:
    - Increases LDL (bad) cholesterol and decreases HDL (good) cholesterol.
    - Elevates the risk of heart disease.
    - Found in vanaspati oil and processed foods like packaged bakery items and snacks.

- **Cholesterol**:
  - **Good Cholesterol (HDL)**:
    - Helps transport cholesterol away from arteries to the liver.
    - Protects against heart disease.
  - **Bad Cholesterol (LDL)**:
    - Can deposit in artery walls and form plaques.
    - Leads to atherosclerosis and increases the risk of cardiovascular diseases.

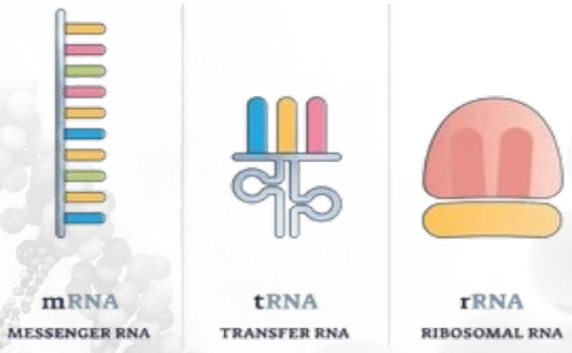


Nucleic Acids:

- **Overview**:
  - Essential biomolecules involved in storing and transmitting genetic information.
  - Composed of long chains of nucleotides, each consisting of:
    - Phosphate group
    - Sugar molecule
    - Nitrogenous base

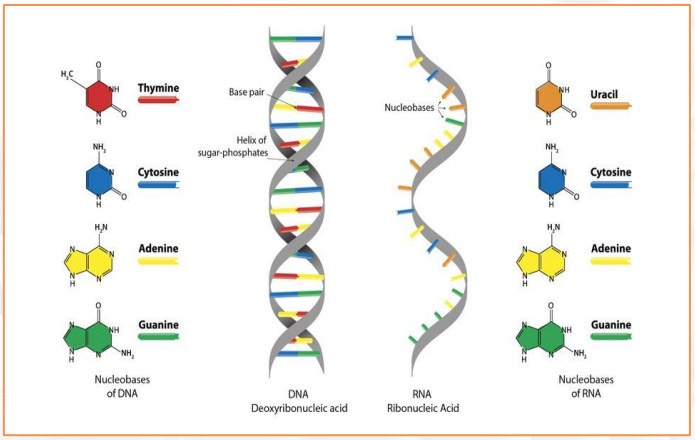
DNA (Deoxyribonucleic Acid):

- **Structure**:
  - Double-stranded helix with two complementary strands running in opposite directions.
  - Each strand has a backbone of sugar (deoxyribose) and phosphate groups.
  - Nitrogenous bases pair in the center:
    - Adenine (A) pairs with Thymine (T)
    - Cytosine (C) pairs with Guanine (G)
- **Function**:
  - Stores and transmits genetic information.
  - Contains instructions for synthesizing proteins and other essential molecules.
- **Location**:
  - In eukaryotic cells: Located in the nucleus.
  - In prokaryotic cells: Found in the nucleoid region (not membrane-bound).
- **Replication**:
  - DNA replication is the process of duplicating DNA before cell division.
  - Ensures that each new cell receives an identical copy of the genetic information.



RNA (Ribonucleic Acid):

- **Structure**:
  - Usually single-stranded.
  - Consists of a backbone of sugar (ribose) and phosphate groups.
  - Nitrogenous bases:
    - Adenine (A)
    - Uracil (U) (replaces thymine in DNA)
    - Cytosine (C)
    - Guanine (G)
- **Function**:
  - **mRNA (Messenger RNA)**:
    - Transcribes genetic information from DNA.
    - Carries it to the ribosome for protein synthesis.
  - **tRNA (Transfer RNA)**:
    - Brings amino acids to the ribosome during protein synthesis.
  - **rRNA (Ribosomal RNA)**:
    - Forms part of the ribosome's structure.
    - Aids in protein synthesis.
- **Location**:
  - Found throughout the cell.
  - **mRNA**: Synthesized in the nucleus; functions in the cytoplasm.
  - **tRNA** and **rRNA**: Primarily located in the cytoplasm and ribosomes.
- **Transcription and Translation**:
  - **Transcription**: RNA is synthesized from a DNA template.
  - **Translation**: RNA sequence is translated into proteins.



Vitamins

Vitamin	Chemical Name	Solubility	Sources	Deficiency Diseases
A	Retinol	Fat-soluble	Liver, carrots, spinach, dairy products, fish oils	Night blindness, xerophthalmia, keratomalacia
B1	Thiamine	Water-soluble	Whole grains, pork, nuts, seeds, legumes	Beriberi, Wernicke-Korsakoff syndrome
B6	Pyridoxine	Water-soluble	Fish, poultry, potatoes, bananas, chickpeas	Anaemia, dermatitis, depression, confusion
B9	Folic Acid (Folate)	Water-soluble	Leafy green vegetables, citrus fruits, beans, fortified cereals	Megaloblastic anaemia, birth defects
B12	Cobalamin	Water-soluble	Meat, fish, dairy products, eggs, fortified cereals	Pernicious anaemia, neurological issues
C	Ascorbic Acid	Water-soluble	Citrus fruits, tomatoes, potatoes, strawberries, bell peppers	Scurvy (bleeding gums, joint pain, anaemia)
D	Calciferol	Fat-soluble	Sunlight exposure, fortified milk, fish liver oils, egg yolks	Rickets (in children), osteomalacia (in adults)
E	Tocopherol	Fat-soluble	Nuts, seeds, vegetable oils, spinach, broccoli	Haemolytic anaemia (in newborns), nerve damage
K	Phylloquinone (K1) and Menaquinone (K2)	Fat-soluble	Leafy green vegetables, broccoli, sprouts, fermented foods	Bleeding disorders due to impaired blood clotting

Minerals

Mineral	Sources	Deficiency Diseases
Calcium	Dairy products (milk, cheese, yogurt), leafy green vegetables, tofu, fortified cereals	Osteoporosis, rickets, muscle spasms
Phosphorus	Meat, fish, poultry, eggs, dairy products, nuts, seeds, legumes	Weak bones, fatigue, joint stiffness
Potassium	Bananas, oranges, potatoes, tomatoes, spinach, avocados, dairy products	Muscle cramps, weakness, arrhythmias
Sodium	Table salt, processed foods, soy sauce, pickles	Hyponatremia (low blood sodium levels), muscle cramps, confusion
Magnesium	Nuts, seeds, whole grains, leafy green vegetables, fish, legumes	Muscle cramps, osteoporosis, fatigue, arrhythmias
Iron	Red meat, poultry, fish, lentils, beans, fortified cereals, spinach	Anemia, fatigue, weakened immune function
Zinc	Meat, shellfish, legumes, nuts, seeds, dairy products	Growth retardation, impaired immune function, hair loss
Iodine	Iodized salt, seafood, dairy products, eggs	Goitre, hypothyroidism, mental retardation in children
Selenium	Brazil nuts, fish, meat, eggs, cereals	Keshan disease (heart disease), weakened immune system
Copper	Shellfish, nuts, seeds, whole grains, beans, potatoes	Anemia, osteoporosis, connective tissue disorders

2. Cell

Cytology: The Study of Cells

- **Origins**:
  - Began in the 17th century with the discovery of cells.
- **Advances in Microscopy**:
  - Development of microscopy techniques has greatly enhanced our understanding of cells.
- **Electron Microscopy**:
  - A significant advancement that has provided detailed insights into cellular structures and functions.

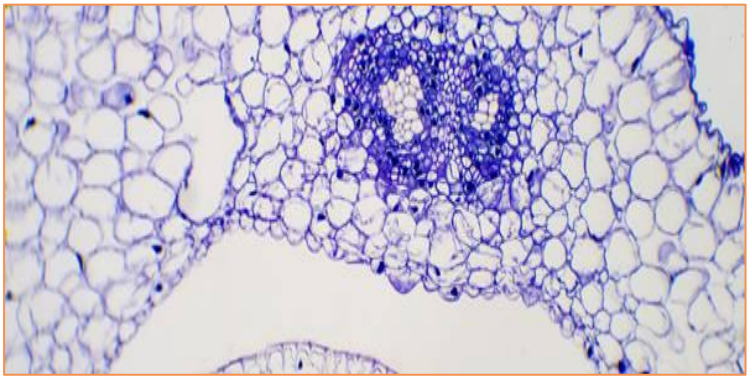


Fig: Microscopic view of cells

Key Discoveries and Microscopy

Types of Microscopes-

Type of Microscope	Description	Year
Simple Microscope	Single lens microscope used by Leeuwenhoek.	1674
Compound Microscope	Multi-lens microscope used by Hooke.	1590
Electron Microscope	Uses electrons for high-resolution imaging.	1931

Discoveries in Cell Biology-

Scientist	Discovery	Year
Robert Hooke	Discovered and coined the term "cell" by observing cork under a microscope.	1665
Anton van Leeuwenhoek	First to observe and describe single-celled organisms (bacteria, protozoa) using a simple microscope.	1674
Robert Brown	Discovered the nucleus in plant cells.	1831
Matthias Schleiden	Co-founder of the cell theory; proposed that all plants are composed of cells.	1838
Theodor Schwann	Co-founder of the cell theory; proposed that all animals are composed of cells.	1839
Rudolf Virchow	Proposed that all cells arise from pre-existing cells, contributing to the cell theory.	1855
Jan Evangelista Purkinje	Coined the term "protoplasm" to describe the cell content.	1839
Camillo Golgi	Discovered the Golgi apparatus (complex) in cells.	1898

Cell Theory

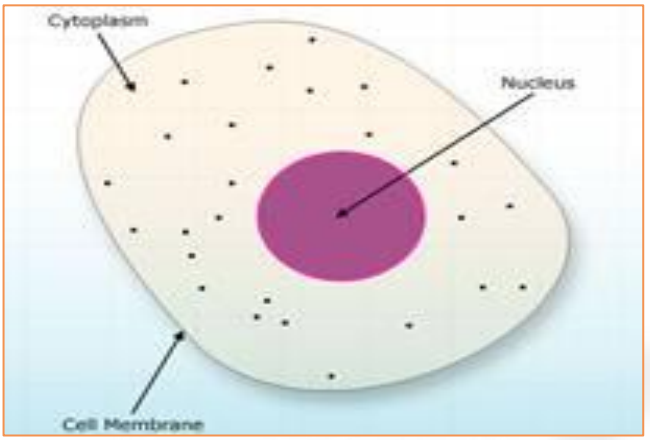
- **Principles**:
  - **All Living Organisms**:
    - Composed of one or more cells.
  - **Basic Unit**:
    - The cell is the basic structural and functional unit of all living organisms.
  - **Cell Origin**:
    - All cells originate from pre-existing cells.
  - **Hereditary Material**:
    - Cells contain hereditary material (DNA), which is transmitted from one cell to another during cell division.
  - **Chemical Composition**:
    - Cells share similar chemical compositions and metabolic processes.
  - **Energy Flow**:
    - Energy flow, including metabolism and biochemistry, occurs within cells.

Cell as the Fundamental Unit of Life

- **Self-Sufficiency**:
  - Capable of performing all necessary life functions independently.
- **Basic Unit**:
  - The smallest entity that can exist individually and sustain life.
- **Functional Autonomy**:
  - Manages essential processes like metabolism, growth, and reproduction on its own.

Cell Structure and Functions

- **Cell Membrane**:
  - **Description**: A selectively permeable phospholipid bilayer embedded with proteins.
  - **Functions**:
    - Regulates the exchange of substances between the cell and its environment.
    - Provides structural support and protection.
    - Facilitates communication and transport.
- **Cytoplasm**:
  - **Description**: The gel-like intracellular fluid that fills the cell, consisting of the cytosol and various organelles.
  - **Functions**:
    - Site of numerous cellular processes, including metabolism and protein synthesis.
- **Genetic Material**:
  - **Location**:
    - **Eukaryotic Cells**: Primarily located within the nucleus.
    - **Prokaryotic Cells**: Found in the nucleoid region.
  - **Functions**:
    - DNA encodes the genetic instructions essential for cellular function, growth, and reproduction.



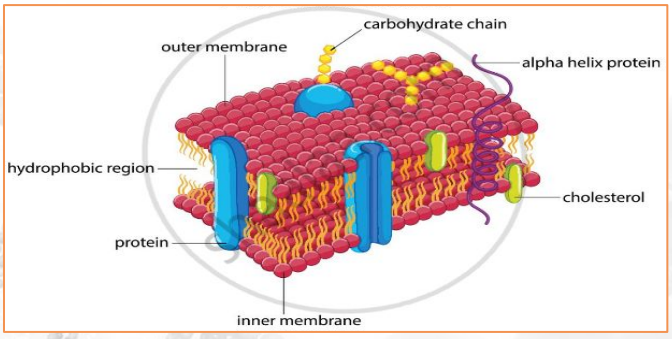
Cell Wall:

- **Structure**:
  - **General**: A rigid, protective layer found outside the cell membrane in plant cells, bacteria, fungi, and some protists.
  - **In Plants**: Composed of cellulose, hemicellulose, and pectin.
  - **In Bacteria**: Made of peptidoglycan.
  - **In Fungi**: Consists of chitin.

- **Associated Points**:
  - Essential in plant cells; absent in animal cells.
  - **Turgor Pressure Maintenance**: Rigidity of the cell wall, combined with osmotic regulation through plasmodesmata, helps maintain turgor pressure, crucial for plant cell structure.
  - **Developmental Role**: Plasmodesmata can vary in number and size based on the plant's developmental and physiological needs.

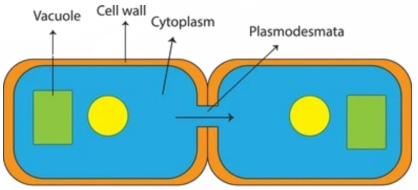
Cell Membrane (Plasma Membrane):

- **Structure**:
  - Composed of a phospholipid bilayer with embedded proteins, cholesterol, and carbohydrates.
  - **Bilayer**: Hydrophilic (water-attracting) heads face outward; hydrophobic (water-repelling) tails face inward.
  - **Fluid Mosaic Model**: Describes the membrane as a flexible layer made up of lipids and proteins that move laterally.
- **Functions**:
  - **Selective Permeability**: Regulates movement of substances in and out of the cell, maintaining homeostasis.
  - **Signal Transduction**: Receptor proteins bind to signaling molecules, triggering internal cellular events.
  - **Cell Recognition and Communication**: Glycoproteins and glycolipids on the membrane surface are involved in cell recognition and immune response.
  - **Structural Support and Protection**: Provides a barrier against the external environment while maintaining cell integrity.



  - **Layers in Plant Cells**:
    - **Primary Cell Wall**: Flexible layer that forms first, allowing cell growth.
    - **Secondary Cell Wall**: Thicker, rigid layer providing additional strength, especially in woody plants.
    - **Middle Lamella**: Pectin-rich layer acting as a glue, holding adjacent cells together.
- **Functions**:
  - **Structural Support and Protection**: Maintains cell shape, protects against mechanical stress, and prevents excessive water intake.
  - **Regulates Water and Nutrient Intake**: Controls the passage of materials in and out of the cell due to its semi-permeable nature.
  - **Facilitates Communication Between Cells**: Through plasmodesmata, channels that perforate the cell wall, allowing direct communication and material transport between adjacent plant cells.

Plasmodesmata:



- **Structure**:
  - Microscopic channels traversing the cell walls, connecting the cytoplasm of neighboring plant cells.
  - Each plasmodesmata consists of a narrow tube of the endoplasmic reticulum called the desmotubule, surrounded by a sleeve of cytoplasm.

Functions:

- **Intercellular Communication**: Allows direct transport of water, ions, small molecules, and some larger molecules like proteins and RNA between cells.
- **Symplastic Pathway**: Facilitates symplastic movement (through the cytoplasm) of nutrients, signaling molecules, and metabolites, crucial for coordinated cellular responses and development.
- **Maintains Tissue Cohesion**: Coordinates activities across plant tissues by maintaining a continuous cytoplasmic connection.

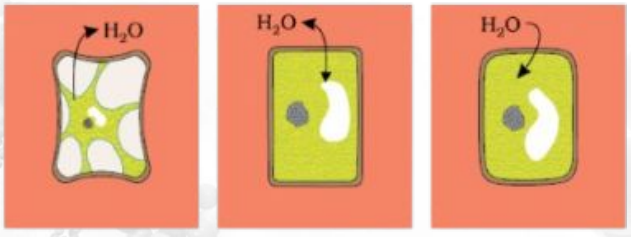
- **Associated Points**:
  - **Transport Mechanisms**: Includes passive transport (diffusion, osmosis, facilitated diffusion) and active transport (using ATP).
  - **Endocytosis and Exocytosis**: Processes for internalizing and expelling large particles or liquids

Movement of Water : Diffusion

- **Definition:** Diffusion is the process by which molecules move from an area of higher concentration to an area of lower concentration until they are evenly distributed.
- **Mechanism:** Molecules move randomly due to their kinetic energy.
- **Equilibrium:** Movement continues until equilibrium is reached, where the concentration of molecules is the same throughout the space.
- **Example:** When a bottle of perfume is opened in a room, fragrance molecules spread out and fill the room through diffusion.

Osmosis

- **Definition:** Osmosis is a special type of diffusion involving the movement of water molecules across a semi-permeable membrane.
- **Direction of Movement:** Water moves from an area with a lower concentration of solutes (more water) to an area with a higher concentration of solutes (less water).
- **Semi-Permeable Membrane:** Allows the passage of water molecules but not solute molecules.
- **Example:** Plant roots absorb water from the soil through osmosis, moving from the soil (lower solute concentration) into the root cells (higher solute concentration).



Plasmolysis Flaccid Turgid

Reverse Osmosis

- **Definition:** Reverse osmosis is the process where water is forced through a semi-permeable membrane from an area of higher solute concentration to an area of lower solute concentration using external pressure.
- **Mechanism:** External pressure greater than osmotic pressure is applied to push water molecules through the membrane, leaving solutes behind.
- **Application:** Commonly used in water purification systems to filter out contaminants.

Effect of Solutions on Plant Cells

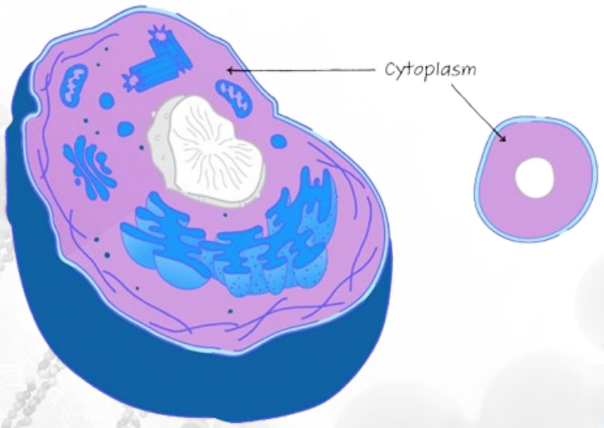
- **Hypertonic Solution:**
  - **Definition:** A solution with a higher concentration of solutes compared to the inside of the cell.
  - **Effect on Plant Cells:** Water moves out of the cell into the surrounding solution, causing the cell to lose water and shrink. The cell membrane pulls away from the cell wall, resulting in plasmolysis. The plant cell becomes wilted and loses turgor pressure.
  - **Example:** A plant cell placed in a highly concentrated salt solution will shrink as water moves out.
- **Hypotonic Solution:**
  - **Definition:** A solution with a lower concentration of solutes compared to the inside of the cell.
  - **Effect on Plant Cells:** Water moves into the cell from the surrounding solution, causing the cell to swell and become turgid. The cell wall prevents excessive swelling, maintaining the cell's shape and structural integrity.
  - **Example:** A plant cell placed in distilled water will swell as water enters, becoming turgid.
- **Isotonic Solution:**
  - **Definition:** A solution with the same concentration of solutes as the inside of the cell.
  - **Effect on Plant Cells:** No net movement of water into or out of the cell. The plant cell remains in equilibrium with its environment.

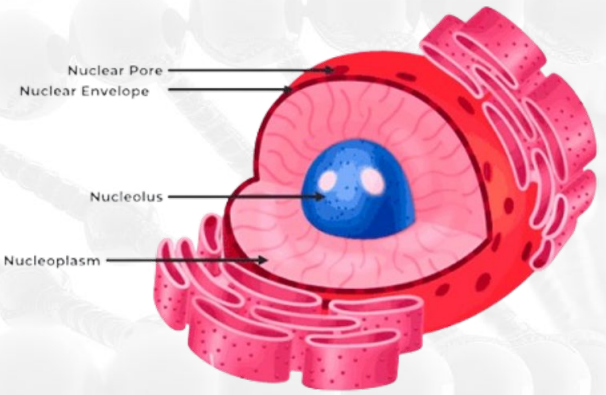
Cytoplasm

- **Structure**:
  - **Description**: A semi-fluid, gel-like substance known as cytosol that fills the cell interior, excluding the nucleus.
  - **Components**:
    - Contains water, salts, organic molecules, and enzymes that facilitate biochemical reactions.
    - Houses all cellular organelles.
- **Functions**:
  - **Site for Metabolic Activities**:
    - Includes glycolysis, protein synthesis, and other enzymatic processes.
  - **Organelles Support and Suspension**:
    - Maintains organelles in place and facilitates their movement.
  - **Intracellular Transport**:
    - Enables movement of materials through cytoplasmic streaming (cyclosis).
- **Associated Points**:
  - **Cytoskeleton**:
    - A network of protein filaments (microfilaments, intermediate filaments, microtubules) provides structural support and aids intracellular transport and cell division.

Nucleus

- **Structure**:
  - **Description**: A membrane-bound organelle with a double membrane (nuclear envelope) containing nuclear pores.
  - **Components**:
    - **Chromatin**: DNA and proteins that condense into chromosomes during cell division.
    - **Nucleolus**: A dense region within the nucleus responsible for ribosomal RNA (rRNA) synthesis and ribosome assembly.
- **Functions**:
  - **Stores Genetic Material (DNA)**:
    - Governs cellular functions and hereditary information.
  - **Regulates Gene Expression**:
    - Controls protein synthesis by transcribing DNA into mRNA.
  - **Cell Division Regulation**:
    - Coordinates cell growth and division (mitosis and meiosis).
- **Associated Points**:
  - **Nuclear Envelope**:
    - Separates genetic material from the cytoplasm and regulates material exchange via nuclear pores.
  - **Chromatin Remodelling**:
    - Facilitates access to DNA for transcription, replication, and repair.





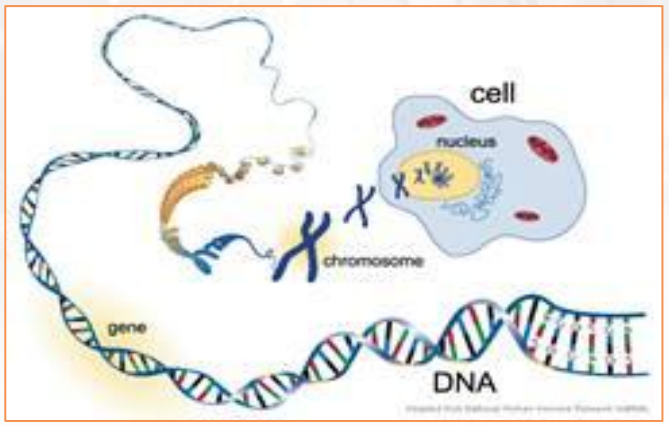


Fig: DNA (Deoxyribonucleic acid)

DNA (Deoxyribonucleic Acid)

- **Structure**: Long, double-stranded molecule with a double helix shape.
- **Function**: Carries genetic information for development, functioning, and reproduction of all organisms.
- **Location**:
  - Eukaryotic cells: Found in the nucleus.
  - Prokaryotic cells: Found in the nucleoid region.

Chromatin

- **Structure**: Complex of DNA and proteins (histones) in a loose, thread-like form.
- **Function**:
  - DNA is packed into chromatin to fit within the nucleus.
  - Regulates gene expression.
- **Miscellaneous**: Exists in two forms:
  - **Euchromatin**: Active form.
  - **Heterochromatin**: Inactive form.

Chromosomes

- **Structure**: Highly condensed, rod-shaped structures made of chromatin, visible during cell division.
- **Function**: Carries genetic information in a more compact form, ensuring accurate distribution of genetic material during cell division.
- **Miscellaneous**:
  - Humans have 46 chromosomes (23 pairs) in each somatic cell.
  - One set from each parent.

Mitochondria

- **Structure:**
  - Double-membraned organelles:
    - Outer membrane
    - Highly folded inner membrane (cristae)
  - **Cristae:**
    - Increase surface area for oxidative phosphorylation
  - Inner membrane encloses:
    - Matrix (containing enzymes, mitochondrial DNA (mtDNA), and ribosomes)
- **Functions:**
  - **ATP Production:**
    - Generates ATP through cellular respiration (Krebs cycle and oxidative phosphorylation)
  - **Metabolic Regulation:**
    - Involved in metabolism of carbohydrates, fats, and proteins
  - **Apoptosis Regulation:**
    - Plays a role in programmed cell death by releasing cytochrome c
- **Associated Points:**
  - **Mitochondrial DNA (mtDNA):**
    - Inherited maternally
    - Encodes proteins for ATP production
  - **Endosymbiotic Theory:**
    - Suggests mitochondria originated from symbiotic prokaryotes

Ribosomes

- **Structure:**
  - Composed of ribosomal RNA (rRNA) and proteins
  - Forms large and small subunits
  - Found:
    - Free-floating in the cytoplasm
    - Attached to the rough endoplasmic reticulum (ER)
- **Functions:**
  - **Protein Synthesis:**
    - Translate mRNA sequences into proteins
    - Assemble amino acids in the correct order
  - **Polyribosomes:**
    - Multiple ribosomes attach to a single mRNA strand
    - Synthesizes multiple protein copies
- **Associated Points:**
  - **Free vs. Bound Ribosomes:**
    - Free ribosomes: Synthesize cytosolic proteins
    - Bound ribosomes: Produce proteins for membranes, lysosomes, or secretion

Endoplasmic Reticulum (ER)

- **Structure:**
  - Network of membranous tubules and flattened sacs (cisternae)
  - **Rough ER:**
    - Studded with ribosomes
    - Involved in protein synthesis and modification
  - **Smooth ER:**
    - Lacks ribosomes
    - Involved in lipid synthesis, detoxification, and calcium ion storage

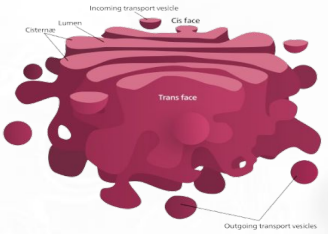
Functions:

- **Rough ER:**
  - Synthesizes and folds proteins
  - Adds carbohydrates to form glycoproteins
  - Packages proteins into vesicles for transport
- **Smooth ER:**
  - Synthesizes lipids
  - Detoxifies drugs/toxins
  - Regulates calcium levels in muscle cells

Associated Points:

- **Transitional ER:**
  - Specialized region where vesicles are formed for transport to the Golgi apparatus
  - **Vesicular Transport Model:**
    - Involves vesicles shuttling **ER Stress and Unfolded Protein Response (UPR):** Manages protein folding and quality control during cellular stress

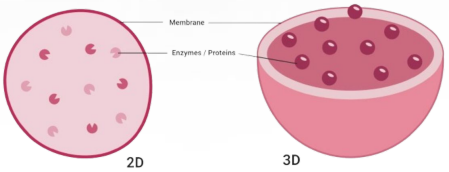
Golgi Apparatus



- **Structure:**
  - Series of flattened, membrane-bound sacs (cisternae) in stacks
  - **Cis Face:** Receiving side facing the ER
  - **Trans Face:** Shipping side facing the plasma membrane
- **Functions:**
  - **Protein and Lipid Modification:** Adds carbohydrate or phosphate groups to proteins and lipids
  - **Sorting and Packaging:** Sorts proteins and lipids into vesicles for delivery
  - **Lysosome Formation:** Produces lysosomes and specialized vesicles

- **Associated Points:**
  - **Vesicular Transport Model:** Involves vesicles shuttling materials between Golgi cisternae and other cellular destinations
  - **Cisternal Maturation Model:** Cisternae mature as they move from cis to trans face, modifying contents

Lysosomes



- **Structure:**
  - Membrane-bound vesicles containing hydrolytic enzymes
  - Maintains an acidic environment (pH ~5) for enzymatic activity
- **Functions:**
  - **Intracellular Digestion:** Degrades cellular waste, including damaged organelles and macromolecules
  - **Defence Against Pathogens:** Destroys pathogens engulfed by phagocytosis
  - **Apoptosis:** Contributes to programmed cell death by releasing enzymes into the cytosol
- **Associated Points:**
  - **Lysosomal Storage Diseases:** Result from enzyme defects, leading to substrate accumulation
  - **Autolysis:** Digestive process by which lysosomes can destroy the entire cell if ruptured

Centrioles

- **Structure:**
  - Cylindrical structures composed of nine triplets of microtubules arranged in a ring
  - Found in pairs, located near the nucleus in the centrosome
- **Functions:**
  - **Cell Division:**
    - Organize microtubules into the mitotic spindle, crucial for chromosome separation
  - **Basal Bodies:**
    - Serve as the origin of cilia and flagella
    - Contributing to cellular motility
- **Associated Points:**
  - **Centrosome:**
    - The region surrounding centrioles that organizes microtubules
  - **Basal Body Formation:**
    - Centrioles anchor cilia and flagella to the cell surface

Chloroplasts (Plant Cells Only)

- **Structure:**
  - Double-membraned organelles
  - Inner membrane forms stacks of thylakoids (grana)
  - **Stroma:**
    - The fluid-filled space surrounding the thylakoid membranes
    - Contains enzymes and chloroplast DNA
- **Functions:**
  - **Photosynthesis:**
    - Converts light energy into chemical energy (glucose) using chlorophyll pigments
  - **Synthesis of Organic Compounds:**
    - Produces carbohydrates, lipids, and amino acids
- **Associated Points:**
  - **Chlorophyll:**
    - The pigment responsible for capturing light energy
  - **Endosymbiotic Theory:**
    - Suggests chloroplasts originated from photosynthetic cyanobacteria

Difference between Prokaryotes and eukaryotes.

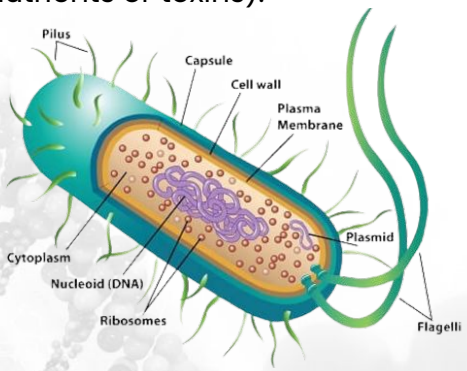
Feature	Prokaryotic Cells	Eukaryotic Cells
Nucleus	No true nucleus; DNA in a nucleoid region.	True nucleus enclosed by a nuclear membrane.
Membrane -bound Organelles	Absent.	Present (e.g., mitochondria, Golgi apparatus, ER).
Cell Wall	Typically present (e.g., peptidoglycan in bacteria).	Present in plant cells (cellulose) and fungi (chitin); absent in animal cells.
DNA Structure	Circular DNA molecule, often one chromosome.	Linear DNA molecules associated with histones, multiple chromosomes.
Reproduction	Asexual reproduction through binary fission.	Asexual reproduction (mitosis) and sexual reproduction (meiosis).
Size	Generally smaller (0.1-5 µm in diameter).	Generally larger (10-100 µm in diameter).
Flagella	Simple structure (rotary motion).	Complex structure (whip-like motion).
Cytoskeleton	Simple, less developed.	Complex, well-developed (microtubules, microfilaments, intermediate filaments).
Examples	Bacteria, Archaea.	Animals, plants, fungi, protists.

Structures Exclusive to Prokaryotes

- **Nucleoid**
  - **What It Is:** The central area in a prokaryotic cell where DNA is located. It is not surrounded by a membrane.
  - **What It Does:** Contains the cell's genetic material, which is usually a single circular piece of DNA.
- **Peptidoglycan Cell Wall**
  - **What It Is:** A tough outer layer composed of sugars and amino acids.
  - **What It Does:** Provides structural support and protection, maintaining cell shape and preventing damage.
- **Capsule**
  - **What It Is:** A sticky outer coating surrounding the cell wall.
  - **What It Does:** Protects the cell from desiccation, aids in adherence to surfaces, and helps avoid phagocytosis by immune cells.
- **Fimbriae (Pili)**
  - **What It Is:** Tiny, hair-like projections on the cell surface.
  - **What It Does:** Facilitates attachment to surfaces and other cells, playing a role in infection and colonization.

Flagella

- **What It Is:** Long, tail-like structures used for locomotion.
- **What It Does:** Enables the cell to move toward or away from stimuli (e.g., nutrients or toxins).



Conjugation Pilus

- **What It Is:** A specialized pilus used for cell-to-cell contact.
- **What It Does:** Facilitates the transfer of DNA between cells, aiding in the spread of traits such as antibiotic resistance.

Endospores

- **What It Is:** Tough, protective structures formed inside the cell.
- **What It Does:** Enables the cell to withstand extreme conditions, such as heat and desiccation.

Plasmids

- **What It Is:** Small, circular DNA molecules distinct from the chromosomal DNA.
- **What It Does:** Carries additional genes that may provide advantages, such as antibiotic resistance.

Bacterial Chromosome

- **What It Is:** A single, circular DNA molecule located in the nucleoid region.
- **What It Does:** Contains essential genes required for cell functions and reproduction.

Membranous Modifications

- **What It Is:** Special structures or folds in the cell membrane.
- **What It Does:**
  - **Thylakoid Membranes:** Found in cyanobacteria; involved in photosynthesis.
  - **Mesosomes:** Membrane folds potentially aiding in cell division and respiration; in some photosynthetic bacteria, they may contain photosynthetic pigments.

Feature	Plant Cells	Animal Cells
Cell Wall	Present; composed of cellulose.	Absent.
Plasma Membrane	Present, but beneath the cell wall.	Present; the outer boundary of the cell.
Chloroplasts	Present; sites of photosynthesis.	Absent.
Vacuole	Large central vacuole; stores nutrients and waste products, maintains turgor pressure.	Small vacuoles; often numerous, but less prominent.
Shape	Generally rectangular or polygonal due to the rigid cell wall.	Irregular or round due to the lack of a cell wall.
Centriole	Absent in most plant cells.	Present; involved in cell division.
Lysosomes	Rare or absent; usually, other structures take on their functions.	Common; involved in digestion and waste removal.
Plasmodesmata	Present; channels between plant cells for communication and transport.	Absent.
Peroxisomes	Present; involved in breaking down fatty acids and detoxifying harmful substances.	Present; similar functions as in plant cells.
Microtubules	Present; involved in maintaining cell shape and transport.	Present; similarly involved in cell shape and transport.
Cytokinesis	Involves the formation of a cell plate that develops into the cell wall.	Involves cleavage furrow that pinches the cell into two.

Cell Cycle: Brief Overview

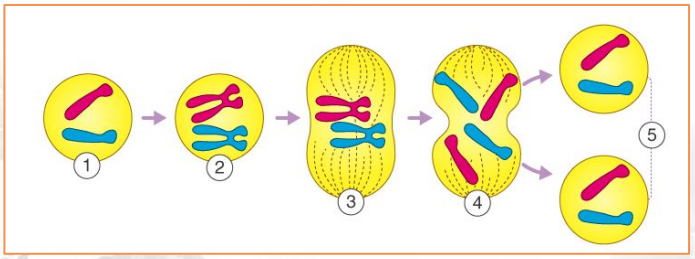
- **Definition:** The sequence of events that cells go through as they grow and divide. It ensures accurate duplication of DNA and organelles, resulting in two genetically identical daughter cells.

Phases of Interphase

- **G1 Phase (Gap 1)**
  - **Purpose:** Cell growth and preparation for DNA synthesis.
  - **Activities:** Protein synthesis, organelle production, and cell enlargement. The cell assesses environmental conditions for division suitability.
- **S Phase (Synthesis)**
  - **Purpose:** DNA replication.
  - **Activities:** Complete copying of the cell's DNA, resulting in two identical chromosome sets to ensure each daughter cell receives an exact genetic copy.
- **G2 Phase (Gap 2)**
  - **Purpose:** Final preparations for cell division.
  - **Activities:** Continued cell growth, additional protein and organelle production, and DNA error checking. Ensures all components are ready for mitosis.

Types of Cell Division

- **Mitosis**
  - **Definition:** Cell division resulting in two genetically identical daughter cells from a single parent cell.
  - **Where It Occurs:** Somatic cells (e.g., skin, muscle, nerve cells).

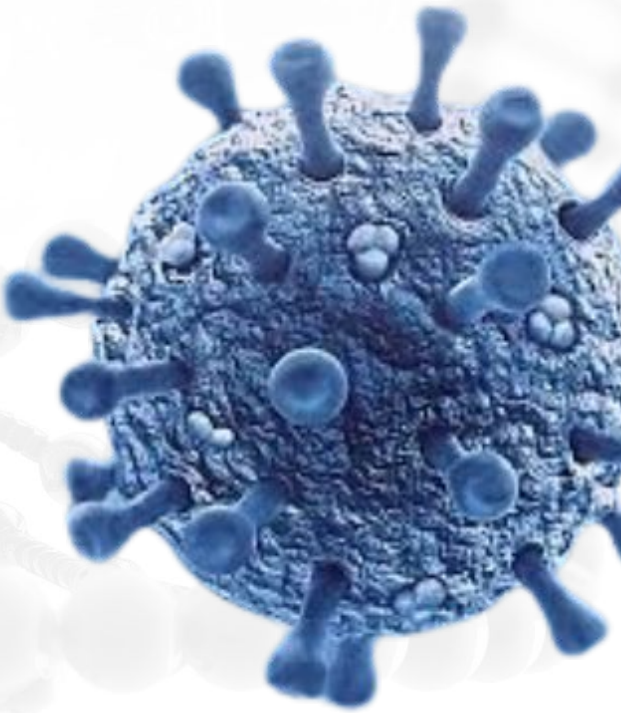


- **Phases:**
  - **Prophase**
    - Chromosomes condense into visible structures.
    - Nuclear envelope dissolves.
    - Spindle fibers form.
  - **Metaphase**
    - Chromosomes align at the metaphase plate.
    - Spindle fibers attach to centromeres.
  - **Anaphase**
    - Sister chromatids are pulled to opposite poles.
  - **Telophase**
    - Chromosomes decondense.
    - Nuclear envelopes reform around each chromosome set.
  - **Cytokinesis**
    - **Division of Cytoplasm:**
      - **Animal Cells:** Cleavage furrow pinches the cell into two.
      - **Plant Cells:** Cell plate forms and develops into a cell wall.
- **Result:** Two genetically identical daughter cells, each with the same chromosome number as the parent cell.
- **Meiosis**
  - **Definition:** Cell division producing reproductive cells (sperm and eggs) with half the chromosome number, ensuring genetic diversity.
  - **Key Points:**
    - **Purpose:** To create four unique cells with half the chromosome number of the original cell.
    - **Stages:**
      - **Meiosis I:**
        a. **Start:** Chromosomes are copied; cell prepares to divide.
        b. **Middle:** Homologous chromosomes pair up and crossover; separate into two cells.
        c. **End:** Two cells with duplicated chromosomes.

- **Meiosis II:**
  - **Start:** The two cells from Meiosis I divide again.
  - **Middle:** Chromosomes line up and separate into chromatids.
  - **End:** Four unique cells are formed, each with half the original chromosome number.
    - **Result:** Four unique cells, each with half the chromosome number, becoming sperm or eggs.

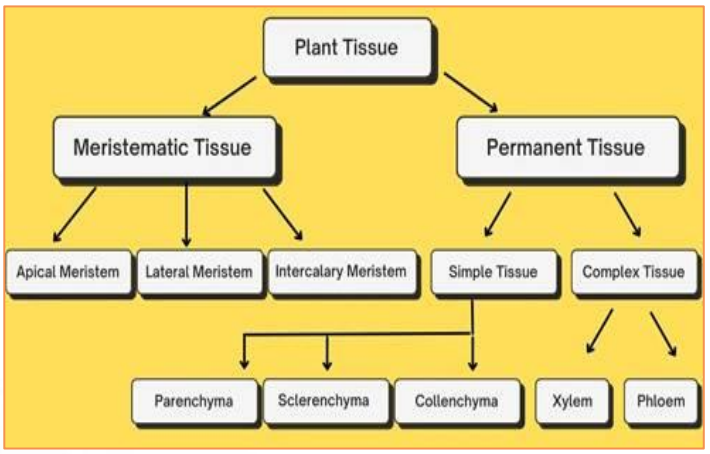
Virus and Viroids: An Overview

- **Virus**
  - **Discovery:**
    - Identified by Dmitri Ivanovsky in 1892; named by Martinus Beijerinck in 1898.
  - **Characteristics:**
    - Non-cellular, microscopic infectious agents.
    - Obligate intracellular parasites; replicate only inside host cells.
    - Infect all life forms.
  - **Structure:**
    - Composed of genetic material (DNA or RNA) in a protein coat (capsid).
    - Some have an additional lipid envelope from the host cell membrane.
    - Genetic material can be single-stranded or double-stranded, linear or circular.
  - **Types:**
    - **DNA Viruses:** e.g., Adenovirus (causes respiratory infections).
    - **RNA Viruses:** e.g., HIV (causes AIDS).
    - **Retroviruses:** e.g., HIV (reverse transcribes RNA into DNA).
  - **Common Examples:**
    - Influenza Virus (flu).
    - HIV (AIDS).
    - SARS-CoV-2 (COVID-19).
- **Viroids**
  - **Discovery:**
    - Discovered by Theodor Diener in 1971.
  - **Characteristics:**
    - Simpler than viruses; consist only of a short circular strand of RNA.
    - Infect plants and cause diseases by interfering with gene expression.
    - Do not code for proteins; rely on host machinery for replication.
  - **Structure:**
    - Short circular RNA molecule; no protein coat.
  - **Types:**
    - Classified based on RNA sequence.
  - **Common Examples:**
    - Potato Spindle Tuber Viroid (PSTVd) (causes tuber deformities in potatoes).
    - Chrysanthemum Stunt Viroid (CSVd) (causes stunted growth in chrysanthemums).



3. Tissues

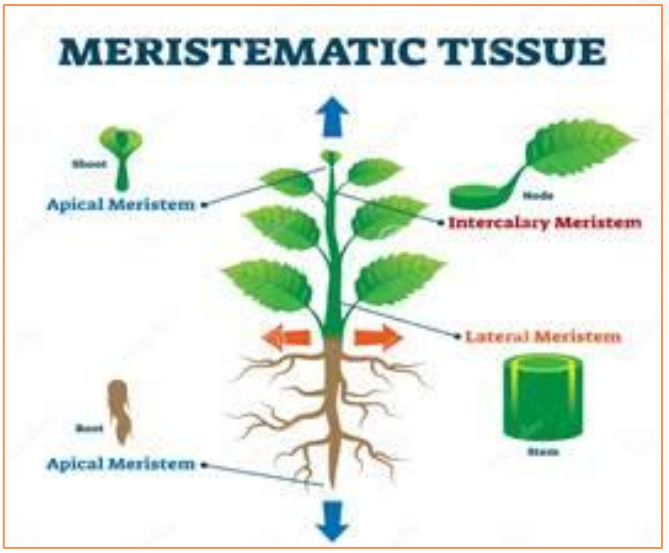
- **Definition**: Tissues are groups of similar cells working together to perform specific functions within an organism.
- **Building Blocks**: Tissues serve as the foundational components of organs.
- **Functionality**: They play crucial roles in maintaining the structure and function of living organisms.
- **Collaboration**: Tissues interact with one another to facilitate complex physiological processes.
- **Importance**: Understanding tissues is essential for studying the overall health and functionality of organisms.



Meristematic Tissues

1. **Definition**:
   Meristematic tissues consist of actively dividing cells that facilitate the growth of plants.

2. **Types**:
   - **Apical Meristem**:
     - Located at the tips of roots and shoots.
     - Responsible for primary growth (lengthwise growth of the plant).
   - **Lateral Meristem**:
     - Found along the sides of stems and roots.
     - Responsible for secondary growth (thickening or girth of the plant).
   - **Intercalary Meristem**:
     - Located at the base of leaves or internodes (regions between the nodes).
     - Contributes to the growth of grasses and other monocots.



Permanent Tissues

- **Definition**:
  - Permanent tissues arise from meristematic tissues.
  - Cells have lost their ability to divide.
  - Perform specific functions in the plant.
- **Types**:
  - **Simple Permanent Tissues**:
    - Made up of one type of cell.
    - Involved in storage, support, and photosynthesis.
    - **Parenchyma**:
      - Involved in photosynthesis, storage, and tissue repair.
      - Cells are alive, thin-walled, and flexible.
    - **Collenchyma**:
      - Provides support while allowing flexibility.
      - Cells have unevenly thickened walls.
    - **Sclerenchyma**:
      - Provides mechanical strength.
      - Cells are dead at maturity with very thick, lignified walls.

Complex Permanent Tissues:

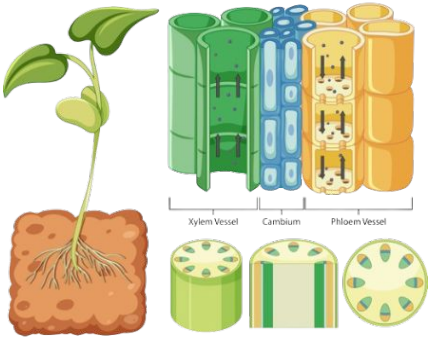
- Consist of more than one type of cell.
- Work together to perform a common function.
- Examples include vascular tissues.

Vascular Tissue

Definition:

Vascular tissue is a type of complex permanent tissue essential for the transport of water, minerals, and nutrients throughout the plant.

Components:



- **Xylem**:
  - **Function**: Transports water and dissolved minerals from roots to other parts of the plant; provides structural support.
  - **Structure**:
    - Composed of tracheids and vessel elements that form tubes for water conduction.
    - Tracheids: Elongated with tapered ends; vessel elements: shorter and wider, forming continuous tubes.
    - Thickened with lignin for rigidity and water resistance.
    - Pits in walls allow water passage between cells.
  - **Water Movement**: Driven by transpiration, creating negative pressure to pull water upwards.
  - **Cohesion and Adhesion**: Water molecules exhibit cohesion (sticking together) and adhesion (sticking to xylem walls), aiding upward flow.
- **Phloem**:

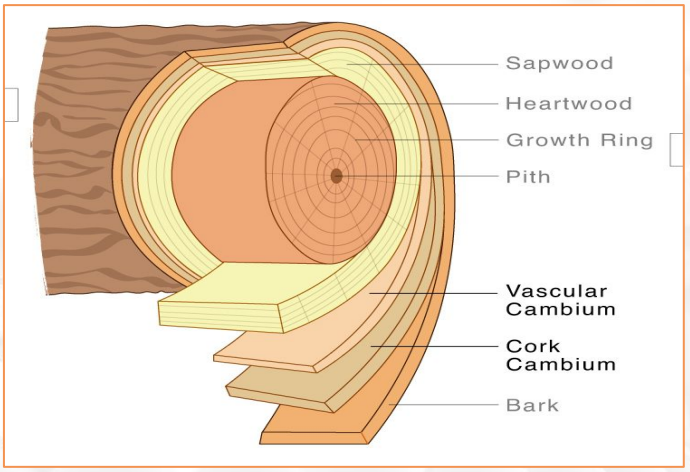
  Function: Transports organic nutrients, especially sugars produced during photosynthesis, from leaves to other parts of the plant.

  Structure:
  - Composed of sieve tube elements arranged end to end with sieve plates to facilitate nutrient flow.
  - Companion cells assist sieve tube elements, maintaining function and aiding nutrient transport
  - **Transport Direction**: Nutrients can move in both directions (up and down) based on the plant's needs, following the pressure flow hypothesis.
  - **Mechanism**: Involves loading sugar into phloem, increasing osmotic pressure, and pushing the sugar solution to where it is needed (from sources to sinks).

- **Cambium:** A special plant tissue that helps plants grow thicker.

- **Vascular Cambium:**
  - **Function:** Produces new xylem (wood) and phloem (bark) cells.
  - **Location:** Found between the xylem and phloem in stems and roots.

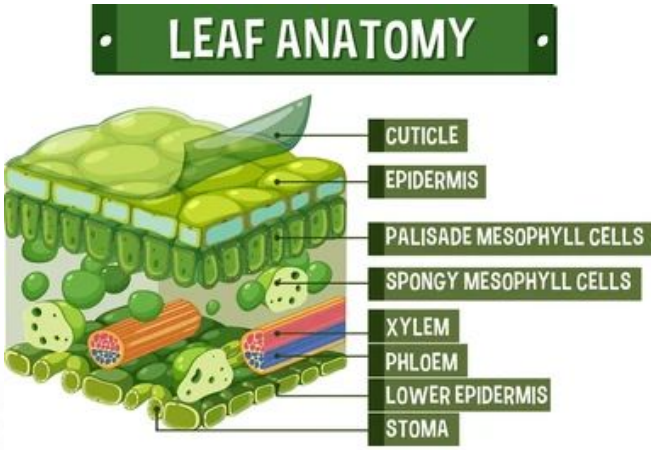
- **Cork Cambium:**
  - **Function:** Produces cork cells, which form the outer bark.
  - **Location:** Develops from the outer layers of the stem or root.



Epidermal Tissue

1. **Definition**:
   The outermost layer of cells that forms a protective covering over plant surfaces.

2. **Structure:**
   - Consists of closely packed cells that form a continuous layer.
   - **Cuticle**: Often covered with a waxy cuticle layer to prevent excessive water loss and protect from environmental stress.
   - **Specialized Cells**: Includes guard cells (for stomata), trichomes (hair-like structures), and root hairs (for absorption).



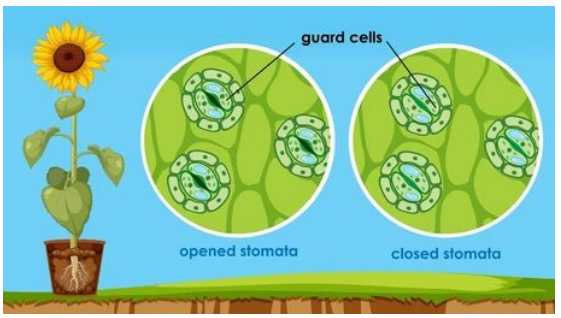
3. **Functions:**
   - **Gas Exchange**: Contains stomata that allow gas exchange (CO_2 in, O_2 out) and regulate water loss.
   - **Water Absorption**: Root epidermis has root hairs that increase surface area for water and mineral absorption.
   - **Regenerative Ability**: Epidermal cells can regenerate to replace damaged areas, maintaining plant health.

Changes in epidermal tissue:

- **Secondary Meristem**: In the stems, the secondary meristem gradually replaces the epidermis with a tougher outer layer.
- **Cork or Bark Formation**: The outer cells develop into multiple layers, forming cork or bark.
- **Cork Cells**: These cells are dead, tightly packed, and lack intercellular spaces, creating a dense barrier.
- **Suberin Content**: Cork cell walls contain suberin, a waxy substance that makes them impermeable to gases and water, providing enhanced protection.

Stomata

- **Definition**:
  - Tiny pores on the surfaces of leaves and stems that enable essential gas exchange.



- **Key Facts:**:
  - **Gas Exchange**: Allow CO_2 to enter for photosynthesis and release O_2 as a byproduct.
  - **Transpiration**: Regulate water loss by releasing water vapor, cooling the plant, and aiding nutrient transport.
  - **Guard Cells**: Surround each stoma and control its opening and closing based on environmental needs.
  - **Role of Potassium Ions (K^+)**: K^+ ions move in and out of guard cells, causing them to swell (open) or shrink (close).
  - **Environmental Response**: Stomata open in light for CO_2 intake and close in dry conditions to conserve water.
  - **Survival Adaptation**: Help plants balance gas exchange with water conservation to thrive in various environments.

Animal Tissues

Epithelial Tissue

Epithelial tissue forms the covering or lining of all internal and external body surfaces. This tissue type serves as a barrier to protect the body and is essential for absorption, secretion, and sensation.

Key Features:

- **Cell Arrangement**: Cells are closely packed, forming a continuous layer.
- **Polarity**: Epithelial cells have an apical surface (facing outward) and a basal surface (attached to underlying tissues).
- **Avascularity**: Lacks its own blood supply; nutrients are obtained from nearby tissues.
- **Regeneration**: Cells regenerate quickly, aiding in tissue repair

Types of Epithelial Tissue:

1. **Simple Epithelium**: Single layer of cells for easy passage of materials.
    - **Simple Squamous**: Thin, flat cells; found in blood vessels and air sacs of lungs.
    - **Simple Cuboidal**: Cube-shaped cells; found in glandular tissues and kidney tubules.
    - **Simple Columnar**: Tall cells; found in digestive tract and uterine tubes.
2. **Stratified Epithelium**: Multiple layers for protection.
    - **Stratified Squamous**: Protects against abrasion; found in skin, mouth, and esophagus.
    - **Stratified Cuboidal**: 2-3 layers; found in sweat and mammary glands.
    - **Stratified Columnar**: Rare; found in large ducts of some glands and parts of the male urethra.
3. **Pseudostratified Epithelium**: Appears multilayered but is a single layer; found in the respiratory tract.
4. **Transitional Epithelium**: Specialized to stretch; found in the urinary bladder.

Functions:

- **Protection**: Barrier against injury, pathogens, and chemicals.
- **Absorption**: Specialized structures enhance absorption.
- **Secretion**: Produces and releases substances like enzymes and hormones.
- **Sensory Reception**: Contains sensory receptors for environmental detection.

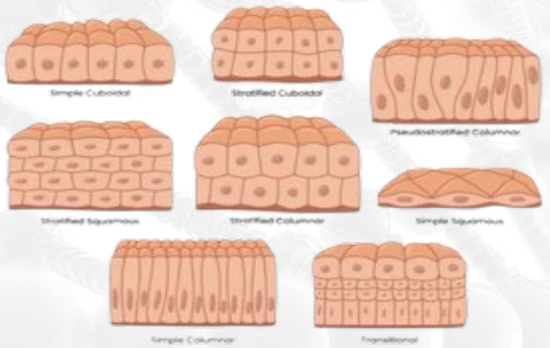
Connective Tissue

Connective tissue is a diverse group of tissues providing structural and functional support to the body, essential for connecting, supporting, and protecting various body parts.

Key Features of Connective Tissue

Composition

- **Cells:**
    - **Fibroblasts:** Produce extracellular matrix (ECM).
    - **Adipocytes:** Store fat.
    - **Macrophages:** Involved in immune response.
- **Extracellular Matrix (ECM):**
    - **Protein Fibres:**
        - **Collagen:** Provides strength.
        - **Elastin:** Provides flexibility.
    - **Ground Substance:** Gel-like substance offering cushioning and support.



Diversity

- **Different Types:**
  - Loose connective tissue
  - Dense connective tissue
  - Cartilage
  - Bone
  - Blood
- **Locations:** Adapted throughout the body for support, protection, and transport.

Functions of Connective Tissue

- **Support and Protection:** Maintains structural integrity and safeguards vital organs.
- **Binding and Connecting:** Connects various tissues and organs, maintaining body structure.
- **Storage:** Stores energy (fat) and minerals (in bone).
- **Transport:** Facilitates movement of nutrients, gases, and waste (via blood).
- **Immune Defence:** Houses immune cells to combat infections.

1. Loose Connective Tissue

- **Characteristics:** Loosely arranged network of fibres and cells; flexible and cushioning.

Areolar Tissue

- **Features:** Collagen and elastin fibres in a gel-like matrix.
- **Functions:** Cushions organs, provides structural support, fills spaces.
- **Location:** Beneath skin, around organs, in mucous membranes.

Adipose Tissue

- **Features:** Composed of adipocytes with minimal ECM.
- **Functions:** Stores energy, provides insulation and cushioning.
- **Location:** Under skin (subcutaneous fat), around organs, in bone marrow.

Reticular Tissue

- **Features:** Contains reticular fibres forming a supportive network.
- **Functions:** Provides structural framework for organs.
- **Location:** Liver, spleen, lymph nodes, bone marrow.

2. Dense Connective Tissue

- **Characteristics:** Tightly packed collagen fibres, strong tensile strength.

Dense Regular Connective Tissue

- **Features:** Collagen fibres aligned parallel.
- **Functions:** Connects muscles to bones (tendons) and bones to bones (ligaments).
- **Location:** Tendons and ligaments.

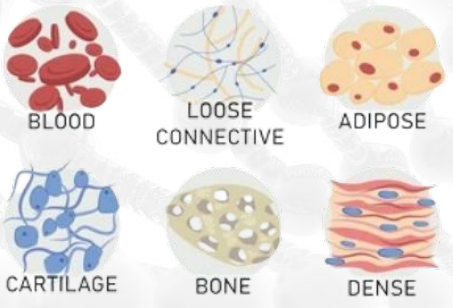
Dense Irregular Connective Tissue

- **Features:** Irregularly arranged collagen fibres.
- **Functions:** Provides structural support, resists stretching.
- **Location:** Dermis of skin, joint capsules, organ capsules.

3. Specialized Connective Tissues

Cartilage

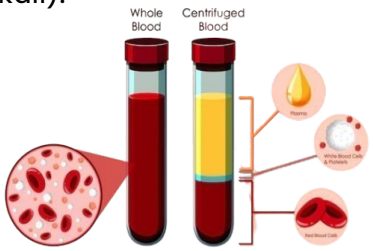
- **Features:** Flexible, semi-rigid tissue with chondrocytes.
- **Functions:** Provides support, cushioning, reduces friction in joints.
- **Types:**
  - **Hyaline Cartilage:**
    - **Features:** Glassy, smooth matrix with invisible collagen fibres.
    - **Functions:** Smooth surfaces for joint movement, supports respiratory structures.
    - **Location:** Ends of long bones, nose, trachea, larynx.



- **Elastic Cartilage:**
  - **Features:** Contains elastic fibres.
  - **Functions:** Provides flexibility and support.
  - **Location:** Ear, epiglottis.
- **Fibrocartilage:**
  - **Features:** Thick bundles of collagen fibres.
  - **Functions:** Strong support, withstands heavy pressure.
  - **Location:** Intervertebral discs, pubic symphysis, menisci of the knee.

Bone

- **Features:** Rigid tissue with collagen and mineral salts (calcium phosphate).
- **Functions:** Structural support, protection, mineral storage, houses bone marrow.
- **Location:** Skeleton (long bones like femur, humerus; short bones like carpals; flat bones like skull).



Blood

- **Features:**
  Fluid connective tissue with cells in liquid matrix (plasma).
- **Functions:**
  Transports nutrients, gases, wastes, and immune cells.
- **Composition:**
  - **Plasma:** Liquid component carrying cells, nutrients, hormones, waste.
  - **Red Blood Cells (RBCs):**
    - **Features:** Biconcave discs, lack nucleus, contain hemoglobin.
    - **Functions:** Transport oxygen and carbon dioxide.
  - **Platelets:**
    - **Features:** Small cell fragments without nuclei.
    - **Functions:** Crucial for blood clotting and wound healing.
  - **White Blood Cells (WBCs):**

    Types:

    - **Neutrophils:** Fight bacterial infections.
    - **Lymphocytes:** Immune responses (B cells, T cells).
    - **Monocytes:** Develop into macrophages.
    - **Eosinophils:** Combat parasites, involved in allergies.
    - **Basophils:** Release histamine, involved in inflammation.

Muscular Tissue

Muscular tissue is essential for movement, characterized by its ability to contract and relax. It plays a crucial role in various bodily functions, from voluntary actions like walking to involuntary processes like digestion.

Key Features

- **Composition:** Made up of specialized cells called muscle fibers, which contain contractile proteins (actin and myosin).
- **Types:** Three main types of muscle tissue: skeletal, cardiac, and smooth.
- **Location:** Distributed throughout the body, with each type located in areas suited to its function.

Types of Muscular Tissue

1. Skeletal Muscle

- **Structure:** Long, cylindrical, multinucleated cells with striations (alternating light and dark bands).
- **Function:** Under voluntary control, facilitating body movements.
- **Location:** Attached to bones via tendons (e.g., biceps, quadriceps).

2. Cardiac Muscle

- **Structure:** Branched, striated cells with a single nucleus and intercalated discs (specialized connections between cells).
- **Function:** Involuntary control, responsible for pumping blood through the heart.
- **Location:** Found only in the heart.

3. Smooth Muscle

- **Structure:** Spindle-shaped cells with a single nucleus and no striations.
- **Function:** Involuntary control, responsible for movements within internal organs.
- **Location:** Walls of internal organs (e.g., intestines, blood vessels).

Functions of Muscular Tissue

Movement	Facilitates body movements and locomotion.
Posture Maintenance	Helps maintain body posture and stability.
Heat Production	Generates heat through muscle contractions, vital for body temperature regulation.
Support	Provides support and protection to organs and joints.

Nervous Tissue

Nervous tissue is crucial for transmitting signals and coordinating activities throughout the body.

Structure

1. Neurons

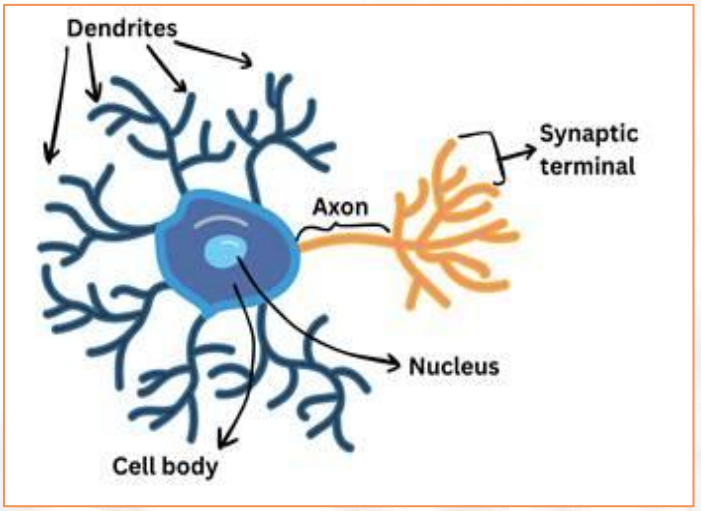
- **Cell Body:** Contains the nucleus and organelles.
- **Dendrites:** Receive signals from other neurons.
- **Axon:** Transmits signals away from the cell body.
- **Axon Terminals:** Release neurotransmitters to communicate with other cells.

2. Neuroglial Cells

- Support and protect neurons, ensuring their proper function.

Function

- **Signal Transmission:** Conducts electrical impulses for communication within the body.
- **Coordination:** Integrates and relays messages between different body parts.



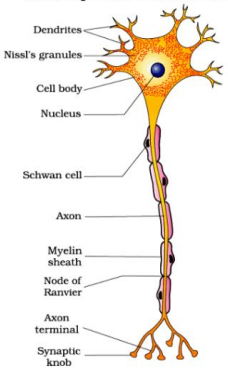
Animal Tissue

Animal Tissues
(Group of cells similar in structure and function)

Nervous tissue
(Receive, conduct & transmit electrical impulse/stimuli)

Found in brain, spinal cord & nerves

Made up of neurons/nerve cells

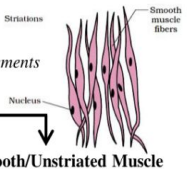


Muscular tissue
(Responsible movements in body, contain contractile proteins which contract and relax to cause movements)

Voluntary Muscle
(Activities are under the control nervous system)
OR
Skeletal Muscle
(Associated with bones)

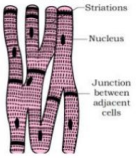
Cells of voluntary tissue are long, cylindrical, unbranched, multinucleate and Striated Muscle
(have striped appearance under microscope i.e. alternate light and dark bands).

Involuntary Muscle
(Responsible involuntary movements in body)



Cardiac Muscle
(Muscles of heart)

Cells of cardiac muscle are cylindrical, branched, uninucleate and striated



Smooth/Unstriated Muscle
(No striation)
OR
Visceral Muscle
(located in the inner walls of hollow visceral organs like alimentary canal, reproductive tract,walls of blodd vessels, ureter, bronchi of lungs, iris etc.)

Cells of smooth muscle are spindle shaped, unbranched, uninucleate

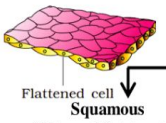
Connective tissue
(Linking and supporting tissues/organs of body)

- **Bone**
  (Strong, non-flexible tissue composed of bone cells & hard matrix of calcium and phosphorus compund)
  → Bone form framework that supports organs & body, anchors muscle
- **Ligament**
  (Elastic tissue with little matrix)
  → Connect bones to bones
- **Tendons**
  (Fibrous tissue with great strength & limited flexibility)
  → Connect muscles to bones
- **Cartilage**
  (Widely spaced cells, composed of proteins and sugars)
  → Smoothens bone surfaces at joints, present in nose, ear, trachea and larynx
- **Areolar connective tissue**
  (Found between skin and muscle, around blood vessels and nerves & in bone marrow)
  → Fills the space inside organs, supports internal organs & helps in repair of tissues.
- **Adipose tissue**
  (Cells of it are filled with fat globules, found below the skin and between internal organs)
  → Stores fats, act as insulator
- **Blood**
  (Transport gases, digested food, hormones & waste materials to different parts of body)
  - Plasma (Fluid matrix)
  - Red Blood Corpuscle
    - Red Blood Corpuscle (RBC)
    - White Blood Corpuscle (WBC)
    - Platelets

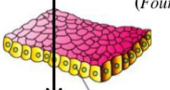
Epithelial tissue
(Protective tissue)

Glandular
(Specialised tissue)
→ Salivary gland

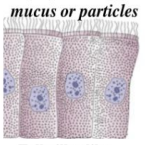
Unilayer



- **Squamous**
  (Thin and flat forming delicate linings of bood vessels, alveoli in lungs, mouth, & oesophagus,)
  → Forms diffusion boundary



- **Cuboidal**
  (Cube shaped, form the linings of renal tubules and ducts of salivary glands where it provide mechanical support)
  → Functions: ***Secretion & absorption***
- **Columnar**
  (Pillar like)
  - **Non-ciliated**
    (Tall cells in the inner linings of stomach & intestine, for secretion & absorption)
  - **Ciliated columnar epithelium**
    (Tall epithelial cells with hair like projections, present inner linings of respiratory tract, genital tract)
    → Functions: ***propulsion of mucus or particles***



Tall pillar like columnar epithelium

Multilayer
→ Stratified Squamous Epithelium
(Found in skin)

4. Life processes

Features of Living Organisms

Living organisms exhibit several defining characteristics that distinguish them from non-living entities.

Key Features

- **Cellular Organization:**
  - All organisms consist of one or more cells, the basic units of structure and function.
  - Multicellular organisms have cells organized into tissues, organs, and systems, while unicellular organisms perform all life processes within a single cell.
- **Metabolism:**
  - Encompasses all chemical reactions necessary to maintain life, including energy production, molecule synthesis, and substance breakdown.
  - Crucial for growth, repair, and overall function.
- **Growth and Development:**
  - Organisms grow and undergo developmental changes throughout their lifespan.
- **Reproduction:**
  - Capable of producing offspring, either sexually or asexually, ensuring species continuity.
- **Response to Stimuli:**
  - Organisms react to external and internal environmental changes.
- **Homeostasis:**
  - The ability to maintain a stable internal environment despite external changes, regulating physiological processes to keep conditions optimal.

Essential Life Processes

1. **Nutrition**
2. **Transportation**
3. **Respiration**
4. **Excretion**
5. **Reproduction**

Nutrition

Types of Nutrition

1. Autotrophic Nutrition

- **Definition:** Organisms that produce their own food.
  - **Photosynthesis:**
    - Utilizes sunlight to convert carbon dioxide and water into glucose and oxygen.
  - **Chemosynthesis:**
    - Uses chemical energy to produce organic compounds, primarily in some bacteria.

2. Heterotrophic Nutrition

- **Definition:** Organisms that obtain food by consuming other organisms, relying on external sources for energy and nutrients.
  - **Holozoic Nutrition:**
    - Involves ingesting and digesting solid food (e.g., humans, animals).
  - **Saprotrophic Nutrition:**
    - Obtains nutrients by decomposing dead organic matter (e.g., fungi, bacteria).
  - **Parasitic Nutrition:**
    - Derives nutrients from living hosts, often harming them (e.g., tapeworms, fleas).
  - **Symbiotic Nutrition:**
    - Organisms live in close association with others, benefiting both (e.g., lichens, nitrogen-fixing bacteria).

Holozoic

Saprophytic

Parasitic

Symbiotic

Photosynthesis

Definition

Photosynthesis is the process by which green plants, algae, and some bacteria convert light energy into chemical energy, producing glucose and oxygen from carbon dioxide and water.

General Equation

$6CO_2+6H_2O+\text{light energy}\rightarrow C_6H_{12}O_6+6O_2$

Stages

1. Light-Dependent Reactions

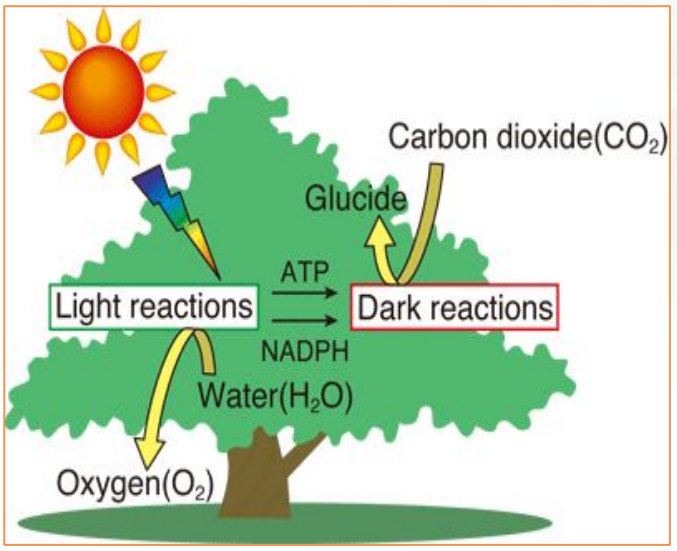
- **Location:** Thylakoid membranes of chloroplasts.
- **Purpose:** Convert light energy into chemical energy (ATP and NADPH).
  - **Process:**
    - Absorption of light by chlorophyll.
    - Splitting of water molecules (photolysis) to release oxygen.
    - Production of ATP and NADPH.

2. Calvin Cycle (Light-Independent Reactions)

- **Location:** Stroma of the chloroplasts.
- **Overview:** Uses ATP and NADPH from light-dependent reactions to convert carbon dioxide into glucose.
  - **Process:**
    - **Carbon Fixation:** CO_2 is fixed into a 5-carbon compound (RuBP) by the enzyme RuBisCO, forming a 6-carbon molecule that splits into two 3-carbon molecules.
    - **Reduction:** ATP and NADPH convert these 3-carbon molecules into glyceraldehyde-3-phosphate (G3P), a sugar.
    - **Regeneration:** Some G3P regenerates RuBP; others synthesize glucose and carbohydrates.

Importance

- **Energy Source:** Primary energy source for nearly all life forms.
- **Oxygen Production:** Releases oxygen essential for respiration in aerobic organisms.



Digestion In Human Beings

Digestion Overview

Digestion is the process of breaking down food into smaller molecules that can be absorbed and utilized by the body. It involves both mechanical and chemical processes throughout the digestive tract.

Buccal Cavity (Mouth)

Teeth

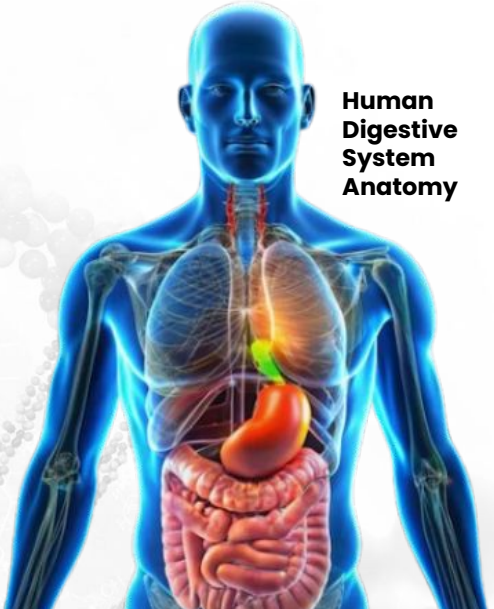
- **Structure:**
  - **Incisors:** Sharp-edged teeth for cutting.
  - **Canines:** Pointed teeth for tearing.
  - **Premolars:** Flat-topped teeth for grinding.
  - **Molars:** Larger, flat-topped teeth for crushing.
- **Set of Teeth:**
  - **Child:** 20 primary (milk) teeth.

    Dental Formula: 2I1C2M | 2I1C2M
  - **Adult:** 32 permanent teeth.

    Dental Formula: 2I1C2P3M | 2I1C2P3M

Salivary Glands

- **Position:**
  - **Parotid Glands:** Near the ear, behind the jaw.
  - **Submandibular Glands:** Under the jaw.
  - **Sublingual Glands:** Beneath the tongue.



Human Digestive System Anatomy

Tongue

- **Papillae:** Small structures containing taste buds.
- **Function:** Tasting, mixing food with saliva, and forming the bolus.

Salivary Enzymes

- **Salivary Amylase:**
  - **Function:** Begins starch digestion by breaking it down into simpler sugars.
- **Lysozyme:**
  - **Function:** Anti-bacterial agent.

Functions of the Mouth

- **Mastication:** Chewing food into smaller pieces.
- **Initial Digestion:** Salivary amylase starts carbohydrate digestion.
- **Formation of Bolus:** Food mixed with saliva into a smooth ball for swallowing.

Oesophagus

Structure

- A muscular tube about 25 cm long connecting the pharynx to the stomach.
- **Epiglottis:** Flap covering the trachea during swallowing to prevent food entry.
- **Gastro-oesophageal Sphincter:** Controls food entry into the stomach.

Function

- **Transport:** Moves food from the mouth to the stomach.
- **Peristalsis:** Wave-like muscle contractions push food down.

Stomach

Regions

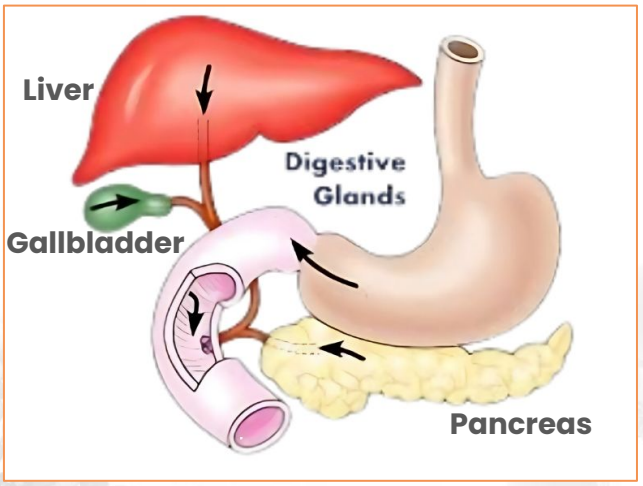
- **Cardia:** Where the oesophagus connects to the stomach.
- **Fundus:** Upper portion, often filled with gas.
- **Body:** Central part of the stomach.
- **Pylorus:** Connects to the duodenum.

Process inside stomach:

- **Gastric Glands**: Located in the mucosa, they secrete hydrochloric acid (HCl) to maintain an acidic pH (1.5 to 3.5). This acidic environment is essential for digestion and activating enzymes.
- **Function of Peptidase**:
  - **Peptidase, Pepsin and renin (Proteolytic Enzymes)**: Breaks down proteins into smaller peptides and this digestion is incomplete and continued in small intestine.

Proteins+H_2O $\xrightarrow{pepsin}$ =peptides + smaller peptides

- **Function of HCl**:
  - Peptidase, Pepsin and renin (Proteolytic Enzymes) requires acidic pH to function correctly.
  - HCl helps in killing any pathogenic agent which might have entered our system with food.
- **Chyme Formation**:
  - **Chyme**: The semi-liquid mixture of food and digestive juices formed in the stomach.
- **Exits to Duodenum**:
  - **Pyloric Sphincter**: Controls the passage of chyme from the stomach to the duodenum (the first part of the small intestine).



Layers of Stomach:

The stomach has four main layers:

1. **Inner lining (Mucosa)** - This is where the stomach juices are made to digest food. It is covered by a thick layer of mucus.
2. **Support layer (Submucosa)** - It holds blood vessels and nerves that help the stomach work.
3. **Muscle layer (Muscularis)** - These muscles squeeze and mix food around.
4. **Outer cover (Serosa)** - A thin outer layer that protects the stomach.

Digestive glands:

- **Liver**: The largest gland in the body, responsible for producing bile.
  - **Bile**: Contains bile salts, which help emulsify fats, breaking them down into smaller droplets. This process increases the surface area for the action of lipase (fat-digesting enzyme).
- **Gallbladder**: Stores and concentrates bile produced by the liver. Bile is released into the duodenum through the bile duct when fatty food enters the small intestine.
- **Pancreas**:
  - **Pancreatic Juice**: Secreted by the pancreas into the duodenum; contains enzymes like pancreatic amylase (digests carbohydrates), trypsin and chymotrypsin (digest proteins), and pancreatic lipase (digests fats). It also contains bicarbonate ions that neutralize the acidic chyme from the stomach, providing an alkaline environment for enzyme action.

Digestive Processes and Enzyme Functions in the Stomach and Small Intestine

Acid Secreted	
Gastric Glands	Secrete hydrochloric acid (HCl) for digestion and enzyme activation.
Functions	
Peptidase (Pepsin)	Breaks down proteins into smaller peptides.
HCl	Activates enzymes and kills pathogens.
Chyme Formation	
Chyme	Semi-liquid mixture of food and digestive juices formed in the stomach.
Exit to Duodenum	
Pyloric Sphincter	Controls chyme passage to the duodenum.

Action of Digestive Glands and Small Intestine

Digestive Glands	
Liver	Produces bile for fat emulsification.
Gallbladder	Stores and releases bile into the duodenum.
Pancreas	
Pancreatic Juice	Contains digestive enzymes and bicarbonate to neutralize chyme.
Enzymatic Reactions	
Carbohydrates	Maltose → Glucose + Glucose Sucrose → Glucose + Fructose Lactose → Glucose + Galactose
Proteins	Proteins → Peptides + Amino Acids (by trypsin and chymotrypsin)
Fats	Triglycerides → Fatty Acids + Monoglyceride (by lipase)

Small Intestine

Structure

- Divided into three parts: duodenum, jejunum, and ileum.

Duodenum

- **Mixing of Bile and Pancreatic Juice:** Combines bile and pancreatic enzymes with chyme.
- **Formation of Chyle:** Resulting milky fluid rich in fatty acids and glycerol.

Jejunum

- **Function:** Primarily absorbs nutrients, has a highly folded inner surface for efficiency.

Ileum

- **Function:** Absorbs vitamin B12, bile salts, and remaining nutrients.

Processes in the Small Intestine

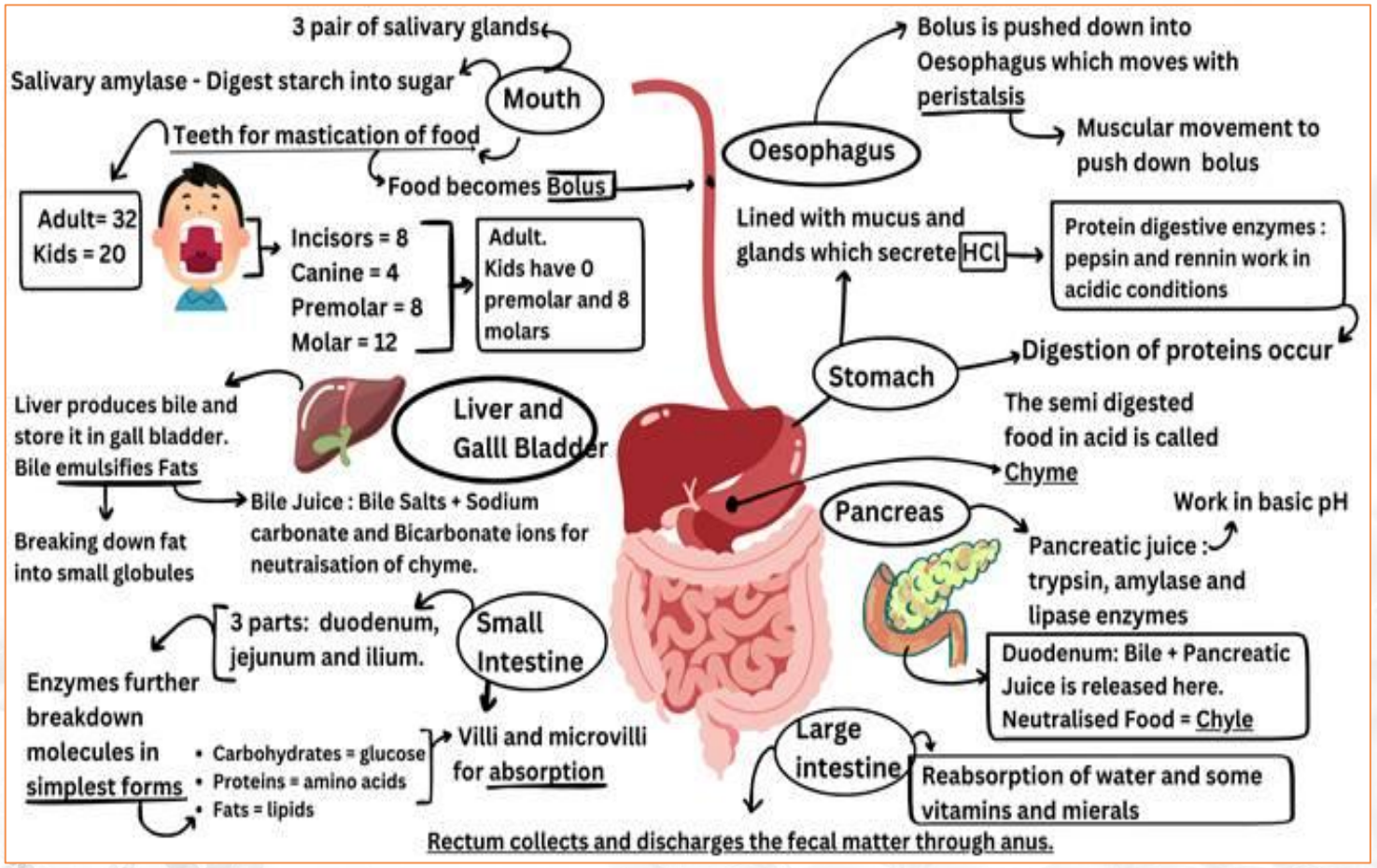
- **Digestion of Biomolecules:** Carbohydrates, proteins, and fats are further broken down.
- **Absorption by Villi and Microvilli:** Finger-like projections enhance nutrient absorption into the bloodstream or lymphatic system.

Large Intestine: Function

Absorbs water and electrolytes, compacting undigested food into faeces.

Parts

- **Caecum:** Beginning of the large intestine; connects to the ileum.
- **Colon:** Longest section, divided into:
  - **Ascending Colon**
  - **Transverse Colon**
  - **Descending Colon**
  - **Sigmoid Colon**
- **Rectum:** Temporary storage for faeces.
- **Anus:** Terminal end where faeces are excreted, controlled by sphincters.



Transportation

Transportation in Living Organisms

Importance of Transportation

- **Homeostasis**: Essential for survival, growth, and function.
- **Adaptation**: Helps organisms adjust to their environment.
- **Physiological Processes**: Supports vital functions.

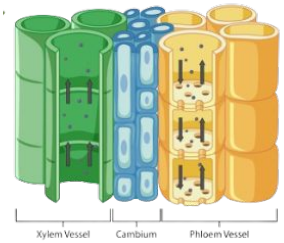
Transportation in Plants

External Transportation

- **Water and Nutrients**:
  - Absorbed through roots.
  - Transported via vascular tissues (xylem and phloem).
- **Nutrients**:
  - Includes essential minerals and organic compounds for growth and development.

Internal Transportation

- **Xylem**:
  - Transports water and dissolved minerals from roots to other parts of the plant.
- **Phloem**:
  - Carries products of photosynthesis (mainly sugars) from leaves to other parts for use or storage.



Transpiration

- **Definition**: Movement of water from soil, through the plant, into the atmosphere as vapor.

Functions

- **Cooling**: Prevents overheating of the plant.
- **Nutrient Transport**: Facilitates upward movement of dissolved nutrients.
- **Water Regulation**: Balances internal water levels.

Types

- **Stomatal Transpiration**: Water vapor exits through stomata; regulated by guard cells.
- **Cuticular Transpiration**: Water vapor escapes through the cuticle layer.
- **Lenticellular Transpiration**: Occurs through lenticels in woody plants.

Factors Affecting Transpiration

- **Temperature**: Higher temperatures increase rate.
- **Humidity**: Lower humidity speeds up transpiration.
- **Wind**: Enhances rate by removing water vapor.
- **Light**: Stimulates stomatal opening, increasing transpiration.
- **Soil Moisture**: Adequate moisture is essential.

Importance

- **Water Cycle**: Contributes to atmospheric water vapor.
- **Plant Health**: Regulates temperature and nutrient uptake.

Guttation

- **Definition**: Expulsion of liquid water from leaf tips or edges.

Mechanisms

- **Hydathodes**: Specialized structures that release excess water.
- **Root Pressure**: Increased pressure in xylem pushes water out.

Conditions Favoring Guttation

- **High Soil Moisture**: Excess water increases root pressure.
- **High Humidity**: Limits water vapor loss.
- **Cool Nights**: Reduces transpiration rates, causing accumulation.

Examples

- Common in grasses, herbs, and certain fruit plants.

Importance

- **Water Regulation**: Maintains internal water balance.
- **Nutrient Excretion**: Removes excess minerals and nutrients.

Transportation in Animals

External Transportation

- **Locomotion and Movement**:
  - Movement of the entire organism (walking, swimming, flying).
  - Involves muscular and nervous systems.

Internal Transportation

- **Blood Circulation**:
  - Movement of blood through a network of vessels, driven by the heart.
  - Distributes oxygen, nutrients, hormones, and waste products.
- **Circulatory System**:
  - Comprises the heart, blood, and blood vessels (arteries, veins, capillaries).
  - Ensures all cells receive necessary substances and efficiently removes waste.

Overview of Plant Transportation

Purpose

- Transport water, minerals, and nutrients throughout the plant.

Main Systems

- **Xylem**: Transports water and minerals.
- **Phloem**: Transports nutrients.

Xylem

Function: Transports water and dissolved minerals from roots.

Structure

- **Tracheids**: Long, thin cells with tapered ends for water movement.
- **Vessel Elements**: Shorter, wider cells with perforation plates for efficient flow.

Process

- **Root Uptake**: Water absorbed from soil via root hairs.
- **Capillary Action**: Water moves through xylem due to cohesion and adhesion.
- **Transpiration Pull**: Evaporation creates negative pressure, pulling water up.

Phloem

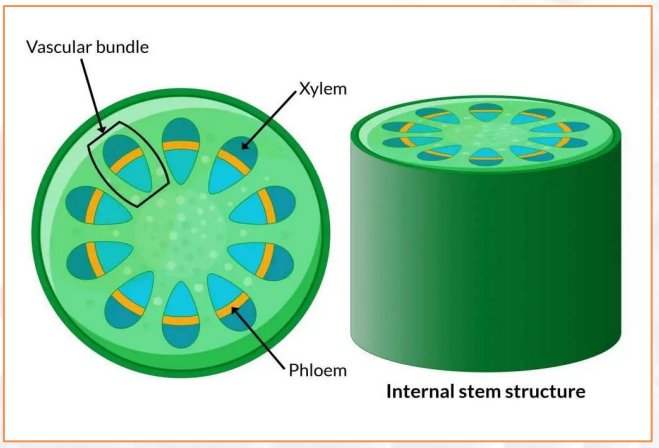
- **Function**: Transports organic nutrients (mainly sugars) from leaves.

Structure

- **Sieve Tube Elements**: Tube-like cells with perforated ends for nutrient transport.
- **Companion Cells**: Support sieve tubes by managing metabolic functions.

Process

- **Source to Sink**: Nutrients are transported from photosynthesis sites to growth or storage sites via active transport.



Mineral Absorption In Plants

Mineral Uptake in Plants

1. Mineral Uptake

- **Location**: Roots absorb minerals from the soil solution.

Process

- **Active Transport**:
  - Minerals are absorbed against the concentration gradient using energy (ATP).
- **Root Hairs**:
  - Increase surface area for absorption, enhancing mineral uptake.

2. Types of Mineral Absorption

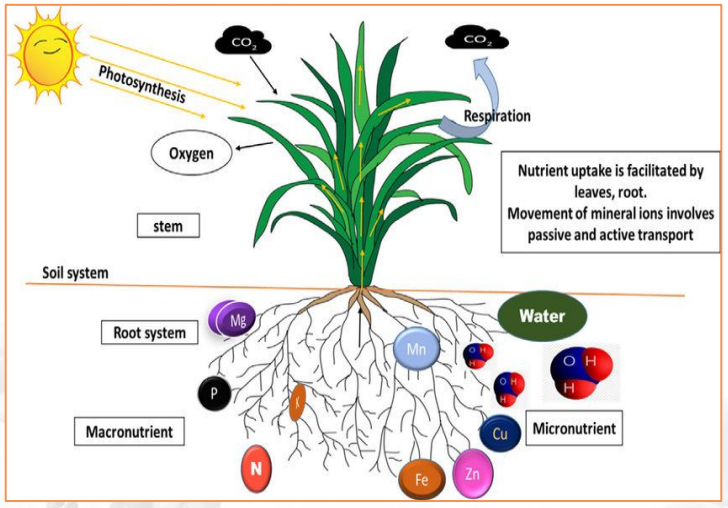
- **Essential Nutrients**:
  - Required in varying amounts for plant growth (e.g., Nitrogen, Phosphorus, Potassium).
- **Micronutrients**:
  - Needed in smaller quantities but are crucial (e.g., Iron, Manganese, Zinc).

3. Mechanisms

- **Ion Exchange**:
  - Roots release hydrogen ions (H^+) into the soil, which exchange with mineral ions (e.g., potassium, calcium).
- **Symbiosis**:
  - Mycorrhizal fungi form associations with plant roots to enhance nutrient uptake.

4. Transport to Xylem

- **In Root Cells**:
  - Minerals move from root cells to xylem vessels for distribution throughout the plant.



5. Role in Plant Health

- **Growth**:
  - Minerals are vital for various physiological processes, including enzyme activation, photosynthesis, and energy transfer.

Nutrient	Symbol	Role	Sources
Nitrogen	N	Protein synthesis, chlorophyll	Soil, manure, fertilizers
Phosphorus	P	Root development, energy transfer	Soil, phosphate fertilizers
Potassium	K	Water regulation, enzyme activation	Soil, potash, fertilizers
Calcium	Ca	Cell wall structure, signaling	Soil, lime, gypsum
Magnesium	Mg	Chlorophyll production, enzyme function	Soil, magnesium sulfate
Iron	Fe	Chlorophyll synthesis	Soil, iron chelates
Copper	Cu	Enzyme activation, photosynthesis	Soil, copper sulfate

Human Skeletal System

Overview of the Human Skeletal System

The human skeletal system provides structural support, protects vital organs, facilitates movement, stores minerals, and houses bone marrow for blood cell production. It consists of bones, cartilage, ligaments, and tendons.

Components

1. Bones

- **Definition**: Rigid structures forming the skeleton.
- **Total**: Adult human skeleton typically has 206 bones, categorized into two main groups:

a. Axial Skeleton

- **Function**: Supports the head, neck, and trunk; protects the brain, spinal cord, and thoracic organs.
- **Major Parts**:
  - **Skull**:
    - Cranium (e.g., frontal bone, parietal bones, occipital bone)
    - Facial bones (e.g., maxilla, mandible)
  - **Vertebral Column**:
    - 33 vertebrae divided into:
      - Cervical (7)
      - Thoracic (12)
      - Lumbar (5)
      - Sacral (5, fused)
      - Coccygeal (4, fused)

  - **Hyoid bone:**
    - U shaped bone located under base of oral pallet (tongue).
    - The primary function of the hyoid bone is to serve as an attachment structure for the tongue and for muscles in the floor of the oral cavity.
  - **Auditory bones (Inside ear):**
    - 3 small bones - Mallus, incus and Stapes.
    - Helps in hearing.
  - **Rib Cage**:
    - 12 pairs of ribs and the sternum, protecting the heart and lungs.

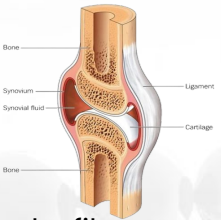
b. Appendicular Skeleton

- **Function**: Includes the limbs and girdles attaching them to the axial skeleton.
- **Major Parts**:
  - **Shoulder Girdle**: Clavicles (collarbones) and scapulae (shoulder blades).
  - **Upper Limbs**:
    - Humerus (upper arm)
    - Radius and ulna (forearm)
    - Carpals (wrist bones)
    - Metacarpals (hand bones)
    - Phalanges (fingers)
- **Upper Limbs**:
  - Humerus (upper arm)
  - Radius and ulna (forearm)
  - Carpals (wrist bones)
  - Metacarpals (hand bones)
  - Phalanges (fingers)
- **Pelvic Girdle**: Hip bones (ilium, ischium, and pubis) connecting the spine to the legs.
- **Lower Limbs**:
  - Femur (thigh bone)
  - Patella (kneecap)
  - Tibia and fibula (shin bones)
  - Tarsals (ankle bones)
  - Metatarsals (foot bones)
  - Phalanges (toes)

2. Cartilage

- **Definition**: Flexible connective tissue found at various sites.
- **Locations**:
  - **Joints**: Provides cushioning and reduces friction (e.g., knee, hip).
  - **Ears and Nose**: Maintains shape and flexibility.
  - **Costal Cartilage**: Connects ribs to the sternum, aiding in breathing.

3. Ligaments



- **Definition**: Tough, fibrous connective tissues connecting bones to other bones.
- **Function**: Provide stability to joints by limiting excessive movement.

4. Tendons

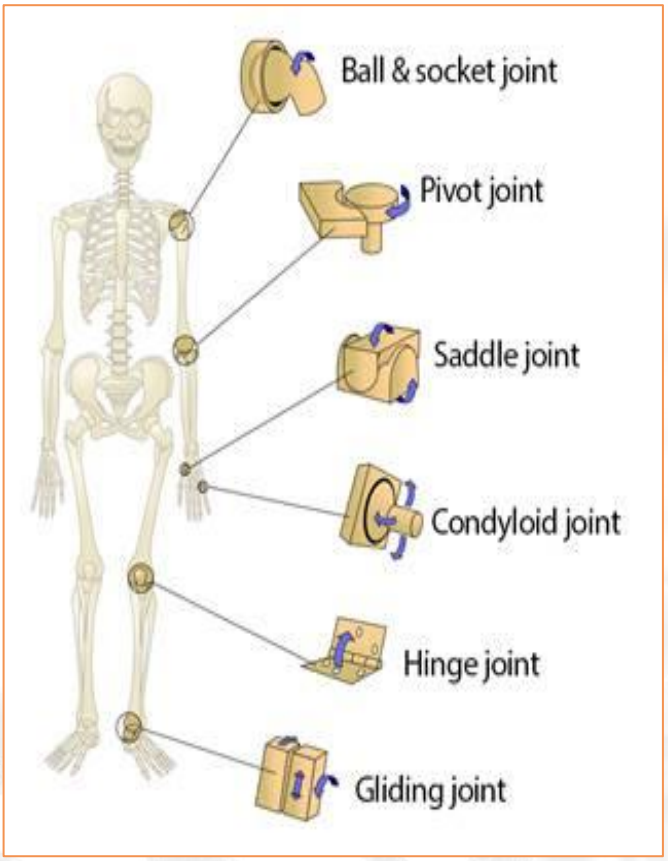
- **Definition**: Strong, flexible connective tissues connecting muscles to bones.
- **Function**: Transmit force from muscles to bones to facilitate movement.

Joints

- **Definition**: Locations where two or more bones meet, allowing movement and flexibility.
- **Types**:
  - **Hinge Joints**:
    - **Location**: Elbows, knees.
    - **Movement**: Allows movement in one plane (flexion and extension).
  - **Ball-and-Socket Joints**:
    - **Location**: Shoulders, hips.
    - **Movement**: Allows for a wide range of movements in multiple planes (flexion, extension, abduction, adduction, rotation).
  - **Pivot Joints**:
    - **Location**: Atlas and axis vertebrae (neck), radioulnar joint (forearm).
    - **Movement**: Allows rotation around a single axis.
  - **Saddle Joints**:
    - **Location**: Thumb (carpometacarpal joint).
    - **Movement**: Allows for movement in two planes (flexion, extension, abduction, adduction).
  - **Condyloid (Ellipsoid) Joints**:
    - **Location**: Wrist (radiocarpal joint), base of fingers.
    - **Movement**: Allows for movement in two planes (flexion, extension, circumduction).
  - **Gliding (Plane) Joints**:
    - **Location**: Between carpal bones (wrist), tarsal bones (ankle).
    - **Movement**: Allows for sliding or gliding movements between bones.

Functions of the Skeletal System

1. **Support**:
   - Provides a rigid framework that supports the body's structure and maintains posture.
2. **Protection**:
   - Shields internal organs such as the brain, heart, and lungs from physical damage.
3. **Movement**:
   - Works with muscles to facilitate movement and mobility.
4. **Mineral Storage**:
   - Stores essential minerals like calcium and phosphorus, which can be released into the bloodstream as needed.
5. **Blood Cell Production**:
   - Houses bone marrow, where red blood cells, white blood cells, and platelets are produced.



Muscle Fiber

- **Definition**: Individual contractile units within a muscle, also known as muscle cells or myocytes.

Structure

- **Characteristics**:
  - Long, cylindrical cells with multiple nuclei at the periphery.
  - Contains myofibrils, which are thread-like structures extending the length of the fiber.

Types

- **Type I (Slow-Twitch)**:
  - High endurance, suited for prolonged activities.
- **Type II (Fast-Twitch)**:
  - Rapid, powerful contractions, suited for short bursts of activity.

Sarcomere

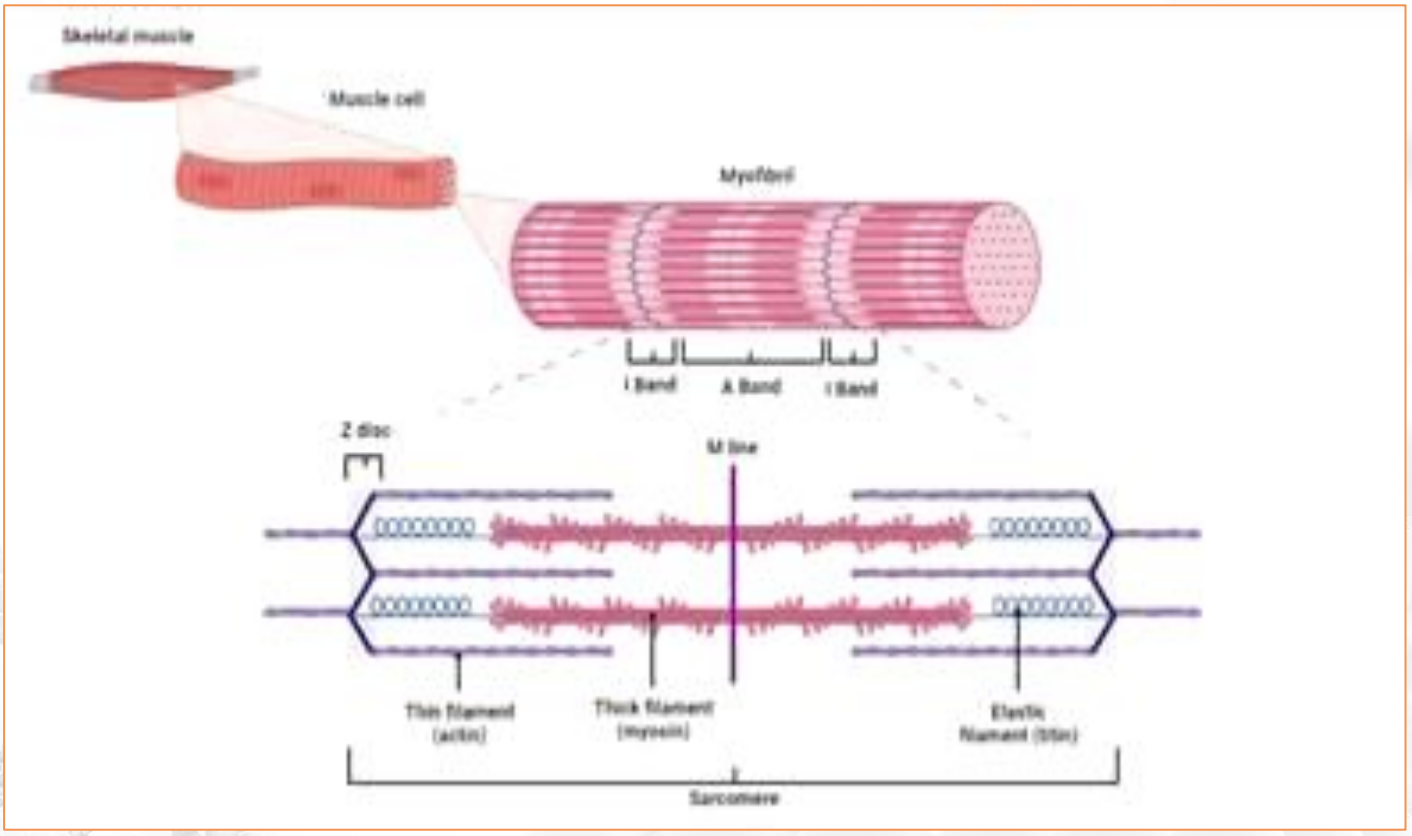
- **Definition**: The smallest functional unit of a muscle fiber, responsible for muscle contraction.

Structure

- **Characteristics**:
  - Defined between two Z-lines (or Z-discs) that anchor thin filaments.
  - Composed of overlapping thick (myosin) and thin (actin) filaments.
- **Regulatory Proteins**:
  - **Tropomyosin**: Blocks actin binding sites.
  - **Troponin**: Binds calcium ions and regulates the actin-myosin interaction.

Function

- **Mechanism**:
  - Sarcomeres contract by the sliding of actin and myosin filaments past each other.
  - Shortening of the sarcomere leads to muscle contraction.
  - The process involves cross-bridge cycling of myosin heads with actin.

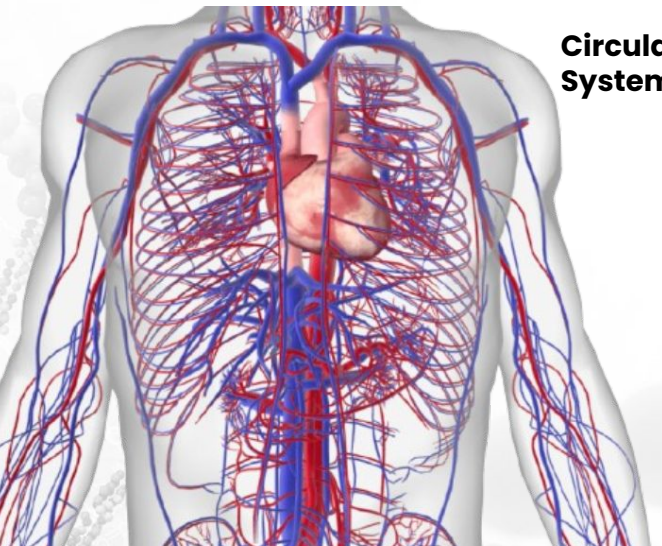


Human Circulatory System

- **Definition**: Essential for transporting nutrients, oxygen, and waste products throughout the body.
- **Components**:
  - **Heart**: Pumps blood.
  - **Blood Vessels**: Arteries, veins, and capillaries.
  - **Blood**: Fluid containing various cells and components.
- **Hemoglobin and Blood Components**
- **Hemoglobin**
- **Function**: Crucial protein in red blood cells for oxygen transport.
- **Structure**:
  - Composed of four globin proteins.
  - Each globin is bound to an iron-containing heme group.
  - Iron is in the Fe^{2+} state, enabling oxygen binding.
- **Gas Affinities**:
  - Highest for carbon monoxide (CO).
  - Moderate for oxygen (O_2).
  - Lowest for carbon dioxide (CO_2).

Blood Components

- **Red Blood Cells (Erythrocytes)**: Transport oxygen and carbon dioxide.
- **White Blood Cells (Leukocytes)**: Play a role in immune response.
- **Platelets (Thrombocytes)**: Involved in blood clotting.
- **Plasma**: Liquid component that carries nutrients, hormones, and waste products.
- **Role of Blood**
- Transports oxygen, nutrients, hormones, and waste products.
- Regulates body temperature and pH balance.
- Provides immune defense.



Circulatory System

Blood Groups and Coagulation

ABO Blood Group System

- **Discovery**: Identified by Karl Landsteiner.
- **Types**:
  - **Type A**: A antigens present.
  - **Type B**: B antigens present.
  - **Type AB**: Both A and B antigens (universal recipient).
  - **Type O**: Neither A nor B antigens (universal donor).

Rh Factor

- **Discovery**: Identified in Rhesus monkeys.
- **Definition**: Presence (+) or absence (-) of the Rh antigen (specifically the D antigen) on red blood cells.
- **Rh Incompatibility**: Can occur during childbirth if an Rh-negative mother carries an Rh-positive baby, leading to hemolytic disease of the newborn (HDN).

Coagulation

- **Definition**: Process by which blood forms clots to prevent excessive bleeding.
- **Importance**: Crucial for wound healing and used in blood typing tests.

Table of blood groups.-

Blood Group	Antigen	Antibody	Donor	Recipient
A	A	Anti-B	A, O	A, AB
B	B	Anti-A	B, O	B, AB
AB	A, B	None	A, B, AB, O	AB
O	None	Anti-A, Anti-B	O	O

Blood Vessels

Types of Blood Vessels

- **Arteries**:
  - Function: Carry blood away from the heart.
  - Characteristics: Thick, elastic walls.
- **Veins**:
  - Function: Carry blood toward the heart.
  - Characteristics: Thinner walls; contain valves to prevent backflow.
- **Capillaries**:
  - Function: Microscopic vessels where the exchange of gases, nutrients, and waste occurs.
  - Location: Between blood and tissues.

Feature	Arteries	Veins	Capillaries
Wall Thickness	Thick and muscular	Thin	Very thin
Lumen Size	Narrow	Wide	Extremely narrow
Valves	Absent	Present	Absent
Function	Carry blood away from heart	Carry blood to heart	Exchange of materials

Heart and Circulation

Types of Hearts in Chordates

- **Two-Chambered Heart**: Found in fish.
- **Three-Chambered Heart**: Found in amphibians and reptiles (except crocodiles).
- **Four-Chambered Heart**: Found in birds, mammals, and crocodiles, including humans.

Structure of Human Heart

- **Four-Chambered Organ**:
  - **Right Atrium**: Receives deoxygenated blood from the body via the superior and inferior vena cava.
  - **Right Ventricle**: Pumps deoxygenated blood to the lungs via the pulmonary artery.
  - **Left Atrium**: Receives oxygenated blood from the lungs via the pulmonary veins.
  - **Left Ventricle**: Pumps oxygenated blood to the body via the aorta.
- **Heart Valves**:
  - **Tricuspid Valve**:
    - Function: Prevents backflow from right ventricle to right atrium.
    - Location: Between the right atrium and right ventricle.
  - **Pulmonary Valve**:
    - Function: Prevents backflow from pulmonary artery to right ventricle.
    - Location: Between right ventricle and pulmonary artery.
  - **Mitral Valve (Bicuspid Valve)**:
    - Function: Prevents backflow from left ventricle to left atrium.
    - Location: Between left atrium and left ventricle.
  - **Aortic Valve**:
    - Function: Prevents backflow from aorta to left ventricle.
    - Location: Between left ventricle and aorta.

Double Circulation

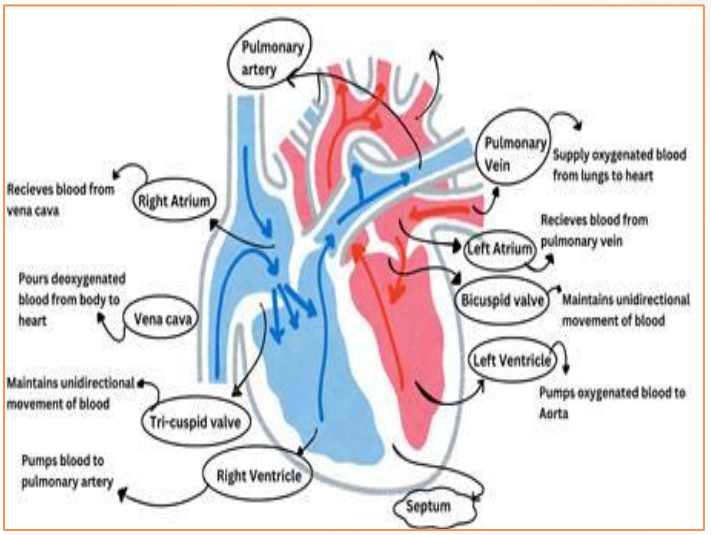
- **Pulmonary Circulation**:
  - Deoxygenated blood from the body enters the right atrium → right ventricle → pulmonary artery → lungs (oxygenated) → pulmonary veins → left atrium.
- **Systemic Circulation**:
  - Oxygenated blood from left atrium → left ventricle → aorta → distributed to the body → returns deoxygenated blood to the right atrium via systemic veins.

Pumping of Blood and Circulation

1. **Blood Returns to the Heart**:
   - **Deoxygenated Blood**:
     - Superior Vena Cava: Drains blood from the upper body.
     - Inferior Vena Cava: Drains blood from the lower body.
   - **Oxygenated Blood**: Returns from the lungs to the left atrium via pulmonary veins.
2. **Atrial Contraction (Atrial Systole)**:
   - SA node sends an electrical signal causing atrial contraction.
   - Right Atrium: Pushes deoxygenated blood through the tricuspid valve into the right ventricle.
   - Left Atrium: Pushes oxygenated blood through the mitral valve into the left ventricle.
3. **Ventricular Filling**:
   - Ventricles are relaxed, filling with blood from atria:
     - Right Ventricle: Fills with deoxygenated blood.
     - Left Ventricle: Fills with oxygenated blood.
4. **Ventricular Contraction (Ventricular Systole)**:
   - AV node triggers contraction in both ventricles.
   - **Right Ventricle**: Pumps blood through the pulmonary valve into the pulmonary artery.
   - **Left Ventricle**: Pumps blood through the aortic valve into the aorta.
5. **Blood Flow to Lungs and Body**:
   - **Pulmonary Circulation**: Deoxygenated blood travels to lungs, oxygenated blood returns to left atrium.
   - **Systemic Circulation**: Oxygenated blood from left ventricle to the body, delivering oxygen and nutrients.
6. **Diastole: Ventricular Relaxation and Filling**:
   - After contraction, ventricles relax, pressure falls.
   - Semilunar valves close to prevent backflow.
   - AV valves open, allowing blood flow from atria into ventricles.

Key Points in Heart Pumping and Circulation

- **Contraction (Systole)**: Atria and ventricles contract to push blood forward.
- **Relaxation (Diastole)**: Atria and ventricles relax, filling with blood.
- **Valves**: Ensure unidirectional blood flow and prevent backflow (AV valves: tricuspid and mitral; semilunar valves: pulmonary and aortic).



Important Blood Vessels/Circulations

- **Coronary Arteries**: Supply blood to the heart muscle.
- **Hepatic Vessels**: Involved in the circulation of blood to and from the liver.
- **Renal Vessels**: Supply blood to the kidneys for filtration.
- **Pulmonary Vessels**: Involved in the exchange of gases between the heart and lungs.

Myogenic Heart

Definition: The human heart is myogenic, meaning it generates its own electrical impulses for contraction, primarily from the sinoatrial (SA) node (the pacemaker).

Cardiac Cycle

The cardiac cycle involves rhythmic contraction (systole) and relaxation (diastole) of the heart. The sequence includes:

1. **Atrial Systole**
   - **Description**: Atria contract, pushing blood into the ventricles.
   - **Process**:
     - SA node generates an electrical impulse, causing atrial contraction.
     - Blood is pushed through open AV valves into the ventricles.
     - Semilunar valves remain closed.
2. **Ventricular Systole**
   - **Description**: Ventricles contract, ejecting blood into the pulmonary artery and aorta.
   - **Process**:
     - Impulse travels to the AV node, then down the bundle of His and Purkinje fibres.
     - Increased pressure causes AV valves to close, producing the "lubb" sound.
     - Semilunar valves open as ventricular pressure exceeds arterial pressure, allowing blood to exit.
3. **Ventricular Diastole**
   - **Description**: Ventricles relax, allowing them to fill with blood.
   - **Process**:
     - After ejection, ventricles relax, and pressure falls.
     - Semilunar valves close, producing the "dub" sound.
     - Initially closed AV valves open as ventricular pressure drops below atrial pressure.
4. **Atrial Diastole**
   - **Description**: Atria relax and fill with blood from veins.
   - **Process**:
     - Atria fill passively during ventricular systole and diastole from superior/inferior vena cava and pulmonary veins.
5. **Ventricular Filling**
   - **Description**: Blood flows passively from atria to ventricles.
   - **Process**:
     - AV valves are open, allowing blood flow.
     - Marks the end of one cardiac cycle and the beginning of the next.

Cardiac Output

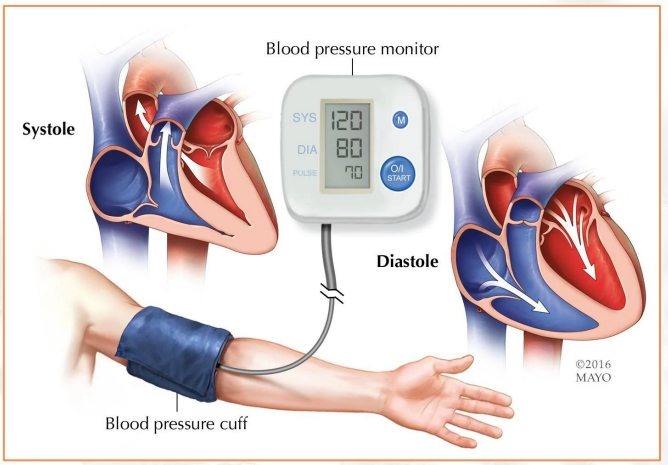
- **Definition**: The volume of blood the heart pumps per minute.
- **Calculation**: Product of heart rate and stroke volume.
- **Normal Value**: Approximately 5-6 litres per minute.

Understanding Heart Sounds

- **"Lubb" (First Heart Sound)**: Closure of AV valves (tricuspid and mitral) at the start of ventricular systole.
- **"Dubb" (Second Heart Sound)**: Closure of semilunar valves (aortic and pulmonary) at the start of ventricular diastole.

Blood Pressure

- **Normal Blood Pressure**: 120/80 mmHg (systolic/diastolic).
- **Hypertension**: High blood pressure, which can lead to heart disease.
- **Hypotension**: Low blood pressure, which can cause dizziness and fainting.



Respiration : An Integrated Process

Respiration is a vital biological process that integrates digestion and energy production, involving the breakdown of nutrients to produce energy essential for life.

Cellular Respiration

- **Definition**: A series of metabolic processes that occur inside cells.
- **Location**: Primarily in the mitochondria.

Stages:

1. **Glycolysis**:
   - Breaks down glucose into pyruvate in the cytoplasm.
2. **Krebs Cycle (Citric Acid Cycle)**:
   - Processes pyruvate into carbon dioxide and high-energy molecules (NADH, FADH2) in the mitochondria.
3. **Electron Transport Chain**:
   - Uses high-energy molecules to produce ATP (adenosine triphosphate), the main energy currency of the cell.

Energy Production

- **ATP Generation**: ATP is produced through cellular respiration and used for various cellular activities, including:
  - Muscle contraction.
  - Synthesis of molecules.
  - Maintaining cell structure.

Waste Removal

- **Byproducts**: Carbon dioxide and water are produced during respiration.
- **Carbon Dioxide Transport**: CO_2 is transported back to the lungs via the bloodstream and expelled during exhalation.

Integration of Processes

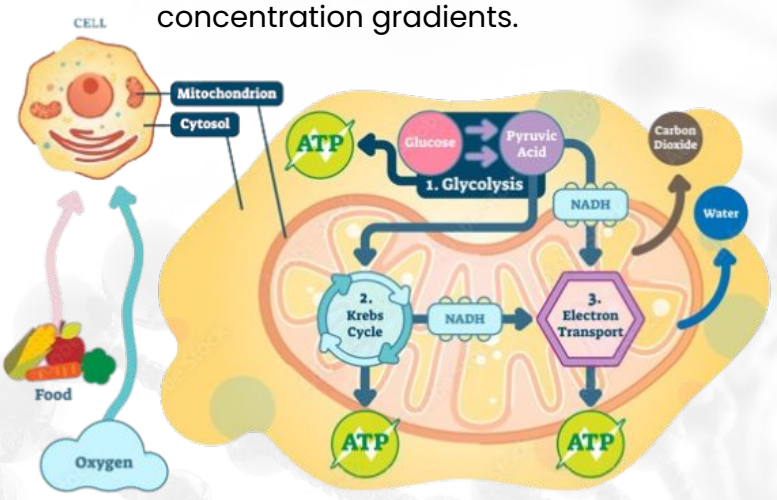
- **Digestion and Respiration**: Digestion provides essential nutrients for cellular respiration, which produces energy necessary for bodily functions.
- **Efficiency**: This integration ensures that energy production meets the body's demands.

Need for Gas Exchange in Respiration

- **Oxygen Uptake**: Oxygen is necessary for cellular respiration to produce ATP.
- **Carbon Dioxide Removal**: CO_2, a waste product, must be expelled to maintain pH balance and prevent toxicity.

Gas Exchange in Plants

- **Stomata**: Small openings on leaves and stems for gas exchange; open during the day for CO_2 intake and O_2 release.
- **Lenticels**: Pores on woody stems that facilitate gas exchange.
- **Root Exchange**: Roots take in O_2 and release CO_2 for cellular respiration.
- **Photosynthesis and Respiration**: While CO_2 is taken in for photosynthesis during the day, respiration occurs continuously, day and night.
- **Diffusion**: Gases move in and out of plant cells via diffusion, driven by concentration gradients.



Human Respiratory System and Breathing Mechanism

1. **Nasal Cavity**:
   - **Process**: Air enters through nostrils, filtered by mucous membranes and cilia; air is warmed and moistened.
2. **Pharynx**:
   - **Process**: Common passageway for air and food; directs air to the larynx and prevents food entry during swallowing via the epiglottis.
3. **Larynx**:
   - **Process**: Voice box containing vocal cords; air passes through and vibrates the vocal cords to produce sound.
4. **Trachea**:
   - **Process**: Tube supported by C-shaped cartilage rings; filters air and traps particles in mucus, which is moved upward by cilia.
5. **Bronchi and Bronchioles**:
   - **Process**: Trachea divides into bronchi, which further divide into bronchioles; distributes air throughout the lungs.
6. **Lungs**:
   - **Process**: Primary organs of respiration; elastic organs that expand and contract during breathing.

Mechanism of Breathing

Inhalation (Inspiration):

- **Diaphragm Movement**: Contracts and moves downward, increasing thoracic cavity volume.
- **Intercostal Muscles**: Contract, pulling ribs upward and outward.
- **Lung Expansion**: Creates lower pressure inside the lungs, drawing air in.
- **Air Inflow**: Fills alveoli with oxygen-rich air.

Exhalation (Expiration):

- **Diaphragm Relaxation**: Relaxes and moves upward, decreasing thoracic cavity volume.
- **Intercostal Muscles**: Relax, allowing ribs to move downward and inward.
- **Lung Contraction**: Increases pressure inside the lungs.
- **Air Outflow**: Air is expelled from the lungs as internal pressure exceeds atmospheric pressure.

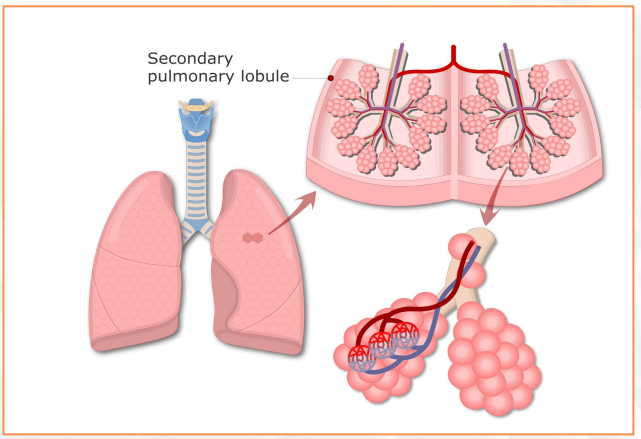
Alveoli

Structure and Process:

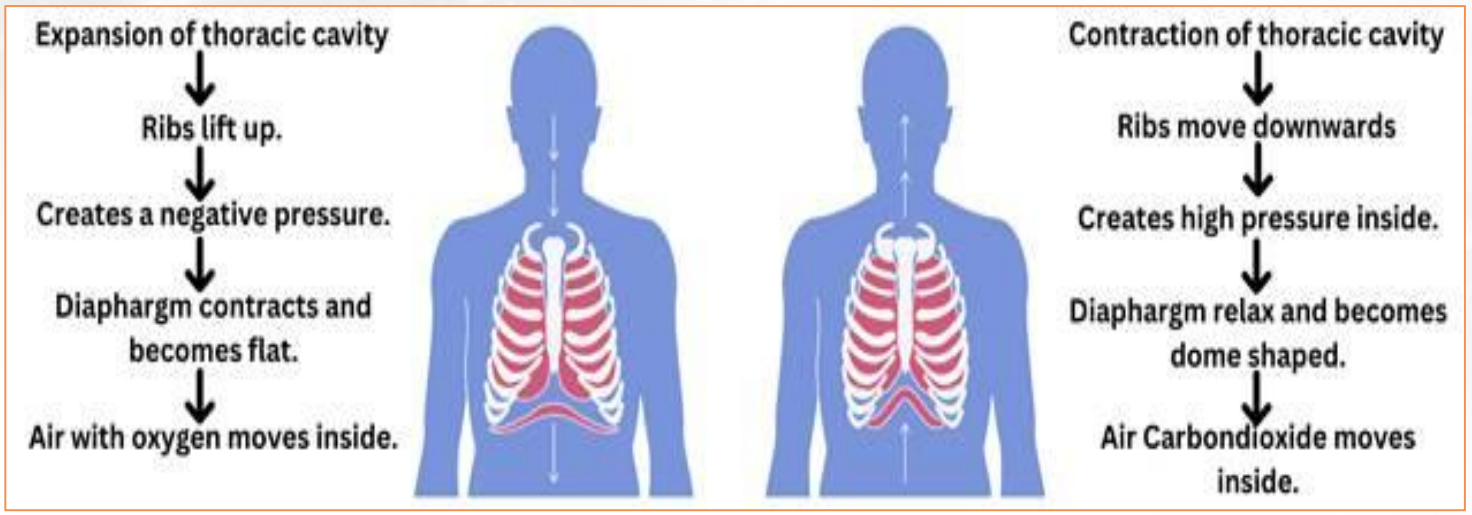
- **Definition**: Alveoli are tiny air sacs located at the end of bronchioles where gas exchange occurs.
- **Surrounding Capillaries**: Each alveolus is encased by a network of capillaries, facilitating gas exchange.

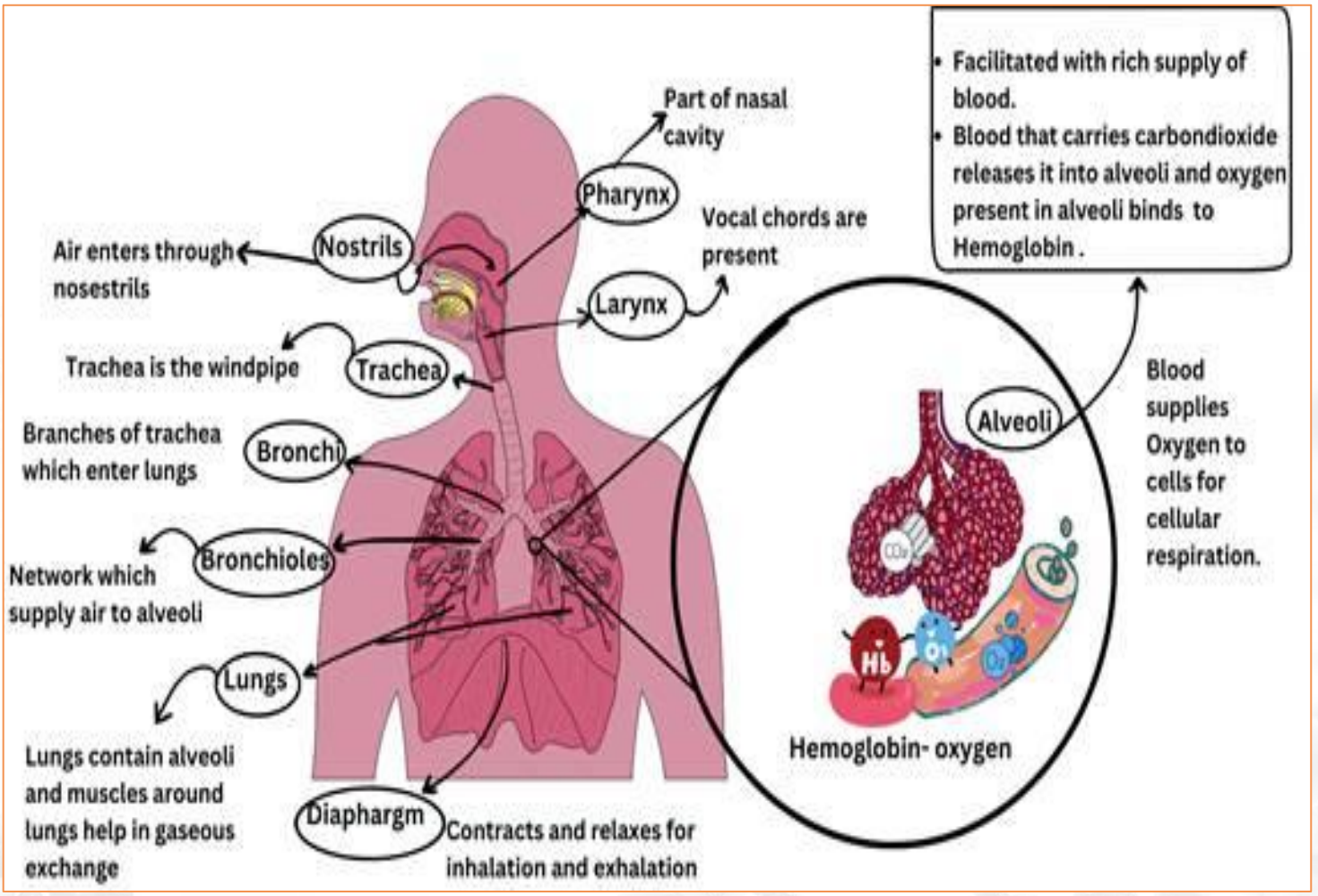
Gas Exchange:

- **Oxygen Diffusion**:
  - Oxygen from inhaled air diffuses across the thin alveolar membrane into the blood in surrounding capillaries.
- **Binding with Hemoglobin**:
  - Once in the blood, oxygen binds to hemoglobin in red blood cells for transport to tissues throughout the body.
- **Carbon Dioxide Diffusion**:
  - Carbon dioxide, a waste product of cellular respiration, diffuses from the blood into the alveoli.
- **Exhalation**:
  - Carbon dioxide is expelled from the body during exhalation.



Mechanism of Breathing





Cellular Respiration

Definition:
Cellular respiration is a biochemical process through which cells convert nutrients into energy in the form of ATP (adenosine triphosphate), essential for all cellular activities. This process occurs in the mitochondria and involves breaking down glucose and other molecules to release energy.

Types of Cellular Respiration

1. Aerobic Respiration

- **Process**: Glucose is completely broken down into carbon dioxide and water in the presence of oxygen.
- **Location**: Mitochondria of the cell.
- **Result**: Produces a large amount of energy (approximately 36-38 ATP molecules per glucose molecule).
- **Equation**:
  $C_6H_{12}O_6+6O_2 \rightarrow 6CO_2+6H_2O+Energy\ (ATP)$

Key Steps:

- **EMP Pathway (Glycolysis)**:

Location	Cytoplasm
Process	One glucose molecule (6-carbon) is broken down into two pyruvate molecules (3-carbon) through a series of enzymatic reactions.
Energy Yield	Produces 2 ATP molecules and 2 NADH molecules per glucose.
Outcome	Pyruvate is transported into the mitochondria for further breakdown.

- **Krebs Cycle (Citric Acid Cycle)**:

Location	Matrix of the mitochondria
Process	Pyruvate is converted into Acetyl-CoA, which combines with oxaloacetate to form citrate. The cycle releases CO_2 and transfers electrons to NAD+ and FAD.
Energy Yield	Produces 2 ATP molecules per glucose (1 ATP per pyruvate), along with 6 NADH and 2 $FADH_2$.
Outcome	Completes the oxidation of glucose derivatives and generates high-energy electron carriers for the next stag

2. Anaerobic Respiration

Occurs in the absence of oxygen and includes two main types:

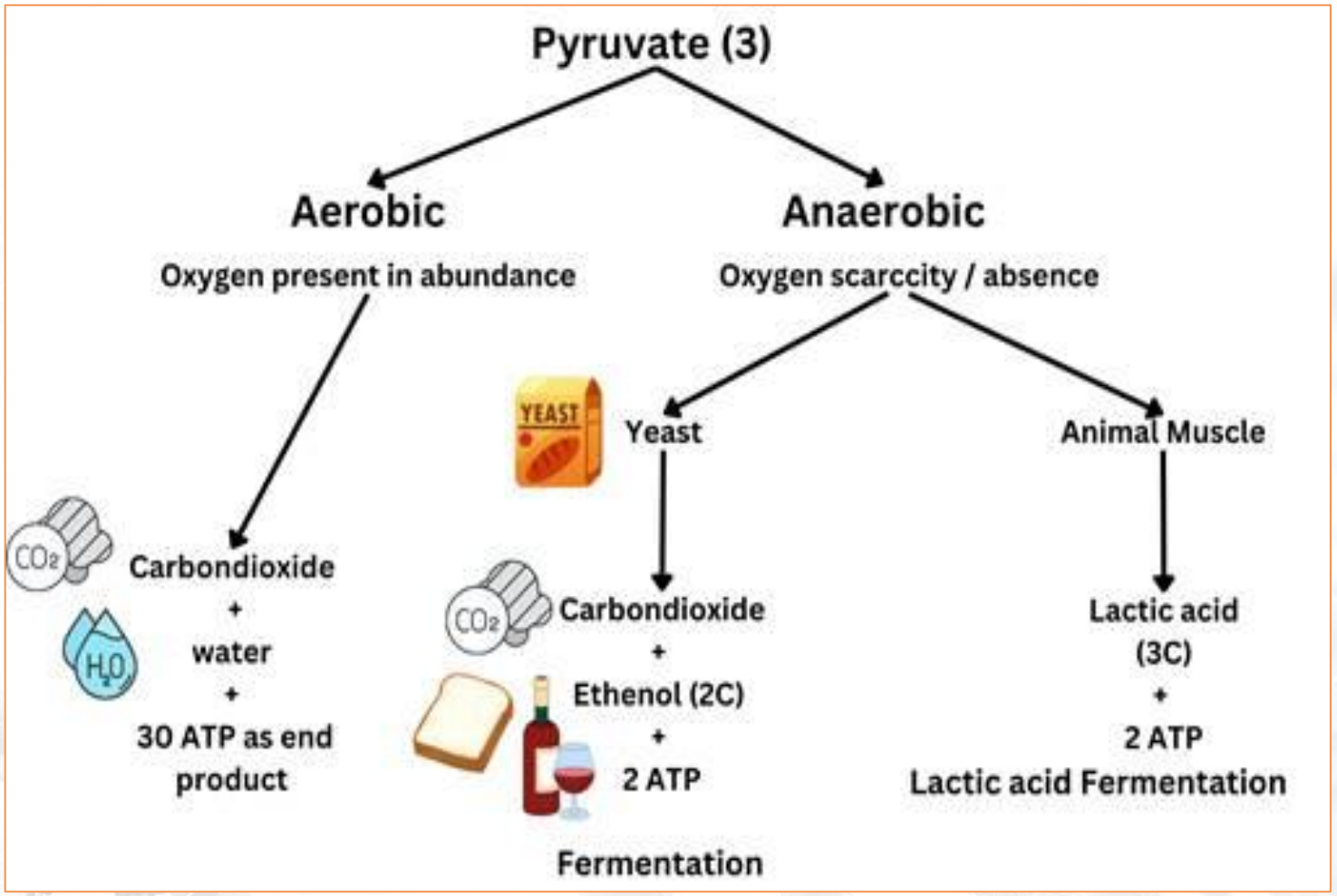
- **Fermentation**:
  - **Types**: Alcoholic fermentation and lactic acid fermentation.
  - **Process**: Partial breakdown of glucose into alcohol or lactic acid and carbon dioxide.
  - **Location**:
    - Alcoholic: Yeast (e.g., *Saccharomyces cerevisiae*).
    - Lactic Acid: Muscle cells.
  - **Result**: Produces a small amount of energy (2 ATP molecules per glucose).

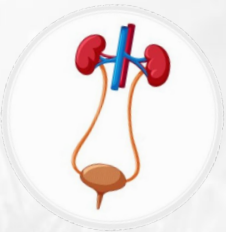
Uses:

- **Alcoholic Fermentation**: Used by yeast and some bacteria to produce ethanol and carbon dioxide; utilized in brewing, baking, and winemaking.
- **Lactic Acid Fermentation**: Occurs in muscle cells during strenuous exercise when oxygen is low, resulting in lactic acid production, causing muscle fatigue. It is also used in dairy production (e.g., yogurt, cheese).

Equations:

- **Alcoholic Fermentation**: $C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2 + \text{Energy (ATP)}$
- **Lactic Acid Fermentation**: $C_6H_{12}O_6 \rightarrow 2C_3H_6O_3 + \text{Energy (ATP)}$





Excretion

Definition:
Excretion is a crucial biological function that enables the removal of metabolic waste products from living organisms. These waste products, generated from cellular metabolism, include substances like ammonia, urea, and carbon dioxide.

Vital Roles of Excretion

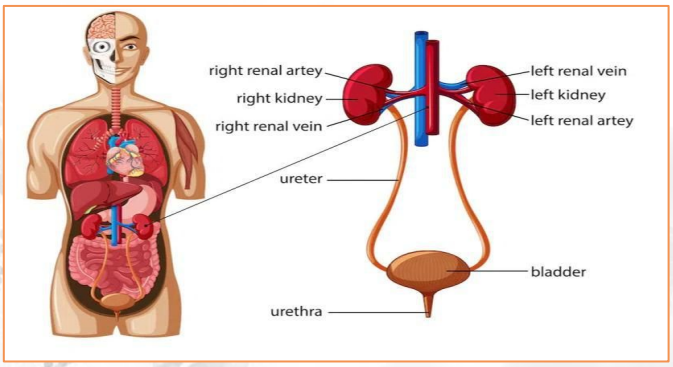
1. **Toxicity Management**
   - Metabolic waste can accumulate and become harmful to cells and tissues if not removed.
   - Excretion helps eliminate these toxic by-products, ensuring proper functioning of biological systems.
2. **Homeostasis Maintenance**
   - Excretion regulates the balance of essential substances such as water, salts, and minerals.
   - This regulation helps maintain a stable internal environment (homeostasis), vital for survival and overall health.
3. **Prevention of Disease**
   - Efficient excretion prevents the buildup of harmful substances, reducing the risk of diseases and conditions that may arise from toxicity or imbalances in metabolic by-products.

Excretion in Plants

- **Gaseous Excretion**: Plants primarily excrete gases like oxygen (produced during photosynthesis) and carbon dioxide (produced during respiration) through their stomata.
- **Waste Products**: Some plants excrete waste products such as resins, tannins, and other substances into their leaves, which are eventually shed.
- **Role of Vacuoles**: Plant vacuoles can store waste products and aid in their removal, contributing to the plant's overall health and function.

Organism	Process	Example
Contractile Vacuole	Expels excess water and waste	Amoeba, Paramecium
Mouth	Ingestion and egestion of waste	Hydra, Jellyfish
Nephridia	Filters metabolic waste	Earthworms, Leeches, Molluscs
Malpighian Tubules	Absorbs nitrogenous waste and converts it to uric acid	Insects
Hindgut	Converts nitrogenous waste and expels it	Cockroach, Termites
Flame Cells	Filters waste and expels it through pores	Flatworms, Planaria, Rotifers
Kidneys	Filters blood, removes waste as urine	Humans, Mammals, Birds
Gills	Excretes ammonia and maintains ionic balance	Fish, Amphibians, Aquatic animals
Lungs	Exhales carbon dioxide	Humans, Reptiles, Birds, Mammals

- **Human Excretory System: Kidney & Urine Formation**
- **Blood Supply to the Kidneys**:
  - Blood enters the kidneys via the **renal artery**, carrying waste products, salts, and water.
- **Functional Unit: Nephron**:
  - The nephron is the key component in urine formation.
- **Steps of Urine Formation in the Nephron:**
- **Glomerulus (Filtration)**:
  - Blood is filtered through the **glomerulus** into **Bowman's capsule**.
  - Small molecules such as water, salts, glucose, and urea pass into the filtrate.
- **Bowman's Capsule**:
  - Collects the filtrate from the glomerulus.
  - Directs it into the tubules of the nephron.
- **Proximal Convoluted Tubule (Reabsorption)**:
  - Essential substances like glucose, amino acids, and some salts are reabsorbed back into the bloodstream.
  - Significant water reabsorption occurs here.
- **Loop of Henle (Concentration)**:
  - Further reabsorption of water and salts takes place.
  - This process concentrates the urine.
- **Distal Convoluted Tubule (Selective Reabsorption and Secretion)**:
  - Additional ions are reabsorbed.
  - Wastes such as potassium and hydrogen ions are secreted into the filtrate.
- **Collecting Duct (Water Reabsorption)**:
  - The filtrate, now concentrated urine, is collected.
  - Water content is adjusted based on the body's needs.

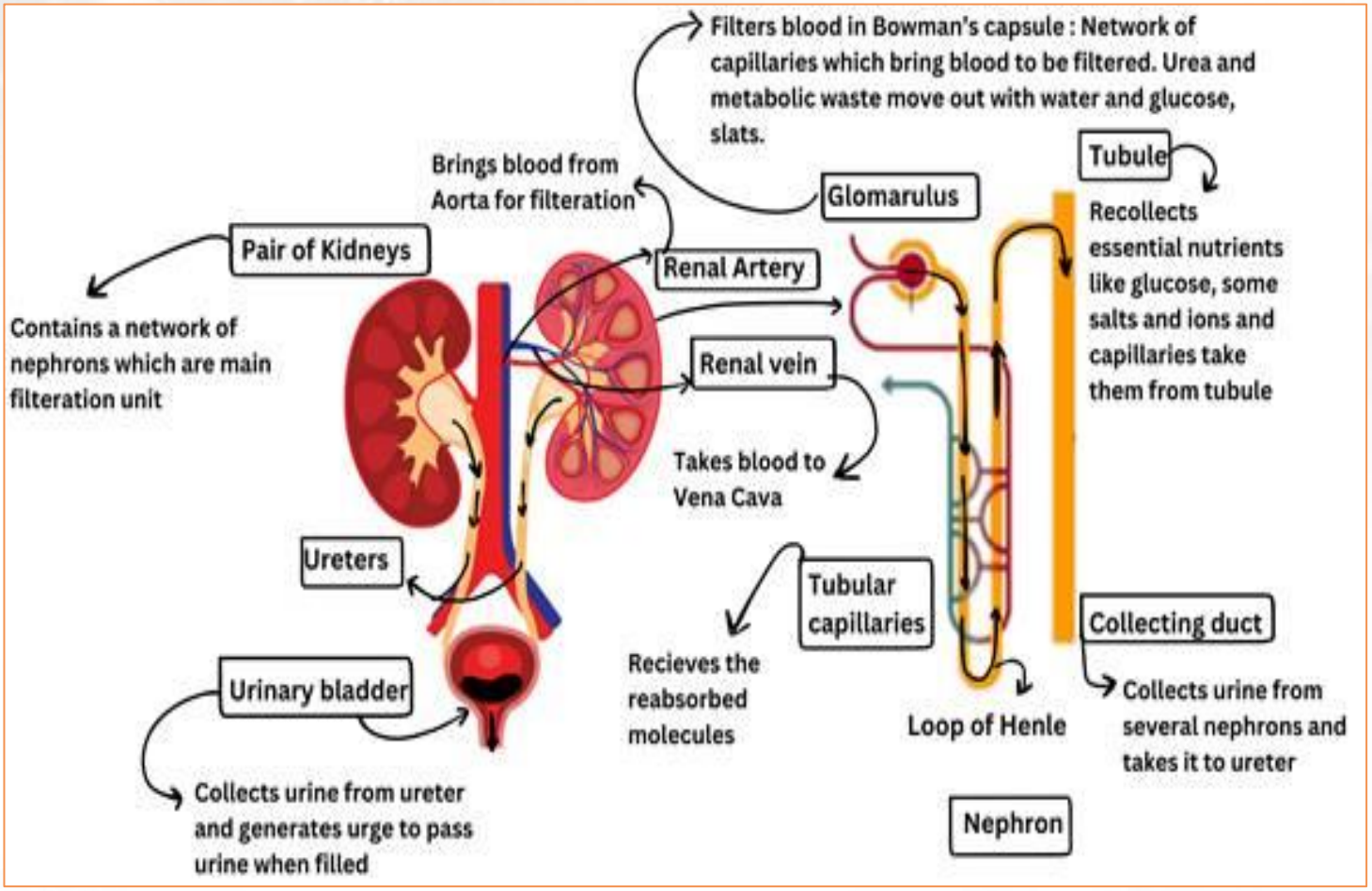


Transport of Urine:

- The urine flows into the **renal pelvis**.
- It is then transported to the bladder via the **ureter**.
- In the bladder, urine is stored until excreted through the **urethra** during urination.

Type of Waste	Organ of Excretion
Carbon dioxide (CO_2)	Lungs
Urea	Kidneys
Uric acid	Kidneys
Ammonia	Kidneys (converted to urea in liver)
Creatinine	Kidneys
Bile pigments	Liver (excreted via intestines)
Excess salts	Kidneys, Sweat glands (skin)
Excess water	Kidneys, Sweat glands (skin)
Heat	Skin (sweat glands), Lungs
Metabolic waste	Kidneys, Liver

Human Excretory System: Kidney & Urine Formation



Control And Coordination

1. Chemical Control

- **Definition**: Involves hormones and chemical signals regulating various physiological processes.
- **Plants**:
  - **Hormones**: Auxins, gibberellins, abscisic acid.
  - **Functions**: Regulate growth, development, and responses to environmental stimuli.
- **Humans**:
  - **Hormones**: Insulin (regulates blood sugar), adrenaline (fight or flight response).
  - **Functions**: Critical for maintaining homeostasis and responding to stress.

2. Electrical Control

- **Definition**: Involves the transmission of electrical impulses through nerves to coordinate responses and regulate bodily functions.
- **Plants**:
  - **Example**: Electrical signals, like action potentials in the Venus flytrap, facilitate rapid responses to stimuli.
- **Humans**:
  - **Function**: Nerve impulses transmitted through neurons control muscle movements and bodily functions, including reflexes and sensory perceptions.

Plant Control and Coordination

Plant Hormones

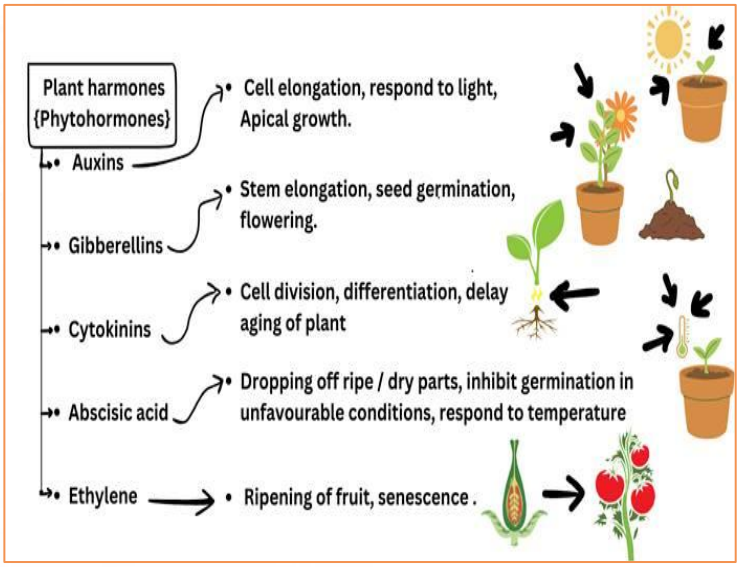
1. **Auxins**:
   - **Function**: Promote cell elongation and root formation; involved in phototropism and gravitropism.
   - **Example**: Aid in root development and formation of new shoots.
2. **Gibberellins**:
   - **Function**: Stimulate stem elongation, seed germination, and flowering.
   - **Example**: Used to increase fruit size and crop yields.
3. **Cytokinins**:
   - **Function**: Promote cell division and differentiation; delay leaf senescence.
   - **Example**: Enhance leaf growth and longevity.
4. **Abscisic Acid (ABA)**:
   - **Function**: Regulates stomatal closure during drought; inhibits growth and promotes seed dormancy.
   - **Example**: Helps conserve water by closing stomata under drought conditions.
5. **Ethylene**:
   - **Function**: Influences fruit ripening and leaf abscission; responds to mechanical stress.
   - **Example**: Accelerates ripening of fruits like bananas.

Electrical Control: Role of Ions in Stomatal Regulation

- **Potassium Ions (K^+)**:
  - **Function**: Regulate the opening and closing of stomata by changing turgor pressure in guard cells.
  - **Mechanism**: High K^+ concentration causes guard cells to swell, opening the stomata; low K^+ concentration leads to closure.

Interesting Facts

- **Touch-Me-Not Plant (Mimosa pudica)**:
  - **Response**: Quickly folds leaves when touched due to rapid loss of turgor pressure, serving as a defense mechanism against herbivores.
- **Pollen Tube Formation**:
  - **Process**: After pollination, the pollen grain germinates on the stigma and forms a pollen tube to deliver sperm cells to the ovule.
- **Plant Responses to Insects**:
  - **Example**: Some plants produce volatile organic compounds to attract predators of herbivorous insects or deter feeding.
- **Venus Flytrap (Dionaea muscipula)**:
  - **Response**: Uses modified leaves to trap and digest insects, providing nutrients.
- **Sundews**:
  - **Response**: Have glandular hairs on leaves that secrete sticky substances to trap and digest insects.



Plant Control and Coordination

Chemical Control (Plant Hormones)

1. **Auxins**
   - **Function**:
     - Promote cell elongation and growth.
     - Involved in phototropism (growth towards light).
     - Involved in gravitropism (growth in response to gravity).
   - **Example**: Auxins assist in root development and the formation of new shoots.
2. **Gibberellins**
   - **Function**:
     - Stimulate stem elongation.
     - Promote seed germination.
     - Facilitate flowering.
   - **Example**: Gibberellins are utilized to increase fruit size and enhance crop yields.
3. **Cytokinins**
   - **Function**:
     - Promote cell division and shoot formation.
     - Delay aging of plant tissues.
   - **Example**: Cytokinins enhance leaf growth and longevity.
4. **Abscisic Acid (ABA)**
   - **Function**:
     - Regulates seed dormancy.
     - Manages stress responses.
     - Closes stomata during water scarcity.
   - **Example**: ABA helps plants conserve water by closing stomata under drought conditions.
5. **Ethylene**
   - **Function**:
     - Regulates fruit ripening.
     - Influences leaf abscission.
     - Responds to mechanical stress.
   - **Example**: Ethylene accelerates the ripening of fruits such as bananas.

Electrical Control (Ion Movement)

Stomatal Regulation

- **Process**: Stomata are pores on plant leaves that open and close in response to ion movements, primarily potassium ions.
- **Mechanism**:
  - **Daytime**: Light triggers potassium ion uptake into guard cells, causing them to swell and open the stomata for gas exchange.
  - **Nighttime or Stress**: Potassium ions are released, leading to guard cell shrinkage and stomatal closure to prevent water loss.

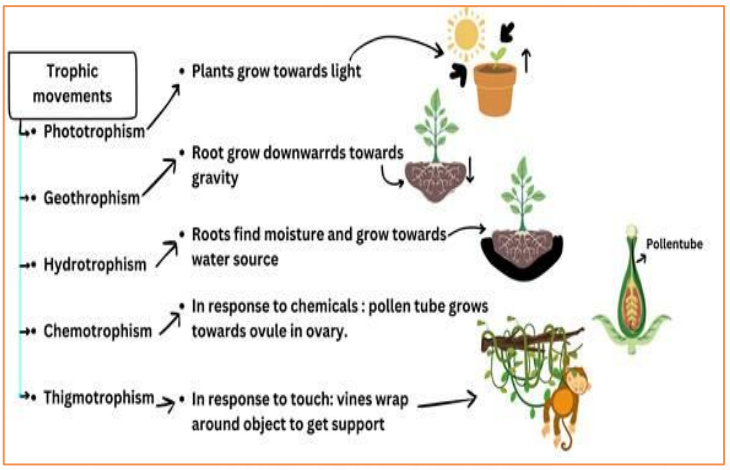
Observations

1. **Mimosa Pudica (Touch-Me-Not)**:
   - **Response**: Rapidly folds its leaves when touched as a defense mechanism to deter herbivores and reduce water loss.
2. **Pollen Tube Formation**:
   - **Process**: After pollination, the pollen grain germinates and forms a pollen tube that grows down the style to reach the ovule, facilitating fertilization.
3. **Insect Response**:
   - **Example**: The Venus flytrap uses electrical signals to trigger the rapid closure of its lobes when prey touches its hair-like structures, capturing and digesting insects for nutrients.

Plant Movements and Responses

Tropisms (Directional Growth)

- **Phototropism**: Growth towards light; auxins cause shoots to bend towards sunlight.
- **Gravitropism**: Growth in response to gravity; roots grow downward (positive), shoots upward (negative).
- **Hydrotropism**: Roots grow towards moisture.
- **Thigmotropism**: Growth in response to touch; seen in tendrils wrapping around supports.
- **Chemotropism**: Growth towards chemicals; pollen tubes guided to ovules for fertilization.



Nastic Movements (Non-Directional)

- **Photonasty**: Movement in response to light intensity; e.g., flowers opening in daylight.
- **Thigmonasty**: Rapid response to touch; e.g., Venus flytrap closing on prey.
- **Nyctinasty**: Movement due to day-night cycles; e.g., legume leaves folding at night.
- **Seismonasty**: Response to mechanical shock; e.g., Mimosa pudica folding when touched.

Human Control And Coordination

Glands Overview

- **Definition**: Glands are specialized organs that produce and secrete substances such as hormones, enzymes, and other fluids.
- **Role**: They maintain homeostasis and regulate body functions, including growth, metabolism, and reproduction.

Types of Glands

1. **Endocrine Glands**:
   - Ductless glands that release hormones directly into the bloodstream to target organs.
   - **Example**: Pituitary gland, Thyroid gland.
2. **Exocrine Glands**:
   - Secrete substances through ducts to specific locations (e.g., skin or digestive tract).
   - **Example**: Sweat glands, Salivary glands.
3. **Mixed Glands**:
   - Perform both endocrine and exocrine functions.
   - **Example**: Pancreas (secretes insulin as an endocrine function and digestive enzymes as an exocrine function).

Major Endocrine Glands and Hormones

1. Pituitary Gland ("Master Gland")

- **Location**: Base of the brain.
- **Hormones**:
  - **Growth Hormone (GH)**: Stimulates growth of bones and tissues.
  - **Thyroid-Stimulating Hormone (TSH)**: Regulates thyroid hormone secretion.
  - **Adrenocorticotropic Hormone (ACTH)**: Stimulates adrenal glands to release cortisol.
  - **Luteinizing Hormone (LH) & Follicle-Stimulating Hormone (FSH)**: Control reproductive processes.
  - **Prolactin**: Stimulates milk production in breastfeeding women.
  - **Antidiuretic Hormone (ADH)**: Regulates water balance in the body.
  - **Oxytocin**: Stimulates uterine contractions during childbirth.
- **Function**: Regulates other endocrine glands and promotes overall growth and metabolism.

2. Thyroid Gland

- **Location**: In the neck, below the larynx.
- **Hormones**:
  - **Thyroxine (T4) & Triiodothyronine (T3)**: Regulate metabolism, energy production, and development.
  - **Calcitonin**: Lowers blood calcium levels.
- **Function**: Controls the rate of metabolism and energy use.

3. Parathyroid Glands

- **Location**: Four small glands behind the thyroid.
- **Hormone**:
  - **Parathyroid Hormone (PTH)**: Increases blood calcium levels.
- **Function**: Regulates calcium and phosphate levels in the blood.

4. Adrenal Glands

- **Location**: On top of each kidney.
- **Hormones**:
  - **Adrenaline (Epinephrine)**: Prepares the body for fight-or-flight response.
  - **Cortisol**: Regulates stress responses and metabolism.
  - **Aldosterone**: Maintains blood pressure.
- **Function**: Helps the body respond to stress and maintain metabolism.

Pancreas (Mixed Gland)

- **Location**: Behind the stomach.
- **Endocrine Hormones**:
  - **Insulin**: Lowers blood sugar.
  - **Glucagon**: Raises blood sugar.
- **Exocrine Function**: Secretes digestive enzymes.
- **Function**: Maintains blood sugar balance and supports digestion.

Ovaries (in females)

- **Location**: In the pelvic region.
- **Hormones**:
  - **Oestrogen**: Regulates the menstrual cycle.
  - **Progesterone**: Prepares the uterus for pregnancy.
- **Function**: Controls female reproductive processes.

Testes (in males)

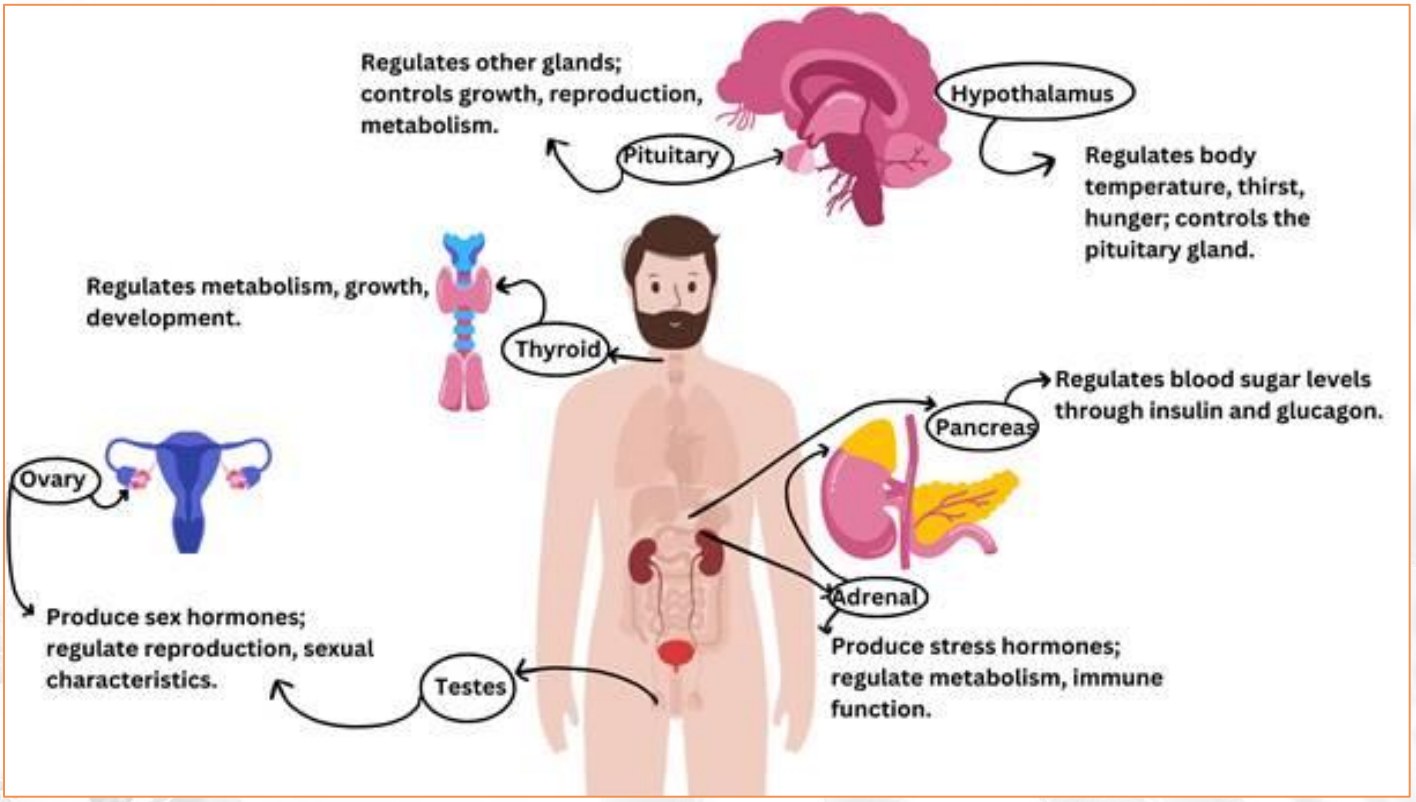
- **Location**: In the scrotum.
- **Hormone**:
  - **Testosterone**: Regulates sperm production and secondary sexual characteristics.
- **Function**: Governs male reproductive functions.

Pineal Gland

- **Location**: Deep in the brain.
- **Hormone**:
  - **Melatonin**: Regulates sleep-wake cycles.
- **Function**: Controls sleep patterns and biological clock.

Thymus

- **Location**: In the chest, behind the sternum.
- **Hormone**:
  - **Thymosin**: Promotes development of T-cells.
- **Function**: Key role in immune system development during early life.



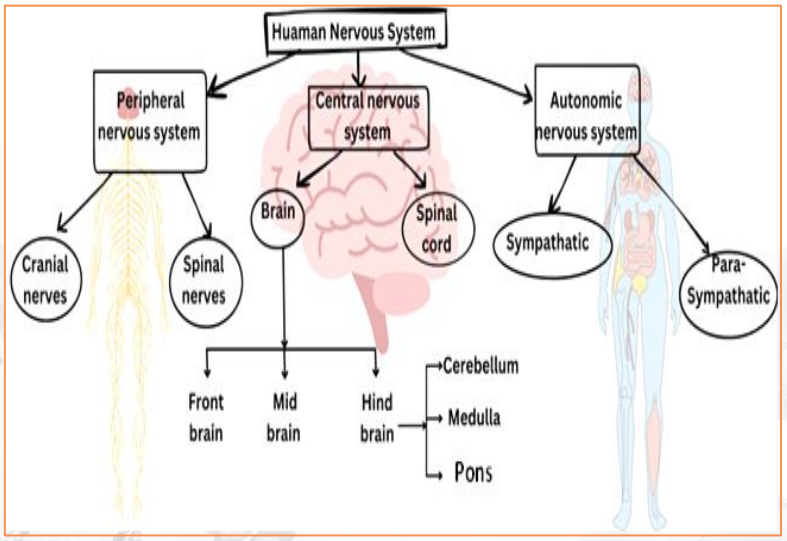
Human Nervous System

Overview:

- The nervous system is a complex network that coordinates the body's actions and sensory information by transmitting signals between different parts of the body.
- It regulates voluntary and involuntary actions, maintaining homeostasis along with the endocrine system.

Divisions of the Nervous System:

1. **Central Nervous System (CNS):**
   - Consists of the brain and spinal cord.
   - Processes information and acts as the control center for the body's functions.
2. **Peripheral Nervous System (PNS):**
   - Comprises all the nerves outside the CNS.
   - Divided into:
     - **Somatic Nervous System:** Controls voluntary movements of skeletal muscles.
     - **Autonomic Nervous System (ANS):** Regulates involuntary functions such as heart rate, digestion, and respiration. Further divided into:
       - **Sympathetic Nervous System:** Activates the fight-or-flight response during stressful situations.
       - **Parasympathetic Nervous-System:** Promotes rest-and-digest functions, calming the body.



Central Nervous System (CNS)

Brain:

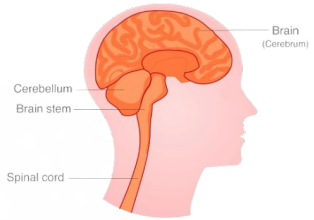
1. **Forebrain:**
   - **Components:** Cerebrum, Thalamus, Hypothalamus.
   - **Functions:**
     - **Cerebrum:** Controls higher functions such as thinking, memory, and voluntary movements; divided into two hemispheres and lobes.
     - **Thalamus:** Relays sensory and motor signals to the cerebral cortex.
     - **Hypothalamus:** Regulates vital functions such as temperature, hunger, and thirst; controls the pituitary gland.
2. **Midbrain:**
   - **Components:** Tectum, Tegmentum.
   - **Functions:**
     - **Tectum:** Involved in auditory and visual reflexes.
     - **Tegmentum:** Controls motor functions and regulates awareness and consciousness.
3. **Hindbrain:**
   - **Components:** Cerebellum, Pons, Medulla Oblongata.
   - **Functions:**
     - **Cerebellum:** Coordinates voluntary movements and maintains balance and posture.
     - **Pons:** Relays signals between the cerebrum and cerebellum; involved in sleep and respiration.
     - **Medulla Oblongata:** Controls vital functions such as heart rate, breathing, and blood pressure.

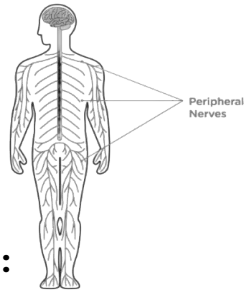
Coverings of the Brain:

- **Dura Mater:** Outermost, tough layer; protects the brain and contains blood vessels.
- **Arachnoid Mater:** Middle, web-like layer; contains cerebrospinal fluid (CSF) for cushioning.
- **Pia Mater:** Innermost, delicate layer; closely adheres to the brain and supplies blood vessels.
- **Cerebrospinal Fluid (CSF):** Cushions the brain and provides nutrient support.

Spinal Cord:

- Extends from the brain and runs down the backbone.
- Responsible for transmitting information between the brain and the rest of the body; controls reflex actions.





Peripheral Nervous System (PNS):

1. **Somatic Nervous System:**
   - Controls voluntary movements by transmitting signals from the CNS to the muscles.
   - Processes sensory information from the external environment (e.g., touch, pain).
2. **Autonomic Nervous System (ANS):**
   - Controls involuntary body functions (e.g., heartbeat, digestion).
   - **Sympathetic Nervous System:** Activates the body's fight-or-flight response (increases heart rate, dilates pupils, releases adrenaline).
   - **Parasympathetic Nervous System:** Calms the body down after stress (slows heart rate, promotes digestion).

Neurons and Synapses:

1. **Neuron (Nerve Cell):**
   - **Basic Functional Unit of the Nervous System.**
   - **Structure:**
     - **Cell Body:** Contains the nucleus and organelles.
     - **Dendrites:** Receive signals from other neurons.
     - **Axon:** Transmits signals away from the cell body.
   - **Function:** Neurons transmit electrical impulses (action potentials) to and from the CNS and PNS.
2. **Synapse:**
   - The junction between two neurons or between a neuron and a target cell (muscle or gland).
   - **Neurotransmitters:** Chemical messengers that carry signals across the synapse, enabling communication between neurons.

Nerve Impulse Transmission Flow:

Overview:

- A nerve impulse is an electrical signal that travels along the axon of a neuron.
- The transfer of a nerve impulse occurs through the movement of ions across the neuron's membrane, generating an action potential.

1. **Resting Potential:**
   - Neuron at rest; inside is negatively charged (~-70 mV).
   - Sodium-potassium pump maintains Na^+ outside and K^+ inside.
2. **Depolarization:**
   - Stimulus opens sodium channels; Na^+ enters, making inside positive (~+40 mV).
3. **Action Potential:**
   - The change in charge travels along the axon.
4. **Repolarization:**
   - Potassium channels open; K^+ exits, restoring negative charge.
5. **Refractory Period:**
   - Neuron resets, preventing immediate reactivation.
6. **Synapse:**
   - Neurotransmitters released at the synapse, triggering a new impulse in the next neuron.

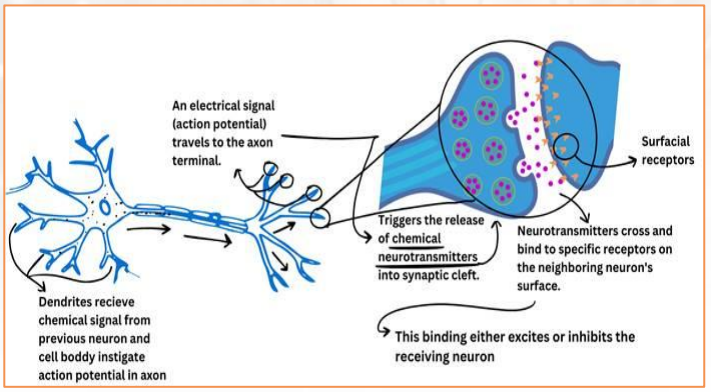
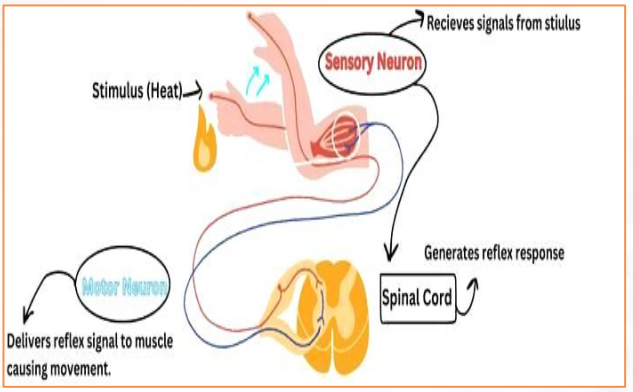


Fig: Nerve impulse transmission flow



Reflex Action and Reflex Arc

Reflex Action:

- **Definition:** A reflex action is a quick, automatic response to a stimulus.
- **Characteristics:**
  - Occurs without conscious thought.
  - Aims to protect the body from harm.

Reflex Arc:

- **Definition:** The reflex arc is the pathway that mediates a reflex action.

1. **Stimulus:**
   - An external factor triggers a reflex (e.g., touching something hot).
2. **Receptor:**
   - **Function:** Detects the stimulus and converts it into an electrical signal.
   - **Location:** Found in sensory organs like the skin or eyes.
3. **Sensory Neuron:**
   - **Function:** Transmits the electrical signal from the receptor to the spinal cord.
   - **Role:** Carries information to the central nervous system (CNS).
4. **Integration Center:**
   - **Location:** Situated in the spinal cord or brainstem.
   - **Function:** Processes the incoming signal and decides on the appropriate response.
   - **Note:** In simple reflexes, this often involves a direct connection (synapse) between sensory neurons and motor neurons.
5. **Motor Neuron:**
   - **Function:** Carries the response signal from the integration center to the effector.
   - **Role:** Transmits instructions for the response.
6. **Effector:**
   - **Definition:** The muscle or gland that responds to the motor neuron's signal.
   - **Function:** Executes the action (e.g., muscle contraction to pull away from the stimulus.
7. **Response:**
   - The reflex action results from the effector's activity.
   - **Example:** Withdrawing a hand from a hot object quickly to protect oneself.

Reproduction In Living Beings

Overview

- **Definition**: Reproduction is the biological process by which new individual organisms are produced from their parents.
- **Importance**:
  - Ensures the continuation of species
  - Promotes genetic diversity
  - Allows for adaptation and evolution

Types of Reproduction

1. Asexual Reproduction

Definition: Involves a single parent and produces offspring genetically identical to the parent.

Types of Asexual Reproduction:

- **Binary Fission**:
  - **Description**: Single-celled organisms divide into two equal halves.
  - **Example**: Bacteria
- **Multiple Fission**:
  - **Description**: Single-celled organisms divide into multiple parts.
  - **Example**: Plasmodium
- **Budding**:
  - **Description**: New individuals grow from a part of the parent organism.
  - **Example**: Yeast (Saccharomyces cerevisiae); Hydra
- **Fragmentation**:
  - **Description**: An organism breaks into fragments, each capable of growing into a new individual.
  - **Example**: Starfish (e.g., Asterias rubens); Planaria
- **Vegetative Propagation**:
  - **Description**: New plants grow from parts of the parent plant.
  - **Example**: Potatoes (tubers); Strawberries (runners)
- **Spore Formation**:
  - **Description**: Spores are released and develop into new individuals.
  - **Example**: Fungi (e.g., Aspergillus); Ferns

2. Sexual Reproduction

- **Definition**: Involves two parents and the combination of their genetic material to produce genetically diverse offspring.
- **Importance**: Promotes genetic variation and adaptation.

Sexual Reproduction in Plants

Flower as Reproductive Organ

- **Definition**: Flowers are specialized reproductive structures of angiosperms (flowering plants) responsible for seed production through sexual reproduction.
- **Function**: Contain both male and female reproductive organs.

Plant Types

- **Unisexual Plants**:
  - Produce either male or female flowers.
  - Example: Cucumbers have separate male and female flowers on the same plant.
- **Bisexual Plants**:
  - Produce flowers with both male (stamens) and female (carpels) reproductive organs.
  - Examples: Roses and lilies.

Flower Types

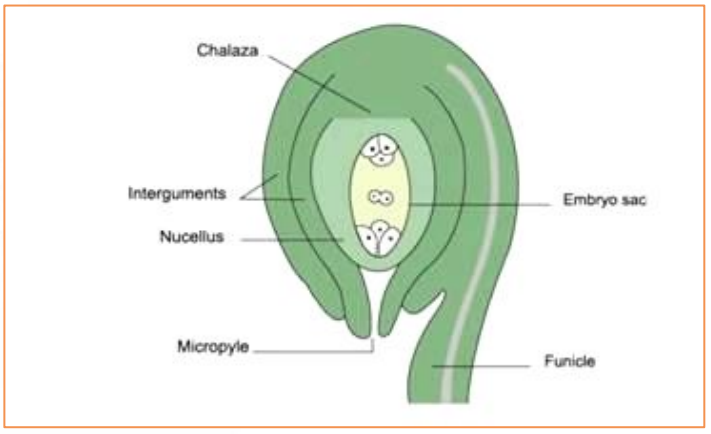
- **Unisexual Flowers**:
  - Contain either stamens or carpels, but not both.
  - Example: Corn (tassels are male flowers; ears are female).
- **Bisexual Flowers**:
  - Contain both stamens and carpels, enabling potential self-pollination.
  - Examples: Tulips, sunflowers, and hibiscus.

Parts of a Bisexual Flower

- **Stamen (Male Reproductive Part)**:
  - **Anther**: Produces and releases pollen grains (male gametes).
  - **Filament**: Supports the anther.
- **Pistil/Carpel (Female Reproductive Part)**:
  - **Stigma**: Sticky surface that captures pollen grains.
  - **Style**: Tube connecting stigma to ovary, allowing pollen tubes to grow.
  - **Ovary**: Contains ovules, which house egg cells; develops into fruit after fertilization.

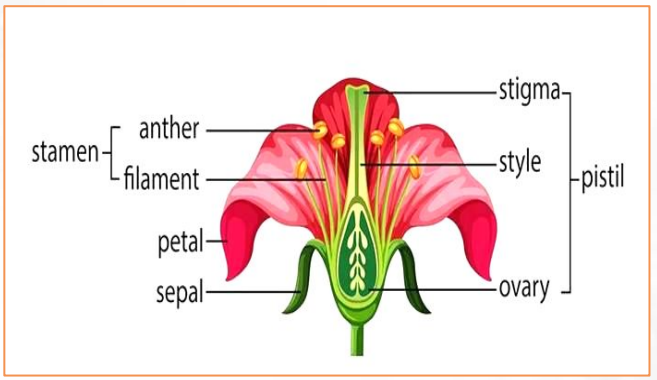
Parts of the Ovule:

- **Integuments**: Protective layers that develop into the seed coat.
- **Nucellus**: Nourishes the developing embryo.
- **Embryo Sac**: Contains the egg cell and other crucial cells for fertilization.
- **Micropyle**: Small opening in the integuments for pollen tube entry.



Other Parts of a Flower

- **Petals**:
  - Often colorful and fragrant.
  - Function: Attract pollinators such as insects and birds; protect reproductive organs.
- **Sepals**:
  - Leaf-like structures that encase and protect the flower bud before it opens.



Process of Pollination

Definition: Pollination is the transfer of pollen from the anther (male part) to the stigma (female part) of a flower, leading to fertilization and seed production.

Types of Pollination

- **Self-Pollination**:
  - **Description**: Transfer of pollen from the anther to the stigma of the same flower or another flower on the same plant.
  - **Characteristics**: Requires no external agents; common in plants like tomatoes and peas.
- **Cross-Pollination**:
  - **Description**: Transfer of pollen from the anther of one flower to the stigma of a flower on a different plant of the same species.
  - **Characteristics**: Increases genetic diversity; facilitated by various pollinating agents.

Pollinating Agents

- **Insects**:
  - Examples: Bees, butterflies, beetles.
  - **Mechanism**: Attracted by color, scent, and nectar; transfer pollen as they move between flowers.
  - **Example**: Apple trees rely on bees for pollination.
- **Wind**:
  - **Description**: Wind-pollinated plants produce large amounts of lightweight pollen.
  - **Examples**: Grasses, corn.

Water:

- **Description**: Aquatic plants use water to carry pollen between flowers.
- **Example**: Water lilies.

Animals:

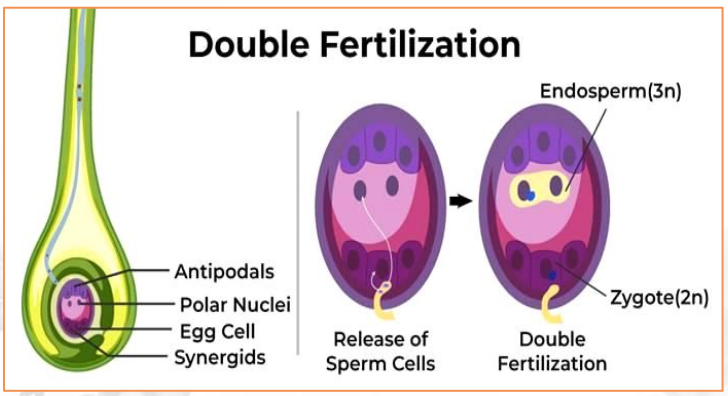
- Examples: Birds (like hummingbirds) and bats.
- **Mechanism**: Attracted by nectar; inadvertently carry pollen as they feed, particularly in flowers that are tubular or bloom at night.

Double Fertilization and Triple Fusion

- **Process**: A unique feature of angiosperms where:
  - One sperm cell fuses with the egg cell to form a diploid zygote (develops into an embryo).
  - Two other sperm cells fuse with the polar nuclei in the ovule to form a triploid endosperm (provides nourishment).

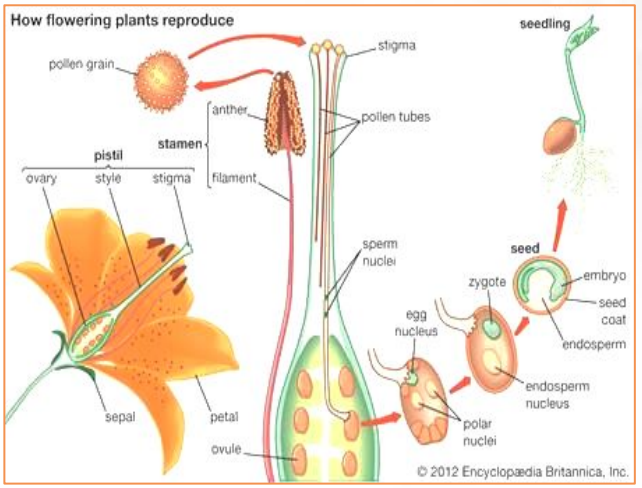
Outcome

- **Zygote Formation**: The zygote undergoes mitotic divisions to develop into the embryo, which will become the future plant.
- **Endosperm Formation**: The triploid endosperm serves as a food reserve for the growing embryo during seed development.



Post-Fertilization Events

- **Seed Development**:
  - After fertilization, the ovule develops into a seed.
  - **Components**: Contains the embryo and the endosperm, encased in a protective seed coat.



- **Fruit Formation**:
  - The ovary transforms into a fruit that encloses and protects the seeds.
  - **Function**: Aids in seed dispersal by attracting animals or through mechanical means.
- **Seed Dispersal**:
  - Seeds are moved from the parent plant to new locations suitable for germination and growth.
  - **Mechanisms**: Includes wind, water, animals, and mechanical ejection.
- **Germination**:
  - Under favorable conditions, the seed absorbs water, swells, and the embryo begins to grow.
  - **Process**: The embryo breaks through the seed coat to develop into a new plant.

Fruit Formation in Plants

Overview: After fertilization, various parts of the flower undergo significant changes to form fruit, which serves to protect developing seeds and assist in their dispersal. The ovary plays a crucial role in this process.

Transformation of Flower Parts

- **Ovary**:
  - Develops into the fruit.
  - The wall thickens and differentiates into the pericarp (fruit wall), which can be fleshy (e.g., apples, tomatoes) or dry (e.g., nuts, grains).
- **Ovules**:
  - Develop into seeds after fertilization.
  - **Components**:
    - **Integuments**: Become the seed coat.
    - **Nucellus**: May be absorbed or form the perisperm.
    - **Embryo Sac**: Contributes to the embryo (egg cell) and endosperm (central cell), while synergids and antipodal cells degenerate.
    - **Micropyle**: Persists as a small pore in the seed coat.
- **Sepals, Petals, Stamens, and Style**:
  - Typically wither and fall off post-fertilization.
  - In some plants (e.g., strawberries), these parts may persist and contribute to the fruit's structure.

Structure of the Fruit

- **Pericarp**: The fruit wall, derived from the ovary wall, consists of three layers:
  - **Exocarp**: The outer layer, often the skin of the fruit.
  - **Mesocarp**: The middle layer, usually fleshy and juicy (e.g., mangoes).
  - **Endocarp**: The inner layer, which can be hard and woody (e.g., peaches) or soft (e.g., grapes).
- **Seed(s)**: Fertilized ovules develop into seeds, with the number varying by plant species.

Types of Fruits

- **Simple Fruits**: Develop from a single ovary of one flower (e.g., mango, peach, tomato).
- **Aggregate Fruits**: Formed from multiple ovaries of one flower, each developing into a small fruitlet (e.g., strawberries, raspberries).
- **Multiple Fruits**: Result from the fusion of ovaries from multiple flowers (e.g., pineapple, fig).

Role of the Ovary in Fruit Formation

- **Fleshy Fruits**: The ovary swells and becomes fleshy (e.g., bananas, grapes, oranges). The mesocarp typically attracts animals that help disperse the seeds.
- **Dry Fruits**: The ovary forms a dry, hard fruit that may crack open to release seeds (e.g., peas, beans, sunflower seeds), aiding in dispersal through wind or mechanical ejection.

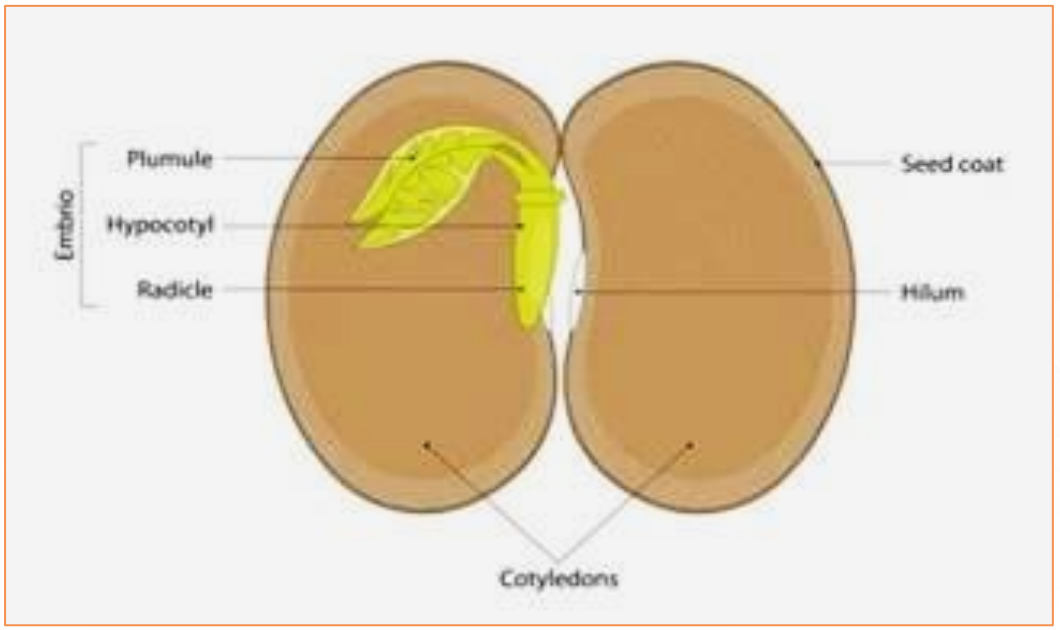
Special Cases

Parthenocarpy: Fruits can develop without fertilization, resulting in seedless fruits (e.g., bananas, certain oranges).

Structure of a Dicot Seed

A dicot seed, such as those from beans and peas, consists of several essential parts:

- **Seed Coat**: The protective outer layer that guards against damage, drying out, and infections.
- **Hilum**: A small scar on the seed coat where the seed was attached to the ovary.
- **Micropyle**: A tiny pore near the hilum that facilitates water entry during germination and aids in gas exchange.
- **Embryo**: The young plant inside the seed, comprising:
  - **Cotyledons**: Seed leaves that store food.
  - **Plumule**: Develops into the shoot.
  - **Radicle**: Develops into the root.
- **Endosperm**: Serves as a nutrient reserve for the growing embryo; in many dicots, it is absorbed by the cotyledons.



Reproduction in Human Beings

Reproduction in human beings is a complex process that involves the production of gametes (sperm in males and eggs in females), fertilization, embryo development, and birth. This process is essential for the continuation of the species and involves both the male and female reproductive systems.

MALE REPRODUCTIVE SYSTEM

Testes

- **Function**: Produce sperm and the hormone testosterone.
- **Location**: Situated in the scrotum, which lies outside the body to maintain an optimal temperature for sperm production.

Epididymis

- **Function**: Stores and matures sperm.
- **Structure**: A coiled tube located on the back of each testis.

Vas Deferens

- **Function**: Transports sperm from the epididymis to the ejaculatory duct.
- **Structure**: A long, muscular tube that passes through the inguinal canal into the abdominal cavity.

Seminal Vesicles

- **Function**: Produce seminal fluid that nourishes sperm and forms a major component of semen.
- **Location**: Located behind the bladder, secreting fluid into the ejaculatory duct.

Prostate Gland

- **Function**: Produces fluid that nourishes and transports sperm, activating sperm motility.
- **Structure**: A walnut-sized gland below the bladder, surrounding the urethra.

Bulbourethral Glands (Cowper's Glands)

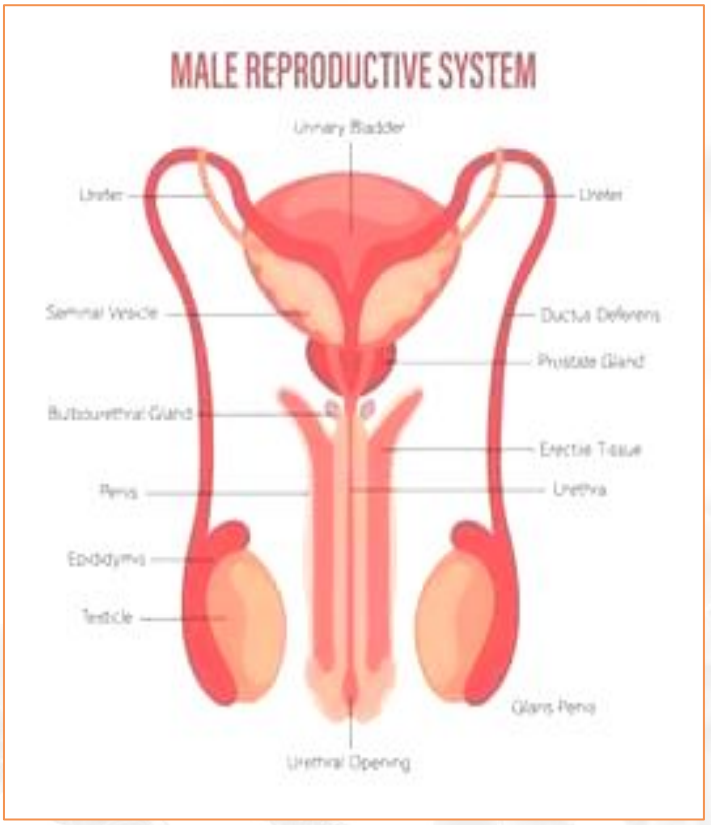
- **Function**: Produce pre-ejaculatory fluid that lubricates the urethra and neutralizes acidity.
- **Location**: Small glands near the base of the penis, connected to the urethra.

Urethra

- **Function**: Carries urine from the bladder and sperm from the reproductive tract to the outside of the body.
- **Structure**: A tube running through the penis.

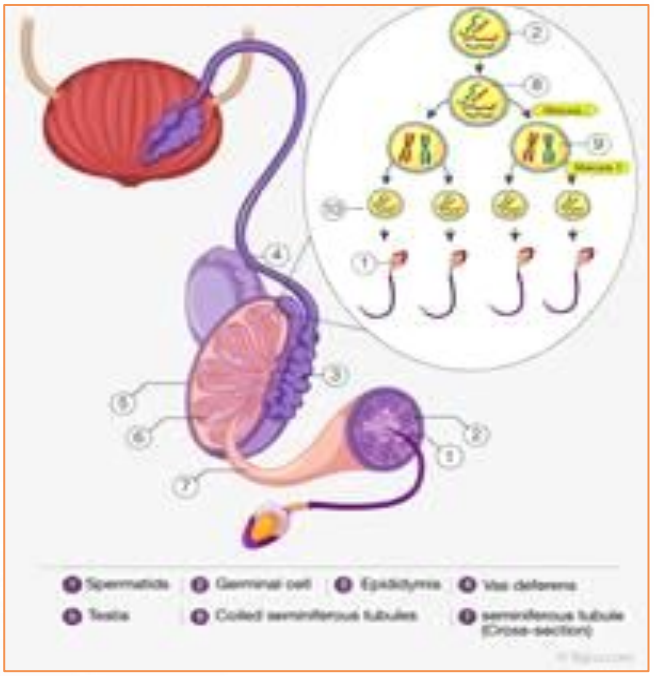
Penis

- **Function**: Delivers sperm into the female reproductive system and serves as the organ of sexual intercourse.
- **Structure**: Composed of the shaft, glans (head), and urethra; becomes erect during sexual arousal due to increased blood flow.



Spermatogenesis

- **Location**: Occurs in the seminiferous tubules of the testes.
- **Process**:
  - Continuous production of sperm cells.
  - Begins with spermatogonia dividing by mitosis.
  - Includes meiosis to produce haploid sperm cells.
  - Sperm cells mature in the epididymis before being ejaculated.



FEMALE REPRODUCTIVE SYSTEM

Ovaries

- **Function**: Produce eggs (ova) and hormones such as estrogen and progesterone.
- **Location**: Paired organs located in the pelvic cavity.

Fallopian Tubes (Oviducts)

- **Function**: Transport eggs from the ovaries to the uterus.
- **Role**: Site of fertilization, if sperm are present.

Uterus

- **Function**: Site where a fertilized egg implants and develops into a fetus.
- **Structure**: Composed of three layers:
  - **Endometrium**: Inner lining.
  - **Myometrium**: Muscle layer.
  - **Perimetrium**: Outer layer.

Vagina

- **Function**: Serves as the birth canal and receives sperm during intercourse.
- **Structure**: Muscular tube connecting the external genitals to the uterus.

External Genitalia

- **Components**: Includes the labia majora, labia minora, and clitoris.
- **Function**: Protects the internal reproductive organs and provides sensory stimulation.

Mammary Glands

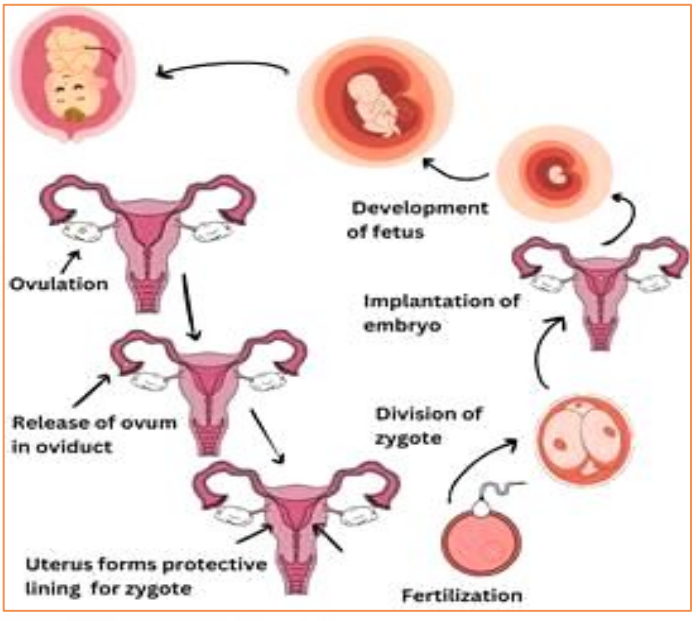
- **Function**: Produce milk for nourishing infants.
- **Location**: Found in the breasts, involved in lactation.

Oogenesis

- **Location**: Occurs in the ovaries, specifically in follicles.
- **Process**:
  - Involves the cyclic production of egg cells (oocytes).
  - Begins with oogonia dividing by mitosis during fetal development.
  - Includes meiosis to produce one mature egg cell (ovum) and polar bodies.
  - Ovum matures in the ovarian follicle and is released during ovulation.

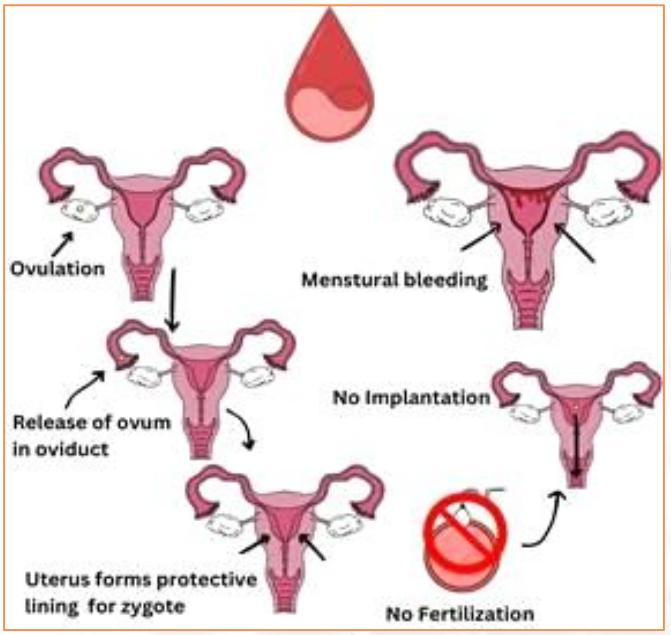
From Ovum to Baby: The Case of Fertilization

1. **Ovulation**: Release of a mature egg (ovum) from the ovary.
2. **Fertilization**: Fusion of the egg with a sperm cell in the fallopian tube to form a zygote.
3. **Early Cell Division**: The zygote undergoes rapid cell divisions (cleavage) while moving through the fallopian tube.
4. **Implantation**: The zygote implants into the uterine lining (endometrium) about 6-7 days after fertilization.
5. **Development**: The zygote develops into an embryo, undergoing differentiation and forming tissues and organs.
6. **Growth**: The embryo grows within the uterus, supported by the placenta and umbilical cord.
7. **Parturition**: The initiation of parturition involves rhythmic uterine contractions.
8. **Birth**: The expulsion of the baby (fetus) and placenta through the birth canal (vagina).



From Ovum to Menstruation: Case of No Fertilization

1. **Ovulation**:
   - Release of a mature egg (ovum) from the ovary into the fallopian tube.
2. **Potential Fertilization**:
   - The egg travels towards the uterus, where it may be fertilized by sperm.
3. **Endometrial Preparation**:
   - The uterus prepares its lining (endometrium) for potential embryo implantation.
4. **Fertilization Does Not Occur**:
   - If fertilization does not occur, the egg is not implanted in the uterus.
5. **Menstruation**:
   - The thickened endometrial lining sheds, leading to menstrual bleeding.



Reproductive Health

Definition

Reproductive health refers to the state of complete physical, mental, and social well-being in all matters related to the reproductive system and its functions and processes.

Common Threats to Reproductive Health

- **Sexually Transmitted Diseases (STDs)**
- **Infertility**
- **Reproductive Cancers**
- **Unsafe Abortions**
- **Sexual Violence**
- **Unintended Pregnancy**

Commonly Transmitted STDs

1. **Gonorrhea**: Caused by *Neisseria gonorrhoeae* (bacteria).
2. **Syphilis**: Caused by *Treponema pallidum* (bacteria).
3. **HIV/AIDS**: Caused by Human Immunodeficiency Virus (HIV).
4. **Genital Herpes**: Caused by Herpes Simplex Virus (HSV).
5. **Genital Warts**: Caused by Human Papillomavirus (HPV).
6. **Trichomoniasis**: Caused by *Trichomonas vaginalis* (parasite).
7. **Hepatitis B**: Caused by Hepatitis B Virus (HBV).

How to Stay Safe

- **Educate Yourself**: Learn about sexual health, consent, and contraception from reliable sources.
- **Avoid Peer Pressure**: Make informed decisions about sexual activity based on personal values and readiness.
- **Be Mindful of Digital Footprints**: Be cautious about sharing personal information or images online.
- **Practice Safe Intercourse**: Use condoms to reduce the risk of STIs and unintended pregnancy.
- **Get Regular Screenings**: Regularly check for STIs to detect any issues early.
- **Use Reliable Contraception**: Employ effective methods to prevent unintended pregnancy.
- **Communicate Openly**: Discuss sexual health openly with partners and healthcare providers.
- **Get Vaccinated**: Protect against infections like HPV and hepatitis B through vaccination.
- **Maintain Good Genital Hygiene**: Practice proper hygiene to prevent infections.
- **Seek Prompt Medical Care**: Address any reproductive health concerns or symptoms with a healthcare provider as soon as they arise.

Contraceptive Methods

1. **Physical Methods**
   - Condoms (Male/Female)
   - Diaphragms and Cervical Caps
2. **Hormonal/Chemical Methods**
   - Birth Control Pills (e.g., Saheli, a non-steroidal oral contraceptive)
3. **Surgical Methods**
   - **Vasectomy**: Surgical sterilization for men by cutting and sealing the vas deferens.
   - **Tubectomy**: Surgical sterilization for women by cutting and sealing the fallopian tubes.
4. **Intrauterine Devices (IUDs)**
   - **Copper IUDs**: Inserted into the uterus to release copper, which is toxic to sperm.
   - **Hormonal IUDs**: Release hormones to thicken cervical mucus and thin the uterine lining.

Female Foeticide

Termination of pregnancy based on the female sex of the fetus.

Causes	
Cultural Preferences	Preference for male children due to traditional beliefs.
Economic Factors	Perceived higher costs and economic returns from male children.
Methods	
Sex Determination	Using ultrasound to identify fetal sex.
Selective Abortion	Aborting the fetus if female.
Consequences	
Gender Imbalance	Skewed sex ratios and societal issues.
Social Impact	Affects population balance and family dynamics.
Prevention	
Legislation	Laws against sex determination and selective abortion.
Education	Promoting gender equality and awareness.
Support Programs	Financial and social support for families with female children.

5. Diversity in Living Organisms

The diversity of life on Earth is immense, with an estimated **1.7 to 1.8 million known species**. This includes everything from microscopic organisms to towering trees.

Key Aspects

- **Range**: Life spans from invisible microbes to trees reaching several feet in height.
- **Variation**: Organisms exhibit a remarkable range of shapes and sizes, from just a few micrometers to several meters.

Importance

- **Understanding Complexity**: Studying this diversity deepens our understanding of the intricate web of life and its interactions.
- **Ecological Balance**: Knowledge of various species is crucial for maintaining ecological balance and ensuring human well-being.

Evolution

Ongoing Change: Life on Earth is in a state of continuous evolution, contributing to the ever-expanding diversity of organisms.

Classification of Living Organisms

Purpose of Classification

- **Organization**: Helps to study organisms systematically, reducing chaos and confusion.
- **Evolution**: New species are continuously discovered, and existing species evolve rapidly.
- **Insight**: Studying organisms with similar features provides insights into their relationships and characteristics.

Historical Classification

- **Aristotle**: Classified organisms based on simple characters such as shape, size (morphology), and habitat.
- **Carl Linnaeus**: Developed the binomial nomenclature system, classifying organisms into two kingdoms: **Plantae** and **Animalia**.
- **Robert Whittaker (1969)**: Proposed a five-kingdom classification system: **Monera**, **Protista**, **Fungi**, **Plantae**, and **Animalia**.
- **Ernst Haeckel**: Introduced a three-kingdom classification, separating unicellular organisms into **Protists**, **Plants**, and **Animals**.
- **Carl Woese**: Proposed a six-kingdom system, incorporating **Bacteria**, **Archaea**, and **Eukarya**.

Modern Classification

- **Taxonomic Hierarchy**: Organisms are classified into seven major groups (taxa):
  - Kingdom
  - Phylum
  - Class
  - Order
  - Family
  - Genus
  - Species
- **Phylogenetic Approach**: Classification is based on evolutionary relationships and similarities with ancient species.
- **Subgroups**: Each major group is further divided into smaller subgroups based on increasing levels of similarity.

Taxonomic Classification

- **Carl Woese**: Introduced a six-kingdom system by dividing Monera into:
  - **Eubacteria**: True bacteria.
  - **Archaebacteria**: Ancient, often extreme-environment bacteria.

- **Five-Kingdom-Classification**: Proposed by Robert Whittaker, based on:
  - **Cell Structure**: Distinguishing between prokaryotic and eukaryotic cells.
  - **Body-Organization**: Differentiating between unicellular and multicellular organisms.
  - **Nutrition**: Classifying organisms based on their methods of obtaining nutrients (e.g., autotrophic or heterotrophic).

Taxonomy: An Overview

Definition

- **Taxonomy** is the science of classifying and naming organisms based on their characteristics and evolutionary relationships. It provides a framework for organizing biological diversity, enabling clear communication and systematic study of organisms.

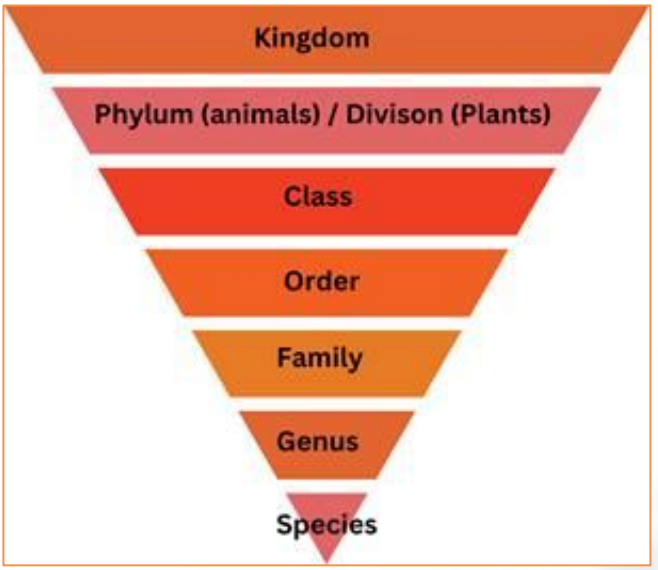
Objectives

- **Organization**: Systematically categorize the vast diversity of life.
- **Identification**: Establish a universal naming system for clear communication about species.

Key Taxonomic Ranks

(Generally used: 7 ranks [KPCOFGS])

1. **Domain**: The highest rank, including:
   - **Bacteria**
   - **Archaea**
   - **Eukarya**
2. **Kingdom**: Broad groups such as:
   - **Animalia**
   - **Plantae**
   - **Fungi**
   - **Protista**
   - **Monera**
3. **Phylum**: Groups organisms based on major body plans and structural features.
4. **Class**: Further categorizes organisms within a phylum based on more specific characteristics.
5. **Order**: Groups families that share common traits.
6. **Family**: A collection of genera (plural of genus) that have more specific similarities.
7. **Genus**: A group of species that are closely related and share a common ancestor.
8. **Species**: The most specific rank, identifying individual organisms that can interbreed and produce fertile offspring



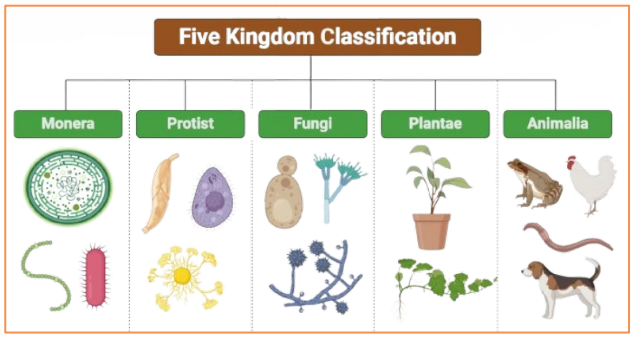
Modern Taxonomy

Key Concepts

- **Phylogenetics**: Classification based on evolutionary relationships and genetic information.
- **Molecular Techniques**: Utilization of DNA sequencing and other molecular methods to determine relationships and classify organisms.
- **Cladistics**: A classification method that organizes organisms based on common ancestry and evolutionary history.

Species

- **Definition**: The fundamental and smallest unit of classification. Organisms of the same species can interbreed and produce fertile offspring.
- **Reproduction**: Members of the same species reproduce, giving rise to progeny that resemble their parents.
- **Hybridization**: Similar species can interbreed to produce hybrids, which may exhibit characteristics of both parent species.



Monera

Characteristics:

- **Nucleus:** Lacks a well-defined nucleus (prokaryotic).
- **Body Organization:** Simple and unicellular.
- **Cell Wall:** Present in most, except for Mycoplasma.
- **Size:** The largest kingdom on Earth.

Mode of Nutrition:

- **Autotrophic:** Producing their own food (e.g., some bacteria and blue-green algae).
- **Heterotrophic:** Obtaining food from other organisms (e.g., many bacteria).

Includes:

- **Bacteria:** Common prokaryotic organisms.
- **Blue-Green Algae:** Also known as cyanobacteria.
- **Mycoplasma:** Smallest bacteria lacking a cell wall.

Examples:

- **Anabaena:** A type of blue-green algae.
- **Bacillus:** Includes bacteria like Bacillus anthracis (causes anthrax).
- **Escherichia coli:** Commonly found in the intestines of warm-blooded organisms.
- **Streptococcus:** Includes bacteria that cause strep throat.
- **Mycoplasma pneumoniae:** Causes atypical pneumonia.
- **Cyanobacteria:** Such as Spirulina, used as a dietary supplement.

Image: Blue Green Algae

Protista

Characteristics:

- **Nucleus:** Eukaryotic, with a well-defined nucleus.
- **Body Organization:** Unicellular; a single cell performs all body functions.
- **Movement:**
  - **Flagella:** Tail-like structures for movement.
  - **Cilia:** Hair-like structures for movement.
  - **Pseudopodia:** Temporary projections used for movement (e.g., in amoeba).

Mode of Nutrition:

- **Autotrophic:** Photosynthetic (e.g., Euglena, dinoflagellates).
- **Heterotrophic:** Obtaining nutrients from other organisms.
- **Photosynthetic:** Examples include Euglena and some dinoflagellates.

Pathogenic Nature:

- Many protists are pathogenic and cause diseases:
  - **Amoeba:** Causes dysentery.
  - **Plasmodium:** Causes malaria.

Examples:

- **Unicellular Algae:** Such as diatoms, which have silica in their cell walls and form sediments on water beds.
- **Diatoms:** Have silica in their cell walls.
- **Paramecium:** Known for its cilia.
- **Amoeba:** Moves using pseudopodia.
- **Euglena:** Exhibits both plant-like and animal-like characteristics.
- **Plasmodium:** Causes malaria.
- **Red Dinoflagellates:** Multiply rapidly, causing red tides that are toxic for marine animals.

Fungi

Characteristics:

- **Nucleus:** Eukaryotic, with a well-defined nucleus.
- **Body Organization:** Can be unicellular or multicellular.
  - **Unicellular:** Example: Baker's yeast (*Saccharomyces cerevisiae*).
  - **Multicellular:** Example: Mushrooms (*Agaricus*).

Mode of Nutrition:

- **Saprotrophic:** Feed on decaying matter.
- **Parasitic:** Obtain nutrients from living hosts.
- **Heterotrophic:** Rely on other organisms for food.

Commercial, Medicinal, and Ecological Uses:

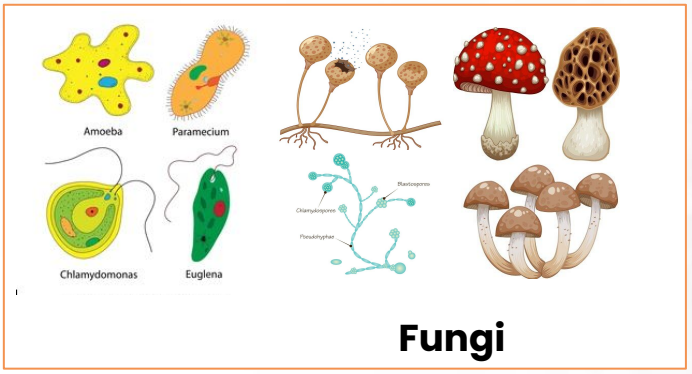
- **Commercial:** Yeasts are used in baking and winemaking.
- **Medicinal:** Certain molds produce antibiotics, such as penicillin from *Penicillium*.
- **Ecological:** Decomposers in ecosystems, breaking down organic material.

Examples:

- **Saccharomyces:** Yeast used in baking and brewing.
- **Penicillium:** Mold used in antibiotic production.
- **Agaricus:** Edible mushrooms, such as button mushrooms.

Structure:

- **Hyphae:** Thread-like structures that make up the fungal body.
- **Cell Wall:** Composed of chitin.



Fungi

The Plant Kingdom

Characteristics:

- **Organization:** Multicellular.
- **Mode of Nutrition:** Primarily autotrophic; occasionally parasitic.

Divisions:

- **Thallophyta:** Includes algae; simple plant structures.
- **Bryophyta:** Includes mosses and liverworts; non-vascular plants.
- **Pteridophyta:** Includes ferns; vascular plants but no seeds.
- **Gymnosperms:** Seed-bearing plants with naked seeds (e.g., conifers).
- **Angiosperms:** Seed-bearing plants with enclosed seeds (e.g., flowering plants).

Classification Basis:

- **Cellular Organization:** Varies from simple thalloid structures to complex vascular systems.
- **Presence of Vascular Tissue:**
  - **Non-Vascular:** Thallophyta, Bryophyta.
  - **Vascular:** Pteridophyta, Gymnosperms, Angiosperms.
- **Mode of Reproduction:**
  - **Cryptogams:** Do not bear visible seeds; include Thallophyta, Bryophyta, and Pteridophyta.
  - **Phanerogams:** Have visible seeds; include Gymnosperms and Angiosperms.

Examples:

- **Thallophyta:** Algae, including green, red, and brown algae.
- **Bryophyta:** Mosses and liverworts.
- **Pteridophyta:** Ferns and horsetails.
- **Gymnosperms:** Pine trees, fir trees, and cycads.
- **Angiosperms:** Roses, orchids, and oak trees.

Thallophyta

Characteristics:

- **Body Organization:** Can be unicellular or multicellular.
- **Body Structure:** Lacks a well-defined body structure; collectively known as thallus.
- **Common Name:** Algae.
- **Habitat:** Predominantly aquatic.

Classification: Divided into classes based on pigments.

Examples:

- **Spirogyra:** Green filamentous algae.
- **Ulothrix:** Green algae found in freshwater.
- **Cladophora:** Green, branched algae.
- **Ulva:** Green seaweed, also known as sea lettuce.
- **Chara:** Freshwater green algae with a plant-like structure.
- **Kelp:** Brown seaweed with large, leaf-like structures.
- **Fucus:** Brown algae found along coastlines.
- **Chlamydomonas:** Unicellular green algae with flagella.

Bryophyta

Characteristics:

- **Ecological Role:** Known as the amphibians of the plant kingdom; essential for various ecosystems.
- **Habitat:** Typically found in moist and shady areas, such as tree bark and near water bodies.
- **Water Dependency:** Require water for reproduction but can survive on land.
- **Vascular Tissue:** Absent; lack specialized tissues for water conduction.

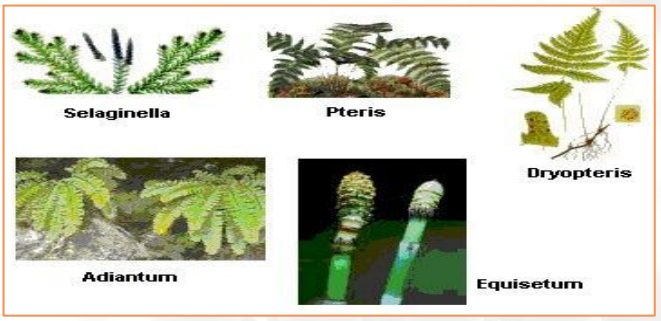
Body Structure: More differentiated than Thallophyta, with structures resembling roots and leaves.

Examples:

- **Marchantia:** Liverwort with a flattened, lobed thallus.
- **Riccia:** Liverwort with a simple, ribbon-like thallus.
- **Sphagnum:** Moss that forms peat bogs; important for soil formation and water retention.
- **Funaria:** Moss with a leafy stem and capsule for spore production.

Ecological Importance:

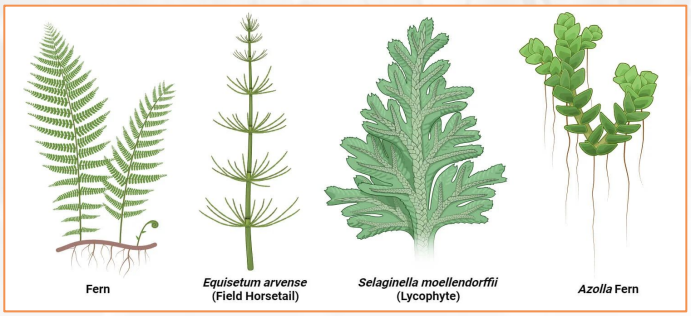
- **Soil Binding:** Helps prevent soil erosion by binding soil particles together.



Pteridophyta

Characteristics:

- **Body Differentiation:** Highly differentiated into roots, stems, and leaves.
- **Habitat:** Typically found in moist, shady, and damp environments.



Importance:

- **Evolutionary Link:** Serves as a transitional group between cryptogams (non-seed plants) and phanerogams (seed-bearing plants).

Vascular Tissue: Contains primitive vascular tissues for the conduction of water and nutrients.

Examples:

- **Marsilea:** Water fern with clover-like leaves.
- **Fern:** Diverse group with feather-like leaves called fronds.
- **Equisetum:** Also known as horsetail; characterized by jointed stems and reduced leaves.

Gymnosperms

Characteristics:

- **Seed Type:** Seeds are not enclosed within fruits; "gymnosperm" means "naked seed."
- **Habit:** Usually perennial, evergreen, and woody.

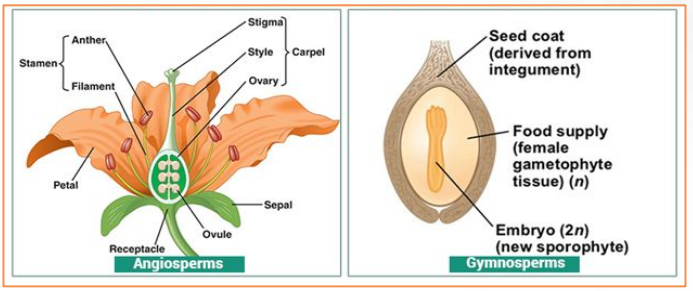
Special Features:

- **Cycus:** Has coralloid roots specialized for nitrogen fixation.
- **Pinus:** Forms symbiotic associations with mycorrhiza, aiding in nutrient absorption.

Examples:

- **Pinus:** Pine trees with needle-like leaves and cones.
- **Ginkgo:** Unique tree with fan-shaped leaves; known for its resilience and medicinal uses.
- **Cycus:** Palm-like plant with large, compound leaves and cones.

Body Structure: Gymnosperms do not have a well-defined body structure, unlike more advanced plants.



Angiosperms

Characteristics:

- **Seed Type:** Seeds are enclosed within an ovary, which matures into a fruit; "angiosperm" means "covered seed."
- **Common Name:** Also known as flowering plants.
- **Embryo Structure:** Seeds contain cotyledons (seed leaves) which provide nourishment to the developing embryo.

Classification:

- **Dicotyledonous (Dicots):** Plants with two cotyledons.
- **Monocotyledonous (Monocots):** Plants with one cotyledon.

Examples:

- **Dicots:** Roses, beans, sunflowers.
- **Monocots:** Grasses, lilies, orchids.

Key Feature:

Fruit Formation: The ovary develops into a fruit, which protects the seeds and aids in their dispersal.

Morphology of Angiosperms

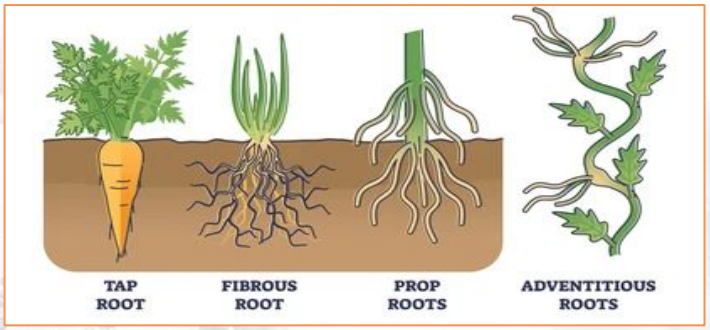
Roots

Functions:

- **Anchorage:** Secure the plant to the soil.
- **Absorption:** Take up water and nutrients from the soil.
- **Conduction:** Transport water and minerals to the stem.
- **Storage:** Store nutrients and carbohydrates (e.g., carrots, beets).

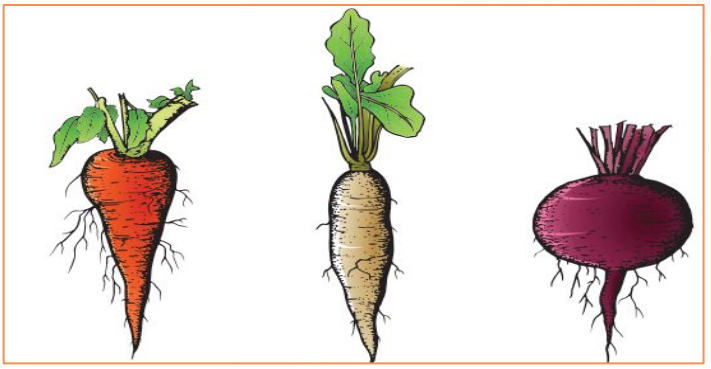
Types:

1. **Tap Root System:**
   - **Description:** The primary root grows deep into the soil and branches into secondary and tertiary roots.
   - **Example:** Mustard plant.
   - **Modification:** In dicotyledonous plants, the radicle directly elongates to form the primary root, which develops lateral roots.
2. **Fibrous Root System:**
   - **Description:** The primary root is short-lived and replaced by numerous thin roots emerging from the base of the stem.
   - **Example:** Wheat plant.
3. **Adventitious Roots:**
   - **Description:** Roots arise from parts of the plant other than the radicle.
   - **Types:**
     - **Prop Roots:** Support structures for plants like banyan trees.
     - **Stilt Roots:** Supporting roots from lower stem nodes in plants like maize and sugarcane.
     - **Pneumatophores:** Roots that grow vertically upwards for oxygen intake in swampy areas (e.g., *Rhizophora*).



Modifications:

- **Food Storage:** Underground stems (e.g., potato, ginger, turmeric).
- **Climbing:** Stem tendrils (e.g., cucumber, grapevines).
- **Defense:** Woody thorns (e.g., Citrus, Bougainvillea).
- **Photosynthesis:** Flattened or cylindrical stems in arid regions (e.g., *Opuntia*, *Euphorbia*).
- **Vegetative Propagation:** Underground stems spreading to form new plants (e.g., grass, strawberry).



Stem

Functions:

- **Support:** Supports branches, leaves, and flowers.
- **Transport:** Moves water, nutrients, and food between roots and other parts.
- **Growth:** Contains meristematic tissues for growth.
- **Storage:** Stores nutrients in some plants.

Types:

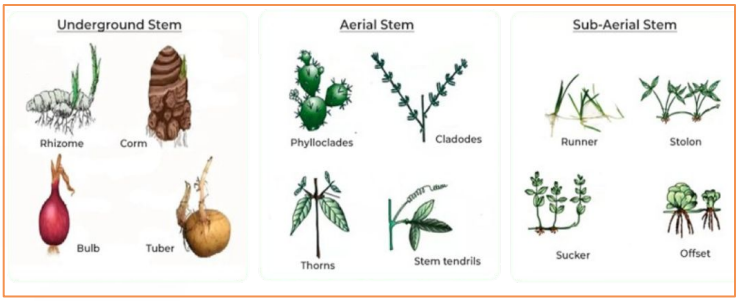
1. **Herbaceous Stem:**
   - **Description:** Soft, green, and flexible.
   - **Example:** Beans, sunflowers.
2. **Woody Stem:**
   - **Description:** Hard, rigid, and covered with bark.
   - **Example:** Oak, maple.

Parts:

- **Node:** Point where leaves or branches attach.
- **Internode:** Space between two nodes.
- **Bud:** Undeveloped shoot or flower.
- **Xylem and Phloem:** Vascular tissues for transport.

Modifications:

- **Food Storage:** Underground stems (e.g., potato, ginger).
- **Climbing:** Stem tendrils (e.g., grapevines).
- **Defense:** Woody thorns (e.g., Citrus).
- **Photosynthesis:** Flattened stems (e.g., *Opuntia*).



Leaves

Functions:

- **Photosynthesis:** Convert light energy into chemical energy.
- **Transpiration:** Release water vapor through stomata.
- **Gas Exchange:** Exchange gases (O_2 and CO_2).

Parts:

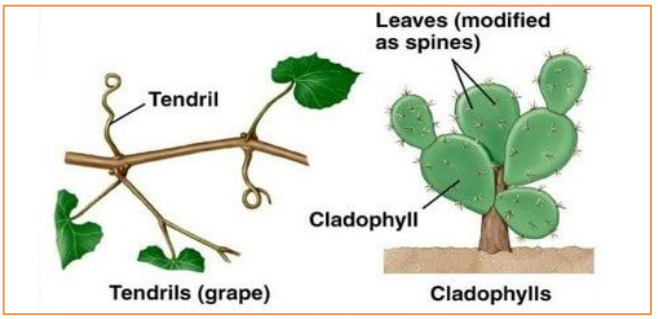
- **Leaf Base:** Attaches the leaf to the stem.
- **Petiole:** Stalk that holds the blade to the light; flexible petioles allow fluttering for cooling.
- **Lamina (Blade):** Green, expanded part with veins and veinlets; midrib is the central vein providing rigidity and transport channels.

Venation:

- **Parallel Venation:**
  - **Description:** Veins run parallel to each other.
  - **Example:** Monocotyledons (e.g., grasses).
- **Reticulate Venation:**
  - **Description:** Veins form a network.
  - **Example:** Dicotyledons (e.g., maple).

Modifications:

- **Tendrils:** For climbing (e.g., peas).
- **Spines:** For defense (e.g., cacti).
- **Food Storage:** Fleshy leaves (e.g., onion, garlic).
- **Insectivorous:** Modified leaves for trapping insects (e.g., pitcher plant, Venus flytrap).



Phylum Porifera

Common Name: Sponges

Symmetry: Asymmetrical

Organization:

- **Level:** Cellular; hence, they are acoelomate (lack a true body cavity).
- **Body Structure:** Simplest multicellular animals with minimal differentiation. The body is covered with numerous pores (ostia) that lead to an internal canal system. This system helps in water circulation, facilitating feeding, respiration, and excretion.

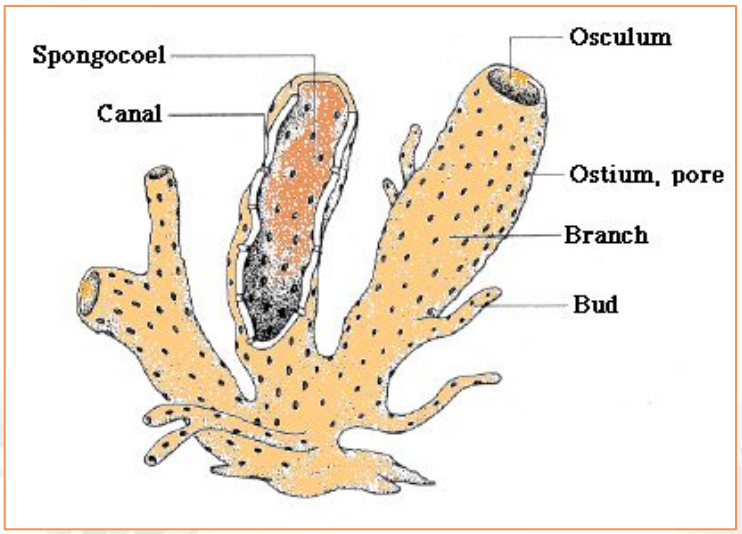
Habitat:

- **Marine:** Predominantly marine species.
- **Aquatic:** Some species are found in freshwater environments.

Movement: Non-motile; they are sessile animals, meaning they are attached to solid surfaces like rocks or submerged objects.

Examples:

- **Euplectella:** Venus flower basket.
- **Sycon**
- **Spongilla**



Phylum Coelenterata (Cnidaria)

Body Cavity: Acoelomate (lacks a true body cavity)

Germ Layers: Diploblastic (body made up of two layers of cells: ectoderm and endoderm)

Symmetry: Radial symmetry

Organization:

- **Level:** Tissue level of organization; although simple, they have specialized tissues.
- **Body Structure:** Possess a single opening that serves as both mouth and anus, surrounded by tentacles.

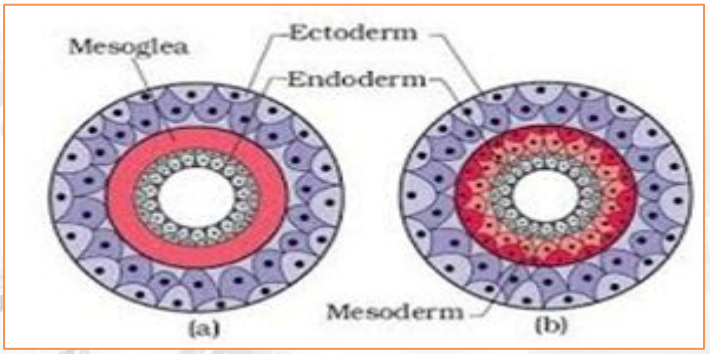
Animal Kingdom

The Animal Kingdom is a vast and diverse classification of living organisms, ranging from simple sponges to complex mammals like humans. The classification of animals is based on several criteria that help organize this diversity into systematic categories.

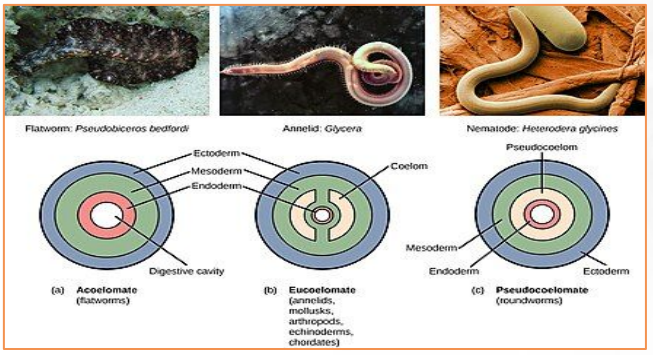
Basis of Classification:

- **Levels of Organization:**
  - **Cellular Level:** Simplest form, seen in sponges.
  - **Tissue Level:** Cells are grouped into tissues, as in cnidarians.
  - **Organ Level:** Tissues form organs, as seen in flatworms.
  - **Organ-System Level:** Organs work together in systems, like in vertebrates.
- **Body Symmetry:**
  - **Asymmetry:** No symmetry (e.g., sponges).
  - **Radial Symmetry:** Body parts arranged around a central axis (e.g., starfish).
  - **Bilateral Symmetry:** Body can be divided into two identical halves (e.g., humans).

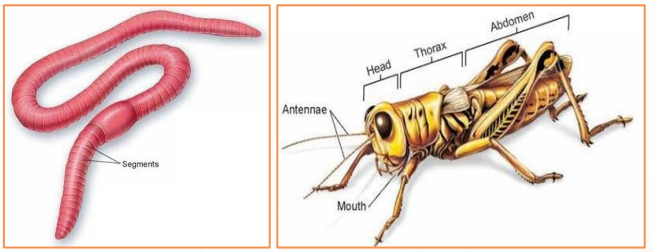
- **Germ Layers:**
  - **Diploblastic:** Two germ layers (ectoderm and endoderm).
  - **Triploblastic:** Three germ layers (ectoderm, mesoderm, and endoderm).



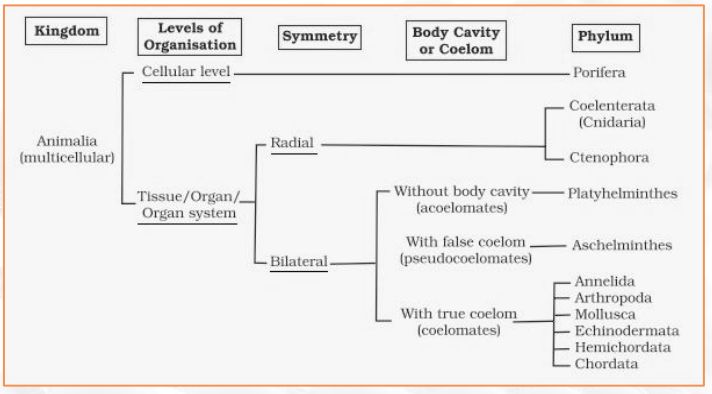
- **Body Cavity (Coelom):**
  - **Acoelomates:** No body cavity (e.g., flatworms).
  - **Pseudocoelomates:** False coelom (e.g., roundworms).
  - **Coelomates:** True body cavity lined with mesoderm (e.g., annelids, vertebrates).



- **Segmentation:**
  - Division of the body into segments, found in organisms like annelids (earthworms).



- **Presence of Notochord:**
  - **Non-chordates:** Lack a notochord (e.g., arthropods).
  - **Chordates:** Have a notochord at some stage in life (e.g., vertebrates).



Habitat:

- **Marine:** Predominantly marine species, but some can also be found in freshwater environments.
- **Colonies and Solitary Forms:** Some, like corals, live in colonies; others, like Hydra, live solitary lives.

Special Features:

- **Metamorphosis:** Some cnidarians exhibit metamorphosis, transitioning from larval to adult forms.
- **Cnidocytes:** Possess specialized cells called cnidocytes, which contain stinging organelles (nematocysts) used for defense and capturing prey.

Examples:

- **Jellyfish:** *Aurelia*
- **Sea Anemones:** *Adamsia*
- **Corals:** *Gorgonia*
- **Hydra**

Phylum Platyhelminthes (Flatworms)

Common Name: Flatworms

Body Cavity: Acoelomate (lacks a true body cavity)

Germ Layers: Triploblastic (three germ layers: ectoderm, mesoderm, and endoderm)

Symmetry: Bilateral symmetry

Organization:

- **Level:** Organ level of organization.
- **Body Structure:** Flattened dorsoventrally, unsegmented body.

Habitat:

Marine, Freshwater, and Terrestrial: Found in a variety of environments, often as parasites in animals and humans.

Special Features:

- **Digestive System:** Incomplete or absent; single opening serving as both mouth and anus.
- **Nervous System:** Simple, with a pair of nerve cords and ganglia.
- **Excretory System:** Flame cells (protonephridia) for excretion and osmoregulation.

Reproduction:

Sexual and Asexual: Most are hermaphrodites, capable of both sexual and asexual reproduction.

Examples:

- **Planaria:** Free-living flatworm, known for its remarkable regenerative abilities.
- **Taenia (Tapeworm):** Parasitic flatworm, found in the intestines of vertebrates.
- **Fasciola (Liver Fluke):** Parasitic, affects the liver of various mammals, including humans.

Phylum Nematoda (Roundworms)

Common Name: Roundworms

Body Cavity: Pseudocoelomate (body cavity partially lined with mesoderm)

Germ Layers: Triploblastic

Symmetry: Bilateral symmetry

Organization:

- **Level:** Organ level of organization.
- **Body-Structure:** Cylindrical, unsegmented, covered with a tough cuticle.

Habitat:

Ubiquitous: Found in almost every habitat, including soil, freshwater, and marine environments. Many are parasitic.

Special Features:

- **Digestive System:** Complete, with separate mouth and anus.
- **Nervous System:** Simple, with a nerve ring and longitudinal nerve cords.
- **Excretory System:** Renette cells or tubular system for excretion.

Reproduction:

- **Sexual:** Dioecious (separate sexes), with internal fertilization.

Examples:

- **Ascaris:** Intestinal parasite in humans and pigs.
- **Wuchereria (Filarial Worm):** Causes lymphatic filariasis (elephantiasis).
- **Caenorhabditis elegans:** Free-living nematode, widely used in scientific research.

Phylum Annelida (Segmented Worms)

Common Name: Segmented worms

Body Cavity: Coelomate (true body cavity fully lined with mesoderm)

Germ Layers: Triploblastic

Symmetry: Bilateral symmetry

Organization:

- **Level:** Organ-system level of organization.
- **Body Structure:** Segmented body, with repeated segments (metameres).

Habitat:

- **Marine, Freshwater, and Terrestrial:** Found in diverse environments; some are parasitic.

Special Features:

- **Digestive System:** Complete, with a specialized alimentary canal.
- **Circulatory System:** Closed circulatory system with blood vessels.
- **Nervous System:** Well-developed, with a ventral nerve cord and segmental ganglia.
- **Excretory System:** Nephridia in each segment for excretion.

Reproduction:

- **Sexual:** Hermaphroditic or dioecious, with external or internal fertilization.

Examples:

- **Earthworm:** *Lumbricus* (important for soil fertility).
- **Leech:** *Hirudinaria* (parasitic, used medicinally for bloodletting).
- **Nereis:** Marine annelid known for its parapodia used in locomotion.

Phylum Arthropoda

Common Name: Arthropods

Body Cavity: Coelomate

Germ Layers: Triploblastic

Symmetry: Bilateral symmetry

Organization:

- **Level:** Organ-system level of organization.
- **Body Structure:** Segmented body, with jointed appendages and an exoskeleton made of chitin.

Habitat:

- **Ubiquitous:** Found in almost every habitat on Earth, including land, water, and air.

Special Features:

- **Digestive System:** Complete, with specialized mouthparts and digestive glands.
- **Circulatory System:** Open circulatory system with hemolymph.
- **Nervous System:** Complex, with a brain, ventral nerve cord, and sensory organs.
- **Excretory System:** Malpighian tubules for excretion.


Phylum Mollusca

Common Name: Molluscs

Body Cavity: Coelomate

Germ Layers: Triploblastic

Symmetry: Bilateral symmetry

Organization:

- **Level:** Organ-system level of organization.
- **Body Structure:** Soft-bodied, usually with a hard external shell made of calcium carbonate.

Habitat:

- **Marine, Freshwater, and Terrestrial:** Found in various environments, with a majority being marine.

Special Features:

- **Digestive System:** Complete, often with a radula (a rasping tongue-like structure).
- **Circulatory System:** Open circulatory system, except in cephalopods.
- **Nervous System:** Varies from simple to complex, with a nerve ring and paired nerve cords.
- **Excretory System:** Nephridia for excretion.


Phylum Echinodermata

Common Name: Echinoderms

Body Cavity: Coelomate

Germ Layers: Triploblastic

Symmetry: Radial symmetry in adults (usually pentaradial), bilateral symmetry in larvae.

Organization:

- **Level:** Organ-system level of organization.
- **Body Structure:** Spiny skin, water vascular system for movement, feeding, and respiration.

Habitat:

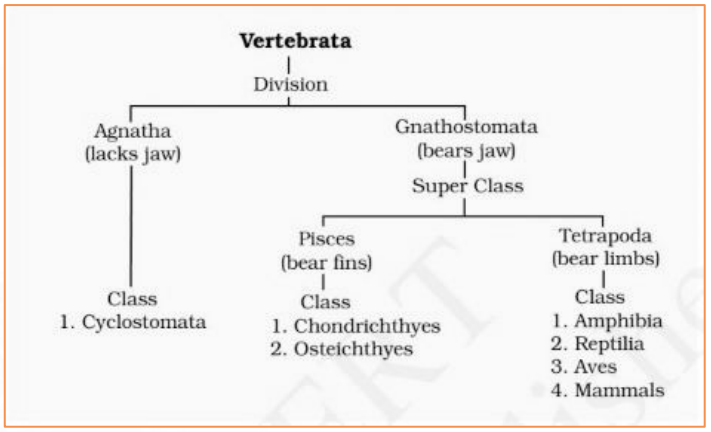
- **Marine:** Exclusively marine, found in various oceanic environments.

Special Features:

- **Digestive System:** Complete, with specialized feeding structures.
- **Circulatory System:** Reduced; relies on the water vascular system.
- **Nervous System:** Simple, with a nerve ring and radial nerves.
- **Excretory System:** No specialized excretory system; waste diffuses out.

Examples:

- **Starfish:** *Asterias* (known for its ability to regenerate lost arms).
- **Sea Urchin:** Spiny, round-bodied; important in marine ecosystems.
- **Sea Cucumber:** Elongated body; can eject internal organs as a defense mechanism.



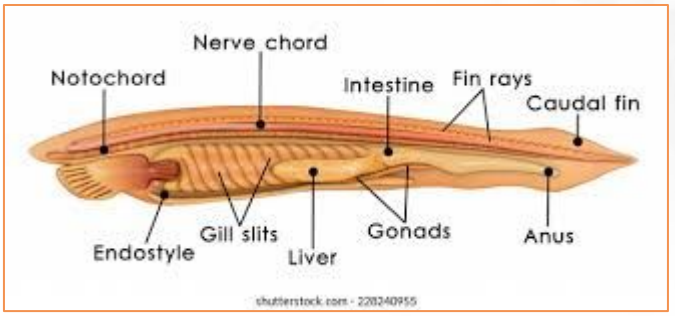
Phylum Vertebrata

Common Features:

- **Vertebral Column:** True vertebral column (backbone) present, replacing the notochord in most vertebrates.
- **Internal Skeleton:** Endoskeleton made of bone or cartilage.
- **Symmetry:** Bilaterally symmetrical.
- **Germ Layers:** Triploblastic (three germ layers: ectoderm, mesoderm, and endoderm).
- **Body Cavity:** Coelomate (true body cavity fully lined with mesoderm).
- **Body Structure:** Complex differentiation of tissues and organs.

Distinctive Features:

- **Notochord:** Present in embryonic stages and replaced by the vertebral column in adults.
- **Dorsal Nerve Cord:** Located along the back and protected by the vertebral column.
- **Paired Gill Pouches:** Present in embryonic stages or throughout life, used for respiration.



Classes of Vertebrata

Cyclostomata (Jawless Fish)

Common Features:

- **Body Shape:** Elongated, eel-like.
- **Mouth:** Circular with suckers.
- **Skin:** Slimy and without scales.
- **Parasites:** Ectoparasites of other vertebrates; sometimes in symbiotic relationships.
- **Gill Slits:** Paired gill slits present.
- **Habitat:** Mostly marine environments.

Examples:

- **Lamprey:** *Petromyzon*
- **Hagfish:** *Myxine*

Pisces (Fish)

Common Features:

- **Jaw:** Present.
- **Habitat:** Can be marine or freshwater.
- **Skin:** Scales present.
- **Gill Slits:** Well-formed paired and covered gill slits.
- **Heart:** 2-chambered.
- **Fins:** Used for movement.
- **Body Temperature:** Cold-blooded (ectothermic).

Examples:

- **Mandarin-Fish:** *Synchiropus splendidus*
- **Angler Fish:** *Caulophyryne jordani*
- **Lion Fish:** *Pterois volitans*
- **Electric Ray:** *Torpedo*
- **Sting Ray**
- **Dog Fish:** *Scoliodon*
- **Rohu:** *Labeo rohita*
- **Sea Horse:** *Hippocampus*
- **Flying Fish:** *Exocoetus*
- **Climbing Perch:** *Anabas*



Tetrapoda (Four-Limbed Animals)

- **Amphibia**
- **Reptilia**
- **Aves**
- **Mammalia**

This classification encompasses a diverse range of animals adapted to various environments, from terrestrial to aquatic habitats. Each class exhibits unique adaptations and characteristics essential for survival.

Amphibia (Amphibians)

Common Features:

- **Limbs:** Present, typically four.
- **Skin:** Covered in slimy mucus, allowing for cutaneous respiration.
- **Respiration:** Use gills in larvae, lungs in adults, and some may have external gills.
- **Life Cycle:** Includes both aquatic (larval) and terrestrial (adult) stages; undergo metamorphosis.
- **Reproduction:** Oviparous (lays eggs in water).
- **Heart:** 3-chambered.
- **Body Temperature:** Cold-blooded (ectothermic).

Examples:

- **Common Frog:** *Rana tigrina*
- **Tree Frog:** *Hyla*
- **Salamander**

Reptilia (Reptiles)

Common Features:

- **Limbs:** Present, usually four (except for some snakes).
- **Skin:** Covered in scales, providing protection and reducing water loss.
- **Respiration:** Lungs are the primary respiratory organs.
- **Habitat:** Mostly terrestrial, some are aquatic.
- **Reproduction:** Oviparous (lays eggs).
- **Heart:** 3-chambered (4-chambered in crocodiles).
- **Body Temperature:** Cold-blooded (ectothermic).

Examples:

- **Turtle**
- **Chameleon**
- **King Cobra**
- **House Wall Lizard:** *Hemidactylus*
- **Flying Lizard:** *Draco*

Aves (Birds)

Common Features:

- **Limbs:** Present, adapted as wings in many species.
- **Skin:** Covered in feathers, aiding in flight and insulation.
- **Respiration:** Lungs with a highly efficient air sac system.
- **Habitat:** Primarily terrestrial, with some species adapted to aquatic environments.
- **Reproduction:** Oviparous (lays eggs, often with complex nesting behaviors).
- **Heart:** 4-chambered.
- **Body Temperature:** Warm-blooded (homeothermic).

Examples:

- **White Stork:** *Ciconia ciconia*
- **Ostrich:** *Struthio camelus*
- **Tufted Duck:** *Aythya fuligula*
- **Pigeon**
- **Sparrow**
- **Crow**

Mammalia (Mammals)

Common Features:

- **Limbs:** Present, adapted for various modes of locomotion.
- **Skin:** Covered in hair or fur; possesses oil glands for moisture and protection.
- **Respiration:** Lungs, facilitating efficient gas exchange.
- **Habitat:** Primarily terrestrial, though many species are adapted to aquatic or aerial environments.
- **Reproduction:** Viviparous (most give birth to live young, with some exceptions like monotremes).
- **Heart:** 4-chambered, providing efficient circulation.
- **Body Temperature:** Warm-blooded (homeothermic), maintaining a constant internal temperature.



Examples:

Whale	Adapted for life in the ocean, with streamlined bodies.	
Human	Highly developed brain, bipedal locomotion.	
Cat	Agile predators with retractable claws.	
Rat	Highly adaptable rodents, often found in diverse habitats.	

Human Health and Diseases

What is Health?

Definition: Health is a state of complete physical, mental, and social well-being, not merely the absence of disease or infirmity.

Factors Affecting Health

- **Genetic Factors:** Inherited traits and predispositions.
- **Environmental Factors:** Pollution, climate, and living conditions.
- **Lifestyle Choices:** Diet, exercise, and habits.
- **Socioeconomic Status:** Access to healthcare, education, and living standards.
- **Healthcare Access:** Availability and quality of medical services.

Immune System Overview

The immune system is the body's defense mechanism against infections, diseases, and foreign invaders like bacteria, viruses, and toxins. It comprises various organs, cells, and proteins that work together to protect the body.

Components of the Immune System

- **Primary Organs:**
  - **Bone Marrow:** Produces blood cells, including white blood cells (WBCs).
  - **Thymus:** Site where T-cells mature, crucial for immune responses.
- **Secondary Organs:**
  - **Lymph Nodes:** Filter lymph fluid, trapping pathogens.
  - **Spleen:** Filters blood and stores WBCs.
  - **Tonsils and Adenoids:** First line of defense against ingested or inhaled pathogens.

Cells of the Immune System

White Blood Cells (WBCs):

- **Neutrophils:** Attack bacteria.
- **Lymphocytes:** Include B-cells and T-cells, central to adaptive immunity.
- **Macrophages:** Engulf and digest pathogens.
- **Dendritic Cells:** Present antigens to T-cells.

Types of Immunity

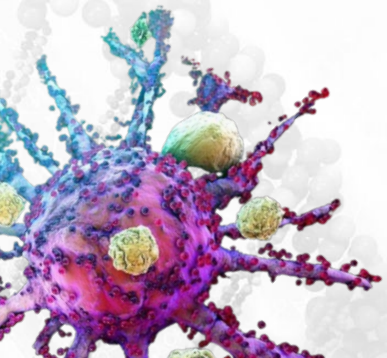
- **Innate Immunity:**
  - Non-specific, immediate response (e.g., skin, mucous membranes).
- **Adaptive Immunity:**
  - Specific defense tailored to pathogens; involves memory for faster response.
  - **Humoral Immunity:** B-cells produce antibodies.
  - **Cell-Mediated Immunity:** T-cells destroy infected cells.

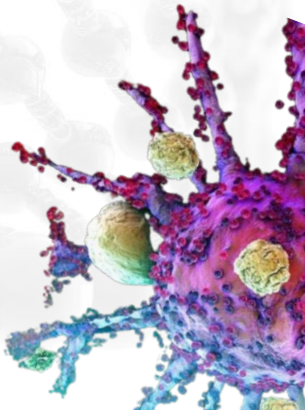
Functions of the Immune System

- **Recognition:** Identifies harmful pathogens.
- **Response:** Activates immune cells to eliminate pathogens.
- **Memory:** Remembers past infections for quicker future responses.

Disorders of the Immune System

- **Autoimmune Diseases:** The immune system attacks the body's own tissues (e.g., rheumatoid arthritis).
- **Immunodeficiency:** Weakened immune system (e.g., HIV/AIDS).
- **Hypersensitivity:** Overreaction to harmless substances (e.g., allergies).





Types of Diseases

- **Infectious Diseases:** Caused by pathogens (e.g., bacteria, viruses).
- **Non-Infectious Diseases:** Chronic diseases (e.g., diabetes) and genetic disorders.
- **Lifestyle Diseases:** Related to lifestyle choices (e.g., heart disease).
- **Degenerative Diseases:** Progressive degeneration of tissues (e.g., arthritis).

Meaning of 'Health' and 'Disease'

- **Health:** State of well-being and optimal functioning.
- **Disease:** A condition of disturbed ease, characterized by discomfort and dysfunction.

Poor Health vs. Disease

- **Poor Health:** General unwellness without a specific disease.
- **Disease:** Specific condition diagnosed through symptoms and tests.

Complexity of Poor Health

- **Poor Health Without Identifiable Disease:** Symptoms present, but no clear disease diagnosed.
- **Societal and Community Health:** Focus on overall well-being and public health measures.
- **Individual Health:** Focus on diagnosing and treating specific diseases.

Not Being Diseased ≠ Being Healthy

Example: Diarrhea might not have a specific cause identified but can still affect overall health.

Disease Manifestation and Diagnosis

- **Tissues and Organ Systems:** Disruption of tissues affects organ systems.
- **Symptoms and Signs:**
  - **Symptoms:** Felt experiences (e.g., headache).
  - **Signs:** Observable indicators (e.g., fever).
- **Laboratory Tests:** Used to confirm the presence of disease.

Identifying Disease

- **Clinical Evaluation:** Patient history, physical examination, and diagnostic tests.
- **Laboratory Tests:** Provide detailed information for diagnosis.

Causes of Diseases

- **Immediate Causes:** Direct factors (e.g., infectious agents).
- **Contributory Causes:** Underlying factors (e.g., environmental, behavioral, socioeconomic).

Effects of Diseases on Health

- **Acute Diseases:** Minimal long-term effects; symptoms are severe but short-lived (e.g., flu).
- **Chronic Diseases:** Prolonged poor health (e.g., diabetes), impacting daily life and well-being.

This framework emphasizes the multifaceted nature of health and disease, recognizing the interplay of biological, environmental, and lifestyle factors in maintaining well-being.

Factor	Acute Diseases	Chronic Diseases
Onset	Sudden	Gradual
Duration	Short-term	Long-term
Severity	Severe	Variable
Treatment	Often resolves quickly	Requires long-term management
Recovery	Usually complete	Ongoing management, may not be curable
Examples	Flu, appendicitis	Diabetes, arthritis

Infectious Diseases

Definition: Infectious diseases are caused by pathogens such as bacteria, viruses, fungi, and parasites. These pathogens invade and multiply within the host's body, leading to various health issues.

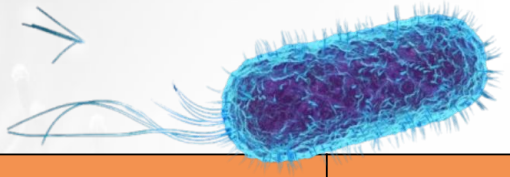
Key Pathogens and Their Effects:

- **Bacteria**:
  - Single-celled organisms.
  - Cause diseases such as tuberculosis, strep throat, and urinary tract infections.
  - Some bacteria are beneficial, while pathogenic bacteria can lead to serious infections.
- **Viruses**:
  - Much smaller than bacteria; require a living host to multiply.
  - Cause diseases including the flu, HIV/AIDS, and COVID-19.
- **Fungi**:
  - Can affect the skin, lungs, and other organs.
  - Common infections include athlete's foot and ringworm.
- **Parasites**:
  - Organisms that live on or in a host.
  - Cause diseases such as malaria (by Plasmodium parasites) and toxoplasmosis.

Disease Transmission:

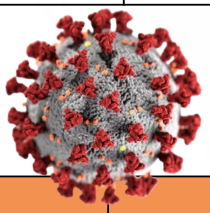
- **Direct Contact**:
  - Involves person-to-person contact (e.g., touching, kissing, sexual contact).
  - Examples: Spread of the common cold, sexually transmitted infections (STIs).
- **Indirect Contact**:
  - Pathogens spread via surfaces, objects, or vectors (e.g., mosquitoes).
  - Examples: Malaria, dengue.
- **Airborne Transmission**:
  - Pathogens spread through droplets in the air, especially during coughing or sneezing.
  - Examples: Tuberculosis, COVID-19..
- **Contaminated Food and Water**:
  - Diseases spread through contaminated food and water.
  - Examples: Cholera, hepatitis A.

Mode of Transmission	Examples of Diseases	Pathogen Type	Transmission Details
Airborne Transmission	Tuberculosis, Measles, Chickenpox, Influenza	Bacteria, Viruses	Spread through droplets or particles in the air from an infected person's cough, sneezes, or talking.
Waterborne Transmission	Cholera, Typhoid fever, Hepatitis A, Giardiasis	Bacteria, Viruses, Protozoa	Spread through contaminated water due to poor sanitation or untreated drinking water.
Skin Contact	Impetigo, Athlete's foot, Scabies, Ringworm	Bacteria, Fungi, Parasites	Spread through direct contact with infected skin, surfaces, or objects.
Sexual Contact	HIV/AIDS, Syphilis, Gonorrhea, Chlamydia	Viruses, Bacteria	Spread through contact with infected bodily fluids during sexual activity.
Vector-mediated Transmission	Malaria, Dengue fever, Lyme disease, Zika virus	Protozoa, Viruses, Bacteria	Spread through bites from infected vectors such as mosquitoes, ticks, and fleas.



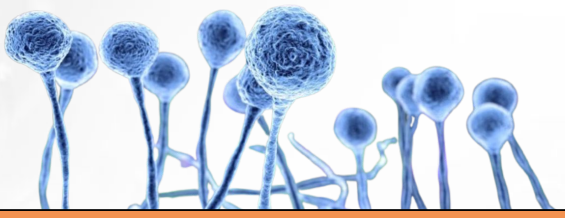
Agent: Bacteria

Infectious Agent	Diseases	Mode of Transmission
Mycobacterium tuberculosis	Tuberculosis	Airborne
Vibrio cholerae	Cholera	Waterborne
Streptococcus pneumoniae	Pneumonia	Airborne
Salmonella typhi	Typhoid	Contaminated food/water



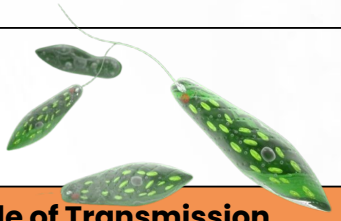
Agent: Virus

Infectious Agent	Diseases	Mode of Transmission
Human Immunodeficiency Virus (HIV)	HIV/AIDS	Sexual contact, body fluids
Influenza virus	Influenza	Airborne
Rhinoviruses	Common Cold	Airborne
Dengue virus	Dengue fever	Vector - Aedes mosquito
Chikungunya virus	Chikungunya fever	Vector - Aedes mosquito
Hepatitis A virus	Hepatitis A	Waterborne, foodborne
Zika virus	Zika fever	Vector mediated (mosquito)



Agent: Fungi

Infectious Agent	Diseases	Mode of Transmission
Trichophyton	Athlete's foot, ringworm	Skin contact
Candida albicans	Candidiasis	Skin contact, mucosal surface



Agent: Protozoa

Infectious Agent	Diseases	Mode of Transmission
Plasmodium	Malaria	Vector - Female Anopheles mosquito
Entamoeba histolytica	Amoebiasis	Waterborne, foodborne

Agent: Helminths

Infectious Agent	Diseases	Mode of Transmission
Ascaris lumbricoides	Ascariasis	Fecal-oral
Wuchereria bancrofti	Lymphatic filariasis (elephantiasis)	Vector - Culex mosquito

Prevention and Control of Infectious Diseases

- **Vaccination**: Effective in preventing many infectious diseases, such as measles, polio, and hepatitis B.
- **Hygiene**: Proper handwashing, sanitization, and food safety practices can prevent the spread of many infectious agents.
- **Quarantine and Isolation**: Essential for controlling the spread of highly infectious diseases.
- **Antimicrobial Treatments**: Includes antibiotics, antivirals, antifungals, and antiparasitic drugs. Misuse can lead to resistance.

Allergy

- **Definition**: An exaggerated immune response to a typically harmless substance known as an allergen.
- **Common Symptoms**: Sneezing, wheezing, itchy or watery eyes, runny nose, skin rashes, and swelling.
- **Common Allergens**: Pollen, dust mites, pet dander, mold, insect stings, certain foods (like nuts and shellfish), and medications.
- **Immune Response**:
  - **IgE Antibodies**: Exposure to an allergen triggers the production of Immunoglobulin E (IgE) antibodies.
  - **Mast Cells Activation**: IgE antibodies attach to mast cells, leading to the release of histamine and other chemicals upon re-exposure to the allergen.
  - **Histamine Release**: This release causes typical allergic symptoms, including inflammation and mucus production.
- **Management**:
  - **Avoidance**: The most effective strategy is to avoid known allergens.
  - **Medications**: Commonly used treatments include antihistamines, decongestants, corticosteroids, and epinephrine for severe reactions.
  - **Immunotherapy**: Allergy shots or sublingual tablets can gradually desensitize the immune system to specific allergens.

Historical Development of Immunization and Vaccination

- **Ancient Practices**:
  - **Variolation**: Practiced in ancient China and India, involving exposure to material from smallpox sores to induce immunity.
- **Modern Immunization**:
  - **Edward Jenner (1796)**: Developed the smallpox vaccine using cowpox material, known as the father of modern vaccination.
  - **Louis Pasteur (1885)**: Created the rabies vaccine, demonstrating the potential for vaccines against other diseases.
- **20th Century Developments**:
  - **Polio Vaccine (1950s)**: Developed by Jonas Salk (inactivated polio vaccine) and Albert Sabin (oral polio vaccine).
  - **Widespread Vaccination Programs**: WHO initiated global immunization efforts, leading to the eradication of smallpox in 1980.
- **21st Century**:
  - **COVID-19 Vaccines**: Rapid development of mRNA vaccines, such as Pfizer-BioNTech and Moderna, during the COVID-19 pandemic, highlighting advancements in vaccine technology.

Immunization vs. Vaccination: A Comparative Overview

Aspect	Immunization	Vaccination
Definition	The process by which an individual becomes protected against a disease through exposure to a specific agent.	The act of administering a vaccine to stimulate the immune system to develop protection against a disease.
Mechanism	Can occur naturally (through infection) or artificially (through vaccination).	Involves the introduction of weakened, dead, or parts of pathogens to the body to provoke an immune response.
Purpose	To provide long-term protection by inducing memory in the immune system.	To safely introduce the immune system to a pathogen, allowing it to learn to fight the disease.
Types	- Passive Immunization: Temporary protection via antibodies from another source (e.g., mother to child). - Active Immunization: Long-term protection via immune system activation (e.g., through vaccination).	- Inactivated vaccines - Live attenuated vaccines - Subunit, recombinant, polysaccharide, and conjugate vaccines - Toxoid vaccines - mRNA vaccines
Duration of Protection	- Passive: Temporary (weeks to months). - Active: Long-lasting, potentially lifelong.	Depends on the type of vaccine; some require booster doses for long-term protection.
Examples	- Natural Infection: Recovering from diseases like chickenpox provides immunity. - Vaccination: Receiving the measles vaccine provides immunity.	- Polio Vaccine - Influenza Vaccine - COVID-19 Vaccine (mRNA-based)

Overview of Endemic, Epidemic, and Pandemic

Aspect	Endemic	Epidemic	Pandemic
Definition	A disease regularly found and consistently present in a specific geographic area or population.	A sudden increase in the number of cases of a disease above what is normally expected in a particular area.	A global outbreak of a disease that spreads across multiple countries and continents, affecting many people.
Duration	Persistent over long periods, often with predictable patterns.	Typically, short-term but can last weeks, months, or even years.	Long-term, often lasting several months to years, with waves of infection.
Geographic Scope	Localized to a specific region or population.	Regional or national, affecting multiple communities or countries.	Worldwide, affecting multiple continents and populations.
Examples	- Malaria in certain parts of Africa and Asia. - Chickenpox in school-aged children.	- Ebola outbreak in West Africa (2014-2016). - SARS outbreak in Asia (2002-2003).	- COVID-19 (2019-present). - Spanish Flu (1918-1919).

AIDS (Acquired Immunodeficiency Syndrome)

Overview:

- **Cause:** Caused by the Human Immunodeficiency Virus (HIV).
- **Transmission:**
  - Unprotected sexual contact
  - Blood transfusions
  - Sharing needles
  - From mother to child during childbirth or breastfeeding

Mechanism:

- **HIV Infection:**
  - Targets and destroys CD4+ T cells, crucial for fighting infections.
- **Immune System Decline:**
  - As the virus multiplies, the immune system becomes increasingly compromised, leading to AIDS.

Symptoms:

- **Early Stage (Acute HIV Infection):** Flu-like symptoms: fever, rash, sore throat.
- **Chronic Stage (Clinical Latency):** Virus is active but reproduces at low levels; may last for years with no symptoms.
- **AIDS Stage:** Severe weight loss, persistent fever, diarrhea, opportunistic infections, and certain cancers due to a severely weakened immune system.

Diagnosis:

- **Tests:**
  - Blood tests that detect antibodies, antigens, or the virus's genetic material.

Treatment:

- **Antiretroviral Therapy (ART):**
  - No cure, but ART manages HIV, prolonging life and reducing transmission risk.

Prevention:

- **Safe Practices:**
  - Using condoms
  - Regular testing
  - Using sterile needles
  - Taking pre-exposure prophylaxis (PrEP) for high-risk individuals

Historical Context:

- **Discovery:**
  - AIDS was first recognized in the early 1980s.
- **Global Impact:**
  - Led to a global health crisis, especially in sub-Saharan Africa; advancements in treatment have improved outcomes

Cancer

Overview:

- **Definition:** A group of diseases characterized by uncontrolled cell division leading to abnormal growths or tumors.
- **Malignancy:**
  - Tumors can be benign (non-cancerous) or malignant (cancerous); malignant tumors invade surrounding tissues and can metastasize.

Causes:

- **Genetic Mutations:**
  - Changes in DNA that disrupt genes regulating cell growth.
- **Environmental Factors:**
  - Exposure to carcinogens (e.g., tobacco smoke, radiation, certain chemicals).
- **Lifestyle Factors:**
  - Diet, physical inactivity, and exposure to certain viruses (e.g., HPV).

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Types of Cancer:

- **Carcinoma:**
  - Begins in skin or tissues lining internal organs (e.g., lung, breast, colon cancers).
- **Sarcoma:**
  - Starts in connective tissues (bone, cartilage, fat, muscle).
- **Leukemia:**
  - Cancer of blood-forming tissues; leads to excessive abnormal white blood cells.
- **Lymphoma:**
  - Cancer of the lymphatic system, affecting immune function.

Symptoms:

- **Varied Symptoms:**
  - Depend on cancer type and location; common symptoms include unexplained weight loss, fatigue, lumps, and persistent pain.

Diagnosis:

- **Screening Tests:**
  - Imaging (e.g., MRI, CT scans), biopsies, and blood tests.
- **Staging:**
  - Determines the extent of cancer spread (Stage I to IV).

Treatment:

- **Surgery:**
  - Removal of the tumor.
- **Radiation Therapy:**
  - High-energy rays used to kill cancer cells.
- **Chemotherapy:**
  - Drugs used to destroy cancer cells.
- **Targeted Therapy:**
  - Drugs targeting specific genes or proteins involved in cancer growth.
- **Immunotherapy:**
  - Boosting the immune system to fight cancer.

Prevention:

- **Lifestyle Changes:**
  - Avoiding tobacco, limiting alcohol, healthy diet, regular exercise, and vaccinations (e.g., HPV vaccine).
- **Screening:**
  - Regular screening for early detection, especially for high-risk individuals.

Historical Context:

- **Ancient Knowledge:**
  - Cancer has been known since ancient times; earliest descriptions found in Egyptian texts.
- **Modern Advances:**
  - Improved understanding and treatment due to advances in genetics, targeted therapies, and immunotherapy.

6. Genetics and Heredity

Heredity:

- The process through which genetic information is passed from parents to offspring.
- Foundation of biological inheritance, determining traits and characteristics of organisms.

Mendelian Genetics

Gregor Mendel:

- **Contribution:** Formulated foundational principles of inheritance through experiments with pea plants.
- **Principles:**
  - **Law of Segregation:** Each individual possesses two alleles for each gene, which separate during gamete formation.
  - **Law of Independent Assortment:** Genes for different traits are inherited independently of each other.

Genotypes and Phenotypes

- **Genotype:**
  - **Definition:** The genetic constitution of an organism, represented by allele combinations (e.g., AA, Aa, aa).
- **Phenotype:**
  - **Definition:** The observable traits or characteristics of an organism, determined by genotype and environmental factors.

Punnett Squares

- **Purpose:**
  - To predict the probability of offspring inheriting specific traits based on the genetic makeup of the parents.

Factors – Genes

- **Definition:**
  - Segments of DNA that encode instructions for development and functioning of organisms; fundamental units of heredity.
- **Role:**
  - Responsible for determining traits and passing genetic information across generations.

Pair of Alleles – Homozygous and Heterozygous

- **Homozygous:**
  - An organism with two identical alleles for a particular gene (e.g., AA or aa).
- **Heterozygous:**
  - An organism with two different alleles for a particular gene (e.g., Aa).

Dominant and Recessive Factors

- **Dominant:**
  - An allele that expresses its trait even when only one copy is present (e.g., A).
- **Recessive:**
  - An allele that expresses its trait only when two copies are present (e.g., a).

Punnett Square for Monohybrid Cross

- **Purpose:**
  1. To predict the genotypic and phenotypic outcomes of a single trait cross.
- **How to Use:**
  1. **Draw a Grid:** Create a 2x2 grid.
  2. **Label the Grid:** Place the alleles of one parent along the top and the alleles of the other parent along the side.
  3. **Fill in the Grid:** Combine the alleles to show possible genotypes.

Example Punnett Square for Monohybrid Cross:-

	A	a
A	AA	Aa
a	Aa	aa

- **Genotypic Ratio:** 1 AA : 2 Aa : 1 aa
- **Phenotypic Ratio:** 3 Dominant : 1 Recessive

Test Cross

- **Definition:**
  A cross between an individual with an unknown genotype (showing the dominant phenotype) and a homozygous recessive individual.
- **Purpose:**
  To determine the genotype of the dominant phenotype individual.

Laws of Inheritance

- **First Law (Law of Dominance):**
  In a heterozygous organism, the dominant allele masks the effect of the recessive allele; the dominant trait appears in the phenotype while the recessive trait is hidden.
- **Second Law (Law of Segregation):**
  Each individual has two alleles for each gene, which separate during gamete formation; each gamete receives one allele from each pair, and the alleles recombine during fertilization.

Dihybrid Cross

- **Definition:**
  A cross between two individuals that are each heterozygous for two traits.
- **Purpose:**
  To examine the inheritance of two different traits simultaneously.

- **Punnett Square for Dihybrid Cross:**
  - **How to Create:**
    1. **Draw a 4x4 Grid:** Representing combinations of alleles for both traits.
    2. **Label the Grid:** Place the alleles for both traits of one parent along the top and the alleles for the other parent along the side.
    3. **Fill in the Grid:** Combine the alleles to show possible genotypes.

	AB	Ab	aB	ab
AB	AABB	AABb	AaBB	AaBb
Ab	AABb	AAbb	AaBb	Aabb
aB	AaBB	AaBb	aaBB	aaBb
ab	AaBb	Aabb	aaBb	aabb

Genotypic Ratio

- **Genotypic Ratio:**
  i. 1 AABB
  ii. 2 AABb
  iii. 1 AAbb
  iv. 2 AaBB
  v. 4 AaBb
  vi. 2 Aabb
  vii. 1 aaBB
  viii. 2 aaBb
  ix. 1 aabb

Phenotypic Ratio

- **Phenotypic Ratio:**
  - 9 Dominant for both traits
  - 3 Dominant for one trait and recessive for the other
  - 3 Recessive for one trait and dominant for the other
  - 1 Recessive for both traits

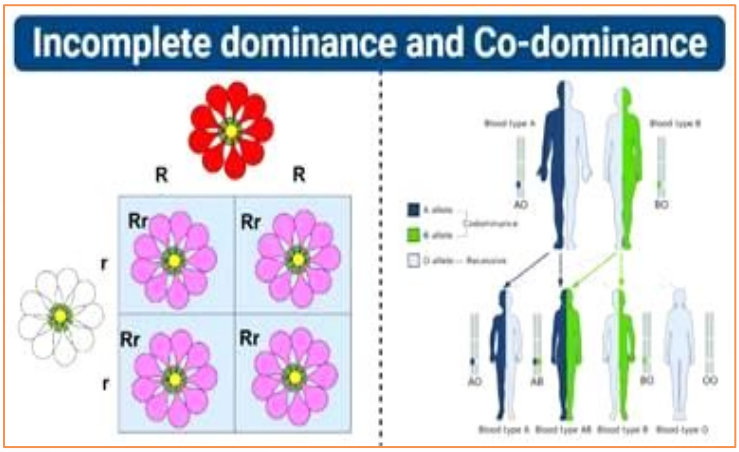
Post-Mendelian Laws of Inheritance

Co-dominance

- **Definition:**
  Both alleles in a heterozygous organism are fully expressed, resulting in a phenotype that displays characteristics of both alleles.
- **Example:**
  AB blood type in humans, where both A and B antigens are expressed on red blood cells.

Incomplete Dominance

- **Definition:**
  The heterozygous phenotype is a blend of the two homozygous phenotypes. Neither allele is completely dominant.
- **Example:**
  In snapdragon flowers, crossing red (RR) and white (WW) flowers results in pink (RW) flowers.



Multiple Alleles

- **Definition:**
  More than two alleles exist for a single gene, although an individual can only have two of these alleles.
- **Example:**
  The ABO blood group system, which includes alleles A, B, and O. The possible genotypes are:
  - AA
  - AO
  - BB
  - BO
  - AB
  - OO

Blood type	Genotype	
A	I^A, I^O	AO
	I^A, I^A	AA
B	I^B, I^O	BO
	I^B, I^B	BB
AB	I^A, I^B	AB
O	$I^O I^O$	OO

Linkage

- **Definition:**
  Genes located on the same chromosome tend to be inherited together because they are physically linked.
- **Example:**
  In fruit flies, genes for body color and wing shape are linked and often inherited together.

Sex-Linked Inheritance

- **Definition:**
  Traits associated with genes located on the sex chromosomes (X or Y). Males and females may express these traits differently due to their different sex chromosome compositions.
- **Example:**
  Color blindness and hemophilia are X-linked recessive disorders, more commonly expressed in males (XY) than females (XX).