VARIETY OF ORGANISMS

LIVING ORGANISM

INTRODUCTION

- **Science:** science is the study of natural things around us.
- **Biology:** is the branch of science that deals with the study of living things. The term biology is got from two Greek words; ***Bios*** *meaning* ***life*** *and* ***logos*** *meaning* ***study.*** Together the two words mean '***study of life***'. They are two branches of biology; ***Botany*** {study of ***plants***} and ***Zoology*** {study of ***animals***}.

CHARACTERISTICS OF LIVING ORGANISMS

"MRS NERG"

- **M – Movement**
- **R – Respiration**
- **S – Sensitivity**
- **N – Nutrition**
- **E – Excretion**
- **R – Reproduction**
- **G – Growth**

CELL

- **Cell:** is the structural and functional unit of life. It is the simplest bit of matter that can exist independently, it show all the basic characteristics of living things. Cell exhibit a variety of shape and sizes. Some are round, square, rectangular, star – shaped, and few can change their shapes.

  They range from small extremely small bacterial cell {1µm} which can only be seen through a powerful microscope to the large yolk cell of an ostrich egg {100 mm}.
- **Form/Type of Cell:**
  - **Prokaryotes:** a single-celled organism lacking a nucleus and other membrane-bound organelles.
  - **Eukaryote:** an organism whose cells contain a nucleus and other membrane-bound organelles.

▯ CELL THEORY

- The cell was first discovered by an English scientist **Robert Hooke** in 1665, who looked at a thin slice of cork through his crude microscope. He saw that it was made up of 'great many little boxes'. He published the drawings of these boxes which he called ***cells*** after the Latin word meaning 'small room'.

  What Robert Hooke saw were the cell walls of dead cork cells. With the widespread use of improved microscopes, scientists realized that the important part of the cell was its living contents, not the wall.

- In 1839, the German zoologist, Theodor Schwann, and the botanist, Matthias Schleiden, stated that the bodies of all animals and plants are composed of cells and product of cells. They described cell as 'units of life' and 'the building blocks from which living organisms are made'.
- Biologists also realized that cells are not only structural but also the functional units of living organisms. In 1885, another German biologist, Rodolf Virchow, stated that all 'cells come from cells'.
- In the present century, studies connected with viruses and bacteria opened up the field of molecular biology. Scientist have now shown that information about the cells 'make up' is in the nucleic acids {Deoxyribonucleic acids, DNA, and ribonucleic acid, RNA} of a cell. This information is passed on from one generation to the next when the cell or organisms reproduce.
- **Briefly, the cell theory states that:**
  - All living organisms are composed of one or more cells.
  - The cell is the structural and functional unit of all living organisms: the basic organization unit of life.
  - All existing cells come from reproduction of pre – existing cells.
  - A cell contains information for its structural and functional development in its nucleic acids. This information is passed down from parent to offspring cell.

▯ CELL STRUCTURE AND FUNCTION

- **Plasma Membrane:** this is flexible membrane made up of mainly proteins and lipids. It prevents the cell contents from escaping. It also controls the materials which are allowed to enter or leave the cell, i.e. it is *selectively permeable*.
- **Cell wall:** in plants, cellulose cell wall surrounds the plasma membrane. It is a tough, fairly rigid structure that is freely permeable, unlike the cell membrane. It provide mechanical support and protection to the cell, and hence to the plant as whole.
- **PROTOPLASM:** This is the living material inside the cell membrane. It consists of the **nucleus** and the **cytoplasm**

❖ **Cytoplasm:** This is a jelly-like, transparent material composed mainly of water. It can exist in a liquid (sol) or semi – solid (gel) state. Many organic and inorganic substances are dissolved in it. All metabolic processes occur here.

The cytoplasm of the cell is the part that is capable of specialization not the nucleus. This is why the structure and function of the cytoplasmic components will differ to a certain extent in various types of cell.

In the cytoplasm, there are many ultra – cellular components known as inclusions and organelles. Inclusions are mainly starch grains, oil globules, and excretory crystals (plants), they're temporary features. Organelles are permanent structures needed for cell function. Each organelle does a specific job.

❖ **CELL ORGANELLES**

Below are the common/important organelles that are found in a cell:

- **Endoplasmic Reticulum**: Is a network of tubular and microsomal vesicular which are interconnected with one another. The lumen of ER contains a fluid called Endoplasmic matrix. ER forms the link between nucleus and cell membrane by connecting the nuclear membrane with the nuclear membrane.
  - **ROUGH ER**: Is the ER with rough, bumpy appearance. Rough appearance is due to the attachment of granular ribosomes to its outer surface. Hence it is called **granular ER**. Its function include: Synthesis of protein and Degradation of worn out organelles.
  - **SMOOTH ER**: Is the ER with smooth appearance because ribosomes are not attached to it. Hence it is called **Agranular ER**. Its functions include: Synthesis of non-protein substance, role in cellular metabolism, storage and metabolism of calcium, catabolism and detoxification.
- **GOLGI APPARATUS**: Is present in all cells except RBC. Usually each cell has one Golgi apparatus. Each Golgi apparatus consist of five to eight flattened membranous sacs called the **Cisternae**. It is situated near the nucleus, it has two ends or faces, namely **cis face** and **trans face**. It is also called the **post office** of the cell or the **shipping department** of the cell. Its functions include: Processing of materials, Packaging of materials, Labeling and delivery of materials.
- **LYSOSOMES**: They are form by the Golgi apparatus. It has the thickest covering membrane. It contains small granules which contain hydrolytic enzymes. It is often called **Garbage System** of the cell. We have **two types** of **lysosomes**; ***Primary lysosome*** which is inactive and pinched off from Golgi apparatus and ***Secondary Lysosomes*** which is active and formed by the fusion of a primary lysosome with Phagosome and Endosome.
  - Importance lysosomal enzymes: proteases, lipases, amylases, nucleases.
  - Functions of lysosomes: Lysosomal function involves two mechanism; **Heterophagy** and **Autophagy**. It functions include Degradation of macromolecules and worn out organelles, Removal of secretory products.

- **CENTROSOME** AND **CENTRIOLES**: is situated in the center of the cell. It consists of two cylindrical structures called centrioles. Centrioles are responsible for the movement of chromosomes during cell division.
- **MITOCHONDRION**: also called the **power house** or plant of the cell. It is responsible for the production of energy, Synthesis of ATP, Apoptosis, Storage of calcium, Detoxification Functions.
- **RIBOSOMES**: are called **protein factories**. They're granular and small dot like structures which are made up of 35% proteins and 65% of RNA? They are two types of ribosomes; ribosomes that are attached to rough ER and Free ribosomes.
- **CYTOSKELETON**: it determines the shape of the cell and gives support to the cell. It is also essential for cellular movement and response of cell to external stimuli. It consists of three major protein components: MICROTUBULES, INTERMEDIATE FILAMENT and MICROFILAMENT.

❖ **NUCLEUS**

- Nucleus is the most prominent and the largest cellular organelle. It has a diameter of 10µ to 22µ and occupies about 10% of total volume of the cell.
- Nucleus is present in all the cells in the body except the red blood cells. The cells with nucleus are called eukaryotes and those without nucleus are known as prokaryotes. Presence of nucleus is necessary for cell division.
- Most of the cells have only one nucleus (uninucleated cells). Few types of cells like skeletal muscle cells have many nuclei (multinucleated cells). Generally, the nucleus is located in the center of the cell. It is mostly spherical in shape. However, the shape and situation of nucleus vary in some cells.

- **STRUCTURE OF NUCLEUS**
  - Nucleus is covered by a membrane called nuclear membrane and contains many components. Major components of nucleus are nucleoplasm, chromatin and nucleolus.
  - **Nuclear membrane** is double layered and porous in nature. This allows the nucleoplasm to communicate with the cytoplasm.
  - **Nucleoplasm** is a highly viscous fluid that forms the ground substance of the nucleus. It is similar to cytoplasm present outside the nucleus. Nucleoplasm surrounds chromatin and nucleolus. It contains a dense fibrillar network of proteins called the nuclear matrix and many substances such as nucleotides and enzymes. The nuclear matrix forms the structural framework for organizing chromatin. The soluble liquid part of nucleoplasm is known as nuclear hyaloplasm.

- **Chromatin** is a thread-like material made up of large molecules of DNA. The DNA molecules are compactly packed with the help of a specialized basic protein called histone. So, chromatin is referred to as the DNA-histone complex. It forms the major bulk of nuclear material.
- **Chromosome** is the rod-shaped nuclear structure that carries a complete blueprint of all the hereditary characteristics of that species. A chromosome is formed from a single DNA molecule coiled around histone molecules. Each DNA contains many genes. Normally, the chromosomes are not visible in the nucleus under microscope. Only during cell division, the chromosomes are visible under a microscope. This is because DNA becomes more tightly packed just before cell division, which makes the chromosome visible during cell division. All the dividing cells of the body except reproductive cells contain 23 pairs of chromosomes. Each pair consists of one chromosome inherited from mother and one from father. The cells with 23 pairs of chromosomes are called diploid cells. The reproductive cells called gametes or sex cells contain only 23 single chromosomes. These cells are called haploid cells.
- **Nucleolus** is a small, round granular structure of the nucleus. Each nucleus contains one or more nucleoli. The nucleolus contains RNA and some proteins, which are similar to those found in ribosomes. The RNA is synthesized by five different pairs of chromosomes and stored in the nucleolus. Later, it is condensed to form the subunits of ribosomes.

Table 1.1 ***DIFFERENCES BETWEEN PLANT AND ANIMAL CELLS***

PLANT CELL	ANIMAL CELL
Cellulose cell wall present	Cellulose cell wall absent
Chloroplast present	Chloroplasts absent
A large central vacuole present	Small vacuoles may be present or absent
Centrioles absent	Centrioles present
Cytoplasm less dense and found along the peripheral of the cell	Cytoplasm dense and granular, and fills cell completely
Starch granules present	Glycogen granules present

MICROSCOPE

- A **microscope** is an instrument that magnifies small objects or specimens, making them appear larger and more detailed for observation and study.

Types of Microscopes

- **Light Microscope (Optical Microscope)**
  - Uses visible light and lenses to magnify objects.
  - Commonly used in schools and laboratories.
  - **Types**:
    - **Simple Microscope**: Uses a single lens (e.g., magnifying glass).
    - **Compound Microscope**: Uses multiple lenses for higher magnification.
- **Electron Microscope**
  - Uses a beam of electrons for magnification instead of light.
  - **Types**:
    - Transmission Electron Microscope (TEM): Views internal structures of cells in detail.
    - Scanning Electron Microscope (SEM): Views the surface of specimens in 3D.
- **Dissecting Microscope (Stereomicroscope)**
  - Used for observing larger specimens like insects and plants.
  - Provides a 3D view.
- **Phase-Contrast Microscope**
  - Enhances contrast in transparent specimens like living cells.

Parts of a Light Microscope

- **Mechanical Parts:**
  - **Base**: Supports the microscope.
  - **Arm**: Connects the base to the head; used for carrying the microscope.
  - **Stage**: Platform where the slide is placed.
  - **Stage Clips**: Hold the slide in place.
  - **Coarse Adjustment Knob**: Moves the stage up and down for focusing.
  - **Fine Adjustment Knob**: Fine-tunes the focus for sharp images.
- **Optical Parts:**
  - **Eyepiece (Ocular Lens)**: The lens you look through; typically 10x magnification.
  - **Objective Lenses**: Multiple lenses with different magnifications (e.g., 4x, 10x, 40x, 100x).
  - **Condenser**: Focuses light on the specimen.
  - **Diaphragm**: Controls the amount of light reaching the specimen.
- **Illumination Parts**:
  - **Light Source (Mirror or Bulb)**: Provides light for viewing the specimen.

- **Magnification**
    - Definition: The ratio of the size of the image to the actual size of the specimen.
    - Total Magnification = Magnification of Eyepiece × Magnification of Objective Lens.
        - For example, if the eyepiece is 10x and the objective lens is 40x, total magnification = 400×.

- **Proper Use of a Microscope**
    - Place the microscope on a stable surface.
    - Turn on the light source or adjust the mirror.
    - Place the slide on the stage and secure it with the stage clips.
    - Start with the lowest objective lens (e.g. 4x).
    - Use the coarse adjustment knob to bring the specimen into view.
    - Switch to a higher objective lens for greater magnification.
    - Use the fine adjustment knob to sharpen the image.

- **Care and Maintenance of a Microscope**
    - Always carry the microscope with both hands (one on the arm and one under the base).
    - Clean lenses with lens paper only.
    - Avoid touching the lenses with fingers.
    - Cover the microscope when not in use to prevent dust accumulation.
    - Store the microscope in a dry place.

- **Uses of a Microscope**
    - Observing cells and microorganisms (e.g., bacteria, protozoa).
    - Studying tissue samples in biology and medicine.
    - Examining the structure of plants and animals.
    - Research in fields like microbiology, genetics, and forensic science.

- **Advantages of Using a Microscope**
    - Enables the study of microscopic organisms.
    - Helps in medical diagnosis (e.g., observing pathogens).
    - Assists in research and discovery in biology and other sciences.

- **Limitations of a Microscope**
    - The resolution of light microscopes is limited compared to electron microscopes.
    - Specimens need to be thin and often require staining for visibility.
    - Electron microscopes are expensive and require special training.

- **CELL AND ITS ENVIRONMENT**

❖ **TRANSPORT ACROSS CELL MEMBRANE**

- Passive transport mechanism.
- Active transport mechanism.

▪ **PASSIVE TRANSPORT**: is the transport of substances along the concentration gradient or electrical gradient or both (electrochemical gradient). It is also known as diffusion or downhill movement. Diffusion is the net movement of anything {for example, atoms, molecules, and ions} generally from region of higher concentration to region of lower concentration.

- **Examples are:**

a) Simple diffusion through lipid layer
b) Simple diffusion through protein layer
c) Facilitated or carrier-mediated diffusion.

- **SPECIAL TYPES OF PASSIVE TRANSPORT:** in addition to diffusion, there are some special types of passive transport, viz.

a) **Bulk flow**: is the diffusion of large quantity of substances from a region of high pressure to the region of low pressure.

b) **Filtration**: is the movement of water and solutes from an area of high hydrostatic pressure to an area of low hydrostatic pressure is called filtration. **Hydrostatic pressure** is developed by the weight of the fluid, it is the pressure exerted by a fluid at rest.

c) **Osmosis**: is the special type of diffusion. It is defined as the movement of water or any other solvent from an area of lower concentration to an area of higher concentration of a solute, through a semipermeable membrane while **Reverse osmosis** is a process in which water or other solvent flows in reverse direction. **Osmotic pressure** is the pressure created by the solutes in a fluid and Oncotic pressure is the osmotic pressure exerted by the colloidal substances (proteins) of the plasma.

- **Types of Osmosis**: Osmosis across the cell membrane is of two types:
    - **Endosmosis**: Movement of water into the cell
    - **Exosmosis**: Movement of water out of the cell.

- **ACTIVE TRANSPORT:** is the movement of substances against the chemical or electrical or electrochemical gradient. It is like swimming against the water tide in a river. It is also called uphill transport. They are two types of Active transport:

a) **Primary active transport**: is the type of transport mechanism in which the energy is liberated directly from the breakdown of ATP.

b) **Secondary active transport**: is the transport of a substance with sodium ion, by means of a common carrier protein.

- **SPECIAL TYPES OF ACTIVE TRANSPORT**: in addition to primary and secondary active transport systems, there are some special categories of active transport which are generally called the vesicular transport.
- Special categories of Active transport:
  - Endocytosis
  - Exocytosis
  - Transcytosis.

- **Endocytosis**: Is defined as a transport mechanism by which the macromolecules enter the cell. Endocytosis is of three types:
  - **Pinocytosis**: the term pinocytosis is used when liquid materials are taken into the cell. It is also called the **cell drinking**. It is a process by which macromolecules like bacteria and antigens are taken into the cells.
  - **Phagocytosis**: the term phagocytosis is used when solid materials are taken into the cell by engulfing them. This how; Amoeba captures it food and White Blood Cell engulfs bacteria that invade the body. It is also called **cell eating**.
  - **Receptor-mediated endocytosis**: Receptor-mediated endocytosis is the transport of macromolecules with the help of a receptor protein.
- **Exocytosis**: is the process by which the substances are expelled from the cell.
- **Transcytosis**: is a transport mechanism in which an extracellular macromolecule enters through one side of a cell, migrates across cytoplasm of the cell and exits through the other side.

ORGANIZATION OF LIFE

- **LEVEL OF ORGANIZATION**
  - A complex multicellular living organism evolved from nonliving atoms and molecules in several steps. This hierarchy of biological organization, shown in below:

Macromolecules
Organelles
Cells
Tissues
Organs
Organ systems
Organisms (multicellular)

- Every living thing is made up of a cell or number of cells. A single celled organism is called *Unicellular Organism.* Those that are made up of many cells are called *Multicellular Organisms.* Organization of life therefore is the existence of life from a single celled organism to a multicellular organism with complex forms that perform different functions.
- **Four levels of organization exist**. These are:
  - Cell level
  - Tissue level
  - Organ level
  - System level
- **Cell Level:** A cell is a basic functional and structural unit of life. It is bounded by a cell membrane containing ***Nucleus*** and ***Cytoplasm***. This is called the ***Protoplasm*** of a cell.

  Protoplasm = *Nucleus* + *Cytoplasm*
  Nucleus = Protoplasm – Cytoplasm
  Cytoplasm = Protoplasm – Nucleus
  - **Definition**: The cellular level is the basic and smallest structural and functional unit of life. All living organisms are made up of one or more cells.
  - **Key Features**:
    - Cells perform essential life processes like respiration, reproduction, and growth.
    - Cells vary in structure and function depending on their role (e.g., nerve cells, muscle cells).
  - **Organisms can be**:
    - **Unicellular**: Composed of a single cell (e.g., bacteria, amoeba).
    - **Multicellular**: Composed of many cells that specialize in specific functions (e.g., plants, animals).
  - **Examples**: Blood cells, skin cells, plant cells.

- **Tissue Level**
  - **Definition**: A tissue is a group of similar cells that work together to perform a specific function.
  - **Key Features:**
    - Tissues allow the division of labor, enabling cells to specialize and work more efficiently.
  - There are four main types of tissues in animals:
    - **Epithelial Tissue**: Covers body surfaces and lines organs (e.g., skin, lining of the digestive tract).
    - **Connective Tissue**: Supports and binds other tissues (e.g., bone, blood, cartilage).
    - **Muscle Tissue**: Responsible for movement (e.g., skeletal muscles, heart muscles).
    - **Nervous Tissue**: Transmits signals throughout the body (e.g., brain, spinal cord).
  - In plants, tissues are divided into:
    - **Meristematic Tissues**: For growth (e.g., root tips).
    - **Permanent Tissues**: For specialized functions (e.g., xylem, phloem).
  - **Examples**: Muscle tissue, xylem in plants.
- **Organ Level**
  - **Definition**: An organ is a structure made up of two or more types of tissues working together to perform a specific function.
  - **Key Features**:
    - Organs are more complex than tissues and perform specialized tasks in the body.
    - Each organ is made up of tissues that contribute to its function.
    - In plants, organs include roots, stems, leaves, and flowers.
  - **Examples**:
    - **Animals**: Heart (pumps blood), lungs (gas exchange), stomach (digestion).
    - **Plants**: Leaf (photosynthesis), root (absorption of water and nutrients).
- **System Level**
  - **Definition**: A system is a group of organs that work together to perform a specific function or set of functions.
  - **Key Features:**
    - Systems coordinate multiple organs to ensure the survival and functionality of the organism.
    - Different systems handle distinct tasks, such as movement, digestion, or reproduction.

✔ **Examples**:

- **In Animals**:
  - **Digestive System**: Includes mouth, stomach, intestines; responsible for breaking down food.
  - **Circulatory System**: Includes heart, blood vessels; transports nutrients and oxygen.
  - **Nervous System**: Includes brain, spinal cord, nerves; controls body functions.
- **In Plants:**
  - **Vascular System**: Includes xylem and phloem for transport of water and nutrients.

❖ **Summary of the Hierarchy:**

- **Cellular Level**: The basic unit of life.
- **Tissue Level**: Groups of similar cells performing a specific function.
- **Organ Level**: Structures made of tissues working together.
- **System Level**: Groups of organs working together to sustain life.

These levels of organization explain how life progresses from simple to complex structures, ensuring survival and efficient functioning of organisms.

CLASSIFICATION OF LIVING ORGANISMS

INTRODUCTION

- Biologists have examined and describe more than 1.8 million kinds of living organisms. There are still many more to be discovered and described. We must therefore have a meaningful way of classifying, identifying and naming them.
- Aristotle (384 – 322 $_{BC}$), a Greek philosopher, was the first to make an attempt to classifying and naming living organisms. The present method of classifying and naming living organisms is based on the work of Carolus Linnaeus (1707 – 1778), a Swedish naturalist. The study of the general principles of classification is known as *Taxonomy* or *Systematics.*

HIERARCHY OF LIVING ORGANISMS

- The largest group of organisms is the *kingdom*. Each kingdom is split into smaller groups, and these groups into even smaller groups, and so on. The arrangement of living organisms in this hierarchy from the highest level to the lowest is as follows:

Kingdom
Phylum or Division (plants)
Class
Order
Family
Genus
Species

Kingdoms

- Linnaeus placed all living organisms into two kingdoms: *plant* and *animals.* In this *scheme*, many one – celled organisms could not fit in properly. Now, most biologists favor the placing of all living organisms into five kingdom
  - *Monera*
  - *Protista*
  - *Fungi*
  - *Plantae* and
  - *Animalia*
- The monerans are composed of very simple cells which do not have true nuclei. Such organisms are known as *prokaryotes*. The majority of organisms, i.e. the protists, fungi, plants and animals, are known as *eukaryotes* as their cells are highly organized with definite or true nuclei.

- The five kingdom way of classifying organisms still presents problems. For example, lichen is made up off a fungus and a protest – so where does it fit in? Viruses are not included in any of the five kingdoms. This is because biologists are still debating over their status as a living organism. Currently, viruses are considered as non – living.
- **VIRUSES:**
    - A virus is extremely small and can only be seen through an electron microscope. It does not have a cell structure but is just made up of a ***coiled strand of nucleic acid*** enclosed within a protein coat.
    - It can only reproduce inside the cells of other living organisms. Outside a living cell, it exists as a crystal, and seems to be no different from other nonliving things.
    - Many biologists see the virus as being on the borderline between living and nonliving things. Viruses are economically important because they cause diseases in plants and animals.

 KINGDOM MONERA

- Monera includes all prokaryotic organisms, which lack a true nucleus and membrane-bound organelles.

- **Characteristics**:
    - **Cell Type**: Prokaryotic (no nucleus).
    - **Number of Cells**: Unicellular.
    - **Cell Wall**: Composed of peptidoglycan.
    - **Mode of Nutrition**: Can be autotrophic (e.g., cyanobacteria) or heterotrophic (e.g., bacteria).
    - **Reproduction**: Mainly asexual through binary fission or budding.
    - **Habitat**: Found in diverse environments, including extreme ones (e.g., hot springs, salty water).
- **Examples:**
    - Bacteria (e.g., Escherichia coli or E. coli).
    - Cyanobacteria (blue-green algae).
- **Importance**:
    - Decomposition of organic matter.
    - Nitrogen fixation (e.g., Rhizobium).
    - Production of antibiotics and fermentation.

❖ ***BACTERIA***

- **Characteristics**:
    - Unicellular, prokaryotic organisms.
    - Lack a defined nucleus and membrane-bound organelles.
    - Reproduce asexually by binary fission.
    - Can be autotrophic (photosynthetic or chemosynthetic) or heterotrophic.

- **Examples**:
  - Escherichia coli (found in the human gut).
  - Staphylococcus aureus (causes infections).

- **Importance**:
  - Decomposers in ecosystems.
  - Industrial applications in food production (e.g., yogurt).
  - Pathogenic bacteria can cause diseases like tuberculosis and cholera.

❖ ***Cyanobacteria (Blue-Green Algae)***

- **Characteristics**:
  - Prokaryotic, photosynthetic organisms.
  - Contain chlorophyll, allowing them to produce oxygen through photosynthesis.
  - Capable of nitrogen fixation (e.g., Anabaena).
- **Examples:**
  - Nostoc: Forms colonies surrounded by a gelatinous sheath.
  - Anabaena: Symbiotic with aquatic plants like water ferns.
- **Importance**:
  - Oxygen producers in aquatic ecosystems.
  - Enhance soil fertility through nitrogen fixation.

Kingdom Protists

- Protists are eukaryotic organisms that are mostly unicellular but can also include some multicellular organisms.

- **Characteristics**:
  - **Cell Type**: Eukaryotic (has a nucleus).
  - **Number of Cells**: Mostly unicellular; some are multicellular (e.g., algae).
  - **Mode of Nutrition**: Can be autotrophic (e.g., algae) or heterotrophic (e.g., protozoa).
  - **Movement**: Use structures like cilia, flagella, or pseudopodia for locomotion.
  - **Reproduction**: Asexual or sexual reproduction.
- **Examples**:
  - Algae (e.g., Chlamydomonas, Euglena).
  - Protozoa (e.g., Amoeba, Paramecium).
  - Slime molds.
- **Importance**:
  - Algae produce oxygen through photosynthesis.
  - Protozoa play a role in food chains and nutrient cycling.
  - Some Protists cause diseases (e.g., Plasmodium causes malaria).

❖ **Algae**

- **Chlamydomonas:**
  - **Characteristics**:
    - Unicellular, green algae with two flagella for movement.
    - Contains chloroplasts for photosynthesis.
  - **Habitat**: Found in freshwater, soil, and damp environments.
  - **Importance**:
    - Contributes to oxygen production.
    - Serves as a model organism for research on photosynthesis.
- **Euglena**:
  - **Characteristics**:
    - Unicellular, flagellated organism.
    - Exhibits both autotrophic (photosynthesis) and heterotrophic nutrition.
    - Lacks a cell wall but has a flexible pellicle for protection.
  - **Habitat**: Found in freshwater and stagnant water.
  - **Importance**:
    - Helps in nutrient recycling in aquatic ecosystems.
    - Used in research to study the evolution of photosynthetic organisms.

❖ ***Protozoa***

- **Amoeba**:
  - **Characteristics**:
    - Unicellular organism that moves using pseudopodia (false feet).
    - Feeds through phagocytosis by engulfing food particles.
  - **Habitat**: Found in freshwater, soil, and moist environments.
  - **Importance**:
    - Plays a role in nutrient cycling.
    - Entamoeba histolytica causes amoebic dysentery.
- **Paramecium**:
  - **Characteristics**:
    - Unicellular, slipper-shaped organism with cilia for movement.
    - Has a specialized feeding structure called the oral groove.
  - **Habitat**: Found in freshwater.
  - **Importance**:
    - Contributes to the decomposition of organic material.
    - Used in biological research to study cellular processes.

- **Kingdom Fungi**
    - Fungi are eukaryotic organisms that decompose organic material for nutrients.
- **Characteristics**:
    - **Cell Type**: Eukaryotic.
    - **Number of Cells**: Mostly multicellular, except for yeasts (unicellular).
    - **Cell Wall**: Made of chitin.
    - **Mode of Nutrition**: Heterotrophic; absorbs nutrients from decaying organic matter (**saprophytic**), living hosts (**parasitic**), or symbiotic relationships (**mutualistic**).
    - **Reproduction**: **Asexual** (spores, budding) or **sexual** (spore fusion).
- **Examples**:
    - Yeast (Saccharomyces cerevisiae).
    - Mold (Rhizopus).
    - Mushroom (Agaricus).
- **Importance**:
    - Decomposition and nutrient recycling.
    - Production of antibiotics (e.g., penicillin).
    - Used in food and beverage industries (e.g., bread and alcohol fermentation).

- **Kingdom Plantae**
    - Plantae includes all multicellular, photosynthetic organisms.
- **Characteristics**:
    - **Cell Type**: Eukaryotic.
    - **Number of Cells**: Multicellular.
    - **Cell Wall**: Composed of cellulose.
    - **Mode of Nutrition**: Autotrophic; produce their own food through photosynthesis using chlorophyll.
    - **Reproduction**: Sexual and asexual reproduction.
- **Examples**:
    - Bryophytes: Mosses (e.g., Funaria).
    - Pteridophytes: Ferns (e.g., Nephrolepis).
    - Gymnosperms: Pine trees (e.g., Pinus).
    - Angiosperms: Flowering plants (e.g., mango, hibiscus).
- **Importance**:
    - Source of food, oxygen, and raw materials.
    - Play a major role in maintaining the ecological balance.

❖ **Bryophytes**

- **Characteristics**:
  - Non-vascular plants (lack xylem and phloem).
  - Reproduce using spores and require water for fertilization.
  - Dominant gametophyte generation.
- **Examples**:
  - **Funaria**: A moss with a leafy appearance.
  - **Marchantia**: A liverwort with a thalloid body.
- **Importance**:
  - Prevent soil erosion by binding soil particles.
  - Retain moisture in ecosystems.

❖ **Pteridophytes**

- **Characteristics**:
  - Vascular plants with true roots, stems, and leaves.
  - Reproduce using spores instead of seeds.
  - Dominant sporophyte generation.
- **Examples**:
  - Nephrolepis (Boston fern): Used as an ornamental plant.
  - Selaginella: A spike moss with creeping stems.
- **Importance**:
  - Contribute to soil formation.
  - Used as ornamental plants.

❖ **Gymnosperms**

- **Characteristics**:
  - Seed-producing plants with "naked seeds" (not enclosed in fruits).
  - Mostly evergreen with needle-like leaves.
  - Pollination occurs through wind.
- **Examples**:
  - **Pinus** (Pine): Produces cones for reproduction.
  - **Cycas**: Has fern-like leaves and a woody trunk.
- **Importance**:
  - Provides timber and resins.
  - Used in landscaping and paper production.

❖ **Angiosperms**

- **Characteristics**:
  - Seed-producing plants with seeds enclosed in fruits.
  - Exhibit a wide variety of forms, from herbs to large trees.
  - Pollination can occur through wind, water, or animals.

- **Examples**:
  - Mango (Mangifera indica): Produces fleshy, edible fruits.
  - Rice (Oryza sativa): A staple food crop.
- **Importance**:
  - Major source of food and oxygen.
  - Provide timber, medicines, and ornamental plants.

Kingdom Animalia

- Animalia includes all multicellular organisms that rely on other organisms for food.

- **Characteristics**:
  - **Cell Type**: Eukaryotic.
  - **Number of Cells**: Multicellular.
  - **Cell Wall**: Absent.
  - **Mode of Nutrition**: Heterotrophic; ingest food for energy.
  - **Reproduction**: Mainly sexual reproduction.
- **Subgroups**:
  - **Invertebrates**: Animals without a backbone (e.g., insects, worms, mollusks).
  - **Vertebrates**: Animals with a backbone (e.g., fish, birds, mammals).
- **Examples**:
  - **Invertebrates**: Spider, earthworm.
  - **Vertebrates**: Lion, human.
- **Importance**:
  - Essential for pollination, food chains, and ecological balance.
  - Provide food, labor, and companionship.

BODY CAVITIES

❖ **Acoelomate**

- **Definition**: Acoelomates are animals that lack a body cavity (coelom) between their digestive tract and body wall. Their body is solid with tissues filling the spaces between organs.
- **Examples**: Flatworms (Phylum Platyhelminthes), such as Planaria and Tapeworm.
- **Features**:
  - Lack fluid-filled cavity for cushioning organs.
  - Organs are embedded directly in tissue.
  - Limited flexibility and movement.

❖ **Pseudocoelomate**

- **Definition**: Pseudocoelomates are animals that have a false body cavity, known as a pseudocoelom, which is not completely lined with mesoderm tissue.

- **Examples**: Roundworms (Phylum Nematoda), such as Ascaris and Hookworm.
- **Features**:
    - Pseudocoelom serves as a hydrostatic skeleton, aiding in movement.
    - Space for distribution of nutrients and waste products.
    - Partially developed body systems.

❖ **Coelomate**

- **Definition**: Coelomates are animals with a true coelom, a fluid-filled body cavity entirely lined by mesodermal tissue. This allows for the development and protection of complex organ systems.
- **Examples**: Earthworms (Phylum Annelida), Mollusks, Arthropods, and Vertebrates (including humans).
- **Features**:
    - Well-organized body structure with efficient organ systems.
    - Greater body flexibility and complex movement.
    - Better protection and support for internal organs.

■ **Phyla and Classes of Kingdom Animalia**

 Invertebrates:

- Invertebrates are animals without a **backbone**. They constitute the majority of animal species on Earth and are classified into several phyla:

❖ **Phylum Porifera (Sponges)**

- **Characteristics**:
    - Simplest multicellular animals.
    - Porous body structure with canals for water flow.
    - Sessile (attached to a substrate).
    - Reproduce asexually (budding) and sexually.
- **Examples**: Sycon, Spongilla.

❖ **Phylum Cnidaria (Coelenterates)**

- **Characteristics**:
    - Radially symmetrical with a sac-like body structure.
    - Possess stinging cells (nematocysts) for capturing prey.
    - **Two body forms**: **polyp** (sessile) and **medusa** (free-swimming).
- **Classes**:
    - **Hydrozoa**: Hydra, Obelia.
    - **Scyphozoa**: Jellyfish (Aurelia).
    - **Anthozoa**: Sea anemones (Adamsia).

❖ **Phylum Platyhelminthes (Flatworms)**

- **Characteristics**:
  - Bilaterally symmetrical, dorsoventrally flattened body.
  - Parasitic or free-living organisms.
  - No body cavity (acoelomate).
- **Examples**: **Planaria** (free-living), **Taenia** (tapeworm).

❖ **Phylum Nematoda (Roundworms)**

- **Characteristics**:
  - Cylindrical, unsegmented body with a complete digestive system.
  - Many are parasites.
  - Possess a pseudocoelom (false body cavity).
- **Examples**: **Ascaris** (human roundworm), **Wuchereria** (causes elephantiasis).

❖ **Phylum Annelida (Segmented Worms)**

- **Characteristics**:
  - Segmented body with true coelom (body cavity).
  - Have setae or bristles for locomotion.
  - Closed circulatory system.
- **Classes**:
  - **Oligochaeta**: Earthworms (Lumbricus).
  - **Hirudinea**: Leeches (Hirudo).
  - **Polychaeta**: Marine worms (Nereis).

❖ **Phylum Arthropoda**

- **Characteristics**:
  - **Largest animal phylum** with jointed appendages and exoskeleton.
  - Segmented body divided into head, thorax, and abdomen.
  - Open circulatory system.
- **Classes**:
  - **Insecta**: Butterflies, ants, mosquitoes.
  - **Arachnida**: Spiders, scorpions.
  - **Crustacea**: Crabs, lobsters.
  - **Myriapoda**: Centipedes (Chilopoda) and millipedes (Diplopoda).

❖ **Phylum Mollusca**

- **Characteristics**:
  - Soft-bodied animals with a calcareous shell.
  - Body divided into head, visceral mass, and foot.
  - Have a radula (tongue-like organ) for feeding.

- **Classes**:
  - **Gastropoda**: Snails, slugs.
  - **Bivalvia**: Clams, oysters.
  - **Cephalopoda**: Octopuses, squids.

❖ **Phylum Echinodermata**

- **Characteristics**:
  - Marine animals with spiny skin and radial symmetry in adults.
  - Possess a water vascular system for movement and feeding.
  - Can regenerate lost body parts.
- **Classes**:
  - **Asteroidea**: Starfish (Asterias).
  - **Echinoidea**: Sea urchins, sand dollars.
  - **Holothuroidea**: Sea cucumbers.

 Vertebrates (Phylum Chordata)

- Vertebrates are animals **with a backbone or vertebral column**. They are divided into five major classes:

❖ **Class Pisces (Fish)**

- **Characteristics**:
  - Aquatic vertebrates with gills and fins.
  - Cold-blooded (ectothermic).
  - Body covered with scales.
- **Examples**:
  - **Bony fish**: Tilapia, Catfish.
  - **Cartilaginous fish**: Sharks (Carcharodon), rays.

❖ **Class Amphibia**

- **Characteristics**:
  - **Dual life cycle**: Aquatic larval stage and terrestrial adult stage.
  - Moist skin for respiration; lungs also present in adults.
  - External fertilization in water.
- **Examples**: **Frog** (Rana), **Toad**, Salamander.

❖ **Class Reptilia**

- **Characteristics**:
  - Cold-blooded vertebrates with dry, scaly skin.
  - Lay shelled eggs on land.
  - Lungs used for respiration throughout life.
- **Examples**: Lizards, snakes, crocodiles, turtles.

❖ **Class Aves (Birds)**

- **Characteristics**:
  - Warm-blooded animals with feathers and beaks.
  - Forelimbs modified into wings for flight (in most species).
  - Lay hard-shelled eggs.
- **Examples**: Pigeons, eagles, chickens, penguins (flightless).

❖ **Class Mammalia**

- **Characteristics**:
  - Warm-blooded animals with hair or fur.
  - Mammary glands produce milk to nourish young.
  - Most are viviparous (give birth to live young).
- **Examples**: Humans, cats, whales, kangaroos.

❖ **Viviparous**

- **Definition**: Viviparous animals give birth to live young instead of laying eggs. The embryo develops inside the mother's body and is nourished directly by her.
- **Examples**: Most mammals (e.g., humans, dogs, and cats).
- **Features**:
  - High parental care and protection.
  - Increased survival rate of offspring.
  - Fewer offspring produced at a time.

❖ **Oviparous**

- **Definition**: Oviparous animals lay eggs that hatch outside the mother's body. The embryos develop within the eggs, receiving nourishment from the yolk.
- **Examples**: Birds (e.g., chickens, ostriches), reptiles, and amphibians.
- **Features**:
  - Eggs are often protected by a shell or jelly-like coating.
  - Larger number of eggs produced to ensure survival.
  - Little to no parental care in many species.

❖ **Ovoviviparous**

- **Definition**: Ovoviviparous animals produce eggs that hatch inside the mother's body, resulting in live birth. The embryo is nourished by the egg yolk rather than the mother.
- **Examples**: Some sharks, snakes (e.g., boa constrictor), and certain fish.
- **Features**:
  - Combines features of oviparous and viviparous animals.
  - Increased survival chances due to internal development.
  - No direct nutrient exchange between mother and embryo.