Unit 3: Cells

What is a Cell?

Introduction: A cell is the smallest and most basic unit of life. Every living thing is made up of one or more cells. Some organisms consist of a single cell and are known as unicellular organisms, like bacteria and paramecium. These organisms carry out all life processes within one cell. Other organisms, like plants and animals, are made up of many cells and are called multicellular organisms. In multicellular organisms, different types of cells work together to perform various functions that sustain life.

Cell Theory

The History of Cell Discovery:

- **Robert Hooke (1665):** First observed cells in a thin slice of cork using a microscope. He coined the term "cell" because the structures reminded him of small rooms.
- **Anton van Leeuwenhoek (1674):** Improved the microscope and observed living cells (like protozoa and bacteria), which he called "animalcules."
- **Matthias Schleiden (1838) and Theodor Schwann (1839):** Proposed that all plants and animals are made up of cells, leading to the development of the cell theory.
- **Rudolf Virchow (1855):** Stated that all cells come from pre-existing cells.

Principles of Cell Theory:

1. All living organisms are made up of one or more cells.
2. The cell is the smallest unit of life.
3. New cells are produced from existing cells through cell division.

Cell Structure and Function

Cells have different structures (organelles) that perform specific functions essential for life. Although cells vary in size and shape, they share common structures:

- **Nucleus:** Controls the cell's activities and contains DNA.
- **Cell Membrane:** A thin layer that surrounds the cell, controlling the movement of substances in and out.
- **Cytoplasm:** The fluid inside the cell where organelles are suspended and where many chemical reactions occur.

- **Mitochondria:** Known as the "powerhouse" of the cell, they produce energy through respiration.
- **Ribosomes:** Sites of protein synthesis.
- **Endoplasmic Reticulum (ER):**
  - **Rough ER:** Studded with ribosomes and involved in protein synthesis.
  - **Smooth ER:** Involved in lipid synthesis.
- **Golgi Apparatus:** Modifies, sorts, and packages proteins and lipids for storage or transport.
- **Lysosomes:** Contain digestive enzymes that break down waste materials and cellular debris.
- **Vacuoles:** Store materials such as water, salts, proteins, and carbohydrates. In plant cells, the central vacuole also helps maintain turgor pressure.
- **Chloroplasts (in plant cells):** Sites of photosynthesis, containing the green pigment chlorophyll.

Types of Cells

Cells are classified into two main types based on their structure:

- **Prokaryotic Cells:**
  - Do not have a nucleus or membrane-bound organelles.
  - Typically smaller and simpler than eukaryotic cells.
  - Example: Bacteria.
- **Eukaryotic Cells:**
  - Have a nucleus and other membrane-bound organelles.
  - Typically larger and more complex.
  - Examples: Plant and animal cells.

Comparison of Prokaryotic and Eukaryotic Cells:

Structure	Eukaryotic Cells	Prokaryotic Cells
Organelles	Membrane-bound (e.g., nucleus, ER)	No membrane-bound organelles
Ribosomes	Relatively large	Relatively small
Chromosomes	DNA arranged in long strands	DNA present, not associated with proteins, may have plasmids
Cell Wall	Present in plants (made of cellulose)	Present (made of peptidoglycan)
Cilia and Flagella	Sometimes present	May have flagella, different structure

Animal and Plant Cells

Common Features:

- Both plant and animal cells have a cell membrane, nucleus, cytoplasm, mitochondria, and Golgi apparatus.

Differences:

- **Plant Cells:**
  - Have a cell wall, chloroplasts, and large central vacuoles.
- **Animal Cells:**
  - Have centrioles and lysosomes, but lack a cell wall and chloroplasts.

Understanding the structure and function of cells helps us grasp how living organisms grow, develop, and maintain their vital functions. Cells are indeed the building blocks of life!

Observing Cells Under a Microscope

Introduction to Microscopy

A microscope is a powerful tool used to observe small objects that are not visible to the naked eye, such as cells. The microscope magnifies the image of an object using one or more lenses that bend light towards the eye, making the object appear larger.

The Cell and Its Environment

Cell Membrane:

- The cell membrane is a selectively permeable barrier that controls what enters and exits the cell. It allows essential nutrients in and waste products out.

Passive Transport:

- **Diffusion:** Movement of molecules from an area of higher concentration to an area of lower concentration without energy input. Oxygen enters cells by diffusion to support respiration.
- **Factors Influencing Diffusion:** Concentration gradient, temperature, mass of molecules, distance, and surface area.

- **Osmosis:** A special type of diffusion involving the movement of water across a selectively permeable membrane. Water moves from a region of higher water concentration (lower solute concentration) to a region of lower water concentration (higher solute concentration).

Active Transport:

- Active transport is the movement of molecules against a concentration gradient, from an area of lower concentration to higher concentration, using energy. Examples include ion uptake by plant roots and glucose absorption in the intestines.

Levels of Biological Organization

Life is organized into a hierarchy from atoms to complex organisms:

1. **Cellular Level:** Atoms form molecules, which assemble into organelles within cells.
2. **Organism Level:** Cells form tissues, tissues form organs, and organs form systems (e.g., digestive system), which work together to form an organism.

Understanding how to observe cells and how they interact with their environment provides a foundation for exploring more complex biological systems.