

Cell and Molecular Biology

Cell and Molecular Biology: Definitions, Theory and Basics, and Applications

Definition:

- **Cell Biology** is the study of the structure, function, and behavior of cells. A cell is the **basic unit of life**—everything living is made of cells.
- **Molecular Biology** is the study of biology at a molecular level, especially focusing on the molecules that make up cells (like DNA, RNA, proteins).
- So, Cell and Molecular Biology is the combined field that studies how cells work and how molecules inside the cell (like DNA, RNA, proteins, lipids, etc.) interact to allow the cell to survive, grow, divide, and function.

Theory and Basics

Cell Theory

- This is the foundation of cell biology and includes three main principles:
 1. **All living organisms are made of cells.**
 2. **The cell is the basic unit of life.**
 3. **All cells come from pre-existing cells.**

Molecular Biology Basics

- The central idea is called the **Central Dogma of Molecular Biology**, which describes the flow of genetic information:

DNA → RNA → Protein

1. **DNA** (deoxyribonucleic acid) stores genetic information.
2. **RNA** (ribonucleic acid) helps to transfer this information.
3. **Proteins** are made using the information in the RNA and carry out most cell functions.

Important Molecules

- **Nucleic Acids:** DNA & RNA – carry genetic code.
- **Proteins:** Made of amino acids – do most of the work in cells.
- **Lipids:** Make up cell membranes.
- **Carbohydrates:** Provide energy and structural support.

Applications of Cell and Molecular Biology:

1. Medicine:

- Understanding how cells work helps us understand **diseases**, especially **cancer**, **genetic disorders**, **infectious diseases**, etc.
- Molecular biology techniques help in **gene therapy**, **vaccine development**, and **drug design**.

2. **Biotechnology:**

- Scientists can **modify genes** of plants, animals, or bacteria to improve traits or make useful products (like insulin, made using genetically modified bacteria).
- **CRISPR-Cas9** is a modern tool to edit genes.

3. **Agriculture:**

- Creating **genetically modified crops** that grow faster, resist pests, or survive harsh conditions.

4. **Forensic Science:**

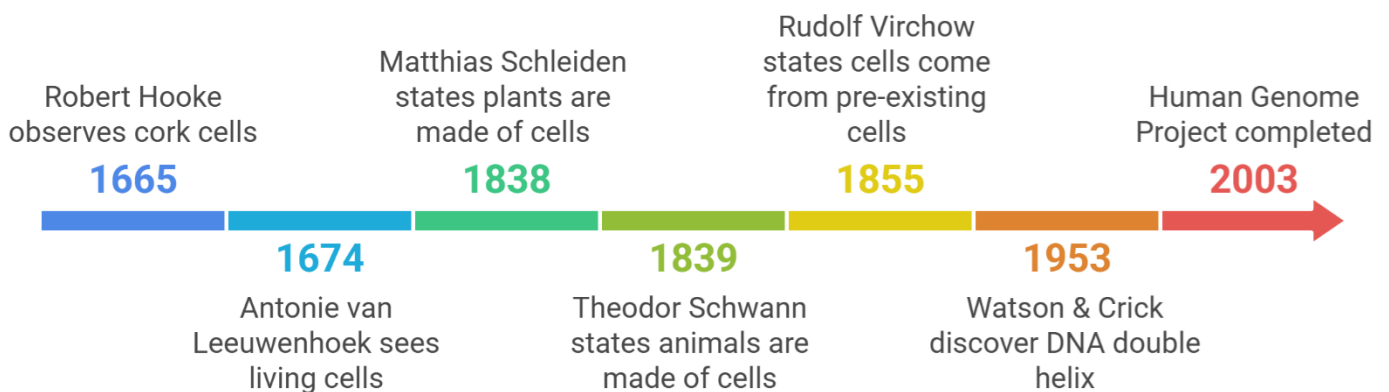
- DNA fingerprinting helps solve crimes or identify people.

5. **Environmental Science:**

- Using microbes to clean oil spills or degrade plastics (bioremediation).

Cell and Molecular Biology: History and Summation

History



Early Discoveries

- **1665 – Robert Hooke:** First person to observe cells using a microscope. He saw cork cells and called them “cells” (like small rooms).
- **1674 – Antonie van Leeuwenhoek:** Improved the microscope and saw living cells like bacteria and sperm.

1800s – Cell Theory Formation

- **Matthias Schleiden (1838):** All plants are made of cells.
- **Theodor Schwann (1839):** All animals are made of cells.

- **Rudolf Virchow** (1855): All cells come from pre-existing cells.

1900s – Molecular Discoveries

- **1920s–40s**: Scientists began understanding cell organelles (like mitochondria, nucleus).
- **1953 – Watson & Crick**: Discovered the double-helix structure of DNA.
- **1960s–70s**: Discovery of how DNA makes RNA, and RNA makes protein.
- **1980s–90s**: Genetic engineering and DNA sequencing developed.
- **2003**: Human Genome Project completed – scientists sequenced all human DNA.

Summation (Quick Summary of Development)

- The field started with microscope invention.
- Gradual understanding of cell structure and function.
- Discovery of molecules like DNA and proteins.
- Now, it is a highly advanced field used in medicine, research, agriculture, and biotechnology.

Properties of Cells

What is a Cell?

- A cell is the basic structural and functional unit of life.
- All living organisms are made up of one or more cells.
 - **Unicellular** organisms: One cell (e.g., bacteria).
 - **Multicellular** organisms: Many specialized cells (e.g., humans).
- Cells may function independently or as part of larger systems (tissues, organs).

General Properties of Cells

1. Highly Organized

- Each cell contains specific parts called **organelles**, each with a distinct function.
- The internal structure is precisely arranged for efficiency.

2. Genetic Material

- All cells carry **DNA**, which holds instructions for growth, functioning, and reproduction.
- DNA is passed on during **cell division**.

3. Metabolism (Energy Use)

- Cells perform **chemical reactions** to extract and use energy.
- They convert food or sunlight into **ATP**, the energy currency of the cell.



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