

Introduction to Biochemistry

Introduction to Biochemistry
Foundations, Scope, and Key Concepts

1. What Is Biochemistry?

Aspect	Description
Definition	The study of the chemical processes and substances that occur within living organisms.
Core Focus	Structure, function, and interaction of biomolecules (proteins, nucleic acids, lipids, carbohydrates).
Interdisciplinary Links	Chemistry, molecular biology, genetics, physiology, pharmacology, and biotechnology.
Goal	Explain how molecular-level events give rise to cellular functions, tissue behavior, and whole?organism physiology.

2. Historical Milestones

Year / Period	Milestone	Significance
1800s	Discovery of cell theory (Schleiden, Schwann)	Set the stage for studying life at the cellular level.
1869	Friedrich Miescher isolates <i>nuclein</i> (DNA).	First identification of a macromolecule that stores genetic information.
1902	Eduard Buchner shows cell?free fermentation.	Demonstrates that enzymes (proteins) can catalyze reactions outside cells.
1920s–30s	Hans Krebs, Krebs cycle; Otto Warburg , glycolysis.	Mapping of central metabolic pathways.
1953	Watson & Crick reveal DNA double? helix.	Structural basis for genetic information storage.
1958–60	Kendrew and Perutz solve protein structures (myoglobin, hemoglobin).	Birth of structural biology.

Introduction to Biochemistry

Year / Period	Milestone	Significance
1970s–80s	Development of recombinant DNA and PCR .	Tools for manipulating and analyzing biomolecules.
2000s	Human Genome Project completed.	Provides a complete reference of genetic information.
2010s–present	CRISPR/Cas9 , single-cell omics , cryogenic EM .	Precise genome editing and high-resolution structural insights.

3. Major Classes of Biomolecules

Class	Building Units	Key Functions	Representative Examples
Proteins	Amino acids (20 standard)	Catalysis (enzymes), signaling, transport, structural support, immunity	Hemoglobin, DNA polymerase, antibodies
Nucleic Acids	Nucleotides (A, T/U, G, C + sugar + phosphate)	Genetic storage (DNA), information transfer (RNA), regulation	DNA, mRNA, tRNA, rRNA
Carbohydrates	Monosaccharides (glucose, fructose)	Energy storage, structural components, cell-cell recognition	Glycogen, cellulose, glycoproteins
Lipids	Fatty acids + glycerol or sterol backbone	Membrane structure, energy storage, signaling molecules	Phospholipids, triglycerides, cholesterol, steroid hormones

4. Central Themes in Biochemistry

4.1. Structure ? Function

- **Primary structure** ? amino acid sequence (proteins) or nucleotide sequence (DNA/RNA).
- **Higher-order structures** (secondary, tertiary, quaternary) dictate activity.

Introduction to Biochemistry

- **Conformational changes** often regulate enzyme catalysis, signal transduction, and molecular recognition.

4.2. Enzyme Catalysis

- **Rate enhancement:** 10^2 – 10^{10}