

Introduction to Biochemical Principles

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Course?level overview – suitable for first?year undergraduates or anyone new to biochemistry.

1. What Is Biochemistry?

Aspect	Description
Definition	The study of the chemical processes and substances that occur within living organisms.
Scope	Includes metabolism, enzyme catalysis, signal transduction, genetic information flow, and the structure–function relationship of biomolecules.
Goal	Explain how molecular-level events give rise to cellular and organismal physiology.

2. Major Classes of Biomolecules

Class	Key Examples	Primary Functions
Carbohydrates	Glucose, glycogen, cellulose	Energy storage & supply; structural components; recognition molecules.
Lipids	Fatty acids, phospholipids, sterols	Membrane formation, energy storage, signaling molecules.
Proteins	Enzymes, antibodies, receptors, structural proteins	Catalysis, transport, signaling, structural support, regulation.
Nucleic Acids	DNA, RNA	Genetic information storage, transmission, and expression.
Small Metabolites	ATP, NAD?, coenzymes	Energy carriers, redox reactions, co?factor roles.

3. Fundamental Concepts

3.1. Structure ? Function

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- **Primary structure** ? amino?acid sequence (proteins) or nucleotide sequence (nucleic acids).
- **Secondary structure** ? ??helices, ??sheets (proteins); double helix (DNA).
- **Tertiary & Quaternary structure** ? 3?D folding, subunit assembly ? determines catalytic sites, binding pockets.
- **Conformation changes** often regulate activity (e.g., allosteric enzymes).

3.2. Thermodynamics in Biochemistry

Term	Meaning in Biological Context
ΔG (Gibbs free energy)	Determines spontaneity of a reaction; $\Delta G < 0$? favorable.
ΔG° (standard free energy)	Free energy change under standard biochemical conditions (pH 7.0, 1 M concentrations).
Coupled reactions	Unfavorable reactions (positive ΔG) are driven by favorable ones (e.g., ATP hydrolysis).
Equilibrium constant (K_{eq})	Relates to ΔG° : $\Delta G^\circ = -RT \ln K_{eq}$.

3.3. Enzyme Kinetics

- **Michaelis–Menten equation:** $v = \frac{V_{\max}[S]}{K_m + [S]}$
 - $V_{\max}$: maximal velocity (all enzyme active sites saturated).
 - K_m : substrate concentration at $\frac{1}{2}V_{\max}$ (inverse measure of affinity).
- **Lineweaver–Burk plot** (double-reciprocal) useful for visualizing kinetic parameters.
- **Inhibition types:** competitive, non-competitive, uncompetitive, mixed; each alters K_m and/or $V_{\max}$ differently.

3.4. Metabolic Pathways

- **Catabolism** ? breakdown of molecules ? release of energy (e.g., glycolysis, ??oxidation).
- **Anabolism** ? synthesis of complex molecules ? consumes energy (e.g., fatty?acid synthesis, nucleotide biosynthesis).
- **Regulation:** allosteric effectors, cov