

Introduction to biochemistry

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What is Biochemistry?

- Biochemistry is the branch of science that explores the chemical processes and substances occurring within living organisms.
- It serves as a bridge between biology and chemistry, aiming to understand life at the molecular level.

Scope and Importance

- Biochemistry helps explain how biological molecules give rise to the processes that occur within and between living cells.
- It plays a critical role in fields such as medicine, genetics, agriculture, and biotechnology.

Key Areas of Study in Biochemistry:



Structure and
Function



Metabolism



Enzymology



Genetics and
Molecular
Biology



Signal
Transduction

A. Structure and Function of Biomolecules

- Study of essential biological molecules including:
 - **Proteins** – enzymes, structural components, signaling molecules.
 - **Carbohydrates** – energy storage and structural functions.
 - **Lipids** – membrane components and energy storage.
 - **Nucleic Acids (DNA & RNA)** – genetic material and information transfer.

B. Metabolism

- Investigation of chemical reactions that sustain life, including:
 - Energy production (catabolism)
 - Synthesis of biomolecules (anabolism)

C. Enzymology

- Study of enzymes, their mechanisms, structure, kinetics, and regulation in catalyzing biochemical reactions.

D. Genetics and Molecular Biology

- Examination of:
 - DNA and RNA structures
 - Gene expression and regulation
 - Molecular mechanisms of inheritance

E. Signal Transduction and Cellular Communication

- Understanding how cells detect, process, and respond to signals, enabling regulation and coordination of cellular activities.

Scope of Biochemistry in Pharmacy

Biochemistry plays a crucial role in pharmacy and pharmaceutical sciences.

A. Drug Design and Development:

- Biochemistry helps in understanding how drugs interact with biological molecules (like enzymes, receptors, DNA).
- Structure-activity relationships (SAR) are derived using biochemical knowledge.

B. Pharmacodynamics and Pharmacokinetics:

- **Pharmacodynamics:** What the drug does to the body — involves understanding biochemical pathways.
- **Pharmacokinetics:** What the body does to the drug — involves metabolism, which is deeply rooted in biochemical processes (e.g., liver enzyme activity).

C. Enzyme Inhibition:

- Many drugs act by **inhibiting specific enzymes** (e.g., ACE inhibitors for hypertension).
- Understanding enzyme kinetics is essential in drug development.

D. Disease Mechanisms:

- Biochemistry helps understand **pathophysiology** — how diseases alter biochemical pathways (e.g., diabetes, cancer).
- This knowledge aids in designing targeted therapies.

E. Clinical Biochemistry:

- Laboratory tests based on biochemical markers are used for **diagnosis, monitoring, and prognosis** of diseases.
- Example: Blood glucose, cholesterol levels, liver and kidney function tests.

F. Biotechnology and Molecular Pharmacology:

- Involves genetic engineering, recombinant DNA technology, and biopharmaceuticals.
- Biochemistry is the foundation for understanding and applying these techniques.

Cell and Its Biochemical Organization

- The **cell** is the **basic structural and functional unit** of life. A clear understanding of cellular organization is essential to appreciate how biochemical reactions occur in different compartments.

Types of Cells:



- **Prokaryotic cells:** Simple structure, no nucleus (e.g., bacteria).
- **Eukaryotic cells:** Complex structure, with nucleus and membrane-bound organelles (e.g., human cells).

Major Components of a Eukaryotic Cell:

Organelle	Structure & Function	Biochemical Significance
Plasma Membrane	Phospholipid bilayer with embedded proteins	Regulates transport, signal transduction
Nucleus	Contains DNA	Site of transcription (DNA → RNA)
Mitochondria	Double membrane, has its own DNA	Site of ATP production (aerobic respiration)
Endoplasmic Reticulum (ER)	Smooth & rough (with ribosomes)	Protein and lipid synthesis
Golgi Apparatus	Stacked membranous sacs	Modifies, sorts, packages proteins

Lysosomes	Membrane-bound vesicles	Contains digestive enzymes (autophagy, apoptosis)
Ribosomes	RNA and protein	Site of protein synthesis
Cytoplasm	Gel-like fluid	Contains enzymes for metabolic reactions

Biochemical Processes in the Cell:

- **Glycolysis** in cytoplasm.
- **Krebs cycle** and **oxidative phosphorylation** in mitochondria.
- **Protein synthesis** on ribosomes (cytoplasmic or attached to ER).
- **DNA replication** and **RNA transcription** in nucleus.
- **Detoxification** in smooth ER (especially in liver cells).

Cell Membrane and Transport:

- **Passive transport:** Diffusion, osmosis.
- **Active transport:** Requires energy (e.g., Na^+/K^+ pump).
- **Endocytosis & exocytosis:** Bulk transport of materials.



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