



# PHARMACOLEARN

*It's Important to Know!*

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## BP203T — Biochemistry

B.Pharm Semester 2 · Unit 1 — Biomolecules and Biochemical Concepts

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### Unit I: Biomolecules and Biochemical Concepts

This unit introduces the molecules found in living systems. Learn each group by its building blocks, major bonds, important functions and one or two representative examples.

#### Carbohydrates

Carbohydrates are polyhydroxy aldehydes, polyhydroxy ketones, or substances that produce them on hydrolysis. They are classified as monosaccharides, oligosaccharides and polysaccharides.

- Monosaccharides are single sugar units. Examples include glucose, fructose and ribose.
- Disaccharides contain two monosaccharide units. Sucrose contains glucose and fructose. Lactose contains glucose and galactose.
- Polysaccharides contain many sugar units. Glycogen is a storage polysaccharide in animals. Cellulose is a structural polysaccharide in plants.

The glycosidic bond joins sugar units. Reducing sugars have a free anomeric carbon that can participate in a redox reaction. Glucose is a reducing sugar. Sucrose is non-reducing because its anomeric carbons are involved in the glycosidic bond.

#### Proteins and amino acids

Proteins are polymers of amino acids joined by peptide bonds. An amino acid has an amino group, a carboxyl group, a hydrogen atom and a variable side chain attached to an alpha carbon. Proline is the special case because its side chain forms a ring with its amino nitrogen.

The 20 standard amino acids can be grouped by side-chain properties:

- Nonpolar: glycine, alanine, valine, leucine, isoleucine, methionine, proline, phenylalanine and tryptophan. They commonly contribute to hydrophobic protein cores. Glycine gives flexibility, proline restricts chain rotation, and methionine can begin protein synthesis.
- Polar, uncharged: serine, threonine, cysteine, tyrosine, asparagine and glutamine. They form hydrogen bonds. Cysteine can form disulfide bonds, and serine, threonine and tyrosine can be sites of phosphorylation.

- Acidic: aspartate and glutamate. Their side chains are negatively charged near neutral pH and participate in ionic interactions and acid-base reactions.
- Basic: lysine, arginine and histidine. Their side chains can carry positive charge. Histidine is useful in enzyme active sites because it can accept or donate a proton near physiological pH.

These groupings describe side-chain behaviour, not dietary classification.

Protein structure is described at four levels:

1. Primary structure: the amino acid sequence.
2. Secondary structure: local folding such as alpha helices and beta sheets.
3. Tertiary structure: the overall three-dimensional shape of one polypeptide chain.
4. Quaternary structure: association of two or more polypeptide chains.

Hydrogen bonds, ionic interactions, hydrophobic interactions and disulfide bonds help maintain protein structure. Denaturation disrupts higher-order structure and biological activity without normally breaking all peptide bonds.

## Lipids

Lipids are water-insoluble or poorly water-soluble biomolecules that dissolve in non-polar solvents. Important groups include fatty acids, triacylglycerols, phospholipids and sterols.

- Saturated fatty acids have no carbon-carbon double bond.
- Unsaturated fatty acids have one or more carbon-carbon double bonds.
- Triacylglycerols contain glycerol esterified with three fatty acids and serve mainly as energy stores.
- Phospholipids contain phosphate and are major components of cell membranes.

## Nucleic acids and nucleotides

Nucleotides contain a nitrogenous base, a pentose sugar and one or more phosphate groups. A nucleoside contains a base and sugar but no phosphate. DNA contains deoxyribose and stores hereditary information. RNA contains ribose and participates in gene expression and protein synthesis.

The bases adenine and guanine are purines. Cytosine, thymine and uracil are pyrimidines. DNA usually contains thymine, while RNA usually contains uracil.

In double-stranded DNA, adenine pairs with thymine through two hydrogen bonds, and guanine pairs with cytosine through three hydrogen bonds. The two strands are complementary and antiparallel. In RNA, adenine pairs with uracil in base-paired regions.

## Lipid classes in detail

Simple lipids include triacylglycerols and waxes. Triacylglycerols contain glycerol esterified to three fatty acids and are concentrated energy stores. Waxes contain long-chain fatty acids esterified to long-chain alcohols and provide protective coatings.

Compound lipids contain additional groups. Phospholipids contain phosphate and form membrane bilayers. Glycerophospholipids contain glycerol, while sphingophospholipids contain sphingosine. Glycolipids contain carbohydrate and are important in cell recognition, especially in nervous tissue. Lipoproteins contain lipid plus protein and transport hydrophobic molecules in

blood.

Derived lipids include fatty acids, sterols and steroid hormones. Cholesterol supports membrane structure and is a precursor for bile acids, steroid hormones and vitamin D. Eicosanoids are signalling molecules formed from polyunsaturated fatty acids.

## Enzymes

Enzymes are biological catalysts. They increase reaction rate by lowering activation energy and are not consumed in the overall reaction. The substrate binds at an active site. Enzyme activity depends on factors such as temperature, pH, substrate concentration and inhibitor concentration.

Competitive inhibition can be reduced by increasing substrate concentration in the simple model of enzyme kinetics. In pure non-competitive inhibition, inhibitor binding lowers  $V_{max}$  without changing  $K_m$ .

## Unit I: Frequently asked questions

### Q: What is the difference between a nucleoside and a nucleotide?

A: A nucleoside contains a nitrogenous base and a pentose sugar. A nucleotide contains a nucleoside plus one or more phosphate groups.

### Q: What is denaturation of a protein?

A: Denaturation is loss of the normal higher-order structure and activity of a protein caused by conditions such as heat, extreme pH or chemicals. The primary peptide-bond sequence is usually not broken.

### Q: Why are enzymes called catalysts?

A: Enzymes increase the rate of biochemical reactions by lowering activation energy and are regenerated at the end of the reaction.

### Q: What are the DNA base-pairing rules?

A: Adenine pairs with thymine and guanine pairs with cytosine in double-stranded DNA. In RNA, adenine pairs with uracil in base-paired regions.

## Unit I: Key takeaways

- Carbohydrates are classified by the number of sugar units.
- Proteins are amino acid polymers joined by peptide bonds.
- Lipids include storage lipids and membrane lipids.
- DNA and RNA differ in sugar, one base and their main cellular roles.
- Enzymes are biological catalysts with activity affected by conditions such as pH and temperature.

## Unit I: Clinical correlation

**Clinical correlation: gout.** Purine breakdown produces uric acid. Persistent elevation of uric acid can promote urate crystal deposition in joints.