

# Chemistry Syllabus

Prof. Maria Luisa Balestrieri

## Educational Objectives

- Understanding of the fundamental laws that govern matter and its transformations.
- Capturing the importance of chemical knowledge in the medical curriculum.
- Acquisition of the importance of chemistry to the understanding of biological phenomena at the atomic and molecular level.
- Capturing the importance of chemical analytical applications for the study of normal and pathological states.

## Knowledge and learning outcomes

- Understanding of the basic concepts about the structure of matter at the atomic and molecular level, as well as the main features and properties of the various states of aggregation.
- Acquisition of the mole concept and the ability to perform elementary stoichiometric calculations.
- Understanding of the properties of the solutions with particular regard to the methods for expressing concentration, to the characteristics of the aqueous solutions of electrolytes, and to the osmotic pressure.
- Understanding of official nomenclature of organic and inorganic chemical compounds.
- Knowledge of the various types of chemical reactions (acid-base reactions, redox reactions, and precipitation reactions).
- Knowledge of and ability to interpret and apply the laws that govern the chemical equilibrium and reaction rates, both in the gas phase and in solution, with special insights on the acid-base reactions.
- Understanding of the thermodynamic bases that regulate chemical reactions.
- Knowledge of the structure and main properties of the most important classes of compounds, organic with special insights on those of biological interest.

## Syllabus

Atoms and molecules. The mole concept. Structure of the atom. Orbitals. Periodic system. Chemical bond. Hybridization of the orbitals. Molecular geometry. Relations between chemical structure and physic properties. Nomenclature of inorganic compounds. Stoichiometry. Ionic compounds. Chemical reactions. Balancing chemical equations. Oxidation and reduction. Formula weights and molecular weights. Mole and calculation of mass relationships. The three states of matter. Gas pressure. Laws that govern the behavior of gases. Avogadro's law and the ideal gas law. Dalton's law of partial pressures. The kinetic molecular theory. Types of attractive forces between molecules. Behavior of liquids at the molecular level. Characteristics of the various types of solids. Phase change.

Solutions. Factors that affect solubility. Units for concentration. Properties of water as solvent. Colloids. Colligative properties.

Reaction rates and chemical equilibrium. Measurement of the reaction rates. Relationship between activation energy and reaction rate. The chemical equilibrium. The equilibrium constant. The value of the equilibrium constant. Le Chatelier's principle. Thermochemistry laws. Entropy, Enthalpy, Free Energy.

Acids and bases. Naming common acids. Properties of acids and bases. The Acidic and Basic Properties of Pure Water. The strength of acids and bases. Conjugate acid-base pairs. Relationship between chemical structure and the acidity strength. Position of equilibrium in an acid-base reaction. Acid ionization constants. The pH and pOH. Titrations to calculate concentration. Buffers solutions. Saline solutions. Salt hydrolysis. pH calculation of strong/weak acid and bases, buffer solutions, saline solutions.

Organic chemistry. Writing structural formulas of organic compounds. Naming organic compounds. The functional groups. Alkanes. Structural formulas of alkanes. Constitutional isomers. Name of alkanes. How do we obtain alkanes? Cycloalkanes. Shapes of alkanes and cycloalkanes. Cis-Trans isomerism in cycloalkanes. The physical properties of alkanes and cycloalkanes. The characteristic reactions of alkanes. Haloalkanes. Alkenes and Alkynes. Structures of alkenes and alkynes. Name alkenes and alkynes. The physical properties of alkenes and alkynes. The characteristic reactions of alkenes. The polymerization reactions of ethylene and substituted ethylenes. Benzene. Structure of benzene. Name of aromatic compounds. The characteristic reactions of benzene and its derivatives. Phenols. Structures, names, and physical properties of alcohols. Reactions of alcohols. The structures, names, and properties of ethers and thiols. Enantiomerism. Configuration of a stereocenter. Stereoisomers. Optical activity. Chirality. The significance of chirality in the biological systems. Amines. Nomenclature of amines. The physical properties of amines. The basicity of amines. The characteristic reactions of amines. Aldehydes and ketones. Nomenclature of aldehydes and ketones. Physical properties of aldehydes and ketones. Characteristic reactions of aldehydes and ketones. Keto-enol tautomerism. Carboxylic acids. Name carboxylic acids. Physical properties of Carboxylic acids. The characteristic reactions of carboxylic acids. Carboxylic anhydrides, esters, and amides. Preparation of esters. Preparation of amides. Characteristic reactions of anhydrides, esters, and amides. Carbohydrates. Monosaccharides. Cyclic structures of monosaccharides. Characteristic reactions of monosaccharides. Disaccharides and oligosaccharides. Polysaccharides. Lipids. Structures of triglycerides. Properties of triglycerides. Structures of complex lipids: Glycerophospholipids, sphingolipids, glycolipids. Amino acids. The primary structure of proteins. The secondary structure of proteins. The tertiary structure of proteins. The quaternary structure of proteins.

**Suggested Books:**

- Introduction to General, Organic and Biochemistry, International Edition. Bettelheim FA, Brown WH, Campbell M.K., Farrell S.O.
- Chemistry. Structure and Dynamics. Spencer JN, Bodner GM, Richard LH, Wiley
- Chemical Principles, Third Edition, Dickerson, Gray, Haight