

I year (1st semester)
A.Y. 2025-26

Scientific Field	CHEMISTRY AND INTRODUCTORY BIOCHEMISTRY	TUTOR	ECTS
BIO/10	Chemistry and Introductory Biochemistry	Ciaccio Chiara	7

SPECIFIC AIMS

The aim of this course is to provide students with a solid foundation in the principles of general, inorganic, physical, and organic chemistry, with a focus on their relevance to the medical and biological sciences. The course is designed to help future medical professionals understand the chemical basis of physiological processes, drug interactions, and diagnostic techniques. Through the study of atomic structure, chemical bonding, thermodynamics, kinetics, equilibria, electrochemistry, and organic functional groups, students will gain the necessary chemical knowledge to comprehend the molecular mechanisms of life and support further learning in biochemistry and medical subjects.

PROGRAM

INTRODUCTORY REMARKS. Periodic table of elements and inorganic nomenclature. Atom: atom models, atomic particles: proton, neutron, electron. Isotopes. Electrons and atom electronic configuration. The quantum-mechanical model of the atom. Quantum numbers and orbitals. Auf-bau. Chemical bonds.

CHEMISTRY

MATTER STATES. Gas: ideal gas law. Absolute temperature and its relation with mean molecular speed. Mixture of gases; Dalton law.

LIQUIDS: vapor pressure of a liquid. Solids: structural characteristics of covalent, ionic, molecular and metallic solids.

THERMODYNAMICS. Thermodynamic potentials; enthalpy, Hess law, entropy. Free energy: relationship with enthalpy and entropy.

SOLUTIONS. Concentrations of solutions: dilution and mixing of solutions. Vapor pressure of a solution (Raoult law). Solubility of gases in liquids: Henry law.

CHEMICAL EQUILIBRIUM. Equilibrium in gaseous phase. Expression of equilibrium constant. K_p and K_c relationship. Equilibrium influencing factors. Homogeneous and heterogeneous equilibrium.

SOLUTIONS OF ELECTROLYTES. Strong and weak electrolytes: dissociation grade. Colligative properties of electrolyte solutions. Van't Hoff binomial. Acid and bases following Arrhenius, Bronsted and Lowry definitions. Strong and weak acid and bases. Dilution law of Ostwald. pH in strong and weak acid and base solutions. Buffers. Dissociation of polyprotic acids and bases. Acid-base titrations.

HETEROGENEOUS SYSTEMS. Equilibria of slightly soluble ionic compounds. The solubility-product constant. The effect of a common ion.

KINETIC. Kinetic introduction, activated complex theory, activation energy. Kinetic equations and reaction order. Relationship between kinetic constant and activation energy (Arrhenius energy). Relationship between kinetic constants and equilibrium constants.

ELECTROCHEMISTRY. Redox reactions and chemical potentials. Oxidation number. Redox reactions and their balance. Redox standard potentials. Nernst equation. Electromotive force potential of a cell. Half-cell. Chemical and concentration cells.

PROGRAM

CARBON ATOM HYBRIDIZATION. sp^3 , sp^2 , sp hybridization and their geometry.

HYDROCARBONS. Saturated hydrocarbons (alkanes, cycloalkanes). Nomenclature. Conformational isomerism and geometric isomerism (cis-trans). Alkanes reactions: halogenation and its mechanism. Unsaturated hydrocarbons: alkenes and alkynes. Nomenclature. Addition reactions to alkenes. Markovnikov rule. Alkynes addition.

AROMATIC COMPOUNDS. Benzene structure: resonance model. Aromatic compounds nomenclature. Electrophilic aromatic substitution and its mechanism. Activating/deactivating groups in electrophilic aromatic substitution. Ortho-para and meta directing group. Polycyclic aromatic hydrocarbons.

ALCOHOLS, PHENOLS, THIOLS. Nomenclature. Acidity and alkalinity of alcohols and phenols. Alcohols' reactions. Alcohol with more than a unique alcoholic group. Alcohols and phenols in comparison. Aromatic substitution in phenols. Thiols. Aldehydes and KETONES. Nomenclature. Aldehydes and ketones preparation. Carbonyl group. Nucleophilic addition at carbonyl groups. Acetals and hemiacetals formation. Oxidation of carbonyl compounds. Keto-enol tautomerism. α hydrogen acidity. Aldol condensation.

CARBOXYLIC ACIDS AND THEIR DERIVATIVES. Nomenclature. Carboxylate ion resonance. Effects of acid structure: inductive effect.

Acids preparation. Carboxylic acid derivatives: esters, anhydrides, amides.

DIFUNCTIONAL ACIDS. DICARBOXYLIC ACIDS. Unsaturated acids. Ketoacids. Esterification mechanisms (Fischer). Glycerol triesters. Amines and OTHER NITROGEN COMPOUNDS. Classification and nomenclature of amines. Amines preparation. Amine alkalinity. Comparison between amines and amides. Amines reactions: heterocycles, pyrrole, pyridine, imidazole, pyrimidine, purines.

STEREISOMERISM. Chirality. Enantiomers. Polarized light. Diastereoisomers. Meso compounds. Racemic mixtures.

CARBOHYDRATES. Definition, classification and nomenclature. Monosaccharides. Monosaccharides chirality. Fischer projections.

INTRODUCTORY BIOCHEMISTRY

TEXTBOOKS

Chemistry by M.S. Silberberg, McGraw-Hill International Edition.

Introduction to General, Organic and Biochemistry by F.A. Bettelheim, W.H. Brown, M.K. Campbell, S.O. Farrell, Brooks/Cole.

EXAM METHOD

The chemistry exam will consist of a written test which covers the entire syllabus. It will last 75 minutes and consist of 45 multiple-choice questions (5) with only one correct answer. The questions will include stoichiometry exercises in general chemistry and theoretical questions (general and organic chemistry). No points are awarded for unanswered questions or wrong answers.

Students who pass the written test with a grade of 18 or higher may accept the grade or may choose to take an optional oral test at the end of which the grade may increase or decrease (up to failing). The oral examination consists of questions regarding the entire program. At the end of the oral exam, the teacher will give an overall mark which the student may refuse.

The score obtained in the written exam is only considered valid for that specific exam and cannot be maintained for later exams. If you fail the exam you can anyway sit the next one.

All students who have not previously taken organic chemistry are required to take a written exam regarding the organic chemistry and biochemistry propaedeutics part of the syllabus. The written exam will consist of 30 multiple-choice questions (5) of theoretical questions and will last 40 minutes.

EXAM COMMISSION

The Coordinator, full Professors of the disciplines, Professors of similar disciplines, Specialists of the subject, compose the exam Commission of the Integrated Course.

Ciaccio Chiara, President

Marini Stefano

CONTACTS

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PREREQUISITES: Previous knowledge and competence in Basic Chemistry.

The specific learning outcomes of the program are coherent with the general provisions of the Bologna Process and the specific provisions of EC Directive 2005/36/EC. They lie within the European Qualifications Framework (Dublin Descriptors) as follows:

1. Knowledge and Understanding

- Demonstrate a comprehensive theoretical knowledge of the main molecular chemical and biochemical principles, rules and structures.
- Identify the structural components of inorganic and organic compound present in nature.
- Understand the importance of these structures, focusing the attention on their natural interaction and their possible alterations.
- Understand the bases of aqueous-electrolytic and acid-base rules and their role on the human body homeostasis.
- Understand the importance of chemical bonds and how they stabilize a chemical structure.

2. **Applying Knowledge and Understanding**

- Determine the core consequences of chemical abnormalities and the influence of chemical compounds in the human body.
- Apply the theoretical knowledge to the clinical setting, being able to recognize the general diagnostic aspects of chemical and metabolic abnormalities.
- Identify and recognize the proper molecular diagnostic techniques to use for any particular topic of examination. Provide a comprehensive description of all the available possibilities.
- Assess the major metabolic values and cut-offs used in the clinical scenario.
- Solve main problems of bioinorganic chemistry based on learning fundamental principles.
- Learn to interpret the results of simple experiments and demonstrations of chemical principles.

3. **Making Judgements**

- Recognize the importance of an in-depth knowledge of the topics consistent with a proper medical education.
- Identify the fundamental application of the theoretical studies to clinical practice.

4. **Communication Skills**

- Present the topics orally in an organized and consistent manner.
- Use of proper scientific language coherent with the topic of discussion.

5. **Learning Skills**

- Identify the possible use of the acknowledged skills in future career.
- Assess the importance of the acquired knowledge in the overall medical education process.