

CdS Medicine and Surgery

1st year (1st semester)
A.Y. 2026-27

COD:	Scientific Field: Chemistry and Biochemistry	TUTOR - Docente	ECTS -CFU
BIO/10	Chemistry and Introductory Biochemistry	Ciaccio Chiara	6
		Marini Stefano	1

COORDINATOR-Coordinatore:
Ciaccio Chiara

SPECIFIC AIMS :

EN: The aim of this course is to provide medical students with a solid foundation in the principles of general, inorganic, and organic chemistry, highlighting their relevance to the biomedical sciences. The course is designed to enable future medical professionals to understand the chemical basis of physiological processes, drug interactions, and diagnostic techniques. Core topics include atomic structure, chemical bonding, thermodynamics, kinetics, equilibria, electrochemistry, and the main classes of organic compounds. This knowledge will enable students to interpret biological phenomena at the molecular level and support their further study in biochemistry and medical sciences.

OBIETTIVI FORMATIVI:

IT: L'obiettivo di questo corso è fornire agli studenti di Medicina una solida preparazione nei principi della chimica generale, inorganica e organica, evidenziandone la rilevanza per le scienze biomediche. Il corso è progettato per consentire agli studenti di comprendere le basi chimiche dei processi fisiologici, delle interazioni tra farmaci e delle tecniche diagnostiche. Gli argomenti principali includono la struttura atomica, il legame chimico, la termodinamica, la cinetica, gli equilibri chimici, l'elettrochimica e le principali classi di composti organici. Tali conoscenze permetteranno agli studenti di interpretare i fenomeni biologici a livello molecolare e costituiranno una base per gli studi successivi in biochimica e nelle discipline mediche.

PROGRAM - PROGRAMMA	
Chemistry	<p>EN: 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.</p> <p>MATTER STATES. Gas: ideal gas law. Absolute temperature and its relation with mean molecular speed. Mixture of gases; Dalton law.</p> <p>LIQUIDS: vapor pressure of a liquid. Solids: structural characteristics of covalent, ionic, molecular and metallic solids.</p> <p>THERMODYNAMICS. Thermodynamic potentials; enthalpy, Hess law, entropy. Free energy: relationship with enthalpy and entropy.</p> <p>SOLUTIONS. Concentrations of solutions: dilution and mixing of solutions. Vapor pressure of a solution (Raoult law). Solubility of gases in liquids: Henry law.</p> <p>CHEMICAL EQUILIBRIUM. Equilibrium in gaseous phase. Expression of equilibrium constant. K_p and K_c relationship. Equilibrium influencing factors. Homogeneous and heterogeneous equilibrium.</p> <p>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.</p> <p>HETEROGENEOUS SYSTEMS. Equilibria of slightly soluble ionic compounds. The solubility-product constant. The effect of a common ion.</p> <p>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.</p> <p>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.</p>
Chimica	<p>IT: INTRODUZIONE. Tavola periodica degli elementi e nomenclatura inorganica. Atomo: modelli atomici, particelle atomiche (protone, neutrone, elettrone). Isotopi. Elettroni e configurazione elettronica dell'atomo. Modello quantomeccanico dell'atomo. Numeri quantici e orbitali. Principio di Aufbau. Legami chimici.</p> <p>STATI DELLA MATERIA. Gas: legge dei gas ideali. Temperatura assoluta e sua relazione con la velocità media molecolare. Miscele di gas; legge di Dalton.</p> <p>Liquidi: pressione di vapore di un liquido. Solidi: caratteristiche strutturali dei solidi covalenti, ionici, molecolari e metallici.</p> <p>TERMODINAMICA. Potenziali termodinamici; entalpia, legge di Hess, entropia. Energia libera: relazione tra entalpia ed entropia.</p> <p>SOLUZIONI. Concentrazioni delle soluzioni: diluizione e miscelazione di soluzioni. Pressione di vapore di una soluzione (legge di Raoult). Solubilità dei gas nei liquidi: legge di Henry.</p> <p>EQUILIBRIO CHIMICO. Equilibrio in fase gassosa. Espressione della costante di equilibrio. Relazione tra K_p e K_c. Fattori che influenzano l'equilibrio. Equilibri omogenei ed eterogenei.</p> <p>SOLUZIONI DI ELETTROLITI. Elettroliti forti e deboli: grado di dissociazione. Proprietà colligative delle soluzioni elettrolitiche. Binomio di Van't Hoff. Acidi e basi secondo Arrhenius, Brønsted e Lowry. Acidi e basi forti e deboli. Legge di diluizione di Ostwald. pH in soluzioni di acidi e basi forti e deboli. Soluzioni tampone. Dissociazione di acidi e basi poliprotici. Titolazioni acido-base.</p> <p>SISTEMI ETEROGENEI. Equilibri di composti ionici poco solubili. Prodotto di solubilità. Effetto dello ione comune.</p> <p>CINETICA. Introduzione alla cinetica, teoria del complesso attivato, energia di attivazione. Leggi cinetiche e ordine di reazione. Relazione tra costante cinetica ed energia di attivazione (equazione di Arrhenius). Relazione tra costanti cinetiche e costanti di equilibrio.</p>

ELETTROCHIMICA. Reazioni redox e potenziali chimici. Numero di ossidazione. Reazioni redox e loro bilanciamento. Potenziali redox standard. Equazione di Nernst. Forza elettromotrice di una cella. Semicelle. Celle chimiche e celle di concentrazione.

PROGRAM – PROGRAMMA

Introductory Biochemistry

EN: CARBON ATOM HYBRIDIZATION. sp^3 , sp^2 , sp hybridization and their geometry.
HYDROCARBONS. Saturated hydrocarbons (arenes): 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. Carbonylic group. Nucleophilic addition at carbonylic groups. Acetals and hemiacetals formation. Oxidation of carbonylic compounds. Keto-enol tautomerism. Alfa 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.
Unsaturated acids. Ketoacids. Esterification mechanisms (Fisher). Glycerol triesters.
AMMINES 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. Racemic mixtures.
AMINO ACID AND PROTEINS. Amino acid properties and their reactions. Peptide bond.
CARBOHYDRATES. Definition, classification and nomenclature. Monosaccharides. Monosaccharides chirality. Fisher projections. Cyclic structure of monosaccharides. Mutarotation. Pyranosidic and furanosidic structures. Glycosidic bond. Disaccharides. Oligosaccharides and their derivatives. Polysaccharides.
FATTY ACIDS: Saturated and unsaturated fatty acids. Essential fatty acids. Unsaturation and physical and chemical properties. Triglycerides and their functions: oils and fats.
NITROGENOUS BASES: definition and structural characteristics of nucleosides and nucleotides. Nucleotides and polynucleotides.

Propedeutica Biochimica

IT: CARBON ATOM HYBRIDIZATION. sp^3 , sp^2 , and sp hybridization and their geometry.
HYDROCARBONS. Saturated hydrocarbons (alkanes, cycloalkanes). Nomenclature. Conformational isomerism and geometric (cis-trans) isomerism. Reactions of alkanes: halogenation and its mechanism. Unsaturated hydrocarbons: alkenes and alkynes. Nomenclature. Addition reactions to alkenes. Markovnikov's rule. Addition reactions of alkynes.
AROMATIC COMPOUNDS. Structure of benzene: resonance model. Nomenclature of aromatic compounds. Electrophilic aromatic substitution and its mechanism. Activating and deactivating groups in electrophilic aromatic substitution. Ortho-para and meta directing effects. Polycyclic aromatic hydrocarbons.

ALCOHOLS, PHENOLS, THIOLS. Nomenclature. Acidity and basicity of alcohols and phenols. Reactions of alcohols. Alcohols with more than one hydroxyl group. Comparison between alcohols and phenols. Electrophilic aromatic substitution in phenols. Thiols.

ALDEHYDES AND KETONES. Nomenclature. Preparation of aldehydes and ketones. Carbonyl group. Nucleophilic addition to carbonyl groups. Formation of acetals and hemiacetals. Oxidation of carbonyl compounds. Keto–enol tautomerism. Acidity of α -hydrogens. Aldol condensation.

CARBOXYLIC ACIDS AND THEIR DERIVATIVES. Nomenclature. Resonance of the carboxylate ion. Structural effects on acidity: inductive effect. Preparation of carboxylic acids. Carboxylic acid derivatives: esters, anhydrides, amides. Unsaturated acids. Keto acids. Esterification mechanisms (Fischer esterification). Glycerol triesters.

AMINES AND OTHER NITROGEN COMPOUNDS. Classification and nomenclature of amines. Preparation of amines. Basicity of amines. Comparison between amines and amides. Reactions of amines: heterocycles such as pyrrole, pyridine, imidazole, pyrimidine, purines.

STEREISOMERISM. Chirality. Enantiomers. Plane-polarized light. Diastereomers. Racemic mixtures.

AMINO ACIDS AND PROTEINS. Properties and reactions of amino acids. Peptide bond.

CARBOHYDRATES. Definition, classification, and nomenclature. Monosaccharides. Chirality of monosaccharides. Fischer projections. Cyclic structure of monosaccharides. Mutarotation. Pyranose and furanose structures. Glycosidic bond. Disaccharides. Oligosaccharides and their derivatives. Polysaccharides.

FATTY ACIDS. Saturated and unsaturated fatty acids. Essential fatty acids. Unsaturation and physical and chemical properties. Triglycerides and their functions: oils and fats.

NITROGENOUS BASES. Definition and structural characteristics of nucleosides and nucleotides. Nucleotides and polynucleotides.

TEXTBOOKS

EN: Chemistry by Zumdahl SS and Zumdahl SA, Brooks/Cole eds. ;
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.
Organic chemistry, a brief course by Atkins R.C. and Carey F.A. McGraw- Hill International Edition.

TESTI DI RIFERIMENTO

IT:

TEACHING METHODS	EN: The course is delivered through frontal lectures supported by problem-solving sessions and exercises aimed at applying theoretical concepts. Lectures are complemented by guided practice in stoichiometry, chemical equilibria, acid–base reactions, and basic organic chemistry. Students are expected to engage in independent study to consolidate the concepts presented in class.
METODI DIDATTICI	IT: Il corso è erogato mediante lezioni frontali, supportate da esercitazioni e sessioni di problem solving finalizzate all'applicazione dei concetti teorici. Le lezioni sono integrate da esercitazioni guidate in stechiometria, equilibri chimici, reazioni acido-base e chimica organica di base. Gli studenti sono tenuti a svolgere uno studio individuale per consolidare i concetti presentati in aula.
EXAM METHODS	EN: The chemistry exam consists of a written test covering the entire syllabus. The test lasts 60 minutes and consists of 31 multiple-choice questions (5 options), with only one correct answer for each question. The questions include stoichiometry exercises in general chemistry and theoretical questions in general and organic chemistry. No points are awarded for unanswered or incorrect answers. Students who pass the written test with a grade of 18/30 or higher may accept the grade or choose to take an optional oral exam. After the oral exam, the final grade may increase or decrease, up to failing the exam. The oral examination consists of questions covering the entire syllabus. At the end of the oral exam, the Professor will assign an overall grade, which the student may accept or refuse. The grade obtained in the written exam is valid only for that specific exam session and cannot be carried over to later sessions. Students who fail the exam at the first call of an exam session may still sit the exam at the second call of the same session. All students who have not previously taken organic chemistry exam are required to take a written exam regarding the organic chemistry and biochemistry propaedeutics part of the syllabus. The written exam will consist of 16 multiple-choice questions (5) of theoretical questions and will last 20 minutes.
MODALITA' DI VALUTAZIONE	IT: L'esame di chimica consiste in una prova scritta che copre l'intero programma. La prova ha una durata di 60 minuti e consiste in 31 domande a scelta multipla (5 opzioni), con una sola risposta corretta per ciascuna domanda. Le domande includono esercizi di stechiometria di chimica generale e quesiti teorici di chimica generale e organica. Non sono assegnati punti per risposte non date o errate. Gli studenti che superano la prova scritta con una votazione pari o superiore a 18/30 possono accettare il voto oppure scegliere di sostenere una prova orale facoltativa. A seguito della prova orale, il voto finale può aumentare o diminuire, fino anche alla non idoneità. La prova orale consiste in domande su tutto il programma. Al termine dell'orale, il docente assegna un voto complessivo, che lo studente può accettare o rifiutare. Il voto ottenuto nella prova scritta è valido esclusivamente per quello specifico appello e non può essere mantenuto per appelli successivi. Gli studenti che non superano l'esame al primo appello di una sessione possono comunque sostenere l'esame al secondo appello della stessa sessione. Tutti gli studenti che non hanno precedentemente sostenuto un esame di chimica organica sono tenuti a svolgere una prova scritta relativa alla parte di propedeutica di chimica organica e biochimica del programma. Tale prova scritta consiste in 16 domande a scelta multipla (5 opzioni) di carattere teorico e ha una durata di 20 minuti.

EXAM COMMISSION

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

IT: Il Coordinatore, i Professori ordinari delle discipline, i Professori di discipline affini e gli Esperti della materia compongono la Commissione d'esame del Corso.

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CONTACTS-CONTATTI

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PREREQUISITES-PREREQUISITI

EN: Previous knowledge and basic competence in chemistry are required. In addition, students are expected to have fundamental knowledge of mathematics, physics, and biology.

IT: Sono richieste conoscenze pregresse e competenze di base in chimica. Inoltre, è richiesta una preparazione di base in matematica, fisica e biologia.

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

- Assess the physiologic principles which govern the function of the lymphoematopoietic and immune systems and the alterations induced by functional and structural abnormalities.
- Highlight the main aspects of hematologic, rheumatologic, allergic and infectious disorders focusing on the etiopathogenesis, diagnosis and therapy.
- Recognize the risk factors, populations at risk, relieving or exacerbating factors for any specific clinical case.
- Demonstrate knowledge about established and evolving medicine that is critical to the practice of the clinical and surgical interventions.
- Determine the major indications or contraindications for both medical and surgical therapeutic strategies.
- Identify the incidence and epidemiology of infectious diseases in order to understand their impact worldwide as well as in most affected countries.
- Recognize the importance of preventive medicine and emphasize the role of early intervention.
- Analyze a clinical case and provide an exhaustive explanation of the possible diagnostic hypothesis and appropriate therapeutic approaches.

2. Applying Knowledge and Understanding

- Apply the theoretical knowledge to the clinical setting, being able to recognize the general diagnostic aspects of the diseases.
- Evaluate the patient, emphasizing the findings obtained from the history, physical examination, and instrumental tests. If the mechanisms underlying these findings can be identified, the correct etiologic, anatomic, and physiologic diagnoses can usually be deduced.
- Predict a differential diagnosis based on given clinical data and provide suitable explanations of the underlying reasonings.
- Learn to interpret appropriate epidemiologic, laboratory and diagnostic studies.
- Learn the practical aspects of the investigation tests and how to perform them.

3. Making Judgements

- Recognize the importance of an in-depth knowledge of the topics consistent with a proper medical education.
- Identify the benefits and adverse effects of any diagnostic and therapeutic interventions.

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 the future career.
- Assess the importance of the acquired knowledge in the overall medical education process.