COURSE DETAILS

" CHEMISTRY AND PROPEDEUTIC BIOCHEMISTRY(INTEGRATED COURSE) "

SSD BIO/10

DEGREE PROGRAMME: CDLM IN MEDICINE AND SURGERY

ACADEMIC YEAR: 2024/2025,1° YEAR, 1° SEMESTER

GENERAL INFORMATION–TEACHER REFERENCES

COORDINATOR: PROF. MARIA ROSARIA RUOCCO

DEPARTMENT: MOLECULAR MEDICINE AND MEDICAL BIOTECHNOLOGIES. ED. 19, 6TH FLOOR

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Professor	Position	Scientific Field	Phone	Reception (day/time/building)	E-mail
Ruocco Maria Rosaria	AssociatePr ofessor	Biochemistry	3121	Wed / 12-14 / Ed.19, 6th floor	mariarosaria.ruocco2@unina.it
Lamberti Annalisa	Full Professor	Biochemistry	3120	Wed / 12-14 / Ed.19, 6th floor	annalisa.lamberti@unina.it
Immacolata Castellano	Associate Professor	Biochemistry	3118	Wed / 12-14 / Ed.19, 6th floor	immacolata.castellano@unina.it.
Del Vecchio Silvana	Full Professor	Imaging Diagnostics & Radiotherapy	3307	Tue / 13-15 / Ed.10	delvecc@unina.it

Didactic Secreteriat: to be defined (mariarosaria.ruocco2@unina.it)

GENERAL INFORMATION ABOUT THECOURSE

INTEGRATED COURSE:
MODULE: BIOCHEMISTRY; IMAGING DIAGNOSTICS & RADIOTHERAPY
SSD OF THE MODULE: BIO/10; MED/36
TEACHINGLANGUAGE: ENGLISH
CHANNEL: SINGLE
YEAR OF THE DEGREE PROGRAMME: FIRST
SEMESTER: FIRST
CFU: 7

REQUIRED PRELIMINARY COURSES (IF MENTIONED IN THE COURSE STRUCTURE "REGOLAMENTO")

None

PREREQUISITES

A basic knowledge on the most common dimension units is required; a good familiarity with mathematical calculations, including logarithmic, as well as with scientific numerical notation is also needed.

LEARNING GOALS

The student should acquire a basic scientific formation on the most important biomolecules through the usage of a rigorous and thoughtful study, aimed at understanding and facing the medical problems that involve the knowledge of an underlying chemical basis.

EXPECTED LEARNING OUTCOMES (DUBLIN DESCRIPTORS)

The student should be capable of:

- recognizing the structure of the most important biological compounds and discussing their reactivity;

- transferring the knowledge acquired on the chemical behaviour of acids and alkalis in aqueous solutions to the biological systems;

- applying the notion of thermodynamic equilibrium to the biochemical transformations;

- recognizing the functional groups in various compounds, as well as discussing the properties of the most important (macro)molecules.

Knowledge and understanding

The student must demonstrate the ability to design strategies for solving problems in biochemistry and to extend the methodologies learned to related fields (physics, statistics, pharmacology) in subsequent studies. The course of training is geared toward imparting the operational skills necessary to apply the knowledge concretely in order to foster the ability to make full use of the methodological tools, including with regard to gender medicine.

Applying knowledge and understanding

The student should be able to independently assess the biochemical processes underlying physiological and pathological states and to indicate the main methodologies aimed at the treatment of certain diseases, and to propose new solutions to address biomedical problems. The necessary tools will then be provided to enable future physicians to make rigorous analysis/judgment when evaluating biomedical reports.

The student must be able to explain to non-experts the biochemical principles underlying the symptomatology and effects of different diseases. He/she must demonstrate the ability to summarize in a comprehensive but concise manner the results achieved, correctly using technical-scientific language, elaborated rigorously but with clarity and simplicity.

The student should be able to update and expand his or her knowledge by drawing independently on texts, scientific articles, specific to biochemical fields, and should be able to gradually acquire the ability to attend specialized seminars, conferences, master's degrees, etc. in biomedical fields. In addition, the course includes interdisciplinary seminars on topics in the clinical area related to biochemical processes, so as to provide the student with guidance and suggestions necessary to enable him or her to deal with other topics related to those in the program.

COURSE CONTENT/ SYLLABUS

General and Inorganic Chemistry (3.5 CFU)**1. Atomic structure and electronegativity** Atomic subparticles. Isotopes. Atomic orbitals. Quantum numbers. Energy scale and shape of orbitals. Rules for electronic configuration. Periodic table of the elements. Metals and non metals. Electronegativity. Radioisotopes and types of radioactivity. *Employment of radioisotopes in Medicine*. **2. Chemical bonds** Ionic bond. Covalent bond. Molecular orbitals (σ and π). Single, double and triple covalent bonds. Nonpolar and polar covalent bonds. Hybridization of orbitals. Polarity and geometry of compounds. Dative (donor-acceptor) bond. Weak bonds. Hydrogen bond. Different types of dipoles. Van der Waals interactions. **3. Concept of mol** Elements and compounds. Atomic, molecular and formula Weight. Avogadro's number. Meaning of mole and relative applications. **4. Inorganic compounds** Different classes of inorganic compounds: oxydes, anydrides, hydroxides, acids (hydracids and oxyacids), salts. Nomenclature and formula of the main compounds belonging to the different classes. Different ways for compounds representation: minimum formula, molecular formula and structural formula. **5. Chemical transformations and related energetics** Chemical transformations: different types of reactions. Reagents and products. Law of mass conservation: balancement of reaction. Stoichiometry of a reaction. Limiting reagents. Reaction rate. Energy of activation. Arrhenius equation. Catalysts. Equilibrium law and meaning of the equilibrium constant. Endothermal and exothermal reactions. Le Chatelier's principle. Thermodynamic parameters: enthalpy, entropy and free energy of Gibbs. Endoergonic and exoergonic reactions. Spontaneous reactions. **6. Properties of water and aqueous solutions** Aggregation states. Properties of the liquid state. Evaporation and ebollition. Vapour pressure. Properties of water. Solubilization of polar and ionic compounds in aqueous solution. Effect of temperature and pressure on the solubilization of gases. Gas embolism. Concentration of an aqueous solution: molarity and its usage in stoichiometric calculations. Strong and weak electrolytes. Dissociation index (alpha). Difference between actual and theoretical concentration. Isotonic coefficient. Diffusion and osmosis. Osmotic pressure. Isotonic, hypertonic and ipotonic solutions. Physiological solutions. Dissociation of water and relative ionic product (Kw). Definition of acidity and alkalinity. pH, pOH, pKw. Definition of acid and alkali according to Brönsted-Lowry. Strength of acid/alkali. Constant of dissociation (Ka and Kb; pKa and pKb). Amphoteric electrolites. Polyprotic acids. Salt hydrolysis. Buffer solutions. Functional mechanism of a buffer solution. Henderson-Hasselbalch equation. Buffering efficiency and useful buffering pH interval. **7. Redox reactions** Oxidation number. Redox reactions. Oxidant and reducent reagents. Semi-reactions (oxidation and reduction). Redox potential. Hydrogen standard electrode. Nernst equation. Voltage of a galvanic cell. ***Organic Chemistry (****1.5 CFU****)*** **1. Backbone of organic compounds** Hybridization of Carbon atom (sp3, sp2 and sp): related geometry and bond angles. Recognition of the different types of hybridization in organic molecules. Writing structural formulas of organic compounds. Saturated and unsaturated aliphatic hydrocarbons: alkanes, alkenes and alkynes. Radicals. IUPAC nomenclature. Aromatic hydrocarbons: benzene. **2. Simple organic molecules** Structure of the main functional groups in organic molecules and their polar, electrophilic and nucleophilic characteristics. Hydrophobic or hydrophilic character of organic molecules. Role of the hydrogen bonds in physical properties and water solubilization. Reactivity between functional groups. Isomerism and its biological relevance. Different types of isomerism: chain, position, function. Stereoisomers: geometry and optical isomers (enantiomers, epimers and diastereoisomers). **3. Classes of organic molecules** Nomenclature, chemico-physical properties and structural features of alcohols, phenols, ethers; aldehydes and ketones; hemiacetals and hemiketals; cyanohydrin; aldimines and ketimines; carboxylic acids; esters; amines; amides. Poly- functional compounds of biological relevance (lactic acid, pyruvic acid, aspirin, urea). ***Introduction to Biochemistry*** *(2 CFU)* **1. Biological molecules and macromolecules: Amino acids and Proteins** Amino acids: different types of classification. Chemical, physical and optical properties of amino acids. Amphoteric character and buffering properties of amino acids. Isoelectric point. Peptide bond: formation, structure geometry and electron delocalization. Polypeptides and proteins. Structural organization of proteins and description of the stabilizing forces. Primary, secondary (alpha helix, beta sheet, beta turns), tertiary and quaternary structure. Structural domains of proteins. Globular and fibrous proteins. Functional classification of proteins. Post-translational modifications of proteins. **2. Biological molecules and macromolecules: Carbohydrates** Carbohydrates and their classification, structure and properties. Monosaccharides: main aldoses and ketoses and their open and cyclical forms: hemiacetal and hemiketal hydroxyl group. Anomerism. O-glycosidic bond. Disaccharides: sucrose, maltose and lactose. Polysaccharides: glycogen, starch and cellulose. **3. Biological molecules and macromolecules: Lipids** Lipids: classification and properties. Structure and properties of the main constituents of lipids: glycerol, saturated and unsaturated fatty acids, sphingosine, choline. Structure and properties of: triglycerides, phosphatidic acids and phospholipids (lecithin and cephalins), sphingomyelins, gangliosides and cerebrosides, sterols (cholesterol). Amphipathic features of phospholipids and their importance in the formation of the lipid bilayer in biological membranes. Relevance of a healthy diet for wellness and tumor prevention: coffee and liver diseases. **4. Biological molecules and macromolecules: Nucleotides and Nucleic Acids** Structure of the aromatic heterocyclic compounds. Nitrogen-containing bases: purine and pyrimidine. Structure and aromatic characteristics of adenine, guanine, cytosine, thymine and uracil. Keto-enol tautomerism of purine and pyrimidine bases. Ribose and deoxyribose. N-glycoside bond. Nucleosides. Nucleotides. Nucleic acids: DNA and RNA primary structure. Secondary structure: double helix of DNA. Different types of RNA.

CALENDAR OF LESSONS

21/10/24

13.00-14.35: Course presentation. Atomic subparticles. Isotopes. Atomic orbitals. - Prof. MR Ruocco -2h

22/10/24

13.00-13:45: Quantum numbers. Energy scale and shape of orbitals. Rules for electronic configuration.- Prof. A Lamberti-1h

24/10/24

15.30-17.05: Periodic table of the elements. Metals and non metals. Electronegativity. - Prof. MR Ruocco-2h

25/10/24

15.30-17.05: Radioisotopes and types of radioactivity. - Prof. A. Lamberti -2h

28/10/24

15.30-17.05: Employment of radioisotopes in Medicine - Prof. Del Vecchio Silvana-2h

29/10/24

13.00-13:45: Ionic bond.- Prof. MR Ruocco-1h

31/10/24

15.30-17.05: - Covalent bond. Molecular orbitals (σ and π). Single, double and triple covalent bonds. Prof. MR Ruocco-2h

4/11/24

15.30-17.05: - Nonpolar and polar covalent bonds. Hybridization of orbitals. Polarity and geometry of compounds. Dative (donor-acceptor) bond. Prof. MR Ruocco-2h

5/11/24

13.00-13:45: - Weak bonds. Hydrogen bond. Different types of dipoles. Van der Waals interactions. Prof. I. Castellano -1h

7/11/24

15.30-17.05: - Elements and compounds. Atomic, molecular and formula Weight. Prof. I. Castellano -2h

8/11/24

15.30-17.05: - Avogadro's number. Meaning of mole and relative applications. Exercises. A. Lamberti -2h

11/11/24

13.00-14.35: - Different classes of inorganic compounds: oxydes, anydrides, hydroxides, acids (hydracids and oxyacids), salts. A. Lamberti -2h

12/11/24

13.00-13:45: - Nomenclature and formula of the main compounds belonging to the different classes. Different ways for compounds representation: minimum formula, molecular formula and structural formula. Prof. MR Ruocco-1h

14/11/24

15.30-17.05: - Chemical transformations: different types of reactions. Reagents and products. Law of mass conservation: balancement of reaction. Stoichiometry of a reaction. Limiting reagents.Prof. MR Ruocco-2h

15/11/24

15.30-17.05: - Exercises.Reaction rate. Energy of activation. Arrhenius equation. Catalysts. Equilibrium law and meaning of the equilibrium constant. Prof. MR Ruocco-2h

18/11/24

13.00-14.35: - Endothermal and exothermal reactions. Le Chatelier's principle. Thermodynamic parameters: enthalpy, entropy and free energy of Gibbs. Endoergonic and exoergonic reactions. Spontaneous reactions.A. Lamberti -2h

19/11/24

13.00-13.45: -Aggregation states. Properties of the liquid state. Evaporation and ebollition. Vapour pressure. Properties of water. Solubilization of polar and ionic compounds in aqueous solution. A. Lamberti -1h

21/11/24

15.30-17.05: - Effect of temperature and pressure on the solubilization of gases. Gas embolism. Concentration of an aqueous solution: molarity and its usage in stoichiometric calculations. Strong and weak electrolytes.Prof. I. Castellano -2h

22/11/24

15.30-17.05: - Dissociation index (alpha). Difference between actual and theoretical concentration. Isotonic coefficient. Diffusion and osmosis. Osmotic pressure. Isotonic, hypertonic and ipotonic solutions. Physiological solutionsExercises. Prof. MR Ruocco-2h

25/11/24

13.00-14.35: Dissociation of water and relative ionic product (Kw). Definition of acidity and alkalinity. pH, pOH, pKw.Prof. I. Castellano -2h

26/11/24

13.00-13.45: - Definition of acid and alkali according to Brönsted-Lowry. Strength of acid/alkali. Constant of dissociation (Ka and Kb; pKa and pKb). Amphoteric electrolites. Polyprotic acids.Prof. I. Castellano -1h

28/11/24

15.30-17.05: -Salt hydrolysis. Buffer solutions. Functional mechanism of a buffer solution. Henderson-Hasselbalch equation. Buffering efficiency and useful buffering pH interval. Exercises.Prof. I. Castellano -2h

29/11/24

15.30-17.05: Redox reactions. Oxidant and reducent reagents. Semi-reactions (oxidation and reduction). Redox potential. Hydrogen standard electrode. Nernst equation. Voltage of a galvanic cell. Exercises. Prof. MR Ruocco-2h

2/12/24

13.00-14.35: - I Self-assessment test. Prof. MR Ruocco-2h AGGIUNGERE 2 ORE A CHIMICA GENERALE

3/12/24

13.00-13.45: -Hybridization of Carbon atom (sp3, sp2 and sp): related geometry and bond angles.Prof. A. Lamberti -1h

5/12/24

15.30-17.05: - Recognition of the different types of hybridization in organic molecules. Writing structural formulas of organic compounds. Saturated and unsaturated aliphatic hydrocarbons: alkanes, alkenes and alkynes. Radicals. Prof. A. Lamberti -2h

6/12/24

15.30-17.05: - IUPAC nomenclature. Aromatic hydrocarbons: benzene. Structure of the main functional groups in organic molecules and their polar, electrophilic and nucleophilic characteristics. Hydrophobic or hydrophilic character of organic molecules. Role of the hydrogen bonds in physical properties and water solubilization. Prof. MR Ruocco-2h

9/12/24

13.00-14.35: - Reactivity between functional groups. Isomerism and its biological relevance. Different types of isomerism: chain, position, function. Stereoisomers: geometry and optical isomers (enantiomers, epimers and diastereoisomers). Prof. MR Ruocco-2h

10/12/24

13.00-13.45: - Classes of organic molecules: alcoholsProf. I. Castellano -1h

12/12/24

15.30-17.05: - Classes of organic molecules: alcohols ; phenols; ethersProf. I. Castellano -2h

13/12/24

15.30-17.05: - Classes of organic molecules: aldehydes and ketonesand hemiacetals and hemiketals; cyanohydrin; aldimines and ketimines Prof. MR Ruocco-2h

16/12/24

13.00-14.35: - Classes of organic molecules: carboxylic acidsProf. MR Ruocco-2h

17/12/24

13.00-13.45: - Classes of organic molecules:estersProf. MR Ruocco-1h

19/12/24

15.30-17.05: - Classes of organic molecules: amines; amides. Poly-functional compounds of biological relevance (lactic acid, pyruvic acid, aspirin, urea) Prof. I. Castellano -2h

20/12/24

15.30-17.05: - II Self-assessment test.Prof. A. Lamberti -2h

7/1/25

13.00-13.45: - Amino acids: different types of classification. Chemical, physical and optical properties of amino acids. Amphoteric character and buffering properties of amino acids. Isoelectric point. Prof. A. Lamberti -1h

9/1/25

15.30-17.05: - Peptide bond: formation, structure geometry and electron delocalization. Polypeptides and proteins. Prof. MR Ruocco-2h

10/1/25

15.30-17.05: - Structural organization of proteins and description of the stabilizing forces. Primary, secondary (alpha helix, beta sheet, beta turns), tertiary and quaternary structure. Structural domains of proteins. Globular and fibrous proteins.Prof. I. Castellano -2h

13/1/25

13.00-14.35: - Functional classification of proteins. Post-translational modifications of proteins. Prof. A. Lamberti -2h

14/1/25

13.00-13.45: - Carbohydrates and their classification, structure and properties. Prof. I Castellano-1h

16/1/25

15.30-17.05: - Monosaccharides: main aldoses and ketoses and their open and cyclical forms: hemiacetal and hemiketal hydroxyl group.Prof. A. Lamberti -2h

17/1/25

15.30-17.05: - Monosaccharides: main aldoses and ketoses and their open and cyclical forms: hemiacetal and hemiketal hydroxyl group. Prof. MR Ruocco-2h

20/1/25

13.00-14.35: - Lipids: classification and properties. Structure and properties of the main constituents of lipids: glycerol, saturated and unsaturated fatty acids, sphingosine, choline. Prof. I. Castellano -2h

21/1/25

13.00-13.45: - Structure and properties of: triglycerides, phosphatidic acids and phospholipids (lecithin and cephalins), sphingomyelins, gangliosides and cerebrosides, sterols (cholesterol). Prof. I. Castellano -1h

23/1/25

15.30-17.05: - Amphipathic features of phospholipids and their importance in the formation of the lipid bilayer in biological membranes. Relevance of a healthy diet for wellness and tumor prevention.Prof. MR Ruocco-2h

24/1/25

15.30-17.05: - Structure of the aromatic heterocyclic compounds. Nitrogen-containing bases: purine and pyrimidine. Prof. A. Lamberti -2h

27/1/25

13.00-14.35: - Structure and aromatic characteristics of adenine, guanine, cytosine, thymine and uracil. Keto-enol tautomerism of purine and pyrimidine bases. Prof. A. Lamberti -2h

28/1/25

13.00-13.45: - Ribose and deoxyribose. N-glycoside bond Prof. I. Castellano - 1h

30/1/25

15.30-17.05: - Nucleosides. Nucleotides. Nucleic acids: DNA and RNA primary structure. Secondary structure: double helix of DNA. Different types of RNA. Exercises Prof. MR Ruocco- 2h

31/1/25

15.30-17.05: - IIISelf-assessment test.Prof. I. Castellano -2h

READINGS/BIBLIOGRAPHY

- F.A. Bettelheim, W.H. Brown, M.K. Campbell, S.O. Farrell: General, Organic, and Biochemistry, International Edition
- J. Armstrong: General, Organic, and Biochemistry. An Applied Approach, International Edition.

Other supporting didactic material available at the web-site of Course Coordinator (www.docenti.unina.it).

TEACHING METHODS

Frontal Teaching Activities (FTA) and Interactive Teaching Activities (ITA)

EXAMINATION/EVALUATION CRITERIA

a) Exam type:

*For **integrated courses**, there should be one exam.*

Exam type	
writtenand oral	X
only written	
only oral	
project discussion	
other	

In case of a written exam, questions refer to: (*)	**Multiple choice answers**	X
	Open answers	
	Numerical exercises	

(*) multiple options are possible

A test with multiple choice questions on all arguments listed in the program and stoichiometric calculations is preliminary to an oral examination. The test must be passed for the access to oral examination.

b) Evaluation pattern:

The exam will consist of a written and oral examination and both are mandatory.
The oral examination will follow the written examination only if the written is passed with a minimum score of 18/30.
The written examination consists of multiple choice answersandnumerical exercises.
The oral examination will consist in theoretical questions and further exercises.