Degree course in Medicine and Surgery

Course: **General Chemistry and Introductory Biochemistry**
Scientific Disciplinary sector: **BIO/10**
CFU Number: **6**
Professors:

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PREREQUISITES

No prerequisites are foreseen to sustain this examination. However, the student is expected to bear basic mathematics (including logarithms and exponentials, quadratic equations) and chemistry (atom structure, principles of stoichiometry, inorganic and organic compounds nomenclature) skills.

LEARNING OBJECTIVES

The main aim of this course is to allow the students to learn the major chemical and physical principles which govern organism life. The course will further cover the study of the composition of inorganic and organic compounds as well as the reactions they undergo.
These aims will be pursued through interactive frontal lectures, exercise-sessions designed to optimize learning and to maximize the student skill in recognizing and solving a given medicinal chemistry task.

LEARNING OUTCOMES

Knowledge and understanding

The course of general chemistry and introductory biochemistry is aimed at allowing the students to learn the chemical, physical and molecular bases of main principles and laws of molecular chemistry and biochemistry.
At the end of the course the student is expected to become able to identify the composition of inorganic compounds present in nature and how they interact and react with each other during patho-physiological processes in human body. The student is asked to learn the water-based reactions, acid-base theories, and their role in maintaining the homeostasis.
The course is further organized to provide the students the basis of the chemistry of Carbon, *i.e.* organic chemistry, with a special focus on how organic compounds are structurally arranged and how they react to form the building blocks of life.

Applying knowledge and understanding

The student will learn how to apply the knowledge acquired during the course to the clinical tasks his/her profession is expected to deal with. This will allow the student to recognize critical diagnostic items and prognostic outcomes by deciphering how a given chemical and metabolic alteration turns out into a pathological condition. At the end of the course, the student will be able to apply this knowledge to the specific clinical area he/she will dedicate his/her medical activity.

Communication skills
The student will be asked to be able to discuss orally the subjects which are part of this course syllabus. He/She will be further asked to learn the right scientific terminology.

Making judgements
Specific attention will be paid to let the students improve the critical capacity when studying key chemical processes which underscore metabolic reaction of living organisms with clinical relevance. The students are expected to learn how critical is to bear a solid conceptual knowledge of each specific clinical task.

COURSE SYLLABUS

General Chemistry
INTRODUCTION 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.

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, entropy. Free energy: relationship with enthalpy and entropy.

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

CHEMICAL EQUILIBRIUM. Expression of equilibrium constant. 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. Acids and bases following Arrhenius, Bronsted and Lowry, Lewis definitions. Strong and weak acid and bases. pH in strong and weak acid and base solutions. Buffers.

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

KINETICS. Introduction to kinetics, activated complex theory, activation energy. Kinetic equations and reaction order. Relationship between kinetic constants and equilibrium constants.

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

Introductory Biochemistry
HYBRIDIZATION OF THE CARBON ATOM - sp^3, sp^2, sp hybridizations and their geometry.

HYDROCARBONS - Saturated hydrocarbons: alkanes and cycloalkanes. Nomenclature. Unsaturated hydrocarbons: alkenes and alkynes. Nomenclature. Conformational isomerism and geometric isomerism (cis-trans).

AROMATIC COMPOUNDS - Structure of benzene: the resonance model. Nomenclature of aromatic compounds. Polycyclic aromatic hydrocarbons (outline).

ALCOHOLS, PHENOLS, THIOLS - Nomenclature. Acidity and basicity of alcohols and phenols. Thiols, analogues of alcohols and phenols.

ALDEHYDES AND KETONES - Nomenclature. Preparations of aldehydes and ketones. The carbonyl group. The nucleophilic addition to the carbonyl groups; formation of semiacetals and acetals. The aldol condensation (outline).

CARBOXYLIC ACIDS AND THEIR DERIVATIVES - Nomenclature of acids. Derivatives of carboxylic acids: esters, amides. Mechanism of esterification; triesters of glycerol.

AMINES AND OTHER NITROGEN COMPOUNDS - Classification of amines and nomenclature. Basicity of amines. Comparison between the basicity of amines and amides.

STEREOISOMERY - Chirality. Enantiomers. Polarized light; the polarimeter (hints). Diastereomers.

CARBOHYDRATES - Definitions and classification. The monosaccharides. Chirality in monosaccharides; Fischer's projections. Cyclic structures of monosaccharides. Anomers. Phenomenon of mutarotation. Pyranosic and furanotic structures.

AMINO ACIDS, PROTEINS - Properties of amino acids. Peptide bond

LIPIDS: Structure, nomenclature, properties

NITROGEN BASES AND NUCLEOTIDES - Structure, nomenclature.

COURSE STRUCTURE

Teaching activity is planned to last 60 hours sub-divided into 2h or 3h-long lectures/day.
Didactic activity will encompass both frontal lecture and exercise-training sessions for either inorganic or organic chemistry. Course attendance is mandatory.

COURSE GRADE DETERMINATION

The examination will consist in a written test followed by an oral exam.
The written test lasts 2 hours and consists of a test of 30 multiple choice questions structured as follows:

1) 15 Questions of General Chemistry
2) 15 Questions of Organic Chemistry and Biochemical Preparation

For each question only one answer is correct and one point is attributed to it. Wrong or not given answers correspond to zero points.
To pass the written test and be admitted to the oral test, it is necessary to achieve a score equal to or greater than 18.
Written tests can be taken at each exam session and the mark obtained is valid only for the session in which the written test is taken.
The oral test will focus on three short questions on the entire program. The score of the oral test will be mediated with that of the written test to obtain the final score.
During the oral proof, the examiner will test the students skills in applying the knowledge obtained and in solving chemistry issues. Further skills which will be evaluated encompass making judgements, communication skills and learning skills according with Dublin Descriptors.

Hence the whole examination will be evaluated as it follows:

Insufficient: severe poor knowledge of the subject, very limited skill in the analysis of specific items.

18-20: knowledge of the subjects of sufficient quality characterized by frequent imperfections. Analysis and reasoning skills of sufficient quality.

21-23: standard knowledge of the specific subject; analysis and reasoning skill of acceptable quality.

24-26: good knowledge of the subjects and good analysis and reasoning skills; arguments are expressed in a rigorous way.

27-29: very good knowledge of the specific scientific subjects, valid analysis and reasoning skills, significant skill in making judgements.

30-30L: outstanding knowledge of the specific knowledge of the scientific tasks. Exceptional analysis, reasoning and making judgements skills.

READING MATERIALS

CHEMISTRY

Hein M, Arena S, *Foundations of College Chemistry*, 14 Edition John Wiley and Sons Inc.
or
Peter Atkins , Loretta Jones, Leroy Laverman Chemical Principles: The Quest for Insight
or
Chemistry by M.S. Silderberg, McGraw-Hill International Edition

BIOCHEMISTRY

Voet D, Voet JG, Pratt CW *Principles of Biochemistry* (international student version) IV edition – John Wiley and Sons Inc.