Degree course in Medicine and Surgery

Course: Medicinal 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 stechiometry, 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 medicinal chemistry course 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 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, 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's law). Solubility of gases in liquids: Henry law.

Chemical equilibrium. Equilibrium in gaseous phase. Expression of equilibrium constant. Kp and Kc 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. 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. Nerst equation. Electromotive force potential of a cell. Half-cell. Chemical and concentration cells.

Introductory Biochemistry

Carbon atom hybridization. Sp^3, Sp^2, Sp hybridization and their geometry.

Hydrocarbons. Saturated hydrocarbons (arenes): alkanes, cicloalkanes. Nomenclature. Conformational isomerism and geometric isomerism (cis-trans). Unsaturated hydrocarbons: alkenes and alkynes. Nomenclature. Addiction reactions to alkenes. Markovnikov rule. Alkynes addiction.

Aromatic compounds. Benzene structure: resonance model. Aromatic compounds nomenclature. Polycyclic aromatic hydrocarbons.

Alcohols, phenols, thiols. Nomenclature. Alcohols and phenols in comparison.

Aldehydes and ketones. Nomenclature. Carbonylic group. Acetals and hemiacetals formation. Keto-enol tautomerism. Aldol condensation.

Carboxylic acids and their derivatives. Nomenclature. Carboxylic acid derivatives: esters and amides. Esterification mechanisms. Glycerol triesters.

Ammines and other nitrogen compounds. Classification and nomenclature of ammines. Comparation between ammines and amides.

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

Carbohydrates. Definition, classification and nomenclature. Monosaccharides. Monosaccharides chirality. Fisher projections.

Amino acids, proteins. Structure and properties of aminoacids. Peptide Bond.

Nucleotides and nucleosides. Nomenclature, structure and properties.

COURSE STRUCTURE

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

COURSE GRADE DETERMINATION

Examination will include both a written and an oral proof.
The written proof, which consists in 4 exercises covering the inorganic chemistry syllabus and in drawing the chemical formula of 15 organic compounds, will last 2 h and 15 minutes.
Regarding inorganic chemistry examination, each exercise score 0-7.5 points, depending on how the students has actually solved it. Regarding organic chemistry, the right drawing of each formula score 2 points. Exercises of inorganic and organic chemistry are corrected independently and to pass the written examination the student is asked to get a minimum mark of 18 in both inorganic and organic chemistry. Students who pass the written proof will be asked to sustain an oral proof. During the oral proof, which will be held few days after the written proof, the examiner will pose questions covering the whole syllabus of inorganic and organic chemistry. The final mark and whether the student is worth passing the whole examination will be decided by the professor at the end of the oral proof. This implies that the written proof mark is not the final mark.
Remarkably, admission to the oral proof once the written one is passed is valid exclusively for the exam session the written proof belongs to. For those students who do not pass the examination it is possible to sustain again the written proof during the next exam session.
During the oral proof, the examiner will test the students skills in applying the knowledge obtained and in solving medicinal 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.

OPTIONAL ACTIVITIES

Beyond the standard didactic activity, the students interested will be encouraged to take part to training sessions in Medicinal Chemistry research laboratories to deepen specific subjects related to the course syllabus. Knowledge of these subjects will not be part of the final examination

READING MATERIALS

Peter Atkins , Loretta Jones, Leroy Laverman Chemical Principles: The Quest for Insight

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

Katherine J Denniston, Joseph J Topping and Robert L Caret. General, Organic & Biochemistry. 7th Ed. 2010. McGraw-Hill Higher Education.