**REQUIREMENTS**

**Semmelweis University, Faculty of Medicine**
**Name of the managing institute (and any contributing institutes):**
Institute of Biochemistry and Molecular Biology, Department of Molecular Biology

**Name of the subject:** Medical chemistry

**in English:** Medical chemistry

**in German:** Chemie für Mediziner

**Credit value:** 6

**Number of lessons per week:** 6 **lecture:** 3 **practical course:** 3 **seminar: –**

**Subject type:** **compulsory course** **elective course** **optional course**

**Academic year: 2022/23/1**

**Subject code: AOKMBT829_1A**

*(In case of a new subject, it is filled by the Dean's Office, after approval)*

**Name of the course leader: Miklós Csala**

**His/her workplace, phone number:** Department of Molecular Biology, 20/666-0100

**Position:** full professor

**Date and registration number of their habilitation:** 6/7/2010, 293

**Objectives of the subject, its place in the medical curriculum:**
The principal aim of the course is to prepare students for the understanding of the subjects of Biochemistry, Molecular cell biology, Physiology and Pharmacology. This requires a firm knowledge of the foundations of general, organic and inorganic chemistry.
The role of the subject in the preclinical studies is to summarize that basic knowledge, which is fundamental for understanding molecular biological and biochemical processes in humans under physiological and pathological conditions.

**Place where the subject is taught (address of the auditorium, seminar room, etc.):**
Semmelweis University, EOK Building, H-1094 Budapest, Tűzoltó utca 37–47., Chemistry Practice Rooms 1–5

**Successful completion of the subject results in the acquisition of the following competencies:**
Students having completed this course possess the basic knowledge which is essential in the following semesters for molecular biology, physiology, biochemistry and pharmacology.

**Course prerequisites:**
There are no prerequisites as this is a subject in the very first semester.

**Number of students required for the course (minimum, maximum) and method of selecting students:**
Obligatory subject for 1st-year medical students; maximum number of participants: 480, there is no student selection

**How to apply for the course:** Neptun

**Detailed curriculum:**
*(Theoretical and practical lessons shall be given separately by numbering the lessons (by weeks). Please provide the names of the teachers of the lectures and practical lessons and indicate guest lecturers. Do not use attachments!*
*Always attach a CV for guest lecturers!)*

*General chemistry:*

1. Atomic structure; periodic table of elements (Miklós Csala)
2. Chemical bonds, hybrid states (Miklós Csala)
3. Secondary bonds and interactions (Miklós Csala)
4. Chemical equilibria (Miklós Csala)
5. Acid-base theories, pH (Miklós Csala)

6. pH of strong or weak acids and bases (Miklós Csala)
7. The theory of buffers (Veronika Zámbó)
8. Buffers of physiological importance, cation and anion hydrolysis, pH of salt solutions (Gábor Bőgel)
9. Solubility of salts and bases, the solubility product (Farkas Sarnyai)
10. Laws of dilute solutions. Specific and equivalent conductivity (Gergely Keszler)
11. Thermodynamics 1 – Enthalpy (Miklós Csala)
12. Thermodynamics 2 – Entropy (Miklós Csala)
13. Thermodynamics 3 – Direction of reactions (Miklós Csala)
14. Electrochemistry 1 (Miklós Csala)
15. Electrochemistry 2 (Miklós Csala)
16. Electrochemistry 3 (Miklós Csala)
17. Reaction kinetics (Miklós Csala)
18. Complex compounds, reactive oxygen species (Péter Szelényi)

*Organic chemistry:*

19. Principles of organic chemistry (Zsolt Rónai)
20. Nomenclature of organic compounds, constitution of organic compounds (Zsolt Rónai)
21. Configuration and conformation of organic compounds (Zsolt Rónai)
22. Saturated and unsaturated hydrocarbons (Szilvia Nagy)
23. Reactions of alkyl halides and aromatic compounds (Szilvia Nagy)
24. Classification and reactions of hydroxyl compounds (Gergely Keszler)
25. Classification and reactions of oxo compounds (Gergely Keszler)
26. Structure, function and reactions of organic acids (Szabolcs Sipeki)
27. Nitrogen-containing organic compounds (Szabolcs Sipeki)
28. Sulfur or phosphorus-containing organic compounds (Szabolcs Sipeki)

*Practices:*

1. Introduction, acid-base titration 1 (titration of strong acids) ***(4×45 Min)***
2. Concentration, pH, problems ***(2×45 Min)***
3. Acid-base titration 2 (titration of weak acids). Relationship between conductivity and dissociation ***(4×45 Min)***
4. Salts ***(2×45 Min)***
5. Titration curves, consultation (buffers) ***(4×45 Min)***
6. Physiological buffer systems ***(2×45 Min)***
7. Electrochemistry, consultation ***(4×45 Min)***
8. Thermochemistry, thermodynamics ***(2×45 Min)***
9. Permanganometry ***(4×45 Min)***
10. Electrochemistry ***(2×45 Min)***
11. Determination of the ionization constant of phenol red by photometry ***(4×45 Min)***
12. Structure of organic compounds ***(2×45 Min)***
13. Complexometry. Precipitation titration ***(4×45 Min)***
14. Isomers, molecule models ***(2×45 Min)***

**Other subjects concerning the border issues of the given subject (both compulsory and optional courses!). Possible overlaps of themes:**

The thematic deliberately overlaps with that of Basics of medical chemistry elective subject. The latter is offered for the students with various levels of former knowledge in chemistry to help them understand the material of the compulsory subject.

**Special study work required to successfully complete the course:**

*(E.g. field exercises, medical case analysis, test preparation, etc.)*

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**Requirements for participation in classes and the possibility to make up for absences:**

Attendance of at least 75% of the practical lessons is obligatory.

**Methods to assess knowledge acquisition during term time:**

(E.g. homework, reports, mid-term test, end-term test, etc., the possibility of replacement and improvement of test results)

Optional written midterm test (30 min) in week 13, about the laboratory measurements during the semester. Performance at the laboratory work during the whole semester is also taken into account at the evaluation.

**Requirements for signature:**
Attendance of at least 75% of the practical lessons is required for getting signature.

**Type of examination:** written + oral

**Requirements of the examination:**
(*In case of a theoretical examination, please provide the topic list; in case of a practical exam, specify the topics and the method of the exam)*

**I. General chemistry**

1. The periodic table of the elements, quantum numbers
2. The covalent bond, the molecular geometry of inorganic molecules (e.g. carbon monoxide, carbon dioxide, ammonia). Ionization energy, electron affinity, electronegativity. The ionic bond, hydroxylapatite and fluoroapatite
3. The structures of polyatomic ions, the complexes
4. The secondary bonds and intearctions between molecules
5. Laws of dilute solutions: vapor pressure, freezing point depression, boiling point elevation
6. The phenomenon of osmosis, its biological significance, isotonic, hypotonic and hypertonic solutions
7. Chemical equilibria, the equilibrium constant and the degree of dissociation, their correlation. The Le Châtelier principle (example: formation, properties, salts, practical use of hypochlorous acid.)
8. Gas mixtures: partial pressure, volume %. The composition of the air. Dissolution of gases in liquids, Henry's law, the decompression sickness
9. The structure and dissociation of water. Acid-base theories. The pH and pOH concept, calculation of the pH of strong acids or bases, and their titration curves. Acid-base indicators
10. The dissociation of weak acids and bases, the concept of specific and equivalent conductivity, their correlations with the dissociation. Titration curves of weak acids
11. Types of salts and their reactions with water. pH of salt solutions
12. The buffers: principle, mechanism of action, calculation of the pH. The titration curves of polyprotic acids (phosphoric acid)
13. Buffers of physiological importance
14. The solution equilibria of solid substances, the solubility product
15. The first law of thermodynamics. Heat of reaction, combustion heat, heat of formation. Hess' law
16. The second law of thermodynamics. The direction of the chemical reactions, Gibbs free energy
17. Oxidation, reduction, oxidation number, standard reduction potential
18. The galvanic cells: arrangement, reactions, calculation of the electromotive force
19. Types of electrodes, redox systems of biological importance
20. The concentration cells, the principle of measuring the pH
21. Reaction rate, order and molecularity, factors influencing the reaction rate

**II. Organic chemistry**

22. The electronic structure of the carbon atom, its hybrid states, the spatial structures of organic compounds
23. The concept of isomerism, types of structural isomerism, nomenclature of organic compounds
24. Geometric isomerism in unsaturated and cyclic compounds
25. Stereoisomerism, chiral compounds, optical activity, D–L and R–S nomenclature
26. Conformations of organic compounds, examples with open chain and cyclic molecules
27. Reaction types and mechanism in organic chemistry
28. Properties and reactions of alkanes
29. Properties and reactions of alkenes
30. Characteristics, reactions and biological roles of aromatic compounds
31. Alcohols, enols, phenols
32. Oxo compounds: aldehydes and ketones. Their chemical reactions, the mechanism of the nucleophilic addition. Oxo-enol tautomerism
33. Properties and reactions of compounds containing a carboxyl group
34. Substituted carboxylic acids (Halogenated, oxo-, hydroxy-; aromatic; mono-, di- and tricarboxylic acids)
35. Organic compounds containing sulfur or phosphorus

36. Nitrogen-containing organic compounds: classification and properties of amines
37. Carboamides, amides of the carbonic acid, imines

**III. Laboratory**

38. Principle of concentration determination by volume measurement: titrations
39. Titration of strong acids and bases
40. Titration of weak acids and bases
41. Conductivity measurement, determination of weak acid dissociation
42. Titration of gastric juice
43. Titration curves of mono- and polyprotic acids
44. Titration based on redox reaction: permanganometry
45. Complexometry: determination of copper concentration
46. Electrochemical measurements: the Daniell cell, concentration cell, redox and non-polarizable electrodes
47. Principle of spectrophotometry, areas of application: determination of the $K_d$ value of the phenol red indicator
48. Precipitation titration

**Method and type of evaluation:**
(*Method of calculating the final mark based on the theoretical and practical examination. How the mid-term test results are taken into account in the final mark.)*
The oral and written exam is based on the topic list announced in the beginning of the semester, and it takes place before a committee of two (examiner and co-examiner). The exam can be passed if all these topics are sufficiently answered. Students pick 3 questions (general chemistry, organic chemistry, practice) and a calculation problem to be solved in writing. Students, who achieve at least 12 points at the practical midterm and at the labs during the semester, get exempted from picking the practical question. The bonus is valid during the whole exam period (in case of an unsuccessful exam).

**How to register for the examination?:** Neptun

**Possibilities for exam retake:** According to general regulation

**Printed, electronic and online notes, textbooks, guides and literature (URL address for online material) to aid the acquisition of the material:**
Ebbing-Gammon: General Chemistry, latest edition
Hrabák-Csermely-Bauer: Principles of Organic Chemistry (2nd edition, 2007, editor: A. Hrabák)
Sasvári: Bioorganic compounds
Tóth: Concise inorganic chemistry for medical students
Hrabák: Laboratory Manual – Medical Chemistry, Biochemistry and Molecular Biology (fourth edition, 2015)
Hrabák: Selected Collection of Chemical Calculations and Biochemical Exercises (latest edition)
E-learning system (Moodle) (itc.semmelweis.hu)

**Signature of the habilitated instructor (course leader) who announced the subject:**

**Signature of the Head of the Managing Department:**

**Hand-in date:** 09/05/2022

**Opinion of the competent committee(s):**

**Comments of the Dean's Office:**

**Dean's signature:**