COURSE OUTLINE FOR "STRUCTURAL AND COMPUTATIONAL MEDICINAL CHEMISTRY"

1. GENERAL

SCHOOL	NATURAL SCIENCES AND HEALTH SCIENCES		
SEPARTMENT	CHEMISTRY AND MEDICINE		
LEVEL OF COURSE	POSTGRADUATE (MSc)		
COURSE CODE	SCC 114	**SEMESTER OF STUDIES**	FIRST
COURSE TITLE	STRUCTURAL AND COMPUTATIONAL MEDICINAL CHEMISTRY		

INDEPENDENT TEACHING ACTIVITIES	**WEEKLY TEACHING HOURS**	**ECTS CREDITS**
Lectures	4	5

COURSE TYPE	Field of Science (Advanced Spectroscopy methods and Molecular Modeling) (Semi Optional)
PREREQUISITE COURSES:	Typically, there are not prerequisite courses. The students should have knowledge of the basic principles of Organic Chemistry and NMR spectroscopy.
TEACHING AND ASSESSMENT LANGUAGE:	Greek. Teaching may be however performed in English in case foreign students attend the course.
IS THE COURSE IS OFFERED TO ERASMUS STUDENTS	YES

2. LEARNING OUTCOMES

Learning outcomes

By the end of this course the student will be able to:

- Interpret 1D and 2D 1H NMR spectra and explain their importance in the identification of the structure and conformation of biologically active molecules and analyze 1H NMR spectra of peptides /small proteins.
- Interpret NMR spectra of other biologically important nucleus (13C, 19F and 31P NMR) and explain their importance in the identification of the structure and conformation of biologically active molecules.
- Describe the basic concepts of Supramolecular Chemistry and explain the Principles of Molecular Recognition and analyze the type of interactions taking place during the formation of Supramolecular entities.
- Explore the conformational space of bioactive molecules in solution and in combination with their receptors.
- Design rationally novel and potent bioactive molecules with improved pharmacological properties.
- Apprehend the three-dimensional crystalline and molecular structure of various materials: chemical/pharmaceutical molecules and biomolecules (proteins, DNA, RNA, complexes, viruses).
- Use databases for extracting structural information as well as bioinformatics programs.

General Competences

By the end of this course the student will, furthermore, have developed the following skills (general abilities) related to the areas of NMR Spectroscopy, Supramolecular Chemistry, Computational Medicinal Chemistry and X- ray analysis:

1. Ability to exhibit knowledge and understanding of the essential facts, concepts, theories and applications which are related to the above areas.

2. Ability to apply this knowledge and understanding to the solution of problems related to the above areas.
3. Ability to adopt and apply methodology to the solution of non-familiar problems.
4. Study skills needed for continuing professional development.
5. Ability to interact with others in chemical or of interdisciplinary nature problems.

Generally, by the end of this course the student will, furthermore, have develop the following general abilities:

- Searching, analysis and synthesis of facts and information, as well as using the necessary technologies
- Adaptation to new situations
- Decision making
- Autonomous (Independent) work
- Group work
- Exercise of criticism and self-criticism
- Promotion of free, creative and inductive thinking
- Work design and management

3. SYLLABUS

NMR

Basic information in the spectra of Nuclear Magnetic Resonance (NMR). Multiple-pulse sequences and their utility. 2D NMR spectra (J-Resolved, COSY, TOCSY, HSQC, HMQC, HMBC, NOESY, ROESY). Applications of 2D-NMR spectroscopy in the conformational analysis of aminoacids, proteins and other biaoactive molecules.

Active nulceus in NMR and their characteristic properties (abundance, gyromagnetic ratio, nucleus spin). NMR ^{13}C, ^{19}F και ^{31}P: Fully and partially decoupled spectra, chemical shifts, and coupling constants. Heteronuclear NMR and integration. Examples of NMR spectra in compounds of biological interest: a) ^{13}C NMR, ^{19}F NMR and ^{31}P NMR, b) ^{1}H NMR and ^{13}C NMR in compounds containing fluorine or/and phosphorus atoms.

Supramolecular Chemistry

Introduction to Supramolecular Chemistry.

Molecular Recognition. Types of Intramolecular interactions and Structural Complementarity. Factors affecting the structure and conformation of the Host-Guest Supramolecule. Examples of the most common Molecular Receptors and their structures.

Application of Supramolecular Chemistry (Biomimetic Systems, Self-Assembly Systems).

Computational Medicinal Chemistry (Design of Bioactive Molecules)

i) Molecular graphics, ii) Conformations of peptides and proteins. Molecular surfaces, iii) Potential energy surfaces, iv) Basic principle of Molecular Mechanics, v) Energy minimization methods. Examples and Applications.

Explore of conformational space of bioactive molecules: i) Monte Carlo method, ii) Grid-Scan method, iii) Molecular Dynamics method. Examples and Applications.

Principles of rational design of bioactive molecules based on receptor-substrate complex: i) Development of receptor homology model, ii) Explore of receptor active site, iii) Determination of pharmacophore groups, iv) Docking studies v) Optimization of a bioactive structure. Examples and

Applications.
Rational design of peptidomimetics molecules: i) Basic principles for depeptidize, ii) Examples and Applications.

X-ray Structure Analysis

- Determination of the three-dimensional structure of crystalline compounds by X-ray diffraction - The electron density function ρ(x, y, z).
- Structure of chemical/pharmaceutical molecules. Structural and functional characteristics of biomolecules (proteins, DNA, RNA, complexes, viruses).
- Qualitative-quantitative analysis by X-ray diffraction of polycrystalline materials.
- Utilizing databases to extract structural information. Principles of bioinformatics.
- Principles, instruments, applications, results.

4. TEACHING and LEARNING METHODS – EVALUATION

DELIVERY	Face-to-face.
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY	Use of powerpoint presentation in teaching.
TEACHING METHODS	***Activity*** | ***Semester workload* (contact hours)** Lectures | 28 Final examination | 3 Student's study hours for learning activity | 94 ***Course total (25 work load for each ECTS credit)*** | ***125***
STUDENT PERFORMANCE EVALUATION	**1.** Written examination after the end of the semester. Minimum passing grade: 5/10. Greek grading scale: 1 to 10. Minimum passing grade: 5. Grades ≤ 3 correspond to ECTS grade F. Grade 4 corresponds to ECTS grade FX. For the passing grades the following equivalence normally holds with the ECTS passing grades: 5 = E, 6 = D, 7 = C, 8 = B and ≥ 9 = A **2.** Greek language is used. For foreign students (e.g. Erasmus students) it can be done in English. **3.** Oral examination will be possible in certain cases (students certified that cannot participate in written examinations) at the same day and time with that of the exam.

5. RECOMMENDED LITERATURE

- Suggested bibliography:

NMR

1. T. Mayromoustakos, I. Matsoukas, "NMR: Principles and applications of Nuclear Magnetic Resonance in Medicine, Medicinal Chemistry, Biochemistry, Food Chemistry", 1st Edition, G.B.

Parisiannos, 2006. (In Greek language only).

2. H. Friebolin, "Basic One- and Two-Dimensional NMR Spectroscopy", 3rd Revised Edition, Wiley-VCH, 1998.

3. Notes of lecturers in Greek.

Supramolecular Chemistry

1. J.-M. Lehn, "Supramolecular chemistry: concepts and perspectives", 1st Edition, VCH, 1995.

2. Notes of lecturers in Greek.

Computational Medicinal Chemistry (Design of Bioactive Molecules)

1. T. Mavromoustakos, P. Zoumpoulakis, "Molecular Modelling: Applications in Organic and Pharmaceutical Chemistry", 1st Edition, G.B. Parisiannos, 2008. (In Greek language only).

2. R.M. Silverstein, F.X. Webster, D.J. Kiemle, "Spectrometric Identification of Organic Compounds", 7th Edition, John Wiley & Sons, 2005.

3. A.R. Leach, "Molecular Modelling: Principles and Applications», 2nd Edition, Prentice Hall, 2001.

4. Notes of lecturers in Greek.

X-ray Structure Analysis

1. J.P. Glusker, M. Lewis, M. Rossi, "Crystal Structure Analysis for Chemists and Biologists", 1st Edition, VCH Publishers, Inc., New York, 1994.

2. G.A. Petsko, D. Ringe, "Protein Structure and Function", 1st Edition, New Science Press, 2004.

3. S.M. Allen, E.L. Thomas, "The Structure of Materials", 1st Edition, John Wiley & Sons, 1998.

Notes of lecturers in Greek.

- Related academic sources and journals:

All scientific articles used in teaching are available.