UNIVERSIDADE DA CORUÑA USC UNIVERSIDADE DE SANTIAGO DE COMPOSTELA Universidade de Vigo

Master in Chemical Research and Industrial Chemistry

CHEMISTRY OF BIOMOLECULES

Course Guide

2014-15

1. Subject Description

Character: Optative

Call: First quarter

Credits: 3 ECTS

Teaching staff:

José Luis Mascareñas Cid
Professor in Organic Chemistry
Departamento de Química Orgánica,
Centro Singular de Investigación en Química Biolóxica e Materiais Moleculares (CiQUS)
Universidade de Santiago de Compostela
Lectures, seminars and tutorials

Juan Carlos Estévez Cabanas
Associate Professor in Organic Chemistry
Departamento de Química Orgánica,
Centro Singular de Investigación en Química Biolóxica e Materiais Moleculares (CiQUS)
Universidade de Santiago de Compostela
Lectures, seminars and tutorials

Miguel Vázquez López
Associate Professor in Inorganic Chemistry
Departamento de Química Inorgánica
Centro Singular de Investigación en Química Biolóxica e Materiais Moleculares (CiQUS)
Universidade de Santiago de Compostela
Lectures, seminars and tutorials

Carlos Jiménez González
Professor in Organic Chemistry
Departamento de Química Fundamental,
Facultade de Ciencias
Universidade de A Coruña
Lectures, seminars and tutorials

María del Carmen Rodríguez Argüelles
Associate Professor in Inorganic Chemistry
Departamento de Química Inorgánica,
Facultade de Química
Universidade de Vigo
Lectures, seminars and tutorials

Language: Spanish or English

2. Status, meaning and importance of the subject in the Master degree

2.1. Module to which the subject belongs in the Master. Related subjects.

Module 2: "*Chemical Biology*". It is mainly related to the subjects of this module.

2.2. Role of this subject in this module and in the Master

This material is intended for students to acquire a thorough understanding of the structure, function and applications of the major biomolecules, mainly proteins, carbohydrates and nucleic acids. It starts from the idea that students have enough knowledge of chemistry to understand various aspects of the molecular behavior of different types of biomolecules. The course will not only deal with structural aspects and the different biological functions of biomolecules, but the study on the different synthetic strategies for their manipulation will also be addressed, as well as the techniques used to modulate and / or modify their biological activity in order to get new tools in biomedical research.

2.3. Prior knowledge (recommended/required) that students must have to study the subject

It is recommended to have previously completed the subject "Chemistry of Biomolecules". Basic knowledge in the visualization of the three dimensional structure of biomolecules using programs such as Pymol, Mercury, etc. will also be needed. Management of databases such as Protein Data Bank (PDB), Expasy, etc. is also recommended.

3. Learning objectives and skills to be achieved by the student with the subject

3.1. Learning objectives

- Acquisition of advanced knowledge in the chemistry of the most important biomolecules (proteins, nucleic acids and sugars).
- Learning of the biogenetic rules and the function of biomolecules.
- Learning the more relevant aspects related to the isolation and characterization of biomolecules as well as their synthetic manipulation.
- Learn the main applications, mainly as modulators of cellular activity and therefore as tools in biomedical research.

3.2. General skills

- Acquire a general knowledge that provides for originality in developing and/or applying ideas, often within a research context.

- The students should apply their knowledge and ability to solve problems in new or unfamiliar environments within broader (or multidisciplinary) contexts related to their field of study.
- The students should be able to communicate their conclusions, and the knowledge and the reasons that support them to specialists and non-specialists in a clear and unambiguous manner.
- The students should acquire the learning skills to allow them to continue studying in a way that will have to be largely self-directed or autonomous.
- Identify information from scientific literature by using appropriate channels and integrate such information to raise and contextualize a research topic.
- Use the scientific terminology in English to explain the experimental results in the context of the chemical profession.
- Apply correctly the new technologies of gathering and organization of the information to solve problems in the professional activity.

3.3. Specific skills

- Define concepts, principles, theories and specialized facts of biomolecules.
- Propose alternatives for solving chemical problems related to the behavior of the most important biomolecules.
- Apply materials and biomolecules in innovative fields of industry and chemical engineering.
- Innovate in the methods of synthesis and chemical analysis of biomolecules.
- Understand the chemical basis of biological processes.
- Promoting innovation and entrepreneurship in the chemical industry and in research.

3.4. Transversal skills

Ability to work in groups on both the resolution and the discussion of problems.

4. Contents

4.1. Sections

Chapter 1. Introduction and historical aspects. Basic structure and functions of cells. Most important biomolecules.

Chapter 2. Peptides and proteins. Structural aspects. Synthesis and modification. Design of functional proteins. Metalloproteins: types, methods of study, examples and applications.

Chapter 3. Nucleic acids. Structural aspects. Synthesis and analysis techniques. Interactions with other nucleic acids. Interactions with small molecules. Interactions with metals. Interactions with proteins and peptides.

Chapter 4. Carbohydrates and their derivatives. Structural and synthesis. Glycoconjugates and its role in cellular communication. Glycocode. Glycotherapy.

4.2. Recommended bibliography

1.- Molecular Biology of the Cell, B. Alberts et all, Garland Science, 2002

2.- Introduction to Bioorganic Chemistry and Chemical Biology. Vranken, D-V; Weiss, G.A. Garland Science 2012

3.- Nucleic Acids in Chemistry and Biology. Blackburn, M.: Gait, M.J.; Loakes, D.; Williams, D.M. (Editors). Rayal Society of Chemistry, 2006

4.- Peptides: Synthesis, Structures and Application. Gutte, B. Academic Press,.1995

5.- Introduction to Protein Structure. Brändén, C-I; Tooze, J. Garland Science 1999.

6.- Glycochemistry, Principles, Synthesis and Applications. Ed. Peng G. Wang, C. R. Betozzi. Marcel Dekker, New York, 2001.

7.- Concepts and Models in Bioinorganic Chemistry. Karls, R

8.- Metal Complex-DNA Interactions. Hadjiliadis, N.; Sletten, E. (Editors), Wiley, 2009.

9.- The Molecular and Supramolecular Chemistry of Carbohydrates. A chemical introduction to glicoscience. D. Serge. Oxford Science publications, 1997

10.- Introduction to Glycobiology. Taylor, M.E.; Drickamer, K. Oxford University press. 2011

11.- Carbohydrate Chemistry. Davies, B.G.; Fairbanks. A.J. Oxford Science publications, 2004

12.- Glycoscience, Synthesis of Substrate Analogs and Mimetics. Driguez, H; Thiem, J. Springer-Verlag, New York, 1997.

13.- Bioinorganic chemistry, inorganic elements in the chemistry of life: an introduction and guide. Kaim, W. Schwederski, B.,Klein, A. 2º ed. John Wiley, Chichester , 2013

Crichton, R.R.. Biological Inorganic Chemistry. An Introduction. Elsevier, Amsterdam, 2008

CHAPTER 1. Introduction and historical aspects. Basic structure and functions of cells. Most important biomolecules.

1. Introduction

The goal of this section is placing the student in the field trying to relate the structure and function of cells with the different biomolecular components.

2. Contents

Different components of the cell. Organization. Structure and function of main biomolecules.

3. Bibliography

Molecular Biology of the Cell, B. Alberts et all, Garland Science, 2002

4. Activities

Team working activities.

CHAPTER 2. Peptides and proteins. Structural aspects. Synthesis and modification. Design of functional proteins. Metalloproteins: types, methods of study, examples and applications

1. Introduction

The goal is that the students acquires the most important aspects of the structure and function of proteins and describe how they can be synthesized and modified using chemical or biological methods.

2. Contents

Amino acids and peptides. Proteins and functions. Primary, secondary, tertiary and quaternary structure. Biosynthesis. Chemical synthesis. Modification by chemical methods. Metalloproteins and synthetic models. Applications.

3. Bibliography

Peptides: Synthesis, Structures and Application. Gutte, B. Academic Press, 1995

Introduction to Protein Structure. Branden, C-I; Tooze, J. Garland Science 1999.

Concepts and Models in Bioinorganic Chemistry. Kraatz, H.-B.; Metzler-Nolte, N. (Editors), Wiley-VCH, Weinheim, 2006.

4. Activities

Exercises on the construction of proteins using synthetic laboratory techniques. Group discussion of research articles related to the proposed headings.

CHAPTER 3. Nucleic acids. Structural aspects. Synthesis and analysis techniques. Interactions with other nucleic acids. Interactions with small molecules. Interactions with metals. Interactions with proteins and peptides

1. Introduction

This is to acquaint the student with the most important aspects of the structure and function of the different nucleic acids, and how they can be prepared and manipulated by chemical and biological methods.

2. Contents

Structure of nucleotides. Structure and function of the different nucleic acids. Supramolecular chemistry of nucleic acids. Biosynthesis. Synthesis and manipulation of nucleic acids by chemical methods. Interaction with small molecules, proteins and metal complexes.

3. Bibliography

Nucleic Acids in Chemistry and Biology. Blackburn, M.: Gait, M.J.; Loakes, D.; Williams, D.M. (Editors). Rayal Society of Chemistry, 2006

Metal Complex-DNA Interactions. Hadjiliadis, N.; Sletten, E. (Editors), Wiley, 2009.

4. Activities

The student will have to perform the exercises related to the chapter indicated by the professor on the date indicated in the subject activity schedule. In the seminars, students will solve the proposed exercises and questions and carry out oral presentations of papers, reviews etc. Those students who have difficulties with the exercises of the chapter should contact with the teacher during the tutorial schedule to receive the necessary support.

CHAPTER 4. Carbohydrates and their derivatives. Structural and synthesis. Glycoconjugates and its role in cellular communication. Glycocode. Glycotherapy

1. Introduction

It will begin with a brief introduction on the monosaccharides, described either as oligosaccharides and polysaccharides, studying in detail their nomenclature, structure, methods of structural determination, methods of chemical synthesis, biological synthesis and its main applications. Monosaccharides derivatives are also small study: glycosides and glycosidase inhibitors; incidence, synthesis and applications. Finally, we will consider the glycoconjugates: glycoproteins and glycolipids was. The concept and current knowledge on the glycocode and glycoconjugate applications in medical therapy.

2. Contents

Monosaccharides, nomenclature, structure and chemistry. Oligosaccharides and polysaccharides, nomenclature, structure. Structural determination of oligo-and polysaccharides. Biosynthesis, chemical synthesis and biological synthesis of oligosaccharides. Glycosides and glycosidase inhibitors: types, incidence in nature, methods of synthesis and biological applications. Glycolipids. Types of structures. Natural incidence. Biosynthesis. Functions. Glycoproteins. Types of structures. Natural incidence. Biosynthesis. Functions. The glycocode concept. Future prospects and scope thereof. Glycotherapy and Glycoconjugates known functions.

3. Bibliography

Glycochemistry, Principles, Synthesis and Applications. Ed Peng G. Wang, C. R. Bertozzi. Marcel Dekker, New York, 2001

Introduction to Glycobiology. Taylor, M.E.; Drickamer, K. Oxford University press. 2011

Glycochemistry, Principles, Synthesis and Applications. Ed Peng G. Wang, C. R. Betozzi. Marcel Dekker, New York, 2001

Glycoscience, Synthesis of Substrate Analogs and Mimetics. Driguez, H; Thiem, J. Springer-Verlag, New York, 1997

The Molecular and Supramolecular Chemistry of Carbohydrates. A chemical introduction to glicoscience. Serge D.. Oxford Science Publications, 1997.

4. Activities

Solve exercises related to the topic indicated by the teacher and deliver on the date indicated on the calendar of activities of the subject (the student should keep a copy of submitted work). In the entries for this topic seminar, students will solve these exercises on the blackboard.

Those students who have particular difficulty with the exercises performed in this area should contact the hours of tutoring with the teacher to receive the necessary support.

5. - Methodological guidelines and ECTS credits assignment

5.1. ECTS credits assignment

CLASSROOM WORK	HOURS	PERSONAL WORK	HOURS
Lectures in large groups	12	independent, individual or in a group study	29
Interactive class in small groups (Seminars)	7	Oral presentation of papers and exercises proposed by the teacher	21
Interactive class in very reduced groups (Tutorials)	2	Preparation of oral presentations, resolution of proposed exercises. Library work or similar.	4
Total classroom work hours	**21**	**Total personal work hours**	**54**
		Total hours	**75**

5.2. Training activities in the classroom

A) *Lectures in large groups* ("L" in the timetable): It will be held 12 sessions of lectures in one group where the theoretical contents of the course will be associated with illustrative examples. It will consist mainly in PowerPoint presentations. Copies of these presentations will be available for the students in advance via the virtual campus of the course. This will allow the students to study ahead the contents of the course and to facilitate the monitoring of explanations.

B) *Interactive class in small groups* (*Seminars*, "S" in the timetable): 7 sessions in small group seminars where students will present the work proposed by the professor followed by a discussion section. Students will have in advance the proposed exercises and papers via the virtual campus of the course. Attendance at these classes is mandatory.

D) *Interactive class in very reduced groups (Tutorials,* "T" in the timetable): Tutoring scheduled by the professor and coordinated by the Centre. It will be 2 hours per student and will involve the supervision of proposed work, clarifying doubts, etc. Attendance at these classes is mandatory.

5.3. Recommendations for the study of the course

- Lecture attendance is more than recommended.

- It is essential to keep the study of course up to date.
- After the reading of a chapter in the reference manual, it is useful to summarize the key points (see summary of important concepts in the Reference Manual).
- Reading the specific biography for each chapter is encouraged for a better understanding of the key concepts.

5.4. Schedule

Noviembre 2014	Lunes	Martes	Miércoles	Jueves	Viernes
16-18 h	3	4	5	6	7
16-18 h	10	11	12	13	14
16-18 h	17	18			

	Lectures
	Seminars
	Tutorials
	Holidays

6. Evaluation

6.1. Evaluation procedure

The evaluation of this course will be done by means of the continuous assessment and completion of a final exam. Access to the exam will be conditioned on the participation in at least 80% of the mandatory classroom teaching activities (seminars and tutorials). Continuous assessment (N1) will be 40% of the qualification and will consist of two components: interactive class in small groups (seminars) and interactive class in very small groups (tutorials). Seminars and tutorials include the following: resolution of exercises and practical cases (15%), realization of homework and reports (10%), oral presentations [(papers, reviews and practical cases), 10%] and oral questions during the course (5%).

The final exam (N2) will cover all the contents of the course.

The student's score will result of applying the following formula:

Final score = 0.4 x N1 + 0.6 x N2

N1 and N2 are the marks corresponding to the continuous assessment (0-10 scale) and the final exam (0-10 scale), respectively.

The repeaters will have the same system of class attendance than those who study the course for first time.

6.2. Recommendations

The students should review the theoretical concepts introduced in each chapter using the reference manual and the material provided by the professor. Those students, which have significant difficulties when working the proposed activities, should contact with the professor during the tutorials, in order to analyze the problem and to receive the necessary support.

The professor will analyze with those students who do not successfully pass the evaluation, and so wish, their difficulties in learning the course content. Additional material (questions, exercises, tests, etc..) to strengthen the learning of the course might be also provided.